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Protective Measures

In the citrus groves of California, plump and colourful fruits ripen in the sunlight that pours upon them—fruit from trees free from the attack of *Tylenchulus semipenetrans*, a pest found wherever citrus is grown. Where the citrus nematode is uncontrolled it restricts root and shoot growth, weakens trees and reduces the size and yield of fruit—damage often referred to as "slow decline". Replanting does not help, for *it is the soil itself that is infested.*

Consequently, California fruit-growers have given a ready welcome to Nemagon, the Shell soil fumigant that can be used after planting as well as before. Applied at low dosage rates around the roots of bearing trees, Nemagon has effectively controlled the citrus nematode and increased fruit yields by up to 20 per cent.

This story has been repeated in other parts of the world on grape, strawberry, olive, peach, walnut, fig, banana, pineapple and many ornamental crops, all of which have benefited from Nemagon. Ask your Shell Company for full details of this and the other Shell pesticides. **Nemagon** *Trade Mark*

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YOU CAN BE SURE OF SHELL **CHEMICALS**

THE UTILISATION OF APPLES*

By V. L. S. CHARLEY

(*Beecham Foods Ltd., Coleford, Glos.*)

Introduction

IT has long been a commonplace to remark that the various apple-growing areas of the world are subject to a series of gluts and shortages which, although they follow no definite pattern, unfailingly present the grower with problems of a very acute nature with reference to the overall economic disposal of the fruit which he has grown. The National Farmers' Union have paid distressingly regular attention to this problem, with particular reference to the utilisation of low-grade, or cull, fruit during the past twenty years, and the very considerable increases in tonnage of apples expected to accrue from the new plantations in the next few years has necessitated a new attack on the problem. The papers, of which the more technical aspects are summarised below, had as their object the bringing of the knowledge of the utilisation pattern of the apple in the rest of the world before food processors in Great Britain.†

During the next ten years vastly increased tonnages of apples are to be expected, which will bring marketing problems in the utilisation of the whole crop. The food manufacturers of Great Britain could well pay attention to the efforts of other countries to utilise their apple crops economically in view of the considerable surpluses which may be thrown on the market in a normal year if grading regulations are enforced or voluntarily tightened up.

The raw material

The unfortunate feature, from a processing point of view, of the chemical composition of apple tissue is its water content of about 84%. The storage of apple products without removal of any water is economically unsound, and herein lies the main problem in apple utilisation, i.e., the removal of water without simultaneous reduction in quality of the final product. The 10–12% of soluble sugars are composed mainly of fructose, glucose and sucrose ; cellulose and pectic substances in the cell walls contribute to the texture of the flesh, and have a real importance in terms of the viscosity of products derived from the fruit. Dried products are hygroscopic, by reason of the presence of sugars and hydrophilic colloids. The presence of these materials has some disadvantages, but the water-holding properties of some apple products can have advantages in the conditioning of mixed products (e.g., during the last war, concentrated apple juice was used as an ingredient in bread to prevent too early staling). The other constituents of the apple are organic acids, polyphenols, amino-acids, vitamins, enzymes and volatile components responsible for the aroma of the apples. A number of specialised uses for apple materials have been devised from time to time. The author, with Dr. Pollard and a colleague, prepared malic acid (or calcium malate) at the Long Ashton Research Station at the beginning of the last war for the specific purpose of providing a supply of a monohydroxy dibasic acid which was needed for the treatment of copper pipes previous to their being dipped in shellac. This process at the time had a very real interest, but other sources of malic acid are now available, and it is unlikely that the surplus apple position will be solved by the application of specialised processes of limited application. It is by the widespread utilisation of apples in products which can be purchased by the whole range of the purchasing public that large tonnages of fruit will be taken off the fresh fruit market.

Apple juice

The apple products utilised and produced in Europe are chiefly the juice and concentrate, which are sold in very large quantities to the inhabitants of the producing countries and exported beyond the Continent itself. The use of concentrate is particularly valuable for conserving the juice from a heavy glut crop over a period of 2 or 3 years until a period of shortage returns. Mention should be made of the fermented products produced from the apple in Europe, such

* A précis of papers read by C. P. Norbury, A. Pollard, G. Borgstrom and R. P. Walrod at a joint meeting of the Food Group, Commonwealth Fruits Council and National Farmers' Union, 10 June, 1959

† For a full generalised report of the papers and discussions see *Chem. & Ind.*, 1959, p. 1112.

as cider, cider brandy (Calvados) and industrial alcohol. In general, however, these products are produced from the genuine cider apple with bitter-sweet characteristics, and the surplus apple problem does not really extend to this type of fruit.

In addition to these juice products, the Continental countries make a wide variety of apple pulps, jams, jellies, confectionery bases (either apple or blended with other fruits), pectins of various setting values, and, of course, animal feeding stuffs from the fruit residues after the pectin has been extracted.

There would seem to be little doubt that the United Kingdom is behind the rest of Europe in its utilisation of apples, but there are signs of an awakening consciousness on the part of some food manufacturers of the value of many of the English varieties of apples as raw materials for a wide variety of attractive foodstuffs.

A new technique for the preparation of spray-dried powders, the Birs process, is being successfully applied on the Continent, and since it includes a method of returning the volatile components to the dried powder, the ultimate product appears to be highly promising.

The apple juice developments on the Continent were much publicised before the war, and since 1948 the production figures have leapt upwards both in Germany and Switzerland. In recent years variations in technique have been introduced on the North American continent, and will be referred to later.

Probably the most important scientific contribution made to apple juice processing since the Böhi pressure system of storage was introduced, is the latest procedure for the separation and fractionation of the volatiles from the juice. This process, in earlier years, had been attempted at the same vacuum as was used for the main stage of the evaporation process. Unfortunately, the condensation of the volatiles in this case was extremely inefficient. The latest process involves the removal of the volatiles at atmospheric pressure, with consequent extra efficiency in the recovery of the fractionated volatiles. These materials can be concentrated up to a figure many thousands of times greater than their concentration in natural juice, and even at a concentration of 150-fold are extremely stable at temperatures below 10° C for several months and at 0° C for 2 or 3 years.

Apple utilisation in U.S.A.

In the U.S.A., apparently no less than 35% of the total apple crop of approximately 2,000,000 tons is utilised in the manufacturing of various categories of foodstuffs. The utilisation pattern, expressed as percentage of the total fruit processed in the years 1954–56, was as follows:

Sauce and baby food	33
Slices	16
Frozen	7·5
Dried	10
Juice	26
Vinegar	7·5

Canned products

The most important American canned apple product is sauce, which is produced with chunks or as a purée. The production of the former type of sauce calls for a most careful choice of fruit in order to get the highest yield of canned product per ton of original fruit. An important item in this search for efficiency is a peeling method involving the least loss of fruit tissue, and flame peeling or the use of electric furnaces is being seriously attempted to this end. Although these methods completely char the outer layers of the epidermis, this material can be removed by combination of abrasion, brushing or washing.

Dehydro-canning is a valuable new type of process in which the apple pieces are soaked in a solution of salt with fruit acid, washed clean from these additives, and dried to 35–70% of water before canning (see U.S.P. 2,784,059).

Pie fillings are produced on a very large scale from a variety of fruits, but with the apple product predominating. A suitable recipe for such a product would be as follows:

Apples	30 lb.	Nutmeg	½ oz.
Water	12 lb.	Cinnamon	½ oz.
Sugar	6 lb.	Lemon purée	1¾ oz.
Starch	1 lb.		

Frozen products

The second world war placed a new emphasis on the freezing of foodstuffs. In the United States apples ranked third to strawberries and cherries among individual fruits preserved by freezing. The apple pie is the most favoured dessert in America, and ready-made frozen pie fillings have been on the market for some years. The frozen fruit pie industry is a major section of the frozen prepared foods market, and apple pies are again the clear leaders in this line of foodstuffs.

Apple juice

Although apple juice falls far behind citrus, tomato and pineapple products, its production in America utilises a very large tonnage of apples. The product is often transported in bulk from the apple-growing areas to States where supplies are not so readily available. The apple has shown itself to be a most accommodating product in that it can be blended in a most satisfactory fashion with other fruits (cherry, cranberry, lime and apricot) without diminishing to any marked extent the characteristic flavour of the other constituent of the blend.

Dehydrated products

Very large tonnages of apples are dehydrated in the United States each year. Such apple products should have a moisture content not exceeding 3%, whereas dried or evaporated apples may have a water content of about 27%. Apple flour, produced by grinding dehydrated apples, is produced in limited quantities for therapeutic uses, mainly in the treatment of diarrhoeas. Other forms of powders have been produced experimentally by the puff-drying of concentrates in vacuum. Such powdered products store without deterioration for at least one year at 73° F and for 6 months at 100° F when packed in 4-oz. cans with a desiccant. These experimental powders were prepared from blended concentrates of 75–80° Brix, dried in a vacuum shelf-dryer and ground to 10-mesh size. Each can contains 95 g. of powder, and an envelope of tough paper containing 9 g. of pelleted calcium oxide as a desiccant.

Apple chips and apple crisps have both been produced on a small scale. The first-mentioned are small pieces of apple tissue oven-dried and packed in bags. The crisps are fat-fried and are more fluffy. No major effort has yet been made to introduce them on a wide scale to the American public.

It is possible to remove half the available water in apple slices before freezing, and thus to reduce transport costs without deterioration of the quality of the reconstituted slices. The product is known as dehydro-frozen apple slices, and the institutional market has been purchasing more and more of this product recently.

Apple processing in Canada

In the Okanagan Valley (British Columbia) there are a number of factories responsible for processing the whole of the surplus fruit produced by the apple growers. Three groups of product are obtained.

First group of products

This group includes those products which could be expected to give a yield to the grower equal to, or better than, their cost of production. Such products are canned apples, apple sauce and frozen apples. The solid pack canned apples are largely used by institutions, and a very large quantity is made each year. Apple sauce continues to gain in popularity, due, probably, to a steady improvement in quality, occasioned by better processing techniques and more careful selection of raw material. For apple sauce it is essential to make a careful choice of the correct apple in order to achieve the correct sugar/acid balance.

Canned ready-to-use pie fillings have been available to the Canadian housewife for several years, but have often been subject to rapid deterioration in storage due primarily to unsuitability of the ingredients. The Food Products Laboratory at the Summerland Research Station under Mr. F. E. Atkinson recently developed a variety of pie fillings with a fruit content of 70–80% in which the problems of stability were largely overcome. These methods have been successfully adapted to commercial production. The possibility of exploiting pie fillings made

from apples with other fruits is very much in mind, and consumer research work is constantly in progress to assess the value of various experimental products.

The Canadian consumer has shown definite preference for apple pies which carry whole pieces of fruit. One of the problems encountered in the manufacture of apple pie filling is that of retaining whole segments of fruit through the processes of blanching, mixing with other ingredients, cooking, filling, processing, cooling and ultimately baking by the housewife. The difficulty appeared to originate at the point of blanching where cell rupture was thought to be caused by expansion of inter-cellular gases during rapid heating.

While the use of vacuum in the pre-treatment of apples for canning is not entirely new, the particular apparatus which was developed in British Columbia to solve the foregoing problem, is original in many respects. The unit consists of four stainless steel pressure-vacuum chambers which operate independently but which are serviced by a common feed and common discharge. The treatment is actually a batch process, but by rotating the operation through four units the result is that of a continuous material flow through the production line. The four chambers are filled in sequence with prepared apple sections. When a chamber is full the vessel is closed and the process taken over by a cyclomatic control. This first draws a vacuum of 27·5 in. for a pre-set period of time, which may be varied for the variety and maturity of the fruit. In from 6 to 9 min. inter-cellular gas pressures reach equilibrium within the chamber. At this point steam is introduced and the vacuum cut. By this method desired temperatures for enzyme inactivation are more quickly reached. The vacuum-blanched apples are then discharged into a surge hopper, from which a constant flow into the production line is maintained by means of a syntron vibrator. The end bells of the chambers, both top and bottom, are activated by pneumatic pistons. In 1958 one of the largest processors in Nova Scotia installed a six-chamber unit of the B.C. design.

Second group of products

Products in this group normally return to the grower only half the cost of production. These products include dehydrated apples, two types of apple juice, apple juice blends, frozen concentrates and cider. The dehydration process has been developed in Canada by the use of a continuous method of curing dried apples. A large drum 8 ft. in diameter and 20 ft. long rotates at 3 r.p.h. The dried fruit is conveyed directly into the drum through a port in the centre of one end. Concurrently, a simple pick-up device feeds the cured product directly on to a conveyor feeding the packing line which emerges from a similar port in the discharge end. This labour-saving method of continuous curing has an additional advantage of facilitating the introduction of sulphur dioxide. A blanket of the gas can be readily maintained at high concentrations in the drum from a metered external supply, and is readily absorbed by the constantly moving fruit to concentrations as high as 2000 p.p.m.

The Canadian workers at Summerland were responsible for the initial introduction of the opalescent apple juice by means of the addition of ascorbic acid. This product retains an extremely fresh apple character. A whole range of blends of apple with lime, apricot and other juices has been prepared, and the apricot product has found wide consumer acceptance in a relatively short time. In exactly the same way, baby food juice blends can be produced.

The Canadian growers have also produced, in association with the Summerland Research Station, a very attractive type of light, sparkling cider from their surplus fruit, and it seems likely that, with suitable publicity, this product will make a substantial contribution to the utilisation of their surplus apples.

Third group of products

Products in this group are the least attractive from an economic point of view. Dried pomace can be produced from the residue left after the juice has been pressed from the milled fruit. Again, apple juice concentrate is made, particularly in Nova Scotia, with special plant designed to evaporate the juice with a minimum of caramelisation in a plant in which the heating time is approximately 45 sec.

Apple pectin can be prepared from the pomace, and a range of apple confections made from such pectin help to provide an outlet for a raw material produced from a by-product of the apple juice factories.

THE UTILISATION OF CITRUS FRUIT*

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Introduction

THE cultivation of citrus fruits has increased tremendously in the past 30 years and world production in 1957 was estimated to be about 15½ million tons, compared with some 8½ million tons for the years immediately prior to the outbreak of the last war. Most of the increased output has been in oranges and, in 1957, world production of oranges was estimated at over 12½ million tons, that of grapefruit just over 1½ million tons, and of lemons 1¼ million tons. Although much of the fruit is consumed fresh, increasing attention is now being given to the utilisation of citrus fruit in processed products in order to market effectively the expanding world production. The United States produces over 40% of the world's total supplies of citrus fruit. Important producing countries are, India, the Union of South Africa, Australia, the West Indies and Cyprus. The oldest centre of the manufacture of citrus products is Italy, and later the West Indies, with its lime juice industry, became important. In the United States, the first plant for processing citrus fruit was erected at National City, Cal., in 1899. Since that date citrus processing in the United States has developed steadily, particularly in Florida, and that country is now the foremost centre for the utilisation of citrus fruit.

In contrast with grape and apple products, the large-scale production of citrus products has been a comparatively recent development, partly because it is only in the last three decades or so that the general public has become conscious of the nutritional value of citrus fruit and citrus juices. It is also due to the fact that while many fruits, such as apples and grapes, have a thin skin and a stone or pips, citrus fruits are more complex in structure. They are covered with a comparatively thick rind or peel, which encloses the pulp or edible portion of the fruit. The rind is made up of a cuticle on the outside, thinly covering an epidermal layer (the flavedo) in which numerous oil sacs, or glands, occur containing an aromatic essential oil. Beneath the flavedo is found white spongy tissue known as the albedo. This layer contains approximately 20% of pectinous substances, of which a proportion may be recovered in the form of citrus pectin. The inner pulp or flesh of the fruit consists of segments, which contain numerous spindle-shaped juice sacs and sometimes many seeds.

From this it can be seen that while many fruits can be easily crushed in a pulper or hydraulic press to obtain the final products, the processing of citrus fruits presents technical problems, due to the necessity of separating the widely different components.

Originally only cull fruit was utilised for citrus products, i.e., fruit which is sound, but because of off-size or peel blemishes is not suitable for the fresh-fruit market. Today, the processing of citrus products is an essential part of the industry and in some countries provides the main outlet for the crop. For example, in Jamaica, of fruit handled by the Citrus Growers' Association in the 1957/58 season, 82% of the sweet oranges, and 79% of the Marsh/Duncan grapefruit crop was processed. Even in the United States, although there is a large domestic market for fresh fruit, during the same season over 63% of the oranges produced were processed, about 48% of the grapefruit and about 37% of the lemons; indeed without citrus products the great expansion in world citrus production that has occurred, and is continuing, could not have been successfully absorbed.

In this paper a brief review is made of the production of the major citrus products and some of the minor ones, although processing techniques can only be considered in very generalised terms. The main principle in the organisation of a citrus products industry is the complete utilisation of the whole fruit, but many factories, particularly in the lesser developed citrus-producing countries, do not achieve this, since there are not the technical resources that are available in the United States. In that country, with its large domestic market, citrus processing

* Read at Joint Meeting of the Food Group, the Commonwealth Fruits Council and the National Farmers' Union, 10 June, 1959

is highly organised and there are many research laboratories working on and improving existing processing techniques and developing new outlets for citrus fruit.

Quality control in the preparation of citrus products is of paramount importance, and several producing countries have found it necessary to develop comprehensive standards for citrus products prepared for direct consumption.

Here, the utilisation of citrus fruits is divided into two broad categories, the products such as juices and canned segments which are obtained from the edible pulp or flesh of the fruits, and the by-products which are derived from the peel, albedo or pulp and are obtained usually after juice has been extracted.

Juice products

Juices—the most important product obtained from citrus fruit—may be canned, frozen or chemically preserved, either as natural-strength juice or after concentration. The present annual production of citrus juices in the United States is estimated to be over 450 million gallons of natural-strength juice and of this total approximately 46 million gallons is canned single-strength orange juice. Most other citrus-producing countries also process orange juice in one form or another.

There is considerable production of canned natural-strength juices, but in addition large quantities of citrus juices are extracted and after pasteurisation are packed in barrels and chemically preserved, usually with sulphur dioxide. Barrelled juices are imported into this country for use in the manufacture of squashes and various carbonated beverages. Production is carried out largely in the Mediterranean citrus-growing countries, the Union of South Africa and the West Indies.

Orange juice

For the production of canned orange juice only fresh fully mature fruit may be used, since over-mature, under-mature or stale oranges do not make good juice. After inspection and removal of all unsuitable fruit, the oranges are carefully washed and sorted according to size prior to the extraction of the juice. Several effective juice extractors are employed and these operate in various ways. Some halve the fruit and remove the juice by reaming or by pressing; one machine, the ' In-line Extractor ', inserts a tube through the peel and by squeezing the whole fruit forces the juice out through the tube. This extractor is considered by many American processors to give a very satisfactory orange juice and nowadays it has been estimated that over 60% of all the juice extractors in use in Florida are of this type.

After seeds and coarse pulp have been removed by screening, the juice is tested for soluble solids and acidity and at this stage in larger factories various juices are blended to produce a uniform product. Sugar is now added to produce a sweetened juice if desired, and the orange juice then de-aerated. In many canneries it is usual for the juice to be de-aerated and de-oiled in the same operation. There are several advantages in de-aerating orange juice, such as improvement in the uniformity of can fill by the elimination of foaming in the filler bowl, and reducing the risk of scorching during pasteurisation. However, the value of de-aeration has been questioned and it appears to be falling from favour in many American juice plants. The most effective method of de-aeration is to introduce the juice in the form of a thin film, or as finely divided particles, into a vacuum chamber.

Excessive quantities of peel oil in orange juice can cause objectionable off-flavours, although some peel oil is necessary to give a good flavoured juice. It is generally recommended that orange juice should contain not more than 0·030% of recoverable oil. To control the amount of peel oil present in the juice, de-oiling is often necessary and this may be accomplished by vacuum distillation in specially designed de-oiling apparatus.

After de-oiling and de-aeration, the orange juice is pasteurised. This is necessary to inactivate the pectinesterase present in the juice, since this enzyme is the principal cause of instability known as ' cloud loss ' in citrus juices, that is when the juice separates out into two distinct layers on keeping. In commercial practice the orange juice is heated to about 200° F for approximately 30 sec. in either tubular or plate-type heat-exchangers.

The pasteurised juice is pumped to the filler bowl where it is maintained at about 185° F.

The time the juice is in the filler bowl should be as short as possible and the speed of delivery of juice from the pasteuriser is usually synchronised with the rate of can filling. After the cans have been filled with hot juice, they are inverted for about 20 sec. to sterilise the inside of the lids and then rapidly cooled.

Time and temperature of storage are important factors in maintaining the quality of canned orange juice. Since the rate of deterioration in flavour increases with rise in temperature, orange juice should always be kept as cool as is economically possible.

Grapefruit juice

Canned single-strength grapefruit juice is mainly produced in Florida, Israel and the West Indies and is prepared by methods similar to those outlined for orange juice.

Grapefruit contain a glycoside, naringin, which can cause a bitter flavour in the juice and consequently efforts are made during processing to minimise the amount extracted from the fruit. Since immature grapefruit have a high naringin content, juice processed early in the season sometimes has a bitter flavour.

Lemon juice

Lemon and lime juices are slightly different from orange and grapefruit juices, and because of their high acidity they are mainly used in the manufacture of products or in the case of lemon juice for flavouring in cooking.

The commercial production in the United States of lemon juice is at present confined almost entirely to California. There is also considerable production of the juice in Italy and, in addition, Israel, Nigeria and the Union of South Africa process moderate quantities. In California a canned single-strength lemon juice is produced on a considerable scale. The initial operations of handling, inspection and washing of fruit and extraction of the juice are similar to those outlined for orange juice, but for the preparation of canned lemon juice, the juice is generally centrifuged to remove a large portion of the suspended material and then pumped through de-oilers where most of the volatile oil is removed by heating the juice to 195–200° F for a very short time. These operations are necessary since excessive quantities of pulp and oil cause pronounced off-flavours in canned lemon juice. This heat treatment also stabilises the cloud and pasteurises the juice. The hot juice is then filled into cans in the normal way. Canned lemon juice should be stored at about 40° F since storage at a higher temperature produces deterioration due to browning and the development of off-flavours.

Lime juice

A limited quantity of lime juice is also canned in the United States and Mexico by methods similar to those used for lemon juice but it is necessary to store the product under refrigeration to ensure a reasonable shelf-life.

As is well-known the processing of lime juice has been a traditional industry in the West Indies for many years. The West Indian Key or Mexican lime which is used is a very small fruit averaging little more than an inch in diameter, thus normal juice extraction methods cannot be employed and the fruit must be crushed whole. Stone rollers are usually used for this and the expressed juice is screened to remove coarse particles of pulp and skin and then run into storage tanks where it is left to settle. During this time the essential oil from the peel gradually rises to form an upper cream layer leaving a fairly clear intermediate layer of juice and a lower layer of solid particles. The longer the liquid is kept, the greater is the degree of separation and the greater the yield of juice, but it is considered that the optimum keeping time is from 10 to 20 days, beyond which there may be a deterioration of juice quality. After the keeping period the juice layer is drawn off, filtered, poured into paraffin-lined barrels, and usually preserved with sulphur dioxide at a concentration of about 350 p.p.m.

Concentrated juices

Citrus juices can be concentrated successfully in vacuum evaporators, of which various types are in use. In the older types, which usually operate at 120° F, the juice is first heated to 200° F to inactivate the pectinesterase. In recent years, falling-film, low-temperature evaporators have also been extensively used to produce hot-pack canned concentrates.

Many types of concentrated citrus juices are produced and the degree of concentration

depends largely upon their ultimate use. Orange juice packed in No. 10 cans or paraffin-lined barrels is commonly concentrated up to 60° Brix for use by the soft drinks industry. Orange juice used for the Welfare Foods Scheme in this country is packed at 65–66° Brix in A10 cans. The degree of concentration for grapefruit and lemon juice is generally lower, since these juices when highly concentrated, tend to brown during storage.

Frozen concentrates

In the United States the production of frozen citrus concentrates, particularly orange juice concentrate, has shown a phenomenal development in recent years. Consumption of these concentrates since their first commercial production in 1945, has increased at a tremendous rate and orange juice concentrate is now the most important of all types of preserved citrus juices produced. This is because of its superior flavour, convenience in use, and its uniformity of quality due to the practice of formulation. Formulation consists of mixing concentrates whose sugar/acid ratio may vary between 8 and 22 according to the season and the variety of fruit processed, so that the final product always has a sugar/acid ratio of between 13 and 15.

The evaporators used to produce this frozen orange concentrate are of several types, but all make use of falling-film heat exchangers, in which the juice runs in a thin film down the inside of a tube which is gently heated. The temperature of the juice during evaporation depends upon the design of the unit, but it is kept within the range of 60–80° F. The evaporators operate in two or more stages, and are generally maintained at the same temperature. The juice is concentrated to about 55–63° Brix and the concentrate on leaving the evaporators is collected in a cold wall tank maintained at 35° F or below. Here the degree of concentration is determined and the concentrate is then diluted, or ' cut-back ', to 42 $\pm \frac{1}{2}$° Brix, with freshly reamed unheated juice. If the oil content is below the desired level of 0·025 ml. per 100 g. of concentrate, cold-pressed orange oil is added at this stage to produce a well-flavoured product. After this the concentrate is further cooled to about 20–25° F and then filled into lithographed cans, which are sealed and conveyed quickly along a wind tunnel at −40° F. After the concentrate has been frozen it is stored under refrigeration until it reaches the consumer.

Although frozen orange juice concentrate is by far the most important product, manufacturers in the United States have found that grapefruit, tangerine, lemon and lime concentrates may be prepared with only slight modifications of the methods used for orange.

Frozen lime concentrate is perhaps the most noteworthy of these since its development has opened a new outlet for limes in Florida. Another development has been the production of a pink-coloured grapefruit concentrate made from coloured varieties of fruit by using cut-back juice rich in naturally coloured pulp.

Chilled natural juices

Although most of the citrus juices produced throughout the world are preserved in one form or another, in recent years the production of a chilled natural orange juice with a comparatively short shelf life has developed in the United States, and it is estimated that at present about one-tenth of the total Florida orange crop is processed into this product. Chilled juice is freshly squeezed whole orange juice which is cooled and transported under refrigeration, either in cartons or in bulk, and packaged in small bottles or waxed cartons for retail sale. The juice will retain its flavour and practically all its vitamin C content for 10–14 days when stored at 30° F.

Dehydrated juices

The dehydration of citrus juices has received considerable attention from workers in the United States for many years. Preparation is accomplished by several methods, but, besides the difficulty of obtaining a product of reasonable quality and flavour, it seems doubtful whether the drying processes at present employed can operate economically. It is not practicable to dry citrus juices directly to a solid form. The usual procedure is first to concentrate the juice in a vacuum evaporator and then to remove the remaining water by a vacuum drying process to avoid heat damage to the flavour. The provision of a desiccant in the package is essential for the storage of a stable dehydrated orange juice. The product is packed as it comes from the dryer, in cans with a sufficient amount of a desiccant to reduce its moisture content from

3–4% down to 1%. Calcium oxide has been used as a desiccant and is packed in sift-proof, moisture-permeable paper containers which permit the transfer of water vapour from the product to the desiccant without any contamination.

In recent years the Florida industry has marketed orange and grapefruit juice crystals. These are two-fifths of the weight of an equivalent quantity of quick-frozen concentrate, and it is claimed are easily reconstituted and will withstand storage at a temperature of 100° F for several months and at the same time preserve most of their vitamin C content.

The essentials of the process which has been developed probably lie in the continuous dehydration of fresh juice under carefully controlled conditions. In addition, the flavours and essential oils which are lost during the evaporation process are trapped in a solid medium which is then granulated and added to the juice crystals in the proportion of 1% total volume. The crystals are packed in cans closed under 15 in. of vacuum and when reconstituted, one pound of crystals will make one gallon of juice of 11·5° Brix.

Comminuted citrus drinks

In recent years the soft drinks industry of this country has been using increasing quantities of imported citrus fruit for the preparation of what are known as comminuted drinks. Briefly the fruit is sliced up and mixed well with sugar syrup so that the flavouring constituents are extracted and in the sugar syrup form the basis for the manufacture of soft drinks of the squash and carbonated beverage type.

Canned segments

Canned grapefruit segments are another important citrus product, particularly in Florida, the West Indies and Israel. This pack is processed as follows : on arrival at the factory sound fruit is sorted according to size, to produce a uniform pack. Two methods are used for peeling the grapefruit. The ' cold peel ' method, in which the peel is sliced off together with the albedo and outer membrane of the segments, is used when the fruit is tender, and a low yield of segments is obtained. The more generally used method of peeling is to subject the fruit to a steam or hot water treatment for about 5 min., after which the grapefruit are cooled slightly and are passed to the peeling tables where they are peeled by hand. Baskets of the peeled fruit are then immersed in an alkaline bath which removes the outer membranes from the segments. The alkali is washed off by sprays of water and the peeled fruit is next sectioned and packed into plain cans, containing the requisite amount of syrup, care being taken not to break the segments. The filled cans are either vacuum-closed and processed, or exhausted by heat, closed and processed.

A limited quantity of citrus salad consisting of a mixed pack of grapefruit and orange segments is also processed in Florida and Israel, but the demand for this product is small.

Most varieties of oranges do not produce a successful canned product, but the notable exception is the Japanese mandarin, which is a seedless Satsuma orange. The Japanese process this pack as follows : the oranges are washed and then passed through steam or a hot-water bath for about 1 min. to facilitate peeling. After being cooled the fruit is peeled and sectioned by hand and the segments then immersed in 2½% HCl at room temperature to remove the fibrous rag adhering to the fruit. The acid is subsequently removed by soaking the segments in water and this washing is followed by immersing them for 25 min. in 1% sodium hydroxide at a temperature of about 113° F. After a further washing the segments are put into cans and a hot 17° Brix sugar syrup is added. The cans are then vacuum-closed and processed.

In the United States both quick-frozen grapefruit segments and citrus salad have become popular in recent years. The segmented fruit is placed in cans and syrup is added. The cans are then subjected to a 27-in. vacuum to expel the air and sealed, after which the product is quick-frozen at −20° F. Quick-frozen grapefruit segments have a very good flavour and are likely to become increasingly popular in the future.

Marmalade

Marmalade is one of the minor citrus products obtained by utilising the whole fruit. Oranges are the principal citrus fruit employed, although moderate quantities of marmalades made from

lemons, grapefruit, limes or mixtures of these fruits are produced in certain countries. Many different methods are used to process this product. Most marmalades manufactured in the United Kingdom contain all the interior fruit juice and tissue together with a fair proportion of sliced peel. This type of marmalade is often prepared by cooking the peeled fruit in a small quantity of water until a pulp is formed, the seeds and undisintegrated fibrous membrane tissue are removed, and the acidity of the pulp adjusted. Sliced peel, which has been previously tenderised by cooking in water, is then added and the mixture converted to marmalade by boiling with sugar until the desired concentration point is reached.

In the United States and certain other countries, clear jelly marmalades are widely favoured. These are produced from citrus juices and require the addition of pectin in order to obtain a jelly of the proper strength.

Fermented products

Like most fruit juices, citrus juices may be fermented into wines, brandies and liqueurs. One of the very popular and widely distributed products in this category is the liqueur Curaçao, which is made with the peel of bitter orange infused in 60° alcohol.

Vinegar made from citrus fruit juice, especially orange vinegar, has a fine flavour and has been processed on a small scale in certain citrus-producing countries as a speciality.

Citric acid production

Although all varieties of citrus fruits contain citric acid, only lemons and to a much lesser extent limes are used as a source of this product. The manufacture of citric acid from lemons originated in Italy and was also widely carried out in California. However, nowadays citric acid is mainly produced by a microbiological process from beet sugar molasses. For example, of the total United States output of 50–60 million pounds of citric acid and calcium citrate, only approximately 5 million pounds are still produced from lemons. The usual process is based on the precipitation of citric acid as calcium citrate by the addition of lime to the lemon and lime juices and decomposition of the calcium citrate with sulphuric acid.

By-products

Since approximately half a citrus fruit consists of peel, pulp and seed, considerable quantities of so-called waste material are left after the utilisation of the edible fruit tissue. The disposal of this waste is a serious problem to all but the very smallest citrus-processing industries and in most countries the production of products, commonly termed citrus by-products, is now firmly established as an integral part of almost every processing plant. In fact, in the United States in some seasons the value of the by-products may largely represent the difference between profit and loss to the processors.

The chief by-products are essential oils, dried citrus pulp and molasses, but pectin, brined and candied peels, citrus seed oil and canning syrup are all produced to a lesser extent in certain factories.

Essential oils

Essential oils, obtained from the peel of citrus fruits, are usually produced in the processing of the whole fruit for juice. The amount of oil present in the fruit is very small, of the order of 0·5–0·7% and the maximum amount of oil can only be recovered by water distillation of the finely divided peel; but as the oil may deteriorate considerably in this process the method is little used, except for the production of distilled lime oil.

While small quantities of so-called distilled oils are produced as by-products in juice processing, by far the greater amount of citrus oils is obtained by expression or by rupturing the oil sacs, either by puncturing them or by abrasion of the flavedo. The numerous methods available for the extraction of citrus peel oils, fall into two main groups—the manual and the mechanical means. The two manual methods used are the sponge and ecuelle processes. The sponge process is now little used, but the ecuelle process is still employed for the extraction of orange oil in Guinea and Tanganyika, and for expressed lime oil in the West Indies. An ecuelle consists of a shallow, funnel-shaped copper bowl attached centrally to a tube closed at the lower end. The bowl is equipped with a large number of brass spikes, on which the fruits

are rolled, thus puncturing the oil sacs. The liberated oil, together with tissue fluids and fragments of peel, collects in the tube from which it is decanted periodically.

The mechanical methods used for extracting citrus essential oils may be conveniently classified into three main groups: those treating the separated peels, those whereby the skin of the whole fruit is rasped, and those whereby the whole fruit is crushed. In all these methods the oil is extracted as an emulsion in water together with fragments of peel, and is separated by screening and then centrifuging. In American practice the oils are then usually stored for a short time at a temperature of 32–40° F so that undesirable waxy materials present separate out, and the clear oil is decanted off into containers.

Besides their use for flavouring purposes, citrus oils are also used in perfumery, soaps and cosmetics and in the manufacture of pharmaceuticals.

Pectin

The albedo of citrus fruits contains pectin. Approximately 5 million pounds of citrus pectin are produced each year in the United States and smaller quantities are extracted in Italy and Israel. In the United States production is concentrated at one factory, the California Sunkist Co-operative, since its production suffices for the requirements of the whole country.

Pectin manufacture is an expensive and complicated process, consisting of numerous batch-type operations, the use of corrosive acids and expensive solvents and the filtration of very viscous solutions. The citrus peel used is usually that from which the essential oil has been removed. The peel is comminuted and then thoroughly washed with water until all the sugars have been extracted. The pectin is then often extracted by heating at 200–212° F with dilute HCl or H_2SO_4, pH about 2, for 45–60 min. The extract is next filtered and the pectin purified by precipitation from the solution with an organic solvent such as acetone and carefully washed. The purified pectin is dried in warm air or on a heated drum until its moisture content is 6–10%. When dry it is ground to a powder and packaged for sale.

The most important use of pectin is in the production of jams and jellies. It also has many other uses in small quantities in the food and pharmaceutical industries because of its ability to form and stabilise emulsions.

Candied peel

There is a limited outlet for citrus peels in the manufacture of candied peel. A certain proportion of citrus peels are brined in the country of origin and then exported for the manufacture of candied peels in the consuming country.

In the brining of peel it is essential to select material which is free from scale or blemish marks. It is usual to use the halved skins or cups which remain after the fruit has been reamed for the preparation of juice. The cups thus obtained still contain a large proportion of rag which must be removed before brining. It is usually accomplished by hand, although a machine has been developed in California. The cleaned cups are washed with water and then packed one inside the other in barrels, and completely covered with 10% brine. The cups are left until they become translucent, when curing is judged to be complete. Throughout this period the brine solution is maintained at a concentration of 10%. After the curing operation, the brine is removed and the cups are covered with fresh 15% brine ready for shipment; sometimes sulphur dioxide is also added to preserve the product.

For candying, fresh or brined peels may be used. In the case of the latter product the brine is removed by soaking the cups in water and washing well. The peels are thoroughly cooked in several changes of water until tender and then candied. Various methods are used for this but the process consists essentially in boiling the peels in a sugar solution until they have absorbed sufficient sugar for their preservation.

Dried pulp and press liquor

Dried citrus pulp which is prepared from the residue left after processing is extensively used for feeding cattle. It is prepared by grinding the pulp and peel in a hammer mill and then adding 1% of lime to neutralise the acids present and to react with the pectin to form calcium pectinate. The mixture is left for a short time and then pressed to remove as much liquid as

possible and dried to produce a light coloured product. About 1 ton of citrus pulp feed is obtained from 10 tons of cannery waste.

The liquid obtained from the pulp, which contains about 5–7% of sugar, may be concentrated to produce molasses. Citrus molasses is dark brown in colour, bitter, and is used mainly in cattle feeds.

Citrus press liquor may contain about 0·2–0·5% of peel oil and since this oil steam distils readily it may be recovered by flashing the liquor at 240° F. The oil which is generally known as citrus stripper oil contains about 95% of limonene and is used as a source of this terpene. In addition, considerable quantities are used in the United States by the paint and varnish industry, since it is an excellent anti-skinning agent.

In recent years the Florida citrus industry has done a good deal of work concerning the possibility of utilising citrus press liquor as a source of sugar for canning syrups. The application of ion-exchange resins to remove the citric acid, minerals and other impurities present in the press liquor has been investigated in pilot plant equipment. The process, unfortunately, requires considerable technical skill, in addition to a large initial capital investment, and its development even in Florida has been slow, although at least one plant has been successfully operating the process on a commercial scale for several years. After demineralisation of the citrus press liquor it is decolorised and concentrated to produce a syrup.

Seed oil

Citrus seeds may be used as a source of a fatty oil and it has been estimated that if all the seeds from the citrus processing plants in Florida alone were used for oil extraction, about 4500 tons of oil would be obtainable each year. However, only relatively small quantities of seeds are utilised as a source of oil, since separation from the pulp is difficult; most are dried with other cannery wastes in the production of stock feed.

Other products

Other potential products of citrus fruits that have been suggested as worthy of development include; lactic acid, feed yeast, the glycosides naringin and hesperidin, and inositol. Indeed, citrus fruits can be used as a source of a great many products and if efficiently utilised are a most valuable raw material.

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ADDENDUM

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Before the war, the world production of oranges, lemons and grapefruit was about $7\frac{1}{4}$ million tons. Today it is about double that figure and the proportion of oranges has remained at about 80% of the total production. Just before the war, this country imported 662,000 tons of fresh citrus per annum. In 1958 the figure was 411,500 tons, i.e., 62% of the pre-war figure. Both pre-war and today about 80% of the imports consists of oranges.

Imports of citrus juices into the U.K., however, show a very different trend. In the years immediately preceding the war the amount of fruit used in the preparation of citrus juices imported into the U.K. was about 35,000 tons, but in 1958 some 280,000 tons of fruit were so used. Thus present imports of citrus juices are eight times the pre-war figure. Before the war, orange juice represented only about 30% of the total—now the proportion is well over 60%.

The price of fresh fruit in 1958 was about five times the pre-war price and citrus juices now cost between three and four times as much as before the war. Much of this juice, however, is used in the preparation of squashes, the prices of which are only about 25% more now than they were pre-war. Incidentally, the much higher juice imports today do not include very substantial additional sales of citrus products which are being made from fresh fruit in the U.K., i.e., comminuted products.

The sales of juice in this country have been very much in line with availability from the supplying countries. However, young trees are rapidly coming into bearing, or are recovering from frost damage, in Florida, Israel, Spain, South Africa and the West Indies. It is extremely difficult to forecast the extent to which processors in the various producing countries will be able to handle additional supplies, as there are so many unforeseeable factors. For example, the local fresh fruit market in Spain has increased enormously in recent years, and now absorbs about one-third of the crop, including a high percentage of culls. On the other hand, hail or pests can blemish the skins, thus rendering the fruit unsuitable for export as fresh fruit and making substantial increased quantities available to the factories.

Probably within the next few years sufficient citrus, mainly oranges, will be available in countries outside the dollar area for the factories in those countries to process and sell to the U.K. alone, a range of products involving an additional 300,000 tons of fruit—more than the total quantity being imported today.

It is obviously important anywhere in the world for growers to obtain maximum yields of fruit from the trees, but the vast tonnages and consequent low overheads in Florida, where the output in individual factories is as great as the total citrus production in most other countries, make it impossible for the latter to compete. One factory in Florida, for example, processes more fruit in a season than the entire annual output of South Africa. Indeed, a factory outside the United States is fortunate if it can process 5% of the tonnage of a reasonably sized Florida factory. The same degree of technical supervision is essential and in consequence, the costs per unit volume must be substantially higher outside America.

The prospects for the future are by no means easy to assess. Some months ago the Joint Parliamentary Secretary to the Ministry of Agriculture indicated to the Commonwealth Fruit Producers' Conference that the world fruit production was increasing so rapidly that the main problem facing growers was how to increase consumption. Future prospects must depend upon the extent to which imports from the U.S.A. are permitted,* but assuming that that door will not be opened wide it appears that the prospects for all other producing countries for substantially increased exports of citrus juices to the U.K. are good.

Orange juice concentrates

By far the biggest individual buyer of concentrated orange juice is the British Government, which purchases concentrate for use in the Welfare Foods Service. The concentrate is made

* Since this contribution was prepared in June 1959, the British Board of Trade announced in November that no further licences would be required for the importation of lemon juices from U.S.A., but that the existing restrictions relating to orange and grapefruit juices would continue.

available to provide vitamin C to expectant and nursing mothers, and babies up to two years of age. At one time this Service was advertised extensively, and the off-take was high. It is well-known that the off-take is now very much lower since advertising on an extensive scale has been discontinued. It is clearly in the interests of suppliers of this concentrate for the off-take to be very much higher, and there is little doubt that renewed extensive advertising would help to bring about this state of affairs. If the uptake of concentrated orange juice in the Welfare Food Service could be increased (e.g., by advertisement subsidised by the suppliers) to its highest previous level it is probable that another 75,000 tons (approx.) of oranges would be needed to provide the additional concentrate. Not only should the needs of very young children be considered in this respect, but if the scheme were extended to children at school and old age pensioners, it would afford a very valuable additional demand for the products of the citrus industry.

Comminuted products

Much controversy has raged in recent years over the vexed question of ' squashes ' versus ' comminuted ' products. Indeed the very name ' comminution ' perplexed a number of people in the early days. From a citrus grower's angle it is, of course, unfortunate that much less fruit is required in the preparation of comminuted products to produce a given amount of drinkable liquid than is needed in the preparation of the traditional squashes. Comminuted products have great popularity which will continue until something better is produced to take their place. It should be remembered that when comminuted products were first introduced the general standard of squashes was not high.

Before the war it was the practice to import unconcentrated citrus juices which had been subjected to no heat treatment whatever, but during the war, in view of the need to save shipping space, the importation of citrus juices was confined to concentrates. Processors in various parts of the world had to make very hasty adjustments to their processes under very difficult conditions, and the concentrates were often exposed to high temperatures, sometimes for periods up to several hours in duration. Essential oils, vital flavouring ingredients, were also often produced under primitive conditions conducive to rapid oxidation. Sulphur dioxide was the standard form of preservative. The Preservative Regulations are at this moment being reviewed and it is widely hoped that they will be revised so as to permit the use of both sulphur dioxide and benzoic acid in the same product.

Citrus juices can be, and often are, concentrated nowadays *in vacuo* in a matter of seconds at comparatively low temperatures. These concentrates have a flavour far superior to those produced under earlier conditions. There has also been a great improvement in the method of extraction of essential oils. There is no doubt that if the use of sulphur dioxide could be reduced to the minimum commensurate with microbiological stability the flavour of the finished product would be much improved.

A better flavour is obtained in a squash by use of more juice. The juice, however, must be of first-class quality and the use of a quality essence or emulsion, which in turn must be produced from high quality oil, is also essential. The field is wide open to processors overseas to demonstrate that they are capable of producing something better than anything on the market today. Soft drink manufacturers in this country, whether of comminuted or of traditional squashes, are always ready and willing to consider something better in which the characteristic fresh flavour of the various citrus fruits are carried through from the fruit to the finished product.

Canned juice

There is undoubtedly a very big future in this country for canned juices in retail packs, which are very largely a post-war development here. Much has been said in recent years of the phenomenal development of frozen concentrates in the U.S.A. This type of product, however, presents great difficulties as far as the U.K. market is concerned, chiefly because of the lack of refrigeration in the homes, especially of deep freeze facilities, while heavy freight rates involved in getting frozen concentrates to this country make the product uneconomic. There is still, however, a very considerable sale in the U.S.A. of unconcentrated juices in cans, and if every person in the U.K. drank as much canned orange juice (apart from the frozen con-

centrate) as his counterpart in the U.S.A., this would absorb 400,000 tons of fruit per annum. Obviously, in order to achieve these additional sales, substantial advertising would be necessary.

The price of the product is also an important factor. In this connexion it is interesting to note that although orange is by far the most popular of the varieties of fruit drinks, canned grapefruit juice comprises about 75% of the sales of canned citrus juices in this country. It is significant that canned grapefruit juice is today about 20–25% cheaper than canned orange juice. If retail packs of juices are to play a large part in the expansion of the citrus industry, other people must make valuable contribution, notably the can and case makers, in reduction of the prices of their products.

Frequently in Florida can makers are installed on a processor's door-step. In other parts of the world cans often have to be transported hundreds of miles, or even shipped from this country in flattened form and re-formed at the factory. In several years during the past decade, prices of Florida juices have been less than the cost of production in other parts of the world, without allowing anything for the contents of the can.

Further reference must be made to imports to this country. When the Americans supplied under Lend-Lease during and after the war they insisted that every effort must be made to procure supplies elsewhere, and supplies under Lend-Lease were only made available with this proviso. Encouraged by the British Government, processors in other parts of the world spent large sums of money, equipping themselves to produce juices of good quality. Their earlier public-spirited action surely entitles them to some consideration when faced with such formidable competition.

There have been numerous conferences in recent years between various citrus-growing areas, notably in the West Indies and some Mediterranean countries, but it is now very desirable that all the principal citrus-producing countries in the world—including in particular the United States—should discuss together global problems, both for fresh fruit and for citrus products. This would make for a better understanding of each other's problems.

THE β-MONOESTER CONTENT OF COMMERCIAL MONOGLYCERIDES AFTER PROLONGED STORAGE

By L. HARTMAN

The technique of determining 'total' and β-monoglycerides by isomerisation with perchloric acid has been re-examined and slightly modified to improve the reproducibility of results. The content of β-monoglycerides in commercial monoglyceride preparations stored for 1½–5 years has been found to be in the range of 5–9% of the total monoglycerides. This is contrary to a recent report that β-monoglycerides are present in freshly prepared products only and disappear on prolonged storage.

Introduction

The estimation of α- and β-monoglycerides in the presence of each other offered in the past considerable difficulties which were solved only recently by Martin.[1] He found that 56% aqueous perchloric acid isomerises monoglycerides readily in chloroform solution and, by combining this procedure with periodate oxidation of isomerised and non-isomerised samples, he was able to demonstrate that the isomers co-exist in an equilibrium composition in the range of 90–92% of the α-form and 8–10% of the β-form.

Martin's work was extended by Brokaw *et al.*[2] to commercial monoglycerides obtained by the usual inter-esterification of fats with glycerol, and the presence of 5–8% of the β-monoesters based on the total monoglyceride content was observed. These monoesters were found to be equal to the α-isomers at least in some applications (baking improvers). Brokaw *et al.*

also suggested a modification of Martin's method of total monoglyceride estimation suitable for routine analysis. In some concentrates obtained by molecular distillation the initial α-monoglyceride content was as low as 86% but increased on keeping for 1–2 days to as much as 94%, again an indication of equilibrium conditions. However, recently Becker & Krull[3] reported that in monoglycerides stored for a long period of time no β-monoglycerides can be detected, which would indicate a complete shift of equilibrium in favour of the α-form.

Brokaw *et al.* did not consider in their experiments the effect of prolonged storage. The present investigation was undertaken to re-examine the existence of β-monoglycerides in commercial preparations stored for a number of years, and further, to detect possible sources of errors in the determination of total monoglycerides.

Experimental

Martin's original method[1] of estimating monoglycerides and its modification by Brokaw *et al.*[2] were first examined. Martin's method consists in dissolving the sample in specially purified chloroform and carrying out isomerisations in a two-phase system by shaking with 0·003 ml. of 56% perchloric acid per ml. of chloroform solution for 1 minute and setting aside for another 9 minutes. The chloroform solution is then washed with water to inactivate the isomerising reagent and the α-monoglyceride content estimated on a micro-scale with periodic acid. The result multiplied by a factor of 1·15 gives the ' total monoglyceride '. After determination of the α-monoglyceride without isomerisation the content of β-monoglyceride is obtained by the difference.

Brokaw *et al.*[2] use as solvent a 2 : 1 mixture of acetic acid and chloroform, isomerise with perchloric acid in one-phase system with the same proportions as Martin (0·045 ml. of 56% perchloric acid per 15 ml. of solvent) and determine the α-monoglyceride without previous washing according to the Handschumaker–Linteris procedure.[4] The periodic acid reagent used in this procedure contains 20% water which inactivates the perchloric acid.

In the present work Martin's original procedure if followed meticulously was found to give reproducible results, but the purification of chloroform proved time-consuming and occasionally unsuccessful. The acetic acid–chloroform mixture suggested by Brokaw *et al.* is much more convenient. Other solvents such as ethanol–chloroform, ethyl acetate–chloroform and ethyl acetate alone were also tried in the present work but found either entirely ineffective or inferior to the acetic acid–chloroform mixture. The strength of acetic acid proved to be critical, however. In the isomerisation of pure α-monostearin used as a standard, 99·8% acetic acid (solidification point 16·4°) was satisfactory but gradual additions of water reduced the degree of isomerisation appreciably as shown in Table I. Accordingly the acetic acid used should be 99·8–100%. On the other hand the presence of small amounts of acetic anhydride in the acetic acid reduces the amount of α-monoglycerides in isomerised samples owing to the acetylation catalysed by perchloric acid. It was found that if acetic anhydride or phosphorus

Table I

Effect of added water on the degree of isomerisation of pure α-monostearin
(100·4% α-monoester)

Volume of water added to monoglyceride solution expressed as % of the solvent mixture	α-Monoglyceride in isomerised sample, % (Pohle & Mehlenbacher method[5])	Volume of water added to monoglyceride solution expressed as % of the solvent mixture	α-Monoglyceride in isomerised sample, %
Addition of water before the treatment with perchloric acid		Addition of water after the treatment with perchloric acid	
Nil	87·0	Nil	86·6
0·2	88·5	5·0	86·4
0·3	90·5	10·0	86·5
0·5	93·9		
1·0	94·2		
1·5	94·0		
2·0	97·9		
3·0	99·8		
3·5	99·7		

pentoxide were used for the removal of water from acetic acid the original α-monoglyceride content was reduced after isomerisation by 20–30%. These reagents must, therefore, not be used in the purification of acetic acid employed in isomerisation; the freezing method is the safest.

For the determination of α-monoglycerides the reagent suggested by Pohle & Mehlenbacher[5] was used in this work. This reagent contains only 5% water and does not cause the precipitation of fat to such an extent as does the Handschumaker–Linteris reagent (20% water content). Table I shows that the water present in the Pohle & Mehlenbacher reagent is sufficient to inactivate the isomerisation catalyst since further addition of water did not alter the results.

The procedure finally adopted in this work, and which did not differ essentially from that used by Becker & Krull,[3] was as follows:

(*a*) A weighed sample (2–5 g.) was dissolved in ether and washed with water to remove free glycerol. The ether solution was dried with sodium sulphate, the solvent evaporated at room temperature *in vacuo*, the product kept for 48 hours in a vacuum desiccator and weighed.

(*b*) Weighed samples of the dry product containing 0·1–0·15 g. of α-monoester were dissolved in 15 ml. of 2 : 1 acetic acid–chloroform mixture in glass-stoppered bottles and isomerised with 0·045 ml. of 56% perchloric acid by shaking for 1 minute and setting aside for 9 minutes.

(*c*) Oxidation with periodic acid was carried out as described by Pohle & Mehlenbacher.[5]

(*d*) The total monoglyceride content was obtained by multiplying the result by 1·15 as suggested by Martin.

(*e*) The actual α-monoglyceride content was determined similarly, but omitting the isomerisation step.

(*f*) All determinations were carried out in triplicate and the results calculated on the basis of the original unwashed sample.

The results for α-monoglycerides both before and after isomerisation were reproducible to within ±0·5% (absolute). The free glycerol contents of the original products were estimated by the 'partition method',[6] i.e., by dissolving a weighed sample in a measured amount of chloroform, shaking with an equal amount of water and taking an aliquot of the water phase for analysis. This assay was carried out for the sake of completeness only, free glycerol having probably little bearing on the equilibrium during the storage.

The materials used in this investigation were commercial monoglycerides and a sample of pure α-monostearin prepared by the classic method of Fischer *et al.*[7] (m.p. 81–81·5°). All commercial samples were well matured products having been received in this laboratory 1½ to 5 years ago, and so was the pure α-monostearin. The periods of storage of the individual samples and the results of monoglyceride and glycerol analyses are shown in Table II, which includes also the iodine values of the various products.

Table II

Analysis of various monoglyceride products stored for 1½–5 years

Sample	Period of storage, years	Uncombined glycerol, %	Iodine value (Wijs)	α-Monoglyceride without isomerisation, %	Total monoglyceride, %	β-Monoglyceride, % of total monoglyceride
Technical monoglyceride (Australian)	2	3·56	1·2	32·8	36·1	9·1
Technical monostearate (English)	4	7·02	6·8	38·4	41·4	7·3
Technical monostearate (New Zealand)	2	8·10	Nil	38·7	40·7	4·9
Distilled monoglyceride (American)	5	0·81	1·4	90·2	96·0	6·0
Technical monoglyceride from hydrogenated oleostearin	1½	0·75	0·2	58·3	61·4	5·1
Linseed oil monoglyceride (for phthalate resin manufacture)	5	5·28	155·9	42·3	47·6	11·1
α-Monostearin (pure)	2	Nil	Nil	100·4	100·2	Nil

Discussion

The data for β-monoglycerides in Table II show that in all commercial products examined, with the exception of linseed oil monoglycerides, β-monoglycerides were present in amounts of 5–9% on the basis of total monoglycerides. These figures are in agreement with the findings of Brokaw *et al.* The figure for linseed oil monoglyceride (product 5 years old) is higher still and might be characteristic for unsaturated monoglycerides or might be due to their disproportionation by perchloric acid with the formation of triglycerides and free glycerol. (In fact the addition of perchloric acid produced a discoloration of the solution.) The iodine values of the remaining samples were too small to account for the difference in their β-monoglyceride content.

On the other hand Becker & Krull found 0–2·5% of β-monoglycerides (on the basis of total monoglycerides) in a number of commercial products, and, the average (0·8%) being within the limits of experimental error, they concluded that the isomerisation procedure is only useful for freshly prepared monoglycerides. In the case of well matured products the conventional periodate method without previous isomerisation gives according to them the total monoglyceride content since the equilibrium is completely on the side of α-monoglycerides.

The change of equilibrium between the α- and β-monoesters would only be feasible if β-monoglycerides underwent decomposition which is unlikely under usual storage conditions. The examination of the analytical procedure used by Becker & Krull did not disclose any obvious source of error. Thus, unless the acetic acid used by Becker & Krull contained traces of acetic anhydride which would lower the results for β-monoglycerides, the reason for the discrepancy between their findings and those of the present investigation is not apparent.

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THE BLEACHABILITY OF NIGERIAN PALM OIL

By G. R. AMES, W. D. RAYMOND and J. B. WARD

Palm oil of excellent bleachability can be obtained from Nigerian (wild) palm fruit if sufficient care is taken in its processing. Commercial Nigerian African-produced oil has inferior bleachability due to oxidation by lipoxidases while the frequently bruised fruit awaits processing. Atmospheric oxidation catalysed by iron may also cause deterioration, and palm oil is frequently heated in iron vessels before shipment. Coupled oxidation of the oil and carotenoids results in the formation of degradation pigments less readily absorbed by bleaching earth or less easily rendered colourless on heat bleaching. The extent of the deterioration depends upon the quantity of carotene present which is usually higher in Nigerian than in Malayan palm oil. The findings are supported by numerous results obtained from the examination of palm fruit and samples of palm oil, many of which were specially collected in Nigeria.

Introduction

Palm oil is used extensively in the food industry in the manufacture of margarine and cooking fat. Since palm oil is highly coloured (from almost white to almost black, usually red or orange) it is necessary that the colour be removed in order to render the final product acceptable to the consumer. Bleaching the oil can be effected by heating or by absorption of the pigments on an activated earth, or else by a combination of the two methods.

It is generally considered that Nigerian palm oil is more difficult to bleach than oil from Malaya or Sumatra and, on that account, often suffers a discount on the United Kingdom market.

Preliminary studies showed that the pigments present in fruit of different types grown in Nigeria consist mainly of β-carotene with small amounts of lycopene, α- and γ-carotenes and other carotenoids. Their content varied from 5 to over 2000 p.p.m. expressed as crude carotene. These results were in agreement with the studies made of oil from different countries by Hunter and his co-workers.[1] The methods employed in the United Kingdom for bleaching palm oil were also studied and standardised procedures were adopted as described below. Whilst the art of the refiner in the use of different bleaching earths, temperatures and other processes may succeed in improving the final product obtained from an unsatisfactory oil, the purpose of this study was to ascertain the fundamental causes of the poor bleachability of Nigerian oil.

Methods of producing oil

The methods by which edible palm oil is prepared in Nigeria can be classified as follows:

(1) *Peasant production*, which can be sub-divided into (*a*) primitive methods involving trampling and the use of a crude type of pestle and mortar, and (*b*) a method involving the use of a hand press.

The fruit remains several hours, often some days, after harvesting before it is processed. The processed oil is sold, usually in small amounts, to middlemen who pass the oil on to licensed buying agents and to the Bulk Oil Plant. During its long progress from peasant-producer to the Bulk Oil Plant, the oil is frequently heated.

(2) *Pioneer oil mills.*—These mills can be regarded as a simplified form of the more complicated mills operated on plantations, but it might be noted that sterilisation in the Pioneer oil mill is normally carried out in the presence of air. After the oil has been produced, it is subjected to two heat treatments. The fruit being processed is often several days old.

(3) *Plantation production.*—This represents less than 10% of the total Nigerian exports of edible palm oil. Whilst milling methods vary only slightly between one plantation and another, the oil is usually cleaned in the mill by methods similar to those applied in the Bulk Oil Plant.

Oil from (1) and (2) above is purified in the Bulk Oil Plant. The oil is decanted from drums and passed through heaters to Laval screens at a temperature of about 60°. The oil is then further heated to about 80° and passed to Westphalia nozzle separators where it is treated with hot water. The temperature of the oil is then raised further to about 100° when it is passed through high-speed centrifuges to remove all visible water. The oil then goes to a ' degassing ' unit to reduce further the moisture content. The finished oil contains less than 0·1% of moisture.

It was considered probable that the comparative difficulty of bleaching Nigerian palm oil was due to one or more of the following factors:

(*a*) The darker colour of Nigerian oil. The carotene content of Malayan oil is about 500 p.p.m., whereas the samples of commercial Nigerian oil which we have examined have contained between 800 and 1600 p.p.m. of carotene.

(*b*) The different variety of palm grown. In Malaya and Sumatra nearly all the oil is produced on plantations, from palms of the ' Deli ' type, whereas in Nigeria most of the oil is from wild trees of the *dura* and *macrocarya* varieties.

(*c*) Differences in climatic conditions.

(*d*) Different processing methods which might be inferior to those used in Malaya.

In order to determine whether the difficulty of bleaching Nigerian oil was due to varietal or climatic factors, a number of special samples were prepared, care being taken to minimise

bruising the fruit, delay in processing after harvesting, heating, oxidation and contamination with iron. It was hoped that these samples would represent the oil in the 'virgin' state—that is, before harvesting.

Experimental and results

The methods by which the special samples were prepared were as follows:

(A) (Based on African methods of production.) The bunch was lowered to the ground by a rope so as to avoid bruising the fruit and immediately sterilised by immersion in boiling water for 1 h. The fruit was then crushed in a wooden pestle and mortar. After removal of the nuts by hand, the pulp was hand-pressed and the resultant suspension of fibre in oil filtered through glass wool. The procedure of simple filtration may be contrasted with the drastic methods applied at the Bulk Oil Plants described earlier, while the transit of the oil in drums and the handling by middlemen were completely obviated. This method was used for Samples 1–4 (Table I).

(B) (Based on plantation procedure.) The fruit was harvested and, 2 h. later, sterilised in clean sacks by exposure to steam at 135° and 2 atmospheres pressure, for 45 min. The nuts were removed by hand, the pulp was hand-pressed and the oil filtered through a double filter paper. More rapid handling of the fruit from collection until sterilisation, and the use of less drastic methods of processing, distinguish this procedure from that currently employed in plantations. This method was used for Samples 5–10 (Table I).

Bleaching tests

In the oil refining industry, palm oil is usually bleached by treatment with an activated earth or by heating or by a combination of these two processes. After comparisons of various conditions, three standard bleaching tests were adopted. These were as follows:

(1) *Earth bleaching.*—The oil (50 g.) was stirred at 105 ± 1° for 1 h. with Fulmont 700C grade Fullers' earth (2·5 g.).

(2) *Heat bleaching.*—The oil was heated under nitrogen at 230 ± 2° for 30 min.

(3) *Combined heat and earth bleaching.*—The oil (50 g.) was heated under nitrogen at 230 ± 2° for 45 min., Fullers' earth (0·5 g.) being added after 30 min.

Table I

Samples of specially prepared palm oil

Sample No.	Free fatty acid content,* %	Iron content, p.p.m.	Peroxide value†	$E^{1\%}_{1\,cm.}$ at 230 mμ	Carotene content, p.p.m.	Residual colour after bleaching		
						With earth	With heat	With heat and earth
Dura variety								
1	0·71	—	0	1·64	648	7	38	—
2	3·03	—	0	1·78	762	9	43	—
3	0·28	—	0·6	2·35	2226	68[a]	48	20
4	0·11	2·2	2·1	1·77	1547	32[b]	108	23
Tenera variety								
5	0·22	0·4	0	1·58	622	3	84	16
6	0·34	8·7	0	1·62	652	14	53	29
Malayan origin								
7	0·29	1·2	0	1·77	648	6	105	16
8	0·39	5·6	0	1·52	478	5	51	17
9	0·31	1·3	0	1·52	946	9	80	22
10	0·38	3·1	0	1·60	538	4	48	20
Malayan[c] mostly 'Deli'	4–5	3–15	0·5–2·0	2·6–3·1	300–500	10–25	about 100	60–70

[a] With an increased amount of earth (in all 15%) residual colour was 13.
[b] ,, ,, ,, ,, ,, ,, (in all 7·5%) ,, ,, ,, 17
[c] Commercial Malayan oils for comparison

* as palmitic acid † ml. of 0·002N-thiosulphate/g. of oil

The colours of oils were determined with a Lovibond Schofield Tintometer. The term Residual colour ' is used to denote the colour after bleaching, expressed as (10 × Red Lovibond Units + Yellow Lovibond Units) for a 1-in. cell.

The specially prepared samples (Table I) had exceptionally good bleachability in all three bleaching tests. The residual colours were, in most cases, below the range found for Malayan oil.

Higher residual colours after earth bleaching were found for Samples 3 and 4, as compared with the other samples. Samples 3 and 4 have unusually high carotene contents (1547 and 2226 p.p.m.), however, and an increase in carotene content would be expected to affect the colour after bleaching. Nevertheless, Samples 3 and 4 are seen to have good earth-bleachability by comparison with many of the normal production samples given in Table II, which have lower carotene contents but higher residual colours after earth bleaching. Moreover, the specially prepared Sample 3 had a residual colour only slightly higher than that of Malayan oil, although it contained over three times as much carotene.

The specially-prepared samples, representing oil from all varieties of palm, therefore had greatly superior bleachability to commercial Nigerian oil and were generally comparable to Malayan oil. It was concluded that the inferior bleachability of commercial Nigerian oil was due to different processing methods, and not to climatic or varietal factors or, primarily, to differences in carotene content.

Effects of heat, oxidation and iron contamination on bleachability

Three of the specially prepared samples (Nos. 5, 7 and 9 in Table I) were found to be unaffected by heating at 105° for 3 h.; also, no changes in carotene content or in earth-bleachability were observed when a current of air was passed (these samples contained about 1 p.p.m. of iron), but, in the presence of added iron, oxidation caused a deterioration in the bleachability of these samples (see Table III). The specially prepared samples containing greater amounts of iron suffered a deterioration in bleachability when air was passed in the absence of added iron. Also, two series of samples drawn at various stages in the processing at a Bulk Oil Plant

Table II

Samples of Nigerian palm oil

Sample No.	Free fatty acid content,* %	Iron content, p.p.m.	Peroxide value†	$E^{1\%}_{1\,cm.}$ at 230 mμ	Carotene content, p.p.m.	Residual colour after bleaching		
						With earth	With heat	With heat and earth
1	3·32	14·2	0·4	1·98	1171	51	100	31
2	3·57	6·1	0	1·37	847	37	90	37
3	4·90	10·4	0	1·91	1395	118	105	31
4	5·33	7·8	0	1·62	932	60	102	40
5	3·39	18·0	0·1	1·92	1260	44	102	50
6	4·21	5·6	1·2	2·23	1446	85	79	25
7	3·90	5·1	1·4	2·38	1287	100	87	32
8	3·22	4·4	0·7	2·30	1285	100	74	30
9	3·14	6·1	1·0	2·16	1250	85	74	40
10	3·86	6·2	0	1·97	1053	26	90	34
11	3·78	13·8	8·8	3·63	1096	73	116	55
12	3·92	14·0	6·2	3·18	1082	56	85	40
13	3·74	14·3	1·1	2·84	787	46	85	50
14	3·45	17·8	4·0	3·34	1115	54	83	66
15	4·23	2·9	0·4	2·71	812	30	140	88
16	1·67	7·0	6·6	3·29	1302	63	90	45
17	2·49	5·8	3·1	2·84	1402	90	69	48
18	1·74	7·8	2·6	2·90	1573	102	80	43
19	2·00	3·8	4·4	3·00	1289	70	112	48
20	1·67	9·4	2·4	2·72	1326	82	82	46
21	2·22	9·6	1·9	2·14	1329	90	104	57

Samples 1–5: Native-produced oil. Samples 6–10: Oil from Pioneer oil mills
Samples 11–14: Oil after processing at Bulk Oil Plant
Samples 15–21: Plantation produced oil. Samples 1–14 were taken in Nigeria, 15–21 on arrival in the United Kingdom

* as palmitic acid † ml. of 0·002N-thiosulphate/g. of oil

were examined. For both series, there was a marked increase in the peroxide value and $E^{1\%}_{1\,cm.}$ at 230 mμ in the 'degassing' process. For one of the series, the bleachability of the oil deteriorated at the same time. It was, therefore, concluded that iron-catalysed atmospheric oxidation can cause a deterioration in bleachability.

In the experiments reported in Table III it was necessary to destroy a large part of the carotenoid pigments in order to cause a major deterioration in the bleachability of the oil. Furthermore, many of the samples described in Table II had poor bleachability despite a low iron content; these samples, presumably, can have undergone little atmospheric oxidation. The major cause of the deterioration in bleachability of the oil must, therefore, be some factor or factors affecting the oil at an earlier stage in the processing.

Table III

Effect of oxidation on earth bleachability of samples of easily bleached palm oil

The samples were heated at 105°, and a current of air was passed for 1 h. (Samples 5–10) or 3 h. (Samples A–D)

(A = values before oxidation B = values after oxidation)

Sample no.	Iron content, p.p.m.	Iron added, p.p.m.	Carotene content p.p.m. A	Carotene content p.p.m. B	Peroxide value* A	Peroxide value* B	Residual colour after earth bleaching A	Residual colour after earth bleaching B
As Table I								
No. 5	0·4	0	622	617	0	0	3	3
		10	622	72	0	0	3	14
No. 7	1·2	0	648	610	0	0·8	6	5
		10	648	543	0	7·5	6	14
No. 9	1·3	0	946	904	0	0·9	9	11
		10	946	441	0	6·8	9	26
No. 6	8·7	0	652	479	0	13·2	14	19
No. 8	5·6	0	478	470	0	5·1	4·5	6
No. 10	3·1	0	538	546	0	3·4	3·5	4
Samples of Cameroons plantation oil								
A	4	15	909	28	10·0	105·3	22	55
B	7	13	696	332	1·2	9·0	11	19
C	4	20	882	36	1·2	63·1	18	38
D	5	15	743	49	1·4	94·0	22	45

* ml. of 0·002N-thiosulphate/g. of oil

Effects of enzymic oxidation

The factor which seemed most likely to affect, at an early stage, the bleachability of palm oil, was enzymic action resulting from bruising and also from delays in processing. Accordingly, two series of samples were prepared by Method A described above, but with various intervals between harvesting the fruit and preparing the oil, using bruised and unbruised fruit respectively. Also, one sample was prepared on a Cameroons plantation from bruised fruit by the Method B above. The data obtained for these samples are given in Table IV. In view of the variation in the carotene contents of the samples, it is necessary to compare the values with those of the corresponding specially prepared samples described in Table I.† For the bruised fruit, a 4 days' delay in processing did not affect the bleachability of Sample A4, whereas comparison with Sample 4 in Table I shows that Samples A2 and A7 suffered considerable deterioration of earth-bleachability. For this series of samples, there is a steady deterioration of the heat- and combined heat–earth-bleachability with increasing processing delay.

For the series of samples prepared from unbruised fruit, there is no apparent deterioration of heat- and combined heat–earth-bleachability up to 4 days after processing, although a major deterioration is apparent for the late samples. Considerable deterioration of earth bleachability has occurred, as is shown by comparison of Samples C2 and C4 with Co and of C16 with C1. Sample C8 has extremely bad earth-bleachability compared with Sample 3 in Table I. Sample

† The samples in Table I are not regarded as an absolute standard for good bleachability. Samples 5–10 were prepared 2 h. after harvesting, and Samples 3 and 4 show signs that some oxidation has occurred. In view of this, it is considered that these samples represent, at least, the bleachability which should be attained by satisfactory processing.

Table IV

Effect of delay in processing on the bleachability of palm oil

Description of sample	Length of delay, days	Free fatty acid content,* %	Moisture content, %	Iron content, p.p.m.	Peroxide value†	$E^{1\%}_{1\,cm.}$ at 230 mμ	Carotene content, p.p.m.	Residual colour after bleaching		
								With earth	With heat	With heat and earth
Samples from bruised fruit										
A0	0	0·87	0	0	0	1·5	631	8	60	42
A2	2	0·44	0·05	0·6	0	1·91	1583	120	76	49
A4	4	1·20	0·06	0·8	0	1·66	687	9	95	63
A7	7	1·99	0	0	0	1·98	1322	63	100	68
B	7	7·52	0·59	11·7	2·0	1·93	550	32	110	77
Samples from unbruised fruit										
C0	0	0·21	0·07	2·0	0	1·72	1677	45	61	39
C¼	0·25	0·66	1·58	0·4	0·6	2·08	2935	185	60	60
C½	0·5	0·40	—	0·2	0·1	1·63	1085	32	40	28
C1	1	0·42	0·03	0·4	0·8	1·84	1208	27	30	28
C2	2	1·3	0·06	0·3	0	1·67	1842	105	71	38
C4	4	0·93	0·04	1·2	0·1	1·81	1877	90	70	38
C8	8	4·6	0·11	1·0	0·1	1·91	2163	190	102	76
C16	16	18·8	0·35	0·4	0·6	1·95	1283	153	114	135

* as palmitic acid † ml. of 0·002N-thiosulphate/g. of oil

C¼, with the unusually high carotene content of 2935 p.p.m., gave a residual colour of 185 in the standard (5%) earth bleaching test. For comparison with Sample 3 in Table I (carotene content 2226 p.p.m., residual colour 68), Sample C¼ was bleached with 7·5% of earth, when a residual colour of 118 was obtained, showing that considerable deterioration of bleachability can occur when processing is delayed even for a few hours. It is noteworthy that the extent to which the bleachability deteriorates appears to depend on the carotene content of the oil as well as the length of processing delay; highly pigmented oils deteriorate rapidly, while samples with low carotene contents are not greatly affected by a few days' delay. For instance, Sample B in Table IV, containing 550 p.p.m. of carotene and prepared 7 days after harvesting, has bleachability only slightly inferior to that of Malayan palm oil.

The enzyme lipoxidase (which has been detected in a wide range of vegetable materials) is known to effect a coupled oxidation of carotenoids and unsaturated fatty acids.[2] Samples of ripe and unripe fruit, forwarded packed in charcoal, were accordingly assayed for lipoxidase activity. In each of nine experiments, the mesocarp of a single palm fruit was defatted by repeated extractions with light petroleum at room temperature, and then the fat-free material was extracted with acetate buffer, pH 4·5 (25 ml./g.). The extract was examined for lipoxidase activity according to Holman's procedure.[3] For individual ripe and unripe fruit, values of 1·9–10·0 units of lipoxidase activity/g. were observed.

To determine the effect of oxidation with lipoxidase on the bleachability of palm oil, experiments were conducted similar to those described by Koch *et al.*[4] Coarsely-ground haricot beans (2·5 g.) were shaken for 10 min. with 125 ml. of water, and then the whole slurry was mixed in a high-speed homogeniser for 10 min. with 100 ml. of a sample of easily-bleached palm oil at 30°. Centrifuging at 1500–2000 r.p.m. then gave a 60–70% recovery of oil. The carotene content, peroxide value, extinction coefficient at 230 mμ and bleachability were then redetermined for the oxidised oil and compared with the corresponding values for the original oil (Table V). These experiments show that, as with autocatalytic oxidation, enzymic oxidation causes a deterioration in the bleachability of palm oil. This deterioration was observed for all three bleachability tests, although in one instance there appeared to be a slight improvement in heat bleachability. The more highly pigmented samples deteriorated to a greater extent than did the lighter-coloured oils. In contrast to the results of the earlier studies of atmospheric oxidation, a considerable deterioration could be observed without total destruction of the carotenoids.

The conditions of these experiments do not reproduce those occurring in the palm fruit as shown by the changes in peroxide value, carotene content and $E^{1\%}_{1\,cm.}$ at 230 mμ. It appears that the laboratory experiments involve a much more rapid oxidation than that obtaining in

Table V

Effect of oxidation with lipoxidase on palm oil

(The haricot bean extract assayed as described in the text had a lipoxidase activity of 2·51 units/ml.)

(A = before oxidation B = after oxidation)

Expt. no.	Carotene content, p.p.m.		Peroxide value*		$E^{1\%}_{1\,cm.}$ at 230 mμ		Residual colour after earth bleaching		Residual colour after heat bleaching		Residual colour after heat and earth bleaching	
	A	B	A	B	A	B	A	B	A	B	A	B
1	618	212	5·4	10·5	3·8	8·31	23	34	—	—	—	—
2	478	245	0	26·7	1·52	8·20	—	—	51	52	17	29
3	542	391	3·0	6·5	2·16	4·85	7	15	—	—	—	—
4	934	683	1·5	4·9	2·17	3·96	34	84	—	—	—	—
5	934	797	1·2	30·2	2·00	10·16	—	—	56	62	48	63
6	1060	604	1·4	5·2	1·96	4·82	23	54	—	—	—	—
7	1060	826	1·4	3·6	1·96	—	—	—	98	92	38	70
8	712	—	2·4	11·9	2·05	—	24	38	—	—	—	—
9	1100	279	1·2	5·4	2·62	4·51	8	23	—	—	—	—
10	1060	1045	1·4	1·6	1·96	2·17	23	40	—	—	—	—
11	696	277	1·2	3·6	1·93	—	—	—	82	100	35	88

* ml. of 0·02N-sodium thiosulphate/g. of oil

palm fruit ; it may well be that much slower oxidation would result in a more selective oxidation of the carotenoid pigments.

In order to confirm that the lipoxidase activity detected in palm fruit was capable of oxidising palm oil, an experiment was conducted (No. 10 in Table V) similar to the above but using defatted palm fruit mesocarp instead of haricot beans. In this experiment, a considerable deterioration of bleachability was observed, even though there was little change in the carotene content, peroxide value and $E^{1\%}_{1\,cm.}$ at 230 mμ. This supports the hypothesis that a less drastic oxidation might result in a greater deterioration of bleachability with less glyceride oxidation. On the basis of the lipoxidase assay of palm fruit mesocarp, the activity of the extract used would have been approximately one-fifth that of the haricot bean extract.

From these studies, it was concluded (1) that the major damage to the bleachability of Nigerian native-produced oil is caused by bruising the fruit and delay in processing the oil, and (2) that this damage can be attributed to the action of the enzyme lipoxidase.

Additional factors

Other factors were also found to have an adverse effect on the bleachability of palm oil. Samples of easily-bleached oil were mixed with oil having poor bleachability and a higher free fatty acid content (mixing of highly acid oil with better oil, so as to reduce the acidity of the mixture, is by no means unusual in Nigeria, where oil having a free fatty acid content, as palmitic acid, greater than 4·5% is not accepted as edible grade oil). The mixtures thus obtained had, in most cases, bleachability inferior to that calculated from the separate values for the samples of oil used. Secondly, samples of oil taken before and after shipment to the United Kingdom were examined to detect any change in bleachability. Two of the three pairs of samples were unchanged, while the third pair showed a slight deterioration.

In the usual marketing of Nigerian oil it is subjected to frequent heating in iron containers. Contamination with iron and oxidation can cause deterioration in good-quality oil. Another factor is the effect of processing methods on bleachability. It is understood that in Malaya the crude oil is usually cleaned by counter-current washing, a procedure seldom employed in Nigeria. Two plantations in the Cameroons are now equipped with counter-current washing : samples of normal commercial production (carotene contents 696–1060 p.p.m.) were found to bleach as easily as Malayan oil (residual colours 10–28 after earth-, 68–98 after heat-, and 26–48 after combined heat–earth-bleaching). This suggests that counter-current washing is to be preferred to the other processing methods at present employed in Nigeria.

Pigments remaining after bleaching

Finally, attention was turned to the nature of the colouring matter remaining after earth bleaching. So as to detect any differences in the pigment composition of samples having good and bad bleachability, two such samples were bleached to the same residual colour (100)

by using 3 and 5% of earth respectively. The absorption spectra of the bleached oils, A and B (see Fig. 1) show that the bleached oils contain a complex mixture of pigments. However, the inferior oil contains approximately twice as much material absorbing at 350 mμ and half that absorbing at 450 mμ, in comparison with the oil of good bleachability. It seems likely that oxidation products of β-carotene ($\lambda_{max.}$ 445 mμ) would absorb at shorter wavelengths. Moreover, some evidence was obtained that the materials absorbing about 350 mμ were less readily absorbed on Fullers' earth than the carotenoids: treatment of these two samples (with residual colour 100) with 1% of earth gave a final colour of 4 for the easily bleached oil (A) compared with 23 for the less easily bleached oil (B). Further work on the exact nature of the residual colouring matter is in progress.

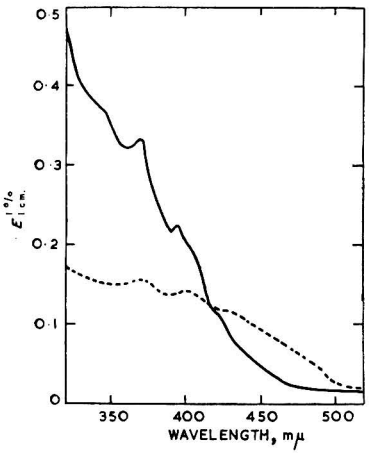

FIG. 1.—*Absorption spectra of two palm oils bleached to the same colour*
——— sample having poor bleachability, treated with 5% of Fullers' earth
- - - - - - - - sample having good bleachability, treated with 3% of Fullers' earth

Conclusions

It has been shown that palm oil with good bleachability can be obtained from Nigerian palm fruit if sufficient care is taken in the processing. However, Nigerian native-produced oil generally becomes difficult to bleach as a result of the following factors:

(1) (the main factor) Oxidation of the oil by lipoxidases, occurring when unbruised or, more generally, bruised unsterilised fruit is left for various periods before the extraction of the oil.

(2) Atmospheric oxidation, which is catalysed by iron, may cause a further deterioration in the bleachability of the oil during processing including the final cleaning at the Bulk Oil Plant.

(3) The mixing of oils having good and bad bleachability often results in a deterioration of the bleachability of the combined oil.

The enzymic oxidation of the oil appears to result in the formation from the carotenoid pigments of yellow materials which are less readily absorbed on Fullers' earth, and less readily degraded by heat than the original carotenoids. As regards earth bleaching, an increase in the polarity of the oil resulting from oxidation may affect the bleachability.

There is a considerable weight of evidence that the extent to which the bleachability of a sample deteriorates is dependent upon its carotene content. That is, an oil having a high carotene content is more liable to deteriorate than an oil with a low carotene content.

This would appear to be the main reason for the inferior bleachability of Nigerian oil as compared with Malayan, especially when both samples are of plantation origin. Nigerian oil, which generally has a high carotene content can, if carefully prepared, have excellent bleachability. However, if not prepared immediately from preferably unbruised fruit, the bleachability deteriorates rapidly. On the other hand Malayan oil (and low-carotene oil from the Cameroons) can have good bleachability even when prepared under conditions which would render more pigmented oils difficult to bleach. Other factors, such as counter-current washing (seldom used in Nigeria) may also affect the bleachability of Nigerian oil compared with Malayan.

Acknowledgments

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THE pC VALUE OF SOILS AND ITS EFFECT ON THE TOMATO CROP*

By R. E. BUTTERS†

The percentage of blotchy ripening of tomato fruit decreases as the soil pC value becomes lower, but total yield and size are reduced at pC values below 3·0 (measured on the 1 : 2½ extract).

Gypsum showed only very slight, if any, effect on plants from applications sufficient to saturate the 1 : 2½ extract. The conductivity of the soil solution and of the saturation extract (which closely resembles it) gave good correlation with the fresh weight of the plants, regardless of the gypsum content of the soil. There was, however, no correlation between the 1 : 2½ extract values and plant weight, because of the soils with a high gypsum content.

It is suggested that there should be a change to the use of an extract more closely resembling the soil solution and that the direct conductivity value should be used in place of the pC figure.

Introduction

In the commercial glasshouses at Fernhurst some of the tomatoes are grown in raised concrete beds, 6 in. deep and 3 ft. wide. This method of culture had been started in 1951 in order to reduce to an economic level, the volume of soil for annual steam sterilisation. As the volume of soil concerned is small, it is possible to fill the beds with the most desirable compost. The John Innes Potting composts were chosen because of their excellent physical structure and their established reliability over many years (earlier experiments had shown that Potting Compost No. 1 was the best for use in raised beds).

The original aim of the experiments was to determine the effect of different amounts of feeding, but as the work developed, a closer study was made of the relation of soil analysis to crop yield, so that feed applications could be based on a soil analysis. It had already become the practice to start feeding some time in April (from mid-February planting) according to the growth of the crop, and to feed at alternate waterings throughout the season with a high-potash liquid feed. Although yields up to 83 tons per acre had been obtained in this way, it was still desirable to improve the quality of the fruit. In 1955, while these feeding experiments were in progress, considerable publicity was being given to the view that the presence of gypsum in glasshouse soils was responsible for depressing yields of tomatoes.[1, 2] On the

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other hand it had been suggested that plants are not damaged by sulphates although the salt concentration appears to be high. As neither view appeared to have been substantiated some investigations were carried out at the end of 1955 to compare the effect of heavy applications of gypsum and of fertilisers on the growth of tomatoes.

In 1956/7 the trials had three main objects, (*a*) to ascertain whether the concentration of the soil solution, with which the plant roots are in contact, is correlated with plant growth, regardless of whether sulphates are present ; (*b*) to show that it is the method of determination of the salt concentration which has led to confusing results where gypsum is present and (*c*) to show the advantage of a method of determination using an extract closely resembling the soil solution, such as the saturation extract.

It should be made clear here that the soil used in the feeding experiments had a very low gypsum content except where this salt was deliberately added.

Experimental

Layout

Investigations into the effect of different feeding programmes began in 1953. A replicated experiment was laid down with four replicates of three treatments, each plot containing 20 plants. The experiments in 1954–6 had the same size of plot, but with four replicates of six treatments. In the raised beds (1953–5) the plots were separated by asbestos sheets reaching from the bottom of the bed to above soil level and the fruit yield was recorded from all 20 plants in each plot. In the glasshouse borders (1956) a line of bricks embedded in the soil between plots prevented water from running on the surface. Only 16 plants in each plot were recorded, the end two in each being treated as guard plants. John Innes Potting (JIP) Compost No. 1 was used both in the raised beds and in the containers. Varieties were Potentate in 1953 and 1954, and Ware Cross in 1955 and 1956. In all seasons planting took place in February and feeding commenced in April.

Treatments

In each season, the start of feeding was decided by the general appearance of the crop, and then continued according to the treatments until the end of the season. Watering was done at the rate of $\frac{1}{2}$ in. ($2\frac{1}{8}$ gal./sq. yd.) per application so that the amounts of nutrients given to each treatment were known. All watering was by hose in 1953, but in the other experiments watering cans were used for some treatments. In the first few weeks of the crop, only small amounts of water were applied around the base of the plant as is usual in commercial practice (ball-waterings). Once normal watering started, the soil moisture at 3 in. depth was maintained at tensions ranging up to 10 cm. Hg by normal watering, except where higher tensions were deliberately allowed to develop (1955).

The basic feeding programme used was a high-potash liquid feed applied at alternate waterings. The dilute solution applied to the soil contained N 198 p.p.m., P_2O_5 107 p.p.m., K_2O 337 p.p.m. and MgO 18 p.p.m.

The first trials with gypsum were conducted with tomatoes from the pricking-out stage, up to the flowering of the second truss, with plants potted in John Innes No. 1 Potting Compost. Gypsum was added to some treatments at 11·6 lb./cu. yd. which gave a saturated solution of gypsum in an extract with a soil/water ratio of 1 : $2\frac{1}{2}$. The effects of low pC values obtained from gypsum were compared with those given by Nitro-chalk and ammonium nitrate.

In 1956/7 tomato seedlings in pots were again used, there being 70 plants per treatment. Nine plants of each treatment were removed at intervals, weighed to give an estimate of the growth and the soil tested for salt concentration by three different methods.

Other details of treatments are dealt with in the account of their particular experiment.

Grading of fruit

All fruit was graded as follows :

A. (1st quality)—evenly ripened, of good shape and of medium size.
B. (2nd quality)—unevenly ripened, regardless of size or shape.

C. (Poor size or shape)—fruit of irregular shape, and too large or too small for A, regardless of evenness of ripening.

This system was devised to show the amount of uneven ripening of fruit, due in the main to blotchy ripening. The total of the percentages will not be 100, as some fruit is placed in two of the grades.

Soil analysis

Throughout the experiments soil samples were taken and analysed at intervals; approximately every month in the feeding experiments and more frequently in the gypsum experiments. The methods were as follows:

Sampling.—A total of 20 borings was taken for each sample with a soil auger to the full depth of the beds or containers (6 in.) and to 12 in. depth in the glasshouse borders. One sample was taken for each treatment in the feeding experiment each month, the 20 borings being divided equally among the replicates.

pH.—A pH meter was used and a soil/water ratio of 1 : 1.

Extraction of nutrients.—Morgan's Extracting Solution was used at a soil/solution ratio of 1 : 5 with shaking for 2 minutes. The results for potash, phosphate and nitrate are expressed as p.p.m. of K, P and N in the soil extract.

Available potash.—In 1953/4 by Tinsley's cobaltinitrite method[3] and from 1955 onwards by use of the EEL Flame Photometer.

Available phosphate.—Sodium molybdate and stannous chloride were used to develop the molybdenum-blue colour as described by Tinsley & Pizer.[4] The colours were estimated in the EEL colorimeter.

Nitrate.—Brucine was used as in the method of Peech & English.[5] The colours were estimated in the colorimeter.

Salt concentration (pC).—The term pC was first used by Whittles & Schofield-Palmer[6] in 1951 and may be defined as the negative logarithm of the specific conductivity of a soil–water extract expressed in mhos. The method of determination used at Fernhurst was based on a soil/water ratio 1 : 2½, chosen because it was the method most widely used in 1952 when tests were first started. Air-dry soil is shaken at intervals for 30 min. with the appropriate quantity of water and then the supernatant liquid is poured off. Conductivity is measured at 20° with a Mullard conductivity bridge.

It was necessary to consider other methods of determination for soils high in gypsum. Gypsum is only sparingly soluble in water and a saturated solution at 20° has a pC of 2·7. This is the lowest pC value that can be reached with gypsum, any further addition of solid to the saturated solution remaining undissolved. As leaching proceeds, any gypsum removed is replaced from the undissolved portion and the soil solution remains saturated at a pC of 2·7. In the preparation of the 1:2½ extract, the added water dissolves some more of the gypsum and if enough of this salt is present the solution tested will also be saturated giving a pC of 2·7. Should the amount of gypsum be too small to give a saturated solution for testing, the pC will be higher than 2·7 although the soil solution itself is again saturated. This suggests that plants may respond in the same way even when pC values are different.

In the gypsum trials in 1956/7 all soil samples were tested for salt concentration on the normal 1:2½ extract and on two other extracts as follows:

A. *Saturation extract.* The paste was prepared from air-dry 2-mm. soil and distilled water, as described by Richards *et al.*[7]

For the John Innes composts, the criteria were met by a mixture of 150 g. of soil and 95 ml. of water. The paste was kept for 5 h. (i.e., long enough for the gypsum to come into solution) before filtration through a No. 2 paper in a Buchner funnel under suction.

B. *Soil solution.* The 1:2½ extract and the saturation extract were made on air-dry 2-mm. soil, whereas the soil solution was extracted 3 h. after the soil had been thoroughly wetted in the clay pots, this period permitting the salts and in particular the sparingly soluble gypsum to come into equilibrium with the added water. Soil from six pots was mixed and packed uniformly with a metal plunger into the brass cylinder of the apparatus suggested by White &

Ross.[8] The soil solution was displaced by water under a pressure of 30 lb. p.s.i. of air supplied to the top of the cylinder, and filtered through a No. 50 filter paper at the base.

With J.I. composts there is very little difference in soil/water ratio between the soil solution and the saturation paste. With heavier soils, the ratios are different owing to their lower content of grit etc., and much lower water content at field capacity. Thus with J.I. composts the conductivity of the saturation extract closely resembles that of the soil solution. In soils of finer texture the saturation extract is more dilute than the soil solution. The author's experience so far has only been with J.I. composts, but American results[7] suggest that there is a reasonably constant relationship between the saturation percentage and the field-moisture content.

Results

(1) Feeding experiments

1953 *Trial*

Treatments and yields are shown in Table I. No differences in growth were observed until the end of May, when plants receiving no feed had grown beyond the overhead wires and began to show slight yellowing of foliage. By the end of June there was much yellowing of foliage and some marginal scorch indicating potash deficiency on the young leaves. Later, deficiency symptoms of all three major nutrients N, P and K could be discerned. No differences in the plants could be seen at any time between treatments 2 and 3.

Table I

Effect of feeding on tomato yield and quality (1953)

	Total yield, lb./plant	% A quality	Trans-formed	% B quality	Trans-formed	% C quality	Trans-formed
1. No feeding	10·46	20·2	26·6	70·4	57·0	24·9	29·8
2. Alternate waterings	12·37	27·9	31·9	61·5	51·7	20·7	27·0
3. Every watering	11·45	36·9	37·4	50·1	45·1	20·7	27·0
Sig. diff.							
P = 0·05	0·52	—	4·7	—	4·1	—	1·4
P = 0·01	0·79	—	7·2	—	6·2	—	2·1

The monthly yields from Treatment 1 were significantly reduced from July onwards, and those from Treatment 3 were lower than those from Treatment 2 from August onwards. Fruit quality was adversely affected by Treatment 1 from June onwards, and quality from 3 was superior to that from 2. It is obvious that ' no feeding ' is unsatisfactory for both yield and quality.

The extra feed provided by Treatment 3 in comparison with no. 2 improved quality and reduced blotchy ripening, but the yield dropped by about 1 lb. per plant, presumably due to the lower pC values, although no visible signs of damage to the plants were seen. During June and July the pC values from every watering were around 2·80 whereas those from alternate waterings never fell below 3·00. It was from June onwards that quality was improved by Treatment 3 and from August onwards the yield from this treatment was significantly lower. Levels of K, P and NO_3^- were high throughout the season with ' every watering ' but it was not possible to conclude which element was responsible for the improved quality.

The cash value of the fruit from the two feeding treatments showed that the gain from improved quality was outbalanced by the loss of 1 lb. per plant in yield. It was obviously desirable therefore to feed frequently to obtain good quality but to keep the pC value above 3·0.

1954 *Trial*

The alternate and ' every watering ' treatments were repeated, but in addition the extra feed given in the ' every watering ' treatment was split into the four nutrients, applying the N, P, K and Mg separately. Thus ' alternate waterings + N ' received the same amount of N as Treatment 2 and the same amounts of P, K and Mg as in Treatment 1. The additional N, P, K and Mg was applied in solution as urea, phosphoric acid, sulphate of potash and magnesium sulphate, respectively. These treatments were designed to show which nutrient was responsible for the improved quality. Details of treatments and yields are shown in Table II.

Table II

Effect of increased feeding with N, P, K or Mg on tomato yield and quality (1954)

	Total yield, lb./plant	% A quality	Trans-formed	% B quality	Trans-formed	% C quality
1. Alternate watering	11·72	22·5	28·3	56·3	48·7	29·8
2. Every watering	11·61	30·9	33·8	48·1	43·9	27·6
3. Alternate waterings + N	11·30	30·6	33·6	47·0	43·3	28·6
4. ,, ,, + P	11·81	26·2	30·1	51·6	45·9	30·7
5. ,, ,, + K	11·71	28·6	32·3	48·9	44·4	28·2
6. ,, ,, + Mg	11·71	25·6	30·4	52·4	46·4	29·6
Sig. diff.						
P = 0·05	Not sig.	—	2·4	—	2·1	Not sig.
P = 0·01		—	3·3	—	2·9	

No consistent differences between treatments were found in growth, appearance or yield of fruit, but differences in quality were again apparent. Fruit from Treatments 2, 3 and 5 was superior to that from Treatment 1 and all treatments had less B quality fruit than Treatment 1. These improvements were recorded right from the start of picking in May, although feeding did not commence till late April. There were no significant differences in the C grade fruit.

The pC values for the six treatments are shown in Fig. 1. The graphs for available potash, available phosphate and nitrate (not shown) indicate almost identical levels in the soil where the same amounts of these elements had been applied (i.e., Treatments 2 and 5 for K, Treatments 2 and 4 for P, and Treatments 2 and 3 for NO_3^-).

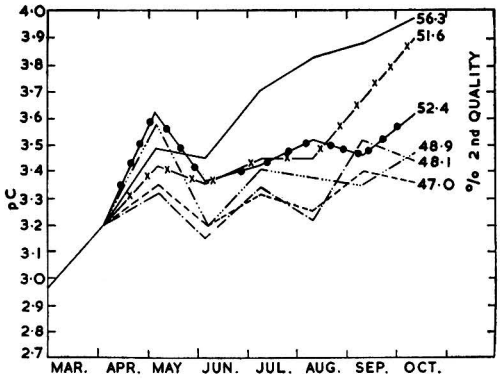

FIG. 1.—*pC values of 1 : 2½ extract showing effects of increased feeding with N, P, K or Mg*

(Raised beds 1954)

'Every watering' gave fruit of better quality than 'alternate waterings' as it did in 1953, but there was no reduction of yield. No single nutrient was found to be responsible for the improvement in quality. Nitrogen gave results equal to those of 'every watering'; potash also gave a considerable improvement; and even treatment with phosphate and magnesium gave slightly less blotchy ripening than 'alternate waterings'. The fact that even with 'every watering' the pC never fell below 3·15 explains why this treatment did not reduce yield as it did in 1953.

Fig. 1 shows a close direct relation between pC value and % blotchy ripening—the lower the pC the better is the fruit quality. It can thus be said that increase in concentration of the soil solution has improved quality, irrespective of the nutrient responsible. The results confirmed that pC values should be kept as near 3·0 as possible.

1955 *Trial*

The effects of pC values down to 2·75 were determined. To prove that the better quality was due to low pC and not to the addition of any one nutrient, a treatment was included in which a non-nutrient salt was used to increase the concentration of the soil solution. Details of treatments and yields are shown in Table III.

Table III

Effects of feeding and drier soil conditions on tomato yield and quality (1955)

	Total yield, lb./plant	% A quality	Trans-formed	% B quality	Trans-formed	% C quality	Trans-formed
1. Alternate waterings	14·35	61·4	51·7	22·4	28·1	17·2	24·5
2. Every watering	13·56	71·2	57·6	13·2	21·2	16·0	23·6
3. Alternate waterings (dry)	13·28	63·2	52·7	20·8	27·1	17·5	24·8
4. ,, ,, + Na_2SO_4	13·56	70·6	57·2	14·2	22·1	17·8	24·8
5. Every watering	13·04	72·1	58·2	11·1	19·3	18·1	25·2
6. ,, ,, (triple)	10·63	64·5	53·4	7·3	15·7	28·7	32·4
Sig. diff.							
P = 0·05	1·03	—	2·9	—	2·4	—	1·7
P = 0·01	1·42	—	4·0	—	3·4	—	2·3

In Treatment 3 where the soil was allowed to dry out to a tension of approximately 20 cm. Hg before watering, the same number of feeds was applied as in Treatment 1 and since it had fewer waterings there were a few consecutive applications. In Treatment 4 the feed and sodium sulphate in solution were applied alternately. The strength of sodium sulphate used was 5 lb. 9 oz. per 250 gal. giving an osmotic pressure of 0·5 atm. which is the same as that of the feeding solution. In Treatments 5 and 6 liquid feed was given right from the start of the ball waterings, and Treatment 5 was fed at the normal strength right through the season, and never received any clear water. Treatment 6 received feed at three times the normal strength, but only so long as the pC did not fall below 2·75. The aim was to see if there was any advantage from this earlier feeding, but it was desirable to avoid any established toxic levels below 2·75.

The extra feeding given to Treatments 5 and 6 in the ball waterings resulted in slightly more vigorous growth for the first 2 weeks after planting, but by mid-April plants with Treatment 6 were shorter and thinner and by mid-July their growth was quite thin and foliage was sparse. Both 'every watering' treatments showed slightly more growth in the tops than 'alternate waterings', Treatment 5 showing the effect by early June, but Treatment 2 not until mid-July. Growth on Treatments 3 and 4 was similar to that with Treatment 1.

Differences in fruit quality were obvious when picking from July onwards: Treatments 1 and 3—bad quality; Treatments 2, 4 and 5—good quality; Treatment 6—fruit small and dull in colour, but evenly ripened.

Treatment 6 markedly reduced yield from June onwards, consistent with pC remaining below 3·0 throughout the season (see Fig. 2). Fruit was generally smaller right from the start of picking, although there was very little blotchy ripening.

Treatment 5 gave a slight but significant reduction in yield although pC values were similar to those in Treatments 2 and 4, but there was much improved quality from the start of picking. The reduction in yield occurred mainly in May, and could be due to the extra vigour resulting from the feed applied as ball waterings.

The lower pC values due to addition of nutrients (Treatment 2) or of sodium sulphate

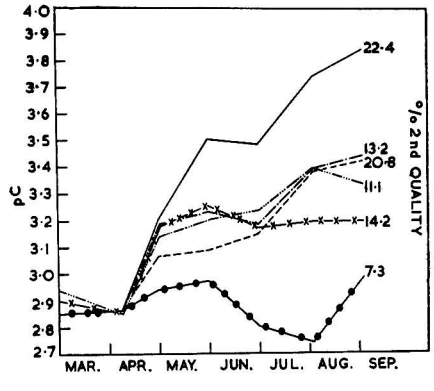

FIG. 2.—*pC values of 1 : 2½ extract showing effects of different feeding programmes and a drier water regime*

(Raised beds 1955)

Treatment 1 ——— alternate waterings
,, 2 —·—·—·— every watering
,, 3 - - - - - - - alternate waterings (dry)
,, 4 —×—×—×— alternate waterings + Na_2SO_4
,, 5 —···—···— every watering
,, 6 —●—●—●— every watering (triple strength)

(Treatment 4) gave much improved quality from the start of picking but no significant reduction of yield. The N, P and K levels in the soil were almost identical in Treatments 1 and 4, where the same amounts were applied, but there was much better fruit quality in Treatment 4 due to the lower pC values. This clearly shows that the effect is due to the salt concentration and not to the increase in level of any nutrient.

Excluding the drier treatment (3), the results confirm that blotchy ripening is influenced by salt concentration in the soil. Results with Ware Cross are similar to those obtained with Potentate.

In the case of Treatment 3, there was a slight reduction in yield, and quality was nearly as bad as Treatment 1. If the effect of a low pC is to reduce uptake of water, so preventing blotchy ripening, as suggested by Kidson & Stanton,[9] then maintaining a drier soil should have a similar effect. In fact, up to the end of June, quality was similar to that with Treatments 2 and 4 and better than Treatment 1, but from July onwards the fruit was equally as bad as in Treatment 1 and it was in June and July that the slight loss of yield occurred. Nitrate levels in the soil of Treatment 3 were higher than in Treatment 1, due to the fact that, although the same amount of feed was applied, fewer applications of clear water were given to Treatment 3 and less leaching occurred. This higher nitrate level resulted in a lower pC than in Treatment 1. The reason why the drier soil and lower pC did not improve quality is discussed later.

1956 *Trial*

Three years' results in raised beds had shown that to obtain the highest quality without reduction in yield it was necessary to maintain pC between 3·0 and 3·2. In 1956 the trial was to show that the same results could be obtained for the more common practice of growing plants in cardboard pots and allowing them to root through into the glasshouse borders. Treatments and yields are shown in Table IV.

All treatments had normal applications of lime, nitrogen, phosphate and potash in the base dressing to the borders. Treatments 1, 2 and 3 were as given in 1955. Treatment 4 had gypsum incorporated before planting, in the borders at 3½ lb./sq. yd. and in the containers at ½ lb. per bushel, and was fed as Treatment 1. For Treatments 5 and 6 pC readings were taken fortnightly to decide the feeding needed to maintain pC values between 3·0 and 3·2. Both treatments received high-K Solufeed at alternate waterings, Treatment 5 receiving additions of high-K Solufeed, and Treatment 6 of sulphate of ammonia as required. All solutions gave an osmotic pressure of 0·5 atm.

There were no visual effects on growth from any treatments. Differences in fruit quality were not significant until July, although the trends showed from the start of picking.

Quality was again related to pC readings. Treatments 5 and 6 gave the lowest percentage of blotchy ripening, Treatment 1 gave poorest quality and other treatments were intermediate. Treatment 3 (sodium sulphate) did not give quite such good quality as Treatment 2, although it did in 1955, and pC values of the two treatments were again similar. With the exception of Treatment 4 pC generally was above 3·0 and as expected no reduction in yield occurred. In Treatment 4 (gypsum), the pC was 2·7–2·8 continuously in the borders and only rose in the

Table IV

Effect of feeding and applications of gypsum on yield and quality of tomatoes grown in glasshouse borders (1956)

	Total yield, lb./plant	% A quality	Trans-formed	% B quality	Trans-formed	% C quality
1. Alternate waterings	10·58	64·8	53·7	19·6	26·2	16·4
2. Every watering	10·51	70·2	56·9	13·9	22·0	15·7
3. Alternate waterings + Na_2SO_4	10·13	67·1	55·0	16·7	24·0	17·4
4. Gypsum	10·40	68·6	56·0	16·5	23·9	15·9
5. pC 3·0–3·2 'Solufeed'	10·40	68·2	55·8	12·8	21·0	18·8
6. pC 3·0–3·2 $(NH_4)_2SO_4$	10·39	70·5	57·1	13·1	21·2	17·1
Sig. diff.						
P = 0·05	Not sig.	—	2·3	—	2·2	Not sig.
P = 0·01		—	3·1		3·0	

pots after leaching. In spite of this, yield was not affected and quality was only slightly improved compared with Treatment 1. These points will be discussed later.

The results, therefore, confirmed the previous findings in raised beds for soils with little or no gypsum present.

(2) Gypsum experiments

Without going into full details of the experiments which have been described elsewhere,[10] the following effects were noted:

(1) Tomato seedlings grown for 8 weeks from pricking out were unaffected by gypsum at 11·16 lb./cu. yd. although the pC was 2·7.
(2) Seedlings at the same stage of growth were affected by ammonium nitrate at rates giving pC values as high as 2·9. At a pC of 2·7 severe damage was caused.
(3) Tomato plants in 9-in. cardboard pots grown to the flowering of the second truss showed no effect from gypsum giving a pC of 2·7. The same pC due to Nitro-chalk gave considerable restriction of growth.
(4) Gypsum did not add to the damage caused by ammonium nitrate when both materials were added to the soil.

Details of treatments and one set of pC readings in this last experiment are given in Table V. JIP.1 compost was used in all treatments, but in Treatments 1–6 and 8–13 ammonium nitrate was added to give levels of nitrogen for JIP.1 to JIP.6. In Treatments 7–13 gypsum was added at 11·16 lb./cu. yd. The gypsum depressed pC values well below those treatments receiving ammonium nitrate only. The plants at the end of the experiment showed no effect from addition of gypsum. At each level of NH_4NO_3 the addition of gypsum had no effect on growth, this being confirmed by statistical analysis of the plant weights. It was thus concluded that high levels of sulphate due to gypsum are not harmful to plant growth, because the concentration in the soil solution cannot rise above that of a saturated solution of gypsum. During 1956, the feeding experiments included a treatment (Treatment 4; see Table IV) in which the soil contained sufficient gypsum to give a saturated solution in the 1 : $2\frac{1}{2}$ extract. This treatment confirmed that these high levels of gypsum are harmless.

1956/7 *Trial*

This experiment was planned to correlate plant weight with the conductivity of three different soil extracts. The treatments were as follows:

1. N at JIP.1 level as hoof + $CaCO_3$ (Ca as in 3).
2. N at JIP.1 level as hoof + $CaCO_3$ (Ca as in 3) + gypsum (11·16 lb./cu. yd.).
3. N at JIP.1 level as calcium nitrate.
4. N at JIP.2 level as calcium nitrate.
5. N at JIP.3 level as calcium nitrate.
6. N at JIP.4 level as calcium nitrate.
7. N at JIP.1 level as calcium nitrate + gypsum (as in 2).

Treatments 3–6 showed the depressing effect on growth of increasing amounts of nitrate, which lowered considerably the pC of both the 1 : $2\frac{1}{2}$ extract and the saturation extract. There were no consistent visible effects due to addition of gypsum, although there was a considerable

Table V

1955/6 *Gypsum trial*

Effect of NH_4NO_3 and gypsum on pC readings

Treatment	NH_4NO_3 level	Gypsum, lb./cu. yd.	pC readings 2/3/56	Treatment	NH_4NO_3 level	Gypsum, lb./cu. yd.	pC readings 2/3/56
1	JIP.1	—	3·36	7	nil	11·16	2·92
2	,, 2	—	3·35	8	JIP.1	11·16	2·86
3	,, 3	—	3·25	9	,, 2	11·16	2·85
4	,, 4	—	3·32	10	,, 3	11·16	2·76
5	,, 5	—	3·11	11	,, 4	11·16	2·81
6	,, 6	—	2·98	12	,, 5	11·16	2·82
				13	,, 6	11·16	2·72

fall in the pC of the 1 : 2½ extract. There was only a slight depression of the pC of the saturation extract.

The relation of the three sets of conductivity values to the plant fresh weights have been determined for the dates 22 January and 5 February. Data for the final assessment on 19 February have not been used because the effect of low pC on plant growth had been masked by the differential supply of nitrogen in the treatments. The correlation diagram for 22 January is shown in Fig. 3. The results show firstly that the conductivity of the soil solution and the saturation extract (very similar in the case of J.I. composts) gives a highly significant negative correlation with the plant weight. This shows that sulphates are similar to other salts in their effect on plant growth at the same soil solution concentration. The maximum possible concentration of gypsum in the soil is, however, too low to damage plant growth. Secondly, the results show the saturation extract to be much superior to the 1 : 2½ extract, which gives no correlation with plant growth where gypsum is present in the soil. The extraction of the soil solution is not of course a practical routine method.

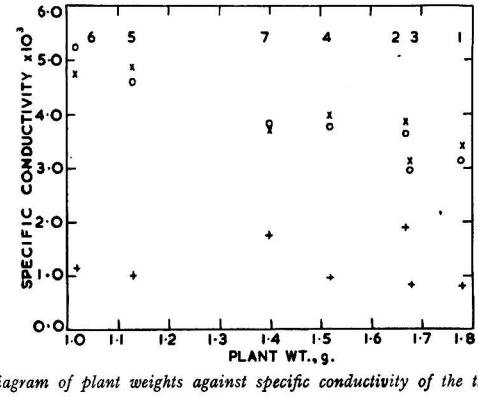

FIG. 3.—*Correlation diagram of plant weights against specific conductivity of the three different soil extracts*

saturated paste × r = − 0·986
soil solution O
pC 1 : 2½ + r = − 0·000245

[Figures at top of figure are treatment numbers (see text)]

Discussion

Certain aspects of the work of Kidson & Stanton[9] on ' cloud ' in New Zealand cast doubts on whether this disorder is the same as the blotchy ripening of the Northern hemisphere. They state that ' cloud ' is associated with the cool temperatures of spring and autumn and with spells of wet weather, and that it is less prevalent in the heat of midsummer. This is completely at variance with the hypothesis of Seaton & Gray[11] who associate blotchy ripening with periods of excessive transpiration. Kidson & Stanton suggest that ' cloud ' is the result of ' an abnormally low content of organic matter in the fruit and may be due either to an excessive water uptake or to decreased photosynthesis under reduced light '. The present results agree in showing that blotchy ripening can be reduced by increasing the salt concentration in the soil and, as did Kidson & Stanton, it was possible to obtain some improvement of quality from less watering until the onset of hot weather. This has been achieved without reduction in yield, whereas in the New Zealand work, there was usually a slight loss of crop.

Records of temperatures in 1955 plotted against the percentage of B quality show some support for Seaton & Gray's theory. The trouble was most serious in July, about 5 days after the temperature had reached its maximum. The figures in Table VI indicate that its incidence is less where pC is low. It seems probable, therefore, that blotchy ripening can be reduced by increasing the salt concentration either by adding salt or by reducing the water content of the soil. In conditions of excessive transpiration, however, plants in a drier soil show more blotchy ripening, while those with the added salts and moister soil are much less affected.

In the gypsum treatments at the final sampling, the saturation extract remained saturated

Table VI

Effect of treatments on incidence of blotchy ripening in midsummer (July 1955)

	B % quality	Transformed
1. Alternate waterings	35·1	36·0
2. Every watering	16·5	23·8
3. Alternate waterings (dry)	34·3	35·9
4. ,, ,, + Na_2SO_4	18·5	25·4
5. Every watering	14·7	22·3
6. ,, ,, (triple strength)	8·1	16·5
Sig. diff.		
P = 0·05	—	3·2
P = 0·01	—	4·5

with a pC of 2·7, but the non-gypsum treatments had pC values around 3·0. This large effect on the concentration of the extract due to gypsum at such low nutrient levels is not likely to be important because shortage of nutrients will be more important than their excess.

There is a constant relation between the pC of the saturation extract and the 1 : 2½ extract, excepting soils rich in gypsum. The results plotted give a straight line with a correlation coefficient of +0·972. The relationship approximates to pC (1 : 2½) = pC (saturated extract) + 0·56.

Thus the critical value of 3·00 on the 1 : 2½ extract becomes 2·4 and the optimum range for fruit quality becomes 2·4–2·6 instead of 3·0–3·2. Further work to verify this new optimum range in soils with and without gypsum is now in progress. Although good results have been obtained with J.I. composts, further experience is needed on other types of soil with the saturation extract. If a general change in method of determining soluble salts is to be made, it seems desirable that the method of expression should also be changed to a direct conductivity value, as is used in U.S.A. and Scandinavia. This would cause less confusion than the use of the negative logarithm and would distinguish the results of the saturation extract from the older method. On this basis, subject to verification, the danger value for tomatoes will be $4{\cdot}0 \times 10^3$ μ-mhos and the optimum range $4{\cdot}0\text{–}2{\cdot}5 \times 10^3$.

The true effect of adding gypsum to the soil is only a slight increase in the conductivity of the soil solution. It is only where there is a very dilute soil solution that gypsum can cause a big increase in conductivity. On the other hand most glasshouse soils contain enough gypsum to give a saturated soil solution, although those at Fernhurst do not. Even small increases in conductivity, however, may be sufficient to affect plants slightly and cannot altogether be disregarded. The author has never observed any visual effect, but the results in Table IV did show an improvement in fruit quality from addition of gypsum which was just significant, and in the trial of pC methods where gypsum had been added plant weights were always lower although not significantly so in every case.

While the use of sodium sulphate in 1955 gave the same pC values and fruit quality as did feeding every watering, in 1956 it failed to give such good results. This may be due to the failure of the 1 : 2½ extract to give a true indication of the concentration of the soil solution. Some or all of the sodium sulphate may have been converted to calcium sulphate and in such circumstances only a determination on the soil solution or saturation extract will give the true pC value. This may apply also to the use of sulphate of ammonia.

Conclusions

(1) Blotchy ripening of tomatoes can be reduced without loss of yield on soils that contain little or no gypsum if the pC of the 1 : 2½ extract is maintained between 3·0 and 3·2.

(2) In conditions of excessive transpiration, plants on drier soil show an increase in blotchy ripening whereas those with added salts and moister soil are much less affected.

(3) On soils where gypsum levels are high, use of the saturation extract to determine the salt concentration gives good correlation with plant growth, while the 1 : 2½ extract is unsatisfactory.

(4) Gypsum has little, if any, effect on plant growth even when added to the soil in quantity sufficient to saturate the 1 : 2½ extract. In the 1 : 2½ extract gypsum gives a low pC reading, but its effect in the soil solution is small.

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ON THE ANTIOXIDANT ACTIVITIES OF THE TOCOPHEROLS. II.*—Influence of Substrate, Temperature and Level of Oxidation

By C. H. LEA

The antioxidant activities of the tocopherols have been compared at 60° and at 37° in distilled methyl esters of cottonseed, linseed and cod liver oil fatty acids containing small additions of oxidised ester as ' starter '.

In the linoleate (cottonseed) system the γ- and δ-compounds were the most and the α-, ζ- and ε-compounds the least effective in extending the induction period. In the polyunsaturated (linseed and cod liver oil) systems the γ- was still good, but the δ- was at the bottom of the series and the α- and ζ-compounds near the top.

Factors, in addition to the presence of polyunsaturated fatty esters in the substrate, which tended to favour a relatively high activity of the α-compound were (*a*) comparison of activities at a low peroxide value, still within the induction period and (*b*) a not too high temperature of oxidation. Under suitable conditions α-tocopherol could be shown to exert the highest and δ- the lowest *in vitro* antioxidant activity, in agreement with their known *in vivo* vitamin-E potencies.

The antioxidant activities of the tocopherols are considered in relation to their structure.

In the first paper of this series[1] the relative antioxidant activities of the seven tocopherols, some natural and some synthetic, were compared in the methyl esters of lard fatty acids at 90° and in methyl linoleate at 50°. In both systems δ- and γ- were the most and ε-, ζ- and α-tocopherol the least effective of the series, with η- and β-tocopherol in between, the precise order depending on the conditions and concentrations used.

Observations in the literature (mainly by high temperature methods in lard) which indicated activities increasing in the order α- < β- < γ- < δ were thus confirmed, and the sharp discrepancy existing between relative *in vitro* antioxidant activity and relative *in vivo* vitamin-E

* Part I: *J. Sci. Fd Agric.*, 1959, **10,** 537

potency was emphasised. Even at 50° no support could be found for the claim of Hove & Hove[2] that the high antioxidant activity of the γ- as compared with the α-compound holds only at high temperatures of testing, and that at lower temperatures there is little difference in the activities of the α-, β- and γ-compounds, with the α- actually most and the γ-compound least effective during the earlier stages of the oxidation.

Most of the reversal of the order of activity observed by Hove & Hove occurred, however, at temperatures of 35° and below and, with the techniques used in Part I, it was not possible to obtain reproducible estimates of the relative antioxidant activities of the tocopherols at temperatures as low as 37° or 25°.

In the present work this difficulty has been greatly reduced by an improved method of testing, in which the unsaturated esters used as substrates are first made peroxide-free and then standardised by the addition of small quantities of the peroxidised ester, to provide by their decomposition a supply of chain-starting free radicals. Under these conditions the relative antioxidant activities of the tocopherols have been found to depend in major degree on the fatty acid composition of the substrate as well as, to some extent, on the temperature and level of oxidation at which comparison is made. The relative order hitherto observed for systems in which mainly linoleate is oxidising at high temperatures can be reversed under suitable conditions, so that α- becomes the most and δ- the least effective of the common tocopherols, thus conforming to the order of the observed *in vivo* vitamin-E activities.

Experimental

The tocopherols

As in the previous work[1] natural α-, β-, γ- and δ-tocopherols were obtained from Distillation Products Ind. Synthetic *dl*-ξ-tocopherol was supplied by Dr. R. J. Ward. The synthetic *dl*-, ε- and η- compounds, and the synthetic unmethylated tocol were supplied by Dr. J. Green. Synthetic compounds are indicated throughout the paper by the subscript s.*

The tocopherols, in solution in purified methanol, were stored over solid carbon dioxide at −80°. Before use the concentrations of the solutions were checked by the ferric chloride–2,2′-dipyridyl method and dilutions in methanol of the required concentration prepared.

Substrates and method of testing

Mixed methyl esters essentially free from natural anti- and pro-oxidants were prepared from refined (*a*) cottonseed, (*b*) linseed and (*c*) cod liver oils by methanolysis, treatment with alumina and vacuum distillation. After tinting by the addition of β-carotene (0·001%) and destruction of any peroxide present by heating *in vacuo*, a portion of the same esters, oxidised with free access of air to a peroxide value of 25–50 μM/g., was added to the main bulk of the ester in quantity calculated to give an initial peroxide value (p.v.) of 1·0. The tocopherol was then added in solution in purified methanol (0·25 ml./5 ml. total ester) to give a concentration of 0·01% by weight of the ester, and 0·2 ml. aliquots of the mixture were pipetted into small flat-bottomed specimen tubes and stored in a thermostatically controlled room at 37° or oven at 60°. At suitable intervals peroxide values were determined by a simple iodometric procedure, the tube containing the ester being dropped directly into the reaction flask. This method of testing has been described more fully elsewhere.[3]

Results

The results of the storage experiments at 60° and 37° for the eight tocopherols, tocol and propyl gallate, all at 0·01%, in the three esters are given in Figs. 1–3. Table I compares the antioxidant activities of the tocopherols under the various conditions (*a*) at a p.v. of 100 and (*b*) at a p.v. of 15. The first two columns at p.v. 100 relate to data from Part I. The relations of structure to antioxidant activity in the tocopherol series are brought out more clearly in Table II.

* As indicated in Part I, work by Green *et al.*, in course of publication, suggests that natural ϵ-tocopherol has not the 5-methyltocol structure hitherto attributed to it, and that, while natural ζ-tocopherol from rice bran is confirmed as 5,7-dimethyltocol, ζ-tocopherol from wheat bran oil is not identical with this substance and may have a trimethyl structure. The structure of the compounds used in the present work is shown in Table II.

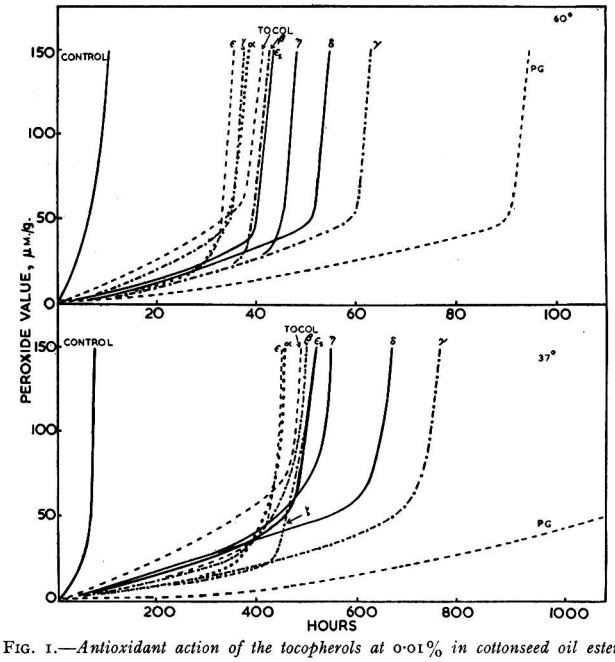

FIG. 1.—*Antioxidant action of the tocopherols at 0·01% in cottonseed oil esters*

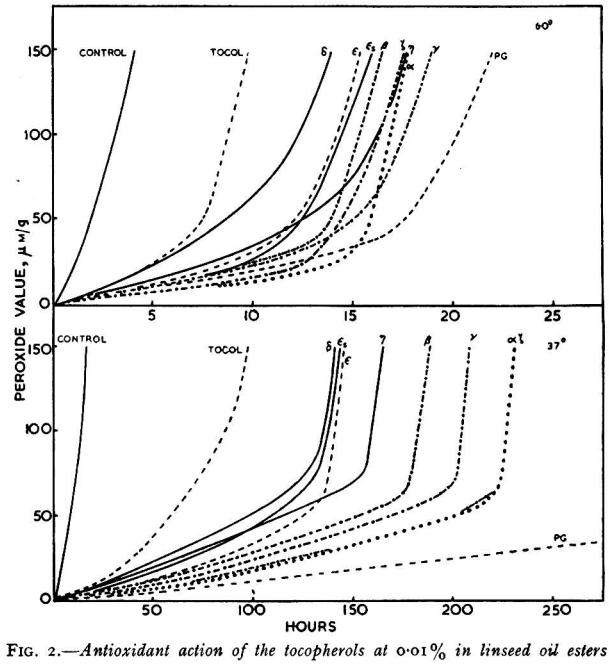

FIG. 2.—*Antioxidant action of the tocopherols at 0·01% in linseed oil esters*

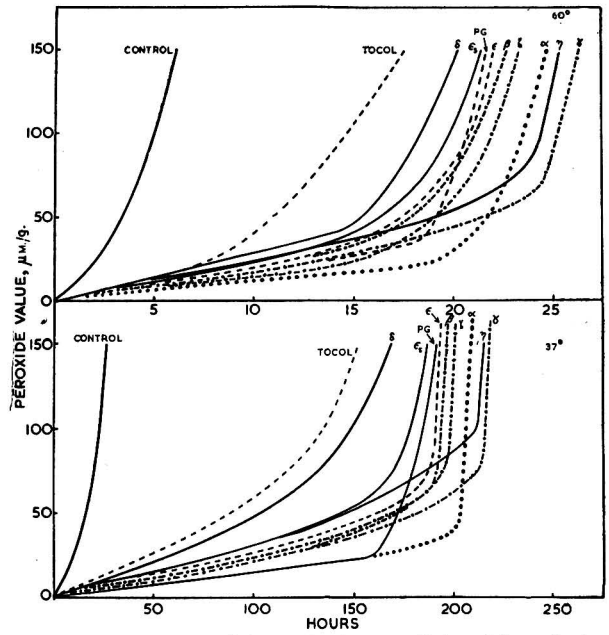

FIG. 3.—*Antioxidant action of the tocopherols at* 0·01% *in cod liver oil esters*

Owing to the slow rate of increase of the peroxide value during the induction period, data based on measurement of the times to reach p.v. 15 are less accurate than those based on p.v. 100.

Discussion

The antioxidant activities of the tocopherols are of interest in the first place because the physiological vitamin-E action of these substances is believed to be linked in some way to their antioxidant properties, and in the second because the presence of tocopherols in oils, fats and fat-containing foods is an important factor in their defence against oxidative rancidity and related disorders.

The present results show that the relative antioxidant activities of the individual homologues vary in rather striking degree with the conditions in the oxidising lipid system in which they are measured.

Effect of substrate and level of oxidation

In lard esters at 90°, with an antioxidant concentration of 0·01% and comparison at p.v. 100, δ- (8-), γ- (7,8-) and η_8- (7-) tocopherols were the most and the α- (5,7,8-), ζ_8- (5,7-) and ε- (5?) compounds the least effective. In pure methyl linoleate at 50° γ- and δ- were still the best and α-, ζ_8- and ε-tocopherol the worst, and the picture was generally similar in the cottonseed esters at 60° and 37°. In all these cases where mainly linoleate was oxidising, α-tocopherol, the most vitamin-E-active member of the series, was a relatively weak antioxidant and the 8- and 7-substituted mono- and di-methyl tocols were strong.

When the degree of protection was measured at a lower peroxide value (15 μM/g.) still well within the induction period, and particularly at the lowest temperatures used (37°), α- and ζ_8-tocopherol appeared in a considerably more favourable light. The γ-compound still retained its position near the top of the table but the δ- moved down (Table I). The unsubstituted tocol showed a relatively high activity only at the highest temperature (90°) or in light (Part I); at moderate or low temperatures, and particularly when activity was measured at a low p.v., it was usually inferior to all the tocopherols.

In the linseed esters, in which mainly linolenate would be oxidising, α- and ζ_s-tocopherol were relatively much stronger than in the linoleate systems, and δ- was relatively much weaker. This trend was accentuated when comparison was made at the lower peroxide level (15 μM/g.), under which conditions α-, followed by ζ_s- and γ-, was most and δ-, preceded by η_s- and ε-tocopherol, least effective.

Cod liver oil, although of lower average unsaturation than linseed oil, contains a considerable proportion of highly unsaturated fatty acids with 4–6 double bonds, and results in the cod liver oil esters were fairly similar to those in linseed oil (Table I).

In general, the conditions in these experiments which favoured a high relative activity of the α-compound appeared to be (*a*) a substrate containing fatty esters more unsaturated than linoleic, (*b*) measurement of activity at a comparatively early stage of the oxidation, before the end of the induction period and (*c*) a not too high temperature of oxidation.

Since the lipids of living tissues contain polyunsaturated fatty acids, and since fat hydroperoxides are now known to be lethal in very small quantities* and therefore cannot be allowed to accumulate, it would seem that conditions favourable for a relatively high antioxidant activity of the α-compound might well exist in the tissues. If this be accepted, the pre-eminent vitamin-E potency of α-tocopherol can then be accounted for on a basis of antioxidant action more reasonably by the two factors of relative antioxidant activity and relative efficiency of absorption

Table I

Relative antioxidant activities of the tocopherols. Influence of substrate, temperature and level of oxidation

	Protection factors† for the tocopherols (0·01%) in							
Substrate **:	L.	M.L.	C.S.	C.S.	L.S.	L.S.	C.L.	C.L.
Temperature:	90°	50°	60°	37°	60°	37°	60°	37°
				Measured at p.v. 100				
	δ 7·0	γ 15·9	γ 6·0	γ 9·7	γ 4·7	α 15·5	γ 4·1	γ 8·3
	T_s 6·7	δ 12·2	δ 5·0	δ 8·4	α 4·4	ξ_s 15·5	η_s 3·9	η_s 8·1
	γ 6·0	β 11·3	η_s 4·3	η_s 6·6	ξ_s 4·3	γ 13·8	α 3·7	α 7·9
	η_s 5·8	η_s 9·9	β 3·7	ϵ_s 6·1	η_s 4·3	β 12·3	ξ_s 3·4	ξ_s 7·6
	β 5·5	η 9·9	ϵ_s 3·7	β 6·0	β 3·9	η_s 10·6	β 3·2	β 7·4
	η 5·0	ε 9·5	T_s 3·5	ξ_s 6·0	ϵ_s 3·7	ε 9·3	ε 3·2	ε 7·3
	ε 4·8	ξ_s 7·7	α 3·2	T_s 5·9	ε 3·6	ϵ_s 9·0	ϵ_s 3·0	ϵ_s 6·7
	ξ_s 3·8	T_s 6·6	ξ_s 3·1	α 5·4	δ 3·0	δ 8·8	δ 2·7	δ 5·4
	α 3·5	α 5·2	ε 2·9	ε 5·4	T_s 1·8	T_s 5·4	T_s 1·9	T_s 4·8
	—	—	PG 9·6	PG 15·0	PG 5·5	PG 35·2	PG 3·1	PG 7·0
Control (h.)	3·5	8·7	8·8	70	3·1	13·8	5·0	23·2
				Measured at p.v. 15				
			γ 6·6	ξ_s 7·4	α 10·5	α 28·6	α 7·4	α 14·5
			η_s 6·6	α 6·4	ξ_s 10·0	ξ_s 25·4	ξ_s 5·9	ξ_s 10·1
			β 6·6	γ 6·3	γ 7·0	γ 20·4	γ 4·7	γ 8·8
			α 6·3	β 5·2	β 6·6	β 19·4	ε 4·2	β 8·8
			δ 5·8	ε 5·0	ϵ_s 6·5	ε 17·0	β 3·9	ε 7·3
			ε 5·5	δ 3·8	ε 5·8	ϵ_s 13·6	ϵ_s 3·3	ϵ_s 6·2
			ϵ_s 5·1	η_s 3·8	η_s 4·7	η_s 11·1	η_s 2·9	η_s 5·9
			ξ_s 3·7	ϵ_s 3·8	δ 3·4	δ 10·4	δ 2·4	δ 4·1
			T_s 2·8	T_s 2·5	T_s 3·1	T_s 7·9	T_s 2·3	T_s 3·3
			PG 11·8	PG 15·0	PG 6·9	PG 42	PG 4·7	PG 14·5
Control (h.)			3·0	35	0·8	2·8	1·5	6·5

** L = lard esters; M.L. = methyl linoleate; C.S. = cottonseed oil esters; L.S. = linseed oil esters; C.L. = cod liver oil esters

† Ratio of the times to reach the indicated p.v. in presence and absence of antioxidant −1

PG = propyl gallate T = tocol

* Horgan *et al.*[4] found the LD_{50} for mice, by intraperitoneal injection, to be 1·2–2·4 mg. for linoleic acid hydroperoxide and 14–19 mg. for methyl linoleate hydroperoxide. Holman & Greenberg[5] found 6 mg. and 12 mg. respectively for methyl oleate and methyl linoleate hydroperoxides: orally, the lethal dose of either substance was over 200 mg. per mouse. No data are available on the toxicity of the peroxides of more highly unsaturated fatty acids or esters. The levels of 15 and 100 μM peroxide/g. used in the present work correspond approximately to hydroperoxide contents of 5 and 30 mg. respectively per g. of ester.

supporting one another, instead of being in opposition as had hitherto appeared to be the case (Part I).

Effect of temperature on the induction period

The unstabilised linseed and cod liver esters both required 4·5–4·6 times as long at 37° to reach a p.v. of 100 as at 60°, corresponding to a Q_{10} of 1·9. The cottonseed esters showed a slight induction period at 37° and gave the rather higher values of 8·0 and 2·5. The nine tocopherols (including tocol) in the cottonseed esters required 11·5–13·4 (average 12·3, Q_{10} 3·0) times as long at 37° as at 60° to reach a p.v. of 100. In linseed esters the corresponding figures were 9·5–13·9 (average 11·2, Q_{10} 2·9) and in cod liver esters 8·5–9·2 (average 8·9, Q_{10} 2·6). The ratios for propyl gallate in cottonseed esters (12·1, Q_{10} 3·0) and in cod liver esters (8·9, Q_{10} 2·6) were similar to those of the tocopherols, but in linseed esters the effect of temperature on the activity of the gallate was much greater (ratio 24·6, Q_{10} 4·0). The highly variable effect of temperature on the activity of different antioxidants in linseed esters has already been noted.[3]

Relation of structure to antioxidant activity

Table II represents an attempt to indicate the influence of the number and position of the substituent methyl groups on the antioxidant activity of the tocopherols in relation to substrate, level of oxidation and oxidation temperature.

In both the linoleate systems used in Part I the extensions of the induction period (measured at p.v. 100) produced by 0·01% of the mono- or di-substituted tocols was observed to decrease in the order 8-methyl > 7-methyl > 5-methyl. In the lard esters at 90° there was also a

Table II

Effect of progressive methylation on the antioxidant activity of tocol under various conditions

Substrate esters	Inhibitor (0·01%)		Hours at indicated temp. to reach p.v. 100		Hours at indicated temp. to reach p.v. 15	
			60°	37°	60°	37°
Cottonseed	—		8·8	70	3	35
	Tri-5,7,8-	α	36·7	449	22	260
	Di-7,8-	γ	61·5	751	23	260
	5,8-	β	41·1 } 46·3	488 } 575	23 } 20	220 } 260
	5,7-	ξ_2	36·3	487	14	290
	Mono-8-	δ	52·9	658	21	170
	7-	η_2	46·5 } 46·3	535 } 563	23 } 21	170 } 170
	5-	ϵ_2	41·6	495	18	170
	Tocol		39·8	481	11	120
Linseed	—		3·1	14	1	3
	Tri-5,7,8-	α	16·7	227	9	80
	Di-7,8-	γ	17·6	204	6	60
	5,8-	β	15·3 } 16·4	183 } 205	6 } 7	60 } 60
	5,7-	ξ_2	16·4	227	9	70
	Mono-8-	δ	12·2	136	4	30
	7-	η_2	16·4 } 14·4	160 } 145	5 } 5	30 } 30
	5-	ϵ_2	14·5	138	6	40
	Tocol		8·7	88	3	20
Cod liver	—		5·0	23	1·5	7
	Tri-5,7,8-	α	23·5	206	13	100
	Di-7,8-	γ	25·3	216	9	60
	5,8-	β	21·1 } 22·8	194 } 203	8 } 9	60 } 70
	5,7-	ξ_2	22·0	200	10	70
	Mono-8-	δ	18·4	149	5	30
	7-	η_2	24·4 } 20·9	212 } 180	6 } 6	40 } 40
	5-	ϵ_2	19·8	179	7	50
	Tocol		14·7	135	5	30

clear trend monomethyl > dimethyl > trimethyl (Table I). This trend was becoming obscured at the 0·01% level in linoleate at 50° (Table I), but was still clear at the 0·03% level (Part I, Table III).

In the present experiments the same trends are again apparent in the linoleate (cottonseed) system at 60° and 37°, when measured at p.v. 100, but not when comparison is made at p.v. 15, during the induction period. The unsubstituted tocol was previously observed to show a relatively high activity only at high temperature or high concentration, or in light (Part I).

In the polyunsaturated substrates antioxidant activity was found to *increase* with increasing nuclear methylation, and this effect was more clear-cut at the lower temperature and the lower peroxide level (Table II). The inferiority of the 5- in relation to the 8-substituted compounds was also no longer apparent under these conditions.

It would seem therefore that the depressing effects of increasing nuclear methylation and of substitution in the 5-position, which operate in linoleate systems at high temperature, do not apply in more unsaturated esters at lower temperatures, particularly in the early stages of the oxidation. Under these conditions the effects are, in fact, largely reversed, leading to the transference of α-tocopherol from the bottom of the activity sequence to the top, and of δ-tocopherol from the top to the bottom.

It is possible that at high temperatures, and perhaps at higher concentrations than 0·01%, the relative performance of tocol and of the 8- and 7-monoethyl tocols will improve, even in the polyunsaturated systems, but this point has not been investigated.

A feature of these experiments has been the consistently good performance of γ-tocopherol which, under all the conditions used, has never fallen below third and has often occupied first or second place in the series.

Acknowledgments

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UPTAKE AND DISTRIBUTION OF STRONTIUM IN VEGETABLES AND CEREALS

By R. B. DUCKWORTH and J. HAWTHORN

Experiments are described in which a range of cereals, root crops and Brassicas was grown in sand using culture solutions containing strontium-89. The distribution of the tracer in the mature plants and in the different parts of the cereal grains is reported and illustrated using auto-radiography. The mode of uptake of fall-out radio-strontium by plants in the field is discussed and the present results are interpreted in terms of the extent to which man's selection of particular parts of plants may affect the levels of radio-strontium in his own immediate diet.

Introduction

A great deal of effort has been expended in recent years in attempts to assess the existing and likely future hazards to man resulting from the presence in food materials of strontium-90.[1] In Western countries particular attention has naturally been paid to milk because of its importance as a source of calcium to the human population, but fewer data are available showing the levels of strontium-90 in foods of plant origin. It has not escaped comment[1–3] that in certain regions the calcium supply is drawn largely from vegetables and in particular cereals, which may contain many times the strontium activity (on a calcium basis) present in milk. Cereal and vegetable plants are not eaten by man in their entirety and it is a matter of interest to know something of the distribution of strontium in such crops, and of the extent to which man's selection may affect the levels in his own immediate diet.

Because of the small amounts of activity occurring 'naturally' in crops at the present time, it is most convenient to use tracer techniques to study strontium distribution. Various authors[4–7] refer to the distribution of absorbed tracer strontium in plants. These studies have generally been confined to one or a few species and only recently has an examination been made by Middleton[8] of a representative selection of important food crops. Middleton, unlike the earlier workers who applied the tracer to the roots of the plants, sprayed it on to the aerial parts in an attempt to simulate fall-out in the form of rain. The mode of entry of the strontium, i.e., whether through the roots or aerial surfaces, may in fact have a considerable effect on the observed pattern of distribution, because it is thought[5, 6, 8] that strontium once deposited in the aerial parts of plants is not readily transported to other regions. Russell, however, suggests[9] that in the case of many annual vegetables most of the strontium-90 present in the plant probably enters through the roots. Moreover, given no large increase in the rate of fall-out, the importance of uptake through plant roots will progressively increase with time. It is not possible, by tracer methods, to reproduce accurately the process of natural fall-out, and it was therefore decided to use root applications in the present exploratory experiments. A range of plants has been studied in this way, the tracer being applied continuously throughout the period of growth, rather than as a single large dose at some intermediate stage of development such as was used by some of the earlier workers.

Experimental

Plant culture

The plants in all experiments were grown in a greenhouse in acid-washed coarse sand (retained by a 12-mesh sieve) contained in polyethylene buckets of 1 gal. capacity. The same culture solution was used in each case and this contained K^+ 10, Ca^{2+} 6, Mg^{2+} 3, NH_4^+ 2, NO_3^- 16, PO_4^{3-} 6 and Fe^{3+} (as ferric citrate) 0·3 mequiv./l. and traces of Mn, Cu, Zn, B and Mo. In the first experiments with carrot, turnip, beetroot, cauliflower, Brussels sprout and wheat, the plants were irrigated from below. Two litres of solution contained in a Winchester bottle under each bucket were forced up by air pressure into the sand, the system being controlled by a switch in such a way that the pump was cut out when the solution reached the surface of the sand in the bucket. A slow leak allowed the solution to run back into the bottle and when the internal pressure reached that of the surrounding atmosphere the pump was again automatically started. Each cycle took 2–3 min. Later in the experiment as more cultures were included, it was found extremely difficult to maintain the same level of solution in each unit and the solutions were pumped up four times a day and allowed to run back slowly over a period of a few hours. The solutions were changed at fortnightly intervals, 1 ml. of a solution of strontium chloride labelled with strontium-89 (and containing ~0·1 mequiv. of Sr per ml.) being added to each 2 l. of new solution and again to each bucket after one week with the new solution. The activity of the tracer solution at the beginning of the experiment was 0·345 μc per ml. Duplicate cultures were set up for each species, five seedlings of wheat per bucket, four of carrot, two of turnip and beetroot and one of cauliflower and Brussels sprout. Potato was also included but could not be grown successfully by this technique. The plants were taken down at maturity, those from one bucket in each case being used for chemical separation of strontium and counting and those from the other for auto-radiography.

In a second series of experiments, wheat, barley, oats and rice were grown. The wheat,

barley and oats were germinated in sand in buckets similar to those used in the first series. In this case, however, these containers were supported inside other buckets with no perforation in the base, in such a way that the culture solution could be introduced into the space between them. The same solution was used as in the earlier series, 1 l. being added to each culture at the beginning of the experiment and further quantities of 500 ml. at fortnightly intervals. Otherwise, de-ionised water was added as necessary to prevent the sand becoming dry. Triplicate cultures were set up containing four seedlings of each of four varieties of wheat. In three other containers four seedlings of three varieties of barley and of one variety of oats were grown in the same way. These cultures were all given an initial dose of 40 μc of strontium-89 as $SrCl_2$ (0·04 mequiv. of Sr). Three further cultures of eight plants of a single variety of wheat, barley and oats respectively were also set up and given an initial dose of 160 μc of strontium-89 (0·16 mequiv. of Sr).

Rice was grown separately in the greenhouses of the Botanic Gardens, Glasgow. In this case three plant pots each containing four young rice plants were used and these were placed inside polyethylene buckets, two being treated with 40 μc and one with 160 μc of strontium-89.

Some of the plants in each case were used for auto-radiography and the remainder for chemical separation and counting. Those given the higher doses were required for work on the distribution of strontium in the grain.

Chemical separation and counting

The plants, harvested at maturity, were divided up into their constituent parts, dried and ashed. The ash was dissolved in a few drops of HCl and dried on a hotplate. Strontium carrier containing 25 mg. of Sr was added, followed by 37·5 ml. of water and 50 ml. of fuming HNO_3 (sp. gr. 1·51). The solution was then filtered into a centrifuge tube. A further 50 ml. of fuming HNO_3 were added slowly and the tube left in the refrigerator for at least 1 h. to allow the precipitate of $Sr(NO_3)_2$ to separate out. This precipitate was collected on to a small paper in a sintered glass funnel, taken up in water and the nitric acid separation repeated twice more. Finally, the strontium was precipitated as carbonate by boiling in alkaline solution with ammonium carbonate and the precipitate filtered on to a small weighed paper, dried and reweighed ready for counting. Counting was carried out using an end-window counter tube housed in a lead castle. The observed count was corrected in each case for yield of strontium carbonate which varied between 50 and 100%, in most cases being over 75%.

Auto-radiography

The plants used for auto-radiography were pressed and dried in the usual way. In the case of bulky organs, a median slice was taken through the part so as to give, as far as possible, approximately the same thickness of tissue over the whole area of the plant. The prepared specimens were placed directly in contact with ' Kodirex ' *X*-ray film, control specimens being used to check on the possible appearance of artifacts. The exposures varied from a few days to as many as 4 months, depending on the subject.

Results

General distribution of absorbed strontium

The results of the analyses from the first series of experiments are given in Table I. In no case was the standard deviation on the count rate greater than 2·3%. Fig. 1 shows auto-radiographs obtained from plants of this series.

The general pattern of distribution in wheat and barley following uptake of ^{89}Sr through the roots has been described by other workers, points of particular interest being the relatively low levels of absorbed strontium in the grain as compared with the rest of the plant[6] and a particular concentration in the nodes of the stem.[7] The second series of experiments was carried out to determine whether a similar distribution occurs in other cereal species and whether there are differences in uptake and distribution among different varieties of the same cereal. The results of these experiments are given in Table II, all figures having been corrected for decay to a common time. In no case did the standard deviation on the count rate exceed 1·4%. Auto-radiography gave general confirmation of the results shown in this table.

Table I

Distribution of absorbed ^{89}Sr in vegetables and wheat

Material	Part	Counts/min./ unit dry wt.	% of total count	Material	Part	Counts/min./ unit dry wt.	% of total count
Turnip	leaf	668	40	Carrot	leaf	3022	75
	turnip	6602	60		carrot	2229	25
Cauli-flower	flower	3042	9	Beetroot	leaf	426	70
	stalk	1055	15		beetroot	243	20
	leaf	4172	43		fibrous root	316	10
	root	6239	33				
				Wheat	infructescence	158	11
Brussels sprout	leaves	3098	67		leaf and stem	838	73
	sprouts	3374	6		root	526	16
	stalks	259	20				
	roots	773	7				

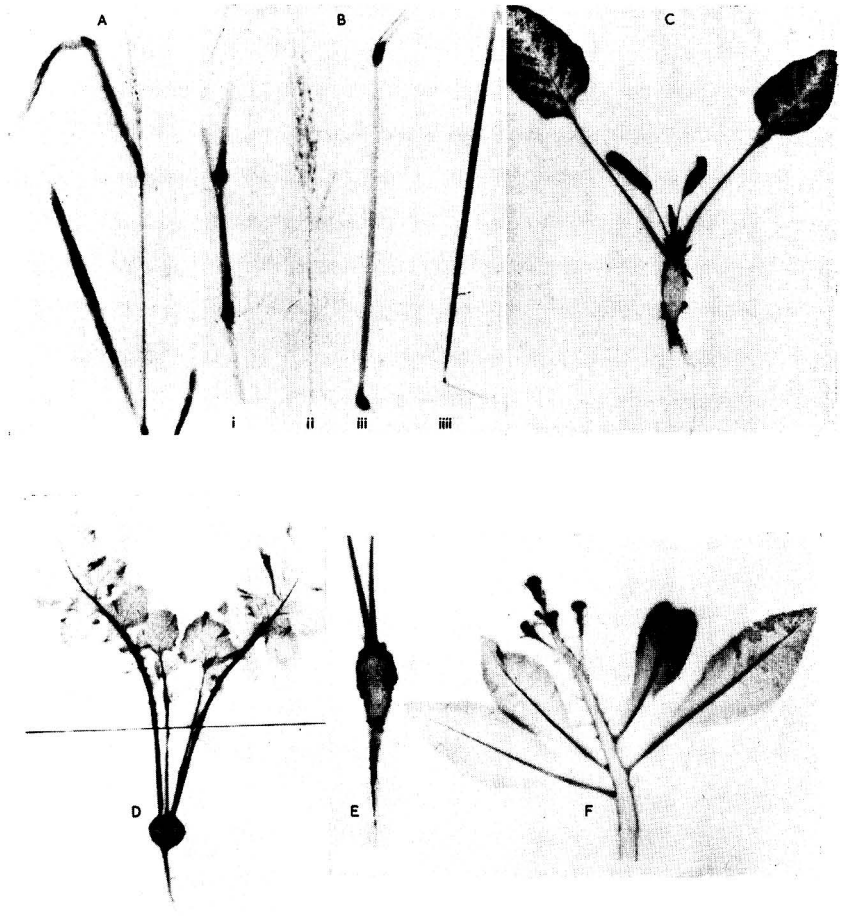

FIG. 1.—*Auto-radiographs from mature plants after uptake of ^{89}Sr*

(A) wheat ; (B) rice ; (i) piece of stem with two nodes and the base of a leaf, (ii) infructescence, (iii) piece of stem, (iiii) a leaf ; (C) beetroot ; (D) turnip ; (E) carrot ; (F) cauliflower

Table II

Distribution of absorbed strontium in cereals

Cereal	Variety	Part	^{89}Sr count per unit dry wt.		^{89}Sr activity as % of total in plant	
			A*	B*	A*	B*
Wheat	Svenno	leaves	9270	3708	78	51
		nodes	1029	2389	1	35
		internodes	1098		10	
		chaff	1294	1114	6	9
		grain	497	431	5	5
	Koga 2	leaves	12080	3108	72	51
		nodes	3756	1919	2	33
		internodes	2748		19	
		chaff	1099	1380	4	12
		grain	322	357	3	4
	Atle	leaves	7716	10680	85	70
		nodes	1818	4052	2	17
		internodes	885		9	
		chaff	373	4585	2	11
		grain	247	1976	2	2
	Peko	leaves	2695	17800	61	64
		nodes	2733	8184	7	25
		internodes	1040		26	
		chaff	350	5858	5	9
		grain	84	1133	1	2
Barley	Carlsberg 2	leaves	23440	12220	78	82
		nodes	4615	2606	1	10
		internodes	8666		12	
		chaff	6355	2790	8	7
		grain	5140	2932	1	1
	Proctor	leaves	2502	12410	48	78
		nodes	6402	3294	9	14
		internodes	3886		31	
		chaff	2226	2158	11	7
		grain	622	5568	1	1
	Ingrid	leaves	19930	9039	63	70
		nodes	177	3420	1	15
		internodes	4780		15	
		chaff	5017	3171	16	8
		grain	1454	2981	5	7
Oats	Pendek	leaves	2148	3860	32	37
		nodes	4162	3628	6	35
		internodes	2294		28	
		chaff	24820	4636	30	27
		grain	679	684	4	1
Rice	Rubibarbis	leaves	10180	6412	88	88
		nodes	4987	428	4	8
		internodes	2522		5	
		chaff	2104	1193	2	3
		grain	206	143	1	1

* A and B are duplicate samples of the same variety. A was harvested before the grain was fully mature and B at full maturity, two weeks later.

Distribution within the cereal grain

A matter of particular interest is the pattern of distribution within the grain itself, since, particularly in the case of rice and wheat, the different morphologically distinct parts are normally separated to a greater or lesser extent during milling and polishing procedures. Samples of grain from the present experiments were dissected and strontium separations carried out on the different fractions. As the careful dissection of cereal grains by hand into bran, germ and endosperm is a tedious and lengthy process, the samples used were comparatively small and the number of complete dissections few. The results are shown in Table III. Also included in this table are the results for two samples of oats separated into hulls and groats.

In the case of wheat and rice, the activities obtained in the grains were sufficiently high

Table III

Distribution of absorbed strontium in cereal grains

Cereal	Variety	No. of grains used	Part	Counts/min./ unit dry wt.	Activity as % of that in whole grain
Wheat	Koga 2	50	germ	7974	12
			endosperm	1186	41
			bran	4180	47
	Koga 2	100	germ	26	6
			endosperm	80	49
			bran	82	45
	Svenno	unknown	germ	1300	12
			rest of grain	395	88
	Koga 2	,,	germ	664	7
			rest of grain	345	93
	Atle	,,	germ	3243	7
			rest of grain	1918	93
	Peko	,,	germ	6139	13
			rest of grain	1269	87
Rice	Rubibarbis	75	germ	1376	23
			endosperm	81	27
			bran	973	50
	Rubibarbis	100	germ	522	15
			endosperm	40	27
			bran	420	58
	Rubibarbis	unknown	germ	484	15
			rest of grain	126	85
Oats	Pendek	,,	hulls	8422	72
			groats	3951	28
	Pendek	,,	hulls	1471	82
			groats	684	18

to allow confirmation of the general patterns of distribution by means of auto-radiography—see Fig. 2. In this figure the auto-radiographic images bear a mirror-image relationship in each case to the cut surfaces of the half grains from which they were obtained. The bran can be seen to be particularly heavily labelled in the region adjacent to the embryo, i.e., at the base of the grain. The endosperm has given little blackening of the film. This is partly due to the fact that the activity is distributed through a greater volume, and partly to absorption of some of the β-radiation by the thick layer of dense tissue.

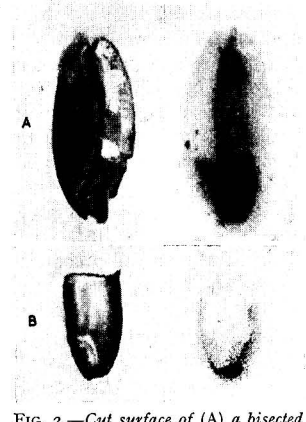

FIG. 2.—*Cut surface of* (A) *a bisected wheat grain,* (B) *a bisected rice grain broken, with, opposite, the corresponding auto-radiographic image*

Discussion

The similarity in behaviour between strontium and calcium in plants has been commented upon by several authors.[4, 10–12] Martin *et al.*[12] show that, after root absorption by barley, strontium moves more slowly inside the plant than does calcium, but that the distribution finally adopted by the two elements is very similar. In the case of cereals, this similarity in distribution is borne out by comparison of the present results with published data for the distribution of calcium both generally within the plant[13] and within the grain itself.[14] A similar agreement can be shown for carrot and beet[15] but in the case of turnip, the present results are at variance with those for calcium in the literature.[16]

In any case, it is not possible to generalise along these lines with regard to fall-out strontium because, in spite of the relative and increasing importance of root uptake in the case of annual crops,[9] some at least of the strontium

probably enters through, or remains superficially upon, the aerial parts. That strontium, in common with many other elements, can be actively absorbed through the surfaces of plant shoots is known[4, 8] and the extent to which strontium entering in this way may be redistributed inside the plant is a relevant question. Because of the normal excess of supply over metabolic demand for calcium in crops, passive movement in the transpiration stream might be expected to play an important part in determining the distribution of these elements.[17] Examples of rapid movement away from sites of aerial application might only be expected in species in which active growth is taking place in regions below those of maximum water loss, e.g., in root vegetables. Middleton[8] does in fact show downward translocation of strontium in potato, although the movement is small compared with that of caesium, a relatively ' mobile ' element. Some downward transfer of strontium is also shown in swede, but this may be due to surface movement in rain rather than to translocation within the plant. The present results for wheat indicate some redistribution of strontium during maturation of the grain. Movement appears to occur not only upwards into the chaff and grain but also backwards from the leaves into the stems. It is probable, however, that, in the case of fall-out, because of the extremely small amounts of material actually involved, little redistribution takes place, although this may depend among other things on the nature of the surface upon which the material is deposited.

Ogawa[3] attributes the high loss of strontium-90 activity during milling and polishing of rice to contamination of the surface of the grain during the period immediately before harvesting. The present results suggest that this loss is partly due to the high concentrations of strontium in the bran and germ resulting from root uptake. There is, however, a big discrepancy between the present results and those of Hiyama[18] for strontium-90 for white rice and bran expressed on a dry weight basis. This can most reasonably be explained by assuming that a considerable degree of surface contamination was in fact present in this latter case. Kurchatov[19] interprets his own results for wheat in a similar fashion. It is likely, if little redistribution of such a direct deposit does in fact take place, that, because of the normally acropetal development of plant shoots, and the continuous nature of the deposition, the resulting general pattern of distribution will not be dissimilar from that of the strontium absorbed from the soil. It is perhaps significant that in those cases where comparison is possible, the percentage of the total activity found in the different parts of the plants by Middleton[8] following aerial application is very similar to that resulting from uptake through the roots in the present experiments. For example, 58·3% of the activity remaining in Middleton's swede plants at harvest was found in the root as compared with 60% in turnip reported here. In contrast, in both cases most of the tracer in beet was found in the leaves with comparatively little in the root. The distribution in wheat sprayed with tracer after the emergence of the inflorescence is also similar to that recorded here. It would appear, however, that in Middleton's experiments the considerable amount of activity washed from the plants by rain would become available for uptake through the roots later in the experiment. While it is not possible therefore to give complete answers to these questions, it would appear likely that the general patterns of distribution described here are not very dissimilar from those resulting from fall-out in the field.

In the cereals examined in the present work only a very small percentage of the activity absorbed by the plants reached the grain. Generally the distribution was similar in the different varieties of wheat and barley. Minor differences may exist but are not shown conclusively by the present results. In oats, less of the activity remained in the leaves and more accumulated in the chaff than in the other species, while in rice, the leaves, which comprise a greater proportion of the dry weight of the plant, retained a higher percentage of the strontium activity. The internal patterns of distribution of strontium in cereal grains described here, confirming and extending the recent observations of Lee[20] for the Thatcher variety of wheat, indicate that milling and polishing procedures would be expected to remove the major part of any root-absorbed strontium in addition to any surface contamination. It is clear that in cereals only a very small proportion of the total radio-strontium in the plant reaches human diet.

Among root vegetables, beet and carrot appear to accumulate strontium to a greater extent in the leaves than in the roots, while most of the activity in turnip was found in the root. In all these cases, the root itself shows a concentration of strontium in the peripheral zone. This

indication that peeling would remove a considerable proportion of the activity has been confirmed in this laboratory by determination of fall-out strontium levels in the peelings and flesh of root vegetables.[21]

The flower of cauliflower (Fig. 1) and the Brussels sprouts, though not well developed in the present experiments, showed relatively high activities on a dry weight basis.

Some food plants therefore appear to concentrate the strontium which they absorb through their roots in parts which man selects for his diet. Others accumulate most or almost all of this strontium in parts of the plant body which are discarded or fed to animals. Much of this discarded activity will however find its way back, over a period of time, along the food chains leading to man.

Addendum

Since the preparation of this paper, further data bearing on the mode of entry of fall-out strontium into crops has been published.[22]

Higher $^{89}Sr/^{90}Sr$ ratios are reported for the outer leaves of cabbages as compared with the inner leaves. A greater contribution must therefore have been made to the strontium pool of the former by fall-out of more recent origin, either by way of the soil or by direct aerial contamination. The evidence cited for cereals demonstrates more conclusively that aerial contamination can be important. ^{90}Sr/stable Sr ratios for bran are shown to be higher than those for flour, indicating that a substantial part of the ^{90}Sr in the bran had not passed through the soil.

Moreover, stable Sr/Ca ratios in bran are also higher than those for flour. There does therefore appear in this case to be some mechanism within the plant which discriminates against strontium in the passage of these elements into the endosperm.

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DIFFUSION OF SULPHITE DURING VEGETABLE DEHYDRATION

By R. B. DUCKWORTH and MARIAN TOBASNICK

Prepared samples of potato, carrot and cabbage were scalded in solutions containing sulphite labelled with ^{35}S. The distribution and movement of sulphite during subsequent dehydration and storage were studied by autoradiographic methods. After dehydration of potato and carrot strips, the sulphite is distributed throughout the strip with a slight concentration at the centre. The development of brown centres in such material is therefore not due to inadequate penetration of sulphite, but probably to accumulation of sugars and amino-acids in this region. In cabbage, the sulphite is readily taken up by the veins of the leaf.

Introduction

Little is known about the diffusion of solutes in scalded biological materials undergoing dehydration in hot air. Van Arsdel,[1] in a short theoretical examination of this phenomenon, points out that during dehydration a steep water gradient exists, the centre of the piece remaining relatively moist while the outermost layers of tissue are comparatively dry. In such conditions, given a more or less homogeneous initial distribution of solutes, the resulting concentration gradients in the water phase will bring about diffusion of the solutes towards the centre of the piece. This centripetal migration could continue so long as there is sufficient moisture present to form a continuous water phase.

A commonly occurring phenomenon in dehydrated strips of root vegetables such as potato is the formation of brown centres. A likely explanation of this feature is that, in accordance with the above argument, sugars and amino-acids, initial reactants in the formation of ' browning ' pigments,[2] become concentrated in the centre of the strip. The situation is, however, complicated by the fact that sulphite is generally applied to these materials during the scalding process, its main purpose being to act as an inhibitor of ' browning '. In order to exert this latter effect in the central part of the strip, the sulphite must penetrate into this region from the surface before the moisture content is reduced below the level which will allow free diffusion.

It was decided, therefore, to begin an examination of this problem by studying the distribution of sulphite in such materials during the process of dehydration and during subsequent storage of the products.

Experimental

Radioactive material

Sodium sulphite labelled with sulphur-35, obtained from the Radiochemical Centre, Amersham, was used in the preparation of solutions for scalding the vegetable material, the activity of these solutions being approx. 3·75 μc/ml.

Processing procedures

Potato and carrot were cut into strips approximately $\frac{3}{16}$ in. × $\frac{5}{16}$ in. in cross-section and cabbage was cut into small pieces. Samples of 28 g. were scalded in 200 ml. of solution, which for potato contained 0·03% of $Na_2S_2O_5$ (pH 6·3) and for carrot and cabbage 0·015% of $Na_2S_2O_5$ and 0·05% of Na_2SO_3 (the pH being adjusted to 7·2). The period of scalding was 3 min. for potato and carrot and $2\frac{1}{2}$ min. for cabbage, measured in each case from the time at which the solution recommenced boiling after the introduction of the material.

After being scalded, the material was dried in an electrically heated oven on a piece of fine wire mesh supported above one of the oven trays. The temperature of the air immediately surrounding the strips was maintained at 100° for 40 min., 75° for a further $2\frac{1}{2}$ h. and 65° for a final period of $2\frac{1}{2}$ h., air circulation being increased by leaving the door of the oven ajar.

Samples were taken immediately after scalding, after drying for 40 min. and again at the end of the drying process. These were used for autoradiography and for determinations of moisture content. The remaining dried material was stored in screw-capped bottles at 55° for 10 days and further samples then taken for autoradiography.

Some potato strips were also treated over half their length with the boiling tracer solution for 2 min., after being previously scalded for 2 min. in non-active $Na_2S_2O_5$. These were dehydrated as above and used to examine the extent of any longitudinal diffusion.

Autoradiography

Two methods were used in preparing the material for autoradiography. In strips taken immediately after the stages of scalding and drying for 40 min., the material was sufficiently soft to be sectioned. Median longitudinal and transverse sections 0·5–1 mm. thick were cut, fixed with Celloidin solution on to metal slides and immediately dried out in a muffle furnace at 600°. The drying took less than 2 min. Cabbage material was fixed on to metal slides in the same way.

The brittleness of the completely dehydrated samples made direct sectioning impossible. The strips were therefore embedded in ' Beetle ' resin (a cold-setting resin) and when the resin was thoroughly set, flat surfaces were cut through the strips in the median longitudinal and transverse planes.

As a check on the efficacy of the first of these methods in preventing adventitious diffusion of sulphite, some carrot material was immediately frozen in acetone–solid CO_2 after being sampled and then freeze-dried. In this case, sampling was carried out at hourly intervals during drying as well as after scalding, the freeze-dried strips being embedded in resin and cut as before.

The sections and surfaces prepared as described above were exposed against ' Kodirex ' *X*-ray film in the dark for 4 days and the films subsequently developed.

Determinations of moisture content

Moisture contents of samples taken after drying for 40 min. were determined by distillation with n-heptane (Dean and Stark). An air-oven method was used for the dehydrated material, 3-g. samples of ground material (passing a 40 mesh sieve) being heated at 100° for 2 h., the loss in weight being reported as % of the original weight. All determinations were carried out in duplicate.

Results

There was little difference between the results obtained for potato and carrot strips and these two will therefore be considered together. Immediately after the scalding stage, the sulphite can be seen to be concentrated near the surfaces of the strips (Fig. 1a, b, c), little inward diffusion having taken place during the scalding process itself. The autoradiograph from the freeze-dried material (Fig. 1c) shows a narrower and more well-defined zone of activity : a little adventitious diffusion appears therefore to have occurred during the drying of sections in the muffle furnace. Sections of both potato and carrot strips taken after dehydration for 40 min. show that, at this stage, penetration of sulphite has not proceeded very far, but that the tracer is still concentrated largely towards the outside of the strip (Fig. 1d). Autoradiographs from freeze-dried carrot material sampled at hourly intervals during drying all show a more or less general distribution of sulphite with, after the first hour, a slightly higher concentration in the centre of the strip than at the periphery, particularly at the ridged edges. This is also shown by the dehydrated material embedded directly in resin. The isotope used gives a very soft pure β-radiation ($E_{max.} = 0{\cdot}167$ MeV) and the fall-off in activity towards the corners is greater than can be accounted for by spreading of the image.

After storage of the dehydrated material at 55° for 10 days, the observed distribution was similar to that shown immediately after dehydration. Longitudinal sections taken at all stages of processing gave substantially the same picture as that illustrated by transverse sections. As a check on the possible diffusion of sulphite longitudinally within the strip during dehydration and/or storage, autoradiographs were also obtained from half-labelled strips. In these, the activity was confined at all stages to the half of the strip which was originally labelled (Fig. 1f).

Potato strips reconstituted by soaking in water for 2 h. and then sectioned as before, showed persistent pockets of higher activity near the centre (Fig. 1g) indicating that reconstitution by this treatment was incomplete.

In the cabbage material, the sulphite penetrated rapidly into the veins of the leaf during

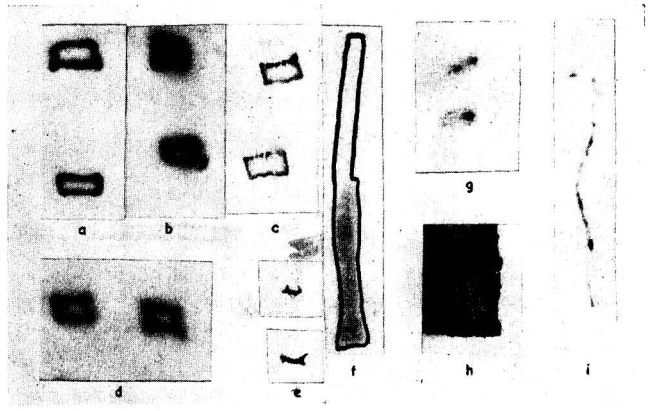

FIG. 1.—*Autoradiographs of sections of vegetable pieces taken at different stages during the dehydration process and showing the distribution of* ^{35}S*-labelled sulphite*

(a) potato, immediately after scalding (T.S.)
(b) carrot, immediately after scalding (T.S.)
(c) carrot, immediately after scalding, (freeze-dried) (T.S.)
(d) potato, after drying for 40 min. (T.S.)—moisture content 40·1%
(e) potato, after the full drying cycle (T.S.)—moisture content 7·05%
(f) potato (half-labelled strip), after dehydration and storage for 10 days at 55° (L.S.)– black line shows outline of original strip
(g) potato, after reconstitution (T.S.)
(h) cabbage leaf, after scalding
(i) cabbage leaf, during dehydration (L.S.)—the darker spots correspond to the veins of the leaf—moisture content 3·58%

scalding (Fig. 1h) and, during drying, the veins showed a higher activity than the intermediate parts of the lamina (Fig. 1i).

Discussion

It is clear from the present results that, although the sulphite is applied to the outside of the piece, it does completely penetrate the material during the dehydration process. The period of maximum diffusion in strips of root vegetables would appear to occur between 40 and 60 min. after the commencement of drying, although this will vary from piece to piece, material to material, and according to the drying conditions used. Movement of sulphite appears to be rather more rapid in carrot than in potato, but the difference shown here is perhaps not as great as would be expected from the difference in composition of the two tissues. The situation at the end of drying in both cases is that the sulphite shows a slightly higher concentration in the centre of the strip than at the periphery, i.e., in the part which generally first shows a brown discoloration. In cabbage also the sulphite accumulates in the parts, viz., the veins, which first become discoloured. Since sulphite is used to inhibit or at least to retard browning, its distribution in dehydrated vegetables would appear to have no causative connexion with the distribution of browning.

However, since sulphite diffuses in this way in potato and carrot strips, it is reasonable to suppose that other solutes such as sugars and amino-acids which are originally present in the material behave in a similar fashion. This being the case, the resulting accumulation of these latter substances in the central region would, as previously contended, be expected to lead to the formation of brown centres.

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JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

APRIL, 1960

The general arrangement of the abstracts is as follows: 1.—AGRICULTURE AND HORTICULTURE. 2.—FOOD; also appropriate Microbiological Processes; Essential Oils. 3.—SANITATION, including Water; Sewage; Atmospheric Pollution, etc. 4.—APPARATUS AND UNCLASSIFIED.

INDEX OF AUTHORS' NAMES

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JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

APRIL, 1960

I.—AGRICULTURE AND HORTICULTURE

General: Soils and Fertilisers

Soil classification—a destructive criticism. T. A. Jones (*J. Soil Sci.*, 1959, **10,** 196—200).—The theoretical and practical errors associated with the use of the soil profile as the working tool of soil classification are discussed. A. H. CORNFIELD.

Two-cycle theory of tropical pedology. C. D. Ollier (*J. Soil Sci.*, 1959, **10,** 137—148).—The theory is described and a number of Uganda profiles and some catenary relationships are discussed on the basis of the theory. A. H. CORNFIELD.

Characteristics of three reddish brown lateritic soils of Georgia. C. B. England and H. F. Perkins (*Soil Sci.*, 1959, **88,** 294—302).—Chemical, morphological and clay mineral analyses are given for two representative profiles from each of the soil series in the area. T. G. MORRIS.

An East African catena. S. A. Radwanski and C. D. Ollier (*J. Soil Sci.*, 1959, **10,** 149—168).—Characteristics of the catena are described. A. H. CORNFIELD.

Generalisations on some Tanganyika soil data. W. E. Calton (*J. Soil Sci.*, 1959, **10,** 169—176).—Physical and chemical data for many profiles of Eastern Tanganyika are presented in the form of mean values of the topsoils and lower subsoils for 8 distinct types of soil. In particular the relative contribution of org. matter and clay content to cation-exchange capacity and the variation in % saturation of Ca, Mg and K are considered. Adjusting % cation saturations and regard to type of colloid complex present are suggested as means of permanently improving the fertility of the soils. A. H. CORNFIELD.

Origin and development of brown earths on clay-with-flints and Coombe deposits. B. W. Avery, I. Stephen, G. Brown and D. H. Yaalon (*J. Soil Sci.*, 1959, **10,** 177—195).—Field investigations and chemical, physical, mineralogical and micromorphological data for two brown earth soil profiles on clay-with-flints and one profile on a Coombe deposit are presented and discussed in relation to the development of the soils. A. H. CORNFIELD.

Method for the equating of results of soil formation processes, with a profile of a N. German boulder clay as an example. P. Kundler (*Z. PflErnähr. Düng.*, 1959, **86,** 215—222).—The technique of equating the calculations and tabulations of gains or losses of various constituents in the individual horizons and in the whole soil is described with a profile as an example. M. LONG.

Dissolution of interlayers from intergradient soil clays after preheating at 400°. J. B. Dixon and M. L. Jackson (*Science*, 1959, **129,** 1616—1617).—By heating dry H^+-saturated clays of the intergradient chlorite–vermiculite–montmorillonite type to 400° for 4 hr. and then boiling with 0·5N-NaOH for 2·5 min., elements which give the intergradient properties may be dissolved. Other temp. of preheating, e.g., 110° and 300°, had only a small effect on the intergradient properties. T. G. MORRIS.

A vibrating probe method for compacting small volumes of soil. N. J. Rosenberg (*Soil Sci.*, 1959, **88,** 288—290).—A commercially available vibrator has been used to compact soil in drums. Dry bulk densities of 1·08—1·95 have been obtained as desired and uniform settlement has been achieved. T. G. MORRIS.

Adjustment of bulk density to an oven-dry volume basis. E. R. Perrier, D. R. Nielsen and J. E. Doan (*Soil Sci.*, 1959, **88,** 291—293).—An empirical technique is described whereby shrinkage and bulk density on an oven-dry volume basis may be estimated without measuring the particle size distribution or the natural soil structure. T. G. MORRIS.

Structure of soil crumbs. W. W. Emerson (*J. Soil Sci.*, 1959, **10,** 235—244).—A model of a soil crumb is proposed showing the probable arrangement of quartz, clay and org. matter. In soils with Ca as the dominant cation orientated clay crystals will behave as a single unit ("clay domain"). Quartz particles and clay domains may be held together by org. matter, which may also bind quartz to quartz and clay to clay. The model satisfies a number of conditions derived from experiments on the effect of org. matter of soil crumbs and also accounts qualitatively for the decrease in shear strength after re-moulding soils. A. H. CORNFIELD.

Aggregate measurements on light soils. II. R. Koitzsch and A. Kullmann (*Z. PflErnähr. Düng.*, 1959, **86,** 193—205).—Changes in soil permeability result from alterations of structure due to change in soil moisture. M. LONG.

Modified permeability test for measuring the cohesion of soil crumbs. M. G. Dettman and W. W. Emerson (*J. Soil Sci.*, 1959, **10,** 215—226).—The method is based on measuring the initial permeability of a 1-cm. thickness of soil crumbs by percolation with 0·05N-NaCl, followed by percolation of the soil with 3 l. of the solution, followed by another permeability measurement. The ratio, final permeability/initial permeability, is then a measure of soil cohesion. Application of the method to a wide range of soils showed that a continuous arable system resulted in poor soil structure. A ley and lucerne produced greater increases in crumb cohesion than did root crops. A short ley improved structure, this improvement being detectable even after a subsequent year in arable cultivation. Even 100 years in grass did not give a soil max. stability. Limitations of the test are described. It may lead to erroneous conclusions when comparing soils of widely differing pH or clay content. A. H. CORNFIELD.

Comparison of some field methods for measuring the hydraulic conductivity of soils. M. Sillanpää (*Acta agric. scand.*, 1959, **9,** 59—68).—Apparatus for measurement of the hydraulic flow of water in soil is described. Data obtained was in good agreement with that given by a piezometer, but tended to give lower values in the more permeable and higher values in the less permeable soils. A. G. POLLARD.

Air space in Scottish soils. J. C. C. Romans (*J. Soil Sci.*, 1959, **10,** 201—214).—Total air-space values were related to the hydrologic sequence. The greatest differences within the profile were found in freely-drained soils, with values from approx. 50% air space in the B_2 horizon to 25—35%, depending on parent material, in the indurated B_3 horizon. Imperfectly-drained soils had a slightly lower air space in the B_2 horizon and values decreased below this. Poorly-drained soils commonly had 35—40% and very poorly-drained soils 30—35% air space. A. H. CORNFIELD.

A resistance network analogue for studying seepage problems. R. V. Worstell and J. N. Luthin (*Soil Sci.*, 1959, **88,** 267—269).—A resistance network is described using cartridge type carbon resistors arranged in readily changeable network patterns. With it, drainage and seepage problems in soil can be simulated and studied. T. G. MORRIS.

Influence of exchangeable hydrogen and calcium, and of sodium, potassium and ammonium at different hydrogen levels on physical properties of soils. J. P. Martin and S. J. Richards (*Proc. Soil Sci. Soc. Amer.*, 1959, **23,** 335—338).—Variation of the % H saturation of three soils (0—85%) and of % Ca saturation (2—50%) up to excess $CaCO_3$ had little effect of aggregation, bulk density, hydraulic conductivity or moisture retention at 0·1—1·0 atm. tension. Probably the deterioration of the physical properties of acid soils is not due to exchangeable H as such. The effect of increasing the saturation of Na^+, K^+ and NH_4^+ from 5% to 50% in base-saturated soil and soil having 30% and 55% H saturation was studied. Increasing exchangeable K^+ and NH_4^+ had little effect on, whilst increasing exchangeable Na^+ greatly reduced aggregation. The effect of Na^+ in this respect increased with decreasing base saturation of the soil. Hydraulic conductivity decreased considerably with increasing Na^+, K^+ or NH_4^+ saturation, the effect increasing with decreasing base saturation. Since NH_3 tends to accumulate in acid soils, the observed reduction in permeability in such soils may be explained on the basis of accumulation of exchangeable NH_4^+. A. H. CORNFIELD.

Control of seed germination by moisture as a soil physical property. N. Collis-George and J. E. Sands (*Aust. J. agric. Sci.*, 1959, **10,** 628—636).—The rates of germination of *Medicago denticulata, M. confinis, M. tribuloides* and *Juncus vaginatus* decreased as soil moisture suction (pF) increased, until at 10 atm. they were negligible. *Medicago* spp. were less affected by suction changes than was *J. vaginatus*. Moisture conditions necessary to allow *J. vaginatus* to germinate at a rate comparable to those of *Medicago* spp. were quite restrictive and corresponded to high water-tables or soils wetter than field capacity. In addition to suction, hydraulic conductivity (or permeability) of soil also affected germination rates. As relations between moisture content and suction and moisture content and hydraulic conductivity are soil characteristics, these character-

istics, as well as moisture contents, should be defined in germination experiments. S. C. JOLLY.

Interaction between kaolin and polyanions. W. Flaig and H. Söchtig (*Z. PflErnähr. Düng.*, 1959, **87**, 44—57).—Low concn. of polyanions (e.g., polyacrylate, etc.) have no effect on kaolin suspensions, moderate concn. increase flocculation and high concn. cause dispersion. Flocculation is inhibited by low-mol.-wt. compounds but favoured by increasing chain length. With increasing time of reaction the optimum flocculating concn. rises to a limiting value. M. LONG.

Effect of electrolyte concentration and exchangeable-sodium percentage on diffusivity of water in soils. W. R. Gardner, M. S. Mayhugh, J. O. Goertzen and C. A. Bower (*Soil Sci.*, 1959, **88**, 270—274).—Soil, in which the exchangeable Na/Ca had been adjusted as required, was placed on a pressure membrane under 15 bars pressure and, after equilibrium had been attained, was packed uniformly into a horizontal channel. Water having the same Na/Ca ratio and appropriate electrolyte concn. was then applied at zero hydraulic head to one end of the channel and the rate of movement determined by weighing sections of the soil. The diffusivity of the soil was calculated and characterised by a "weighted mean diffusivity" (W.M.D.). The W.M.D. decreased with decreasing electrolyte concn. in the diffusing solution, the effect increasing rapidly with rising exchangeable Na in the soil. Using K- instead of Na-soils the diffusivity was about 10 times larger and with Ca larger still. Most of the decrease in diffusivity in Na-soils occurs at water contents near saturation. T. G. MORRIS.

Fixed ammonium in rocks. F. J. Stevenson (*Science*, 1959, **129**, 221—222).—Ground (100-mesh) Palaeozoic shales and granite rocks after boiling with N-KOH and heating with 7·5N-HF–N-HCl at 80°, yielded free NH_3. The total N of the granites was much less than that of the shales. The proportion of total N as NH_3 in the shales was 52—68% while in the granites it was 24—56%. The implications of the existence of this reservoir of N in rocks are discussed. T. G. MORRIS.

Factors influencing the isotopically exchangeable phosphate in soils. I. Effect of low concentrations of organic anions. II. Effect of base-saturation with sodium and calcium in non-calcareous soils. III. Effect of temperature in calcareous soils. P. Arambarri and O. Talibudeen (*Plant & Soil*, 1959, **11**, 343—354, 355—363, 364—376).—I. In the presence of 0·001M-citrate total labile PO_4^{3-} was increased in a non-calcareous and decreased in a calcareous soil. In the presence of diethyl barbiturate (non-chelating ion) total labile PO_4^{3-} decreased in both soils. The org. anions greatly decreased the "slowly-exchanging fraction" in both soils. The citrate ion usually increased the "rapid"- and "medium"-exchanging fractions, whilst the barbiturate anion either had no effect or decreased them.

II. Total labile PO_4^{3-} in 6 of 7 soils was 8—40% higher in Na- than in Ca-saturated soil. A much larger part of the total labile PO_4^{3-} was found in solution in the Na-saturated soils. At 25° the rates of isotopic exchange of the more slowly exchanging forms of soil PO_4^{3-} were 4 times higher in a Na- than in a Ca-soil, although the total labile PO_4^{3-} in the two forms were similar. Increasing the temp. to 35° doubled the rates of exchange in the Na-soil, but had no effect on that in the Ca-soil.

III. Influence of temp. (25—45°) on the rate of dissolution and equilibrium concn. of PO_4^{3-}, on the labile PO_4^{3-} and its components, and on the rates of isotopic exchange in four soils of varying $CaCO_3$ content and PO_4^{3-} status are reported. A. H. CORNFIELD.

Behaviour of ^{32}P in tracer studies. S. R. Olsen and F. S. Watanabe (*Soil Sci.*, 1959, **88**, 256—259).—P and ^{32}P in the same ionic form act in the same way in chemical reactions involved in plant and soil studies. The unusual reactions of ^{32}P reported by Yuan and Robertson (*ibid.*, 1958, **86**, 220) were not observed in these tests. T. G. MORRIS.

Biological liberation in soils of soluble phosphates from insoluble phosphorus compounds. R. Moreau (*C. R. Acad. Sci., Paris*, 1959, **249**, 1804—1806).—The presence is shown of organisms which solubilise and make available phosphates in three poor forest soils. Most of these organisms are moderately active; some are very active due probably to an enzyme, uncombined CO_2 or org. acids which are metabolic products of the organisms. M. C. M.

Place of fertilisers in forestry. M. V. Laurie (*J. Sci. Fd Agric.*, 1960, **11**, 1—8).—Literature recording the responses to different fertilisers (e.g., P, N, K and Ca), the practice of liming older conifer forests in Germany and recent work on N is reviewed. (28 references.) E. M. J.

Nutrition problems in forest nurseries. B. Benzian (*J. Sci. Fd Agric.*, 1959, **10**, 637—644).—The literature from 1943 is reviewed. Small plot tests with Sitka spruce as the main crop have shown that commercial fertilisers [e.g., Nitro-Chalk, $(NH_4)_2SO_4$, superphosphate and KCl] are safe when used in seedbeds and transplant beds. Seedlings grown with fertiliser were slightly taller than those grown with compost. Needle tip burn has been cured by foliar application of Bordeaux mixture. Near neutral soils produced stunted growth, but good growth was obtained after soil acidification, or after application of steam, formalin or chloropicrin. E. M. J.

Use of fertilisers in the afforestation of deep peat. T. W. Wright (*J. Sci. Fd Agric.*, 1959, **10**, 645—650).—Successful establishment of trees depends on P manuring combined with ploughing and correct choice of species. Application of other nutrients (e.g., K) which may become necessary is revealed by foliage analysis. E. M. J.

Comparison of leaching and fixation of potassium and rubidium in soils using the isotopes ^{42}K and ^{86}Rb. A. Øien, G. Semb and K. Steenberg (*Soil Sci.*, 1959, **88**, 284—287).—Columns of soil were leached with water and then aq. KCl or RbCl labelled with ^{42}K and ^{86}Rb in known amounts was added to the tops of the columns which were then leached with the equivalent of 100 mm. of rainfall. After keeping overnight the radioactivity of vertical half-columns was determined twice, immediately to give the sum of ^{42}K and ^{86}Rb and then after 8 days when the ^{42}K had decayed to zero, to give the ^{86}Rb. K and Rb were concentrated in the upper parts of the column, the concn. (especially of Rb) decreasing rapidly with depth. Neither Rb nor K was found in the leachate from a clay soil but both were present in the leachate from a sandy soil In other tests soil was shaken with RbCl and KCl and after standing overnight the soil was filtered off and leached with Mg acetate. Any Rb or K not removed was taken as "fixed." In a clay soil 30% of the Rb and 15% of the K were fixed. Neither was fixed by a sandy soil. T. G. MORRIS.

Amorphous iron oxides in soils. R. M. Taylor (*J. Soil Sci.*, 1959, **10**, 309—315).—The exothermic peak at about 320° in differential thermal analysis of soils and clays which has usually been presented as evidence for the presence of amorphous iron oxides was in fact shown to be due to org. matter, since the peak did not occur after prolonged treatment with H_2O_2, or when differential thermal analysis was carried out in an atm. of N_2. A. H. CORNFIELD.

Interaction of iron with rainfall leachates. M. Schnitzer (*J. Soil Sci.*, 1959, **10**, 300—308).—The ability of rainfall leachates from decomposing leaves of four species of deciduous trees to remove Fe on percolation through Fe-saturated Dowex-50 resin decreased in the order maple, poplar, birch, beech. Fe-enriched leachate from maple leaves lost significantly less Fe to Al-saturated resin than did that from other species. The loss of Fe from leachates percolated through resin saturated with various cations decreased in the order H-, Al-, Mn-, Ca-resin. Potentiometric titration of metal-free and Fe-enriched leachates indicated that titratable acid groups were blocked by added Fe. pK values for metal-free and Fe-enriched leachates are presented. A. H. CORNFIELD.

The bicarbonate ion as an indirect cause of iron chlorosis. J. C. Brown, O. R. Lunt, R. S. Holmes and L. O. Tiffin (*Soil Sci.*, 1959, **88**, 260—266).—Chlorosis susceptible (PI) and non-susceptible (HA) soya-beans were grown using a split medium technique, roots growing through soil to provide Fe into a nutrient solution. Data indicate that HCO_3^- does not stimulate chlorosis or inactivate Fe. More P was found in the plants grown with roots in solutions without, than in those with HCO_3^-. HA beans did not develop chlorosis in any of these treatments. PI beans developed severe chlorosis in complete solution cultures containing HCO_3^-. HA beans were unaffected. The presence of HCO_3^- in the solution increased the concn. of sol. P and the occurrence of chlorosis in PI plants is related more closely to $[PO_4^{3-}]$ than to the $[HCO_3^-]$. T. G. MORRIS.

Determination of small amounts of copper as copper diethyldithiocarbamate by a displacement reaction. K. Scharrer and E. Schaumlöffel (*Z. PflErnähr. Düng.*, 1959, **87**, 1—15).—The method is based on the exchange of Pb for Cu in the Pb complex, the Cu complex then being determined colorimetrically. Maximum error is ±3·0%. Wet ashing with a $HNO_3/HClO_4/H_2SO_4$ mixture gives the best results with plant material, the extract being brought to the desired pH in presence of NH_4 citrate buffer. Cu in soil is determined after removal of silica by HF. With calcareous and phosphatic fertilisers a solution of lower pH and higher buffer capacity is required. Results compare well with those by other methods. M. LONG.

Method for assessing zinc status of soils using acid-extractable zinc and "titratable alkalinity" values. J. L. Nelson, L. C. Boawn and F. G. Viets, jun. (*Soil Sci.*, 1959, **88**, 275—283).—Zn extracted from soil by three treatments with 0·1N-HCl was determined as well as the "titratable alkalinity" (the amount of acid in mequiv. per 100 g. of soil needed to change the pH to 5). When the acid-extractable Zn is plotted against the titratable alkalinity of the soils a good separa-

tion into Zn-deficient and -non-deficient soils can be obtained. The amount of Ca present appeared to have no effect on the results. T. G. MORRIS.

Sulphur oxidation in tidal mangrove soils of Sierra Leone. M. G. R. Hart (*Plant & Soil*, 1959, **11**, 215—236).—Tidal mangrove soils contained an average of 0·017 g. of oxidisable S per g. soil (dry basis) of which about 55% was insol. in acetone (much of this was probably polysulphide absorbed in decayed wood). Soil pH decreased with decreasing soil moisture during drying from an initial pH of 6 down to 3. Soil SO_4^{2-} content increased with time and the count of S-oxidising bacteria was high during this period but declined when pH fell to about 3. This was probably due to increased concn. of Fe in solution at low pH. Application of $CaCO_3$ increased or decreased S oxidation depending on whether soil pH was brought into or moved out of the pH requirements of the organisms for max. activity, and also reduced oxidation of pyrites. Pyrites was not oxidised above pH 3 and was not involved in acid formation. A. H. CORNFIELD.

Decontamination of soils containing strontium-90. R. K. Schulz, J. P. Moberg and R. Overstreet (*Hilgardia*, 1959, **28**, 457—475).—Treatment of contaminated soil with HCl or aq. $FeCl_3$ followed by leaching with 5 in. of irrigation water displaced 90% of ^{90}Sr to a depth of 6 in. By spraying the soil surface with asphalt which was later peeled off 97% of the ^{90}Sr was removed from the soil. The latter became again available to plants when the peeled crust was mixed with soil. In lysimeter cultures of barley, the uptake of ^{90}Sr placed 2 ft. deep in the soil was approx. 10% of that from placements of 2 in. A. G. POLLARD.

Relationship of Walkley–Black carbon values to total organic carbon in Indian soils. R. S. Dewan, A. Sen and R. B. Rewari (*J. Indian Soc. Soil Sci.*, 1959, **7**, 103—106).—Walkley–Black C values (*Soil Sci.*, 1934, **37**, 29) for ~300 soils from many parts of India were highly correlated with total org. C values. In spite of the high correlation, the scattering of values indicated that the use of a correlation factor for calculating total org. C from Walkley–Black values is not justified. On an average Walkley–Black C values as % of total org. C were higher for non-calcareous than for calcareous soils. A. H. CORNFIELD.

Increases in the carbon and nitrogen contents of tropical soils under natural fallows. D. J. Greenland and P. H. Nye (*J. Soil Sci.*, 1959, **10**, 284—299).—The rate of increase of humus C in tropical soils rested under natural fallows is calculated, assuming that the rate of decomposition of C is proportional to the amount present, and that the rate of addition, by humification of litter and roots, remains constant. The rate of decomposition was derived from the max. humus level that the soil attains under the fallow vegetation, and the rate of addition from data on litter production. Shifting cultivation in forest areas resulting in alternation of cropping and fallowing resulted in relatively small fluctuations in soil humus at about 75% of the max. level. Rates of increase of soil N at this level are 20—50 lb. per acre per annum in forest land and 4—10 lb. per acre per annum in savannah. A. H. CORNFIELD.

Humus formation in the laboratory catalysed by naturally occurring iron compounds. F. Scheffer, B. Meyer and E. A. Niederbudde (*Z. PflErnähr. Düng.*, 1959, **87**, 26—44).—The formation of humic acid layers on natural iron oxide in soil and the synthesis of humic acid in solution take place by adsorption catalysis and an ionic oxidation–reduction process. M. LONG.

Reducing action of peat fulvic acids on trivalent iron and fulvic acid–iron complexes. T. Béres and I. Király (*Z. PflErnähr. Düng.*, 1959, **87**, 16—26).—Nearly all the Fe in the fulvic acid complexes obtained from peat exists in the divalent state. Fulvic acid solutions can reduce Fe^{3+}, this reduction being inhibited by H_3PO_4 and increased as HCl and fulvic acid concn. are decreased. Reduction is faster in boiling solutions. Artificially prepared complexes, obtained by pptg. fulvic acid in Fe salt solutions, also possess reducing powers. M. LONG.

Humic acid investigations. II. Fractionation of humic acids. C. B. Coulson, R. I. Davies and E. J. A. Khan (*J. Soil Sci.*, 1959, **10**-271—283).—Studies on the use of paper chromatography and electrophoresis, glass "paper" chromatography, column chromatography with ion-exchange resins and cellulose, and diffusion in gelatin for fractionating humic acids extracted from peat and soil are presented. A. H. CORNFIELD.

Humus decomposition and nitrification. H. F. Birch (*Plant & Soil*, 1959, **11**, 262—286).—The extent of mineralisation of org. C and N on wetting air-dried soils increased with length of air-dried storage. Water-sol. org. materials also increased with length of air-dried storage and this effect was intensified when soils were dried at a higher temp. The sol. org. material mineralised rapidly without concomitant mineralisation of N. Drying probably changes the org. gels (fragmentation and increased exposure of surface area) and such changes continue during air-dried storage and are enhanced by heat. The initial high rate of mineralisation of org. C and N following wetting an air-dried soil, and the rapid decline in rate, is associated with high microbial activity in the early phase of a developing microbial population, and its decline as the microbial population ages. A. H. CORNFIELD.

Decomposition of forest litters. I. Production of ammonia and nitrate, changes in microbial population, and rate of decomposition. K. C. Ivarson and F. J. Sowden. **II. Changes in nitrogenous constituents.** F. J. Sowden and K. C. Ivarson (*Plant & Soil*, 1959, **11**, 237—248, 249—261).—I. Liberation of NH_3 during incubation (28°) for 6 months of the litter from a brown forest soil under a stand of deciduous trees was greater than that from a podsol soil under a coniferous stand. Nitrate developed only in the later stages of incubation, and then only in the deciduous litter. The deciduous litter lost more dry matter than did the coniferous litter. Bacteria and actinomycetes were more numerous in deciduous than in coniferous litter, but the reverse held for fungi. An antifungal antibiotic had little effect on no. of fungi in coniferous litter, whilst an actibacterial antibiotic reduced slightly the no. of bacteria and actinomycetes. Dry matter loss in the coniferous litter was unaffected by addition of the antifungal antibiotic, in spite of the great increases in the no. of bacteria and actinomycetes.

II. Most of the amino-acids increased (dry basis) in acid hydrolysates of the decomposing litters with time of incubation. The amino-acid/total N ratio increased slightly up to 53 days and then decreased, this decrease being greater with the deciduous than with the coniferous litter. Changes in contents of individual amino-acids showed no significant pattern. Total hexosamine content and hexosamine as % of total N increased with time and was greater in the deciduous than in the coniferous litter. Changes in amino-acids did not help to explain the formation of mull and mor under deciduous and coniferous litters respectively. A. H. CORNFIELD.

Comparison of humic acids, formed by many years of organic manuring, with natural humic acids of different origins. U. Springer and A. Wagner (*Z. PflErnähr. Düng.*, 1959, **86**, 223—249).—Most humic acids are insol. in acetyl bromide, the insolubility increasing with age. In contrast to soil humic acids, those from protein rich material and their intermediates are very soluble on acetolysis. Most humic acids are resistant to acid hydrolysis. A high methoxyl content points to lignin as a precursor of humic acids. Hydroxyl content is a guide to origin and age. Different org. treatments lead to differences in the nature and amount of humic acids formed. Two types of natural humic acid exist: those in which the individual structural units can be more or less distinguished and those of high mol. wt., in which this is not the case. M. LONG.

Influence of organic manures on the colonisation density of Enchytraeidae in arable soils. W. Sauerlandt and M. Marzusch-Trappmann (*Z. PflErnähr. Düng.*, 1959, **86**, 250—257).—The count of Enchytraeidae is ~50% higher in the top layers of treated plots than in control plots. No effect is found in the lower layers. These counts may be used as a measure of biological activity of arable soils. M. LONG.

Organic materials extracted from soils and composts. I. Isolation and characterisation of ligno-proteins from compost. D. S. Jenkinson and J. Tinsley. **II. Infra-red spectra of ligno-proteins isolated from compost.** J. D. S. Goulden and D. S. Jenkinson (*J. Soil Sci.*, 1959, **10**, 245—263, 264—270).—I. Proteins were extracted from $Na_4P_2O_7$ and Na_2SO_3 extracts of the water-insol. fraction of a wheat-straw compost. About half of the N present in the two extracts was removed by these methods. The isolated material yielded 55—60% of its N as α-amino-acid N on acid hydrolysis. The non-hydrolysable part was very similar to lignin from wheat straw.

II. Infra-red absorption spectra of the ligno-proteins isolated as above showed absorption bands characteristic of the peptide link. The i.r. spectra of residues from acid and alkaline hydrolysis of ligno-proteins were very similar to that of straw lignin. Wheat-straw lignin was little altered by boiling with 2N-NaOH for 4 hr. in the absence of air. A. H. CORNFIELD.

Effects of the flowerpot on plant growth. J. E. Eastoe and A. G. Pollard (*Plant & Soil*, 1959, **11**, 331—342).—Air and water permeability through clay pots from different sources (hand made and machine pressed) differed considerably in spite of very similar appearance of the pots. The availability to plants of the P and K in pot material was small compared with that available from soil; availability of Ca from pot material was similar to that from soil. Pot material absorbed PO_4^{3-} but not K or NO_3^-. Soil nitrification increased with permeability of the pots, and uptake of N by plants growing in the pots increased similarly. A. H. CORNFIELD.

Stand seed and potting composts. P. J. Sutton (*Rep. Glasshouse Crops Res. Inst.* [1958], 1959, 69—78).—A review of the literature. (54 references.) A. G. POLLARD.

Chemical and biological changes during the decomposition of *Crotolaria juncea* (sann hemp) of varying ages in soil. B. P. Ghildyal and U. C. Gupta (*Plant & Soil*, 1959, **11**, 312—330).—The whole plant of *C. juncea*, grown for 3–7 weeks, was chopped up and mixed with soil (5% dry basis) and incubated at 30° for 120 days. The no. of bacteria, actinomycetes and fungi first increased and then decreased with advancing incubation. Bacteria attained the highest no. with the youngest and actinomycetes and fungi with the oldest material. Nitrate increased to a considerable extent during the early stages of incubation, but only with the young material. Total N decreased with time with all materials, the greatest reduction occurring with the young material; org. matter showed a similar trend. Pentosans and cellulose decomposed relatively rapidly compared with lignin and ether extract. A. H. CORNFIELD.

Effect of decomposing organic matter on the availability of phosphorus and calcium. M. M. Rai (*Res. J. Hindi Sci. Acad.*, 1959, **2**, 175—179).—The processes involved are outlined and briefly discussed. (10 references.) (From English summary.) C. V.

Effect of organic matter on crumb structure. W. W. Emerson and M. G. Dettman (*J. Soil Sci.*, 1959, **10**, 227—234).—Dry soil crumbs from long-term arable and comparable grassland plots showed the same degree of swelling when wetted slowly (to prevent slaking) with water, as with the same rate of water uptake from an atm. of 98% R.H. The latter value was unaffected by addition of 0·5% of a synthetic soil conditioner to Na-illite prior to preparing synthetic soil crumbs. Removal of org. matter from soils by treatment with H_2O_2 did not affect water uptake of synthetic crumbs. From slaking and dispersion tests made on natural crumbs and on remoulded crumbs formed by drying a past of the natural crumbs it was inferred that re-moulding did not disperse the clay in either the grassland or arable crumbs, but did break up many of the aggregates of 2—50μ diameter in the grassland crumbs. A. H. CORNFIELD.

Rôle of polysaccharides in soil aggregation. N. C. Mehta, H. Streuli, M. Müller and H. Deuel (*J. Sci. Fd Agric.*, 1960, **11**, 40—47).—Natural aggregates of a Swiss Braunerde and synthetic soil aggregates produced with several polysaccharides were tested against various chemical treatments designed to destroy polysaccharides or other soil constituents. The difference in behaviour of the natural and synthetic aggregates during treatment shows that normal polysaccharides cannot be solely responsible for the natural aggregation of the soil. The extreme stability of the aggregates may indicate that more than one agent is involved. (28 references.) E. M. J.

Initiation of the rhizosphere effect. J. W. Rouatt (*Canad. J. Microbiol.*, 1959, **5**, 67—71).—Counts of bacteria and fungi in the rhizosphere rose rapidly in the first week after planting, but changed little in the next 10 days. Individual rhizosphere isolates grew more rapidly than those in control soils. Even in the initial development stages, the root profoundly influences the numbers and nature of micro-organisms in the rhizosphere, due to substances (amino-acids and sugars) elaborated by the seed and growing root. (12 references.) K. R. BUTLIN.

Growth factor relationships of soil micro-organisms as affected by proximity to the plant root. F. D. Cook and A. G. Lockhead (*Canad. J. Microbiol.*, 1959, **5**, 323—334).—Bacterial isolates from the wheat root surface (rhizoplane), rhizosphere and control soil were examined for their (*a*) growth factor requirements and (*b*) synthesis of growth factors. The control soil contained a much higher proportion of organisms needing one or both factors. Thiamine was most frequently required. Biotin and vitamin B_{12} were commonly needed by control-soil isolates, but were less important in the rhizoplane and rhizosphere. Bacteria synthesising growth factors were more numerous in the root zone than outside, and were somewhat fewer in the rhizosphere than in the rhizoplane. Rhizoplane fungi were more active in producing vitamins than those from more distant sources. (26 references.) K. R. BUTLIN.

Metabolic activity and phosphate-dissolving capability of bacteria isolates from wheat roots, rhizosphere and non-rhizosphere soils. K. Katznelson and B. Bose (*Canad. J. Microbiol.*, 1959, **5**, 79—85).—The glucose- and alanine-oxidising activities of bacterial isolates from the wheat root surface (rhizoplane) were greater than those from rhizosphere or non-rhizosphere soils; their greater activity with alanine indicates the importance of amino-acids for soil organisms. More than 1/3 of cultures tested dissolved $CaHPO_4$. The significance of these observations on the phosphate economy of the plant is discussed. (12 references.) K. R. BUTLIN.

Physiology of nitrification in Kenya highland soil. J. W. Millbank (*Plant & Soil*, 1959, **11**, 293—311).—Organisms responsible for the $NH_3 \rightarrow NO_3^-$ conversion in humic red latosols in Kenya (altitude over 6000 ft.) morphologically, apart from motility, and physiologically closely resembled the classical genera *Nitrosomonas* and *Nitrobacter*. pH effects, affinity for soil particles and reaction to inhibitors were similar to those of temperate latitude organisms. A. H. CORNFIELD.

Factors affecting nitrification in Alberta soils. K. N. Synghal (*J. Indian Soc. Soil Sci.*, 1959, **7**, 73—80).—Nitrate production during incubation of 4 soils increased with time of incubation (2—6 weeks), with temp. (15—35°) and with addition of vermiculite (soil : vermiculite 1 : 1). Leaching the soils increased NO_3^- production during incubation; nitrification was greater at 50—60% field capacity than at 40% field capacity moisture. Addition of all essential macro-nutrients (except N) before incubation decreased nitrification. A. H. CORNFIELD.

Nitrogen fixation by *Azotobacter chroöcoccum* in culture. W. V. B. Sundara Rao and V. Iswaran (*J. Indian Soc. Soil Sci.*, 1959, **7**, 91—95).—The N-fixing power of *Azotobacter chroöcoccum* freshly isolated from soil decreased with successive sub-culturing but increased again when an extract of sterile soil was added to the culture. The cell-free extract of the organisms did not fix N. The extent of N fixation decreased with increasing NO_3^--N concn. of the medium, 15 p.p.m. almost completely inhibiting the process. A. H. CORNFIELD.

Nitrogen-fixing bacteria of the genus *Beijerinckia* in South African soils. J. H. Becking (*Plant & Soil*, 1959, **11**, 193—206).—*Beijerinckia* was found in 15 of 40 South African soils (mainly laterites) examined. It occurred in soils with pH 4·5—6·7, but not in soils with pH <4·3 or >7·0, and under many types of soil cover. This is the first report of the occurrence of *Beijerinckia* in lateritic soils outside the tropics in South Africa. A. H. CORNFIELD.

Nitrogen fixation in lakes. R. Dugdale, V. Dugdale, J. Neess and J. Goering (*Science*, 1959, **130**, 859—860).—By using ^{15}N as indicator natural lake waters are shown to fix N at measurable rates. Under constant illumination at 15° a reservoir water fixed 0·021 μg. of N/l. per day during the first 58 hr. and then 0·068 μg. of N/l. for a further 42 hr. T. G. MORRIS.

Dehydrogenase activity in soils. I. L. Stevenson (*Canad. J. Microbiol.*, 1959, **5**, 229—235).—Colorimetric determination of triphenylformazan (TPF), produced by reduction of 2,3,5-triphenyltetrazolium chloride (TTC), was used to estimate the dehydrogenase activity of soil microflora *in situ*. Reduction of TTC and oxygen uptake were directly correlated both in different soils and in one soil during decomposition of org. supplements; during decomposition, although not otherwise, dehydrogenase activity was related to bacterial numbers. The method provides a reliable index of microbial activity in soil. K. R. BUTLIN.

Efficient use of fertilisers. Various authors (eds. V. Ignatieff and H. J. Page) (*Fd Agric. Organ. United Nations*, 1958, *Agric. Studies*, No. 43, 355 pp.).—This is an enlarged edition of the monograph of 1949 (*Agric. Studies*, No. 9), having new chapters on crops and their soil and nutrient needs, and on economic aspects of fertiliser use, and other chapters are brought up to date. There is a comprehensive bibliography and a subject index. H. S. R.

Nitrogen interchange in soil as affected by soil type, source and rate of nitrogen addition, moisture, and time of incubation. W. G. Walunjkar, W. V. Bartholomew and W. G. Woltz (*J. Indian Soc. Soil Sci.*, 1959, **7**, 65—72).—Studies with labelled N (NH_4^+ or NO_3^-) added to two soils and incubated for 75 days showed reduced extractable inorg. N from both fertiliser and soil source during the early stages of incubation followed by a gradual increase from both sources. Type of N added had little effect on the results. Increasing rate of applied N (75 or 150 lb. per acre equiv.) resulted in increasing concn. of inorg. N from both soil and fertiliser. Increasing moisture content during incubation (from 25% below to 25% above the moisture equiv.) resulted in slightly increased concn. of inorg. N from both sources. N interchange between org. and inorg. forms was greater with the soil of higher org. matter content. A. H. CORNFIELD.

Chemical changes in an irrigated soil during 28 years of differential fertilisation. P. F. Pratt, R. B. Harding, W. W. Jones and H. D. Chapman (*Hilgardia*, 1959, **28**, 381—420).—Manurial systems involving various N fertilisers, P, K, lime and gypsum are compared over a 28-year period on a citrus fruit soil irrigated with slightly alkaline water. Accumulation of Ca under certain treatments reached max. in the surface 6 in. of soil, min. in the 6—12 in. layer and increased at greater depths. $(NH_4)_2SO_4$ and $NaNO_3$ increased the salinity of the soil; orange yields and soil salinity were negatively correlated. Farmyard manure increased the org. C content of the soil only to a depth of 6 in. Increase in sol. P was associated with fall in pH. Org. C and cation-exchange capacity were posi-

tively correlated. Of the P applied as triple superphosphate >60% accumulated in the upper 6 in. and >80% in the 0—12 in. layer of soil. Fixation of added K, which occurred chiefly at depths of >12 in. increased with the level of application. Sol. Zn was highest in unlimed soil having pH 6·5 approx., and least in limed soil and also in highly acid soil. Sol. Cu was not specifically influenced by pH but was lowest in limed soil; it decreased in amount with rise in org. C content of the soil. A. G. POLLARD.

The "lettuce" method (a modification of the Neubauer method) compared with those of Egner-Riehm and Dirks-Scheffer. K. Ehrendorfer (*Z. PflErnähr. Düng.*, 1959, **87**, 57—70).—Agreement between the "lettuce" method, the Dirks-Scheffer and lactate methods for assessing fertiliser requirements of soils was good for K in all the soils examined, but for P, the agreement with the lactate method is good only on non-calcareous soils. M. LONG.

Balance sheets for determining phosphorus and potassium requirements of mixed and pasture farming. S. F. Kuipers and T. de Vries (*Landbouwvoorlichting*, 1958, **16**, 498—511).—Examples are given of the application of two forms of balance sheet for the convenient detection of serious errors in farm economy. The system based on animal manure production against the manurial requirements of the pastures is more satisfactory than that based on intake of P and K as fodder against outgoings by way of milk and meat. P. S. ARUP.

Field experiments on phosphate fertilisers. A joint investigation. (Co-ordinated by) G. W. Cooke and F. V. Widdowson (*J. agric. Sci.*, 1959, **53**, 46—63).—Results of numerous fertiliser trials comparing $CaHPO_4$, superphosphate, nitrophosphate, ammoniated phosphates and Gasfa phosphate on neutral and acid soils with a no. of different crops are recorded and discussed. A. G. POLLARD.

Initial and residual effectiveness of two leached-zone phosphate fertilisers. E. C. Doll, O. H. Long and J. A. Lutz, jun. (*J. agric. Fd Chem.*, 1959, **7**, 719—721).—Florida leached-zone phosphate was used to prepare two NPK fertilisers, in which 4 and 32% respectively of the available (citrate-sol.) P was water-sol. These were compared with conc. superphosphate as sources of P for three successive crops (Sudan grass, wheat, and Sudan grass), in greenhouse and field experiments. In the first year, yields with the 32% fertiliser were comparable with those with conc. superphosphate; those with the 4% fertiliser were lower. In the 2 subsequent years, yields were the same for all treatments. M. D. ANDERSON.

Suspension fertilisers. W. S. Newsom, jun. (*Farm Chem.*, 1959, **122**, No. 12, 60—62).—The prep. of mixed fertiliser suspensions using H_3PO_4 from the wet process without purification, is described. Material pptd. during neutralisation is maintained in reasonably homogeneous suspension by addition of a well-dispersed clay (attapulgite, Western bentonite). A. G. POLLARD.

Hydrolysis of urea in soil as affected by season and by added urease. B. J. Stójanovic (*Soil Sci.*, 1959, **88**, 251—255).—In six soils examined the amount of urea hydrolysed during 24 hr. incubation at 37° varied both with the time of sampling and with the soil. Rainfall and temp. influenced the microbial population of the soil and also the hydrolysis. The highest enzymic activity occurred in June and the least in the winter. T. G. MORRIS.

Influence of urea-acetaldehyde condensates on the nutrient uptake of plants. H. Kuntze (*Z. PflErnähr. Düng.*, 1959, **86**, 206—214).—In pot trials with "Deutsche Weidelgras," urea-acetaldehyde compounds increased the uptake of P, K and Mn and decreased that of Ca. Evaluation of these compounds cannot be based on water solubility alone. M. LONG.

Stable manure and urine. J. Knol (*Landbouwvoorlichting*, 1959, **16**, 567—571).—A survey of the analyses of ~600 samples from Dutch farms show very considerable variations in the N and K content of the urine and solid stable manure, and moderate variations in the composition of liquid dung. The causes for the variations are discussed, and the importance of a knowledge of the composition of animal manure is pointed out, especially with respect to the dangers of over-manuring. P. S. ARUP.

Observations for eleven years on a liming trial. P. Bergin (*Econ. Proc. R. Dublin Soc.*, 1959, **4**, 119—136).—Burnt lime, finely and coarsely ground $CaCO_3$, cement-factory lime and sugar-factory waste lime (~3 tons ground limestone/acre) are compared. Differences in yields between the materials were very small but average yields for all materials for 11 years was 157% of control. pH was a more reliable index of liming than available Ca levels obtained by using Morgan's extract. pH and yield data indicated a need for reliming after 8—10 years. Downward movement of the Ca applied was 1 in./annum. Large applications of Ca tend to deplete other bases in the soil. E. M. J.

Granular materials [fertilisers]. Fisons Ltd. (Inventor: R. W. Palmer) (B.P. 805,159, 3.7.54).—Fertiliser material, viz., NH_4 salts, nitrates or urea, is adjusted to contain enough water to induce incipient nodulation, and is then subjected to heat treatment (at 70—110°) and stirring in an atm. of ≮30% R.H., to give a granular product. F. R. BASFORD.

Fertilisers. Fisons Ltd. (Inventors: G. G. Brown and T. P. Dee) (B.P. 805,160, 9.2.55).—At least one ammonium and/or alkali metal sulphate is incorporated in a mixture of NH_4NO_3 and a superphosphate (or other material containing free H_3PO_4), then the product (of NO_3^-/SO_4^{2-} mol. ratio ≯4 : 1) is heated, to give a granular fertiliser with use of less water than is needed for granulating mixtures free from NH_4NO_3 and without loss of strength. F. R. BASFORD.

Plant Physiology, Nutrition and Biochemistry

Photosensitive site in lettuce seeds. H. Ikuma and K. V. Thimann (*Science*, 1959, **129**, 568—569).—Red light promotes germination of lettuce seeds when only the hypocotyl is exposed, almost as well as it does that of uncovered seeds. Infra-red light inhibits germination irrespective of the amount of seed exposed. Exposure of the cotyledons had little effect. It is suggested that the photosensitive site is either in the seed covering at the hypocotyl end or more probably in the tip of the hypocotyl itself. T. G. MORRIS.

Carbon monoxide in green plants. S. S. Wilks (*Science*, 1959, **129**, 964—966).—Determinations of CO in plants are reported. Samples taken near midday showed values from 0·001 mg./100 g. of tissue on lettuce leaves to 2·1 mg. on lucerne leaves. In celery and carrots there was none. The content of stems was also within this range. Only small amounts of CO were formed when dry lucerne-leaf flour was placed in O_2 and exposed to sunlight. More CO was formed when the flour was wetted. No CO appeared in the absence of O_2, or in darkness. Aldehydes were also produced with the CO. Various enzyme inhibitors did not prevent CO formation. CO was formed under sterile conditions and also by leaf pigments when isolated. Polythene bags filled with various mixtures of O_2, CO_2 and N_2 were tied round branches of trees; CO appeared to the extent of 800—900 p.p.m. in 3—4 days only in bags containing O_2. *Avena sativa* seedlings were dark grown, harvested, dried and ground to flour. These did not give CO under the conditions used. T. G. MORRIS.

Apparatus for the study of the mutual effects of root exudates on plants. R. G. Lambert (*Plant Dis. Reptr*, 1959, **43**, 1117—1119).—An apparatus is described which automatically drains and mixes the nutrient solutions from pots growing different species in sand culture. Preliminary tests showed that when grown in "association" in this way oats reduced the growth of lucerne whilst lucerne increased slightly the growth of oats. A. H. CORNFIELD.

Competitive adaptation of the cation-exchange capacity of roots. L. K. Wiersum and K. Bakema (*Plant & Soil*, 1959, **11**, 287—292).—Single plants of several species were grown in split-root sand culture with part of the root in a mixture of sand and cation-exchange resin (previously saturated with a mixture of cations against Hoagland nutrient solution) and part in sand anion-exchange resin (similarly saturated with anions). After some weeks growth, root cation-exchange capacity (dry basis) was higher with roots developing in the cation-exchange resin mixture than in the anion-exchange resin mixture. Thus roots appear to adapt their cation-exchange capacity depending on whether or not they have to compete for cations. A. H. CORNFIELD.

Influence of soil compaction on phosphorus absorption by tomato plants from an applied phosphate fertiliser. W. J. Flocker, J. C. Lingle and J. A. Vomocil (*Soil Sci.*, 1959, **88**, 247—250).—Tomato plants were grown in three different soils, each being treated with P at three levels. The soils were wetted to half field capacity and then compacted to densities of 1·0, 1·3 and 1·6 g. per c.c. The increase in yield due to P fertilisation was evident until the effects of increased density overcame the effect of the fertiliser. In general the greatest uptake occurred at the highest fertilisation rate and the medium compaction rate. Density of soil did not influence the amount of P obtained from the fertiliser. T. G. MORRIS.

Distribution of radioactivity in wheat plants grown in the presence of ^{90}Sr. C. C. Lee (*Science*, 1959, **129**, 1280).—Wheat plants grown in pots in loam soil were treated at different stages of growth with aq. $SrCl_2$ tagged with ^{90}Sr. Under these conditions the amount of ^{90}Sr taken up by the kernels was only a few thousandths of 1% of that added to the soil. The uptake by leaves and stems was about

10 times that of the kernels. There was a direct relationship between total ash and ^{90}Sr concn. Milled kernels contained least isotope in the flour and most in the bran. T. G. MORRIS.

Seed soaking as method of supplying the molybdenum requirements of lettuce and tomatoes. G. L. Wilson and L. F. Notley (*Aust. J. agric. Sci.*, 1959, **10,** 621—627).—The Mo requirement of tomatoes grown in Mo-deficient solutions was met by soaking the seeds in solutions of Na molybdate containing 5000 or 50,000 p.p.m. as Mo; satisfactory results were not obtained with lettuce. The ability of soaked seeds to retain Mo against outward diffusion during germination was important; well-washed soaked seeds may lose much Mo in this way. The implications of such loss of Mo to the soil are discussed. S. C. JOLLY.

Pipecolic acid in leaves of strawberry plant as influenced by treatments affecting growth. L. Yatsu and D. Boynton (*Science*, 1959, **130,** 864—865).—Field-grown strawberry plants sprayed with aq. maleic anhydride (1000 and 2000 p.p.m.) showed growth-inhibition although the leaves appeared healthy. In the leaves pipecolic acid (**I**) had increased markedly (3—4-fold). Leaves of chilled plants contained much less **I** than did those of unchilled controls. Later, **I** became the dominant form of ninhydrin-reacting N in the samples. Probably **I** accumulated as a result of blockage of metabolic conversion due to the treatments. T. G. MORRIS.

Inactivity of the carotene-oxidising system in iris leaf. V. H. Booth (*J. Sci. Fd Agric.*, 1960, **11,** 8—13).—In 20 species of plants which included yarrow, carrot, tomato, clover, nasturtium, etc., on grinding the green leaves to pulp, ~25% of the carotene was lost by enzymic activity in ~13 min. at room temp. The enzyme occurred in pods, green fruits and chlorophyll-containing, but not in chlorophyll-free materials. This carotene-oxidising activity was not found in damaged leaves of iris. In this case the ascorbic acid present (4·1 mg./g. fresh wt.) may protect the carotene in the macerated leaves. E. M. J.

Determination of carotene by paper chromatography. A. Jensen (*Acta chem. scand.*, 1959, **13,** 1259—1260).—Carotenes in dried seaweed and grass are determined after extraction with acetone and chromatographic separation with light petroleum on a kieselguhr-loaded paper. Absorption of carotene is determined at 456 mμ. E. J. H. BIRCH.

Providing aseptically-cultivated plants with water through bacteria-tight glass-filters. A. Szember (*Plant & Soil*, 1959, **11,** 392—394).—The technique is described. A. H. CORNFIELD.

Growth inhibition of *Chlorella pyrenoidosa* by sodium dihydrogen phosphate and its reversal by calcium. C. Eyster (*Plant & Soil*, 1959, **11,** 207—214).—The growth of *C. pyrenoidosa* in a medium based on the critical concn. of nutrients for autotrophic growth was simulated more by NaCl than by KCl, more by Na_2SO_4 than by K_2SO_4, and was inhibited by NaH_2PO_4 (**I**) and not by KH_2PO_4. Ca reversed the growth inhibition induced by **I**. Sr was only partially effective in this respect. A. H. CORNFIELD.

Male sterility induced in tomato by sodium 2,3-dichloroisobutyrate. J. F. Moore (*Science*, 1959, **129,** 1738—1740).—The gametocide was supplied in aq. solution at concn. of 0·075—0·6%, three dates at fortnightly intervals after the first flowers were at anthesis. The 0·075% level had no effect but the 0·3 and 0·6% doses almost prevented fruit setting 21—35 days after treatment. In the following 7 days only the highest level prevented further setting. No male sterility followed the 0·075% treatment, the 0·15% level induced sterility for 13 days beginning 15 days after treatment, and the 0·3% level caused complete absence of pollen for 12 days beginning 12 days after treatment. T. G. MORRIS.

Translocation of antibiotics in higher plants. III. Determination of griseofulvin relatives in plant tissues. IV. Systemic fungicidal activity and chemical structure in griseofulvin relatives. S. H. Crowdy, J. F. Grove, P. McCloskey and (III) A. P. Green and A. Morrison (*Biochem. J.*, 1959, **72,** 230—241, 241—249).—III. Analytical methods, similar to those used for griseofulvin (Crowdy *et al., J. exp. Bot.*, 1955, **6,** 371) are described for determining 11 compounds related to griseofulvin and their metabolites in bean tissues and in solutions. (16 references.)

IV. There was no direct correlation between *in vitro* and systemic fungicidal activities among griseofulvin relatives. All were absorbed by the roots, and those active *in vitro* and as systemic fungicides were closely related to griseofulvin in structure; they were translocated unchanged, and acted directly against the pathogen. Compounds active *in vitro*, but inactive systemically, did not attain the required min. concn. in shoots; they were either degraded in the roots or their insolubility did not permit translocation. Compounds inactive *in vitro*, but feebly active systemically, were degraded considerably in the tissues and acted by an indirect mechanism. A systemic fungicide based on the structure of griseofulvin should be very active *in vitro*, be chemically stable in tissues, and have a low oil-water partition coeff. (13 references.) J. N. ASHLEY.

Effect of heteroauxin treatment of roots on growth and metabolism of tomato seedlings. R. A. Andreeva and I. V. Morozova (*Dokl. Akad. Nauk SSSR*, 1959, **125,** 417—419).—Starting from the appearance of the first two leaves the treated tomato plants each received 20 ml. of solution containing 20 mg. of K salt of heteroauxin/l. with the tomato fertiliser over 54 days. The treatment increased the size and adsorption capacity of the roots, their assimilation of N and P, plant growth, photosynthesis and leaf respiration. Heteroauxin probably increased both the intake of nutritive substances from the soil and the synthesis of org. substances in the leaves of the plants, the higher N intake from the soil not only increased the synthesis of plant proteins but also contributed to the synthesis of natural growth stimulants. A. L. GROCHOWSKI.

Auxin-like action of coumarin. J. Neumann (*Science*, 1959, **129,** 1675—1676).—Sections of *Helianthus* seedling hypocotyls 1 cm. thick, grown in vermiculite at 26° in the dark, were taken 1 cm. below the cotyledonary node of 6-day-old plants and placed in the solutions to be tested in red light. Length increases were measured after immersion in water or different concn. of coumarin. Coumarin markedly stimulated the growth of sections of *Helianthus* hypocotyls grown in darkness, the optimum concn. being 250 p.p.m. Supra-optimal levels caused marked initial stimulation followed by a decline. Substituted coumarins (250 p.p.m.), e.g., 3-chlorocoumarin and 3-methylcoumarin, also stimulated growth to a lesser degree, but 4-hydroxycoumarin had no effect. Other species such as *Avena*, *Pisum* and *Phaseolus* also responded. T. G. MORRIS.

Identification of a growth inhibitor from extracts of dormant peach flower buds. C. H. Hendershott and D. R. Walker (*Science*, 1959, **130,** 798—799).—Methods for the isolation of the inhibitor are given. The crystalline material obtained was identified as naringenin (5,7,4-trihydroxyflavanone). T. G. MORRIS.

α-Substituted arylacetic acids as plant growth regulators. A. Takeda (*Contr. Boyce Thompson Inst.*, 1959, **20,** 197—203).—An account is given of the prep. of seven ring-substituted phenylglycollic acids, the corresponding *O*-methyl deriv., and four related compounds. When tested for their effects on cell elongation and leaf growth in tomato seedlings, *O*-methylated deriv. were usually more active than the corresponding unmethylated compounds, except in the case of α-methoxy-(2-chlorophenyl)acetic acid. Cl atoms introduced into the benzene ring tended to enhance activity, to an extent depending on the no. of atoms and the position of the substitution. The most active compound tested was α-methoxy-(3,4-dichlorophenyl)acetic acid. (20 references.) M. D. ANDERSON.

***m*-Nitro- and *m*-trifluoromethyl-aryl acids as plant growth regulators.** A. Takeda (*Contr. Boyce Thompson Inst.*, 1959, **20,** 191—196).—The prep. of *m*-nitro- and *m*-trifluoromethyl-aryl compounds related to phenoxyacetic acid and *N*-phenylglycine is described; five were new compounds. The trifluoromethyl group in the *m*-position had the same effect as the nitro-group in enhancing cell elongation, as assessed by the tomato leaf curvature test. The carboxyl group in the *m*-position did not have this effect. Three compounds of low solubility in water were inactive when applied to the foliage, but active when applied to the soil. (20 references.) M. D. ANDERSON.

Gibberellins: stimulants of plant growth. B. B. Stowe and T. Yamaki (*Science*, 1959, **129,** 807—816).—A review. T. G. MORRIS.

Gibberellins: powerful plant growth regulators. L. V. Barton (*Trans. N.Y. Acad. Sci.*, 1959, Ser. ii, **20,** 717—732).—A general review of some of the physiological and morphological effects of the gibberellins is presented together with examples of specific experimental results obtained at the Boyce Thompson Institute for Plant Research during 1956 and 1957. (50 references.) E. G. BRICKELL.

Flower induction in Japanese chrysanthemums by gibberellic acid. H. Harada and J. P. Nitsch (*Science*, 1959, **129,** 777—778).—Three varieties of Japanese chrysanthemums were used, which, after a cold treatment can be induced to flower under both long and short day illumination. These were treated either by cold or by gibberellic acid in lanolin applied to the growing tip and subjected to 18 hr. illumination daily. Two weeks after both treatments the plants began to grow and after 19 weeks were in flower. Controls remained in the rosette stage but eventually bloomed 11 weeks later. T. G. MORRIS.

Joint action of gibberellic acid and coumarin in germination. A. M. Mayer (*Nature, Lond.*, 1959, **184,** 826—827).—In lettuce seeds allowed to germinate for 48 hr. at 25° in darkness in water, or solutions of coumarin, gibberellic acid (Na salt) (**I**) or mixtures of

the two, **I** reversed the inhibition of germination by coumarin, the extent being a function of the concn. of both the substances. **I** had no detectable effect on growth inhibition induced by coumarin. (10 references.) E. M. J.

Prevention of onset of seed dormancy by gibberellic acid. M. Black and J. M. Naylor (*Nature, Lond.*, 1959, **184,** 468—469).—A study of *Avena fatua* seeds, which exhibit a very deep dormancy, has been made. Seeds taken from plants treated with gibberellic acid were found not to be dormant. C. A. SLATER.

Residue analysis of gibberellic acid in grapes by bioassay and isotope methods. C. Zweig and G. R. Cosens (*J. agric. Fd Chem.*, 1959, **7,** 717—719).—Seedless-grape vines (two varieties) were sprayed 1 week after bloom with gibberellic acid, and with gibberellic acid labelled with tritium. Initial deposit on grape clusters, and residues at harvest 2 months later, were determined. The extraction procedures were shown to be effective. Values by the bioassay method were consistently lower than those by the isotope method; the former method gives a more reliable level, and is preferred. M. D. ANDERSON.

Crops and Cropping

Effects of nitrogen on three stiff-strawed winter wheat varieties. F. V. Widdowson (*J. agric. Sci.*, 1959, **53,** 17—24).—Manurial trials with Nitro-chalk given in varying amounts to three varieties at different locations are recorded. In general, spring dressings gave better yields than split (autumn/spring) applications. Varietal differences in ability to utilise fertiliser N are shown. A. G. POLLARD.

Effect of lodging on grain yield of oats. M. Sonnema and G. A. S. Uiterkamp (*Landbouwvoorlichting*, 1959, **16,** 572—574).—Experimental fields which had been struck by a heavy rainstorm in July showed considerable increases in the incidence of lodging with increases in the amount of green manure which had been ploughed in during the previous Dec. The same effect was observed with respect to N-manuring which had taken place during the previous spring. P. S. ARUP.

Comparison between combine-drilling and broadcasting muriate of potash for spring barley. F. V. Widdowson, A. Penny, R. J. B. Williams and G. W. Cooke (*J. agric. Sci.*, 1959, **53,** 10—16).—Drilling KCl with the seed at the rate of 0·25 cwt. per acre produced higher yields than did 0·5 cwt. broadcast and harrowed into the seedbed. The uptake of the applied KCl by grain and straw was 11% with the 0·25 cwt. and 8% with the 0·5 cwt. dressing. The yield response was not correlated with either the dil. HCl-sol. or the exchangeable K of the soil. A. G. POLLARD.

Soil and plant potassium studies with potatoes in Kern district, California. K. B. Tyler, O. A. Lorenz and F. S. Fullmer (*Amer. Potato J.*, 1959, **36,** 358—366).—Petiole K <9% during early growth, <7% during mid-season, and <4% in late-season were associated with K deficiency symptoms and reduced yields. The application of 100—200 lb. of K_2O per acre was required to eliminate K deficiency symptoms and produce max. yields. Low petiole K, reduced yields, and deficiency symptoms occurred when the soil contained <100 p.p.m. of exchangeable K. A. H. CORNFIELD.

Technique for evaluating the ability of potato selections to yield consistently in different locations or season. R. L. Plaisted and L. C. Peterson (*Amer. Potato J.*, 1959, **36,** 381—385).—The statistical technique is described. A. H. CORNFIELD.

Grasses in agriculture. R. O. Whyte, T. R. G. Moir and J. P. Cooper (*Fd Agric. Organ. United Nations*, 1959, *Agric. Studies*, No. 42, 417 pp.).—A review is made, with many references, of the adaptation, management, improvement and utilisation of cultivated grasses in dry land and irrigated pastures throughout the world. One long section details the distribution, agricultural value and agronomy of the various genera and species of grasses. H. S. R.

Cobalt on grassland. C. H. Henkens (*Landbouwvoorlichting*, 1959, **16,** 642—651).—A survey is given of Co levels in Dutch pasture lands. The most serious deficiencies occur in light sandy soils. Advice is given on the correction of deficiencies by applications of Co salts or ground Co-containing slags from Cu-smelting. P. S. ARUP.

Sulphur and phosphorus responses of Batatais grass (*Paspalum notatum*). A. C. McClung and L. R. Quinn (*IBEC Res. Inst.*, 1959, Bull. 18, 16 pp.).—Grass receiving N fertiliser (NH_4NO_3) only showed poor growth and chlorosis. Application of N + superphosphate markedly increased growth and eliminated chlorosis, the effect being further increased by treatment with Na_2SO_4, $CaSO_4$ or (more slowly), with S. The S cycle in soil under these conditions is discussed. A. G. POLLARD.

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Stimulation of winter growth of a Brazilian pasture grass by gibberellic acid. L. M. Freitas, A. C. McClung and L. R. Quinn (*IBEC Res. Inst.*, Tech. Note No. 1, [undated], 6 pp.).—Spraying recently-cut Colonião grass (*Panicum maximum*) with gibberellic acid (10—1000 p.p.m.) in amounts to give 5·9—590 g./acre broke the winter dormancy and initiated new growth. With the higher concn. leaves were relatively light in colour suggesting N deficiency. A. G. POLLARD.

Effect of frequency of cutting on yield and composition of some fodder grasses in Nigeria (*Pennisetum purpureum*, Schum: elephant grass). V. A. Oyenuga (*J. agric. Sci.*, 1959, **53,** 25—33).—Gross yields and % of dry matter in elephant grass increased with the interval between cuttings. Yields of dry matter diminished in successive cuttings, especially when these were made frequently. A. G. POLLARD.

Influence of sowing density on the development of lucerne fields in dry and in irrigated crops. I. I. Eynard (*Ric. sci.*, 1959, **29,** 1893—1897).—Irrigation produced positive effects with significant differences in regard to total green matter production, and dry matter yield. In the first year of the tests effects of different sowing density were not clearly defined. C. A. FINCH.

Girdling: its relation to carbohydrate nutrition and development of Thompson Seedless, Red Malaga and Ribier grapes. R. J. Weaver and S. B. McCune (*Hilgardia*, 1959, **28,** 421—456).—Girdling increased the amount of carbohydrate above the girdle and decreased that in roots. The effect in accelerating ripening varied with the time of girdling. A. G. POLLARD.

Effects of gibberellin on seeded *Vinis vinifera* and its translocation within the vine. R. J. Weaver and S. B. McCune (*Hilgardia*, 1959, **28,** 625—645).—Spraying with or dipping clusters in gibberellin (100 p.p.m. as K salt) before blooming elongated the clusters, earlier treatments giving the greater effects in the Zinfandel variety. Flowering and coloration of the fruit were accelerated, total sol. solids were increased and the incidence of rot lowered; crop yields frequently were diminished somewhat. Gibberellin was not translocated from shoot to shoot but in an individual shoot an application to the basal leaf was translocated to the whole shoot. A. G. POLLARD.

Effect of the addition of organic amendments to soil on root knot of tomatoes. I. Preliminary report. L. F. Johnson (*Plant Dis. Reptr*, 1959, **43,** 1059—1062).—Root-knot infection of tomatoes in pot tests was reduced by incorporating in the soil org. materials (cereal straws and legume hays) at 5—10 ton/acre. The materials were effective for 30 weeks, at which time plants in treated soil showed 5—14 galls per plant and those in control soil 99 galls per plant. A. H. CORNFIELD.

Effect of nutrients on field lettuce. R. B. Marlatt (*Plant Dis. Reptr*, 1959, **43,** 1019—1022).—Lettuce head wt. were reduced by application of lime (200 lb.) or Ca ethylenediaminetetra-acetate (EDTA, 200 lb./acre) to soil. Foliar sprays of $MgSO_4,7H_2O$ (2·4 g./gal. of water) decreased rib-discoloration disease. Mg-EDTA (10—15 lb./acre) increased head wt. Mn-EDTA (2 lb./100 gal.) reduced rib discoloration and head size. $CoCl_2$ (1000 p.p.m.) also decreased rib discoloration. Early yields were increased by weekly foliar sprays of $ZnSO_4,7H_2O$ (323—969 p.p.m.) by direct application to soil. A. H. CORNFIELD.

Disease of poinsettia stock plants caused by waterlogging. C. M. Tompkins (*Plant Dis. Reptr*, 1959, **43,** 1034—1035).—The development of small, chlorotic leaves followed by wilting in poinsettia stock plants was traced to waterlogging due to poor drainage. No pathogens were involved in the development of the disease symptoms. A. H. CORNFIELD.

Control of leaf rot of poinsettia cuttings. C. M. Tompkins (*Plant Dis. Reptr*, 1959, **43,** 1036—1037).—A leaf rot occurring in unrooted and rooted poinsettia softwood cuttings grown under excessively wet conditions was traced to *Rhizoctonia solani* infection. The disease was practically eliminated by reducing overhead irrigation. A. H. CORNFIELD.

Chlorosis of loblolly and shortleaf pine seedlings. C. L. Wilson (*Plant Dis Reptr*, 1959, **43,** 964—965).—Nursery plots on which chlorotic pine seedlings were found were not significantly different in pH or nematode counts from plots growing normal seedlings, but the former had an average exchangeable Ca content approx. 50% greater than the latter. Foliar sprays of chelated Fe and $MgSO_4$ to chlorotic seedlings had no effects. A. H. CORNFIELD.

Toxicity of certain soils with regard to young fir-trees (*Abies alba* Mill) in Vosges forests. L. Rousseau (*C. R. Acad. Sci., Paris*, 1959, **349,** 1802—1804).—In the Vosges forests, "Mull" soil which is favourable to the growth of fir-trees, exercised a toxic action on young fir-plants, due to an accumulation of divalent, available Mn (carried down from the mother rocks). The toxicity is aggravated particularly in the dry season. M. C. M.

Top growth of cultivated tea. D. N. Barua (*Nature, Lond.*, 1959, **184,** 1424).—Green wt. of top growth per unit area of bush surface (after 15 years) is statistically equal for twelve variable populations of *Camellia sinensis* var. *assamica* grown in the sun ($4\frac{1}{2}$ ft. apart triangularly), under *Albizzia chinensis* trees, with and without $(NH_4)_2SO_4$. On the same basis, yield of plucked shoots differs between populations, indicating partition of growth between prunings and pluckings. W. J. BAKER.

Influence of temperature on growth of coffee plants. C. M. Franco (*IBEC Res. Inst.*, 1958, Bull. 16, 24 pp.).—Optimum growth of the plants occurred with root temp. 20—26°; transpiration rates were max. at approx. 33°. Leaves showed highest contents (dry basis) of N with root temp. approx. 28°, P at 18°, K at 13—18°, Ca at 28° and Mg at 18—28°. A. G. POLLARD.

Chemical composition of tobacco leaves and its influence on the grade obtained on flue-curing. A. S. Sastry and P. Sitapathi (*J. sci. industr. Res.*, 1959, **18A,** 472—478).—Statistical correlations between the chemical constituents in the green leaf (**I**) of *Nicotiana tabacum*, L. var. Chatham) and the quality of the cured leaf (**II**) have been worked out. The influence of moisture and starch in **I** on the quality of **II** is positive while that of N in **I** is negative. Moisture appears to be nearly twice as important as starch as regards final quality of **II**. Probably chlorophyll is held by the proteins and simultaneous degradation takes place unmasking the yellow colour of the leaves; carbohydrates facilitate resynthesis of the proteins and moisture aids the mobility of the carbohydrates. Nitrogeneous substances are unfavourable and plants should be grown with a min. concn. consistent with normal growth. Leaves should be covered with wet gunnies to protect them from the sun; the quality of top leaves can be improved by culturing them in water before curing. (16 references.) C. V.

Effect of nitrogen, phosphorus and potash on *Nicotiana rustica* tobacco. J. J. Chandnani, A. I. Thomas and R. Babu (*J. Indian Soc. Soil Sci.*, 1959, **7,** 107—113).—Application of N (40—80 lb./acre) to three sandy loams increased the wt. per unit area of leaf, yield of cured leaf per acre, and N and nicotine contents of the leaf. Application of P (40—80 lb. P_2O_5 per acre) had no effect on wt. per unit area of leaf or leaf N and nicotine but increased the yield of cured leaf per acre. Application of K had no effect on any of the characteristics measured. A. H. CORNFIELD.

Effect of cultural factors on growing hops for the picking machine. F. C. Thompson (*Brew. J., Lond.*, 1959, **95,** 506—510).—A general review of the effects on hop yield of (*a*) planting distance (Oregon Cluster and Fuggle), (*b*) height of wire work (Fuggle and Bullion) and (*c*) cutting the bine at picking time (Early Bird and Petham Golding) is given. The effect on the root stock of the variety and age of plant, etc., are considered in the discussion of the data. C. V.

Effects of salts on mushroom pests and diseases. P. B. Flegg and I. J. Wyatt (*Rep. Glasshouse Crops Res. Inst.* [1958], 1959, 89—91).—Application of $CaCl_2$ (5—15 g. per kg. dry wt.) to casing soil, infected with *Mycogone perniciosa*, for mushroom composts reduced the incidence of the disease. $Ca(NO_3)_2$ added to the compost at 10 and 20 g. per kg. diminished the no. of larvae of *Lycoriella fenestralis*, *Leptocera heteroneura* and *Mycophila speyeri*. Salts added to the casing soil generally were more effective than when mixed with the compost. A. G. POLLARD.

[A] **Land preparation and crop yield,** [B] **crop sequence and crop yield.** L. J. Phillips. [C] **Native pasture on Tippera clay loam at Katherine, N.T.** W. Arndt and M. J. T. Norman (*Commonw. sci. industr. Res. Org. Aust., Div. Land Res. reg. Survey tech. Papers*, 1959, No. 1, 2, 3, pp. 19, 8, 20, respectively).—[A] Except in seasons that are particularly favourable to vegetative growth deep ploughing both in the wet and the dry season increases the yield of groundnuts and sorghum compared with the practice of shallow wet ploughing, if seedbeds are thoroughly worked down. With cotton, deep ploughing leads to greater vegetative development. Land prep. influences moisture penetration and soil tilth; ploughing affects the mass and vertical distribution of crop roots.

[B] Crops of groundnuts, sorghum and cotton were grown in various sequences. Yield of groundnuts was highest after groundnuts and lowest after cotton, with previous sorghum intermediate. Yield of sorghum was lower following sorghum than following groundnuts or cotton. Variation in previous cropping had no significant effect on yield of cotton. E. M. J.

Plastics in hydroponic culture. E. Ferraris (*Mater. plast.*, 1959, **25,** 941—944).—A general account, with illustrations, is given of the use of formed plastics in the culture of plants in all-liquid media. C. A. FINCH.

Pest Control

Plant protection preparations. A. Regan (*Kem. u Industr., Zagreb*, 1959, **8,** 193—206).—An extensive review of insecticides, rodenticides, fungicides, herbicides and other plant-protection preparations used in Yugoslavia is presented. The chemical composition and the properties are stated for all compounds and application methods and analytical data are quoted for several. (89 references.) A. L. GROCHOWSKI.

Factors influencing uptake and toxicity of fungicides. L. P. Miller (*Trans. N.Y. Acad. Sci.*, 1959, Ser. ii, **21,** 442—445).—Various conidia were subjected to 2-heptadecyl-2-imidazoline, 2,3-dichloro-1,4-naphthaquinone and Ag, Hg, Ce, Cd, Zn and Cu. Studies on toxicant uptake and on release of cell contents both with or without the presence of toxicants show that conidia are fairly permeable to various materials. Certain ion interferences were noted and marked differences were found between spores of different species. Low toxicity is not necessarily associated with lowered uptake by the species in question. (12 references.) E. G. BRICKELL.

Significance of plant metabolites of insecticides. E. Y. Spencer (*Canad. J. Biochem. Physiol.*, 1959, **37,** 1145—1150).—Metabolites of pesticides in plants are important largely in converting the material to more reactive and therefore usually more toxic intermediates. These are confined almost entirely to certain organophosphorus insecticides. (14 references.) E. G. BRICKELL.

Organic arsenic compounds as fungicides. G. Fehérvári (*Commun. Res. Inst. heavy chem. Ind., Hung.*, 1959, **1,** 307—308).—Deriv. of phenarsazine chloride (**I**), diphenylarsine trichloride (**II**) and similar poison-gases with org. radicals substituted for Cl (e.g., phthalimide in **I** and PhOH in **II**) can safely be used as strong fungicides. Admixture with org. Hg or S-containing fungicides during application is unnecessary. (From English summary.) W. J. BAKER.

Comparative toxicology of organophosphorus compounds in insects and mammals. R. D. O'Brien (*Canad. J. Biochem. Physiol.*, 1959, **37,** 1113—1122).—Available selective organophosphates and the fundamentals of selectivity are reviewed. The development of new compounds of predictable selective toxicity is discussed and future approaches outlined. (13 references.) E. G. BRICKELL.

Toxicological studies of *OO*-dimethyl *O*-(2,4,5-trichlorophenyl) phosphorothioate (Ronnel) in laboratory animals. D. D. McCollister, F. Oyen and V. K. Rowe (*J. agric. Fd Chem.*, 1959, **7,** 689—693).—Tests on laboratory animals showed Ronnel to have low acute toxicity by mouth or skin absorption, and only a slight irritating effect on the eye. Skin irritation in human beings occurred in 6 out of 450 tests, there was no evidence of skin sensitisation. Long-term feeding studies on rats at 15 mg. per kg. per day, and on dogs at 10 and 25 mg., caused no morphological changes. The cholinesterase of plasma was more markedly depressed than that of red blood cells or brain, but substantial amounts of enzyme remained even after large doses. Ronnel is safe for use as recommended, and no unusual precautions are necessary in handling it. (24 references.) M. D. ANDERSON.

Malathion-type compounds. Ö. Kovács (*Commun. Res. Inst. heavy chem. Ind., Hung.*, 1959, **1,** 313—316).—The one-stage prep. of malathion-type deriv. of dialkyldithiophosphoryl-mercaptosuccinic acid is described. Insecticidal toxicity of the compounds decreases with increase of free CO_2H groups and is slightly less than that of malathion. (From English summary.) W. J. BAKER.

Production by *Bacillus thuringiensis*, Berliner, of a heat-stable substance toxic for insects. E. McConnell and A. G. Richards (*Canad. J. Microbiol.*, 1959, **5,** 161—168).—*B. thuringiensis* produces a heat-stable substance toxic to insects; production parallels cell growth. The toxic principle was not identified but was neither protein nor lipid. *B. cereus* produces a similar toxin. K. R. BUTLIN.

Toxicology of the microbial insecticide, Thuricide. R. Fisher and L. Rosner (*J. agric. Fd Chem.*, 1959, **7,** 686—688).—Thuricide, consisting of spores of the bacterium *Bacillus thuringiensis* (originally isolated from diseased flour-moth larvae) with a filler of diatomaceous earth, was injected into mice with toxic effects. Injections of the spores and vegetative forms without filler had no toxic effects, and no virulence was developed by serial passage. Both *B. thuringiensis* and *B. cereus* persisted in the blood of mice for 48 hr. after intraperitoneal injection, but, not for 72 hr. When guinea-pigs were given massive doses of three comparable micro-organisms, 7 out of 10 died with *B. thuringiensis*, 5 out of 5 with *B. cereus*, and 0 out of 5 with *B. subtilis*. No toxic symptoms were observed in (i) mice after inhaling Thuricide, (ii) human volunteers after ingestion or inhaling, (iii) in workers employed in the manufacture of Thuricide, or (iv) in rats treated orally. There was no allergic response to Thuricide in guinea pigs. During field applications of

nearly 1000 lb. of Thuricide in 1957 and 1958, no toxicity to plants, animals, beneficial insects or human beings, was observed. (18 references.) M. D. ANDERSON.

Stabilities of Dyrene, 1-fluoro-2,4-dinitrobenzene, dichlone and captan in silt loam soil. H. P. Burchfield (*Contr. Boyce Thompson Inst.*, 1959, **20**, 205—215).—The stability of fungicides in a silt loam decreased in the order: captan > dichlone > 1-fluoro-2,4-dinitrobenzene > Dyrene. As measured by amount of reactive halogen, Dyrene added to moist soil had half disappeared in 0·5 days, whereas the corresponding period for captan was 3 to 4 days. Breakdown was slower in air-dried soil, but was not correlated with rate of hydrolysis in aq. buffer solutions; e.g., captan took seven times longer than Dyrene to fall to half concn. in moist soil, and Dyrene 200 times longer than captan to fall to half concn. in aq. buffer at pH 7. This anomaly may be related to the greater reactivity of Dyrene with amino-groups and of captan with SH groups. The rates of disappearance of Dyrene and dichlone from soil followed first-order kinetics, and so did those of the other two fungicides after the first day, during which breakdown was more rapid. (12 references.) M. D. ANDERSON.

Structure and nematocidal activity of allylic and acetylenic halides. W. Moje (*J. agric. Fd Chem.*, 1959, **7**, 702—707).—The toxicities of some allylic and acetylenic halides to the citrus nematode *Tylenchulus semipenetrans* were related to their reactivities with KI in acetone (bimol. nucleophilic displacement). Other factors involved are the reactivity with water (rate of solvolysis), and the toxicity of the resulting alcohol; some allylic and acetylenic alcohols have toxicities in the same range as those of the halides. The structure–toxicity relations established can be used to predict the toxicities of substituted allylic and acetylenic halides, and they hold for other organisms, e.g., the eggs and larvae of the oriental fruit-fly, *Dacus dorsalis*. (39 references.) M. D. ANDERSON.

Nature and fungitoxicity of an amino-acid addition product of chlorogenic acid. R. S. Clark, J. Kué, R. E. Henze and F. W. Quackenbush (*Phytopathology*, 1959, **49**, 594—597).—Potato peel extracts contained an amino-acid addition product of chlorogenic acid highly toxic to *Helminthosporium carbonum*. Its breakdown in aq. or alcoholic solution to chlorogenic acid, caffeic acid and eight ninhydrin-reacting substances was accompanied by a marked decrease in inhibitory activity. The mechanism of the toxic action is discussed. Amino-acid addition products of chlorogenic acid may be important not only in disease resistance but in hydrogen-transfer systems and protein synthesis. K. R. BUTLIN.

Fungistatic activity of captan in pea seedlings after treatment of the seeds or roots of seedlings. V. R. Wallen and I. Hoffman (*Phytopathology*, 1959, **49**, 680—683).—Seedlings from pea seed treated with Orthocide 75 (75% captan) were less susceptible to *Ascochyta pisi* (causing leaf and pod spot), than were seedlings from untreated seed. Bioassays (using *Saccharomyces pastorianus*) and chemical tests revealed fungistatic substances, probably breakdown products of captan, in the foliage of the treated seedlings. Captan dissolved in acetone or chloroform gave greater protection against *A. pisi* than did aq. suspensions. (14 references.) K. R. BUTLIN.

Utilisation of 1-amino-2-propanol by a soil bacterium. S. F. Gottlieb and M. Mandel (*Canad. J. Microbiol.*, 1959, **5**, 363—368).—A bacterium capable of using DL-1-amino-2-propanol as sole source of C, N and growth energy in mineral media was isolated from soil. Its nutrition and biochemical reactions are described. Its rôle in a possible cycle of vitamin B_{12} synthesis and degradation in soil is discussed. K. R. BUTLIN.

Toxicity of *N*-methyldithiocarbamate and methyl isothiocyanate to *Rhizoctonia solani*. R. T. Wedding and J. B. Kendrick, jun. (*Phytopathology*, 1959, **49**, 557—561).—*N*-Methyldithiocarbamate and Me isothiocyanate both inhibited the respiration of the fungus, apparently by different mechanisms; S had no effect. Incubation with dithiocarbamate increased the permeability of the mycelium; isothiocyanate had no effect. The evidence supports the hypothesis that dithiocarbamate reacts with the outer cell membrane, thus allowing entry of enzyme poisons or loss of essential cell constituents. (13 references.) K. R. BUTLIN.

Stimulatory effect of organic fungicides. A. Kovàcs and C. Garavini (*Ric. sci.*, 1959, **29**, 1912—1920).—In germination tests with conidia of *Botrytis cinera*, all the tested fungicides (zineb, ferbam, Nirit, captan, tetramethylthuriam disulphide and $CuSO_4$) stimulate germination. In low concn. after 4 hr. the amount of conidia germinated was sometimes higher than in a distilled-water control. Conidia of *Cryptocline cyclaminis* (Sib.) (ARX.) do not germinate in distilled water, but do so in zineb suspension (1·4—120 p.p.m.), and in maneb, Coprantol, DNRB, and captan suspensions. Conidia germinated in 0·5% malt solution, but growth of promycelium was greater when the drops also contained 40 or 120 p.p.m. of zineb, 12·5 p.p.m. of maneb, or 0·8 p.p.m. of Nirit C. A. FINCH.

Metabolism of oats susceptible to *Helminthosporium victoriae* and victorin. L. R. Krupka (*Phytopathology*, 1959, **49**, 587—594).—The toxin victorin, produced by *H. victoriae*, markedly increased the O_2-consumption of susceptible oat tissues but had no effect on resistant varieties. The increase in respiration is probably due to activation of ascorbic acid oxidase. (20 references.) K. R. BUTLIN.

Macro- and micro-gravimetric methods for determination of mercury in plant-protective substances. D. Pirtea and I. Albescu (*Studii Cerc. Chim., Bucharest*, 1959, **7**, 137—147).—The proposed method is a combination of that of Walton and Smith (*Analyt. Chem.*, 1956, **28**, 406; cf. J.A.C. Abstr., 1956, ii, 396) for the oxidation of organic matter, and a modification of that of Spacu and Suciu (*Z. analyt. Chem.*, 1929, **78**, 244) for determination of Hg. Fe, Al, Zn, Mg, Mn, Ni and Co are masked by Na EDTA. H. SHER.

Disease control through intimate mixing of mercuric oxide with soil. J. Grainger (*Phytopathology*, 1959, **49**, 627—633).—A new machine (described) incorporates 13 cu. ft. of dust containing 5 lb. of Hg (as yellow HgO)/acre evenly in the top 9 in. of soil. It successfully controlled potato root eelworm and club root of turnips; *Rhizoctonia* and *Colletotrichum* root rots, *Spongospora* tuber scab and soil-borne (but not seed-borne) blackleg pathogen were substantially reduced. Treatment at half the standard rate was almost as effective. K. R. BUTLIN.

Determination of L-5-vinyl-2-thio-oxazolidone in plant material and milk. M. Kreula and M. Kiesvaara (*Acta chem. scand.*, 1959, **13**, 1375—1382).—L-5-Vinyl-2-thio-oxazolidone (**I**) in green plants seeds, silage and milk is determined by extraction (after incubation), two-dimensional chromatography and measurement of the corrected extinction at 240 mμ. Data for seeds and green parts of cruciferous plants and silage are given. **I** disappears rapidly from milk; ~75% of **I** added to milk can be recovered, the greater part of the loss occurring in the $CHCl_3$ extraction necessary in the prep. of the sample. E. J. H. BIRCH.

Effect of fungicides and insecticides on the germination of maize after storage. C. O. Grogan, M. S. Zuber, H. E. Brown, M. D. Whitehead and V. M. Stanway (*Plant Dis. Reptr*, 1959, **43**, 1132—1137).—Extensive trials with various insecticides and fungicides applied alone and in combination to the seed are reported. A. H. CORNFIELD.

Effects of isopropyl *N*-(3-chlorophenyl)carbamate on respiration water uptake and ion leakage of potato tissue. C. C. Craft and W. V. Audia (*Amer. Potato J.*, 1959, **36**, 386—393).—The O_2 uptake by small tubers or discs was not affected by dipping in 0·5% isopropyl *N*-(3-chlorophenyl)carbamate (**I**). 2,4-Dinitrophenol increased O_2 uptake considerably in control discs, but only slightly in discs treated with **I**. **I** and gibberellic acid (**II**) had no effect on water uptake by potato discs. Naphthylacetic acid (**III**) increased water uptake when present alone or with **II**, but not when present with **I**. **I** and **III** increased, whilst **II** had no effect on, ion leakage from potato tissue. **I** increased the accumulation of *o*-dihydroxyphenols in potato tissue. A. H. CORNFIELD.

Occurrence and transfer of a biological factor in soil that suppresses potato scab. J. D. Menzies (*Phytopathology*, 1959, **49**, 648—652).—Long-cultivated irrigated soils suppress potato scab common in newly irrigated soils of central Washington. Scab was controlled by mixing equal amounts of infested soil and suppressing soil (SS) but not steamed SS; also by addition of 1% of SS and 1% of lucerne meal in combination but not of either alone. The suppressing factor, probably microbial, has developed naturally in older farmed soils and can be established in other soils by mass soil inoculation supplemented with microbiol food. (11 references.) K. R. BUTLIN.

Fungicide treatment of forage legume seed. H. W. Johnson (*Plant Dis. Reptr*, 1959, **43**, 1016—1018).—Treating crimson clover, red clover, sweetclover and lucerne seed with Arasan, Spergon or Vancide 51 ZW (8 oz. per 100 lb. seed) prior to sowing at three locations usually had no significant effect of seedling stands. When treated seed was stored for 14 months prior to sowing at one location stands of crimson clover were improved by all treatments and of red clover and lucerne by Spergon. Stands were not improved when treated seeds were stored 26 months before sowing. A. H. CORNFIELD.

Post-harvest decay of peaches as affected by temperatures after hydrocooling in water or in solutions of Dowicide A. T. T. McClure and W. L. Smith, jun. (*Phytopathology*, 1959, **49**, 472—474).—Hydrocooling peaches infected with brown rot (*Monilinia fructicola*) or *Rhizopus* rot (*R. stolonifer*) at varying temp. ranges (40—60°F) followed by 3—6 days at 75°F lowered the % of infected fruit. Use

of a 1% solution of Dowicide A (Na *o*-phenylphenoxide) instead of water in the cooling process further reduced the decay, the effect being greater at 60°F than at lower temp. A. G. POLLARD.

Chlordane soil drench for control of peach rosette mosaic virus inoculum. R. H. Fulton and D. Cation (*Plant Dis. Reptr*, 1959, **43**, 991—992).—Drenching infested soil with 0·5% chlordane prior to planting peach seedlings gave complete control of peach rosette mosaic, whilst a control soil developed a high proportion of infected plants with severe symptoms. A. H. CORNFIELD.

Comparison of methods of application of 1,2-dibromo-3-chloropropane for control of root knot. J. M. Good and A. E. Steele (*Plant Dis. Reptr*, 1959, **43**, 1099—1102).—Good control of root-knot of tomato and squash was obtained when 1,2-dibromo-3-chloropropane was applied in liquid or granular form 6 in. or more under the soil surface. Discing-in a granular formulation placed on the soil surface was relatively ineffective. A. H. CORNFIELD.

Tomato leaf-spot control. M. J. Goode and G. D. Reading (*Arkansas Farm Res.*, 1959, **8**, No. 2, 10).—Control of a range of leaf-spot diseases in tomato was obtained with maneb as 8% dust or as spray (2 lb. of 70% maneb/100 gal.) applied at weekly intervals. Use may be continued safely through the harvest season. A. G. POLLARD.

Some effects of crop rotation on the *Fusarium* root rot of bean. O. C. Maloy and W. H. Burkholder (*Phytopathology*, 1959, **49**, 583—587).—The effects of various crop rotations and org. treatments on bean root rot and on populations of *Fusarium solani*, bacteria, fungi, actinomycetes and nematodes were studied. In the field, bean root rot was significantly reduced when following wheat; lucerne had the greater effect. The reduction could not be attributed to fewer soil pathogens. Root rot severity was associated with high populations of amino-acid-requiring bacteria. Nematodes were most numerous in bean roots grown in soil previously cropped with wheat. (14 references.) K. R. BUTLIN.

Effects of gibberellin and fungicides on bean root rot. R. L. Rackham and J. R. Vaughn (*Plant Dis. Reptr*, 1959, **43**, 1023—1026).—Soil treatment with chloropicrin, Orthocide 75 and several antibiotics did not control bean root rot, due to *Fuasrium solani* f. *phaseoli*. Soil treatment with urea–formaldehyde or Vapam-4S combined with foliar application of gibberellin (5 or 50 p.p.m.) gave good control of the disease. Seed treatment with Orthocide 75–gibberellin also gave good control. A. H. CORNFIELD.

Diseases and pests of onions in New Zealand and their control. R. M. Brien, E. E. Chamberlain, D. W. Dye, R. A. Harrison and H. C. Smith (*N.Z. Dep. sci. industr. Res., Plant Dis. Div., Inf. Ser.* 1959, No. 24, 24 pp.).—Fungous, bacterial, virus and non-parasitic diseases (e.g., Cu deficiency, sunscald), symptoms and control are described. The pests described are onion thrips, onion maggot and leaf mining fly. E. M. J.

Insecticide residues on tobacco. T. G. Bowery, W. R. Evans, F. E. Guthrie and R. L. Rabb (*J. agric. Fd Chem.*, 1959, **7**, 693—702).—Methods for determining residues of TDE and endrin on tobacco were based on chromatographic purification of de-waxed hexane extracts, and measurement of TDE by the modified Schechter–Haller method, of endrin by Bann, Lau and Potter's dechlorination–sulphanilic acid–phenyl azide method, and of total org. Cl by combustion and potentiometric titration. After treatment at usual dosages, residues of TDE and endrin on green tobacco during priming time were above 50 and 10 p.p.m. respectively, 5—10 days after application. About 45% of the residues was dissipated during flue-curing, leaving about 37 and 1·8 p.p.m. in tobacco as auctioned. An average of 13 μg. of TDE and 0·2 μg. of endrin was found per commercial cigarette, and an average of 1·6 μg. and 1·4 μg. respectively of TDE and dehydrochlorinated TDE in the mainstream smoke of one cigarette. Stress is laid on education of growers to minimise insecticide residues, and on search for less persistent insecticides which would not appear in cigarette smoke. (28 references.) M. D. ANDERSON.

Chemical soil drenches to control *Phytophthora parasitica* var. *nicotianae* causing black-shank of tobacco. O. D. Morgan (*Phytopathology*, 1959, **49**, 525).—Of the fungicides examined best results were obtained with the disulphide and the Mn salt of Omadine (2-pyridinethione-1-oxide) and N 521 (3,5-dimethyltetrahydro-1-3,5-2*H*-thiadiazine-2-thione). A. G. POLLARD.

Control of pre-emergence damping-off and two leaf-spot diseases of sesame by seed treatment. C. A. Thomas (*Phytopathology*, 1959, **49**, 461—463).—Among fungicidal seed-dressings tested Orthocide-75 (75% captan) gave best control of damping-off. Streptomycin lowered the incidence of leaf-spot diseases. A. G. POLLARD.

Biology and control of the stem nematode *Ditylenchus dipsaci*. K. R. Barker and J. N. Sasser (*Phytopathology*, 1959, **49**, 664—670). —Techniques were developed for testing the degree of resistance of lucerne varieties under controlled conditions. Differences in staining reactions of resistant and susceptible plants were studied. An experimental nematocide, *OO*-diethyl *O*-2-pyrazinyl phosphorothioate, eliminated the nematode under controlled conditions. (17 references.) K. R. BUTLIN.

Effects of asphalt varnish–fungicide mixtures on growth in pure culture of fungi that cause decay in trees. C. May and J. G. Palmer (*Plant Dis. Reptr*, 1959, **43**, 955—959).—Mixtures of nine common fungicides with an asphalt varnish were tested in pure culture against 11 fungi. 0·25% PhHg nitrate (but no other material tested) in the varnish inhibited growth of all the fungi, although most of the other materials inhibited growth of one or more of the fungi. A. H. CORNFIELD.

Preparation of virus antisera from strawberry. R. M. Lister (*Nature, Lond.*, 1958, **182**, 1814).—Leaf extracts giving high yields of virus were prepared (details given) from mature leaves from plants infected with raspberry ringspot virus. Antisera were prepared by intravenous injection into rabbits of 2-ml. aliquots of this prep. at intervals over three weeks. C. A. SLATER.

Effect of metal chelates in overcoming arsenic toxicity to peach trees. L. P. Batjer and N. R. Benson (*Proc. Amer. Soc. hort. Sci.*, 1958, **72**, 74—78).—Chelated Fe and Zn applied to the soil of old orchards mitigated the toxic effects in peach trees of As (derived from accumulated spray residues) in the soil. L. G. G. WARNE.

Residual behaviour of various insecticides on and in lemons and oranges. R. C. Blinn, G. E. Carman, W. H. Ewart and F. A. Gunther (*J. econ. Ent.*, 1959, **52**, 42—44).—Over 34 days residues in the pulp of lemons never exceeded 0·1 p.p.m. for chlordane and dieldrin and 0·2 p.p.m. for heptachlor; residues of malathion in orange pulp were <0·04 p.p.m. On peel the half-life of chlordane was 19, dieldrin 60, heptachlor 23 and malathion 32 days. C. M. HARDWICK.

Stem canker and related blueberry diseases. J. Taylor (*N. Carolina agric. Exp. Sta.*, 1958, Tech. Bull. 132, 24 pp.).—Characteristics of the diseases are described. Application of ferbam or maneb (1·5 lb./100 gal. at two-weekly intervals from May to August) gave good control of all leaf and stem diseases except powdery mildew. Bordeaux mixture (2—4—100) gave fairly good control but caused considerable leaf injury and defoliation. Captan (2 lb. per 100 gal.) was ineffective. A. H. CORNFIELD.

Seasonal changes in acid content of Ruby Red grapefruit as affected by lead arsenate sprays. E. J. Deszyck and S. V. Ting (*Proc. Amer. Soc. hort. Sci.*, 1958, **72**, 304—308).—Ruby Red grapefruit trees given a post-blossom spray of Pb arsenate showed during the period Aug.—Jan. a 30 to 40% decrease in the acid content of the fruit. In control trees the fall was only 25%. L. G. G. WARNE.

Disinfectants and tool disinfection for prevention of spread of bacterial wilt of bananas. I. W. Buddenhagen and L. Sequeira (*Plant Dis. Reptr*, 1958, **42**, 1399—1404).—Pruning knives were completely disinfected by immersion in 10% formaldehyde for 10 sec. Although many other chemicals tested were much more effective, they were readily inactivated with continuous use or were toxic, unstable or expensive. A. H. CORNFIELD.

Effect of certain insecticides and fungicides on fungi pathogenic to spotted lucerne aphid. I. M. Hall and P. H. Dunn (*J. econ. Ent.*, 1959, **52**, 28—29).—Parathion, malathion, demeton, Trithion and DDT, added to agar were lethal to the vegetative stages of *Entomophthora exitialis* but only Trithion affected *E. coronata*. Other species gave intermediate results. Wettable S, Dithane, ferbam and Bordeaux (5—5—50) mixture were all lethal to some species. The immersion of resting spores of *E. virulenta* in any of the insecticide solutions only retarded germination. C. M. HARDWICK.

Mexican bean beetle and its control. Anon. (*U.S. Dep. Agric.*, 1958, Fmrs Bull. 1624, 15 pp.).—The life history and habits of the beetle are described. It is best controlled by applying rotenone. Methoxychlor, malathion and parathion are also effective. It is important to destroy the crop residues after harvesting the beans. R. H. HURST.

Control of aphids on lettuce with fluoroacetamide. V. A. Gentle (*Glasshouse Crops Res. Inst. Annu. Rep. 1957*, [1958], 157—158).—Some preliminary results are recorded. A. G. POLLARD.

Control of fungus diseases on cucumbers. G. Sowell, jun. (*Plant Dis. Reptr*, 1958, **42**, 1333—1336).—Nabam + $ZnSO_4$ gave the best control of downy mildew and highest yields of cucumbers. Thiram gave excellent control of soil rot (*Rhizoctonia solani*), anthracnose and cottony leak. Captan, maneb and nabam + $MnSO_4$ gave excellent control of anthracnose. A. H. CORNFIELD.

Control of *Botrytris* leaf rot, caused by *B. cinerea*, of hothouse rhubarb. H. H. Murakishi and H. S. Potter (*Plant Dis. Reptr*, 1958, **42**,

1316—1318).—Of materials tested by spraying at weekly intervals from first bud to harvesting, Phaltan 50-W (50% *N*-trichloromethylthiophthalimide, 2 lb./100 gal.) gave the best control of the leaf rot. Orthocide 50-W (50% captan, 2 lb./100 gal.) was also fairly effective. A. H. CORNFIELD.

Control of *Ditylenchus dipsaci*, (Kühn), Filipjev in organic soils. G. D. Lewis and W. F. Mai (*Plant Dis. Reptr*, 1958, **42**, 1360—1363).—Treatment of infested fields with D-D (50—110 gal./acre) in Sept. gave excellent control of infestations in the following season without phytotoxic effects to onions. A. H. CORNFIELD.

Fungicides for control of cotton seedling damping-off. J. B. Sinclair, D. C. Neal, E. K. Chandler, D. M. Johns, L. W. Sloane and W. Walters (*Plant Dis. Reptr*, 1958, **42**, 1372—1375).—Treatments which gave promising control when applied as liquids in-the-furrow were, PCNB + captan + zineb, captan + zineb, PCNB + captan, dichlone or nabam, and $CaCl_2$ + nabam. A. H. CORNFIELD.

Control of sting nematodes, *Belonolaimus* spp., by soil fumigation. J. M. Good and A. E. Steele (*Plant Dis. Reptr*, 1958, **42**, 1364—1367).—Row application of 1, 2-dibromo-3-chloropropane (**I**) (0·9 gal.) and 41% ethylene dibromide (**II**) (9·5 gal./acre) four weeks prior to sowing cotton gave good control of sting nematodes and greatly increased yields. Yields of maize in the following season were increased where **I** but not where **II** had been applied in the previous season. A. H. CORNFIELD.

Chemical dips for the control of nematodes on bare root nursery stock. L. Jenkins and H. W. Guengerich (*Plant Dis. Reptr*, 1959, **43**, 1095—1097).—Dipping young *Weigela hybrida* roots in 1% hydrogenated fish oil or American Cyanamid 18133 (4·5 oz. of 50% emulsion per 15 gal. water for 15 min.) gave good control of nematodes without affecting the plant. Both treatments tended to be phytotoxic to roses and hydrogenated fish oil was toxic to fire thorn. A. H. CORNFIELD.

Termite nests. I. Chemical, physical and biological characteristics of a termitarium in relation to its surroundings. A. N. Pathak and L. K. Lehri (*J. Indian Soc. Soil. Sci.*, 1959, **7**, 87—90).—Soil from a termite nest showed higher moisture, loss on ignition, org. C, total N, and HCl-extractable Ca, Mg and P but lower HCl-extractable K than did adjacent soil. The nest soil had pH 4·5 and adjacent soil pH 8·1. The clay and silt fractions in the nest soil showed much higher aggregation than did comparable fractions in the adjacent soil. N fixation, nitrification and CO_2 evolution during incubation were higher in the nest than in the adjacent soil. A. H. CORNFIELD.

Decomposition of 2,2-dichloropropionic acid by soil bacteria. L. A. Magee and A. R. Colmer (*Canad. J. Microbiol.*, 1959, **5**, 255—260).—Dalapon may be decomposed rapidly by certain soil micro-organisms. Other groups of organisms may possibly operate to restrict or prevent the decomposition of the herbicide. A. G. POLLARD.

Control of Spanish moss, *Tillandsia usneoides*, L., on pecan trees. J. R. Cole (*Plant Dis. Reptr*, 1959, **43**, 960—961).—Application of $CuSO_4.5H_2O$ (10 lb.) + $CaHAsO_4$ (10 lb.) per 100 gal. water during February or March over 3 years eliminated Spanish moss from pecan trees. A. H. CORNFIELD.

Chemical control of Volunteer potatoes. K. H. Fernow (*Amer. Potato J.*, 1959, **36**, 407—409).—Volunteer potatoes from previous crops constitute a hazard by spreading diseases and producing a mixed variety where a potato crop is being grown for seed-pieces. Application of 3-amino-1,2,4-triazole (1·25 oz. per gal.) to the plants in July or August killed both the plants and the tubers. A. H. CORNFIELD.

Large scale soil fumigation against broomrape. S. Wilhelm, R. C. Storkan, J. E. Sagen and T. Carpenter (*Phytopathology*, 1959, **49**, 530—531).—Application of MeBr (180 lb./acre as a proprietary prep.) at a depth of 8 in. using chisel distributors and covering with polythene sheeting eliminated Cooper's broomrape (*Orobanche ludoviciana* var. *cooperi*). Weed growth and the development of root-knot nematodes were controlled, and the subsequent tomato crop was greatly increased. A. G. POLLARD.

4th British Weed Control Conference (London), 1958 (*Proc.*, 1960, 272 pp.).—A record of 56 papers read at the Conference with the discussions that followed. The uses of various insecticides in the control of weeds in various environments are discussed. H. S. R.

αα-Dichloroisovaleric acid and its salts. Dow Chemical Co. (B.P. 805,260, 13.9.57. U.S., 5.10.56).—The prep. of αα-dichloroisovaleric acid and its Na, aniline, ethylamine, Mg etc. salts is described in detail starting from isovaleric acid. The products are useful as herbicides in the control of a variety of grasses, e.g., rye grass. H. S. R.

1-Halogenoacetoxy-4-substituted-butene. A. Schwerdle and M. Schwerdle (Vineland Chemical Co.) (B.P. 804,765, 12.7.56. Isr., 13.7.55).—Compounds $Y{\cdot}CH_2{\cdot}CO_2{\cdot}CH_2{\cdot}CH{:}CH{\cdot}CH_2X$ (X is OH or $CO_2{\cdot}CH_3Y$; Y is Cl, Br or I), useful as fungicides, germicides or herbicides (especially active as systemic fungicides), are obtained by interaction of but-2-ene-1,4-diol with $CH_2Y{\cdot}CO_2H$ at 70—90 (±85)° in an org. solvent. Thus, *cis*-but-2-ene-1,4-diol and $CH_2Br{\cdot}CO_2H$ are added to benzene with immediate esterification to give cis-1,4-di-(*bromoacetoxy*)*but*-2-*ene*, b.p. 135—136°/0·005 mm., n_D^{20} 1·5223, in 90% yield. F. R. BASFORD.

Fungicide based on ethylene-dithiocarbamates. Montecatini Società Generale per l'Industria Mineraria e Chimica (B.P. 805,108, 3.4.56. It., 1.4.55).—A mixture of ethyleneamine hydrochlorides (viz., a mixture of the hydrochlorides of ethylenediamine 65—80, diethylenetriamine 19—29, triethylenetetramine hydrochloride, and higher mol. products 0—2%, obtained by interaction of ethylene chloride and NH_3) is treated with base (aq. NaOH or milk of lime), to liberate the org. bases, then CS_2 is added (at 20—35°), followed by mineral acid (dil. aq. HCl) to neutrality. The resulting product is now admixed with conc. aq. $ZnCl_2$, to precipitate fungicidal insol. Zn salt of dithiocarbamic acids. F. R. BASFORD.

Animal Husbandry

Protein concentrates for animal feeding. J. Bunyan and S. A. Price (*J. Sci. Fd Agric.*, 1960, **11**, 25—37).—Outlines of tests of protein quality are reviewed, viz., by biological, microbiological, chemical and physical methods. Protein quality and vitamin contents of meat meals and of whalemeat meals, protein quality of fish meals and of miscellaneous samples are considered in detail. Attention is drawn to various correlations. (53 references.) E. M. J.

De-amination of amino-acids *in vivo* by rumen micro-organisms. C. G. Looper, O. T. Stallcup and F. E. Reed (*J. Anim. Sci.*, 1959, **18**, 954—958).—In feeding trials with fistulated steers, deamination with production of NH_3 was observed with β-alanine, DL-aspartic and L-glutaric acid but not with glycine or L-lysine. A. G. POLLARD.

Relative efficiency of three pasture utilisation schemes. C. H. Gordon, O. J. Hunt, R. G. Mowry and W. R. Harvey (*J. Dairy Sci.*, 1959, **42**, 1686—1697).—The average amounts of forage utilised per acre were essentially the same for rotational grazing (5—10-day intervals) and strip grazing (1 day's grazing assigned daily), and were significantly greater than for "soiling" (forage harvested and fed in barn or dry lot). Neither milk production nor live wt. changes were significantly affected by method of providing forage. Conventional rotation was the most suitable method of using this forage (low in clover); but under other conditions strip grazing and "soiling" may have distinct advantages. S. C. JOLLY.

Effect of intensity of grazing on nutritive content of the diet. R. Pieper, C. W. Cook and L. E. Harris (*J. Anim. Sci.*, 1959, **18**, 1031—1037).—With increase in no. of sheep per unit grazing area the lignin content of the diet rose and, on pure stands, the contents of protein, ether extract, P and gross energy declined; the total forage intake and digestibility of the contained nutrients also diminished. A. G. POLLARD.

Nutrient losses, quality and feeding values of wilted and direct-cut orchard grass stored in bunker and tower silos. C. H. Gordon, E. A. Kane, J. C. Derbyshire, W. C. Jacobson, C. G. Melin and J. R. McCalmont (*J. Dairy Sci.*, 1959, **42**, 1703—1711).—First-cutting orchard grass was preserved as (i) wilted silage stored in tower silo, (ii) direct-cut, $Na_2S_2O_5$-treated silage stored in tower silo, and (iii) as in (ii), but stored in bunker; all silos were sealed with weighted plastic covers. Methods (i) and (iii) were equally efficient in preserving feed nutrients; method (ii) caused high seepage losses. All silages were of good chemical quality and of approx. equal feeding value. Silage prepared by method (i) contained more butyric acid and the animals tended to eat more of it. The bunker silo was more suitable for the storage of direct-cut forage. When forages were stored in tower silos, method (i) was more satisfactory than (ii). S. C. JOLLY.

Measures against destruction of carotene in stored dehydrated green fodders. J. Kreyger and M. H. Huisman (*Versl. Landbouwk. Onderz.*, 1959, No. **65.10**, 39 pp.).—The temp. of the dried product (grass or lucerne meal), usually 30—50°, sinks very slowly during storage in large stacks. Losses of carotene are proportional to the amounts of carotene present at any given time, and, taking the rate of loss at 10° as unity, the rates at 20°, 30°, 40° and 50° are 1·4, 6, 11 and 22, respectively. Data are given for the amounts of fresh air required for effective cooling. No protection is afforded by airtight

storage or the use of (fat-free) antioxidants. Adequate protection can be attained only by the use of the atm. free from O_2 during operations. P. S. ARUP.

Influence of method of preparation on the feeding value of lucerne hay. J. H. Meyer, W. C. Weir, J. B. Dobie and J. L. Hull (*J. Anim. Sci.*, 1959, **18,** 976—982).—With lambs the feed consumption and daily gains in live-wt. were higher when lucerne was given finely ground ($\frac{1}{16}$ in.) than when coarsely chopped (1 in.). Pelletting the finely-ground material, further increased its efficiency, a similar though smaller effect being obtained by moistening with water. Moistening chopped hay tended to lower its efficiency. A. G. POLLARD.

Effect of pelletting on the chemical composition and digestibility of lucerne meal. I. L. Lindahl and P. J. Reynolds (*J. Anim. Sci.*, 1959, **18,** 1074—1079).—Pelletting the meal increased the ether extract without affecting the gross energy content or altering the digestibility of the dry matter, crude fibre, crude protein, N-free extract or gross energy. The apparent digestibility of the ether extract increased and this persisted when pellets were reground. The ether extract of the faeces was unaffected by pelleting or regrinding the meal. A. G. POLLARD.

Summer feeding of dairy cattle. C. F. Huffman (*J. Dairy Sci.* 1959, **42,** 1495—1551).—A review with 315 references. S. C. JOLLY.

Effects of feeding various "filled" milks to dairy calves. I. Physical condition and weight gains, with special reference to low-fat rations. R. S. Adams, T. W. Gullickson, J. E. Gander and J. H. Sautter. **II. Faecal characteristics and digestibility data. III. Blood plasma-tocopherol and -vitamin A levels, diet storage effects and evidence of toxicity.** R. S. Adams, J. E. Gander, T. W. Gullickson and J. H. Sautter. **IV. Necropsy findings, electrocardiographic studies and creatinuria ratios.** R. S. Adams, J. H. Sautter, T. W. Gullickson and J. E. Gander (*J. Dairy Sci.*, 1959, **42,** 1552—1561, 1562—1568, 1569—1579, 1580—1591).—I. Calves fed skim milk filled with maize oil (*M*) were emaciated and unthrifty. Calves fed whole milk or milks filled with hydrogenated vegetable oil (*H*), lard (*L*) or butter oil (*B*) were not adversely affected, except for symptoms of muscular involvement with *L* and *B* prepared from oxidised butter. Supplementation of *M*- and *L*-filled milks with high levels of tocopherol (**I**) prevented muscular involvement, but did not improve wt. gains of calves fed *M*. Diets containing 0·10—0·15% of butterfat were not detrimental. Calves fed several of the filled-milk and low-fat rations were satisfactorily maintained on the liquid diets until 5—6 months of age.

II. The apparent dry-matter digestibility of *M*-filled milk prepared weekly was significantly less than that of the milk prepared daily and of the other filled milks. Fat digestibility was not improved significantly, by daily preparation of the milk. The apparent digestibility coefficients for *B* were significantly greater than those for *M*, *H* and *L*.

III. Calves fed milk filled with *M*, *L* or *B* from oxidised butter had low blood-plasma-**I** and -vitamin-A levels. Oral supplementation of *M*- and *L*-filled milks with 500 mg. of α-**I** daily restored plasma-**I** levels. *M*-filled milk lost 30 to 40% of its total **I** content and developed a high peroxide content in a week. The possibility that *M*-filled milk is toxic to calves is discussed. S. C. JOLLY.

Pasture for young dairy calves. C. H. Noller, M. C. Stillions, B. W. Crowl, N. S. Lundquist and A. L. Delez (*J. Dairy Sci.*, 1959, **42,** 1592—1599).—The growth of calves reared either (i) in barns until 116 days of age, (ii) on pasture from ≯14 days of age, and (iii) on pasture with free choice of hay is reported. Those in group (iii) ate hay even when plenty of lush grass was available. Calves on pasture ruminated earlier than did those in barns. The use of pasture mixtures for young calves deserves consideration. S. C. JOLLY.

Effect of chlortetracycline, erythromycin and hygromycin on the growth rate and well-being of young dairy calves. C. A. Lassiter, L. D. Brown and C. W. Duncan (*J. Dairy Sci.*, 1959, **42,** 1712—1717).—Supplementation of a milk replacer–calf starter–hay ration for newborn calves for 84 days with either chlortetracycline or erythromycin (both 50 mg. per lb. of replacer plus 15 mg. per lb. of starter) improved wt. gains, increased feed consumption and reduced the incidence of scours. Supplementation with hygromycin at the same and at half the above rate reduced the incidence of scours and, particularly at the higher level, the consumption of starter; it did not improve wt. gains or skeletal growth. S. C. JOLLY.

Chlortetracycline and penicillin in the nutrition of young calves. H. Hvidsten (*Acta agric. scand.*, 1959, **9,** 3—22).—Addition of chlortetracycline (60—120 mg./kg. of concentrates) to a low-milk diet for calves (3 days—15 weeks) increased the consumption of concentrates, accelerated growth, lowered the incidence of scouring and in some cases increased food utilisation, improved carcass grading and raised the levels of serum-Ca and -P and bone ash content. Penicillin in the same range of dosages produced similar results. A. G. POLLARD.

Vitamin-A and vitamin-D supplementation for young calves. H. Hvidsten (*Acta agric. scand.*, 1959, **9,** 23—37).—Use of vitamin-A and -D supplements to a low-milk diet for calves increased growth rates and bone calcification. To some extent penicillin produced similar effects. Cod-liver oil and a mixed concentrate of the vitamins were equally effective. Starter rations containing high contents of herring meal together with good-quality sun-cured hay would probably obviate the need for vitamin supplements for indoor calf rations. A. G. POLLARD.

Influence of hormone implants on gains made on native pastures and in the feedlot and on carcass characteristics of yearling steers. R. M. Koel, K. E. Gregory, J. E. Ingalls and V. H. Arthaud (*J. Anim. Sci.*, 1959, **18,** 1010—1017).—The average daily gain in wt. of steers on range was increased by implantation of stilboestrol (24 mg.) or of progesterone (200 mg.) + oestradiol benzoate (20 mg.) but not significantly by that of 17-α-hydroxyprogesterone caproate (60) + testosterone oenanthate (60) + oestradiol valerate (24 mg.). Similar effects resulted from implantation during either grazing or winter feeding and no advantage was obtained by implantation in both seasons. Control animals reached the slaughter stage 10 days later than did treated animals and yielded higher grade carcasses. A. G. POLLARD.

Effect of stilboestrol on pasture-fed Zebu steers. L. R. Quinn, G. O. Mott, W. B. Bischoff and A. C. McClung (*IBEC Res. Inst.*, 1958, Bull. 15, 17 pp.).—Implantation of stilboestrol (24 mg.) increased the growth rate of the steers by an average of 40% over a 140-day grazing period. The actual effect varied with age at treatment in the order, 3 > 2 > 1 years. In 2- and 3-year animals the efficiency of the hormone had not diminished 140 days after implantation. A. G. POLLARD.

Poultry slaughter by-products in steer-fattening rations. M. L. Ray (*Arkansas Farm Res.*, 1959, **8,** No. 2, 3).—Utilisation by steers of feather meal, blood and bonemeal from poultry slaughter houses was as efficient as that of cottonseed meal. Digestibility was similar in the two materials and carcass grading was unaffected. A. G. POLLARD.

Factors affecting weight gains of dairy heifers fed all-roughage rations. M. E. McCullough and W. E. Neville, jun. (*J. Dairy Sci.*, 1959, **42,** 1698—1702).—A statistical examination of wt. gains by 28 dairy heifers on pasture and 10 individually fed heifers on either all-hay or grass silage ration is presented. The large no. of animals required to show differences between rations is emphasised. S. C. JOLLY.

Comparison of orchardgrass–ladino clover and orchardgrass as pasture for milking dairy cows. F. R. Murdock, A. S. Hodgson and H. M. Austenson (*J. Dairy Sci.*, 1959, **42,** 1675—1685).—Economic returns were greater from mixed orchardgrass–ladino clover pasture than from orchardgrass heavily fertilised with N. Differences between the pastures declined over 3 years, presumably due to decrease in clover in the mixed stand. S. C. JOLLY.

Evaluation of short-interval milking as a physiological technique. D. R. Lamond and W. V. Candler (*J. Dairy Sci.*, 1959, **42,** 1724—1725).—Some statistical observations are made on the paper of Lakshmanan *et al.* (*ibid.*, 1958, **41,** 1601) on the effects of short-interval milking with the aid of oxytocin on milk and milk fat production. S. C. JOLLY.

Feeding trial concerning optimum protein allowance in winter rations for dairy cows. A. M. Frens and N. D. Dijkstra (*Versl. Landbouwk. Onderz.*, 1959, No. **65.9,** 39 pp.).—The experiment confirms that the reduction of the digestible crude protein allowance by 10% (made in 1950) with respect to the allowance calculated by the Frederiksen formula has had no significant effect on the milk yield. A further 10% reduction would cause a reduction of 0·65 kg. of milk per cow per day in comparison with the Frederiksen standard. No differences are observed with regard to the condition or live wt. of the cows, or the composition of the milk at the three levels of protein feeding. (19 references.) P. S. ARUP.

Off-flavours in milk. O. H. Horton, O. T. Stallcup and E. R. Garrison (*Arkansas Farm Res.*, 1959, **8,** No. 2, 7).—Milk taken from cows immediately after grazing ladino clover possessed an off-flavour, which, however, disappeared when the interval between grazing and milking was 2—4 hr. A. G. POLLARD.

Onset of lactation in the Merino ewe and its modification by nutritional factors. I. McCance and G. Alexander (*Aust. J. agric. Res.*, 1959, **10,** 699—719).—Changes in the type of udder contents and rate of milk secretion in Merino ewes at about the time of parturition are described. In ewes fed to gain wt. during pregnancy,

copious lactation started at or before parturition, but in ewes fed to lose weight this was often delayed for >12 hr. after parturition and then the rate of secretion was only about half that of well-fed ewes. This delay was not associated with a shorter gestation period. The chance of survival of lambs born to poorly fed ewes would be substantially reduced by the delayed onset of lactation and reduced rate of milk production. (30 references.) S. C. JOLLY.

Salt tolerance of sheep. II. Tolerance of sheep for mixtures of sodium chloride and magnesium chloride in drinking water. A. W. Peirce (*Aust. J. agric. Res.*, 1959, **10**, 725—735).—Sheep on a ration of chaffed lucerne and wheaten hays drank more water containing 1·3% of NaCl than they did rain water. Fluid intake increased still further, without adverse effect, as part of the NaCl was replaced by >0·10% of $MgCl_2$; replacement of larger amounts of NaCl by $MgCl_2$ (0·2 and 0·5%) reduced water intake and food consumption and occasionally caused diarrhoea. Ambient temp. affected fluid intake, which was 60 to 100% higher in the hottest than in the coolest months of the year. Saline drinking water had no effect on the concn. of Na, K, Ca and Cl in blood plasma, but that of Mg was significantly higher in sheep drinking water containing 0·5% of $MgCl_2$ and 0·69% of NaCl. (18 references.) S. C. JOLLY.

Metabolic changes occurring in sheep transferred to lush spring grass. I. Changes in blood and rumen constituents. II. Changes in acid–base balance of the whole animal. E. F. Annison, D. Lewis and D. B. Lindsay (*J. agric. Sci.*, 1959, **53**, 34—41, 42—45).—I. Metabolic changes in sheep when first turned out to spring grass may be temporary in some cases [e.g., α-amino-acids in rumen and volatile fatty acids (V.F.A.) in blood] and persistent in others, e.g., rumen-V.F.A., increase in which remains for about three weeks. Previous dietary regimes may influence the nature and extent of these effects.

II. Changes in acid–base balances in the blood of sheep on turning out to graze lush spring grass occurred in those previously receiving a hay–concentrate diet but not in those previously given hay alone. Acidosis developing in some of the animals is probably due directly to the grass and not to the exercise or excitement of out-door feeding. A. G. POLLARD.

Effects of oxalic acid ingestion by sheep. I. Small doses to chaff-fed sheep. II. Large doses to sheep on different diets. P. S. Watts (*J. agric. Sci.*, 1959, **52**, 244—249, 250—255).—I. Oxalic acid (**I**) (3 and 6 g. per head daily) was administered by rumen fistula or flexible tube. Blood-Ca levels fell, blood urea and the CO_2 combining power were raised. Very little **I** was excreted in faeces and only small amounts were found in carcasses. With the heavier dosage crystals were deposited in the kidneys. The data is discussed in relation to sheep poisoning by *Oxalis pes caprae* (soursob) in S. Australia.

II. Inclusion of lucerne in the diet or addition of Ca or Sr to the sheep ration increased the tolerance to **I**, large amounts of which were excreted in faeces as oxalate and as carbonate and oxalate in urine. In animals surviving dosage with **I** much of the acid is decomposed by bacteria in the rumen. Sub-acute poisoning results primarily from rumen dysfunction following change of pH. A. G. POLLARD

Growth responses to selenium in lambs. J. W. McLean, G. G. Thomson and J. H. Claxton (*Nature, Lond.*, 1959, **184**, 251—252).—Increased growth after 2—3 weeks and live-wt. gains (over the control) of 4—10 lb. after ~100 days were observed in various breeds of Canterbury lambs when Na_2SeO_4 was given subcutaneously at the rate of 1 mg. Se every 7—10 days. Se responses were obtained in lambs from areas where white-muscle disease was common and also where it was very rare. The mode of action of Se is discussed; Se deficiency is probably an important factor in the regional ill-thrift syndrome. (10 references.) W. J. BAKER.

Proteolytic enzymes in baby pig nutrition. R. O. Baker (*Dissert. Abstr.*, 1959, **20**, 10).—Addition of 1% of pepsin, or of any of four other proteolytic enzymes, to a protein–lactose diet, improved the rate of growth and feed efficiency of pigs weaned at 1 week of age. Papain had no effect. Pepsin did not improve the growth rate or feed efficiency of pigs on a skim-milk diet, or of pigs weaned at <3 weeks. The positive results with pigs weaned at 1 week occurred only in cases of scouring. During the growth of pigs from birth to 8 weeks of age, pepsin activity per g. of stomach tissue increased, but pepsin activity of stomach contents did not. M. D. ANDERSON.

Saccharin in baby pig nutrition. S. M. Aldinger (*Dissert. Abstr.*, 1959, **20**, 9—10).—Sol. saccharin added to rations for baby pigs improved palatability, and increased food consumption, rate of gain of wt. and feed efficiency. The effect was more marked in pigs under 5 weeks old than in pigs 5 to 8 weeks old, and more marked in stale or stored feed than in fresh feed. Saccharin did not affect the rate of removal of glucose from the blood. M. D. ANDERSON.

Comparison of different levels of all-meal feeding for fattening pigs. R. Braude, K. G. Mitchell, A. S. Cray, A. Franke and P. H. Sedgwick (*J. agric. Sci.*, 1959, **52**, 223—229).—Pigs were fed the same dry meal at four different levels. With decrease in rate of feeding, growth rates, thickness of back-fat and of belly diminished whereas the depth and breadth of the eye muscle increased; carcass length and dressing % were unaffected. A. G. POLLARD.

Influence of a thyro-active compound in diets for swine during lactation. W. A. Dudley, D. E. Becker, A. H. Jensen and S. W. Terrill (*J. Anim. Sci.*, 1959, **18**, 825—829).—Inclusion of iodinated casein (1% thyroxine activity) in pig rations (100 mg./lb.) either from the 109th day of gestation or two weeks *post partum* until weaning caused loss of wt. or reduction in gain in Duroc pigs or crosses prior to farrowing or subsequently between farrowing and weaning, probably by lowering feed consumption. Pigs in which the Yorkshire breed predominated did not show this effect. A. G. POLLARD.

Use of tri-iodothyronine as a lactation stimulant for swine. W. F. Davis, jun., H. D. Wallace, G. E. Combs, jun., and A. C. Warnick (*J. Anim. Sci.*, 1959, **18**, 843—848).—Addition of tri-iodothyronine to the ration (600 or 300 mg. per ton of feed) from the 109th day of gestation until the 14th day of lactation did not affect the no. or wt. of pigs weaned but increased the loss of wt. of the sow during lactation. A. G. POLLARD.

Lucerne meal as a source of energy for swine. H. Heitman, jun., and J. H. Meyer (*J. Anim. Sci.*, 1959, **18**, 796—804).—With the inclusion of increasing proportions of lucerne meal in pig rations there was a decline in live-wt. gains, feed consumption and feed efficiency. A. G. POLLARD.

Oats as replacement for maize in complete mixed rations for growing-finishing swine. A. H. Jensen, B. E. Becker and S. W. Terrill (*J. Anim. Sci.*, 1959, **18**, 701—709).—Replacement of ground oats for ground yellow maize in a maize–soya-bean–oil meal ration for pigs lowered the rate of gain in wt. and the feed-efficiency. The extent of this reduction was related to the % of hull in the oats and to the % of oats in the ration. A. G. POLLARD.

Effect of protein level and quality in swine rations on growth and carcass development. D. H. Kropf, R. W. Bray, P. H. Phillips and R. H. Grummer (*J. Anim. Sci.*, 1959, **18**, 755—762).—Satisfactory growth of pigs from weaning to 200 lb. live-wt. was obtained with rations containing 16 and 12% of protein, provided a small amount of high-quality protein (brewers' yeast, dried skim-milk) was included. Pigs on a 16% good-quality-protein ration yielded carcasses having higher sp. gr., higher proportions of muscle and thinner back-fat than did those receiving a 16% poor-quality-protein or a 12% good-quality-protein ration. A. G. POLLARD.

Growth, economy of feed utilisation and carcass quality in pigs in relation to dietary protein level and antibiotic administration. J. T. Morgan, F. R. Green and R. A. Costain (*J. agric. Sci.*, 1959, **52**, 170—176).—The effects of a standard and a sub-standard ration on carcass characteristics are examined in relation to feed efficiency and to the protein and amino-acid contents of the diet. None of these factors was affected by feeding Aureomycin at nutritional levels. Relationships between killing % and the energy and fibre contents of the ration are discussed. A. G. POLLARD.

Inedible lard in swine rations. C. C. Brooks and H. R. Thomas (*Va agric. Exp. Sta.*, 1959, Bull. 506, 12 pp.).—The addition of 6—8% of inedible lard improved the energy content of standard and high-fibre rations for pigs. Supplying additional protein or crude carbonated phospholipid did not improve wt. gains of pigs receiving diets containing inedible lard. A. H. CORNFIELD.

Relation of pre-natal and pre-weaning treatment to the effect of arsanilic acid on selenium poisoning in weanling pigs. R. C. Wahlstrom and O. E. Olson (*J. Anim. Sci.*, 1959, **18**, 578—582).—A Se-free ration fed to weanling pigs from sows previously given Se-free rations grew faster than did those from sows fed rations containing Se or Se + arsanilic acid (**I**). Addition of (**I**) (0·01%) to a selenised ration increased growth rates, feed consumption and efficiency and diminished symptoms of Se toxicity. A. G. POLLARD.

Zinc toxicity in the weanling pigs. M. F. Brink, D. E. Becker, S. W. Terrill and A. H. Jensen (*J. Anim. Sci.*, 1959, **18**, 836—842).—The max. tolerance of Zn by weanling pigs was 0·1% (as $ZnCO_3$) in the ration. The tolerance was unaffected by further addition of 1% of Ca (as $CaHPO_4$) to the ration. A. G. POLLARD.

Utilisation by pigs of diets containing oats and oat husks ground to different degrees of fineness. A. F. Calder, J. Davidson, J. Duckworth, W. R. Hepburn, I. A. M. Lucas, J. Sokarovski and D. M. Walker (*J. Sci. Fd Agric.*, 1959, **10**, 682—691).—Growth and digestibility trials showed that there was no advantage in grinding to a greater degree of fineness than that achieved by ordinary farm

grinding equipment. Very finely ground oats caused a small reduction in the apparent digestibility of the diet protein and in the retention of N. Similar trials with finely ground oat husks added to barley–groundnut meal fattening diets showed that the fine grinding had no effect on the digestibility of org. proximate constituents. E. M. J.

Digestion of starch and some of its degradation products by newborn pigs. H. M. Cunningham (*J. Anim. Sci.*, 1959, **18**, 964—975).—Digestion of raw maize starch by newborn pigs was slower than that of sol. starch, maltose or glucose ; it was not improved by introduction of pancreatic amylase into the intestine. The principal factor limiting the digestion of whole starch is that effecting the initial rupture of the starch granule. The rate of digestion of sol. starch, maltose and glucose provides for a considerable proportion of the energy required by the newborn pig. A. G. POLLARD.

Early weaning of pigs. IV. Comparisons of levels of antibiotic and sources of protein in diets for pigs weaned at nine pounds live weight. I. A. M. Lucas, A. F. C. Calder and H. Smith. **V. Inclusion of digestive enzymes and antibiotics in diets for pigs weaned at 6—7 pounds live weight.** A., F. C. Calder, G. A. Lodge and R. Blair. **VI. Effects of early weaning and of early growth curves before 10 lb. live weight or subsequent performance and carcass quality.** I. A. M. Lucas, A. F. C. Calder and H. Smith (*J. agric. Sci.*, 1959, **53**, 125—129, 130—135, 136—144).—IV. In rations for piglings weaned at 9 lb. live-wt., replacement of half of the dried skim milk protein by white fish meal and rolled oat groats, increased growth rates. Complete replacement of the skim milk had the opposite effect. Addition of chlortetracycline and procaine penicillin (3 : 1) at the rate of 22—90 mg. per lb. of feed for pigs of 9—26 lb. live wt. increased growth rates and food conversion efficiency, though not to an extent justified economically.

V. Feeding antibiotics to pigs from weaning (6—7 lb. live wt.) up to 40 lb. increased growth rates by increasing food consumption and restricting scouring : efficiency of food conversion was unaffected. Pepsin supplements lowered growth rates and efficiency of feed conversion but increased scouring. Amylase had little effect on growth or food conversion but tended to counteract the ill-effects of pepsin. A. G. POLLARD.

Lysine requirement of weaning swine at two levels of dietary protein. G. W. McWard, D. E. Becker, H. W. Norton, S. W. Terrill and A. H. Jensen (*J. Anim. Sci.*, 1959, **18**, 1059—1066).—Weanling pigs receiving purified diets containing 12·8 or 21·7% of protein as sesame seed meal + L-histidine were given supplements of lysine. With the 12·8%-protein ration the lysine requirement was 0·71% and with the higher protein ration 0·95%. Mathematical relationships are established. A. G. POLLARD.

Lysine and methionine supplementation of maize–soya-bean oil-meal rations for pigs in dry-lot. D. C. Acker, D. V. Catron and V. W. Hays (*J. Anim. Sci.*, 1959, **18**, 1053—1058).—Using a maize–soya-bean meal ration containing 12% of protein, the growth rate and feed efficiency of sheep were increased by supplements of L-lysine (up to 1·0%). Methionine had no effect. With a similar ration containing 14% of protein, methionine but not lysine supplements had beneficial effects. A. G. POLLARD.

Influence of tri-iodothyronine on feedlot performance and carcass characteristics of growing-finishing swine. H. D. Wallace, G. E. Norris, G. E. Combs, G. E. McCabe and A. Z. Palmer (*J. Anim. Sci.*, 1959, **18**, 1018—1024).—Administration of tri-iodothyronine (25—75 mg./ton of feed) to pigs at weaning had no consistent effect on rates of growth or on feed efficiency. Larger doses (125 mg. upwards) produced deleterious effects. A. G. POLLARD.

Use of grain and silage from maize ears in fattening pigs for bacon H. Duniec and J. Szeszula (*Roczn. Nauk rol.*, 1958, **73, B**, 93—117). —Replacement of part of the grain ration by maize ear silage diminished the growth rates of bacon pigs and increased the proportion of lean to fat in the carcasses. The I val. of the back-fat diminished with increase in either maize grain or silage as compared with the standard ration. A. G. POLLARD.

Effect of sodium fluoride and hygromycin on growing-finishing pigs. R. C. Wahlstrom (*J. Anim. Sci.*, 1959, **18**, 1067—1073).—Inclusion of chlortetracycline (**I**) (15 g.) or hygromycin (12 g./ton) in pig rations increased the average rate of gain in wt. up to 100 lb. live wt. Fed simultaneously, the two antibiotics exhibited synergistic effects. Growth from 100 to 200 lb. live wt. was greater when **I** was given alone. Intestinal round worms were effectively controlled by hygromycin, but the use of NaF (0·5% of ration) as an anthelmintic reduced growth rates. A. G. POLLARD.

Protein requirements of laying hens. P. H. C. Du Plessis and J. Erasmus (*S. Afr. J. agric. Sci.*, 1959, **2**, 33—40).—Feeding trials with hens on diets containing 13—17% of protein showed that only the 13% level had an adverse effect on egg production. Body wt., feed efficiency, and mortality were not affected by differences in protein level. (19 references.) M. D. ANDERSON.

Influence of rate of changes in ambient temperature on production traits and mortality of laying pullets. A. C. Campos (*Dissert. Abstr.*, 1959, **20**, 11).—Exposure of laying pullets to a temp. of 100°F for 24 hr. caused a sudden severe temporary drop in egg production by some breeds, but not by others ; egg wt. and shell thickness decreased and albumin height increased. When the high temp. was attained quickly, the effects were somewhat more marked than when it was attained slowly, and there was a slightly greater mortality. Fluctuations of temp. between 32° and 88°F, or a daily period of 6 hr. at 100°F, had no effects except on shell thickness. Exposure of pullets to temp. of 22°F and below diminished egg production, heavy breeds being less affected than White Leghorns. Shell thickness, feed consumption and body wt. were decreased, the effects being rather more marked when the low temp. was attained quickly than when it was attained slowly. The size and albumin quality of the eggs were not affected. M. D. ANDERSON.

Rough rice in turkey feeds. E. L. Stephenson, D. Hamm and L. Tollett (*Arkansas Farm Res.*, 1959, **8**, 2).—Rough rice replaced maize in turkey rations without change in growth rate or feed efficiency. Pelleting increased growth rates with rations based on either grain. A. G. POLLARD.

Anti-bacterial and anti-fungal agents in diets for laying and breeding hens. C. W. Carlson (*S. Dakota agric. Exp. Sta.*, 1959, Tech. Bull. 22, 21 pp.).—Reports of many trials with a wide variety of materials are presented. A. H. CORNFIELD.

Comparative toxic effects of 3-nitropropionic acid, sodium nitrite and *Indigofera endecaphylla* on chicks. E. J. Britten, H. Matsumoto and A. L. Palafox (*Agron. J.*, 1959, **51**, 462—464).—Incorporation of *Indigofera endecaphylla* (creeping indigo) or 3-nitropropionic acid (in amount equiv. to that found in the plant) in the diets of chicks produced identical toxic symptoms. Incorporation of NO_2^- (in amount equiv. to that found in the plant) did not produce toxic symptoms. A. H. CORNFIELD.

Toxicity to chicks of histamine formed during microbial spoilage of tuna. M. Shifrine, L. E. Ousterhout, C. R. Grau and R. H. Vaughn (*Appl. Microbiol*, 1959, **52**, 45—50).—In pre-cooked tuna muscle, histidine may be carboxylated to histamine during spoilage. Chick rations which include tuna meal having a high histamine content depress the rate of growth and the total growth of the birds. A rapid chromatographic method for determining histamine is described. A. G. POLLARD.

Effect of selenium and other factors on vitamin-E deficiency in the chick. M. C. Nesheim (*Dissert. Abstr.*, 1959, **20**, 13—14).—Se prevented the development of exudative diathesis in chicks receiving vitamin E-deficient diets containing *Torula* yeast, purified soya-bean protein or cryst. amino-acids. Se was necessary for the max. growth of chicks receiving diets containing *Torula* yeast, whether vitamin E was present or not ; vitamin E decreased the amount of Se required to produce max. growth. The Se content of diets in which protein was supplied by purified soya-bean protein and/or cryst. amino-acids could not be reduced below 0·04 mg. per kg., and this satisfied the Se requirement of the chick when enough vitamin E was supplied. Se was partly effective against muscular dystrophy in chicks fed diets deficient in vitamin E and S-containing amino-acids. The dystrophy was prevented by addition of vitamin E, methionine or cystine ; it was not prevented by other methyl donors (choline, betaine), or by —SH compounds. Deficiency of arginine or glycine (creatine precursors) did not cause muscular dystrophy in chicks, although the contents of creatine and phosphorylase in muscle were diminished. M. D. ANDERSON.

Unidentified growth factors required by the chick. R. Dam (*Dissert. Abstr.*, 1959, **20**, 1—2).—Mevalonic acid, thioctic acid and adenosine, singly or in combination, did not stimulate the growth of chicks on a diet adequate in known nutrients. Growth was stimulated by addition of a crude liver fraction to a purified diet containing soya-bean protein. This response was still obtained when the drinking water was sterilised by Zephiran chloride, or when antibacterials were added to the diet (eliminating yeasts but not bacteria from the intestine). When the contents of K, Na and Zn in the basal diet were doubled, the liver fraction did not stimulate growth. The ash of the liver did not stimulate growth on the diet with the lower mineral content. When 10% of highly unsaturated vegetable oils, or of triolein, supplied the fat in the diet, growth was better than with hydrogenated fat, coconut oil or triacetin. Basal growth was better with 10% than with 5% of maize oil, but was not improved by an increase to 20%. This effect was not due to any non-glyceride constituent, nor to content of essential fatty acids, for the supply of which the 5% was more than enough. M. D. ANDERSON.

Toxicity to chicks of histamine formed during microbiol spoilage of tuna. M. Shifrine, L. E. Ousterhout, C. R. Grau and R. H. Vaughn (*Appl. Microbiol.*, 1959, **7**, 45—50).—Spoilage of tuna meal is associated with the formation of relatively large amounts of histidine and thence of histamine. Diets containing such material depressed the growth of chicks. A. G. POLLARD.

Reactions of animals to infestation with ticks. IV. Protein components of tick extracts. R. F. Riek (*Aust. J. agric. Res.*, 1959, **10**, 604—613).—Filter paper and starch electrophoresis and gel diffusion have been used to separate and identify the protein components of tick extracts. Toxicity of laboratory animals was due on most occasions to three fractions, F_1, F_2 and F_6, in the egg extract, but to only one fraction, F_{2-3}, in the larval extract. The antigen largely responsible for development of skin hypersensitivity F_1, is a γ-globulin and has the greatest mobility of the γ-globulins under specified electrophoretic conditions. Skin-sensitising activity was also shown by fraction F_2, and to a lesser degree by F_3. (15 references.) E. G. BRICKELL.

Control of animal parasites with systemic insecticides. D. G. Peterson and A. A. Kingscote (*Canad. J. Biochem. Physiol.*, 1959, **37**, 1105—1112).—A review. (65 references.) E. G. BRICKELL.

Control of fungus in sea-trout and salmon spawners by Malachite Green. S. Sakowicz and S. Gottwald (*Roczn. Nauk rol.*, 1958, **73, 13**, 282—292).—Mature fish for breeding are freed from fungus by bathing in freshly prepared solution of Malachite Green (1 : 200,000) for 20 min. A. G. POLLARD.

Control of fungus on pike eggs by Malachite Green. S. Gottwald (*Roczn. Nauk rol.*, 1958, **73, B**, 295—312).—Eggs of *Esox lucius*, L., during incubation are rinsed for 15 min. every second day in a solution of Malachite Green (1 in 100,000) to prevent fungal growth. For eggs of *Coregonus albula* treatment with the dye (1 in 200,000) for 30 min. every third day was effective. Embryonic development was unaffected and mortality rates were lowered considerably. A. G. POLLARD.

2.—FOODS

Carbohydrate Materials

Cereals, flours, starches, baking

Determination of moisture content in cereals. I. Interaction of type of cereal and oven method. T. A. Oxley, S. W. Pixton and R. W. Howe (*J. Sci. Fd Agric.*, 1960, **11**, 18—25).—Five different oven-drying methods in common use were tested on non-oily cereal grains at different moisture levels. Differences of the moisture content of a grain sample given by various methods are influenced by the type of grain under test, being less for high-protein, hard wheats, parboiled rice and flint maize than for soft wheats, milled rice, dent maize, oats or barley. These results preclude the possibility of alternative standard methods being specified if more than one kind of grain is to be tested. Two different methods may give identical results for one type of grain, but the inference that they will do so for all other grains is not valid. E. M. J.

Chemicals from cereals: fermentation acids. F. W. Tanner, jun. (*Cereal Sci.*, 1959, **4**, 256—258).—In the U.S. at present the fermentation acids produced from cereal carbohydrates are gluconic, 2-ketogluconic and lactic acid. Sorbose is also produced. Acetic, citric, oxalic, ascorbic, fumaric, itaconic and kojic acids, and some amino-acids, are also produced by the fermentation industry, using cane and beet molasses, fruit, and other substrates. S. G. AYERST.

Radioactive contamination of grain and grain products. E. P. Laug (*Cereal Sci.*, 1959, **4**, 273—275).—Wheat was exposed to radioactive fallout during tests in Nevada. In miniature silos, fallout particles sifted to a depth of 3—5 inches from the surface. Flour obtained after cleaning and milling contaminated wheat showed very little radioactivity, but there was a significant amount in the bran and shorts dust. During a wheat and bread monitoring survey, significant contamination was found in wheat samples from the 1958 harvest. S. G. AYERST.

Fluidisation in beds of rice or wheat. Liang-Tseng Fan and C. J. Swartz (*Canad. J. chem. Engng*, 1959, **37**, 204).—Application of the generalised theory of Leva *et al.* (*Genie chimique*, 1956, **73**, 33) for small heavy particles in fluidisation, is quite possible for light and relatively large food grains. Tables show agreement of fluidisation velocity to $\pm 4\%$. It is necessary to adopt a mean diameter for the particles given by the square root of the product of the two smaller linear dimensions. F. RUMFORD.

Analysis of air and solid flow in a spouted wheat bed. B. Thorley, J. B. Saunby, K. B. Mathur and G. L. Osberg (*Canad. J. chem. Engng*, 1959, **37**, 184—192).—"Spouting" or a central upward jet with down flow at sides is a common phenomenon in fluidised solid beds. The pressure drop in a "spouted" bed is about $\frac{2}{3}$ of bed wt., but for any specific cross section of channel there is a max. height of solid bed above which spouting does not occur. Entry air conditions are important, and the tests are confined to a single cone-shaped entrance section (angles of the cone were varied). A large proportion of the total air (up to 80%) flows upward through the annular space round the central spout. Curves are constructed to show the flow pattern of the wheat grains, and to give the cycle time for individual particles. F. RUMFORD.

Effect of freeze-processing on amyloclastic susceptibility, crystallinity and hydration characteristics of rice. A. S. Roseman and H. J. Deobald (*J. agric. Fd Chem.*, 1959, **7**, 774—778).—Freezing boiled rice resulted in the development of a B-type *X*-ray diffraction pattern, and made the rice less susceptible to attack by β-amylase (an effect abolished by soaking the freeze-processed rice in water at 45°). The changes were similar to those associated with retrogradation. Freeze-processed whole-grain boiled rice absorbed much more water than did unfrozen boiled rice or raw rice. After grinding, all showed much increased absorption of water at temp. >80°, raw rice then having the greatest absorption. (16 references.) M. D. ANDERSON.

Factors affecting the stability of frozen white sauces. E. M. Osman and P. D. Cummisford (*Food Res.*, 1959, **24**, 595—604).—Pastes and sauces prepared from amylopectins from different starches varied greatly in their stability. Tapioca amylopectin and waxy rice flour produced white sauces of about the same stability, greater than that of any other thickening agent tested. Pastes of tapioca amylopectin and water alone were more stable than white sauces containing the same starch fraction or than pastes of waxy rice flour. White sources containing waxy rice flour were more stable than those containing waxy rice starch. The structure of the starch used and the other ingredients present were important in determining the freeze–thaw stability of a starch-thickened food. (15 references.) E. M. J.

Gel properties of common and waxy maize starches. L. A. Wollermann (*Cereal Sci.*, 1959, **4**, 270—272).—Using the embedded-disc method, the gel strength of eight different starches was determined after various cooking times and after homogenisation. The same method was used to evaluate the gel rate of two types of gum-candy. S. G. AYERST.

Reproducible periodate oxidation method for determination of glycogen end groups. F. W. Fales (*Analyt. Chem.*, 1959, **31**, 1898—1900).—The test solution is oxidised with Na metaperiodate and a methyl-α-D-glucoside standard is run concurrently. Formate released is determined by titration with standard alkali or by an iodometric procedure. From the relative titrations of the test solution and standard, and the relative glycogen contents as determined by the anthrone method, the average chain length can be measured to 0·5 glucose unit with 6 replications. (11 references.) G. P. COOK.

Spectrophotometric determination of aldoses by iodometric procedure. G. L. Miller and A. L. Burton (*Analyt. Chem.*, 1959, **31**, 1790—1793).—The sample solution is treated with Na_2CO_3 and standard I_2–KI. After standing, the mixture is acidified with H_3PO_4 and the excess iodine measured spectrophotometrically at 480 mμ. Glucose is used as standard. (16 references.) G. P. COOK.

Influence of γ-rays on quality of flour. M. Blinc (*Brot u. Gebäck*, 1959, **13**, 205—209).—Weak flour from Italian wheat, Autonomia, San Pastore and Fortunato was treated with γ-rays from ^{60}Co, at dosages of 30,000, 50,000, 100,000 rep. The Farinograms, Amylograms and Extensograms were compared with those of the original flours. It was shown on the Farinograms that the degree of softening fell from 120 to 80 in the case of Autonomia. The Amylograms of San Pastore improved on all irradiated samples but showed the most suitable curves at 50,000 rep. Fortunato was the weakest flour and showed the best improvement at 30,000 rep for all three curves. Bread baked with irradiated flour did not have the slightly sticky taste attributed to bread baked with untreated flour. The output and the loaf vol. increased and the crust was satisfactory. (Photographs of loaves and curves are given.) I. DICKINSON.

What do we know about wheat proteins? D. C. Abbott (*Cereal Sci.*, 1959, **4**, 264—270).—A review of the literature concerning the chemical and physical properties of the sol. proteins and gluten proteins of wheat. (31 references.) S. G. AYERST.

Amino-acid distribution in gluten fractions. C. E. Stauffer, O. J. Banasik and R. H. Harris (*Food Res.*, 1959, **24**, 401—409).—Crude

gluten, purified crude gluten and three gluten fractions were prepared from each of three flours which differed widely in their gluten strength characteristics. The protein prep. were analysed for amino-acid content by chromatography. In the three flours, the main differences in glutamic acid, leucine + isoleucine, alanine and lysine occurred in the third fraction and the differences in glycine + serine and proline distributions were in fractions II and III. A more comprehensive analysis of the third fraction of various flour glutens seems desirable to define further the quality of the flour. (14 references.) E. M. J.

New method of acid fermentation. G. Weiser (*Brot u. Gebäck*, 1959, **13,** 209—218).—A new type of acid ferment has been developed. It is a partly dried, pure culture of homo- and heterofermentative acid formers and yeasts. It looks like ordinary baker's yeast and keeps fresh for 8—10 weeks. It is suitable for both long and short fermentation periods. Bread was baked at two-hourly intervals and it was found that the acid content of the various loaves did not vary much after 16—20 hr. of fermentation, thus making it easier for the baker to organise his programme and to eliminate human error. The bread improved in taste and appearance. (23 references.) I. DICKINSON.

Influence of different dough rolling machines on structure of rolled doughs. I. Bansbach (*Brot u. Gebäck*, 1959, **13,** 218—220).—Various types of dough rolling machines are described. Great improvement of structure can be obtained with suitable machines and accessories. For flour of high gluten content intensive kneading, more yeast and a cool temp. are required. Good structure requires rolling in stages with gradual reduction. Improvement can be achieved by folding the rolled dough several times and rolling again after a short resting period. I. DICKINSON.

Light destruction of riboflavin in partially-baked rolls. L. C. Stephens and M. F. Chastain (*Food Technol.*, 1959, **13,** 527—528). E. M. J.

Preparation of protein-rich biscuits with protein hydrolysates of pulses. R. L. Nath (*Bull. Calcutta School trop. Med.*, 1959, **7,** 100—101).—Pulses (*Phaseolus radiatus, P. mungo, Cajanus indicus, Lans esculants,* and *Cicer arietinum*) as pastes with water were proteolysed by fermentation with *Carica papaya*; the product was extracted with boiling water and the extract concentrated to a gummy residue. This was incorporated in biscuits giving palatable products of high (11·3 to 15·5%) protein content. A. G. COOPER.

Manufacture of biscuits. Baker Perkins Ltd. (Inventors: F. Dewhurst and K. Farrer) (B.P. 819,212, 27.9.56 and 25.7.57).—Plant is illustrated and described in detail for the manufacture of wafer sandwich biscuits. H. S. R.

Sugars and confectionery

Distinguishing xylose from arabinose and other sugars. B. Drożdż (*Acta biochim. polon.*, 1959, **6,** 369—372).—Best results were obtained by drop analysis on Whatman No. 1 chromatograph paper. The sugar in solution (1—10 μg.) is placed on the paper. This is dried and sprayed with 1% barbituric or 0·5% thiobarbituric acid in glacial acetic acid. The paper is dried, when yellow spots appear; after holding the paper over boiling water the spots take on a colour characteristic of the sugar present. B. LAKE.

Citric acid interference in estimation of reducing sugars with alkaline copper reagents. L. G. Paleg (*Analyt. Chem.*, 1959, **31,** 1902—1904).—In analysis of reducing sugars by the molybdo-arsenate modification of Somogyi's method (*J. biol. Chem.*, 1952, **195,** 19), citric acid will compete with tartaric acid in the alkaline Cu reagent and greatly reduce sensitivity. A. R. ROGERS.

Prevention of stickiness and graining in stored hard candies. R. Heiss (*Food Technol.*, 1959, **13,** 433—440).—The processes, (*a*) the surfaces becoming sticky, (*b*) the surface becoming opaque and graining developing towards the centre, when hard candies are stored in a humid atm., are examined. Stickiness in the outer layer depends on the concn. of the sugar solution. The rate of graining increases with increasing R.H. At 35% R.H. graining starts in hard candies made with invert sugar. At 70% R.H. the first stickiness peak is higher and shorter than at 50% and at 65% R.H. stickiness is still higher than at 70% R.H. For wet summers polymer coating packaging is necessary and the candies may be powdered with suitable substances or a desiccant included in the water-vapour-tight packaging. (12 references.) E. M. J.

Selective media used in the microbiological examination of sugar products. M. P. Scarr (*J. Sci. Fd Agric.*, 1959, **10,** 678—681).—For the three groups of organisms of particular interest, differential media are used or claimed to be used for each group; (*a*) osmophilic medium for examination of osmophilic yeasts, consists of a synthetic wort agar made in a 45° Brix, partially inverted syrup; (*b*) a modified Sabaroud's broth for yeasts on membrane filters; (*c*) dextrose tryptone agar, liver broth and iron sulphite agar for thermophiles. There is no satisfactory selective medium for capsulated bacteria in sugar products, but *Leuconostoc* spp. are rare in sugar products in this country and occur in raw beet sugar. (10 references.) E. M. J.

Pectin standardisation. Final report of the IFT Commee. (*Food Technol.*, 1959, **13,** 496—500).—The report summarises the activities of the Commee over a 10-year period. Method 5–54 is proposed as a standard procedure for grade evaluation of pectins sold for manufacture of 65% sol. solids jellies. (16 references.) E. M. J.

Fermentation and Alcoholic Beverages

Evolution of different forms of nitrogen during fermentation of grape musts of Alsace vintages. H. Weiss, A. Rousset and R. Bonnet (*C. R. Acad. Sci., Paris*, 1959, **249,** 1796—1798).—The initial concn. of various forms of N (total N is directly related to the rainfall of the year of production) varies so widely in different vintages that no classification of the evolution of the forms of N is possible. Figures are however given for Gewürtztraminer having the highest total N content. M. C. M.

Analytical chemistry of wines. VIII. Determination of cobalt in wine with β-nitroso-α-naphthol. H. Eschnauer (*Z. Lebensmitt-Untersuch.*, 1959, **110,** 196—200).—A 500-ml. sample of wine is ashed, the ash is dissolved in aq. HCl and at pH 7 interfering Fe is complexed and held by Na citrate (50% solution). In presence of glacial AcOH, β-nitroso-α-naphthol and toluene are added and the mixture is shaken. The toluene layer is shaken twice with 2N-NaOH and separated; the combined NaOH layers and washings are extracted with a small amount of toluene and this is added to the toluene. The extinction is measured at 360 mμ against pure toluene. In 12 wines and juices examined the Co content varied between 0·5 and 12 μg. of Co/l. E. M. J.

Determination of formic acid in wine. W. Diemair and C. Gundermann (*Z. LebensmittUntersuch.*, 1959, **110,** 261—265).—Separation of formic acid can be effected by Fincke's process involving steam distillation or vac. distillation. In presence of sugars some decomposition of the sugars occurs and in the vac. distillation the extract content of the wines has to be considered. A sample of acid separated by either of the above processes can be quant. reduced to formaldehyde by Mg + conc. HCl at 0° and by addition of chromotropic acid the resulting violet colour may be determined colorimetrically. The sensitivitiy of the method is 0·14 μg. and the accuracy of determination ±5% in dessert wines and ±10% in dry wines. The method is suitable for determination of formic acid in fruit syrups. E. M. J.

Trace elements in wine. H. Eschnauer (*Angew. Chem.*, 1959, **71,** 667—671).—A review. (157 references.) A. J. B.

Gas-chromatographic analysis of alcoholic distillates. F. Cacace, M. Ikram and M. L. Stein (*Ann. Chim., Roma*, 1959, **49,** 1383—1390).—The identification and determination of minor components in alcoholic liquids is carried out by gas chromatography using two columns in series. The first contains didecyl phthalate as stationary phase, and effectively separates isobutyl and isoamyl alcohols and acetates; the second contains polyethylene glycol, which separates the more volatile components, e.g., EtOAc and acetaldehyde acetal. Typical results on some samples of brandy are shown. L. A. O'NEILL.

Consumer tests of grape juices. W. Saller and K. Körbler (*Fruchtsaft-Industr.*, 1959, **4,** 239—245).—In connexion with the overproduction of wines, which is due partly to improved methods of growing grapes and partly to a diminishing demand for wines, attempts were made to increase the consumer acceptability of grape juice by the addition of CO_2 and essences. In a series of tests the most favourable was the one with a sugar-acid proportion of 70° Öchsel and a pH of 2·98. (70° Öchsel = 17·05° Brix.) The addition of essences showed promising results, further work in this direction would be worthwhile. (16 references.) I. DICKINSON.

Selective media for yeasts and bacteria in apple juice and cider. F. W. Beech and J. G. Carr (*J. Sci. Fd Agric.*, 1960, **11,** 38—40).—Out of 46 antibiotics and other inhibitory chemicals tested against 23 species of yeasts and 20 species of bacteria only a few were satisfactory. Bacteria were isolated on a basal medium of apple juice plus yeast extract in presence of actidione and oxine. A medium containing actinomycin and Aureomycin with aerobic incubation was most effective for isolating yeasts. Diphenyl (100 p.p.m.) prevents the germination of many mould spores. (16 references.) E. M. J.

Determination of yeast viability. R. B. Gilliland (*J. Inst. Bew.*, 1959, **65**, 424—429).—A new technique for the determination of yeast viability is described. The yeast is cultivated on a haemocytometer slide and the microcolonies are counted. The results would appear to be more accurate and more reproducible than those obtained by other methods. (14 references.) C. A. SLATER.

Influence of yeast strain on production of beer by continuous fermentation. A. D. Rudin and J. S. Hough (*J. Inst. Brew.*, 1959, **65**, 410—414).—A comparative study has been made of 12 strains of top and bottom yeasts for use in continuous fermentation. All but one produced palatable beers. C. A. SLATER.

Evaluation of hops. VIII. Preparation of extracts in estimation of α-acids. J. R. Hudson (*J. Inst. Brew.*, 1959, **65**, 422—423).—A method of preparing extracts of hops by shaking with ceramic balls and solvent is described. The extract is suitable for conductometric or spectrophotometric determination of α-acids. C. A. SLATER.

Commercial application of gibberellic acid to hops. A. S. Nash and P. D. Mullaney (*Nature, Lond.*, 1960, **185**, 25).—In newly-bred triploid hop plants the triploid material tended to hang in the burr stage for a long period; after spraying with gibberellic acid the sprayed material showed normal development of the cones. The yield was increased but the content of α-resin in the treated hops was 1·8 compared with 10·16% in untreated hops and total soft resin was 9·7 and 21·8% respectively. E. M. J.

Occurrence of 2-methylbutyl esters in hop oil. G. A. Howard and R. Stevens (*Chem. & Ind.*, 1959, 1518—1519).—Preparative gas chromatography of the oxygenated portion of the fraction (b.p. 44—56°/1 mm.) from hop-oil distillation yielded a compound identifiable, from i.r. spectrum and other properties, as the isobutyric ester of (−)-2-methylbutanol. Active amyl alcohol is present in hop oil and may originate biogenetically from isoleucine. W. J. BAKER.

Composition of beer, especially dextrin content. E. Schild and H. Weyh (*Z. LebensmittUntersuch.*, 1959, **110**, 115—120).—Literature on the composition of beer and especially of the extract is discussed. A series of errors is shown in the reductometric determination of dextrin and even after modification, the process is not satisfactory. A method is proposed in which a sample of wort or beer is fermented, the sugar is removed. The dextrin is hydrolysed with HCl and the glucose obtained is fermented to alcohol on which the dextrin is calculated. Values obtained by this method are higher than those determined by the reductometric method; they are in the same order of magnitude as those determined by chromatography. (18 references.) E. M. J.

Non-biological hazes of beers. IX. Effect of nylon 6-6 in delaying formation of haze. G. Harris and R. W. Ricketts (*J. Inst. Brew.*, 1959, **65**, 418—422).—Under appropriate conditions any given % of anthocyanogens may be removed from beer by filtering through nylon 6-6 powder. In practice 15—30% removal of anthocyanogens is sufficient to extend shelf-life several-fold. C. A. SLATER.

Oxygen uptake by beer during production. K. Silbereisen and C. Weymar (*Mschr. Brauerei wissen. Beil.*, 1959, **12**, 187—192).—Th concn. of dissolved O_2 reaches a min. after the main fermentation and during lagering, and then rises steadily during filtration and whilst in the pressure tanks, and rapidly during bottling. The figures given for uptake are apparent, being modified by conditions favouring reduction at the time of measurement. (21 references.) P. S. ARUP.

Practical solutions to corrosion in brewing industry. D. H. Edmonds (*J. Inst. Brew.*, 1959, **65**, 398—405).—A general review of the nature of corrosion and methods of control. C. A. SLATER.

Timbers used by brewers. W. P. K. Findlay (*J. Inst. Brew.*, 1959, **65**, 405—409).—A discussion of the timbers suitable for use in vats and casks. C. A. SLATER.

Fruits, Vegetables, etc.

Free amino-acids of certain British fruits. L. F. Burroughs (*J. Sci. Fd Agric.*, 1960, **11**, 14—18).—Total and alcohol-sol. N contents and free amino-acids were determined in strawberry, gooseberry, blackcurrant, redcurrant, loganberry, raspberry, blackberry and tomato. The amino-acid patterns of the fruits were broadly similar, alanine and glutamine being the chief amino-acids present but the tomato had a predominance of glutamic acid and γ-aminobutyric acid. In 20 non-edible species of apple and pear, in medlar (unripe and ripe) and in three species of *Vaccinium* examined, 1-aminocyclopropane-1-carboxylic acid (occurring in perry pears) was found in ripe cowberries (*V. vitis-idaea*) only. (24 references.) E. M. J.

Chromatographic identification and estimation of free amino-acids in strawberry juice. I. J. Tinsley and A. H. Bockian (*Food Res.*, 1959, **24**, 410—412).—In juice which had been held at 0° for 6 months the following amino-acids were found: asparagine, glutamine, alanine, glutamic acid, aspartic acid, serine, threonine, arginine, valine, cystine and/or cysteine, and leucine and/or isoleucine. Concn. ranged from 59 mg./100 ml. to <2 mg./100 ml. E. M. J.

Effects of cathode ray and γ-ray irradiation on the anthocyanin pigments of strawberries. P. Markakis, G. E. Livingston and I. S. Fagerson (*Food Res.*, 1959, **24**, 520—528).—The pigments in strawberry juice are destroyed by 0·465 megarads of 2 MeV cathode rays up to 55% and by the same dose of γ-rays up to 63%. Resistance to radiation is increased by freezing or dehydrating the juice before irradiation. Prep. of jelly at low temp. followed by surface irradiation results in higher pigment retention than in jelly prepared by the open kettle method. (12 references.) E. M. J.

Chemical changes associated with ripening of apples and tomatoes. C. W. Woodmansee, J. H. McClendon and G. F. Somers (*Food Res.*, 1959, **24**, 503—514).—Certain constituents in apples (Red Delicious and Stayman) and tomatoes (Brookston and Valiant) were determined at the unripe, ripe and overripe stages. E.g., the 70% alcohol-insol. solids decreased with significance at 1% level during the ripening of apples, and in Brookstone tomatoes a decrease was observed at either the unripe to ripe or unripe to overripe stages. On a fresh wt. basis, the total pectin decreased significantly from the unripe to the overripe stages for Stayman apples and Valiant tomatoes, and for Red Delicious apples and Brookston tomatoes without significance. Other data are recorded. (28 references.) E. M. J.

Determination of cyanide residues in apples. M. Feuersenger (*Dtsch. LebensmittRdsch.*, 1959, **55**, 277—280).—Studies of cyanide retention in apples after fumigation are reported. Retention varies with variety of apple, fumigant concn. and contact time. After fumigation with 0·5% HCN by vol. for up to 1 hr. and airing the fruit for ≤48 hr., the retained cyanide is <2 p.p.m. Residues were determined by distillation of the cyanide in a stream of N_2 from the fruit acidified with trichloroacetic acid, collection of the cyanide in alkali, and measurement of the colour produced on heating the distillate with 1% picric acid. E. C. APLING.

Effect of temperature on physiology and storage quality of pears. S. W. Porritt (*Dissert. Abstr.*, 1959, **20**, 841).—Pears had max. storage life when cooled to 30°F within 4 days of harvest. Slow cooling shortened storage life more than did 2 to 3 days' exposure to 70°F, followed by rapid cooling. Storage life of Bartlett pears was 40% longer at 30° than at 32°F. The amount of CO_2 given off by pears decreased with rising storage temp. A period of low metabolic activity after harvest lasted 4 days in Bartlett pears, and over 50 days in Anjou pears, at 50° to 70°F. Anjou pears ripened normally at 70°F only after a period of cold storage. M. D. ANDERSON.

Histology and texture of Elberta peaches from trees of high and low levels of nitrogen nutrition. R. M. Reeve and C. H. H. Neufeld (*Food Res.*, 1959, **24**, 552—563).—Fruit of high-N nutrition had more but smaller parenchyma cells than that grown under conditions of low-N availability. In peaches of each type cell no. were more important than cell size in determining fruit size. On canning the high-N fruit remained firm and finely textured and the low-N fruit was coarse, stringy and often ragged in appearance. (20 references.) E. M. J.

Carotenoids of cling peaches. A. L. Curl (*Food Res.*, 1959, **24**, 413—422).—Fractionated by countercurrent distribution and chromatography, the principal carotenoid constituents found were: violaxanthin, cryptoxanthin, β-carotene, phytoene and a new xanthophyll "persicaxanthin"; in lesser quantity: phytofluene, zeta-carotene, lutein, zeaxanthin, antheraxanthin, mutatoxanthins, luteoxanthins, trollixanthin-like polyols and "persicachromes a and b." (25 references.) E. M. J.

Freestone peaches. I. Effect of sucrose, citric acid and maize syrup on consumer acceptance. R. M. Pangborn, S. Leonard, M. Simone and B. S. Luh (*Food Technol.*, 1959, **13**, 444—447).—Optimum sweetness in all-sucrose pack was ~22·5° Brix (range 18·46 to 31·40° Brix) and acidification (0·3 or 0·4%) did not improve flavour. At 40° Brix the all-sucrose control received significantly higher consumer preferences than did maize syrup-containing samples. Fruit flavour decreased and off flavour increased with increasing replacement by maize syrup at the 40° Brix level. (12 references.) E. M. J.

Spectrophotometric determination of hydrocyanic acid in canned apricots, cherries and prunes. B. S. Luh and M. F. Pinochet (*Food Res.*, 1959, **24**, 423—427).—After steam distillation of the sample into a receiver containing aq. NaOH, the distillate was acidified with

AcOH, the cyanide was converted into cyanogen bromide and the cyanide–benzidine complex was measured at 520 mμ. The concn. of HCN in canned whole apricots, cherries and prunes were : 0·13, 0·048 and 0·012 p.p.m. respectively. Canned cherry juice had HCN content of 0·44 p.p.m. Amygdalin, the responsible glucoside, is present only in the pit, and not in the flesh of apricot fruit. Assuming that the lethal dose is 65 mg. the amount found in the above fruits is small. E. M. J.

Chemistry of non-enzymic browning. IX. Sugar monoesters of malic acid found in browned freeze-dried apricots. D. L. Ingles and T. M. Reynolds. **X. Difructose-amino acids as intermediates in browning reactions.** E. F. L. J. Anet (*Aust. J. Chem.*, 1959, **12**, 483—490, 491—496).—IX. Chromatography shows that when glucose, fructose and sucrose are heated with DL-malic acid four esters each are formed from glucose and fructose ; six are formed from sucrose. From the glucose mixture were obtained 1-α-, 6-α-, and 6-β-hydrogen malates, and from the fructose was obtained 6-α-hydrogen malate. The acids and esters in freeze-dried fruit were similarly determined.

X. Difructose-glycine mixtures with amino-acids brown much faster than similar mixtures containing fructose-glycine, and there is very little browning with glucose mixtures. Results show that diketose-amino-acids can be important intermediates in non-enzymic browning reactions. C. A. SLATER.

Catalase and peroxidase activity in raw and blanched Southern peas, *Vigna sinensis*. A. Lopez, M. F. Bocklet and C. B. Wood (*Food Res.*, 1959, **24**, 548—551).—Blanching for 1 min. in water at 100° inhibited 70—90% of the peroxidase and 80—100% of the catalase activity ; blanching for 2 min. inhibited 90—100% of the peroxidase and 98—100% of the catalase ; blanching for 3 min. inhibited 98—100% of the peroxidase. No significant regeneration of activity was observed after any storage periods at 0°F. (10 references.) E. M. J.

Control of exudation in prepeeled French-Fry potatoes with antibiotics. F. J. Francis, B. L. Amla and A. Kiratsous (*Food Technol.*, 1959, **13**, 485—488).—The exudation of liquid from prepeeled potatoes can be minimised by adding 10 p.p.m. of oxytetracycline or chlortetracycline to the sulphite dipping solution for French-Fry style strips packed in polyethylene bags or, if packed in Cryovac bags, 5 p.p.m. of the antibiotic is effective. Shelf life is shorter at 50°F than at 38°F. E. M. J.

Sloughing in canned potatoes. K. G. Weckel, R. K. Scharschmidt and G. H. Rieman (*Food Technol.*, 1959, **13**, 456—459).—The degree of sloughing observed in small mature harvest potatoes is relatively much greater than that in immature harvest potatoes. Ca^{2+} was effective in reducing the sloughing and in increasing slice firmness in the canned potatoes, especially those with sp. gr. >1·082. E. M. J.

Factors influencing the quality of sliced, precooked frozen sweet potatoes. M. W. Hoover and D. T. Pope (*Food Technol.*, 1959, **13**, 448—450).—Problems associated with a freezing process of the larger sweet potatoes are discussed. Best results were obtained when the potatoes were sliced longitudinally and cooked in 45—60% sucrose syrup. There was little difference in the quality produced of frozen sweet potatoes from cured and uncured roots. E. M. J.

Non-alcoholic beverages

Natural purity of fruit juices. J. Koch and R. Kleesaat (*Dtsch. LebensmittRdsch.*, 1959, **55**, 246—251).—Hydroxymethylfurfural (**I**) is not present in fresh apple or grape juice and is only produced in small quantities in high-temp. storage. Juices containing >2 mg. of **I**/l. are no longer of natural purity and those containing >10 mg. of **I**/l. or grape juice containing 20 mg./l. show the presence of juice concentrate. (29 references.) E. C. APLING.

Non-enzymic browning in some fruit juices and pulps. B. S. Bhatia, N. S. Kapur and G. S. Siddappa (*Food Sci., Mysore*, 1959, **8**, 347—350).—Fruit juices and pulps were preserved in various ways, and browning was followed by spectrophotometric determination of total carbonyl content at intervals during storage at 37°. Controls were quick-frozen at 20°F, and stored at 0°F. Protection against browning by SO_2 was more marked in pasteurised than in unheated products. Heated jack-fruit pulp and orange juice showed least browning when packed under N_2. Deaeration while hot, and vac.-packing, were also helpful. Na benzoate was less effective than SO_2 in guava, jack-fruit and mango pulps. No carbonyls were found in lime juice, probably because of low sugar content and low pH. Passion-fruit juice and tomato serum browned very little. A separate study of jaman juice by determinations of optical density showed that, with all treatments, browning decreased to 6 weeks, increased to a max. at 13 weeks, and decreased again afterwards, perhaps because of formation of polymers. M. D. ANDERSON.

Detection of adulteration in blackcurrant juices. H. Woidich and T. Langer (*Fruchtsaft-Industr.*, 1959, **4**, 234—238).—A chromatographic method suitable for routine analysis has been developed which distinguishes blackcurrant juice from other fruit juices and detects any adulteration. The fruit juice, adjusted to pH 10, is extracted with ether, the ether is evaporated, and the residue is taken up with ethanol. The solution in 25μ drops is transferred to filter paper and developed with a mixture of n-butanol-glacial acetic-water (63 : 27 : 10), dried at room temp. and treated with NH_3 fumes. One blue fluorescent spot and two yellow spots (R_F value 0·58 and 0·33) appear under u.v. light. The yellow spot of R_F value 0·33 is characteristic of blackcurrant juice. The chromatogram of red currant juice also shows two yellow and one blue spot, but the R_F values of the yellow spots are 0·58 and 0·81. Other juices from blackberries, bilberries and raspberries were tested, their chromatograms were found to be different from that of blackcurrant juice. (13 references.) I. DICKINSON.

Debittering grapefruit products with naringinase. F. P. Griffiths and B. J. Lime (*Food Technol.*, 1959, **13**, 430—433).—Optimum conditions of enzymic hydrolysis of naringin in grapefruit pulp and juice to less bitter substances, prunin and naringenin, are : enzyme concn. 0·05—0·01%, pH 3·1, and holding at 50° for 1—4 hr. Enzymic hydrolysis of coloured grapefruit pulp (0·025% enzyme), at 50° for 1½ hr. reduced bitterness and enabled the pulp to be used for colour fortification of poorly coloured, late season juice. (10 references.) E. M. J.

Tea, coffee, cocoa

Examination of coffee and coffee substitutes. V. Quantitative determination of soluble mannan in coffee infusions and extracts. H. Thaler (*Z. LebensmittUntersuch.*, 1959, **110**, 442—449).—A method is described for the estimation in coffee extracts of mannan (a high mannose/galactose polymer). Details are given of the analytical procedure which gives reproducible results. The method depends on the oxidation of extract solution with $NaClO_2$ and pptn. of mannan as Cu complex. The mannan is finally weighed. Accuracy is 2·5%. The mannan content of brewed coffee was between 7·5—11% of the extract whilst the brew of caffeine-free coffee contained only 4·3—6·4%. Various coffee extracts contained 3·5—10·5% of mannan with the exception of two samples which contained only 3·0% and 2·4%. I. DICKINSON.

Simplified photometric determination of caffeine in coffee infusions. K. Hase (*Z. LebensmittUntersuch.*, 1959, **110**, 127—128).—The aq. extract of coffee is treated with aq. $CuSO_4$ and $K_4Fe(CN)_6$ and filtered. To the clear solution is added I solution and caffeine periodide is precipitated. The ppt. is dissolved in methanol and the yellow colour is measured photometrically. The method is rapid and in agreement with that of Richter. E. M. J.

Determination of degree of roasting of coffee. W. Hohlfeld (*Z. LebensmittUntersuch.*, 1959, **110**, 129—130).—A colorimetric method for determination of degree of roasting of commercial vac.-packed coffee available in Sweden is described. Extracts were prepared from six different samples and the colour compared with that of an inorg. standard solution containing $CoCl_2$, $CuSO_4$ and $K_2Cr_2O_7$. The following values were derived : light >10, medium 8—9, dark 5·5—7·5 and french-roasted <5·5. E. M. J.

Organic acids in coffee in relation to the degree of roast. C. Lentner and F. E. Deatherage (*Food Res.*, 1959, **24**, 483—492).—Hot water extracts of various samples were studied by partition on silica gel- and paper chromatography. The following acids were present in green and roasted coffee : acetic, propionic, butyric, valeric, malic, citric, quinic, caffeic, chlorogenic, isochlorogenic, neochlorogenic, a further isomer of chlorogenic, *p*-coumarylquinic and two isomers of ferulylquinic. Formic acid occurred only in roasted coffee. Losses in the two chief acids during roasting were : chlorogenic 32—52% and citric 33—56%. The min. pH is reached in brews of light-roasted coffee. (23 references.) E. M. J.

Processing of raw cocoa. III. Enzymic aspects of cocoa fermentation. M. Holden (*J. Sci. Fd Agric.*, 1959, **10**, 691—700 ; cf. J.S.F.A. Abstr., 1959, i, 45).—In large- and small-scale fermentations of Amelonado cacao beans, inactivation of enzymes took place sooner in the top layer, where the temp. rise was more rapid than at the centre. Inactivation began during the period when the beans were dying and 48 hr. after all beans were dead, little or no enzyme activity was detectable. Prolonging the fermentation stage for several days after the death of the beans appears to be unnecessary. A substance which inhibited germination, occurring in the pulp and

testa, decreased during ripening and disappeared during fermentation. (25 references.) E. M. J.

Improved tea preparation. H. G. Furlong (B.P. 805,269, 2.2.56).—A method of manufacturing a leafless tea prep. comprises withering green tea leaves; boiling the withered leaves with water (preferably after pounding or disintegrating them); extracting the aq. liquor with ether or other suitable solvent; evaporating the aq. portion to dryness; powdering the resulting residue; and admixing the latter with product obtained by successively washing the solvent extract with water then evaporating the aq. washes. There is obtained a cryst. concentrate which with hot water forms a stimulating drink free from tea leaf or residue. F. R. Basford.

Milk, Dairy Products, Eggs

Use of plastics in food [industry]. V. Applicability of polyethylene for milk conduction tubes. F. Kiermeier and G. Schattenfroh (*Z. LebensmittUntersuch.*, 1959, **110**, 241—249; cf. J.S.F.A. Abstr., 1959, ii, 56).—In considering the use of polyethylene for making tubes to conduct milk, the chemical, physical and biological characteristics of the plastic are reviewed. No objection can be raised against its employment for this purpose. (27 references.) E. M. J.

Relations between composition and viscosity of cow's milk. C. P. Cox, Z. D. Hosking and L. N. Posener (*J. Dairy Res.*, 1959, **26**, 182—189).—Regression analyses confirmed that within the range of composition usually found for natural milk, the effective η of milk increased with increasing fat % at constant solids-not-fat content, and with increasing solids-not-fat contents at constant fat %. The analyses also showed appreciable differences between results. S. C. Jolly.

Citric acid content of milk in Mannitoba. A. Reinart and J. M. Nesbitt (*J. Dairy Res.*, 1959, **26**, 128—133).—The average citric acid content of bulk milk from ~10,000 cows was 0·172%, that of mixed milk of 35 Holsteins was 0·168%, and that of milk from individual cows was 0·171 to 0·189%; the respective coeff. of variation were 3·49, 7·74 and 10·6 to 13·5. The citric acid content of milk during the grazing season was slightly lower and more variable than in the housing season, but was unaffected by stage of lactation or time of the day of the milking. The amount in milk from individual cows sometimes differed by 20% between successive milkings. S. C. Jolly.

Composition of sow's milk during lactation with particular reference to the relation between protein and lactose. G. A. Lodge (*J. Dairy Res.*, 1959, **26**, 134—139).—Changes occurring in the composition of sow's milk during the course of 24 lactations are reported; the mean values for total solids, crude protein, lactose, fat and ash were 20·0, 5·7, 4·7, 8·6 and 0·89% respectively. Composition of milk differed between sows and between successive lactations, but differences were appreciable only for fat % between sows. Apart from the general trend for protein content to decrease with advancing lactation, the negative correlation ($P < 0{\cdot}001$; $r = -0{\cdot}62$) between % of protein and lactose was highly significant. S. C. Jolly.

Amino-acid content of goat's milk at different stages of lactation. T. Barnabas and R. B. Mawal (*Indian J. Dairy Sci.*, 1959, **12**, 63—67).—Changes in amino-acid composition of the milk of a goat up to 61 days after parturition were studied by paper chromatographic and microbiological assay methods. There was a progressive decrease in the values for total solids, fats and total N with advance in lactation. The values for glutamic acid, glycine and serine remained constant throughout the lactation period, the other amino-acids gave max. values on the first few days after parturition and thereafter the values generally decreased with advance in lactation. (15 references.) I. Dickinson.

Effect of heat on the vitamin B_6 of milk. I. Microbiological tests. M. E. Gregory. **II. Comparison of biological and microbiological tests of evaporated milk.** M. K. Davies, M. E. Gregory and K. M. Henry (*J. Dairy Res.*, 1959, **26**, 203—214, 215—220).—I. Approx. 80% of the vitamin-B_6 activity of raw milk is due to pyridoxal (**I**), the remainder being due to pyridoxamine (**II**). In the manufacture of evaporated milk, the **I** content decreased markedly, while that of **II** increased slightly, resulting in an overall loss of activity of ~60%. During storage at room temp. a further loss of activity occurred in evaporated and sterilised liquid milk. Most of the residual activity in the former was due to a substance other than **I** or **II**, possibly pyridoxine (**III**). Examination of the various microbiological methods for measuring vitamin-B_6 activity are described, and suitable procedures for milk are recommended.

II. Results of microbiological and biological assays for vitamin-B_6 activity in raw milk agreed within limits of experimental error, but for processed milk significant differences occurred between measurements made with *Saccharomyces carlsbergensis*, chicks and rats. All 3 methods indicated a 45 to 70% loss of activity on processing, and a further loss of 30% of the remainder after 6 months at room temp. For chicks and rats, **I**, **II** and **III** were equally active when given separately from the diet. No loss in activity occurred when **III** was mixed with the diet, but 20% of **II** and a variable amount of **I** were lost under these conditions. S. C. Jolly.

Effect of oxygen on various milk constituents. H. Lück and A. Schillinger (*Z. LebensmittUntersuch.*, 1959, **110**, 267—283).—The effects of O_2 on vitamins, whey proteins, amino-acids and reducing substances of milk were studied. In pasteurisation SH is slightly oxidised but oxidation is increased after intensive heat treatment or heat and O_2 pressure. Changes in whey protein ($\frac{1}{2}$ hr at 70° with and without 8 atm. O_2) show that O_2 hastens changes caused by heat. Cysteine, tyrosine, tryptophan and methionine were affected, but only when ascorbic acid was added at the same time. In milk pasteurised under 8 atm. of O_2, and stored for 1 month in darkness, the vitamins B_1, E_2, B_6 and E were not changed; there was a loss of vitamin A and β-carotene of ~8% and of vitamin C, 100%. (48 references.) E. M. J.

Estimation of total solids and solids-not-fat of milk from density and fat contents. S. J. Rowland and A. W. Wagstaff (*J. Dairy Res.*, 1959, **26**, 83—87).—From examination of 2425 milk samples, the total solids (T) and solids-not-fat (S) contents estimated from the density (D) and fat content (F) by the method specified in B.S. 734 : 1934 were lower, on average, by 0·06% than those determined gravimetrically. It was to correct for this error and to compensate for the lower and more accurate F arising from the recent reduction in the capacity of the Gerber milk pipette that the formulae in the standard were modified in 1955 to $T = 0{\cdot}25D + 1{\cdot}22F + 0{\cdot}72$ and $S = 0{\cdot}25D + 0{\cdot}22F + 0{\cdot}72$. S. C. Jolly.

Anoptal contrast microscopy of casein in milk, condensed milk and milk powder. N. King (*J. Dairy Res.*, 1959, **26**, 140—143).—Descriptions, supplemented with photomicrographs, are given of the appearance of casein particles >0·1 to 0·2 μ in diameter when viewed by anoptal contrast, a modification of phase-contrast microscopy. The different aggregation and coagulation forms of casein comprised irregular flocks of aggregated particles, thin membranes and micro-fibres, nodulated or smooth. S. C. Jolly.

Reaction of lactose with anthrone and its application to the estimation of lactose in casein and other dairy products. E. L. Richards (*J. Dairy Res.*, 1959, **26**, 53—57).—Lactose was estimated accurately and rapidly in casein by use of the anthrone colorimetric method on the clear filtrate from the pptn. of a $NaHCO_3$ solution of the casein with 0·1N-H_2SO_4. Almost complete recoveries of added lactose were obtained, and the results by this method were in all cases higher than those given by the British Standard method (B.S. 1417 : 1948). The results were also higher (on average ~0·07%) than were those by the Cu-reduction method for the determination of lactose in milk. S. C. Jolly.

Proposed method for the rapid determination of lactose in separated milk and condensed whey by infra-red absorption. J. D. S. Goulden (*J. Dairy Res.*, 1959, **26**, 151—156).—The lactose concn. in separated milk can be determined rapidly with an accuracy of $\pm 1{\cdot}5\%$ by absorption measurements at wavelengths in the 10μ region. The method is also applicable to condensed whey, and is probably adaptable to continuous recording. S. C. Jolly.

Rate of mineral removal from milk by ion exchange. S. J. Bishov, A. S. Henick and J. H. Mitchell, jun. (*Food Res.*, 1959, **24**, 428—433).—Quant. relations for the rates of removal of the major mineral ions from milk by mixed bed ion-exchange system have been established; effects on rates and degree of Ca removed from milk by means of resinous ion exchangers through columns of varying diameter, resin bed, height and milk downflow rates are described. Procedures using ion-exchange process charts and nomographs are described. Extent of decalcification to within $\pm 5\%$ over a wide range of variables is determined. (15 references.) E. M. J.

Removal of strontium and caesium from milk. B. B. Migicovsky (*Canad. J. Biochem. Physiol.*, 1959, **37**, 1287—1292).—^{89}Sr added to cow's milk was removed (96%) by stirring 20 ml. of milk 3 times with 1 g. of Ca-saturated cation-exchange resin. Shaking twice with 0·5 g. of resin was more effective than shaking once with 1 g. Duration of stirring was relatively unimportant. Concn. of Sr did not affect the % removed. Sr entering guinea-pig's milk after intraperitoneal injection was removed as efficiently as added Sr. Added ^{137}Cs was removed (92%) by two treatments with resin. Some K and Na were removed from milk by the resin, and some Ca

was added. Resin previously equilibrated with a solution containing Ca, K and Na chlorides in the same cation proportions as in milk removed added Sr without affecting the concn. of Ca, K or Na. M. D. ANDERSON.

Frozen concentrate of *Lactobacillus acidophilus* for preparation of a palatable acidophilus milk. D. E. Duggan, A. W. Anderson and P. R. Elliker (*Food Technol.*, 1959, **13,** 465—469).—A supplemented whey medium which supports excellent growth and permits efficient recovery of the cells by centrifugation, is described. Such cells may be " quick frozen " and stored for 6 months with only slight loss of vitality. (25 references.) E. M. J.

Differential media for lactobacilli. M. E. Sharpe (*J. Sci. Fd Agric.*, 1959, **10,** 674 ; *J. Dairy Res.*, 1958, **25,** 92, 421).—Selective media evolved by different workers to isolate and enumerate lactobacilli from various natural habitats are described. Selective action is based on suppression of other micro-organisms by a high concn. of acetate and low pH (5·4) in the medium, and growth of lactobacilli is stimulated by presence of oleate. Lactobacilli have been isolated and enumerated from faeces, silage, cheese, milk, air, etc., with complete suppression of large no. of streptococci, micrococci, Gram-negative rods which may be found in these habitats. E. M. J.

Physical changes in milk caused by the action of rennet. IV. Effects of varying rennet concentration and temperature. V. Effects of varying concentrations of milk powder and of low temperature pretreatment. G. W. Scott Blair and J. Burnett (*J. Dairy Res.*, 1959, **26,** 58—62, 144—150).—IV. The increase in the overall rigidity modulus of curd when the time after renneting was doubled varied inversely with the cube root of the rennet concn. With normal rennet concn. some rheological parameters increased or decreased progressively as temp. was increased from 21° to 41° ; others passed through max. or min., all between 29° and 35°. Creep and slow recovery increased progressively with temp. in this range. Although relaxation times showed the simplest distribution at 32°, they were too readily affected by unavoidable differences in firmness at different temp. to assess their temp. dependence.

V. The elastic and viscous setting parameters of the curd formed by the action of rennet on reconstituted skim milk in the presence of $CaCl_2$ progressively increased with increasing concn. of the fat-free milk powder. These changes were related mainly to changes in protein concn., the addition of fairly large amounts of lactose having little effect. When renneted milk was kept for 1·5 hr. at 2° before raising to 21° to 38°, there was considerable delay before the normal equation of setting was established in the curd. As in the normal process of setting, high temp. were detrimental to setting. S. C. JOLLY.

Rennet and its action on casein of milk. XIII. Peptides liberated by rennet. H. Nitschmann and R. Henzi (*Helv. chim. Acta*, 1959, **42,** 1985—1995).—A neutral Na caseinate solution was treated with rennet, the paracasein pptd. at pH 4·7 and the supernatant subjected to paper chromatography. A macropeptide (mol. wt. ~8000) and eight smaller peptides were isolated. The former is produced more slowly than the latter, and only after a short induction period. From α-casein, the macropeptide and only four smaller peptides were isolated. The release of the macropeptide from the casein complex as a consequence of rennin action may be responsible for the instability of the colloidal dispersion of the Ca caseinate particles in natural or reconstituted milk. (17 references.) A. G. COOPER.

Steam distillation of taints from cream. IV. Vapour/liquid equilibrium relations for mesityl oxide and some α-diketones as possible reference substances. V. Vapour/liquid equilibrium relations for some α-diketones in lactose solution. VI. Butterfat/lactose-solution distribution coefficients of some reference substances. VII. Butterfat/water distribution coefficients in relation to vapour/liquid equilibrium coefficients for tainting substances in cream. VIII. Effect of fat content of dairy product on deodorisation process. F. H. McDowall (*J. Dairy Res.*, 1959, **26,** 24—32, 33—38, 39—45, 46—52, 113—122).—IV. Vapour/liquid equilibrium relations in the steam distillation of dil. aq. mesityl oxide, acetylpropionyl (**I**), acetylisobutyryl (**II**), acetylvaleryl (**III**), acetylcaproyl (**IV**), and acetylbenzoyl (**V**) are reported. Only diacetyl (**VI**), **I** and, with restrictions, **V** are suitable for use as reference substance in detailed investigations on cream deodorisation equipment.

V. The presence of 4·5% of lactose in solutions did not appreciably affect the vapour/liquid equilibrium relations for **I** and **V** ; for **IV** the equilibrium coeff. was lowered. At low concn. of **II** (>4 p.p.m.) and **III** (<3 p.p.m.) the coeff. was lowered by lactose, but at higher concn. of **II** it was unaffected and at higher concn. of **III** it was raised. Variation of the lactose concn. over the range 0·5 to 10·0% had little effect on the equilibrium coeff. for **I** and **V**, but it progressively reduced that for **II**, **III** and **IV**.

VI. The coeff. of distribution for acetoin (**VII**), **I** and **VI** between butterfat and skim milk increased linearly with temp. up to 190°F. That for **II**, **III**, **IV** and **V** between butterfat and 4·5% lactose solution at 100° are also reported. The distribution coeff. for **I** and **VI** were unaffected by the concn. of **I** and **VI** in the lactose solution.

VII. The relation between the vapour/liquid equilibrium coeff. for a tainting substance in cream (m_c) compared with the coeff. for the substance in skim milk (m_s) at 100° is given by : $m_c = 100m_s/\{100 - F(1 - k)\}$, where F is the fat % in the cream and k is the butterfat/skim-milk distribution coeff. at 100°. Calculated values for m_c for **I**, **II**, **III**, **IV**, **V**, **VI** and **VII** agreed well with experimental results for these substances in cream. High solubility of a substance in butterfat relative to that in skim milk greatly reduced the steam volatility of a substance from cream ; this volatility may be affected also by temp. of deodorisation, due to the effect of temp. on the butterfat/skim-milk distribution coeff.

VIII. Increase in the fat content of cream (*a*) increased the vapour/liquid equilibrium coeff. in cream for tainting substances of low butterfat/skim-milk distribution ratios and decreased the coeff. for substances of high distribution ratios, and (*b*) reduced the amount of tainting substance in the cream per unit wt. of butterfat in the cream for substances of all distribution ratios. Separation of milk to give cream of high fat content greatly facilitated elimination of substances of low distribution ratios from the cream and butter. Variation in temp. of separation may affect the concn. of tainting substances in the final cream. Fat content of cream affected the proportion of residual taint passing from the treated cream into the butter in the churning process. The threshold concn. for a tainting substance in butter will probably vary with the rate of salting of the butter, because of the effect of salt in increasing the vapour/liquid equilibrium coeff. of some steam-volatile substances. S. C. JOLLY.

Influence of temperature treatment and season on the dilatometric behaviour of butterfat. J. M. DeMan and F. W. Wood (*J. Dairy Res.*, 1959, **26,** 17—23).—Increasing the cooling rate of melted butterfat increased the solid-fat content (C) of the solidified fat, which was consistent with the formation of mixed crystals. Similar values for C were obtained when the melted fat was cooled in a bath at either 5° or 0°, indicative of an optimum cooling rate beyond which no further increase in C occurs. Differences in cooling rate affected mainly the proportion of glycerides of low m.p. Seasonal variations in C indicated relatively large differences in the content of high-melting glycerides. Butter hardness was influenced apparently not only by C but also by the composition of the crystals. Mixed crystals in butterfat can be recrystallised at 22·5°, thereby reducing C. S. C. JOLLY.

Isolation and identification of high-molecular-weight saturated fatty acids of butterfat. R. P. Hansen, F. B. Shortland and N. J. Cooke (*J. Dairy Res.*, 1959, **26,** 190—195).—By fractional crystallisation and column procedures, resulting in the isolation and examination of their chemical and physical properties, the presence of n-eicosanoic (arachidic), n-heneicosanic, n-docosanoic (behenic), n-tricosanoic and tetracosanoic (lignoceric) acids in butterfat was established, and the presence of n-hexacosanoic (cerotic) acid was confirmed. n-Nonadecanoic and n-octadecanoic (stearic) acids were also found. The presence of all saturated fatty acids from n-C_{10} to n-C_{26}, except n-C_{25}, which is probably present in trace amounts, has now been reported. S. C. JOLLY.

Working up freezing cream with butter. F. Kiermeier and C. Kayser (*Z. LebensmittUntersuch.*, 1959, **110,** 168—177).—Model experiments with frozen cream show that on thawing out and dissolving in milk a homogeneous mixture cannot be obtained. The use of churned freezing cream in the prep. of butter gives a product of fine structure but a microtome section of the butter shows numerous large fat drops, whereas normal winter butter has a uniform fat structure. The keeping qualities of the cream are limited and after storage for a year oxidative changes and off flavours are observed. Packaging in polyethylene in deep-freeze storage does not affect the quality and bacterial counts are satisfactory. The practice of adding this stored summer cream to winter butter is discussed, especially in regard to a possible depreciation in quality. (28 references.) E. M. J.

Heat resistance of lactobacilli from English Cheddar cheese. K. D. Perry and M. E. Sharpe (*J. Dairy Res.*, 1959, **26,** 72—76).—Heat resistance of lactobacilli, previously isolated from Cheddar cheese, to laboratory pasteurisation at 140°F for 10 sec. varied in a manner unrelated to spp. ; when the temp. was increased to 150°F, 99·55% of all strains were destroyed. With commercial pasteurisation at 155°F for 17 sec., almost complete destruction occurred ; heating at 160°F for 17 sec. destroyed 100% of all strains of lactobacilli. S. C. JOLLY.

Microscopical observations on Cheddar cheese and curd. M. R. Dean, N. J. Berridge and L. A. Mabbitt (*J. Dairy Res.*, 1959, **26,** 77—82).—The microscopical appearance of curd in sections cut in

a freezing microtome after fixation in formaldehyde are described with the aid of photomicrographs. As cheese ripening proceeded the finer structures tended to disappear. The distribution of bacteria in curd was markedly uneven. Colonies of bacteria were found only in crevices. S. C. JOLLY.

Making Cheddar cheese on a small scale under controlled bacteriological conditions. L. A. Mabbitt, H. R. Chapman and M. E. Sharpe (*J. Dairy Res.*, 1959, **26**, 105—112).—A cover is described for a 40-gal. cheese vat which allows cheese to be made under aseptic conditions. This technique permitted Cheddar cheese in which no lactobacilli grew during ripening to be made with lactobacillus-free milk, thus providing a means of assessing the rôle of these and other micro-organisms in cheese ripening. S. C. JOLLY.

Factors influencing the lactic acid-producing properties of streptococci used in the manufacture of Cheddar cheese. II. Observations relating susceptibility with insusceptibility. G. R. Jago and M. F. Swinbourne (*J. Dairy Res.*, 1959, **26**, 123—127).—Continuous growth of lactic streptococci in autoclaved milk (*A*) allowed strains originally insusceptible to become susceptible to inhibition by raw milk (*R*). Variants of the original organisms, the growth of which was inhibited in *R* but not in *A*, appeared to predominate in strains maintained in *A*. The time required for these changes to occur in *A* varied with the strain used. S. C. JOLLY.

Lactobacilli in Cheddar cheese. C. K. Johns and S. E. Cole (*J. Dairy Res.*, 1959, **26**, 157—161).—Lactobacilli in 38 experimental Cheddar cheeses multiplied rapidly, even during the first few days of curing, and the no. reached max. in 3 to 6 months; in 1 year, the no. had declined appreciably. Flavour intensity of the cheeses was apparently correlated with no. of lactobacilli in (*a*) milk at the start of cheesemaking, and (*b*) cheese during ripening; these two counts were usually correlated closely. Flavour was most intense in cheese made from raw factory milk, which had the highest counts, followed by that in cheese made from similar milk which had been pasteurised and inoculated with selected strains of lactobacilli. S. C. JOLLY.

Chemical changes occurring in Domiati cheese during pickling. Hassan A. Sharara (*Indian J. Dairy Sci.*, 1952, **12**, 77—85).—Moisture content of (Domiati) cow's milk cheese and buffalo cheese decreased with ageing and the cows' milk cheese retained the greater amount of water and had the higher acidity content. The % of fat increased with storage and was slightly higher in buffalo milk cheese. Cows' milk cheese contained the greater amount of total N and sol. N and the values decreased as the ripening period was prolonged. In both kinds of cheese the max. sol. N content and ratio of sol. N to total N was at the end of the pickling period and the non-protein-N increased gradually throughout ripening. Buffalo milk cheese contained the smaller amount of Cl which decreased and the greater amount of Ca and P which increased throughout pickling. (11 references.) I. DICKINSON.

Effect of u.v. irradiation on micro-organisms important in cheese making. II. Dehydrogenase system of *Penicillium camemberti*, var. *candidum* and its behaviour against u.v. rays. J. Schormüller and H. Mahler (*Z. LebensmittUntersuch.*, 1959, **110**, 183—196; cf. J.S.F.A. Abstr., 1958, ii, 286).—The dehydrogenase system of *P. candidum* was studied by the Warburg and tetrazolium techniques; the methods were compared with regard to their activity and limits of application. Individual dehydrogenases were characterised at first by their behaviour against effects (inhibitors, vitamins and coferments). Org. solvents, surface active agents and u.v. rays in high dosage decrease the dehydrogenase activity, and in low concn. increase the fermentation activity. If u.v. radiation is applied in low dosage so that little damage is done to the dehydrogenases but permeability of the cell wall is increased, an activation of enzymes concerned in the citric acid cycle is attained and this is made use of in specific substrate experiments. The availability of this cycle for acetate metabolism of *P. candidum* is shown. (39 references.) E. M. J.

Effect of various salts on the coagulation of casein. D. Rose and H. Tessier (*J. Dairy Sci.*, 1959, **42**, 989—997).—Addition of KCl or NaCl (80 or 130 mM) had a stabilising effect on skim milk held in frozen storage; addition of Ca^{2+} or PO_4^{3-} (10mM) had the opposite effect. Addition of a large amount of NaCl (>1·0M) offset the destabilising action of Ca^{2+} and PO_4^{3-} at 0°, 10° and 20°F, but KCl in similar amounts was effective only at 10° and 20°F. Addition of KCl (<1·0M) and of PO_4^{3-} (<100mM) induced gelation of milk at room temp., but addition of NaCl and PO_4^{3-} did not. Addition of either KCl or NaCl (2·3M) solubilised ~20% of the insol. Ca and 7·5% of the insol. PO_4^{3-}, displaced Ca from casein and increased the dissociation of Ca citrate. A possible explanation, based on the interlinking of K–Ca–caseinate micelles by precipitating Ca phosphate, is suggested. S. C. JOLLY.

Tritium-radioactive-casein and cheese ripening. A. G. Wolin and F. V. Kosikowski (*J. Dairy Sci.*, 1959, **42**, 998—1007).—^{3}H-labelled casein, containing 6 mc. per g., was prepared by the gas-exposure technique. The ^{3}H entered randomly into the various amino-groups. The presence of the labelled casein had no effect on cheese ripening; changes in free amino-acids, rate of acid formation, and sol. N were similar to those in normal cheese. ^{3}H was detected in two carbonyl compounds isolated from ripe cheese, indicating protein as a possible source of these compounds. Labelling with ^{3}H may also be applicable to degradation studies of compounds other than casein in cheese. S. C. JOLLY.

Flavour of creamed cottage cheese. D. W. Mather and F. J. Babel (*J. Dairy Sci.*, 1959, **42**, 809—815).—During cottage cheese manufacture by the long-set method, the whey contained considerably more citric acid, lactose, diacetyl (**I**) and acetylmethylcarbinol than did the curd, but at the time of cutting the curd a proportionate amount of **I** was retained in the cheese. The max. amount of **I** capable of being produced by a lactic culture was not attained at the time of cutting the curd (pH 4·7). Addition of citric acid alone to a creaming mixture for cottage cheese did not increase the content of diacetyl in cheese held at 45°F; when lactic culture was also added the content of **I** increased, but a sour flavour was evident after a few days. Nearly 75% of 41 commercial cheeses from retail stores contained <1 p.p.m. of **I**, the content of which varied from 0 to 3·2 p.p.m. S. C. JOLLY.

Method for standardising the diacetyl content of creamed cottage cheese. D. W. Mather and F. J. Babel (*J. Dairy Sci.*, 1959, **42**, 1045—1056).—Addition of *Streptococcus citrovorus* (*S*) to creamed cottage cheese slightly increased diacetyl (**I**) content; the increase was greater when 0·15% of citric acid (**II**) was also added, although **II** alone was without effect. No **I** formed in a 12%-fat creaming mixture containing *S* or *S* and **II**. Considerable amounts of **I** formed in a mixture containing large no. of *S* after adjustment of the pH to 4·2 with **II** and holding at 70°F; the initial **I** content of cheese creamed with such a mixture was high. A method of preparing a creaming mixture containing sufficient **I** and volatile acid to affect the flavour of creamed cottage cheese is described. S. C. JOLLY.

Tests to measure syneresis and firmness of cottage cheese coagulum, and their application in the curd-making process. D. B. Emmons, W. V. Price and A. M. Swanson (*J. Dairy Sci.*, 1959, **42**, 866—869).—A series of tests based on measurement of curd firmness and drainage failed to assess reliably the suitability of batches of skim milk powder for making cottage cheese. Drainage and curd strength at cutting tended to vary directly, but not uniformly, with acidity of coagulum at cutting and with amount of rennet used. Increased total solids in skim milk increased curd strength but decreased drainage. S. C. JOLLY.

Effect of skim milk heat-treatments on cottage cheese manufacture. D. B. Emmons, A. M. Swanson and W. V. Price (*J. Dairy Sci.*, 1959, **42**, 1020—1031).—Addition of 0·02% of $CaCl_2$ to the milk did not improve cottage cheese made from pasteurised skim milk, from skim milk heated at 175°F for 30 min., and from "low-heat" and "bakery-type" skim milk powders. Heat treatments of conc. skim milk, such as might occur in condensing or drying, had no effect on solubility of whey proteins, but they did decrease the strength of casein coagulum and impaired the cheesemaking properties of the milk after reconstitution. Cottage cheese of good commercial quality was prepared from skim milk heated at 175°F for 30 min. to denature whey proteins by using 20 ml. of rennet per 1000 lb. of milk and cutting at the A–C end-point; yields of curd were increased by ~10% and time to cutting the curd decreased, but quality was less consistently good than was that of "low-heat" controls. S. C. JOLLY.

Simplification of standard methods for salt analysis in cheese. G. J. Silverman, A. G. Wolin and F. V. Kosikowski (*J. Dairy Sci.*, 1959, **42**, 1095—1096).—In order to eliminate the need for separation of the pptd. AgCl by decantation or filtration in the A.O.A.C. and other methods recommended for determination of salt in cheese, it is suggested that nitrobenzene be added to the titration liquid and the titration be performed in the presence of the coated AgCl ppt. No loss in accuracy results. S. C. JOLLY.

***Staphylococcus aureus* in Cheddar cheese.** I. Takahashi and C. K. Johns (*J. Dairy Sci.*, 1959, **42**, 1032—1037).—Growth of staphylococci was rapid at 32° and moderate at 22° in milk with a low standard plate count, but was negligible, even at 32°, in milk with a high standard count. Large no. of staphylococci might therefore develop in bacteriologically clean milk held at fairly high temp. Staphylococci grew poorly during cheese making and most were concentrated in the curd; the initial staphylococcal count of milk was apparently the most important factor in determining the no.

in cheese. Prompt cooling of milk after milking and heat treatment before cheese making are recommended. S. C. JOLLY.

Interrelations between pH, populations of *Propionibacterium shermanii*, levels of free fatty acids and flavour ratings of Swiss cheese. F. E. Kurtz, J. A. Hupper, E. A. Corbin, R. E. Hargrove and H. E. Walter (*J. Dairy Sci.*, 1959, **42**, 1008—1019).—In normal experimental Swiss cheeses, pH off the press (an experimentally induced variation) varied from 4·95 to 5·37, max. population of *Propionibacterium shermanii* varied from 145×10^6 to 2100×10^6 per g., and max. levels of acetic, propionic, butyric and higher acids varied from 38 to 59, 44 to 104, 6 to 40, 22 to 48 μM per g. respectively during a year. With added Na propionate, pH and *P. shermanii* population increased, but propionic acid produced decreased. Levels of acetic acid were higher in commercial cheeses. pH off the press and growth of *P. shermanii* were significantly related, and so were max. level of propionic acid and both max. population of the bacteria and population–time intergals. All relations involving "sweet flavour" component were without significance, and all except one (the relation to propionic acid level) of those involving the "nutty flavour" component were either of doubtful or of no significance. Compounds other than propionic acid, which was a component of the flavour complex, are apparently responsible for both the sweet and nutty characteristics of typical Swiss cheese flavour. S. C. JOLLY.

Influence of temperature history on the response of psychrophiles to different incubation temperatures. V. W. Greene (*J. Dairy Sci.*, 1959, **42**, 1097—1099).—The incubation temp. of mother cultures of the psychrophile *Pseudomonas fluorescens* had a definite effect on the response of sub-cultures to their subsequent temp. Growth at 20° was better when the subcultures came from mother cultures at 5° and 20° than from those at 37°; incubation at 5° favoured subcultures at 5° and incubation at 37° favoured subcultures at 37°. Exposure to 2° followed by exposure to 8° resulted in higher counts than did exposure to the lower temp. following exposure to the higher temp. In studies on psychrophiles, consideration must be given therefore to their temp. histories. S. C. JOLLY.

Factors affecting the dispersibility of whole egg solids in water. G. A. Miller, E. M. Jones and P. J. Aldrich (*Food Res.*, 1959, **24**, 579—583).—The effects of water temp. and method of mixing on optimum dispersibility in the hydration of spray-dried whole-egg solids were studied. Methods in which (*a*) water was added in three, (*b*) in two portions and (*c*) all the water was added to the egg solids before blending, with temp. of water ranging from 45—21°, produced the greatest % dispersibility with equally effective results. E. M. J.

Comparison of the gelation properties and palatability of shell eggs, frozen whole eggs and whole egg solids in standard baked custard. G. A. Miller, E. M. Jones and P. J. Aldrich (*Food Res.*, 1959, **24**, 584—594).—Objective and subjective measurements showed that an internal temp. of 86—88° produced optimum gelation in shell, homogenised frozen and blended frozen egg custards. Dried egg custards baked to the same internal temp. were not comparable in firmness with that of custards made with shell or frozen eggs. For quality of crust, inside colour, aroma and flavour, custards made with egg solids were significantly different from and somewhat less desirable than custards made from shell and from frozen eggs. (10 references.) E. M. J.

Lysozyme studies on chicken egg chalazae. R. C. Baker, S. E. Hartsell and W. J. Stadelman (*Food Res.*, 1959, **24**, 529—538).—The turbimetric method of assay for lysozyme as described by Smolelis and Hartsell (*J. Bact.*, 1949, **58**, 713—736) is satisfactory for prepared chalazae cords. A phosphate buffer at pH 7·2 at room temp. allowed greater lysozyme activity than the same buffer at pH 6·2. The lysozyme content of the chalazae cords was 2—3 times higher than that of the albumin, and differed in concn. in different strains of chickens. *Proteus vulgaris* and *Serratia marcescens* produce a "mucinase" which increases the lytic activity of the chalazae in both cultures. (15 references.) E. M. J.

Enzymes, including phospholipases, in eggs and dried egg products. L. Acker and E. Lück (*Dtsch. LebensmittRdsch.*, 1959, **55**, 242—245).—Present knowledge of the occurrence of enzymes, including lipases, phospholipases, phosphatases and proteinases in eggs and egg products, is reviewed, and storage tests on dried egg-yolk are reported. A significant drop in lecithin content after one month and mould growth after 90 days were found on storage at 75% relative humidity, but at humidities below 65% no drop in lecithin content was observed over a period of 5 months. Free choline also notably increased during storage at 75% R.H. due to phospholipase activity. The enzymic activity is concluded to be of microbiological origin and, in efficiently dried products, only becomes important in conditions favourable for the multiplication of micro-organisms. (36 references.) E. C. APLING.

Steam distillation treatment of liquids. Murray Deodorisers Ltd. (B.P. 798,970, 19.1.56. N.Z., 20.1.55).—Volatile substances are continuously removed from liquids (milk or cream) by passing the liquid successively through a series of steam distillation stages. Steam from an extraneous source is admitted directly into several of the distillation stages, the used steam being re-used in earlier distillation stages of the series. The arrangement is such that less steam is required than when it is introduced at a single point in the series of stages. J. M. JACOBS.

Edible Oils and Fats

Carbonyls in oxidising fat. II. Identity and amounts of steam-volatile monocarbonyls in a rancid freezer-stored pork fat. A. M. Gaddis and R. Ellis (*Food Res.*, 1959, **24**, 392—400).—Heating at 165° influenced not only the amount but the kind of monocarbonyls detectable. n-Alkanals C_1, C_2, C_3, C_6, C_9, three unknown carbonyls, alk-2-enals C_7, C_8, C_9, C_{10}, C_{11} and alk-2,4-dienals C_7, C_9, C_{10} C_{11} were found in the unheated fat. In the heated fat, n-alkanals C_6, C_8, C_9, alk-2-enals C_7, C_8, C_9, C_{10}, C_{11} and alk-2,4-dienals C_7, C_{10}, C_{11} were observed. Quant., hexanal and deca-2,4-dienal were the dominant compounds present. (14 references.) E. M. J.

Autoxidative changes in unsaponifiable matter in butcher's fat. A. Mirna (*Fette Seif. Anstrichm.*, 1959, **61**, 1163—1169).—Unsaponifiable matter from fresh abattoir fats shows no selective absorption in the 210—330 mμ band. After autoxidation, maxima occur at 230 and 270 mμ, and indicate presence of compounds with two conjugated double bonds; these may be derived from α- and β-carbonyl compounds formed by the oxidation of unsaturated compounds. Consequently, fats which have a low peroxide value, but changed u.v. absorption spectra of the unsaponifiable matter, are not necessarily of acceptable quality. (20 references.) G. R. WHALLEY.

Detection of butylated hydroxyanisole in fats. J. Wurziger and U. Chandra (*Dtsch. LebensmittRdsch.*, 1959, **55**, 281).—The colour reaction with 2,6-dichloroquinone chloroimide is not specific for BHA, but the presence of BHA may be confirmed by means of its colour reaction with alcoholic KOH. Gallates, nordihydroguaiaretic acid and butylated hydroxytoluene also give red colours with alcoholic KOH, but the colour due to gallates rapidly changes to yellow-brown, that due to NDGA changes to yellow-brown on heating and the colour due to BHT is ether-sol. To detect BHA the fat (5 g.) is refluxed with 2N-alcoholic KOH (20 ml.) for 2 hr., added to water (10 ml.) and cooled. In presence of over 0·004% BHA a pink to red colour slowly develops, with a max. after 12 hr. Lesser quantities may be detected by alkali treatment of an alcoholic extract of the fat. If the saponified solution is dark brown, or for final confirmation, set aside for 12 hr. and pass the solution through a 10 cm. column of alumina. In presence of BHA the effluent is pink or red. E. C. APLING.

Inversion effects with fat-antioxidants. II. Effects with α-tocopherol. W. Heimann and H. v. Pezold (*Z. LebensmittUntersuch.*, 1959, **111**, 1—6; cf. J.S.F.A. Abstr., 1959, i, 223).—In experiments with lard incubated at 100°, the antioxidative effects of α-tocopherol are reduced or reversed when comparatively large doses (>0·1%) are added at the beginning of the experiment, but not when the same doses are added in 2—4 portions during the course of the experiment. With smaller doses, the results are not affected by the method of addition. The oxidation products of α-tocopherol, α-tocopherylquinone or chroman-5,6-quinone cause no inversion. Inversion is probably caused by the presence of large excesses of α-tocopherol. A theory concerning the reaction-mechanisms involved is proposed to account for the observed facts. (13 references.) P. S. ARUP.

Isomers of vitamin A in fish-liver oils. P. S. Brown, W. P. Blum and M. H. Stern (*Nature, Lond.*, 1959, **184**, 1377—1379).—Presence of iso-*a* and iso-*b* in the vitamin A of cod, shark and mixed-fish liver oils has been established by means of reaction with opsin after oxidation of the vitamin to retinene. Concn. of the two isomers is 19—26% of total vitamin A, and is approx. the same for synthetic isomers prepared by equilibrating retinene *in vitro* with dil. HCl; mean ratio of iso-*a* : iso-*b* varies from 2 : 1 to 4 : 1. Nomenclature, structure and biopotencies are listed, origin is discussed briefly, and the experimental procedures are described. Interference from neo-*b* retinene is not serious as this isomer does not occur outside the eye; the i.r. assay was used for three samples. W. J. BAKER.

Nephelometric detection of lipids in chromatographic column effluents. A. C. Arcus (*Analyt. Chem.*, 1959, **31**, 1618—1620).—The lipid (<1 mg.) in methanol is precipitated by slow and con-

trolled addition of water, and the suspension is examined in a nephelometer. Cholesterol (2 μg.) can be detected and larger amounts can be determined semi-quant. The method has been used to show the presence of at least 17 components in the unsaponifiable matter of cod-liver oil. A. R. ROGERS.

Biogenesis of oil in ripening coconut and arecanut. A. R. S. Kartha, A. S. Sethi and R. Narayanan (*J. sci. industr. Res.*, 1959, **18C**, 172—175).—Free acids present in appreciable amounts in the crude fats of coconuts and arecanuts during the earlier stages of ripening do not include butyric acid or higher fatty acids. These two monocotyledons resemble dicotyledons in this respect. The I val. of the fats fell during ripening from 21·2 to 5·2 for coconut, and 103·0 to 37·0 for arecanut. Large amounts of lauric and myristic acids are formed during the later stages of ripening. The chain-length regulating systems in the fat depots are apparently synthesised as a collection of independent units; unlike the desaturating systems, they are not affected by temp. (15 references.) M. D. ANDERSON.

Colour of oils and bleaching by earths. M. Naudet (*Rev. Ferment.*, 1959, **14**, 154—160).—The method of estimating colour in oils by the three-colour system is described. The estimation of colour by the Lovibond tintometer and by transmission spectra is not sufficiently accurate. Much of the colour and dullness in oil is removed during refining and neutralising, but for the remainder, mainly carotenoids and chlorophylls, the treatment is adsorption by earths. The temp. of the oil, degree of agitation, and amount and composition of the earths used are important factors in the treatment. S. G. AYERST.

Effects of ionising radiation on fats. II. H. Lück and H. Kühn (*Z. LebensmittUntersuch.*, 1959, **110**, 430—442).—Oleic acid-ethyl-ether, olive oil, lard and two types of margarine were irradiated. [Van de Graaff Generator 2 MeV-Cathode rays, dosage 10^5, 10^6, 10^7, 10^8 r. (1 r = 100 erg/g. fat).] The peroxide value (Lea No.), acid value, I val., carbonyl groups and fatty acids (*trans*-form calculated as elaidic acid) were determined before and after irradiation. Margarine started to bleach at a dose of 10^6 r. and was completely bleached at 10^7—10^8 r., all fats, except lard, did not show any appreciable difference in taste or smell at 10^8 r. The I val. remained almost constant up to 10^7 r. Except in the case of lard, the other analytical figures remained stable and began to rise at 10^7 r. The i.r. spectra remained similar to those of normal fats and changed slightly after an irradiation of 10^7—10^8. (18 references.) I. DICKINSON.

Meat and Poultry

Estimation of percentage of fat and lean in edible portion of steer carcasses. W. H. Kennick (*Dissert. Abstr.*, 1959, **20**, 828).—Measurements were made on beef carcasses with a view to possible prediction of carcass composition. A multiple regression prediction equation, using wt. of fat in two side probes, and warm carcass wt., as independent variables, predicted % of protein in the edible portion of the 9–10–11 rib with a standard error of estimate of 0·71% of the protein content, and a multiple correlation coeff. (R^2) of 0·7349. A second equation, using % of fat area in the rib cross-section, and warm carcass wt., as independent variables, had a standard error of estimate of 2·16% of the fat content of the edible portion of the 9–10–11 rib, and a multiple correlation coeff. of 0·8830. M. D. ANDERSON.

Interrelationships of subjective, chemical and sensory evaluations of beef quality. D. H. Kropf and R. L. Graf (*Food Technol.*, 1959, **13**, 492—495).—Carcass lean muscle became coarse textured and darker coloured as the animal matured. Fat covering was closely related to marbling, lean firmness, colour of lean, tenderness, flavour and ether extract of loin eye. Sensory preference had a correlation coeff. of 0·53 (significant at the 5% level) to tenderness and correlation coeff. of 0·43 and 0·17 (non-significant at 5% level) to sensory flavour and juiciness respectively. Preference was significantly related to carcass length and wt. Other correlations were found. (10 references.) E. M. J.

Anti-autolytic effect of epinephrine in skeletal muscle: non-additive process for preservation of meat. C. Radouco-Thomas, C. Lataste-Dorolle, R. Zender, R. Busset, H. M. Meyer and R. F. Mouton (*Food Res.*, 1959, **24**, 453—482).—The ante-mortem administration of adrenaline was strongly preservative against post-mortem autolysis of skeletal muscle stored under aseptic and anaerobic conditions as judged by the action on muscle metabolism, structural integrity and organoleptic characteristics. A better meat, resistant to long storage, even in tropical countries, is produced; the process allows a more efficient meat distribution which can be further improved if associated with adequate physicochemical antimicrobial techniques. (10 references.) E. M. J.

Over-all assay and partial purification procedures for proteolytic enzymes in beef muscle. R. A. Sliwinski, D. M. Doty and W. A. Landmann (*J. agric. Fd Chem.*, 1959, **7**, 788—791).—Enzyme fractions from aq. extracts of autolysed homogenates of beef muscle were precipitated by 50 to 60% $(NH_4)_2SO_4$, and chromatographed on a column of diethylaminoethanol-modified cellulose anion-exchanger. A purified protease with an 18-fold increase in specific activity was obtained. Fractions were screened by the use of haemoglobin in 3M-urea as substrate, proteolytic activity being determined from the amount of tyrosine liberated in 4 hr. at pH 4·4 and 37°. (12 references.) M. D. ANDERSON.

Scoring for three components of tenderness to characterise differences among beef steaks. S. Cover (*Food Res.*, 1959, **24**, 564—573).—Four steaks from each of two cuts, from each of 55 animals were used, and each of the four steaks from a cut was cooked differently. Instead of obtaining a single score for tenderness, judges were able to distinguish successfully between the following components of tenderness: softness, friability and the tenderness of connective tissue. (17 references.) E. M. J.

Factors influencing radiation-induced chemical changes in raw beef. O. F. Batzer, R. A. Sliwinski, L. Chang, K. Pih, J. B. Fox, jun., D. M. Doty, A. M. Pearson and M. E. Spooner (*Food Technol.*, 1959, **13**, 501—508).—Of the effects of pre-irradiation ageing time and temp. and post-irradiation storage time and temp. on chemical changes, those of storage conditions and irradiation dosage were most significant. The product was not more acceptable after pre-irradiation ageing and post-irradiation storage. (11 references.) E. M. J.

Detection of amines produced on irradiation of beef. R. E. Burks, jun., E. B. Baker, P. Clark, J. Esslinger and J. C. Lacey, jun. (*J. agric. Fd Chem.*, 1959, **7**, 778—782).—Minced raw beef that had received 2·33 and 3·72 megarads of γ-radiation was freeze-dried. The condensate had the usual odour of irradiated meat, which was to some extent neutralised by addition of HCl to pH 2. The content of volatile bases in the beef increased with dose of radiation, from 364 p.p.m. (as NH_3) in control beef to 443 p.p.m. in that receiving the higher dose. Content of amines, estimated by reaction with ninhydrin, increased from 0·8 to 15 p.p.m. (as methylamine). NH_3 formed 92 to 95% of the total volatile bases. The presence of methylamine and ethylamine and at least four other amines was detected. (12 references.) M. D. ANDERSON.

Determination of volatile components of foodstuffs. Techniques, and their application to studies of irradiated beef. C. Merritt, jun., S. R. Bresnick, M. L. Bazinet, J. T. Walsh and P. Angelini (*J. agric. Fd Chem.*, 1959, **7**, 784—787).—The sample (200 to 500 g.) is brought to −196° and a pressure of 1 μ, and then allowed to warm to room temp.; volatile compounds are received in a flask at −196°. The condensate consists mainly of water and CO_2, with <1% of odorous compounds. CO_2 is separated by cooling the condensate to −140° and condensing CO_2 at −196°. Other components can be separated from water at −80°. The CO_2 fraction from meat was submitted to gas chromatography, and the compounds were identified by mass spectrometry as methyl mercaptan, dimethyl sulphide, methyl formate, acetaldehyde, acetone, methanol, ethanol and methyl ethyl ketone. The same fraction from irradiated meat contained larger amounts of these compounds, and also dimethyl disulphide, ethyl mercaptan and isobutyl mercaptan. M. D. ANDERSON.

Preparation and properties of methyl arachidonate from pork liver. O. S. Privett, R. P. Weber and E. C. Nickell (*J. Amer. Oil Chem. Soc.*, 1959, **36**, 443—449).—The isolation and identification of >20 fatty acids from vac. dried (10—15°) pork liver lipids are described. The fat (extracted with light petroleum, ethanol and ether) was saponified with alcoholic KOH and acid treated. Fractionation of the fatty acids or urea adducts by crystallisation, distillation and chromatography showed presence of palmitic 22·9, stearic 16·8, oleic 38·5, linoleic 5 and arachidonic 4·4%. The last named was isolated in 44% yield (purity 99%) as Me ester. Unknown isomers (1%) of linoleic, arachidonic and palmitoleic acids were also detected. Alkali-isomerisation analysis of Me arachidonate showed an absorption at 346 mμ for the resultant acid and different absorptivities from previous publication. Isolation of Me_2 glutarate and Me caproate after periodate/permanganate oxidation suggested double bonds were in 5, 8, 11 and 14 positions. (19 references.) P. M. KINGSTON.

Vitamin and amino-acid content of drip obtained on defrosting frozen pork. A. M. Pearson, R. G. West and R. W. Luecke (*Food Res.*, 1959, **24**, 515—519).—In the drip from thawing pork the % of B vitamins ranged from 4·15 of riboflavin to 10·69 of niacin, and of amino-acids from 7·15 of tryptophan to 11·08 of isoleucine. The losses seem to be associated not with solubility in water, but in part, to leaching of more complex substances. (18 references.) E. M. J.

Curing of ham : sodium chloride accumulation. I. Methods, effect of temperature, cations, muscles and solution concentration. H. E. Wistreich, R. E. Morse and L. J. Kenyon (*Food Technol.*, 1959, **13,** 441—443).—Accumulation values (**I**) (amount of aq. NaCl diffused into pork thigh muscles through 1 sq. cm. of contact area) were determined in mg./sq. cm. over a 24-hr. period. **I** increased directly with concn. of NaCl, by addition of $NaNO_2$ to the solution, and also with temp. E. M. J.

Quality of cured bacon in relation to *ante-mortem* treatment. I. Results of sugar feeding. II. Relationship between carbohydrate metabolites and curing yield. III. Effects on the colour of cured hams. J. Wismer-Pedersen (*Acta agric. scand.*, 1959, **9,** 69—90, 91—101, 102—109).—I. Feeding sugar to pigs a few hours before slaughter increased the yield of cured bacon and improved its keeping quality. Liver-wt. was increased and the glycogen content of the meat was raised, causing a lower pH 24 hr. after slaughter.

II. Loss of wt. during the curing and maturing of bacon was smaller in carcasses from sugar-fed pigs and was related to the accumulation of reducing sugars in the meat.

III. Hams from sugar-fed pigs were paler than those from control animals. Addition of polyphosphate to the cure improved the colour of the meat from both control and sugar-fed pigs.
A. G. POLLARD.

Influence of sodium chloride on toxin production and organoleptic breakdown in perishable cured meat inoculated with *Clostridium botulinum*. R. A. Greenberg, J. H. Silliker and L. D. Fatta (*Food Technol.*, 1959, **13,** 509—511).—Toxin formation by *Cl. botulinum* was observed in inoculated perishable cured meat with no accompanying organoleptic degradation of the product. In a perishable cured product the level of salt must be within the range in which botulism toxin formation is obviously broken down (below 6·25% brine or above 9%). (12 references.) E. M. J.

Fish

Composition of fresh-water fish. II. Comparative data for 21 species of lake and river fish. C. E. Thurston, M. E. Stansby, N. L. Karrick, D. T. Miyauchi and W. C. Clegg (*Food Res.*, 1959, **24,** 493—502).—In general the proximate composition was uniform, but exceptions demonstrate the wide variation in composition that may exist among the different species and among the individual fish within a single species. Eight of the 21 species were analysed for K and Na contents. E. M. J.

Fat content of preserved fish " with oil." L. Bertling (*Dtsch. LebensmittRdsch.*, 1959, **55,** 282).—Results obtained on 58 different products from 30 firms are reported. In 40 cases the fat content was over 15% and in 47 cases over 12%. In one sample of " herring-fillets in tomato sauce, with oil," the fat content of the liquid was only 4·1%. It is considered that the fat content in products labelled " with oil " should be not less than 12%. E. C. APLING.

Engineering aspects of recent research projects in preservation of fish. G. C. Eddie and S. F. Pearson (*Chem. & Ind.*, 1959, 1427—1435).—A review of pilot- and commercial-scale work at Torry Research Station on (i) shore-based quick freezing of consumer packs or packs for storage and further processing, (ii) plant and process for freezing fish at sea (a thermostatically controlled vertical-plate freezer operable in all weathers, and a large semi-freezer trawler competitive with trawlers using ice alone have been developed), (iii) freezer design and performance, (iv) design of cold stores, (v) chilling and stowage of fish, including control of bacterial spoilage.
W. J. BAKER.

Spices, Flavours, etc.

Chemical analysis of trade grades and by-products of pepper (*Piper nigrum* L.). C. T. Dwarakanath, T. N. Ramachandra Rao and D. S. Johar (*Food Sci., Mysore*, 1959, **8,** 351—352).—Analyses of Indian trade grades of pepper showed them to be above the specified standards for ash, and for ether and alcohol extracts. The ether and alcohol extracts of pepper infested with mould were not affected, and the pepper can be reclaimed by antifungal treatment. Insect-infested pepper, and trade wastes and by-products, also have high contents of " bite factor," and can be processed to give a new flavouring agent, " pepper-sal." M. D. ANDERSON.

Comparison of student preference panels with a household consumer panel. L. D. Calvin and L. A. Sather (*Food Technol.*, 1959, **13,** 469—472).—(18 references.) E. M. J.

An intensity-response method for the measurement of flavour intensity. J. E. Sinsheimer (*Food Res.*, 1959, **24,** 445—450).—The method is psychologically sound and offers decided statistical advantages. A flavour level in g. of flavour per vol. of solution with limits of error for the measurement is established and the method provides a determination of the panel's sensitivity or a given panel member's sensitivity together with the limits of error. E. M. J.

Odour difference test with applications to consumer preferences. V. Mrak, M. A. Amerine, C. S. Ough and G. A. Baker (*Food Res.*, 1959, **24,** 574—578).—Two odour difference experiments are presented which show that olfactory sensitivity varies so greatly that differences detected by some are never detected by others, with graduations between. E. M. J.

Methods of examination for odour and taste. I., II. G. Jellinek and H. D. Cremer (*Dtsch. LebensmittRdsch.*, 1959, **55,** 251—256, 275—277).—I. Available methods for the organisation of organoleptic tests are described and their application is discussed.

II. A summary of general considerations applicable to the organisation of organoleptic tests, with practical examples in relation to beer and fish. (15 references.) E. C. APLING.

Visual and eating preferences of consumer household panel for beef from Brahman-Hereford crossbreds and from Herefords. M. Dunsing (*Food Technol.*, 1959, **13,** 451—456). E. M. J.

Visual and eating preferences of consumers household panel for beef of different grades. M. Dunsing (*Food Res.*, 1959, **24,** 434—444). E. M. J.

Colouring matters

Natural pigments in foods. J. W. Haken (*Chem. Weekbl.*, 1959, **55,** 666—673).—A review covering colouring matters arising in foods or derived from the natural raw materials. (38 references.)
P. S. ARUP.

Artificial food colours. IV. Spectrophotometry of green, blue and violet water-soluble colours in acid, neutral and alkaline media. V. Circular paper chromatography of permitted water-soluble colours. L. Villanúa and (IV) A. Carballido, (V) M. T. Valdehita and R. García Olmedo (*An. Bromatologia*, 1959, **11,** 265—278, 287—300).—IV. Absorption max. and curves in acid, neutral and alkaline solution are reported graphically and in tabular form for the ten blue, green and violet water-sol. colours permitted by Spanish legislation for use in food products. (12 references.)

V. R_F values and the appearance of the bands under ordinary and u.v. light are tabulated for chromatograms conducted according to Rutter's technique. (14 references.) E. C. APLING.

Artificial food colours. Appendix to II, III and IV. A. Carballido and L. Villanúa (*An. Bromatologia*, 1959, **11,** 279—285).—Spectrophotometric data for certain colours dealt with in Parts II, III and IV are re-presented graphically, classified according to the colour of their solutions in acid or alkaline media. E. C. APLING.

The action of a fission product of the food colour azorubin on dichlorophenolindophenol (Tillman's reagent). J. Eisenbrand and H. W. Eich (*Dtsch. LebensmittRdsch.*, 1959, **55,** 240—241).—In lactic fermentations the food colour azorubin yields by reductive splitting naphthionic acid and 1-hydroxy-2-amino-naphthalene-4-sulphonic acid (**I**). Reaction of **I** with dichlorophenolindophenol is pH dependent. The oxidation products of **I** were studied by paper chromatography and the presence was shown of a reductone formed by removal of the sulphonic acid group from **I**. E. C. APLING.

Preservatives

Use of coating materials or film impregnated with chlortetracycline to enhance colour and storage life of fresh beef. J. C. Ayres (*Food Technol.*, 1959, **13,** 512—515).—(23 references.) E. M. J.

Comparison of the methods for applying Acronize chlortetracycline [CTC] to beef. M. C. Firman, H. J. Bachmann, F. J. Heyrich and P. F. Hopper (*Food Technol.*, 1959, **13,** 529—533).—While permission to use CTC in or upon meats has not yet been granted by the U.S. Government, from experimental data it may be concluded that the use of CTC applied directly as a spray to beef cuts or as an impregnated film will make " in plant " packaging of meat a possibility. CTC applied to meats by an injection to the live animal, as a carcass or retail cut spray, or as an impregnated film will also increase the period of saleability of meat packaged at the retail level. (22 references.) E. M. J.

Effect of storage and of cooking on chlortetracycline [CTC] residues in meat. O. I. Escanilla, A. F. Carlin and J. C. Ayres (*Food Technol.*, 1959, **13,** 520—524).—Regardless of treatment level of CTC or the temp. attained during cooking, the antibiotic in the meat was not reduced to undetectable amounts. (10 references.) E. M. J.

Food Processing, Refrigeration

Conduction errors in thermocouples used for heat penetration measurements in foods which heat by conduction. N. D. Cowell H. L. Evans, E. W. Hicks and J. D. Mellor (*Food Technol.*, 1959, **13,** 425—429).—Data support the principle of Ecklund (J.S.F.A. Abstr., 1956, i, 289). Conduction errors are largest in the early stages of heating and cooling and they often cause large errors in the evaluation of the lethal value of the cooling phase of processes. Fine wires of much lower thermal conductivity than Cu should be used when accurate measurement of the cooling phase is required. E. M. J.

Subtilin and nisin as additives that lower the heat-process requirements of canned foods. L. L. Campbell, E. E. Sniff and R. T. O'Brien (*Food Technol.*, 1959, **13,** 462—464).—Data are presented showing that subtilin and nisin effectively reduce the thermal process requirements necessary to control spoilage of food products inoculated with spores of P.A. 3679, *Bacillus coagulans* and *B. stearothermophilus*. (21 references.) E. M. J.

Time–temperature relationship for heat enzyme-inactivation of radiation-sterilised beef and pork. C. J. Chiambalero, D. A. Johnson and M. P. Drake (*J. agric. Fd Chem.*, 1959, **7,** 782—784).—Irradiated meat products are not stable during long storage at room temp., because of residual activity of enzymes, especially proteases. Time–temp. treatments for inactivating proteolytic enzymes in irradiated meat ranged from 23 min. at 140°F to 0·28 min. at 170°F. The heat-treatment required was the same whether applied before or after irradiation. M. D. ANDERSON.

Lipoxidase activity and off-flavour in underblanched frozen corn-on-the-cob. A. C. Wagenknecht (*Food Res.*, 1959, **24,** 539—547).—Victory Golden maize showed residual lipoxidase activity and had developed off-flavour after storage for 6 months at −17·8°. The greatest activity was in the intermediate layer containing the germ, decreasing in the cobs and occurring in only trace amounts in the kernels. Positive peroxide no. were observed in the ether-extracted lipids from all sections. The off-flavours were considered to be due in part to the action of residual lipoxidase. (23 references.) E. M. J.

Use of potassium and sodium sorbate in extending shelf-life of smoked fish. J. J. Geminder (*Food Technol.*, 1959, **13,** 459—461).—Aq. K or Na sorbate solutions (5%, w/v) can be applied before smoking as a spray or dip, or after smoking as a dip, to fish, giving levels of 0·03 to 0·05% of sorbic acid based on fish wt. At 10% w/v, sprayed after smoking, growth of yeasts and mould spores is inhibited. E. M. J.

Cold sterilisation of liquid foods using mercury resonance radiation. II. Apple juice. S. D. Mack, J. J. Albrecht, J. H. Litchfield and M. E. Parker (*Food Res.*, 1959, **24,** 383—391).—Fresh unprocessed apple juice may be preserved by the action of u.v. light from Hg resonance radiation. The rate of microbial destruction was not affected by addition of sorbic acid, but was reduced by that of ascorbic acid. Thiamine, riboflavin and ascorbic acid contents of the juice were reduced by u.v. irradiation. Flavour changed but the product was palatable. (15 references.) E. M. J.

Prevention of darkening in frozen broilers. C. Ellis and J. G. Woodroof (*Food Technol.*, 1959, **13,** 533—536).—Heating chicken legs and thighs to an internal temp. of 180°F before freezing effectively controlled meat darkening. This was due to heat coagulation of the marrow prior to freezing. E. M. J.

Time–temperature tolerance of frozen foods. XIX. Ready-to-cook cut-up chicken. A. A. Klose, M. F. Pool, A. A. Campbell and H. L. Hanson (*Food Technol.*, 1959, **13,** 477—484).—Storage in tin cans with controlled atm. and in air showed the deteriorative effects of O_2 availability and moisture loss. Access to O_2 contributed as much to rate of deterioration as a substantial rise in temp. Anaerobic reactions were also involved as indicated by CO_2 production in N_2 packs. Results of various temp. tests showed that 0°F or below were best for storage. Statements on storage life should define intimate product environment as governed by packaging as well as by temp. conditions. (16 references.) E. M. J.

Application of the Burri method for determining the microbial content of frozen vegatables. A. H. Jones and J. L. Ross (*Food Res.*, 1959, **24,** 365—368).—The method applied to frozen and unfrozen vegetables at the processing plant level provides an inexpensive and relatively accurate procedure for determining the microbial content. E. M. J.

Packaging

Packaging and palatability of frozen beefsteak. J. D. Winter, S. R. Trantanella, W. J. Aunan and W. B. Ackart (*Packag. Engng*, 1959, **4,** No. 10, 81—86, 89, 104).—Meat samples were enclosed in 15 different packs and stored for periods at −17·8° to −21·7°; sealed bags alone and unsealed bags in cartons (with and without overwraps) were used. Palatability was judged after 9, 12 and 16 months and most of the samples proved acceptable up to 12 months, a sharp drop being noted during the following period. The customary darkening in colour during storage was noted in all cases, but there was no evidence of desiccation. C. V.

Plastics in the food industry with particular reference to beverages. W. Ludwig (*Plaste u. Kautsch.*, 1959, **6,** 356—359).—The various uses of plastic materials in the packaging and transport of beverages, and the particular requirements are discussed. L. A. O'NEILL.

Miscellaneous

Nutrition, proteins, amino-acids, vitamins

Terramycin and growth. IV. Studies on rice diets. T. Balakrishna Rao, D. V. Tamhane and A. Sreenivasan (*J. sci. industr. Res.*, 1959, **18C,** 157—160).—Weanling rats were fed *ad lib.* on diets containing (i) rice 90%, (ii) rice 90% + lysine 0·2% + threonine 0·2%, (iii) rice 60% + legume 30%. Growth was poor on (i), better on (ii), but liver fat content was increased. Addition to these diets of Terramycin, or of folic acid and vitamin B_{12}, did not improve growth, and tended to increase liver fat. Growth was faster on (iii) than on (ii), and less fat was formed in the liver; growth was stimulated by Terramycin, and by folic acid and vitamin B_{12}, which also raised the contents of N, riboflavin, choline and vitamin B_{12} in the liver, and of protein and choline in the plasma. (19 references.) M. D. ANDERSON.

Distribution of nitrogen, calcium and phosphorus between husk and endosperm of ragi (*Eleusine coracana*). P. P. Kurien, K. Joseph, M. Swaminathan, V. Subrahmanyan and V. A. Daniel (*Food Sci., Mysore*, 1959, **8,** 353—355).—Determinations were made of the N, Ca and P contents of the whole grain and husk of four varieties of ragi, and of the sediment and supernatant of endosperm suspended in water. The husk contained 28% of the N, 49% of the Ca, and 14% of the P present in the whole grain. The high concn. of N and Ca in the husk may account for the low digestibility of N, and the poor absorption of Ca, previously reported for ragi. M. D. ANDERSON.

Nutritive value of composite protein foods based on blends of groundnut, soya-bean, Bengal gram and sesame flours. K. Krishnamurthy, T. N. Ramakrishnan, S. N. Granapathy, R. Rajagopalan, M. Swaminathan, A. N. Sankaran and V. Subrahmanyan (*Ann. Biochem.*, 1959, **19,** 139—146).—The diets (of known chemical composition and having different protein levels) were fortified with vitamins A and D, Ca phosphate, thiamine and riboflavin, and fed to rats over eight-weekly periods. Mean body-wt. tests showed that the 16% protein diet compared well with skim milk powder. Whereas the protein efficiency ratios at 10% protein level were 1·7—2·3, ratios for skim milk ranged from 2·55—2·71. Addition of the blends (at 12·5%) to poor rice diets more than doubled the average weekly increase in body wt. (14 references.) P. M. KINGSTON.

Supplementary value of a protein food based on a blend of coconut meal, groundnut flour and Bengal gram flour to the diet of children. V. Subrahmanyan, T. R. Doraiswamy, R. K. Bhagavan, P. K. Tasker, A. N. Sankaran, R. Rajagopalan and M. Swaminathan (*Ann. Biochem.*, 1959, **19,** 147—152).—The effect of adding 2 oz. per day of the protein food (50% groundnut, 25% coconut, 25% Bengal gram) to the diet of 20 boys was compared, over an eight-month period, with an equal no. fed the same but unfortified diet. Nutritional studies on growth, haemoglobin, red-cell count, etc., showed an improvement in 70% of the test children. (16 references.) P. M. KINGSTON.

Effect of supplementary protein food containing coconut meal, groundnut and Bengal gram flours on metabolism of nitrogen, calcium and phosphorus in children subsisting on a poor rice diet. P. K. Tasker, M. Narayana Rao, M. Swaminathan and V. Subrahmanyan (*Ann. Biochem.*, 1959, **19,** 153—158).—From a further extension of previous tests, using 2 oz. of the protein food per day (cf. preceding abstr.), a positive N, Ca and P balance was maintained. Daily retention of these elements was 12—15% higher in subjects fed the fortified diet. P. M. KINGSTON.

Condensed fish solubles. Review of preparation and properties. R. A. MacLeod (*J. Fish. Res. Bd Can.*, 1959, **16,** 685—694).—The stickwater is concentrated after treatment with acid or enzymes to remove interfering proteins. The composition of the condensed solubles (e.g., amino-acid and vitamin contents, especially vitamin B_{12} in herring solubles) depends on the freshness of the fish, degree of spoilage of the stickwater and methods of processing the solubles; it

depends also on the species of fish used, the age and extent of maturation of the fish and type of material (whole fish or scraps). Used as a feed supplement or in nutrition studies the fish solubles should be of known history. (42 references.) E. M. J.

Evaluation of protein in foods. III. Study of bacteriological methods. C. G. Rogers, J. M. McLaughlan and D. G. Chapman (*Canad. J. Biochem. Physiol.*, 1959, **37**, 1351—1460).—Protein efficiency ratios determined by a standard rat assay were compared with bacteriological assays of protein quality. With *Streptococcus faecalis* A.T.C.C. 9790, autolysis occurred in media containing hydrolysates of proteins deficient in lysine, and this was largely responsible for results that did not agree with protein efficiency ratios. The growth of *Leuconostoc mesenteroides* P-60 A.T.C.C. 8042 was influenced by the limiting amino-acid. With both organisms, results with enzymic hydrolysates correlated poorly with protein efficiency ratios, but results with acid hydrolysates of cereal proteins were in good agreement. Differences between protein efficiency ratios and assays by *L. mesenteroides* were largely due to differences in amino-acid requirements, especially with legumes, and foods of animal origin. It is concluded that bacteriological assays are unsatisfactory for screening the protein quality of foods. (25 references.) M. D. ANDERSON.

Evaluation of protein in foods. IV. Simplified chemical score. J. M. McLaughlan, C. G. Rogers, D. G. Chapman and J. A. Campbell (*Canad. J. Biochem. Physiol.*, 1959, **37**, 1292—1299).—The amino-acids most usually deficient in foods are lysine in, e.g., cereals, and methionine + cystine in meat, casein, legumes. The content of the most deficient amino-acid, e.g., lysine or methionine, or the contents of methionine and cystine where cystine was the most deficient, were used, in % of the content of the amino-acid(s) in whole egg, to calculate "simplified chemical scores" for a no. of foods. These scores were found to be closely correlated with the protein efficiency ratio of Chapman, Castillo and Campbell (*Canad. J. Biochem. Physiol.*, 1959, **37**, 679). Microbiological assays of these limiting amino-acids on 2-hr. hydrolysates of food proteins are relatively rapid and reproducible, and could be used for the rapid screening of the protein quality of foods. The method does not take into account digestibility, or possible heat damage. (11 references.) M. D. ANDERSON.

Utilisation of nitrogen-containing compounds for biosynthesis of protein in secondary treatment. G. B. Morgan (*Sewage industr. Wastes*, 1959, **31**, 1275—1280).—Synthesis of proteins in activated-sludge units and sand filters treating sewage is integrated with the well-known Gibbs and Embden–Meyerhof pathways. Urea appears to be a better NH_2 donor than even the simplest amino-acids. Most of the amino-acids added to these units were oxidised in the citric acid cycle. Some of the components of this cycle were then used to produce other amino-acids that were incorporated into protein synthesis. O. M. WHITTON.

Separation of amino-acids on ion-exchange columns. J. Schormüller and E. Hofmeister (*Z. LebensmittUntersuch.*, 1959, **111**, 20—23).—The method of Ishii (described) gives reproducible results, accurate within ±3%, in the separation of arginine, histidine, lysine, tryptophan and NH_3 on Amberlite XE-64 with the use of a single eluting buffer. The method is more convenient than that of Moore and Stein. A method is described for the analysis of mixtures of hydroxyproline and aspartic acid by a calculation based on the extinction values of their mixed reaction product with ninhydrin at two different λ. P. S. ARUP.

Microbiological determination of Group-B vitamins. J. Adrian (*Contr. tech. Centre nat. Nutr. Aliment.*, 1959, No. 4, 183 pp.).—The general technique of the microbiological determination of vitamins of the B group is discussed with reference to the organisms used, extraction of the vitamins, culture methods, calculations of results and the specificity of the methods. Published methods for the various vitamins of the B group are reviewed, and recommended procedures for the prep. of media for the separate vitamins are detailed in appendices. (A very large no. of references.) H. S. R.

Comparative vitamin B_{12} assay of foods of animal origin by *Lactobacillus leichmannii* and *Ochromonas malhamensis*. H. Lichtenstein, A. Beloian and H. Reynolds (*J. agric. Fd Chem.*, 1959, **7**, 771—774).—The vitamin B_{12} contents of foods of animal origin were determined by assays with *Lactobacillus leichmannii* and *Ochromonas malhamensis*. In 15 out of 27 samples, vitamin B_{12} activity was higher when measured by *O. malhamensis*, mean differences being 13% or more. Only one product, yoghurt, gave a higher value when assayed by *L. leichmannii*, the difference being 26%. The results are unexpected, as determinations of vitamin B_{12} by *O. malhamensis* are reported to be more specific. The results are perhaps due to the presence in certain foods of substances other than vitamin B_{12} that stimulate the growth of *O. malhamensis*. (19 references.) M. D. ANDERSON.

Vitamin C in Spanish foods, and losses in cooking and preservation. F. Caballero and R. García Olmedo (*An. Bromatologia*, 1959, **11**, 315—364).—The ascorbic acid content is reported for 20 fruits, 30 fresh vegetables, 13 fruit juices and 4 concentrates and sauces, purchased in the Madrid market. Cooking loss studies confirm the minimisation of loss of vitamin C by pressure cooking. Losses in vegetable canning are much less than in normal marketing and domestic cooking, but are greater than reported abroad. Spanish industrial processes require modification to ensure better conservation of vitamin C. (121 references.) E. C. APLING.

Estimation of vitamin C by agar diffusion. A. H. Chaiet and L. Chaiet (*Nature, Lond.*, 1959, **184**, 1487—1488).—Vitamin C can be titrated directly with 2,6-dichlorophenolindophenol, or $KMnO_4$, suspended in agar; diffusion of the vitamin is directly proportional to its concn. Paper discs (S. & S. No. 740-E) are completely saturated with an aq. solution of the sample and placed on the agar plates, at 30-sec. intervals; the zone diameter (mm.) (r) is measured after 30 min. to 2 hr. (up to 20 hr. with $KMnO_4$), preferably with a Spencer colony counter. Results are obtained from a standard linear curve of r *vs.* concn. (1—5 mg.) for ascorbic acid. The effect of acids other than ascorbic on the indicators is obviated by initially adjusting the solution to pH 6·5—7·5. Lower limit of assay is 1 mg./ml.; $FeCl_3$ interferes. Method is rapid and applicable to highly coloured solutions (tomato or orange juice). W. J. BAKER.

Determination and stabilisation of reduced ascorbic acid in extracts from plant material. H. T. Freebairn (*Analyt. Chem.*, 1959, **31**, 1850—1851).—The use of 0·0025M-EDTA containing 0·3% trichloroacetic acid as an extraction medium results in a high recovery of ascorbic acid from plant material as well as good stability of the extract. Metaphosphoric acid and oxalic acid solution are inferior. The extract should be clarified by centrifugation at a low temp. A. R. ROGERS.

Preservation of fish food. H. A. Corbett (B.P. 805,707, 4.4.56).—Fish meal is distributed (2—3·5) throughout a plastic mass of water (24) and plaster of Paris (32 oz.), then the mixture is dried (at 20—38°), to provide a product which may be used to supply food to fishes over a prolonged period (e.g., during the owner's absence) without spoilage. F. R. BASFORD.

Unclassified

Effect of sugar, storage time and temperature on dill pickle quality. R. M. Pangborn, R. H. Vaughn, G. K. York, jun. and M. Estelle (*Food Technol.*, 1959, **13**, 489—492). E. M. J.

Determination of mineral elements in foods. M. T. Valdehita (*An. Bromatologia*, 1959, **11**, 367—380).—Ca, P, Fe and K contents are reported for 31 samples of fish, legumes and shell-fish. (21 references.) E. C. APLING.

Hydroxamic acids. IX. Micro-detection and -determination of formic acid and inorganic formates. Application to food products. O. A. Guagnini and E. E. Vonesch (*An. Asoc. quím. Argent.*, 1959, **47**, 41—51).—The method is based on esterification of formic acid to form the ethyl ester, separation of the ester by distillation, its conversion to formohydroxamate, and, finally, its detection and estimation by its colour reaction with ferric perchlorate. A special micro-distillation apparatus is described for simultaneous esterification and distillation of the ester. The detection limit is 2 μg. formic acid and quant. estimations of from 50 to 500 μg. are possible with errors of less than 5%. Carboxylic acids, α-keto-acids, aldehydes and reducing agents do not interfere. Results obtained in various food products vary from 0 to 45 mg. of formic acid per 100 g. (21 references.) E. C. APLING.

Quantitative evaluation of defrosted *Escherichia coli*. H. W. Bretz and S. E. Hartsell (*Food Res.*, 1959, **24**, 369—375).—Pure strains of *E. coli* frozen in phosphate buffer showed higher storage counts when thawing agents and diluents of increased osmotic strength were used in the Standard Plate Count technique. The term "osmo-sensitive" is applied to those cells which succumb to dilution in ordinary buffer or distilled water but remain capable of producing colonies when diluted in sucrose solutions. Sampling variation of frozen cells was much greater than of non-frozen. (28 references.) E. M. J.

Prevention of infection and toxic-infection of food. D. A. A. Mossel, J. Bechet and R. Lambion (*Rev. Ferment.*, 1959, **14**, 141—153).—The reasons for the increase in some types of food poisoning in recent years are discussed. Pathogenic bacteria are listed, together with brief characteristics and sources of infection. The

principal habitats, clinical effects and life histories of the organisms causing certain bacterial infections; and of intestinal viruses, protozoa, round and flat worms, and rare intestinal bacteria, are given. Measures to prevent infection of foodstuffs at all stages of processing, manufacture and distribution are discussed.
S. G. AYERST.

Use of antibiotics in media for assessing bacterial contamination in food yeast. M. Fleming, N. H. Barnard and L. A. Allen (*J. Sci. Fd Agric.*, 1959, **10**, 651—656).—Criteria for a medium which would allow unrestricted growth of species of bacteria likely to be encountered as contaminants in factory conditions and inhibit, by low concn. of antibiotic, the growth of food yeasts, were fulfilled by a basal medium of tryptone–Yeastrel–glucose agar containing any one of the antibiotics, candicidin, filipin, fungichromin, rimocidin (5 p.p.m.) or nystatin (15 p.p.m.). E. M. J.

Differential and selective media for the faecal streptococci. E. M. Barnes (*J. Sci. Fd Agric.*, 1959, **10**, 656—662).—Na azide and thallous acetate have been incorporated separately in media for the selective isolation of the faecal streptococci (Lancefield group D). For determination of faecal streptococci in water and processed foods methods are suitable which select the more resistant strains *Str. faecalis*, *Str. faecium*, *Str. durans*, etc., organisms likely to survive the adverse conditions. By addition of tetrazolium to thallous acetate medium at pH 6 colonies of the organisms may be distinguished. By this means no. and types occurring in the intestines of meat animals and poultry, especially following antibiotic feeding, may be examined. (25 references.) E. M. J.

Enumeration of sulphite-reducing clostridia occurring in foods. D. A. A. Mossel (*J. Sci. Fd Agric.*, 1959, **10**, 662—669).—A modification of the Wilson & Blair type agar, containing no glucose, 0·05% w/v $Na_2SO_3,7H_2O$ (SO_2 content about 25%), and 10 p.p.m. of polymyxin B sulphate was used. The medium, which should be incubated at 32° for 3 days, permits the growth of faecal streptococci and staphylococci (white colonies) and many *Proteus* species (black colonies). Confirmation of a representative selection of the black colonies is necessary. Spore forming, but not non-sporulating, types are heated for 1 min. at 80°, and subcultured in poured plates of sulphite–polymyxin–agar. Black colonies can be confirmed by their morphology and growth under aerobiosis and anaerobiosis, fermentation of glucose, lactose, sucrose, etc., reductions of nitrate, liquefaction of gelatin and formation of indole. (14 references.)
E. M. J.

Differential media for sulphur bacteria. J. R. Postgate (*J. Sci. Fd Agric.*, 1959, **10**, 669–674).—Of the four main groups considered (*a*) the sulphur-reducing bacteria (e.g., *Desulphovibrio desulphuricans*) are grown anaerobically at 30 or 37° in media containing NH_4^+, $CaSO_4$, or Na_2SO_4, Na lactate and ~0·05% of Fe^{2+} salt, and agar medium containing Na_2SO_3 and Fe citrate is used to detect *Clostridium nigriflcans* in foods. These media detect the organisms only if large no. are present. Quant. procedures are available only for *D. desulphuricans*. (*b*) Sulphur-oxidising bacteria (thiobacilli) are detected by pH change induced in media of mineral salts and S or Na thiosulphate. (*c*) Sulphide-oxidising (anaerobic) bacteria are grown in illuminated media of mineral salts and H_2S at ~pH 7 and 100 p.p.m. H_2S. (*d*) Sulphide-oxidising (aerobic) bacteria are obtained in crude culture in a Winogradsky column; there are no reliable selective media. (21 references.) E. M. J.

Radioactive isotope in our [Swiss] foodstuffs. R. Müller and J. Bäumler (*Mitt. Lebensm. Hyg., Bern*, 1959, **50**, 39—53).—Data on radioactivity in 1957/58, in five common vegetables and in salad plants, mineral content and radioactivity in vegetables (7) and fruits (5) and drinking water are compared. Details are given of methods of determination of radioactivity and of the isolation of the isotopes ^{89}Sr and ^{90}Sr. Summarised results considered in conjunction with those of English and American authors, especially in regard to ^{90}Sr, indicate no ground for assumption of an alarming threat to human health, but problems of further increase of Sr isotopes are discussed. (11 references.) E. M. J.

Relation between depth distribution of ionisation and lethal effects on bacteria. J. L. Newcomer (*Dissert. Abstr.*, 1959, **19**, 1685—1686).—The depth distribution of the lethal effect on *Serratia marcescens* of 1-MeV cathode rays was found to be non-linear, and in general comparable to the ionisation-in-depth curve obtained by absorption methods. M. D. ANDERSON.

Bacterial contamination of hospital food with special reference to *Clostridium welchii* food poisoning. E. J. McKillop (*J. Hygiene*, 1959, **57**, 31—46).—Samples of uncooked (89) and cooked (38) foods purchased by hospital showed bacteriological cleanliness; a similar sampling (173) after cooking and prep. showed the bacterial flora to be greatly reduced with the exception of cold chicken, 10 out of 46 samples being contaminated with *Cl. welchii*; this was probably due to kitchen dust and immediate refrigeration is recommended to control growth. Six outbreaks in which there was an association between consumption of chicken and clinical symptoms of this form of poisoning are reported and discussed. C. V.

Comparative studies of media for counting anaerobic bacterial spores. E. Wheaton, G. B. Pratt and J. M. Jackson (*Food Res.*, 1959, **24**, 134—145).—The recovery of viable spores of PA-3679 and *Clostridium botulinum* type B, after heat treatment and γ-radiation independently, was studied. Of 11 media tested, for both heated and irradiated spores of the test organisms no one medium gave universally higher recovery counts; deviations occurred with the strain and type of treatment. The medium yielding consistently higher counts throughout, regardless of strain of PA-3679 used, or severity of the heat process was pork–pea agar. E. M. J.

Identification of micro-organisms from maple tree tapholes. J. M. Sheneman and R. N. Costilow (*Food Res.*, 1959, **24**, 146—151).—Maple trees not previously tapped were used for sap collection in the 1955/6 seasons. Of 588 bacterial cultures isolated >390 were Gram-negative rods of the genera *Pseudomonas*, *Achromobacter* and *Flavobacterium*, *P. geniculata* being the most frequently occurring sp.; other genera present were *Micrococcus*, *Bacillus*, *Sarcina* and *Chromobacterium* and a heterogeneous group of non-spore forming, Gram-positive bacteria. Of the 446 yeast cultures isolated, all were anascosporogeneous, non-fermentative types. *Trichosporon pullulans* and *Rhodotorula glutinis* occurred most frequently: two spp. of Candida, three of Cryptococcus, two of Torulopsis and a miscellaneous group of unidentified yeasts were about equally distributed. Of mould cultures, 370 were studied and nine different genera recognised. (13 references.) E. M. J.

Correlation between microbial populations and sap yields from maple trees. J. M. Sheneman, R. N. Costilow, P. W. Robbins and J. E. Douglass (*Food Res.*, 1959, **24**, 152—159).—A high degree of correlation was shown between the occurrence of high populations of bacteria early in the sap season and low yields of sap. Micro-organisms cause premature stoppage of sap flow, probably by physical blocking of the vessels, depending on the rate of growth of the microflora. Suggestions for control are discussed. E. M. J.

Response of various bacteria to drying in an air stream. C. W. Bruch (*Dissert. Abstr.*, 1958, **19**, 933—934).—The strict anaerobic *Clostridium pasteurianum* did not survive drying by any method tried. Most aerobes and facultative anaerobes survived poorly unless the medium in which they were suspended for drying contained dextrin and antioxidants (ascorbic acid and thiourea). In the absence of antioxidants, drying in a stream of N_2 instead of air increased survival. *Streptococcus lactis* and *Lactobacillus casei* survived well without protective substances; survival of *L. casei* was not improved by the use of N instead of air. Gram-positive spp., as a group, were more resistant to drying than Gram-negative spp. Spp. that dried poorly on the laboratory scale also failed to survive when spray-dried on a pilot-plant scale, but spp. that dried well on the small scale did not necessarily survive when spray-dried. Efforts to identify the cell system that is protected by the antioxidants were unsuccessful. Phage-resistant cultures of *Serratia marcescens* were less sensitive to drying than phage-sensitive cultures.
M. D. ANDERSON.

Culture media for fungi. G. Smith (*J. Sci Fd Agric.*, 1959, **10**, 674—678).—At one culture centre some 60 different culture media are regularly used to maintain a miscellaneous collection of fungi. Out of these, for moulds about a dozen are used. For diagnosis and identification purposes, use of synthetic media of definite and reproducible composition is important, but such media are not always satisfactory for maintenance. Presence of certain accessory factors and correct sterilisation etc. affect growth. E. M. J.

Fractionation of commercial papain by acetone and investigation of the proteolytic milk-clotting properties of the fractions obtained. K. Bahadur and I. Kumari (*Enzymologia*, 1959, **21**, 114—122).—The different enzymic properties of commercial papain may be due either to the presence of one prosthetic group or the presence of a mixture of several enzymes. In support of the latter view a fractional pptn. by acetone was carried out and the resultant seven fractions were found to have different milk-clotting properties and a different proteolytic activity towards casein at 30°, 40°, 45° and 50°. H_2S was used as activator. The fourth fraction had the best milk-clotting property (189·8 sec.), whilst the worst was the seventh (900 sec.). Proteolytic maxima were obtained at 40°, 45°, 30°, 45°, 45° and 40° for papain and the first five fractions respectively. The second fraction showed the overall max. of proteolytic activity.
I. DICKINSON.

Analysis of small quantities of fluorine in foods and in water samples. III. Quantitative fluoride determination. K.-E. Quentin

and J. Indinger (*Z. LebensmittUntersuch.*, 1959, **110,** 249—260).—The described and illustrated procedure consists of (i) the pretreatment of the test materials and concentration of the fluoride by steam distillation in presence of perchloric acid at 135° and (ii) determination of F by a colorimetric method. Of these, the zircon–alizarin and the zircon–Eriochromecyanin methods are the most useful in determining F in the range 0—60 μg. which may occur in foods or water. The merits of the two processes are considered in detail. E. M. J.

3.—SANITATION

Toxicology of butoxypolypropylene glycol 800 (Crag fly repellent). C. P. Carpenter, C. S. Weil, P. E. Palm, M. D. Woodside and H. F. Smyth, jun. (*J. agric. Fd Chem.*, 1959, **7,** 763—769).—The fly repellent butoxypolypropylene 800 (BPG) was tested for acute and chronic toxicity by single and repeated doses to rodents and dogs. It had only slight toxicity when single oral or topical doses were given to rodents. LD_{50} was 8·9 to 17·3 ml. per kg. for rats receiving it orally, 3·6 ml. per kg. for rabbits (subcutaneously), 0·8 to 2·2 ml. per kg. for rats (intraperitoneally), and 0·22 ml. per kg. for rats and 0·088 ml. per kg. for rabbits (intravenously). BPG was not synergistic with any of nine other insecticides. It was not stored in the bodies of animals; 45 to 66% of a single dose was recovered from the faeces and urine. Rats tolerated 640 p.p.m. in the diet for 2 years, and dogs 890 p.p.m. for 1 year. M. D. ANDERSON.

Fly control for the dairy herd. E. H. Fisher (*Soap, N.Y.*, 1959, **35,** No. 12, 102—103, 144).—Excellent fly and mosquito control was attained, using a formulation with 0·1% pyrethrins + 1·0% piperonyl butoxide; methods of application specially by fogging are discussed. An automatic self-treatment device is described where each cow trips a solenoid valve or electric eye releasing compressed air, thus dispersing the insecticide through one or two mist-spray nozzle units. C. V.

Comparison of the toxicities of pyrethrins to *Calandra oryzae* L., and *Calandra granaria* L. G. D. Glynne Jones and E. H. Green (*Pyrethrum Post*, 1959, **5,** No. 2, 3—7).—*C. oryzae*, the smaller of the two species, was half the wt. of *C. granaria* when both were fed on wheat but *C. oryzae* reared on maize was nearly equal in wt. to *C. granaria* fed on wheat. There was a significant positive correlation between body wt. and resistance to pyrethrins, which was independent of the species, but response to piperonyl butoxide as a synergist/pyrethrins ratio 1 : 8 was three times greater by *C. granaria* than by *C. oryzae*. (12 references.) E. M. J.

Laboratory scale molecular distillation of pyrethrins. M. Elliott, J. S. Olejniczak and J. J. Garner (*Pyrethrum Post*, 1959, **5,** No. 2, 8—18).—Recent developments in mol. distillation equipment are described and illustrated whereby the process is made more efficient, especially with regard to the mechanical means for promoting thin, turbulent, accelerated films on the heating surface, and subjecting the process material to less thermal hazard. A distillate of much improved colour containing a large % of the pyrethrins present in the original feed with very little thermal degradation or loss of biological activity is obtained. (27 references.) E. M. J.

Inheritance of DDT-dehydrochlorinase in the house fly. J. B. Lovell and C. W. Kearns (*J. econ. Ent.*, 1959, **52,** 931—935).—The DDT-dehydrochlorinase of individual flies was measured by a modification of the method of Sternburg *et al.* The amount present in the progeny was near the mean of that of the parents. Resistant strains were back-crossed to susceptible flies and crossed with other resistant flies. A relationship between the presence of DDT-ase and resistance was shown and results approximate to the ratios expected for a partially dominant gene. C. M. HARDWICK.

The attractant in sucrose fed on by house flies. F. Acree, jun., P. L. Davis, S. F. Spear, G. C. LaBrecque and H. G. Wilson (*J. econ. Ent.*, 1959, **52,** 981—985).—Two groups of tests failed to produce any chemical attractant from the atm. of the rearing room or fed-on sucrose. Fed-on sucrose seemed to absorb moisture more readily and held it better. The addition of 6% water made ordinary sucrose as attractive as that fed on by flies. Dried fed-on sucrose was not an attractant. C. M. HARDWICK.

Screening tests in 1957 with synthetic compounds for toxicity to house flies when applied in space sprays. P. G. Piquett and W. A. Gersdorff (*J. econ. Ent.*, 1959, **52,** 954—955).—Of 107 compounds tested, 11, which were mostly esters of *dl-cis-trans*-chrysanthemumic acid, were sufficiently active to warrant further testing. C. M. HARDWICK.

Metabolic fate of prolan in a dilan-resistant strain of house flies. A. S. Perry and A. J. Buckner (*J. econ. Ent.*, 1959, **52,** 997—1002).—Flies resistant to dilan showed greater resistance to prolan than to bulan. Prolan is absorbed slowly and the amount in the tissues is never >0·5 mg. Analysis of the excreta by infra-red and u. v. spectroscopy showed a neutral and an acidic derivative. The neutral product was unchanged prolan. Only 20—30% of sublethal doses to susceptible flies were recovered, but up to 90% of lethal doses were identified. This strain was also resistant to all chlorinated hydrocarbons and to malathion and Dipterex. (11 references.) C. M. HARDWICK.

γ-Radiation for sterilisation and control of *Anopheles quadrimaculatus*. A. N. Davis, J. B. Gahan, D. E. Weidhaas and C. N. Smith (*J. econ. Ent.*, 1959, **52,** 868—870).—Doses of 12,900 r for pupae and 8865 r for adults reduced appreciably the number of fertile eggs laid. Pupal mortality was also increased. With the introduction of sterilised males at the rate of >6 : 1 normal male : 1 normal female viable eggs were reduced by 80%. C. M. HARDWICK.

Effect of varying conditions in a laboratory testing technique on mortality of mosquito larvae. C. H. Schmidt and D. E. Weidhaas (*J. econ. Ent.*, 1959, **52,** 977—979).—The mortality of 3 spp. of mosquitoes in different vol. of insecticides and in containers of different diameters is given. These factors did not affect the toxicity of parathion but greatly affected that of DDT. Malathion, dieldrin and lindane gave intermediate results. C. M. HARDWICK.

Toxic effects of boron trioxide against immature stages of *Aeges aegypti*, *Anopheles quadrimaculatus* and *Culex quinquefasciatus*. R. W. Fay (*J. econ. Ent.*, 1959, **52,** 1027—1028).—The mortality of all instars and pupae of the 3 species in solutions of metabolic acid (2000—8000 p.p.m.) during 24 hr. and 48 hr. is determined. Each species kept its relative susceptibility and this decreased with development. Addition of org. matter did not affect this. C. M. HARDWICK.

Harmlessness of asphalt as floor pavement in stables. J. Köves and P. Zakar (*Bitumen, Teere*, 1959, **10,** 393—395).—By asphalt is meant a bitumen produced by distillation or extraction from crude mineral oil. Pigs weighing 40 kg. were fed for 63 or 71 days, respectively, with 10 g. of extracted or distilled bitumen crude oil per day. No damaging effect on the appetite, wt. increase and health of the animals was observed and no pathological processes were found by histological examination of the liver. A comparison by feeding pigs with lignite pitch from a low-temp. lignite distillation showed a certain negative effect on the appetite and development in two out of four tested animals. A slight toxic effect was observed in the liver of all four animals. Mineral oil bitumen obtained by distillation and (or) extraction is a harmless building material from the viewpoint of veterinary hygiene. (16 references.) H. FRIEDMANN.

4.—APPARATUS AND UNCLASSIFIED

Determination of calcium in plant material by atomic-absorption spectrophotometry. D. J. David (*Analyst*, 1959, **84,** 536—545).—The apparatus is that previously described (*ibid.*, 1958, **83,** 655) with the addition of a lens between the hollow-cathode tube and the Lundegårdh flame and another between the flame and the slit. The sample is wet-ashed with H_2SO_4, $HClO_4$ and HNO_3, excess of HNO_3 and $HClO_4$ are removed by heating and pptd. SiO_2 by filtration after dilution. To an aliquot of the filtrate and to the standard solution are added solutions providing specified amounts of the chlorides of Mg, Na and K. Sample and standard solutions are analysed spectrographically as previously described. A. O. JONES.

Monamycin: new antibiotic. C. H. Hassall and K. E. Magnus (*Nature, Lond.*, 1959, **184,** 1223—1224).—The antibiotic is isolated from a new species of *Streptomyces jamaicensis* grown on neopeptone-glucose medium in stationary and aerated submerged culture. It is extracted from the culture medium and from the mycelium with Et_2O or BuOH. Further purification affords the base, $C_{22}H_{36-38}O_5N_4$, m.p. 126° (hydrochloride, m.p. 187°, $[\alpha]_D^{18}$ —62 ± 5° in EtOH). The u.v. spectrum has end absorption only; the i.r. spectrum shows no aromatic character and presence of the amide linkage. The antibiotic is very active against a variety of Gram-positive organisms, including strains of *Staphylococcus aureus* which are resistant to penicillin, Aureomycin, chloramphenicol and sulphamethazine. It is relatively stable, and there is no loss of activity after it is kept at pH 9 and 114° for 10 min.; it is not inactivated by human serum. There are no unfavourable reactions after subcutaneous injection of 850 mg./kg. into mice. J. N. ASHLEY.

ERRATA

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Col. 32 line 24 *for* proteolytic *read* pectinolytic
,, 40 ,, 5 *for* **nitrate** *read* **nitrite**
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