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The following papers are appearing in the July, 1955, issue of the *Journal of Applied Chemistry*

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By J. S. Fitzgerald

The recovery of wool from sheepskin pieces
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Colour reactions of 2 : 6-dichloroquinone chloroimide with derivatives of glyoxaline-2-thiol
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Foam as a medium for gas absorption
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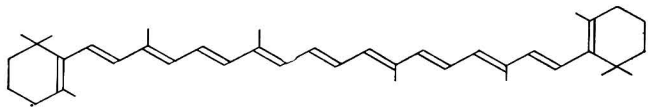
THE MODES OF ACTION OF VITAMIN A*

By R. A. MORTON

Department of Biochemistry, The University of Liverpool

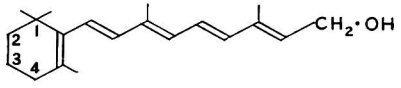
Chemical background

β-CAROTENE, which occurs in a great variety of plant products, is the natural precursor of vitamin A. It is a hydrocarbon $C_{40}H_{56}$, whereas vitamin A is a primary alcohol $C_{20}H_{29}\cdot OH$. The



(I)

structure of β-carotene (I) is symmetrical about a central double bond; the molecule contains two β-ionone rings and a chain of nine conjugated double bonds.[1] The structure[2, 3] of vitamin A_1 (II) closely resembles that of one half of the β-carotene molecule. Vitamin A_2 (III), found in many freshwater fish liver oils, is a 3-dehydrovitamin A.[4, 5, 6]



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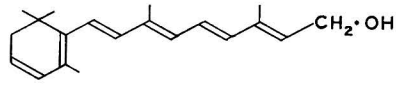


(III)

As might be expected from their unsaturated nature, vitamins A_1 and A_2 are easily destroyed, especially by oxidation at the unsaturated linkages.

Advantage can be taken of the ease of oxidation of the $-CH_2\cdot OH$ group to prepare the corresponding aldehydes. It suffices to dissolve the vitamin in purified light petroleum and to leave the solution at room temperature over powdered manganese dioxide.[7] If the process is carried out in the dark with occasional shaking, most of the vitamin is slowly converted to the corresponding aldehyde which may be purified by chromatography on alumina. The aldehydes of vitamin A_1 and A_2 are perhaps better known as retinene$_1$[8] and retinene$_2$ and both can be converted to the usual aldehyde derivatives such as oximes and Schiff bases.

Vitamin A, as is well known, has been synthesized on a commercially successful scale. Several routes to the synthesis have been published[9] and some distinguished work in that direction has been done in this country, but so far as is known the commercial production of synthetic vitamin A does not yet take place here. The Roche company of Basel and the Merck Company at Rahway, New Jersey and the Pfizer Company are producing considerable quantities of synthetic vitamin A. Very good natural concentrates can be prepared by molecular distillation of selected fish liver oils[10] or by the *cyclo*propane segregation of the Solexol process used in South Africa.

The pure chemistry of vitamin A does not at the moment offer many attractive problems to the organic chemist; in fact the constitution of kitol,[11] $C_{40}H_{60}O_2$, a substance present in quantity in whale liver oil, is the main gap to be filled in. Little has been published concerning the structure of this interesting vitamin A dimer but it is said to give a fair yield of vitamin A on pyrolysis at very low pressure.

Biochemical background

Although the state of knowledge concerning the nature of vitamin A is thus satisfactory, the same cannot be said about its biological functions.

* Read at the Annual Meeting of the Society, Liverpool, July 1954.

The natural history of vitamin A is clear enough at any rate in broad outline.[12] The vitamin is never found in plants, yeasts, fungi or bacteria. The animal, e.g. the herbivorous animal, may not obtain any preformed vitamin A in its diet, but a precursor,[13] typically β-carotene, will undergo fission (or a succession of fissions),[14] to yield finally vitamin A. This process occurs in the intestinal mucosae[15] and the resulting vitamin A is carried in the blood stream to the liver where it is stored. Carnivorous animals, by eating liver, may acquire sufficient vitamin A for their needs.

Small but very significant amounts of both provitamin A (β-carotene) and vitamin A occur in egg yolk and in milk, and as would be expected from its fat-soluble nature most of the vitamin A of milk passes into cream or butter. The normal animal stores vitamin A very largely in the form of esters of higher fatty acids such as oleic, palmitic and stearic, but a small amount of free vitamin A circulates in blood.[16]

In man, the blood level corresponds to about 1 i.u. per ml. (Pure vitamin A has $3{\cdot}33 \times 10^6$ i.u./g. so that the blood level is about $\frac{1}{3}$ μg. per ml.) The minimum daily requirement for an adult man is of the order 0·5 mg./day but 1·5 mg. is often recommended. Most adults in this country have a substantial liver reserve of vitamin A possibly enough for some 500 days ;[17] the need for vitamin A is increased for nursing mothers and there is wide agreement that a generous intake is desirable in pregnancy and in childhood.

Pronounced vitamin-A deficiency in man has been recorded and studied in some detail,[18] in conditions of near-famine and in primitive populations, but it is not nowadays a very common condition. For the present purpose the deficiency will be discussed in terms of observations on the rat.

The effect[12] of withholding vitamin A from the diet of weanling rats is (after a variable delay) to retard growth, i.e. litter mates on the same diet supplemented by as little as 2 i.u./day will continue to grow when the vitamin-A-deficient animals are either declining or stationary in weight. The process of depletion, of using up the liver reserves, can be followed by determining blood levels and liver reserves in selected animals. After some weeks on the deficient diet, when the body reserves of vitamin A have very largely, if not entirely, disappeared and the animal is losing weight, lesions in the external eye appear. The condition, which is known as xerophthalmia, is an inflammation in and around the eyelids brought about by an accumulation of keratinized cells following on a keratinizing metaplasia of epithelial tissues. In man, as well as the rat, the gross appearances of damage to the external eye tissues are characteristic of the later stages of vitamin-A deprivation.

Uncomplicated vitamin-A deficiency is not equally easy to produce in different species and is not often seen in man. There is however general agreement about three types of physiological derangement : (*a*) night blindness,[19] or impaired vision in very dim light, (*b*) atrophy of many epithelial tissues—often described as keratinizing metaplasia,[12] (*c*) disturbances in the normal growth and shaping of bone.[20]

Defective low-intensity vision is perhaps the earliest measurable abnormality[17] and the dry roughened state of the conjunctiva and cornea (xerosis) the most easily seen manifestation of deficiency.

It is however possible to over-simplify the position. Vitamin A is in a class by itself—even for a vitamin. In spite of the fact that in many species it is readily stored on a considerable scale, too much of it is harmful and in a most interesting way. A man can easily store 2 years' supply (about 0·6 g.) in his liver, and some fishes, e.g. halibut, sturgeon and some shark species, have extremely large stores in liver and intestines. Yet hypervitaminosis A is very real since the ingestion of amounts very much in excess of normal needs results in growth of skeletal tissue (epiphyseal cartilage) out of step with growth in the rest of the body. There is also decalcification and spontaneous bone fracture. Mellanby[20] considers that vitamins A and D are to some extent complementary, the one osteoclastic and the other osteoblastic in its action.

The keratinizing metaplasia of vitamin-A deficiency affects the epithelia of the entire respiratory tract, and lesions of the middle ear and the respiratory sinuses are often followed by secondary infection. The deficiency also affects the genito-urinary tract ; in rats the bladder is often seen to be abnormal. Glands such as the parotid and submaxillary glands are often keratinized and in some species become prone to infection. Wolbach[20a] puts the matter as

follows : ' It [vitamin A] is necessary for growth and differentiation of epiphyseal cartilage and for the maintenance of differentiation of many epithelia but not for their growth. Its role in vision has been beautifully and completely elucidated but otherwise its *in vivo* chemistry is unknown '.

Ordinarily the phenomena of hypervitaminosis-A[12] do not occur in animals or persons with very large liver stores. This can be explained by the fact that the absorbed vitamin is stored in the form of fatty acid esters in the true liver cells and in the phagocytic Kupffer cells. The circulating vitamin-A in the blood stream of the fasting animal is almost entirely free alcohol which is released from the esters by a liver esterase.[21] This enzyme tends to regulate the blood level and it is only when vast excess of vitamin A is administered in a short time that the concentration becomes harmfully high. It may be noted in passing that the circulation of free vitamin may provide a hint concerning modes of action.

The chemistry and biochemistry of vision

There are two kinds of vision in man : daylight or bright light vision, which is called *photopic* vision, and dim light vision or night vision, which is called *scotopic* vision. The microscopical anatomy of the retina shows that there are two types of light receptors known as cones and rods. The cones are responsible for photopic vision and the rods for scotopic vision. When a person goes from a well-lit room into a dark room or out into the open on a dark night, some little time is needed for the process of dark adaptation. Indeed more than half an hour in total darkness is needed before dark adaptation is complete, i.e. before maximal sensitivity to dim light is reached.

If the performance of the human eye, e.g. in respect of the minimum perceptible intensity of light at say 500 mμ., is plotted against time of dark adaptation, the curve shows a sharp discontinuity which can be called the cone–rod transition time or the rod–cone threshold. This discontinuity is clear evidence of two distinct mechanisms. In photopic vision there is colour discrimination but when rod vision ' takes over ' we are all colour-blind.

Hecht and others,[22] by plotting the sensitivity of the eye to different wavelengths of monochromatic light, have been able to show from the ' action spectrum ' that the curve is broad and smooth with a maximum at 500 mμ. As long ago as 1878 Kühne[23] discovered a pink pigment which he could extract from dark adapted retinas ; he called it *seh-purpur* which was badly translated as visual purple. The pigment is now best known as rhodopsin and it can be extracted from retinas by a detergent solution, 1% digitonin being the most suitable. The absorption spectrum of rhodopsin agrees very closely with the action spectrum of ' scotopic luminosity curve '.[22] The rhodopsin is very readily destroyed by bright light and it is evident that the photochemistry of rhodopsin will have a bearing on the chemistry of vision.

Vitamin A is involved here inasmuch as ' night blindness ' or defective low intensity vision is a symptom of vitamin-A deficiency. In fact, the cone–rod transition time—normally about 8 minutes in the well-nourished man—is extended to 30–45 minutes in persons with plasma vitamin-A levels less than half the normal[17]—by which time probably they have only very small reserves left.

Dark adaptation may be regarded (perhaps over-simply) as a slow formation of rhodopsin in the rods ; in avitaminosis A the process is greatly delayed and may not be complete even after very lengthy dark adaptation, e.g. overnight. On this basis vitamin A could have been a catalyst or a moiety in a catalyst molecule ; it is however not a catalyst so much as an integral part of the rhodopsin molecule. It is necessary to bear in mind the two possibilities—a direct, integral role and an indirect catalytic role in considering the systemic mode of action.

To return however to the retina and to rhodopsin, extraction of the pigment is the first practical problem.[24] A dozen fresh ox eyes are obtained from the abattoir. The container is opened in the dark room and the eyes are dissected in a red light. The retinas are lifted off and dropped into saline solution. The rods consist of two portions which tend to separate by shaking the solution ; the outer segments rich in rhodopsin become detached. The outer portion of each rod projects from the retina towards the back of the eye, whereas the inner portion is firmly imbedded in the retina proper and contains the cell nuclei and has connexions to the nerve fibres. If the partially disintegrated retinal tissue is suspended in 0·88M-sucrose solution the rod outer segments remain in suspension and heavier debris can be centrifuged down.

Isolated rod outer segments consist of tiny discs of diameter about 2·1 μ and thickness 3 mμ. Electron microphotographs show a pile of 2000 discs each thickened at the circumference.[25] A fibre runs along a groove up the length of each outer segment.

A preparation of rod outer segments from the sucrose suspension is first treated with potash alum as a hardening agent. The rhodopsin is extracted by means of a 1% aqueous solution of digitonin and after standing for one hour the solution is centrifuged. The supernatant liquor is mixed with buffer, re-centrifuged and examined in a photoelectric spectrophotometer. Here the incident light is too weak to destroy the pigment, but care must be taken to exclude daylight. The absorption spectrum[24, 26] has a broad band with $\lambda_{max.}$ 500 mμ and a less prominent peak near 340 mμ. There is also a strong absorption band near 270 mμ due to protein. Rhodopsin can be described as a chromoprotein or a conjugated protein (probably 6% tyrosine and 3% tryptophan). It is moreover a light-sensitive protein and as it is only obtainable in solution in the presence of a detergent like digitonin, absolute criteria of purity and unequivocal molecular weight determinations are lacking. The best estimate of the molecular weight (Hubbard[27]) is 40,000.

Wald[8] showed that freshly bleached retinas (i.e. exposed to daylight so that the pink colour had gone) yielded to chloroform a substance showing (in that solvent) an absorption peak at 385 mμ and with the antimony trichloride reagent a blue colour with a peak at 664 mμ. These two properties served to identify a new compound which was called retinene. From the retinas of fresh water fishes (known to have vitamin A_2 in their liver oils) was similarly obtained retinene$_2$[28] which in chloroform solution shows maximum absorption at 405 mμ, and with antimony trichloride reagent gave a colour showing maximum absorption at 705 mμ.

About the same time, Lythgoe and his colleagues[29] had shown that where rhodopsin suffers photodecomposition in solution the resulting compound exhibits absorption spectra which vary with pH. Indicator yellow was the name given to the decomposition product which showed $\lambda_{max.}$ 365 mμ in alkali and 440 mμ in acid. In the process of 'bleaching', free sulphydryl groups are formed (Wald & Brown[30]).

The photopic luminosity curve shows a maximum at 560 mμ; this corresponds to an elusive cone pigment iodopsin which also liberates retinene on bleaching. It will not be possible to review cone vision and colour vision in this paper; it is sufficient to say that there is a very strong case in favour of the idea that vitamin A is concerned in both scotopic and photopic vision.

One of Wald's earlier findings[8] was that although chloroform extracted retinene from freshly 'bleached' retinas, the product from retinas which had been allowed to stand for an hour in daylight was vitamin A. Similarly,[28] vitamin A_2 was obtained from retinas of certain species of fresh water fishes.

It was later shown[31] that retinene was the aldehyde of vitamin A and on that basis the phenomena could be neatly explained, i.e. retinene was being converted to vitamin A by the action of the enzyme[32] alcohol dehydrogenase:[33]

$$\begin{array}{lcl} \text{Vitamin A} & \overset{-2H}{\underset{+2H}{\rightleftharpoons}} & \text{Retinene} \\ C_{19}H_{27}\cdot CH_2\cdot OH & & C_{19}H_{27}\cdot CHO \end{array}$$

$$+ \text{ alcohol dehydrogenase}$$

$$\begin{array}{ll} \text{Co-enzyme I} & \text{reduced co-enzyme I} \\ DPN^+ & DPNH \end{array}$$

Research on the chemistry of vision was very much handicapped by the fact that only microgramme quantities of retinene could be isolated from retinas. The discovery at Liverpool[31] in 1944 that retinene$_1$ and retinene$_2$ were respectively the aldehydes of vitamins A_1 and A_2 and that the two substances could be obtained merely by leaving a solution of the vitamin in light petroleum to stand over manganese dioxide,[34] re-opened the field. The pure synthetic retinenes were found readily to form alcohols in the presence of alcohol dehydrogenase and the system reaches an equilibrium.

The spectra of indicator yellow solutions arise from the interaction of retinene and amino groups,[35] which has been explained recently. It is enough here to say that retinene with methylamine will form a Schiff base:

$$C_{19}H_{27}\cdot CHO + H_2N\cdot CH_3 \longrightarrow C_{19}H_{27}\cdot CH{:}N\cdot CH_3 + H_2O$$

which has been isolated, purified and analysed. Its properties fit well with the idea that in rhodopsin one such chromophoric unit exists per molecule of protein. This conclusion had been reached in an elegant manner by Hubbard,[27] one of Wald's colleagues.

The test of a biochemical mechanism of this kind lies in reconstructing it *in vitro*. The indicator yellow has been adequately reproduced. Wald,[26] using opsin, the specific protein of rhodopsin, finds that opsin and retinene spontaneously form rhodopsin and that vitamin A and opsin, plus coenzyme I (DPN) and alcohol dehydrogenase will also form rhodopsin. It is true that there are complications.[36] Natural vitamin A is mainly the all-*trans* isomer and the purest synthetic product is entirely all-*trans*. Wald found that the latter did not regenerate rhodopsin but that the natural vitamin A concentrates were effective. Natural vitamin A from liver oils consists in the main of the all-*trans* form plus a *cis*-isomer, neovitamin A.[37] It seems clear from the interesting work carried out by a group of American workers that there are no less than five *cis-trans* isomers of retinene$_1$[36, 19] and five corresponding vitamins A_1. These products differ in their power to regenerate rhodopsin and (in an apparently independent manner) in growth-promoting activity. Full publication of these results is awaited.

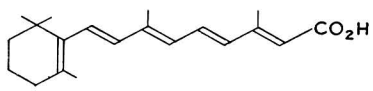
In taking stock of the present state of knowledge, it is safe to say that (1) vitamin A plays an indispensable part in animal (and avian) vision, both photopic and scotopic. This role is integrally related to the alcohol $\rightleftharpoons$ aldehyde equilibrium mediated by alcohol dehydrogenase with coenzyme I (DPN) as hydrogen acceptor; (2) retinene is attached to protein via a link $X{\cdot}CHO + H_2N{\cdot}Y = X{\cdot}CH{:}N{\cdot}Y + H_2O$ of the Schiff's base type. Such compounds account for the properties of indicator yellow; (3) the role of vitamin A (via its aldehyde) in vision is to form the coloured part of the chromoprotein, which is light-sensitive.

The water-soluble vitamins, such as nicotinamide, riboflavin, thiamine and pantothenic acid, as constituents of co-enzymes, are rightly considered as parts of biochemical catalysts. The role of vitamin A in vision is fundamentally different in that it is an integral part of the photosensitive system. Wolbach says that this role has been beautifully and completely elucidated, which is rather an over-statement; the structures of rhodopsin and iodopsin still need to be worked out and the biochemistry of what transpires between the absorption of light quanta and the electrical impulse to the brain has still to be cleared up. Nevertheless, what we do know is indeed beautiful and in large measure so fully evidenced as to be safe from any criticism.

The systemic actions of vitamin A

The contrast between what is known of the mode of action of vitamin A in the retina and what is known of its more general systemic actions is indeed striking.

To begin with, it is interesting that vitamin-A acid[38] (V), when tested by its capacity to



(IV)

restore growth in deprived rats, has about two-thirds the potency of vitamin-A alcohol.[39] This substance has never yet been isolated from a natural source; it is only known as a product of synthesis. The apparent absence of such an acid from animal tissues does not favour the idea that the alcohol can be oxidized (perhaps via the aldehyde) to the acid—which could conceivably be the ' true ' systemic vitamin. The alternative argument that the animal could by hydrogenation turn the acid into the alcohol cannot be sustained—in fact the administered vitamin A acid disappears without so far being traced. There is certainly no storage of the acid itself nor of alcohol derived from it. It is also asserted that the methyl ether of vitamin A is biologically active, but there is no evidence that it is broken down to vitamin A. The amounts of vitamin A needed by animals suggest on the whole catalytic mechanisms.

Thus for the rat the requirement (expressed as i.u./100 g. body weight) would be of the order

2 i.u./day to prevent hyperkeratosis of epithelia and xerophthalmia, etc.; 8–10 i.u./day would permit nearly normal growth. Although estimates vary, 10–20 i.u./day suffices to provide a normal blood level and to begin liver storage. In depletion experiments, vitamin A seems towards the end to be transferred from liver to kidney so that as the liver store approaches zero the kidney level is increased to a point which although still low, is well above the normal for that organ. The 'migration' process has still to be accounted for. A further complication is that vitamin E (tocopherol) has a genuine sparing action on vitamin A.[40] Again there is no established mechanism.

Recent work by Fell and Mellanby[41] on the cultivation of the ectoderm of chick embryos in media overdosed with vitamin A showed that excess of vitamin suppressed the formation of keratinizing epithelia and produced instead mucus-secreting ciliated epithelium. Explants in a normal medium produced squamous keratinizing epithelium. This work tends to show that vitamin A is pretty directly concerned with epithelial processes. It would not therefore be surprising if vitamin A were a normal constituent of epithelial tissue. The perhaps disappointing fact, however, is that no vitamin A can be located in skin or in the epithelium of mucous membranes. The characteristic histological changes which occur on withholding vitamin A are fundamentally similar in the salivary glands, the pharynx, trachea, bronchi, parts of the digestive tract and the urino-genital tract including vagina and testes, as well as bladder. Vitamin A seems 'to be needed for some chemical process uniquely related to normal differentiation in basal cells of epithelial tissues' (Wolbach & Bessey[42]). The fact that vitamin A cannot be found in such tissues may mean either that incredibly minute amounts are needed or that the vitamin itself is only a precursor of some catalyst which works directly. No such vitamin A resultant is yet known. Many substances having some structural resemblance to vitamin A have been tested biologically but none of them approach the vitamin in potency. Neither hypothesis is very serviceable and a third idea is being considered, namely that keratinizing metaplasia is brought about by the presence of a harmful resultant of generalized avitaminosis A. Vitamin A itself need not be a unique antagonist to such a product.

Lowe & Heaton[43] have been examining in great detail the unsaponifiable matter from the tissues of rats kept on a vitamin-A-free diet from weaning until xerophthalmia was manifest. Tissues from control rats given just enough vitamin A have been studied similarly. Each lot of tissue unsaponifiable matter has been subjected to chromatography and the fractions have been examined by spectroscopic methods. This work is giving quite a complicated picture and much experimental work will be involved to clarify it. Three quite distinct substances are being obtained consistently and are designated compounds SA, SB and SC. *Compound SA* shows $\lambda_{max.}$ 272 mμ ($E^{1\%}_{1cm.}$ 175–180) (in *cyclo*hexane) with weaker absorption at 330 and 405 mμ. Its analysis (admittedly not on crystalline material) and its molecular weight suggest that it is a steroid. The infra-red absorption spectrum shows hydroxyl groups to be absent and provisionally we are considering (V) as a plausible structure.

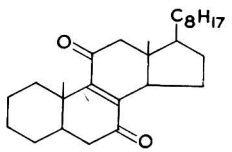
A substance having that structure has not previously been recorded although analogues with OH at position 3 are known. Compound SA has been also obtained from horse intestine mucosa (Festenstein) and it seems to be a new, normal constituent of animal tissues. Compound SB is somewhat more polar than Compound SA and has two absorption peaks, one near 275 mμ and the other near 332 mμ. Compound SB is also found in very small amount, in tissues of animals not suffering from avitaminosis A.

Compound SC could not be found in more than minute traces in liver or kidney from normal rats; these, taken from a stock colony, had vitamin-A stores of the order 700 i.u./g. liver tissue. Compound SC was recorded in small amounts in liver and intestine taken from rats with low liver vitamin-A reserves (3–20 i.u./g. tissue). Liver, kidney and intestine from animals which had exhausted their vitamin-A reserves and were showing the full deficiency syndrome yielded Compound SC with less difficulty and in markedly increased amounts.

Compound SC acetate in *cyclo*hexane (purest preparation so far) has $\lambda_{max.}$ 232, 276, 285, 317 mμ ($E^{1\%}_{1cm.}$ 240, 93·6, 87·3, 28·4, respectively). This compound is almost certainly a polycyclic compound more unsaturated than either Compound SB or SA, but although the spectrum closely resembles certain naphthalenic compounds, the chromophore cannot be identified. The fact which emerges clearly from a good deal of patient work is that the occurrence of Compound SC

coincides with the disappearance of vitamin A, but since Compound SC increases in amount after the vitamin has gone it clearly is not derived from vitamin A.

So far we consider Compound SC to be derived from a sterol by dehydrogenation. It seems from our results that the quantity of 7-dehydrocholesterol (or a chromophorically identical substance) may be increased or decreased in vitamin-A-deficient animals according to the particular tissue under investigation. The change is however often quite marked. This compound (VI) is of course provitamin D_3.



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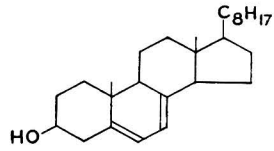
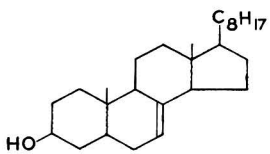


(VI)

A cholesterol dehydrogenase[44] occurs in many tissues (guinea-pig intestinal mucosae seem to be the richest source) but it is now difficult to maintain that the activation of provitamin D_3 to form vitamin D_3 is a full explanation.

In fact, new aspects of the metabolism of sterols are raised by the vitamin-A deficiency syndrome. Among the cholesterol derivatives which may be concerned are cholest-7-en-3-β-ol (VII), cholesta-5 : 7-dien-3-β-ol (provitamin D_3) (VI), cholest-5-en-3-β-ol-7-one (VIII) and cholesta-3 : 5-dien-7-one (IX).



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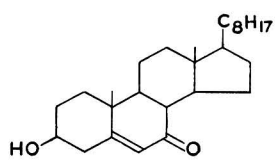

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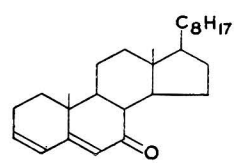

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The question of the validity of this picture is not at the moment very relevant. The fact, which seems beyond any doubt, that a new and abnormal metabolite accumulates in vitamin-A deficiency represents the first opening on the chemical side of the systemic mode of action.

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THE MEASUREMENT OF SOIL STRUCTURE AND FACTORS AFFECTING IT: A REVIEW

By A. H. CORNFIELD

Imperial College of Science and Technology, London, S.W.7

THE importance of suitable soil physical conditions for good plant growth has long been realized by soil scientists. The continual flow of literature dealing with the physical properties of soils testifies to the importance of the subject and indicates that many problems have as yet to be solved. The purpose of this paper is to review recent work on one aspect of soil physics, namely soil structure, with particular reference to soil aggregation, since it is this aspect of structure which has received most attention during recent years. Stallings[1] has made a general survey of the literature on this subject published up to about 1950, whilst Low[2] has briefly reviewed methods of assessing structure.

Measurement of structure

Most of the studies on structure have involved some form of aggregate analysis by wet sieving as introduced by Tiulin[3] and subsequently modified by Yoder.[4] One difficulty which has arisen in connexion with this method has been to find a suitable method of expressing results. Many workers have used just one size class, e.g. water-stable aggregates greater than 0·25 mm. Procedures such as the geometric mean method or the mean weight diameter method, which utilize all size fractions, have been favoured by other workers, but they are somewhat more time-consuming. In this connexion recent work reported by Schaller & Stockinger[5] on a comparison of the various methods is of interest. They found, for a variety of soils from a number of experiments, that there were very high correlations between results expressed by using the percentage of water-stable aggregates greater than 2 mm. or 1 mm. and those expressed by both the geometric mean and mean weight diameter methods. The percentage of water-stable aggregates greater than 0·25 mm. did not in all tests correlate very well with the other methods. Although the reproducibility of results using the larger single size fractions was not quite as satisfactory as were those obtained with the other methods, it would appear that for routine work the former method of expressing results would be satisfactory. Low,[2] however, has given an example which indicates the danger of using a single size fraction. He found, in a study of changes of aggregate stability of an old arable soil which had been put to grass that, as the obvious physical condition of the soil improved with time under grass, the percentage of water-stable aggregates between 0·25 and 1 mm. decreased whilst those greater than 3 mm. increased. The utilization of the single fraction of aggregates greater than 0·25 mm. would have indicated that no changes in aggregation had taken place. It is interesting to note that the Physical Analysis Committee of the Soil Science Society of America[6] have recently recommended the adoption of the mean weight diameter method with a view to obtaining some uniformity in the expression of results.

Soil samples are usually air-dried prior to being subjected to wet sieve analysis. Low[2] has shown that the actual moisture content of the ' air-dried ' soil prior to wet sieving may be critical, and he suggests that all samples should be brought to a standard degree of wetness, for example, by being maintained at a standard humidity for some days prior to analysis. Evans[7] found that when air-dried soils were wetted to the moisture equivalent and then incubated for 24 hours prior to analysis, aggregation was higher than when the soils were wetted to the same degree 5 minutes prior to analysis.

The stability of aggregates to the action of falling water drops has been used as a test which simulates the aggregate-disrupting effect of raindrops. Emerson & Grundy[8] have described a rapid and sensitive method of assessing the cohesion of aggregates based on this method. Cernuda *et al.*[9] found that initial soil moisture was of importance in this type of test, in that the ease of destruction of aggregates increased with decreasing initial soil moisture content. Since field soils seldom become drier than about the wilting percentage (pF 4·2), it is suggested that this is probably a better starting point than using air-dried aggregates.

In recent years the wet sieving method has been criticized by a number of workers (Emerson,[10] Reeve[11]). The main criticism is that since the soil is subjected to a continual mechanical disturbance the apparent stability of aggregates decreases with time of sieving. This has led to the adoption of methods in which the sample is disturbed as little as possible during the measurement. For example, Emerson[10] describes a method in which the sample is first wetted with strong sodium chloride solution under suction, so as to avoid breakdown due to slaking, and then percolated with sodium chloride solutions of successively decreasing concentration. That concentration of sodium chloride, called the critical concentration, at which permeability falls effectively to zero because of complete dispersion of the aggregates, is taken as a measure of aggregate stability. The method clearly showed differences in aggregate stability between soils which had been subjected to different treatments, e.g. the critical concentrations of a soil which had received no manures, one which had received both inorganic and organic manures for 80 years, and one of adjoining grassland were 0·034N, 0·005N, and less than 0·0003N respectively. Reeve[11] has suggested the use of the air–water permeability ratio, i.e. the ratio of the intrinsic permeability of sample to air to that of the same sample to water, as a measure

of structure. Details of the technique used are described by Reeve & Brooks.[12] The permeability ratio varied from slightly more than unity for a highly water-stable soil to about 10,000 for a highly unstable alkali soil. The method also reflected changes in structure due to treatment of the soil with synthetic soil conditioners. Kirkham & Feng[13] and Swartzendruber *et al.*[14] have studied the value of the rate of capillary adsorption of water by soils as a possible index of structure. The method was found to correlate well with other methods of assessing structure only for soils treated with synthetic soil conditioners and for undisturbed clods taken below the A-horizon. For samples taken in the A-horizon, the method was not a good index of structure, and this was attributed to the action of the organic matter in increasing the wetting angle.

Greacen & Huon[15] used glass-sided cells to follow changes in the structure of aggregates during permeation. It was found that when sodium chloride solution was introduced into the cells there was a sudden increase in aggregate size accompanied by a considerable decrease in permeability; this was soon followed by a complete collapse of aggregates, after which permeability fell to zero. When calcium-saturated aggregates were permeated with water there was little evidence of micro-erosion either in the form of aggregate breakdown or silting up of pores.

Richards[16] has described an apparatus for determining the modulus of rupture of soils and has shown that this value may be a useful index of crusting. Payne & Fountaine[17] have described a torsional shear box for measuring the shear strength of soils in the field.

It would appear, however, that the wet sieving method is still the main method used for assessing the aggregate status of soils. In the next section of this review, where factors affecting structure are considered, the expressions 'improved structure', 'improved aggregation', etc., will, except where otherwise indicated, mean that aggregation as measured by the wet sieving method has improved.

Factors affecting structure

The effect of seasonal variations of structure have been reported by Kämpf.[18] A loess-loam soil had optimum structure in June. Structure then tended to deteriorate under the puddling influence of rain in the autumn but was improved again by frost action in winter. Further deterioration occurred until microbial action was resumed in spring. The 1–3 mm. aggregates, which were considered to have been formed by the action of micro-organisms, had a higher water-stability and showed less seasonal changes than had aggregates of greater or lesser size which were thought to have been formed by chemical and physical processes. Chepil[19] found that frost action tended to break down the large water-stable aggregates and at the same time to aggregate the finer water-stable particles to an intermediate size of water-stable aggregates. During summer the reverse tendency occurred, namely, a reduction of intermediate size aggregates accompanied by an increase in small and large sizes of aggregates. Seasonal fluctuations in structure were not apparent below the 3-in. soil depth.

It has probably now been accepted generally that the effect of the calcium ion in improving structure is due to its ability to flocculate soil clays rather than to any cementing effect of the calcium ion. The findings by Robinson & Page[20] and Mazurak[21] that artificial aggregates formed from base-free clays were more stable to wet sieving than were those formed from calcium-saturated clays, and also that aggregate stability decreased with increasing percentage calcium saturation, confirms this. The comparative effects of potassium and sodium on stability have been reported by Reeve *et al.*,[22] who found that whilst an increase in the percentage sodium saturation usually resulted in a reduction in the stability of aggregates (as measured by the air–water permeability ratio) as well as increased susceptibility to crusting, similar increases in the percentage potassium saturation usually had little effect on either factor.

The clay fraction of soils is known to be one of the most important cementing agents to which aggregates owe their stability. Recent work on this aspect has been concerned with the aggregating effect of different clay types. Mazurak[23] found that aggregates formed from bentonite and hydrous micatype clays were somewhat more stable to wet sieving than were those formed from kaolinite. Robinson & Page[20] showed that whilst dry aggregates of calcium-saturated kaolinite and illite showed little or no breakdown when wetted under vacuum, those

of montmorillonite showed a slow but complete disintegration, presumably due to the swelling to which montmorillonite is subject on being wetted.

It has now been more or less established that the beneficial effects which organic matter exerts on aggregation are due to the chemical and microbiological changes which occur after organic manures are added to the soil. Robinson & Page[20] consider that humus promotes aggregate stability by reducing swelling and the destructive forces of entrapped air and by decreasing the wettability of the clay. Emerson[10] suggests that this reduced wettability may be the reason for the correlation frequently found between the water-stability of aggregates and their organic matter content.

In an attempt to assess the relative importance of the various cementing agents in promoting aggregation, Kvaratskhelia[24] subjected soils to successive treatment with various reagents. Treatment with benzene, which removed resinous materials, decreased the number of macro- but not of micro-aggregates. Treatment with sodium oxalate–sodium hydroxide, which removed organic colloids and dispersed the clay, resulted in the greatest disruption of aggregates. However, even after these treatments were followed by Tamm's oxalate reagent and sodium hypobromite, whereby nearly all humic matter was removed, micro-aggregates were still present on grass roots from soil samples taken from podsolic soils under grass. It was considered that the most active agents in structure formation are grass roots which compress soil particles into discrete aggregates, to which water stability is then imparted by organic cements formed from humic matter.

It has been shown frequently that the products of microbial activity, such as mucins, gums, and polyuronides, are of importance in improving structure. Since the type of microbial activity is dependent on the cation status of the soil it might be expected that variation in this status would affect aggregation. In a recent paper Aldrich & Martin[25] found that where variations in the numbers of organisms were produced by changes in the cation status of the soil, the effects upon aggregation were not comparable with changes observed in the numbers of organisms. For example, in soil treatments involving different levels of exchangeable hydrogen, a change of microbial population from one composed mainly of bacteria and actinomyces to one made up primarily of fungi had little effect on degree of aggregation. Also, the dispersing effect of the sodium ion on both organic and inorganic colloids far outweighed the beneficial aggregating effect which may have accrued through the ability of the increasing sodium status to increase the microbial numbers of the soil. With regard to the effect of different types of organic matter, Aufhammer & Kämpf[26] found that leguminous materials had a much better aggregating effect on soils than had cereal straw or forest litters, whilst peat had very little effect in this respect.

It has long been known that the most effective practical method of improving soil structure is to put the soil to grass for a year or longer. Recent work on this aspect has been concerned with comparing the structure-improving effects of different grass–legume mixtures as well as of grasses and legumes grown in pure stand. Rodionovskii[27] found that grass–legume mixtures had a much greater structure-improving effect than had grasses or legumes grown separately. This was considered to be due to the denser and more even root distribution and the enhanced quantity and quality of the humus produced by the mixture. Burov[28] reports that the extent of aggregation induced by grass–legume mixtures was proportional to the shoot and root mass. Bolton & Webber[29] found that in the 0–4-in. soil layer the aggregating effects of crops decreased in the order Kentucky bluegrass, lucerne–bromegrass (second year), lucerne–bromegrass (first year), oats, continuous maize. Bluegrass improved aggregation even in the 4–12-in. soil layer. Barley[30] reports that a cocksfoot–white clover pasture had a better aggregating effect than had ryegrass–white clover and ryegrass–lucerne. Koshelkov *et al.*[31] consider that the improved structure arising from the application of inorganic fertilizers to grassland is due mainly to their effect in stimulating the growth of the sward. Applications of nitrogen and phosphate improved structure, whilst potash applications had no effect. These reports indicate that the interrelationship between the nature of the herbage crop and the extent to which aggregation is improved is complicated and will be established only by much further work.

The increasing use of heavy agricultural machines has stimulated work on their effects on structure, and more especially on compaction. Day & Holmgren[32] found that plastic

deformation was a dominant mechanism in the compression of loose assemblages of moist soil aggregates. The compressibility of soil was affected considerably by its water content, which acted predominantly by altering the shearing strength of the aggregates. Jamison *et al.*[33] found that the depth of compaction due to tractors increased with moisture and initial looseness of the soil. They stress that heavy machinery operations should take place at the lowest possible soil moisture contents. Gliemeroth[34] reports that compaction due to tractors extended to a greater depth than did that due to treading by horses. Frei & Keller[35] found that even though sugar-beet cultivation machinery compacted the soil, this had no effect on emergence, whilst the compaction induced by rainfall of high intensity had an adverse effect on emergence. It is common practice to compact light-textured soils by rolling or folding sheep on them. On the other hand compaction of heavy soils must be avoided as much as possible. For soils of intermediate texture it is possible at the moment to tell only by practical experience whether or not compaction is desirable. It would appear that a simple laboratory or field test to establish this point would be extremely useful.

Kämpf & Wagner[36] have reported on the effect of plant protection materials on soil structure. They found that even the application of 20 times the normal rates of 2,4-D (amine), 2,4,5-T, benzene hexachloride, or DNOC had no adverse effect on structure, whilst 2,4-D (sodium salt), a sulphur fungicide, and DDT had an adverse effect on structure. A copper fungicide and E605 were harmful to structure even at normal rates of application. Van Bavel[37] found that partial sterilization of soils with ethylene dibromide or by steaming significantly increased aggregation during incubation under sterile conditions, but not when the soils were inoculated prior to incubation. Martin & Aldrich[38] found that although fumigation treatments (DD, chloropicrin, carbon disulphide, propylene oxide, and ethylene dibromide) markedly increased microbial population, they had little effect on aggregation after varying periods of incubation. Steaming resulted in a slight temporary increase in aggregation in some of the soils used. The few results published to date indicate that, in general, the amounts of plant protection materials that are added to soils or that are likely to reach the soil in the form of spray or dust residues are very unlikely to have any direct adverse effects on structure.

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SOME CHEMICAL ASPECTS OF RESEARCH ON PLANT GROWTH SUBSTANCES*

By R. L. WAIN

Wye College, University of London

THE discovery by Kögl in 1934 that indol-3-ylacetic acid was an active growth substance, which led directly to the study of aryl- and aryloxy- alkanecarboxylic acids, is considered by some to represent the greatest contribution which science has made to agriculture within the past few decades. At the present time, over 100 million acres of the world's surface are sprayed annually with such compounds for weed control. In addition, growth substances find important uses in promoting the rooting of cuttings, preventing fruit drop, prolonging dormancy and setting fruit in absence of pollination. As these and other applied aspects have recently been reviewed[1] they will not be discussed further here.

Since growth-regulating properties can be shown not only by aryl- and aryloxy-acids but by simple molecules like ethylene and carbon monoxide, as well as by certain benzoic and naphthoic acids, it is unlikely that the mode of action of all growth substances is the same. The growth response may well arise from a disturbance in a complex series of biochemical reactions associated with growth, one molecule acting at a certain point, another elsewhere in the chain. Such considerations justify studies on the relationship between chemical structure and growth-regulating activity in say the aryloxy-acids—the type of investigation which has been carried out at Wye over the past few years. In all such work, the assessment of growth-regulating activity is of great importance. Since some compounds are active in certain tests and not in others, it is necessary to use a range of tests in order to obtain a reliable assessment. Some of these depend mainly on a cell elongation response and in others, cell division is also involved. For critical work, the wheat cylinder elongation test and the pea curvature test are important. The former method depends on linear growth measurements of cylindrical pieces of wheat coleoptile immersed in a solution of the compound, and the latter on measurements of inward curvature induced in divided pea shoots placed in a solution of the substance. Another method which we have employed is the tomato leaf epinasty test in which application of the growth substance in lanolin to the leaf axil causes the angle between leaf petiole and main stem to increase.

A study we have made of all the chloro-, dichloro- and certain trichloro-phenoxyacetic, α-phenoxypropionic, α-phenoxybutyric and α-phenoxy*iso*butyric acids and of the corresponding series of phenylthioalkanecarboxylic acids has indicated that for growth-regulating activity depending on cell elongation, at least one hydrogen atom must be present on the carbon atom adjacent to the carboxyl group. Other structural requirements for activity are the unsaturated ring system and the carboxyl group. Substitution into the nucleus of phenoxyacetic acid, itself a compound with practically no growth-regulating properties, can have a profound effect on activity. Thus, for example, the 2 : 4-dichloro- and 2 : 4 : 5-trichloro-derivatives are very potent growth-substances, whereas the 2 : 6-dichloro- and 2 : 4 : 6-trichloro-acids are almost completely inactive. 3 : 5-Dichloro-substitution is likewise not consistent with high activity. Although a number of theories have been put forward to explain such findings, none can be regarded as completely acceptable.[2]

The three essential groupings present in active aryloxy-acids, namely, unsaturated ring system, α-hydrogen atom and carboxyl group are arranged round the asymmetric carbon atom in α-aryloxypropionic and α-aryloxybutyric acids. α-(2-Naphthoxy)propionic acid has been resolved and the (+)- and (−)-enantiomorphs examined as growth substances.[3] In all tests employed, the (+)-isomer showed high activity, whereas little, if any, was shown by the (−)-isomer. The racemic acid was found to possess intermediate activity. Similar results were obtained with the (+)- and (−)- forms of α-(2 : 4-dichlorophenoxy) propionic and α-(2 : 4 : 5-trichlorophenoxy)propionic acids,[4] and it is of interest to note that all three (+)-acids and the

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active isomers of other α-aryloxy-propionic acids resolved elsewhere, have the same configuration.[2] Consideration of all these results led to the formulation of a hypothesis on the mode of action of aryloxy acids which involves association of the three essential groupings, namely, ring system, —COOH group and α-hydrogen atom, with specifically placed receptor groups at a surface boundary representing primary site of action.[3, 4] Such considerations are consistent with the marked differences in activity shown by (+)- and (−)-enantiomorphs and explain the negligible activity of aryloxy*iso*butyric acids. On the basis of this theory, (−)-isomers, although themselves incapable of providing the three essential groupings in the correct relative positions, might well provide some groupings to receptor centres. Should this occur, one might expect the (−)-isomer to antagonize the activity of the (+)-isomer when the two are tested together. Using the wheat cylinder elongation test, such competitive antagonism was in fact demonstrated; indeed, at certain concentrations, the high activity of the (+)-isomers was found to disappear completely when a relatively large excess of the (−)-isomer was present.[4]

The above account of these investigations on the relationships between molecular structure and growth-regulating activity has only been given briefly, for the work has been recently reviewed.[2] It is more appropriate now to consider some of our more recent investigations involving enzymic breakdown of certain aryloxy-acids within plant tissues, for these have led to developments in the field of selective weed control which promise to be of agricultural importance.

That β-oxidation is a means by which fatty acids are degraded in the animal body, first suggested by Knoop,[5] has now been firmly established and, within recent years, some evidence that such oxidation may occur in plant tissues has been obtained. Thus, Synerholm & Zimmerman,[6] studying the growth-promoting activity of the first seven homologues of the ω-(2 : 4-dichlorophenoxy)alkanecarboxylic acid series ($C_6H_3Cl_2 \cdot O \cdot [CH_2]_n \cdot CO_2H$) in the tomato leaf epinasty test, found that only the acetic derivative and its alternate homologues were active (see also Grace[7]). These results were explicable on the basis of β-oxidation of the side chain; by such means, the butyric, caproic and octanoic derivative ($n = 3, 5, 7$) might be expected to yield the active acetic acid (2 : 4-D), whereas the propionic, valeric and heptanoic acids ($n = 2, 4, 6$) would yield 2 : 4-dichlorophenol, inactive as a growth substance.[6]

e.g. $ArO \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot CO_2H \rightarrow [ArO \cdot CH_2 \cdot CO \cdot CH_2 \cdot CO_2H] \rightarrow ArO \cdot CH_2 \cdot CO_2H$

butyric derivative ($n = 3$) — acetic derivative

$ArO \cdot CH_2 \cdot CH_2 \cdot CO_2H \rightarrow [ArO \cdot CO \cdot CH_2 \cdot CO_2H] \rightarrow [ArO \cdot CO_2H] \rightarrow ArOH$

propionic derivative ($n = 2$) — phenol

This biological evidence for β-oxidation was supported by the results of an investigation[8] in which flax seedlings were supplied through their roots with ten homologues of the ω-phenoxyalkanecarboxylic acid series $C_6H_5 \cdot O \cdot [CH_2]_n \cdot CO_2H$. Thus, when the treated seedlings were macerated and steam-distilled, appreciable quantities of phenol were only obtained from those acids containing an even number of side-chain methylene groups ($n = 2, 4, 6, 8, 10$). In addition to these chemical results, we have obtained considerable biological evidence that β-oxidation of ω-phenoxy-acids can occur within plant tissues. In all this work, the methods for assessing plant growth-regulating activity mentioned above were employed, namely the wheat cylinder elongation test, the pea curvature test and the tomato leaf epinasty test. A number of series of ω-phenoxyalkanecarboxylic acids, substituted in the nucleus, were examined and in most cases, e.g. the 4-chloro-, 2 : 4-dichloro-, 3 : 4-dichloro- and 2-methyl-4-chloro- derivatives, the alternation in activity which we associate with β-oxidation was exhibited in all three tests. With other series, however, e.g. the 2 : 4 : 5-trichloro- and 2 : 4-dichloro-5-methyl- derivatives, although the alternation was shown in the cylinder test, all homologues higher than the acetic were inactive in the pea and tomato tests.[9, 10] It had previously been reported[6] that γ-(2 : 4 : 5-trichlorophenoxy)butyric acid is inactive in the tomato test, but our finding that this compound,

for example, and its alternate homologues are active in one test and not in another was an important new development, for it indicated that specific β-oxidase enzyme systems may be present in the tissues of different plant species. Working with the 2 : 4 : 5-trichloro-acids, further evidence that this was the case was obtained by direct experiment. Solutions of the seven homologues were allowed to stand with wheat coleoptile tissue. They were then found to show the typical alternation in activity in the pea test, indicating that only alternate members of the series had been degraded to the active acetic acid by β-oxidation.[10] In other experiments it was proved by chromatographic and biological methods that γ-(2 : 4 : 5-trichlorophenoxy)butyric acid was in fact degraded to the acetic derivative in presence of wheat coleoptile tissue.[10] More evidence that β-oxidation of specific compounds may occur in certain plant tissues and not in others was obtained in investigations with a series of ω-(1-naphthyl)-acids. The effect on activity of substituting alkyl groups into the α- or β-positions of the side chain was also studied and shown to be consistent with these theoretical considerations.[10]

The possibility arising from this work that the β-oxidase enzyme systems present in plants may show marked substrate specificity indicated a new and fundamental principle upon which selective weed control might operate. Accordingly it was decided to investigate whether the responses of intact plants to members of these series of substituted phenoxy-acids were consistent with what would be expected from degradation of the side chain by β-oxidation. Very striking evidence for this was obtained in certain cases. Thus, for example, when Annual Nettle (*Urtica urens*) or Creeping Thistle (*Cirsium arvense*) plants were sprayed with 0·1% solutions of ω-(2-methyl-4-chlorophenoxy)alkanecarboxylic acids, the acetic, butyric and caproic derivatives produced a drastic effect, killing the plants within three weeks. On the other hand, those plants sprayed with propionic, valeric and heptanoic derivatives remained unaffected.[9] This type of behaviour, however, was not obtained with all the plant species which were susceptible to the acetic acid. When young celery plants, for example, were sprayed with the above solutions, the acetic derivative produced drastic growth effects but all other homologues were inactive.[9] Such observations as these strongly supported the idea that a new type of selective weed control based upon enzyme make-up was possible.

This season a wide range of crop plants and weeds have been treated with various substituted γ-phenoxybutyric acids and the results leave no doubt that some of these compounds have a part to play in selective weed control. Experiments carried out, for which detailed results are available,[11] have included the spraying of potted crop plants and weeds in the glasshouse and a number of small-scale field trials have also been undertaken.

On present evidence, γ-(2-methyl-4-chlorophenoxy)butyric acid (MCPB) appears to be the most promising of these new herbicides, although γ-(2 : 4-dichlorophenoxy)butyric acid (2 : 4-DB) also shows possibilities. We have found that both of these compounds will control a number of noxious weeds such as Annual Nettle, Creeping Thistle, Fumitory (*Fumaria officinalis*), Fat Hen (*Chenopodium album*) and Charlock (*Sinapsis arvensis*) with one application of 2 lb. per acre. Such treatment, however, was found to be safe with respect to certain crop plants. Amongst these, clover is perhaps the most important agriculturally, for the chemical control of weeds in grassland or in corn undersown with clover has always proved difficult owing to the danger of destroying this valuable legume crop. Weed control in celery, carrot, parsnip, lucerne, flax and pea crops also appears to be a possibility with certain of these materials[11] and no doubt other specific uses will be found.

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KAMALA SEED OIL

By J. S. AGGARWAL

National Chemical Laboratory of India, Poona, India

Kamala, kamila or Rohini, botanically known as *Mallotus philippinensis* Muell. Arg., belongs to the N.O. Euphorbiaceae. It is a small evergreen tree found throughout tropical India along the foot of the Himalayas from Kashmir eastwards up to 5000 ft., all over the Punjab, Utter Pradesh, Bengal, Assam, Burma, Singapore and from Sind southwards to Bombay and Ceylon. It is also reported as growing in China, the Malaya islands and Australia. The tree is noted for the kamala dye which is a powdery substance obtained as a glandular pubescence from the exterior of the fruit. Besides imparting a beautiful bright durable orange colour to silk, the dye—the active principal of which is rottlerin—possesses anthelminitic and purgative properties, and is also an antioxidant towards various oils and fats.[1] The seeds are black in colour and about 7000 maunds can be collected annually in India.

The drying properties of the oil were first mentioned by Brodie[2] in 1937. Some initial characteristics of the oil were reported from the Forest Research Institute (F.R.I.), Dehra Dun,[3] in 1941–42, by Singh & Saran[4] in 1942 and from the Harcourt Butler Technological Institute, Kanpur,[5] in 1949. The work on kamala seeds was started in the laboratories of the Council of Scientific & Industrial Research (C.S.I.R.), Delhi,[6] in 1946, when it was found that the seeds contain about 60% of kernels. Benzene and light petroleum (40–60°) were found to be the best solvents for the extraction of kamala oil. The last traces of benzene are, however, difficult to remove and unless a high vacuum is applied for solvent stripping, the oil polymerizes. The characteristics of the oil as determined by various investigators are given in Table I.

Table I

Characteristics of kamala oil

Characteristics	C.S.I.R. Delhi[6]	F.R.I. Dehra Dun[3]	Singh & Sarin[4]	H.B.T.I. Kanpur[5]
Kernels in seeds, %	60	47	—	49·6
Solvent used for extraction	Light petroleum	Light petroleum	Benzene	Ethyl ether
Oil in kernels, %	32	50	48·8	35·1
Colour and consistency	light brown viscous	reddish brown viscous	dark brown	viscous
Specific gravity	0·9409 (40°)	0·8860 (30°)	0·9333 (30°)	0·9444 (30°)
Refractive index 30°	1·5052	1·5105	1·5155	—
Viscosity 40° (centistokes)	386·3	—	—	—
Acid value	6·4	5·7	11·3	5·2
Saponification value	195·0	178·3	207·6	190·7
Unsaponifiable matter, %	1·7	1·75	1·9	2·3
Acetyl value*	15·7–44	49·24	46·8	—
Hehner value	95·6	—	96·1	96·4
Titer test	45·5°	51–52°	—	—
Hexabromide value	0·3	—	—	—
Carbonyl value	nil	26	—	—
Iodine value	166 (Wijs)	183·2 (Hanus)	157·3 (Wijs)	—
Iodine value (Woburn A)	185·6	—	—	—
Iodine value (Woburn B)	179·8	—	—	—
Partial iodine value (Wijs 2 min.)	122·6	—	—	—
Diene value (difference of total and partial iodine values)	57·2	—	—	—
Diene value (maleic anhydride, Ellis & Jones method)	40·4	42·9	—	48·5
Saturated acids, %	12·3	—	—	—
Browne heat test	9·5 min.	2 min.	—	—

* In the determination of the acetyl value by means of acetic anhydride either alone or in the presence of pyridine, the oil is polymerized to a semi-solid mass during the process.

The characteristics of the total fatty acids as obtained at the National Chemical Laboratory (N.C.L.)[7] and by Puntambekar[8] at F.R.I. are given in Table II.

Table II

Characteristics of total fatty acids

Characteristics	N.C.L.[7]	F.R.I.[8]
Mean molecular weight	281·2	300·6
Iodine value	182·7 (Woburn B)	168·0 (Hanus)
Diene value (Ellis & Jones)	56·6	58·0
Carbonyl value	nil	60·0

The difference between the carbonyl values of the oil and the total fatty acids determined by Puntambekar as 26 and 60 is surprisingly large. These values for the *total* raw oil, the refined oil and its total fatty acids have been determined at the N.C.L.[7] by the method of Trozzolo & Leiber[9] and have been found to be 4·4, 4·2 and 5·5, respectively. The corresponding values determined by the method of Leithe[10] were nil for all the three samples. As pointed out by the first authors such slight values are caused by the interfering effect of conjugated double bonds even in those compounds which have no carbonyl group.

It was found at the C.S.I.R. laboratory[6] that the separation of total kamala oil fatty acids into saturated and unsaturated constituents by the usual lead salt–alcohol method was not possible, the iodine value of the soluble and insoluble fractions being 177·0 and 143, respectively. Also some of the acids were polymerized during the treatment. It was, however, found[7] that if light petroleum (40–60°) is added to the total fatty acids, an insoluble acid was obtained which melted at 78–79° after crystallization from benzene and/or ethyl acetate. When the light petroleum suspension of this acid is irradiated in ultra-violet light in presence of traces of iodine, it is changed into its β-isomer melting at 90–91°. Both the acids were found to have the empirical formula $C_6H_{10}O$ and neutralization equivalent 293–294. If the acid is monobasic, the molecular formula is therefore $C_{18}H_{30}O_3$. The two isomeric acids have been designated as α- and β-kamlolenic acids respectively. The β-acid can be directly obtained from the total fatty acids by irradiating a solution in light petroleum in ultra-violet light in presence of traces of iodine. A small quantity of the same acid can be isolated when the light petroleum mother-liquor obtained after the removal of α-acid is irradiated in ultra-violet light in presence of traces of iodine and cooled. The characteristics of these two acids are given in Table III.

Table III

Characteristics of α- and β-kamlolenic acids

Characteristics	α-Kamlolenic acid	β-Kamlolenic acid
Neutralization value	190·9	191·1
Neutralization equivalent	293·3	293·0
Iodine value (Wijs)	186·3	195·4
Iodine value (Woburn B)	236·8	248·9
Partial iodine value (Wijs 2 min.)	172·6	173·6
Diene value (difference of total and partial iodine value)	64·2	74·7
Diene value (Ellis & Jones)	120·6	120·6

The alkali soaps of both acids are sparingly soluble in water, β-acid soaps being less soluble than those of the α-acid. Both the acids are unstable and polymerize after about two days ; the polymerized materials are partially insoluble in chloroform and carbon tetrachloride. The acids do not give phenylhydrazones or semicarbazones. Both acids on bromination in chloroform solution absorb four atoms of bromine per molecule of the acid. On catalytic reduction with platinum they both absorb six atoms of hydrogen per molecule corresponding to three double bonds giving the same 18-hydroxystearic acid, $OH{\cdot}(CH_2)_{17}{\cdot}CO_2H$, melting at 99–100°, confirmed by its acetyl derivative (m.p. 72°) and methyl ester (m.p. 62·0–62·5°). The identity of 18-hydroxystearic acid thus produced was further confirmed by oxidation of the acid in acetone solution with potassium permanganate when hexadecamethylene-1 : 16-dicarboxylic acid, $HO_2C{\cdot}[CH_2]_{16}{\cdot}CO_2H$ melting at 125–126°, was obtained. The nature of this acid was further confirmed from its equivalent weight and characteristics of its dimethyl ester. The position of the hydroxyl group in the terminal position to the carboxyl group in the original α- and β-kamlolenic acids was thus established by this indirect method because these unsaturated acids, like kamala oil itself, could not be acetylated with acetic anhydride.

Puntambekar,[8] however, has not accepted it as a convincing argument of the presence of the hydroxyl group in the terminal position in the original α-kamlolenic acid. On the basis of his results for the carbonyl values of the oil and its fatty acids and those obtained in his lead salt–alcohol separation in which about 20% of the acids were polymerized, he concluded that the conjugated unsaturated acids are a mixture of polyethenoid C_{18}-keto-acid and isomeric elaeostearic acid. On this scanty data and on the oxidation and bromination results of the liquid acids and also the fractional crystallization of the solid acids, Puntambekar gave to the polyethenoid C_{18} keto-acid and isomeric elaeostearic acid, structures I*a* and I*b*, or II*a* and II*b*.

I (*a*) $CH_3{\cdot}[CH_2]_9{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CH_2{\cdot}CO{\cdot}CH_2{\cdot}CO_2H$
Isomeric keto-linoleic acid

(*b*) $CH_3{\cdot}[CH_2]_3{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}[CH_2]_7{\cdot}CO_2H$
Elaeostearic acid

II (*a*) $CH_3{\cdot}[CH_2]_3{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CO{\cdot}[CH_2]_6{\cdot}CO_2H$
Keto-elaeostearic acid

(*b*) $CH_3{\cdot}[CH_2]_9{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CH_2{\cdot}CO_2H$
Isomeric elaeostearic acid

He is of the opinion that after irradiation the keto-acid tautomerizes to the enolic form which gives the acetyl value on reduction with hydrogen. He also arbitrarily gave the following composition to the mixed acids of the kamala seed oil :

	%
Oleic	28·6
Linoleic	2·4
Polyethenoid keto-C_{18}	25·7
Isomeric elaeostearic	38·4
Saturated acids	4·5

Puntambekar considers that the two conjugated acids will be very reactive and on this basis he explains the 2-min. Browne heat test value of kamala oil. However, oiticica oil which contains licanic acid having a carbonyl group and conjugated double bonds, has a much higher Browne heat test value (~ 24 min.) than tung oil which contains elaeostearic acid having no carbonyl group (10–12 min.).

The α- and β-kamlolenic acids have later been acetylated with acetyl chloride in ether solution,[11] the acetylated products melting at 43–44° and 58–59°, respectively, and giving almost the theoretical acetyl values (162–164 ; theoretical 166·9). Thus the presence of a hydroxyl group in both of these acids has been conclusively proved. The higher diene value (Ellis & Jones) of α- and β-kamlolenic acid (120·6) can be ascribed to the presence of the hydroxyl group which is known to react partly with maleic anhydride.

For ascertaining the position of the three double bonds in α- and β-kamlolenic acids, the products obtained in alkaline aqueous permanganate oxidation were studied, when azelaic, succinic, oxalic acids and a very small quantity of suberic acid were obtained.[7] No steam-volatile acids could be isolated. On the basis of these results the following four structures for the two isomers were suggested, the isomerism between α- and β-forms being geometrical about one or more of the double bonds.

(1) $OH{\cdot}[CH_2]_3{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}CH_2{\cdot}CH{:}CH{\cdot}[CH_2]_7{\cdot}CO_2H$
18-Hydroxyoctadeca-9 : 12 : 14-trienoic acid

(2) $OH{\cdot}[CH_2]_2{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}[CH_2]_2{\cdot}CH{:}CH{\cdot}[CH_2]_7{\cdot}CO_2H$
18-Hydroxyoctadeca-9 : 13 : 15-trienoic acid

(3) $OH{\cdot}[CH_2]_3{\cdot}CH{:}CH{\cdot}CH_2{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}[CH_2]_7{\cdot}CO_2H$
18-Hydroxyoctadeca-9 : 11 : 14-trienoic acid

(4) $OH{\cdot}[CH_2]_2{\cdot}CH{:}CH{\cdot}[CH_2]_2{\cdot}CH{:}CH{\cdot}CH{:}CH{\cdot}[CH_2]_7{\cdot}CO_2H$
18-Hydroxyoctadeca-9 : 11 : 15-trienoic acid

Suberic acid may be formed by oxidation at the eighth carbon atom instead of at the ninth, as has been observed also for elaeostearic acid. Malonic acid, which must be one of the products of oxidation, must have been decomposed during the process.

In order to exclude one or more of the alternative structures referred to above, a study of the permanganate oxidation products of the maleic anhydride adducts of α- and β-kamlolenic acids was attempted, as was done by Morrell & Samuels[12] and Morrell & Davies[13] for elaeostearic and licanic acids respectively. Azelaic acid was obtained in both instances, which can only be possible if the structure of the isomers is either (1) or (2) : formulae (3) and (4) are thus excluded. The ultra-violet absorption spectra, however, are identical with those of α- and β-elaeostearic acids ($E^{1\%}_{1\,cm.}$ = 1800 at 270·5 mμ and 1990 at 268 mμ), and hence both α- and β-kamlolenic acids are 18-hydroxyoctadeca-9 : 11 : 13-trienoic acid[11, 14] containing all the three double bonds in conjugated positions :

$$OH\cdot[CH_2]_4\cdot CH{:}CH\cdot CH{:}CH\cdot CH{:}CH\cdot[CH_2]_7\cdot CO_2H$$

A proof for the existence of $[CH_2]_7$ chain adjacent to the carboxyl group has been obtained from the products of ozonization of α- and β-kamlolenic acids, when azelaic half-aldehyde was obtained from both the cases. δ-Hydroxyvaleraldehyde was also obtained from the products of ozonization,[15] showing thereby that the third double bond in kamlolenic acid is present between carbon atoms 13 and 14. The infra-red spectra of α- and β-kamlolenic acids have indicated the positions of the three double bonds as *cis*-9, *trans*-11, *trans*-13, and *trans*-9, *trans*-11, *trans*-13, respectively.[16] Similar conclusions on the constitution of kamlolenic acid have been recently reported by Calderwood & Gunstone[17] and Crombie & Tayler.[18]

The presence of 57–65% kamlolenic acid as a major component renders impossible the extraction of the whole of the oil (34–35%) from the seeds with light petroleum and only 16–19% of the oil (containing 38–50% of kamlolenic acid) can be extracted with the different fractions of this solvent. The residual 15–17% of oil is a very viscous material containing 72–80% kamlolenic and can be extracted with ethyl ether. Ethyl ether, ethyl acetate and benzene extract all the oil from the seeds.[19] Chlorinated solvents and acetone are not suitable for this purpose.

The composition of the fatty acids[20] of kamala oil has been derived mostly from the ultra-violet absorption spectrophotometric technique from which kamlolenic and linoleic acid contents could be computed. The saturated acids were found by the Bertram method and subsequent ester fractionation of these acids. Oleic acid is determined by difference. The fatty acid composition of the *total* kamala oil found as above is as follows :[20]

	%
Kamlolenic acid	57·5–58·5
Conjugated diene acid	2·0–4·5
Linoleic acid	11·7
Oleic acid	13·3–19·6
Lauric acid	0·1
Myristic acid	2·1–2·5
Palmitic acid	7·4–8·7
Stearic acid	0·6–0·7

Preliminary work on the molecular constitution of kamala oil has been recently reported by O'Neill, Dennison & Ahlers[21] who suggest that the oil is wholly or partly a polyester and does not consist entirely of the usual triglycerides of the constituent fatty acids.

Utilization of kamala seed oil

Kamala seed oil extracted with light petroleum behaves very much like tung oil in the preparation of various types of surface coatings. If varnishes are prepared from kamala seed oil using ester gum, congo copal, kauri gum or modified phenolic resins under controlled conditions, wrinkling coatings are obtained on air drying.[22] Pigments may be mixed in these varnishes to give air-drying wrinkling paints. As these varnishes and paints dry in air they can be used for large objects which cannot be conveniently baked in an oven, e.g. doors, house walls, etc., in addition to smaller objects such as typewriters, scientific instruments, toys, etc. Films of alkyd

resins[23] prepared from this oil set to wrinkle patterns on baking. These films are very hard and are resistant to water, various common organic solvents and dilute mineral acids.

A method for the extraction of kamala oil with linseed and other vegetable oils has been patented by the Forest Research Institute, Dehra Dun. The oil thus extracted has been named 'Friol'.[24] This material has been employed in the preparation of paints and varnishes.

Kamlolenic acid may be a useful raw material for the preparation of many commercially useful products such as polyesters, polyamides, germicides, fungicides and wetting agents. Work on these lines is in progress at the National Chemical Laboratory, Poona.

Kamala seed cake

The kamala seed cake on analysis has been found to contain about 48% of proteins and hence will be a useful fertilizer.

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THE DETECTION OF WASHED EGGS. II.—A Rapid Method of Detection*

By J. BROOKS

About 97% of washed or unwashed eggs could be identified correctly by placing small drops of a solution of gelatin and silver nitrate on the shell and exposing the drops to ultra-violet light for 1–1½ minutes. The behaviour of eggs washed in solutions of potassium chloride is described.

* The paper published in *J. Sci. Fd Agric.*, 1955, **6,** 37 is regarded as part I of this series.

Introduction

An earlier paper[1] described an examination of existing methods for the detection of washed eggs and a search for new methods. It was already known that washing reduced the amount of available potassium chloride on or in the shell[2] and diminished the electrical conductivity of a drop of water subsequently placed on the shell.[3, 4] It was found[1] that washing also tended to deplete the surface of the shell of magnesium, but the most promising method was based on the photochemical reduction of silver chloride on a test paper exposed to ultra-violet light.

About 70,000 eggs are graded each day in a medium-sized packing station in this country. The tests that are effective are not sufficiently rapid to make the testing of even a small proportion of these eggs an easy task. This paper describes a rapid and simple test that is as accurate as the chloride test previously described.

As it is potassium chloride that is principally removed from the shell by washing, it will readily occur to the reader that the existing chemical and electrical tests might be circumvented by washing dirty eggs in a solution of this salt. As will be seen, this can be done in the laboratory although it is hardly likely to be achieved elsewhere. The test described in this paper has the advantage that it can be used to detect most of the eggs that have been treated in this manner.

The treatment of eggs with potassium chloride

A drop of distilled water (0·04 ml.) placed on an unwashed egg contains on the average about 0·004% of potassium chloride after 3 minutes' contact.[1] From the area of contact of shell and drop (about 0·22 cm.^{2}), it follows that the shell of an unwashed egg carries on its surface about 7 μg./cm.^{2} of available potassium chloride. A similar value (about 7·5 μg./cm.^{2}) can be deduced from the area of the shell (about 70 cm.^{2} for an egg of average size) and the fact that an unwashed egg sprayed with water yielded on the average about 1·1 mg. of soluble material of which 47% consisted of potassium chloride. The mean electrical resistance of the drop after 3 minutes' contact was 32,000 ohms (Ω), and the drop was therefore equivalent in this respect to a 0·0066% solution of potassium chloride. The difference between this value and the 0·004% of potassium chloride actually present seems to be largely accounted for by the magnesium bicarbonate in the drop.

Although the amount of potassium chloride carried by the shell is very small, a wet egg drains and dries so rapidly that it is necessary to wash it in a relatively concentrated solution if approximately the correct amount of the salt is to be left behind on the dried shell. In Table I are summarized the results of a few experiments in which eggs were soaked in 1% and 0·5% solutions of potassium chloride for 30 minutes and dried in the manner described below. The duration of soaking (up to 2 hours) had little or no influence, and similar results were obtained whether the egg had been previously washed in water or not. Measurements were made on drops of distilled water placed at roughly equal intervals along the shell, the first drop being placed on the apex of the broad end, and the fourth drop on the apex of the narrow end of the egg. The first and third lines of the Table give the mean resistance (kΩ) of the drops to the nearest 1000 ohms, and the second and fourth lines the mean densitometer readings on the test spots[1] corrected for the readings on control spots, ($b - c$).

Table I

The mean resistance, kΩ, *and the mean densitometer readings,* b — c, *for eggs soaked in solutions of potassium chloride.*

	Position of drop on egg			
	1	2	3	4
	Eggs soaked in 1% KCl solution			
kΩ	22	19	18	19
$b - c$	0·80	0·83	0·90	0·76
	Eggs soaked in 0·5% KCl solution			
kΩ	36	32	33	40
$b - c$	0·47	0·49	0·68	0·38

If the earlier paper is consulted, it will be seen that the eggs washed in a 0·5% solution of potassium chloride closely resembled an unwashed egg. Although only mean values are given in the Table, the individual values also fell within the appropriate confidence limits for the two tests employed. Such results, however, can only be obtained if each egg receives individual attention during drying since drainage is incomplete at the points of support, and solution also accumulates on the lower parts of the shell. Unless these local surpluses are carefully removed during drying, easily detectable areas with a very low resistance (of the order of 500 Ω) and a very heavy coating of chloride are left on the shell. In fact, the trouble required to imitate an unwashed egg would outweigh any advantage to be gained by doing so.

It was interesting to find that even when eggs were washed in distilled water, drainage and drying often resulted in a significant gradation of resistance in a vertical direction. Four eggs were soaked in distilled water for 1 hour, and allowed to dry with their long axes vertical. The shells were marked out in five horizontal zones, and seven drops were placed in turn at equidistant points on each zone. The mean zonal resistances are set out in Table II.

Table II

The variation of resistance within washed eggs

	Mean zonal resistance, kΩ			
Zone/Egg	1	2	3	4
1 (top)	59·0	86·4	81·4	47·3
2	56·3	68·6	65·7	49·9
3	49·3	75·7	63·6	53·4
4	43·3	67·1	62·1	50·0
5	35·4	67·1	62·1	44·7
Grand mean	48·7	73·0	67·0	49·1
Standard deviation (±)	7·81	10·84	7·81	4·25
F (degrees of freedom = 34)	10·58*	4·11†	7·71*	4·13†

* denotes the 0·1% level of significance
† denotes the 1% level of significance

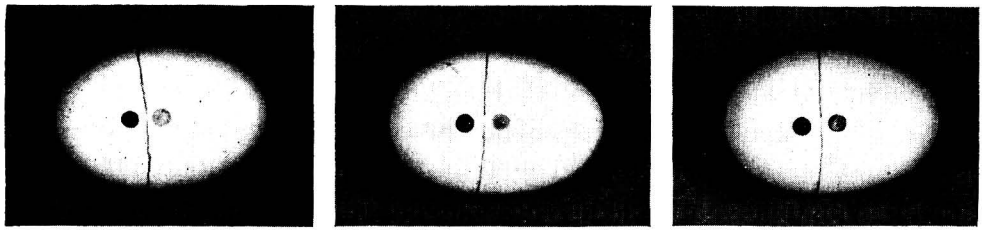
The action of silver nitrate and gelatin

In the chloride test,[1] water that had been in contact with the shell for 3 minutes was allowed to react with $AgNO_3$ on suitably-prepared Whatman Drop Reaction Paper No. 120, and the paper was exposed to ultra-violet light for 5 minutes. When a densitometer was used to measure the light absorption of the silver spots, 96% of washed or unwashed eggs could be identified correctly; when the spots were judged by eye, the corresponding figure was 89%. It was thought that as the system resembled a toning-out paper in containing silver chloride and an excess of silver ions (the 'silver body' of Fajans and Frankenberger[5, 6]), photochemical reduction might be more rapid or more apparent if the system also contained photographic gelatin. This was found to be so when a solution of silver nitrate and gelatin was applied directly to the shell.

Two commercial samples of photographic gelatin were used. The first sample was freed from chloride by repeatedly washing the swollen sheets at 10° C in a dilute acetate–acetic acid buffer (pH 4·6). The second sample had been de-ashed during manufacture by means of ion-exchange columns. Both samples behaved in the same way, and no further distinction is made between them. The reagent contained 0·1% of silver nitrate and 0·3% of gelatin; its pH was 4·7. It was kept in bottles of brown glass at ordinary temperatures; the silver ions present seemed to be an adequate protection against bacterial attack.

When a drop of the solution was placed on an unwashed shell, and the egg was held so that the drop was approximately 2 cm. below the bulb of an ultra-violet lamp (Osram MBW/U —a 125-W mercury discharge unit enclosed in a bulb of Woods glass), the drop darkened. After 1 minute the drop usually contained a fairly heavy precipitate, dark brick-red in colour. On the other hand, if the egg had been washed by rubbing for 3 minutes with wet cotton wool

or by soaking in water for an hour or more, the drop did not darken and either no precipitate or a sparse grey one appeared. The egg in Fig. 1*a* had been previously washed on one half



(*a*) (*b*) (*c*)

FIG. 1.—*The action of $AgNO_3$–gelatin solution on unwashed, washed and KCl-treated shells. The half of the shell on the right of the pencilled line was soaked for one hour* (a) *in water,* (b) *and* (c) *in a* 0·5% *solution of potassium chloride. Time of exposure to ultra-violet light:* (a) *and* (b) 1 *minute,* (c) 3 *minutes*

of its surface by soaking in distilled water for 1 hour; the two drops were exposed to ultra-violet light for 1 minute. When 50 eggs out of 100 were washed by completely immersing them in distilled water for 1 hour, and all the eggs were tested by exposing single drops for 1 minute, 96% of the unwashed eggs and 98% of the washed eggs were identified correctly. In a similar experiment where the period of illumination was increased to 1½ minutes, the corresponding figures were both 98%.

It was not essential, however, to use such large drops as those shown in the figure. It was easy with a small brush to place minute drops (about 0·0025 m.) on the eggs, and to use them without markedly impairing the accuracy of the test; 96 out of 100 washed or unwashed eggs were identified correctly by this method using an exposure of 1 minute.

In general there was, as would be expected, a difference between the intensity of the reaction at different points on the same unwashed shell, and the same point on different shells but, as between washed and unwashed shells, there was hardly any overlap. The mercury lamp used emitted mainly light of 365 mμ. Mercury lamps without filters were tested; if there was any increase in the rate of reduction, it was not large enough to warrant the use of wave-lengths smaller than 365 mμ. A reduction in the concentration of silver nitrate below 0·1% reduced the rate of reaction. Other samples of photographic gelatin were tested; presumably because they contained small amounts of chloride, drops on washed eggs darkened slightly after 1 minute's illumination. All the tests were carried out at room temperatures in the range of 15° to 20° C. The effect of time and humidity of storage on the behaviour of the test was not studied in detail, but its efficiency was not impaired when eggs were kept for 14 days at ordinary temperatures and humidities in the laboratory.

The behaviour of eggs treated with potassium chloride

When eggs were soaked in a 0·5% solution of potassium chloride, carefully dried and tested with the silver nitrate–gelatin reagent, they did not behave in the same way as unwashed eggs although they carried, on the average, rather more potassium chloride on their surface. The apparent rate of reduction in ultra-violet light was considerably slower, although it was faster than for a washed egg. Further, whereas with unwashed eggs the colour of the precipitate in the drop was nearly always a dark brick-red, with KCl-treated eggs the precipitate was usually grey in colour.

One half of the surface of the unwashed egg shown in Figs. 1*b* and 1*c* had previously been soaked in 0·5% KCl for 2 hours; the drops were exposed to ultra-violet light for 1 minute and 3 minutes respectively. The difference in the actual rate of reduction between the two halves of the shell may not have been so great as it appears to be to the naked eye (the shells

of the KCl-treated eggs were usually found to be more deeply stained when the drops were removed). Nevertheless, there was no difficulty in distinguishing between unwashed eggs and the majority of KCl-treated eggs.

In Table III are brought together the results of an experiment with 9 eggs that had been soaked in a 0·5% solution of potassium chloride for 30 minutes. The eggs were kept at room temperature and a relative humidity of 43% ; measurements were made at intervals at different points on the shell. The second column of the table gives the mean resistance, and the third column the proportion of the eggs that, if their history had been unknown, would have been classed as washed eggs on the basis of the results of the $AgNO_3$–gelatin test using an exposure of 1 minute. It will be seen that a combination of the two tests would provide a useful guide if it were suspected that eggs had been washed in a solution of potassium chloride. The use of the silver nitrate–gelatin solution alone will, in any case, classify most of these eggs as washed eggs.

Table III

The behaviour of eggs treated with potassium chloride

Days	Mean resistance, kΩ	Proportion classed as washed eggs
0	26·2	7/9
2	28·0	7/9
7	28·8	8/9
14	31·3	7/9

The different behaviour of unwashed and KCl-treated eggs suggests that the unwashed shell, in addition to potassium chloride, also carried on its surface a soluble compound that can either reduce silver nitrate in ultra-violet light or can sensitize the photochemical reduction of silver chloride in the presence of gelatin, and that this compound is removed when the egg is washed in water or a solution of potassium chloride. Some support for the suggestion was furnished by the following observation : the precipitate or deposit in a drop on a washed or KCl-treated egg was usually grey in colour, but microscopical examination showed that the mucin plaques covering the entrance of the pore canals were usually stained brick-red. It is possible that washing does not remove the soluble compound so readily from these minute pits as from the rest of the surface.

When gelatin was omitted from the reagent, reduction seemed usually to be slower, as judged by the naked eye, on an unwashed egg and, curiously enough, to be rather faster on a washed egg than the corresponding rates in the presence of gelatin. These apparent differences may be related to the fact that in the absence of gelatin reduction took place mainly on the shell instead of in the body of the drop. With an unwashed egg, the colour of the reduced silver was a metallic grey in the absence of gelatin and, as already mentioned, was usually a dark brick-red when gelatin was present. Given the presence of sufficient chloride on the shell, both gelatin and the soluble compound postulated above seem to be necessary for the rapid production of a coloured precipitate.

Discussion

The use of a solution of silver nitrate and gelatin seems to be a rapid and simple way of identifying washed eggs. The disadvantages of the method are (*a*) that it leaves a stain on the egg, and (*b*) that silver nitrate is not a harmless compound. When drops of 0·0025 ml. are used, the extent and degree of staining is negligible (being confined to a circle less than 2 mm. in diameter), and the amount of silver nitrate applied to one shell is very small (being about 2·5 μg. or 1·6 μg. of silver). Any silver nitrate that is left behind after the drop is removed is soon reduced. Bell[7] has determined the natural silver content of the ash of egg whites ; as might be expected, eggs differ amongst themselves but his results with 17 eggs, recalculated on the original substance, indicates that the average silver content of the white (35 g.) of one egg is about 10 μg.

Although tests for washed eggs are required when, as in Eire, the washing of eggs on

farms is prohibited or when, as in Australia, farmers are required to send washed eggs to packing stations in separate and labelled containers, it is improbable that, lacking such regulations, the tests would ever be applied to eggs in a body in order, for example, to select unwashed eggs for storage. There was little point, therefore, in trying to increase the rapidity of the silver nitrate–gelatin test still further, although this could probably be achieved by moving a file of eggs through a tunnel illuminated by ultra-violet light and applying and removing the drops mechanically.

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Low Temperature Station for Research in Biochemistry and Biophysics
University of Cambridge and Department of Scientific and Industrial Research

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VEGETABLE OILS. IV.*—A New Method of Determining the Component Acids of Oils containing Epoxy- and/or Hydroxy-Acids

By K. E. BHARUCHA and F. D. GUNSTONE †

A new method of determining the component acids of oils containing epoxy- and/or hydroxy-acids is described and applied to the seed oils of *Vernonia anthelmintica* and *Strophanthus hispidus* containing 12 : 13-epoxyoctadec-9-enoic (74%) and 9-hydroxyoctadec-12-enoic acid (15%) respectively. Some new derivatives of this latter acid are reported and the periodate method of determining α-glycols is criticized.

Introduction

In previous publications[1, 2, 3] it has been shown that seed oils of the *Strophanthus* species differ from all other seed oils in that so far as is at present known they alone elaborate among their component acids 9-hydroxyoctadec-12-enoic acid isomeric with the more familiar ricinoleic acid (12-hydroxyoctadec-9-enoic acid). This discovery led to the re-examination of some other

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† Present address, The University, St. Andrews.

seed oils reported to contain hydroxy-acids and we have found[4] that the major component acid of *Vernonia anthelmintica* is not 11-hydroxyoctadec-9-enoic acid[5] but 12 : 13-epoxyoleic acid.

The usual method of component acid determination involves the separation of the mixed fatty acids by low-temperature crystallization into three fractions containing, respectively, mainly saturated, mono- and polyethenoid acids, followed after esterification by fractional distillation of each fraction. Determination of mean unsaturation, mean equivalent, and ultra-violet absorption after alkali-isomerization then suffices to characterize each of the relatively simple ester fractions. When this method was applied to various *Strophanthus* oils containing relatively small amounts (7–14%) of a monohydroxyoctadecenoic acid, certain modifications had to be made, mainly because this acid does not react quantitatively with Wijs reagent but gives values considerably higher than theoretical. This effect is reduced or eliminated by acetylation of the esters. In our previous analyses of *Strophanthus* oils, fractions containing the hydroxy-acid were methylated and acetylated before distillation and the proportion of methyl acetoxyoctadecenoate in the distilled ester fractions was computed solely from the saponification equivalent. This method which then appeared to be adequate might be less satisfactory in the presence of larger proportions of hydroxy-acid. In addition, the accuracy of the process is dependent on the thermal stability of the acetoxy-ester.

It is perhaps on account of this last factor that other methods of analysing castor oil (which contains high proportions of ricinoleic acid) have been described. In the most complete study of castor oil Gupta, Hilditch & Riley[6] did not separate the acids by low-temperature crystallization, as they found this process unsuitable for mixtures containing ricinoleic acid, nor were the esters distilled. The proportion of ricinoleic acid followed from the acetyl value determined by Riley's method[7] after making allowance for the dihydroxystearic acid weighed after crystallization ; ultra-violet absorption after alkali-isomerization gave the content of linoleic acid, whilst oleic acid was determined from the iodine value after allowance for the linoleic and ricinoleic acid ; the saturated acids were determined as a group by difference. This method of computing the content of oleic and of saturated acids would obviously be unsatisfactory in the presence of acids which react abnormally with Wijs reagent.

Another method of examining mixtures containing ricinoleic acid was described by Achaya & Saletore.[8] Saturated acids were first removed by lead salt separation and the remaining acids were then separated into two fractions by a technique in which oleic and a little linoleic acid formed a urea complex whilst ricinoleic and most of the linoleic acid did not. This last fraction was subsequently methylated, acetylated and distilled.

In our investigation of the seed oil of *V. anthelmintica*, the reactive nature of the epoxy-group greatly limited the processes available in any method of analysis ; in particular the acid could not be esterified by the usual methods as the epoxide ring reacts readily with methanolic hydrogen chloride or methanolic sulphuric acid.[4] This difficulty was avoided by converting the acid to the corresponding dihydroxy acid and this procedure has enabled us to devise a method of analysis suitable for oils containing monohydroxy-, dihydroxy- or epoxy-acids. In view of the difficulty of determining the iodine value of both 12 : 13-dihydroxyoleic (ref. 4, but see ref. 9) and 9-hydroxyoctadec-12-enoic acids,[1] separation of the hydroxy- and non-hydroxy-acids was tried using a method of distribution of the acids between two suitable immiscible solvents, as the two types of acids have different solubility characteristics. This technique has been successfully applied in the concentration of the hydroperoxide resulting from autoxidation experiments.[10, 11] This method of separation was found to be effective and a method based on it for the analysis of oils containing hydroxy- and/or epoxy-acids has been developed.

Experimental

The method of analysis

It will be convenient to describe the method in general terms before discussing its application in certain specific instances. This method was later modified slightly in the light of experience gained during its use.

The first step involves the preparation of mixed acids freed from unsaponifiable matter and

so treated, if epoxy-acids be present, that the latter are converted to dihydroxy acids. This is achieved by refluxing the oil with five volumes of acetic acid for 5–7 hours, after which the acetic acid is distilled off, the last traces under reduced pressure. The product (in which any epoxy-glyceride has been converted to monohydroxy-monacetoxy-glyceride) is hydrolysed with alcoholic potash and the unsaponifiable material removed in the usual way. The treatment with acetic acid is not required in the absence of epoxy-acids.

The hydroxy-acids are next separated from non-hydroxy-acids by partition between light petroleum (b.p. 40–60°) and methanol–water (4 : 1) which have previously been equilibrated by shaking together. Mixed acids containing a high percentage of hydroxy-acids are best dissolved in 80% methanol and extracted repeatedly with light petroleum, whilst acids containing smaller proportions of hydroxy-acid are dissolved in light petroleum and extracted with 80% methanol. The process is best illustrated by an actual example.

To 1 l. of 80% methanol in each of three separating funnels (1–3) was added about 50 g. of acids from *V. anthelmintica* seed oil ; 500 ml. of 80% methanol was placed in each of two further funnels (4–5). Light petroleum (250 ml.) was added to the first funnel and after equilibration passed to each of the other four funnels in turn. This was followed by other portions of light petroleum until little or no material was extracted from the methanol solutions ; acids remaining in the methanol solution were then recovered by distilling off most of the methanol, adding water, and extracting with ether. The distribution of the material was then as follows :

	Methanol solutions		Light-petroleum extracts				
No.	1 2 3	4 5	5	4	3	2	1
Wt., g.	113·8	4·3	1·1	1·8	3·6	9·9	21·3

These figures suggest that the separation of dihydroxy- from non-hydroxy-acids is readily effected ; later results indicate that the separation is fairly sharp.

The non-hydroxy-acids are then divided into two fractions by crystallization from methanol at — 20° (which is known to separate saturated from unsaturated acids[12]), or by the lead salt method. The original mixed acids are thus divided into three fractions in which saturated (A), unsaturated (B) and hydroxy-acids (C) are separately concentrated. It may be advantageous in some cases to effect the low-temperature crystallization before the light petroleum/methanol distribution.

Fractions A and B are further examined in the usual way, except that fraction B, which may contain small proportions of hydroxy-acids, is acetylated prior to distillation. When fraction C was methylated, acetylated and distilled there was evidence of slight decomposition of the diacetoxy-esters and accordingly we have analysed this fraction without distillation. From the saponification equivalent (determined in quadruplicate) of the methyl esters of this fraction before and after acetylation it is possible to determine the content of hydroxy-ester. These values are connected by the following expression :

$$\% \text{ Hydroxy ester} = \frac{100 \times M(\mathrm{B} - \mathrm{A})}{56{,}100n - \mathrm{B}(M' - M)}$$

(M and M' are the molecular weights of the hydroxy- and acetoxy-esters ; n is the number of hydroxyl groups present in the ester ; A and B are the observed saponification values before and after acetylation.)

This value was found to exceed 90%, leaving only a small proportion of unknown composition, and, in view of the difficulty of determining the iodine value of this fraction, we have assumed that the non-hydroxy-acids present have the same composition as the non-hydroxy-acids in fractions A and B together. Although this must introduce some element of doubt into the final results, we do not consider that the error will be very great. It seemed to us that the proportion of hydroxy-acid in fraction C (90–95%) should be higher, but we have shown that this value is not seriously low on account of incomplete acetylation (the value obtained after refluxing with acetic anhydride for 1 hour is hardly changed after 10 hours) and by the fact that pure dihydroxyoleic acid gives a value of 98·5% after refluxing for 2 hours (the recommended period).

At this point it is possible to calculate the composition of the mixed acids in terms of the

various non-hydroxy- and hydroxy-acids and it is then necessary for oils containing epoxy-acids to determine the proportion of epoxy-glyceride in the original oil by the method of King[13] using dioxan–hydrochloric acid reagent. This value expressed as a molecular percentage is compared with the amount of dihydroxy-acid similarly expressed. If the latter exceeds the former by more than the experimental error, then epoxy- and dihydroxy-acid must have been present originally. The method of calculation assumes the presence of only a single hydroxy- or dihydroxy-acid; experiments supporting this are described later for each oil.

This procedure has been successfully applied to *V. anthelmintica* seed oil containing over 70% of epoxyoleic acid, to *S. hispidus* seed oil which contains less than 20% of monohydroxyoctadecenoic acid, and to *Cephalocroton cordofanus* seed oil which has also been shown to contain epoxyoleic acid in high proportion.[14] We consider that the method may be usefully applied to oils containing epoxy-, monohydroxy- or dihydroxy-acids and, whilst there is a little more manipulation than in low-temperature crystallization, no special apparatus or materials are required.

Vernonia anthelmintica *seed oil*

The oil (Table I) was extracted from a further sample of the seeds previously used in the characterization of the epoxy-acid.[4] This was converted into mixed hydroxy-acids (Table I) by the methods already described and the mixed acids were distributed between light petroleum and aqueous methanol. The non-hydroxy acids were then crystallized from methanol at — 20°. At this point difficulty was encountered because of the unsaponifiable material present; this was therefore removed from fractions A and B. Fraction A was esterified with methanol and sulphuric acid, fractions B and C were esterified with methanolic hydrogen chloride and the whole of fraction B and a part of fraction C subsequently acetylated by boiling with acetic anhydride for 2 hours. Fractions A and B were then distilled and examined in the usual way, the small quantity of A esters being distilled through a small Widmer column. The saponification equivalent of fraction C esters was determined in quadruplicate before and after acetylation; unsaponifiable material in this fraction was measured quantitatively.[15]

The composition of fractions A and B was computed in the usual way; that of fraction C was calculated in terms of dihydroxyoleic acid, unsaponifiable material and non-hydroxy-acids (considered to have the same composition as in fractions A and B together). The results are summarized in Table I.

The absence of monohydroxy-acid was indicated by the following experiment. A sample of the fraction C acids was dissolved in 80% aqueous methanol and extracted with light petroleum in a continuous extractor for 16 hours. The extracted material (2·4 g., 5·8%) contained 56% of dihydroxy-acid as determined by the glycol value and a maximum of 49% as determined by the equivalent (single determination) of the ester before and after acetylation. The former value is not affected by the presence of mono-hydroxy-acids which would be concentrated in this extract if they were present.

The presence of all the acids listed in Table I has previously been confirmed[4] with the exception of arachidic and oleic acids; the oleic acid present in fractions A1 and A2 has now been identified by oxidation to 9 : 10-dihydroxystearic acid (m.p. and mixed m.p. 129–130°).

V. anthelmintica seed oil is of great interest in that it contains almost 90 mol.-% of epoxyoleic and linoleic glycerides together. Dehydrated castor oil containing a high content of octadecadienoic glycerides has found extensive use as a drying oil; dehydration of epoxyoleic acid could lead to octadecatrienoic acid and dehydrated *V. anthelmintica* seed oil might have valuable drying properties. Experiments on this aspect of the matter are now in progress.

Strophanthus hispidus *seed oil*

Work on this oil was carried out for two purposes. Firstly to see how successfully the method developed for oils containing high proportions of dihydroxy-acids could be applied to oils containing low proportions of monohydroxy-acids and secondly to try to devise a quicker method of analysing *Strophanthus* oils.

The oil used was the same as that previously examined,[3] and the mixed acids after removal of unsaponifiable material (1·32%) were submitted to the following procedures.

Table I

V. anthelmintica *seed oil*

Characteristics	Oil	Mixed hydroxy-acids
Saponification equivalent	320·7	329·5
Iodine value (mean of two determinations)	101·7 ± 0·5	107·4 ± 1·5
Epoxyoleic glyceride (% wt.)	71·5	—
Absorption max. ($E^{1\%}_{1\,cm.}$) at 234 mμ after isomerization (180°/60 min.)	—	115·3*

* Measured on acids freed from unsaponifiable material

Separation of acids	%	Iodine value
Fraction A	3·8	24·4
Fraction B	13·5	149·0
Fraction C	75·8	88·9
Unsaponifiable material from A and B	6·9	246

Distillation of Fractions A and B

No.	Wt., g.	Iodine value	Sapon. equiv.	No.	Wt., g.	Iodine value	Sapon. equiv.
A1	2·29	13·1	276·9	B1	2·68	112·4	280·7
A2	1·76	20·7	286·8	B2	2·58	150·1	291·6
A3	0·66*	—	361·2	B3	2·47	153·4	292·3
				B4	2·73	152·1	290·9
				B5†	2·76	150·1	292·9
				B6	2·66	146·5	292·3
				B7	1·35	141·5	293·9
				B8‡	1·91	102·6	298·3

* This fraction contained a further 0·066 g. of unsaponifiable material.

† B5 Acids; iodine value 158·3, $E^{1\%}_{1\,cm.}$ (180°/60 min.) at 234 mμ 717, at 268 mμ 1·9.

‡ 0·944 g. of this fraction contained 0·083 g. of unsaponifiable material.

Fraction C

Saponification equivalent of esters before acetylation 326·1; after acetylation 143·4; unsaponifiable material 1·40%: whence composition (% wt.) was calculated as dihydroxyoleic acid 90·8, non-hydroxy acids 7·8, unsaponifiable 1·4.

	Component acids					Excluding unsaponifiable		
	A	B	C	Unsaponifiable	Total	% (wt.)	% (mol.)	% (wt.)*
Palmitic	1·90	0·49	0·83	—	3·22	3·5	4·2	3·7
Stearic	0·73	0·51	0·43	—	1·67	1·8	2·0	1·9
Arachidic	0·48	—	0·17	—	0·65	0·7	0·7	0·7
Oleic	0·63	2·17	0·97	—	3·77	4·1	4·4	4·3
Linoleic	—	10·14	3·51	—	13·65	14·9	16·1	15·5
Dihydroxyoleic	—	0·07	68·83	—	68·90	75·0	72·6	—
Epoxyoleic	—	—	—	—	—	—	—	73·9
Unsaponifiable	0·06	0·12	1·06	6·90	8·14	—	—	—

* Since the quantity of epoxyoleic glyceride determined directly (74·1 mol.-%) exceeds the quantity of dihydroxyoleic acid (72·6 mol.-%), all the latter is considered to have been originally present as epoxyoleic glyceride. This final column gives the composition of the original acids on a weight basis.

(i) The saponification equivalent of the mixed esters was determined before (295·1) and after acetylation (263·2). These values, each determined in quadruplicate, indicate the presence of 15·2% of methyl hydroxyoctadecenoate in the mixed esters (15·3% calculated as acids). The absorption ($E^{1\%}_{1\,cm.}$ 266) at 234 mμ after isomerization (180°/60 min.) corresponds to 29·7% of linoleic acid after making allowance for unsaponifiable material. The balance (55·0%) consists of oleic and saturated acids, but the iodine value cannot be used to compute the content of oleic acid.

(ii) The mixed acids were partitioned by the procedure already described. The quantities of acids and of solvent were as before except that the acids were dissolved in the light petroleum and washed with seven successive portions of methanol (250 ml. each time). In this way 22·0 g. was extracted (5·13, 5·74, 4·20, 2·87, 1·91, 1·28, 0·92 g.), whilst 119·8 g. remained in petroleum

solutions 1–3 and 6·2 g. in petroleum solutions 4–5. The methanol extract (Fraction C, 14·9%) from the equivalent of its ester before (306·8) and after (179·8) acetylation contains 93·8% of hydroxyoctadecenoic acid. The remaining acids (fractions A and B, 85·1%) have iodine value 97·3, absorption ($E^{1\%}_{1\,cm.}$) at 234 mμ (180°/60 min.) 298, and still contains 2·65% of hydroxyoctadecenoic acid (this value was calculated from the value later found for fraction B alone). If it is assumed that this small quantity of hydroxy-acid does not appreciably affect the iodine value of this fraction, then its composition can be calculated in terms of hydroxyoctadecenoic, linoleic, oleic and saturated acids. The non-hydroxy-acids in fraction C are assigned the same composition as in fractions A and B. The results are given in Table II, column (ii).

(iii) A portion of fractions A and B was crystallized from methanol at — 20°. The insoluble acids (fraction A, 21·2% of the mixed acids) had iodine value 11·6 and the soluble acids (fraction B, 63·9%) had iodine value 126·7, $E^{1\%}_{1\,cm.}$ at 234 mμ (180°/60 min.) 384, and contained 3·53% of hydroxyoctadecenoic acid. Another set of results (Table II, column iii) is obtained by calculating fraction A as saturated and oleic acid on the basis of the iodine value ; fraction B as saturated, oleic, linoleic and hydroxyoctadecenoic acid ; and fraction C as hydroxyoctadecenoic and non-hydroxy-acids with the same composition as in fractions A and B together.

(iv) Finally fraction B was methylated, acetylated and distilled and the ester fractions examined as in the previous analysis of this oil.[3] (The fractionation data are not reproduced here.) The results for this fraction are combined with those for fraction A (obtained as in iii) and from fraction C (hydroxyoctadecenoic acid plus non-hydroxy-acids as in fractions A and B) to give the results given in Table II, column (iv).

Table II

Component acids of S. hispidus *seed oil (excluding unsaponifiable) as % of total acids*

	(i)*	(ii)*	(iii)*	(iv)*	(v)†
Saturated	55·0	21·4	19·8	21·2	21·0
Oleic		34·1	36·6	35·1	35·5
Linoleic	29·7	28·3	27·4	28·5	30·0
Hydroxyoctadecenoic	15·3	16·2	16·2	15·2	13·5

* For the significance of these see text
† Previous results[3]

In considering the distribution procedure as a method of examining oils containing monohydroxy-acids the results in column (iv) are relevant. There is a close accordance between the results obtained by this method and those of the previous analysis except that the figure for hydroxyoctadecenoic acid is now slightly higher at the expense of the linoleic acid content. The value previously reported may be low due to partial decomposition during distillation and, since decomposed acetoxyoctadecenoate would be calculated mainly as linoleate, the linoleic acid content would be correspondingly increased. We consider the present figures to be an improvement on those previously recorded and to show, further, that the method here described of separating hydroxy- from non-hydroxy-acids can be satisfactorily applied to oils containing relatively small amounts of monohydroxy-acids.

There are a number of ways in which the *Strophanthus* oils may be more quickly examined with varying degrees of accuracy. It is seen from Table II, column (i), that the method involving no separation of the acids gives good results which could be extended by determining the saturated acids independently by Bertram oxidation.[16, 17] Alternatively the hydroxy- and non-hydroxy-acids can be separated and examined independently. (It would be possible to take the methanol extract as wholly hydroxy-acid and at the same time neglect the small amount of this left in the petroleum extract ; the two errors so introduced would tend to cancel out.) This allows the oleic and saturated acids to be computed without resort to a Bertram oxidation but otherwise there seems to be little advantage unless a complete investigation is being made.

Glycol values

Much of the work just described would be facilitated by a quicker method of determining the content of hydroxy-acid and of distinguishing between various types of hydroxy-acids. For

these reasons we examined the methods of determining α-glycol based on the use of periodic acid.[18, 19] In our hands these methods were not entirely satisfactory, as high results were obtained with unsaturated compounds (cf. ref. 20), although there was considerable improvement when the reagent was a solution of potassium periodate in aqueous acetic acid used as described below, but even so the results are not more accurate than ± 1·5–2·0%. Some of our results are recorded in Table III from which it will be seen that the discrepancies observed are less marked with the triglycerides than with the acids or simple alkyl esters and that, as expected, the method cannot be used in the presence of epoxy-compounds.

Method.—The periodate solution is prepared by dissolving 1·4 g. of potassium periodate in water (200 ml.) and diluting to 1 l. with acetic acid; stronger solutions could not be prepared because of the low solubility of potassium periodate. The sample, the weight of which should be such that liberated iodine is not less than 80% of that liberated in the blank, is dissolved in 10 ml. of a mixture of acetic acid and chloroform (2 : 1) contained in a glass-stoppered vessel, with warming if necessary. To the solution at room temperature is added periodate solution (100 ml.) followed after thirty minutes by 10% potassium iodide solution (15 ml.) and distilled water (40 ml.). The liberated iodine is titrated with 0·1N-sodium thiosulphate solution. A blank is run at the same time omitting only the glycol.

$$\% \text{ glycol} = \frac{M(V_b - V_s)N}{20w}$$

where M = molecular weight of glycol, N = normality of thiosulphate, w = weight of sample, V_b and V_s are the amounts of thiosulphate required for the blank and the determination respectively.

Table III

Glycol values (as % dihydroxy-acid)

Reagent	KIO_4–H_2SO_4	HIO_4	KIO_4
Saturated acids	0·1–0·4		0·3–0·8
Methyl 12-hydroxystearate	1·5		1·5
Oleic acid	12–16	3·8	1·5–2·7
Methyl linoleate	19–28	3·9	1·9–3·8
Castor oil mixed acids	10		1·9
Groundnut oil	2·9		nil
Cottonseed oil	1·0		nil
Olive oil	0·8		nil
V. anthelmintica seed oil	77	17	7·4
Cephalocroton cordofanus seed oil	68	13	4·4
9 : 10-Dihydroxystearic acid (m.p. 95°)	103		101
9 : 10-Dihydroxystearic acid (m.p. 132°)	106		104
12 : 13-Dihydroxystearic acid (m.p. 95°)	102		97
12 : 13-Dihydroxyoleic acid (m.p. 54°)	162	111	102

Some derivatives of hydroxy-acids

In order to have some derivatives that might serve as useful reference compounds, the following compounds which have not previously been described were prepared.

9-*Hydroxyoctadec*-trans-12-*enoic acid.*—A concentrate of the naturally occurring *cis*-acid obtained from *Strophanthus* oils was isomerized by the method used by Kass & Radlove[21] for the isomerization of ricinoleic acid. The *trans* acid was obtained as small white needles from light petroleum (b.p. 40–60°), m.p. 57·5–59·5° (Found: C, 72·6; H, 11·1. $C_{18}H_{34}O_3$ requires C, 72·4; H, 11·5%).

9 : 12 : 13-*Trihydroxystearic acid.*—Oxidation of 9-hydroxyoctadec-*cis*-12-enoic acid with cold dilute alkaline permanganate gives two isomeric trihydroxystearic acids only one of which has been isolated in a pure state:[1] we have now purified the lower-melting isomer, which had m.p. 108–110° (Found: C, 64·9; H, 11·0. $C_{18}H_{36}O_5$ requires C, 65·0; H, 10·9%).

p-*Bromophenacyl esters.*—The *p*-bromophenacyl esters of the following acids were prepared by the standard procedure, the esters being crystallized from alcohol or aqueous alcohol.

9-Hydroxyoctadec-*cis*-12-enoic, m.p. 73·5–74·5° (Found: C, 63·1; H, 7·8; Br 16·2. $C_{26}H_{39}O_4Br$ requires C, 63·0; H, 7·9; Br, 16·1%); 9-hydroxystearic, m.p. 97·5–98° (Found: C, 62·6; H, 8·4; Br, 16·0. $C_{26}H_{41}O_4Br$ requires C, 62·8; H, 8·3; Br, 16·1%); and 12-hydroxystearic acid, m.p. 99·5–100° (Found: C, 62·8; H, 8·2; Br, 16·0%).

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The University
Glasgow

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PLANT PROTEINS. III.*—Amino-acid Content of Isolated Hay Proteins

By J. KOLOUŠEK† and C. B. COULSON‡

Approximate values of the amino-acid content of the proteins of lucerne hay cut at various stages of growth and the hays of lucerne, red clover, timothy and orchard grass cut for hay in maturity are given, a modified method of rapid direct estimation on two-dimensional paper chromatograms being used. A higher glycine value is found for casein and the hay proteins than those previously reported for these proteins. There is some evidence that the haymaking process together with the stage of growth and the species of grass may affect the end amino-acid composition of the hay proteins, but the composition changes are small for certain amino-acids.

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† Present address: Physiological Institute, Czechoslovak Academy of Sciences, Na cvičiště 2, Prague XIX, Czechoslovakia
‡ Present address: Institute of Seaweed Research, Inveresk, Midlothian

Introduction

The quantitative amino-acid composition of plants used, in the main, in animal foodstuffs as well as of isolated proteins has been the subject of several recent papers,[1–5] and the earlier ideas on the importance of amino-acids in animal nutrition and the difficulties involved in their estimation have been reviewed by Armstrong.[1] The present authors have examined qualitatively a number of plant materials for their amino-acid content.[6, 7]

Morris *et al.*[8, 9] and others find a relation between milk production and quality of protein and in particular its lysine and tryptophan content, and more recent feeding trials with lactating cows seem to support this.[10] It has been claimed by other workers that lysine has special importance for lactating cows during protein synthesis.[11]

Earlier work (e.g. Chibnall[12]) and that of Armstrong[1] and Smith & Agiza[2] indicates that there is no great variation in the amino-acid composition of different plant or leaf proteins, or of proteins from plants at different stages of growth. The examination by Waite *et al.*[3] of the basic amino-acids of isolated grass proteins suggests that there is little difference in their composition. Waite *et al.*[3] also point out that the varying influence of herbage on milk production might be due to other non-protein constituents of the plant. There is new evidence that the monoamino-monocarboxylic acids are, in the main, liberated uniformly from herbage protein during wilting proteolysis,[12a] and that, *in vitro*, the content of these same amino-acids is little affected by wilting.[12b]

This paper presents approximate quantitative amino-acid compositions of isolated hay proteins, the amino-acids being estimated by a direct and rapid paper-chromatographic method that is essentially the same as that used by Block.[13] The aim of this work was to examine the isolated hay proteins for any significant difference of nutritional interest that might arise, among other things, from enzymic action during the drying process.

Experimental

Preparation of material, protein isolation and routine analyses

The methods of hay preparation and protein isolation have already been published together with the results of routine analyses.[14] The proteins were obtained from the hays of lucerne cut in various stages of growth (obtained from the State Agricultural Research Station at Liběchov near Mělnik) ; and red clover, orchard grass, timothy and lucerne hays cut in maturity obtained from the State Agricultural Research Station at Měšic near Tábor. The lucerne hays were grown on unmanured plots and the mature hays on manured plots, these hays being the same as those used previously.[14]

Protein hydrolysis

Accurately weighed small quantities (~10 mg.) of the various proteins were hydrolysed with 6N-hydrochloric acid (1·5 ml.) in sealed tubes (48 hours ; 105°). The hydrolysates were dried *in vacuo* over calcium chloride and sodium hydroxide. A small quantity of water was added and the solution again evaporated in a similar fashion to remove traces of hydrochloric acid. This was repeated several times.

Chromatography

The method used was that previously employed by the authors.[7] Large chromatographic cabinets were used to carry a large number of two-dimensional paper chromatograms thus aiding reproducibility. Duplicate runs were made. Whatman No. 1 filter paper sheets (18¼ in. × 22½ in.) were used. The order of solvents was firstly phenol–water (4 : 1) in 3% ammonia atmosphere and secondly *n*-butanol–acetic acid–water (4 : 1 : 5, upper phase). A blotting paper strip was attached to the bottom of the sheet before the second phase was run, so as to allow a longer run in this phase and thus obtain better separation. Ninhydrin (0·1%) was included in the second phase[15] (50 ml. of solution used per chromatogram). After each phase the chromatogram was dried in a forced air draught at 50–60°. After drying from the second phase and allowing the colours to develop, the chromatogram was placed in a thermostat at 60° for 5 min. to obtain maximum colour development.

Blood pipettes (20 μl.) were used to add the hydrolysate to the chromatogram. The hydrolysate residue was dissolved in a small quantity of distilled water (0·5 ml.) for this purpose.

Area of amino-acid spot

The outline of the spot was carefully traced on a sheet of paper of uniform thickness, the outline was cut out and the paper so cut out was weighed using a torsion balance weighing up to 500 mg. The area was then calculated from the weight per unit area of the paper used for tracing the spot.

Estimation of colour density

The simple apparatus used for the estimation of colour density is given in Fig. 1. A small bulb (with accumulator as d.c. source) in a housing with a small circular hole acts as a light source and colour density readings are taken by means of a mounted photoelectric cell connected to a micro-ammeter (0–100 μA). The instrument was calibrated using seven different dilutions of a synthetic amino-acid mixture.

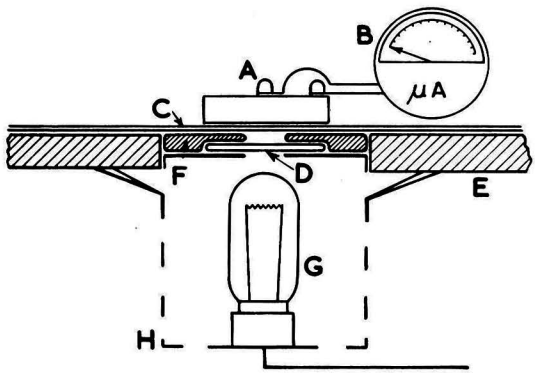

FIG. 1.—*Diagram of photoelectric densitometer used for the determination of spot colour density*

A. Mounted photo-electric cell
B. Microammeter (0 — 100 μA)
C. Chromatogram
D. Colour filter (Yellow filter for red-violet spots; Blue-green filter for yellow spots)
E. Top of the special table
F. Filter-holder with hole diameter approximately 14 mm.
G. Light source connected to d.c. source with non-varying potential
H. Lamp housing with perforations for ventilation.

Accuracy

Casein (Hammersten, manufactured by Merck) was hydrolysed in the same way as the hay proteins. The following results were obtained for four amino-acids: glycine, 2·3%; alanine, 3·3%; tyrosine, 8%; phenylalanine, 5%. Results from the literature are as follows: glycine, 0·4% (colorimetric[16]), 2·1% (microbiological[17]); alanine, 2·5%[16]–3·7%[18]; tyrosine, 5·3%[19]–7·3%[20]; phenylalanine, 4·0%[21]–6·8%.[22] The numerical results obtained for the basic amino-acids are substantially the same as those of Waite *et al.*[3] Results for other amino-acids obtained by this method by the authors (see below) have an accuracy of the order of from $\pm$20% to $\pm$50% and are given also (Tables I and II). This method, which gives approximate results only, was used in preference to more accurate methods because of its rapidity and simplicity. The accuracy indicated by the duplicate determinations on identical samples is given in Tables I and II.

Results

A two-dimensional chromatogram of a 6N-hydrochloric acid hydrolysate of mature lucerne hay protein (Tábor) is given in Fig. 2.

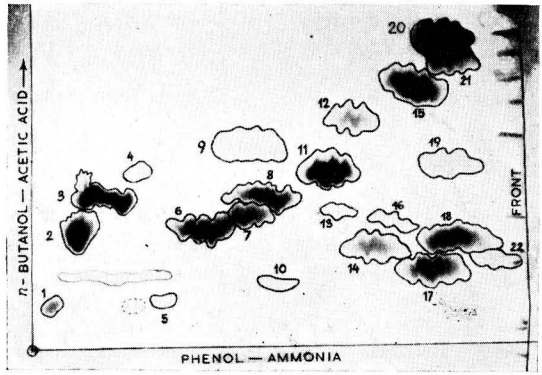

FIG. 2.—*Two-dimensional chromatogram of protein from mature alfalfa hay (Tábor)*

1 Cysteic acid. 2 Aspartic acid. 3 Glutamic acid. 4 3 : 4-Dihydroxyphenylalanine ? 5 Cysteine–cystine oxidation product (?) 6 Serine. 7 Glycine. 8 Threonine. 9 Yellow spot, R_F phenol = 0·44. 10 Cysteine–cystine oxidation product. 11 Alanine. 12 Tyrosine. 13 Methionine sulphone. 14 Histidine. 15 Valine + methionine. 16 Methionine sulphoxide. 17 Lysine. 18 Arginine. 19 Proline. 20 Leucine + *iso*leucine. 21 Phenylalanine. 22 Unknown.

This figure reveals, apart from the presence of the usual amino-acids, spots corresponding to methionine sulphone (spot 13), methionine sulphoxide (spot 16), besides a number of other spots. Spot 4 (red-violet) is thought to correspond to 3 : 4-dihydroxyphenylalanine[23] and has also been seen in chromatograms of whole-plant hydrolysates of these hays,[6] but Dent[24] claims that it is oxidized during the period of the run on the paper chromatogram, although Smith[24a] finds that fresh solutions give a fairly compact spot. Spot 4 occurs in all the chromatograms of hydrolysates of isolated mature hay proteins (Tábor) in varying strength : lucerne, very weak ; orchard grass, medium ; timothy, very weak ; red clover, medium. It has not been found in the isolated proteins of the lucerne growth stages. Spot 9 (yellow) has recently been reported on the chromatograms of other protein hydrolysates.[25] Tryptophan and spots thought to correspond to iodo-amino-acids[25] were found on chromatograms of barium hydroxide hydrolysates (baryta solution saturated at room temperature, 48 hours, sealed tube, 105°). Spots 5, 10 and those not numbered are probably the oxidation products of cystine and cysteine. Spot 22 may correspond to Dent's ' fast arginine '.[24] Cysteic acid, not found in timothy whole-plant acid hydrolysate, was found in the isolated protein.

The calibration curves (spot area × colour density plotted against concentration) for various amino-acids were found to be uniform and were in the main straight lines. The results were calculated to a 100% recovery.

The results for the proteins isolated from different growth stages of the grass (Liběchov) are given in Table I and that for the different mature hays (Tábor) in Table II.

Discussion of results

The method of hydrolysis in a sealed tube has been shown to be superior to other methods.[3] The acid–protein ratio of the hydrolysis system is 150 : 1 (v/w) and is considerably higher than

Table I

Lucerne in different stages of growth (Libĕchov). Amino-acid content of isolated hay proteins (as % of moisture-free protein containing 16% nitrogen)

Calculated to 100% recovery

Amino-acids	Accuracy %	Stage of growth				
		1st (12 cm.)	2nd (14 cm.)	3rd (46 cm.)	4th (55 cm.)	5th (70 cm.)
Aspartic acid	± 30	6	11	8	6	7
Glutamic acid	± 20	7	11	7	6	6
Serine	± 40	4	2	5	3	3
Glycine	± 15	10·0	12·3	8·3	6·1	7·1
Threonine	± 25	9	7	7	7	7
Alanine	± 15	7·0	8·4	9·0	6·8	6·4
Tyrosine	± 20	2	1	3	1	1
Histidine	± 15	1·0	3·7	1·0	1·1	1·0
Lysine	± 15	12·7	7·2	7·3	6·8	8·0
Arginine	± 15	5·8	6·8	6·3	4·8	4·8
Phenylalanine	± 20	1	1	1	1	1
Leucines	± 20	14	19	19	14	14
Proline	± 25	1	1	1	1	1
Valine and methionine	± 20	5	11	19	11	15

Table II

Isolated hay proteins. Amino-acid content of mature grasses (Tábor) (as % of moisture-free protein containing 16% nitrogen)

Calculated to 100% recovery

Amino-acids	Accuracy %	Lucerne	Red clover	Orchard grass	Timothy
Aspartic acid	± 30	9	8	7	8
Glutamic acid	± 20	11	11	10	8
Serine	± 40	6	8	6	3
Glycine	± 15	8·0	5·7	9·2	5·6
Threonine	± 25	10	10	11	10
Alanine	± 15	5·9	7·0	6·9	8·5
Tyrosine	± 20	6	2	5	5
Histidine	± 15	1·9	1·8	1·5	1·7
Lysine	± 15	7·9	6·7	7·8	5·2
Arginine	± 15	6·9	6·5	7·9	4·8
Phenylalanine	± 20	4	3	3	7
Leucines	± 20	9	9	10	16
Proline	± 25	2	1	3	1
Valine and methionine	± 20	13	14	16	14

that used by Waite[3] or Smith & Agiza[2] (20 : 1 ; v/w). It is thought that high dilution (1500–2000 : 1 ; v/w) of the protein during hydrolysis will largely prevent carbohydrate destruction :[26] thus, in this case, it is probable that amino-acid destruction due to carbohydrate impurities in the protein will have been reduced somewhat. So far there has been little advance in the purification of grass proteins despite the modern developments in preparative electrophoresis[27] and ion exchange.[28] It is possible, of course, that the 'impurity' may be a component part of the plant protein molecule.

Glycine.—The results obtained by the authors for the glycine contents of casein and hay proteins are higher than the results reported previously for casein (colorimetric–Zimmerman)[26] and for grass proteins,[2] respectively (Tables I and II). The results for casein by the present method are comparable with results obtained by the microbiological method.[17] A similar high result for glycine has been obtained for grass proteins[29] using a modified paper chromatographic method.[12b] The lack of agreement between earlier and more recent results involves a difference in order (in this case >10) and is thus significant.

The high glycine result for amino-acids free or in peptide form in grasses (obtained by a microbiological method)[30] implies a further confirmation of a higher glycine content of the protein. It would seem that the older chemical methods of analysis give consistently lower results for glycine.

Basic amino-acids.—The results for the basic amino-acids are substantially the same as those of Waite *et al.*,[3] and would seem to confirm their observations on the inadequacy of methods of hydrolysis previously used.[2]

Other amino-acids.—The values of other amino-acids are of relative value only and these are given for a more complete picture. They are as follows : aspartic acid, serine, threonine, proline, glutamic acid, phenylalanine, leucines, valine and methionine. Their accuracy is of the order of ±20 to 50% (see Tables I and II).

Although the results of amino-acid analyses of extracted fresh grass proteins indicated little difference in their amino-acid composition[3, 12, 31] whatever their source, little work has been done on the fodders prepared from grass. These proteins are from grasses and legumes which have gone through the wilting stage (permanent wilting following cutting as opposed to transient plasmolysis caused by drought). The proteins have thus been subjected to a period of exposure to enzymic proteolysis (and oxidation) with the possible result of changed amino-acid composition. The extent of proteolysis (and oxidation) may vary with the stage of growth and physiological condition of the grass prior to cutting, but this is more a matter of degree than quality. It has been shown that late grasses suffer less protein breakdown than do young grasses, whether moist or dry wilted.[32] Protein breakdown during wilting can vary between 16% and 40%.[32]

A number of the amino-acids show a variation of only small significance both between the various proteins isolated from lucerne at different stages of growth and the proteins isolated from the different mature grass hays (i.e. variation between species).

A somewhat larger variation than is accounted for by experimental error is shown by the following amino-acids : phenylalanine, 1–2% (lucerne during growth) ; 3–7% (mature grasses) ; tyrosine, 1–3% (lucerne during growth) ; 2–6% (mature grasses) ; valine and methionine, 5–19% (lucerne during growth) ; proline, 1–3% (mature grasses) ; glycine, 6–12·3% (lucerne during growth). A similar variation is shown by histidine, 1·0–3·7% (lucerne during growth) and lysine, 6·8%–12·7% (lucerne during growth) but this is a result for one growth stage only.

Variation in tyrosine and methionine contents can be expected, the former as a result of conversion to melanins via 3 : 4-dihydroxyphenylalanine (' dopa '),[33] the latter by oxidation of the sulphur to the sulphoxide and sulphone. Variation might be expected in the aspartic and glutamic acid contents as a result of decarboxylation to β-alanine and γ-aminobutyric acids respectively, but in fact little, if any, occurs. The monoamino-monocarboxylic acids are, in the main, liberated uniformly from herbage during the proteolysis of wilting[12a] and the composition of the herbage protein is thus little affected.[12b] There is some evidence from the chromatograms that tyrosine may be oxidized while still in the protein (formation of ' dopa ') and the presence of methionine sulphone and methionine sulphoxide indicates the occurrence of methionine oxidation.

It would thus seem that there is some evidence that the protein amino-acid composition is affected during the haymaking process and that the actual stage of growth or the species of grass may affect the end amino-acid composition wherever changes do take place. Tyrosine, methionine (as methionine and valine), phenylalanine, proline and glycine are the main ones effected. The basic amino-acids are, in the main, not so much affected and the rest of the monoamino-monocarboxylic acids show relatively smaller change (if any).

Determinations of the amounts of the free amino-acids in these hays are required to give a fuller picture before the nutritional significance can be judged, as the free amino-acids help to supplement the protein.

From the results given in Tables I and II, some variation seems to exist in the protein amino-acid composition which may have been brought about by the drying process, as some of the variations exceed the stated experimental variation, and as there is little variation in the composition of proteins from fresh herbage.[3, 12, 31]

Summary

1. The approximate quantitative amino-acid composition of various hay proteins is given, a rapid method of direct estimation on two-dimensional paper chromatograms being used.

2. The glycine content in all the protein samples examined is found to be higher than that previously reported.[2, 12, 16]

3. The hay proteins are examined for composition changes which may have resulted during the haymaking process. There is some evidence that the haymaking together with the growth stage and grass species may affect the end amino-acid composition of the hay proteins in relation to methionine, tyrosine, proline, phenylalanine and glycine, but the composition changes are small for most amino-acids.

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Agrobiochemical Laboratory
Faculty of Agriculture
Technicka 1903
Prague XIX

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ADDENDUM: OCCURRENCE OF CITRULLINE IN VARIOUS PLANTS

*By. J. Koloušek**

Citrulline is an intermediate in the *in vivo* conversion of ornithine into arginine.[1] Its presence as a free amino-acid has been shown in the thallus of *Galega officianalis* L.,[2] *Urtica doica*,[3] *Alnus glutinosa*, *A. nicana* and *Pisum sativum*.[4] Szörényi *et al.*[5] have described the

* Present address : Physiological Institute, Czechoslovak Academy of Sciences, Na cvičiště 2, Prague XIX.

biosynthesis of arginine phosphate from citrulline, while Szörényi[6] has prepared a pure citrulline iminase. Arginase is absent from alder leaves[7] but a glutamic acid decarboxylase[7] and γ-aminobutyric acid and citrulline transaminase have been shown to be present.[4]

The following hay seeds and thallus were examined for citrulline: *Trifolium pratense* L., *Medicago sativa* L., *Phleum pratense* L., *Dactylis glomerata* L., and *G. officianalis* by means of one-dimensional paper chromatography (unwashed Whatman No. 4 paper), with *n*-butanol–acetic acid–water (4 : 1 : 5, upper phase) as the solvent. A pleated filter card was attached to the bottom of the paper during the three-day run. Pure citrulline was used as a standard (60 μg. per chromatogram). The dried extracts were made up with 75% ethanol and small quantities pipetted on to the starting point. The chromatogram was developed with *p*-dimethylaminobenzaldehyde in 1N-hydrochloric acid.[8]

Citrulline was present in *T. pratense*, *M. sativa*, *D. glomerata* and *G. officianalis* seeds (the last in smaller quantities), as well as in *G. officianalis* thallus (cf. ref. 2).

The above evidence suggests that citrulline is relatively widespread in the plant world.

Agrobiochemical Laboratory, Faculty of Agriculture, Prague XIX

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THE SORBITOL TEST

By DAN W. STEUART*

This test will detect 5% of cider in grape wine. The reagent used, *o*-chlorobenzaldehyde, can also be used to estimate the sorbitol in cider.

Introduction

Sorbitol is a hexahydric alcohol $C_6H_8(OH)_6,\frac{1}{2}H_2O$ (or $1H_2O$) found first by Boussingault in 1872 in rowan berries and subsequently, to greater or lesser extent, in most fruits and fruit wines, specially in perry, rather less in cider and little or none in grape wine. It is most likely to be found in grape wine prepared from a must which is high in acidity and low in gravity. Martin has shown that the sorbitol content of pears decreases during ripening.[1] On a commercial scale sorbitol is produced by the reduction of glucose, and is marketed as a sugar substitute for diabetics. The addition of sorbitol is permitted in German diabetic Schaumwein.[2] An addition of 1% of sorbitol is said to increase the sweetening power of saccharin threefold in canned fruits.[3]

Mannitol, another sugar alcohol, is found in traces in fruits, and much more, occasionally, in spoilt wine due to the mannite fermentation. This is due to the action of heterofermentative lactobacilli which ferment fructose to mannitol and lactic and acetic acids, and is most liable to occur in musts which are low in acidity and high in gravity. Such wine shows abnormally high non-sugars content.[4]

In 1934 the 'Office International du Vin, Rome', recommended the Werder test for detecting other fruit wines in grape wine. In this test, benzaldehyde is used as precipitant and the

* Present address: 24 Stanley Ave., Thorpe Rd., Norwich

precipitate is nominally dibenzalsorbitol. More recently, substituted benzaldehydes have been used as reagent, of which the most common is Litterscheid's *o*-chlorobenzaldehyde which precipitates the condensate tri-*o*-chlorobenzal sorbitol, giving consequently a greater quantity of material to weigh. The tests have been improved by various authors to make them more sensitive. For this reason sophistication of grape wine with other fruit wines has been greatly reduced on the Continent.[2] Both tests are described by Vogt.[2]

In the Litterscheid test[5] 100 ml. of decolorized wine is evaporated to 4 or 5 ml. and treated with 0·2–0·25 ml. (6–8 drops) of *o*-chlorobenzaldehyde in the presence of 2 vol. of fuming hydrochloric acid (sp. gr. 1·18–1·19). After setting aside for 6–8 h., the precipitate is filtered off, washed with cold water and methanol, and dried. Tarantola & Strada[6] used a similar amount of reagent, but divided it in two, adding the second half after filtering, so as to repeat the precipitation, and stated that a temperature of 4–5° gave the best results. Actually with some fruit wines three such precipitations are necessary to obtain maximum yield of condensate and removal of excess of reagent from the precipitate is difficult.

The sample of wine tested must contain less than 1% of sugar, so that with sweet wines a preliminary fermentation with yeast is necessary.

Litterscheid[5] claimed to detect 2·5% of other fruit wine in grape wine. Vogt[7] in 47 tests in which 95 ml. of grape wine and 5 ml. of various fruit wines were used, obtained 45–140 mg. of condensate, and stated that amounts less than 25 mg. should be ignored. Later,[8] he showed that of 44 grape wines of good vintage only 5 contained sorbitol and in very small amounts. Iselin[9] found from 0·3 to 1·0 g. of sorbitol per 100 ml. in Swiss ciders which often include pears with the apples. Tarantola & Strada[6] found 0·4–0·5 g. of sorbitol per 100 ml. in Italian cider whilst in 19 out of 70 Italian wines sorbitol was absent. In 1949 Mortara[10] obtained from 0 to 6·5 mg. of sorbitol per 100 ml. of Italian wines and suggested a tolerance limit of 10 mg. In 1950 Staub & Widmer[11] found no sorbitol in 17 grape juices of four seasons and claimed to detect an addition of 1% of cider or 0·5% of perry. Eekhaut[12] affirmed that grape wine, even from unripe grapes, does not contain sorbitol, and an addition of 5% of fruit wine can be detected, as 100 ml. will then yield not less than 30 mg. of condensation product.

Experimental

Determination of sorbitol in wine

The technique used in the first tests on wine is as follows : The alcohol is distilled from 100 ml. of wine and the remaining extract is exactly neutralized, treated with 5 ml. of neutral lead acetate solution (40 g. of solid salt with 100 ml. of water) made up to 100 ml., agitated, and filtered through a dry 15-cm. filter into a flask containing 1 g. of dry potassium oxalate. After well shaking, the solution is filtered through a dry 9-cm. filter paper and measured (about 80 ml.). The whole of this is evaporated to 4 ml. on the water bath and transferred to a 25-ml. graduated glass cylinder with a ground-glass stopper, with a little water to make at most 6 ml. when cool. Twice the volume of A.R. hydrochloric acid (sp. gr. 1·18) is added with shaking and then 4 drops (about 0·17 g.) of *o*-chlorobenzaldehyde. After stoppering and shaking vigorously for 1 minute, the cylinder is placed in a dark cupboard and after half-an-hour the shaking is repeated and the vessel kept overnight. Meantime a Whatman-42 filter paper (9 cm.) has been dried and weighed in a 20-ml. beaker. The solution is then filtered through the paper, the filtrate being received in a second stoppered graduated cylinder which contains 4 drops of chlorobenzaldehyde, and the whole is shaken as before. The first cylinder and filter are now rinsed with 5 × 2-ml. portions of cold water and this filtrate is rejected. After keeping for 6 h. in the dark cupboard, the liquid in the second cylinder is filtered through the same paper and the cylinders and the precipitate on the paper washed with a total of 50 ml. of cold water, followed by 50 ml. of solvent methyl alcohol. (A long glass rod may be useful in detaching some precipitate from the bottom of the cylinders.) The moist drained filter paper with its contents is now suspended in its 20-ml. beaker, placed in the steam oven for half-an-hour, cooled and weighed. If desired the precipitate can be dissolved through the filter with about 25 ml. of hot acetone and the paper redried and reweighed, or the acetone extract may be evaporated and the residue weighed after drying for half-an-hour in the steam oven. Red Bordeaux (Medoc) and White Bordeaux (Graves) were tested alone and also when mixed with 5% of cider.

Determination of sorbitol in cider

In the case of cider, 5 ml. of extract (prepared from 100 ml. of sample by distillation) was used as sample and clarified with neutral lead acetate and dry potassium oxalate as before. As the amount of dried precipitate soluble in the 25 ml. of methyl alcohol used for washing purposes is 9–11 mg., the volume of alcohol used for washing the precipitate was reduced to 10 ml. Also it was considered better to use fuming hydrochloric acid (sp. gr. 1·19–1·20) instead of the A.R. previously used. The double precipitation technique was followed as before.

$$\text{wt. of ppt} \times 20/2{\cdot}88 = \text{wt. of sorbitol per 100 ml. of sample.}$$

Sweet cider can be tested without previous fermentation.

The samples tested included extra dry and sweet ciders, 'over-yeared' and new ciders, pure juice and others down to draught ciders.

Although the sorbitol in fruit juices will withstand the primary fermentation with yeasts, it can be oxidized to sorbose by ketogenic acetic bacteria and can be destroyed by moulds, coli-aerogenes and other bacteria. When a bottle of wine or cider has been opened, especially in the absence of a refrigerator, the completion of the tests should be made without delay.

Tests with sorbitol (sorbite)

In these tests 5 ml. of solution was used, usually 0·5 g. per 100 ml., but in some cases 1 g. per 100 ml., using the double precipitation method as for cider. Clarifying the solution with lead acetate and potassium oxalate apparently made little difference to the yield of precipitate. Replication of results on different days gave good agreement. Evaporating a sorbite solution to dryness on the boiling water-bath and redissolving caused no change in the yield of precipitate. Evaporating 6 × 5 ml. of a solution containing 0·5 g. of sorbite per 100 ml. and drying to constant weight in the oven gave 0·152 g. of dry matter; also 0·25 g. of sorbite with 50 ml. of water, evaporated and dried in the oven gave 0·252 g. Dilute sulphuric acid (1 : 1) was found to be less suitable than fuming hydrochloric acid for the test.

The results are shown below (Table I).

Table I

Wines	Condensate mg.	Sorbitol, per 100 ml.
Red Bordeaux 100 ml.	5	2 mg.
White Bordeaux 100 ml.	5	2 mg.
White Bordeaux 50 ml. + red Bordeaux 50 ml.	0	0 mg.
Red Bordeaux 95 ml. + cider 5 ml.	35	12 mg.
White Bordeaux 95 ml. + cider 5 ml.	35	12 mg.
Red Bordeaux 95 ml. + cider 5 ml.	43	15 mg.
White Bordeaux 95 ml. + cider 5 ml.	25	8 mg.
Ciders	**Condensate mg.**	**Sorbitol, g. per 100 ml.**
Bottled cider	54, 53	0·37
Cider	73	0·51
Cider	53	0·37
Bottled cider	51	0·35
Cider	50	0·35
Cider	47	0·33
Cider	64	0·44
Bottled cider	(14) 28	0·19
Draught cider	32	0·22
Draught cider	16, 19	0·12
Cider, extra dry	70	0·49
Cider, 8% sugar	42	0·29
Sorbitol (sorbite) (5 ml. of sample)	**Condensate mg.**	**Sorbitol, g. per 100 ml.**
0·5 g. per 100 ml.	62, 59	0·43, 0·41
Ditto but clarified	57, 58	0·40
Ditto but evaporated to dryness and redissolved in 100 ml.	60, 60	0·42
1·0 g. per 100 ml.	124, 125	0·86, 0·87

Discussion of Results

It is admitted that this method is not free from disadvantages and is not quantitative, as recovery of sorbitol from pure solution is only approximately 80%. Red and White Bordeaux wines give only a small amount of precipitate in the test, equivalent to about 2 mg. of sorbitol per 100 ml., whereas the samples of cider examined contained 0·12–0·51 g. per 100 ml. It is therefore possible to detect 5% of cider in wine.

Wm. Gaymer & Son, Ltd.
Attleborough
Norfolk

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THE INFLUENCE OF PROTEIN LEVELS ON POULTRY PRODUCTION

R. B. SHAW and E. W. NIGHTALL

The report is divided into three parts. In Part I a comparison is made of the effects of rations with and without protein supplement on chickens and laying pullets with access to grass runs. Evidence is presented that by use of farm-grown foods poultry food costs can be reduced, the only essential purchases being minerals and vitamins.

The chickens having no animal protein grew more slowly than usual and there was a delay in the commencement of egg production of three to four weeks. Satisfactory egg production followed to the extent that in the first year the birds without fish meal in their diet laid more eggs than the birds having fish meal.

It is shown in Part II that under the folding system with folds moved daily, egg production was high and the health of the birds good when no protein supplement was incorporated in the food given to the birds. In two of the three years the birds without fish meal gave a higher average production than the birds having fish meal. Under intensive battery conditions (Part III), however, the need for a protein supplement is definite.

Under all three systems of housing, egg size and shell quality were very satisfactory and similar from all rations used. Small differences in the internal quality of the eggs produced by the birds on different rations is referred to.

PART I

Introduction

For several years following World War II, farmers were urged to increase their flocks of pullets and bring about a substantial increase in the supply of eggs. Many farmers were

reluctant, however, to keep more pullets because of the shortage of animal protein, and on many farms vegetable protein also. It was believed that these protein foods were essential to success, particularly in the rearing of pullets. Muir[1] stated that chicks could be reared on a ration to which no protein had been added, provided they had access to good grass.

For these reasons it was decided to demonstrate at this centre what could be done in chicken rearing without the aid of animal or vegetable protein, and furthermore, to find out if eggs could be produced at an economic level without these protein supplements and when using very simple rations. An animal protein group was included merely to provide an interesting comparison.

We were further encouraged to carry out the egg production project by the results of experiments conducted at the Poultry Research Institute, Hillsborough, Northern Ireland, between 1925 and 1934,[2] and the experiments carried out at Sutton Bonington, between 1934 and 1937,[3] wherein most years the birds receiving no protein supplement produced more eggs than the other birds. In these earlier experiments, wheat offals were used, thus raising the protein content of the ration compared with the ration used in our more recent experiments.

Results at Midland Agricultural College, Sutton Bonington, 1934–37

	Birds studied	Egg production	
		Basal + Salt	Basal + Protein
1934–35	2 groups of 17 White Leghorn pullets	156 in 39 weeks	137 in 39 weeks
1935–36	2 groups of 18 Rhode Island Red pullets	185 in 44 weeks	175 in 44 weeks
1936–37	2 groups of 28 Rhode Island Red pullets*	140 in 39 weeks	165 in 39 weeks

* Birds in this group contracted colds in January.

Experimental

With regard to more recent experiments, three progress reports were issued[4] in 1950, 1951 and 1952. This report covers three Trials and gives the average results.

Three separate mashes were used, 'A' containing Sussex ground oats + minerals; 'B' Sussex ground oats, bean meal and minerals; and 'C' a normal rearing ration followed by a normal layers ration. These mashes are set out in Tables I and II. The bean meal used was prepared from the tick or horse bean (*Vicia faba* or *Faba arvensis*). All mashes were fed dry and *ad lib.*

Table I

Rearing rations

	Ration 'A' No protein supplement		Ration 'B' Vegetable protein supplement		Ration 'C'
	lb.	oz.	lb.	oz.	
Ground oats	28		*21		More normal in its make up and was the same as that fed to the other growing stock on the farm. During the first few weeks it contained dried separated milk 3%, dried yeast 2%, fish meal 8%. The latter had by the fifteenth week been reduced to 5%
Bean meal			* 7		
Sterilized bone flour		12		$9\frac{3}{5}$	
Manganized common salt		2		$3\frac{1}{5}$	
Cod-liver oil (omitted after the eighth week)	$\frac{1}{8}$ pint		$\frac{1}{8}$ pint		

* In the first year 14 lb. each of Sussex ground oats and bean meal were used.

Group A Wheat, one half of total daily ration
Group B Wheat, one third of total daily ration
Group C Wheat, barley, maize, oats, about one half of total daily ration

Table II

Layers rations

	Ration 'A' No protein supplement	Ration 'B' Vegetable protein supplement		Ration 'C' Normal ration with animal protein supplement
		1949–50	1950–52	
	lb. oz.	lb. oz.	lb. oz.	lb. oz.
Ground oats	56	14	21	15
Bean meal	—	14	7	—
Sterilized bone flour	2 8	1 4	1 4	—
Manganized salt	4	2	2	1
Grass meal	3	1 8	1 8	3
Cod-liver oil	¼ pint	⅛ pint	⅛ pint	¼ pint
Barley meal	—	—	—	9 8
Maize meal	—	—	—	5
Fine wheat offals	—	—	—	10
Coarse wheat offals	—	—	—	3
Fish meal	—	—	—	3 8
Limestone flour	—	—	—	15

Grain	Wheat	Barley	Oats
Group A	1	1	
Group B	1	1	½
Group C	1	1	1

All fed as a mixture at rate of 2 oz. per bird daily

Chemical analysis of layers mash 1952

	Group 'A'			Group 'B'			Group 'C'		
	Feb. %	June %	Nov. %	Feb. %	June %	Nov. %	Feb. %	June %	Nov. %
Moisture	10·56	10·8	11·3	11·05	10·6	11·6	9·98	10·9	11·2
Crude protein	11·1	10·9	10·6	14·2	15·1	14·8	14·9	16·1	16·2
Crude fibre	9·8	10·3	7·5	9·0	9·8	9·7	8·8	7·9	7·6
Ether extract (fat)	4·9	5·0	6·1	4·8	4·0	4·8	5·0	4·0	4·4
Total ash	6·6	6·4	6·2	6·8	7·1	6·2	7·1	6·8	6·5
Nitrogen-free extractives (soluble carbohydrates)			58·3			52·9			54·1
Acid-insoluble ash (silica)			0·8			0·7			0·6
Silica-free ash			5·4			5·5			5·9
Calcium (as CaO)			1·76			1·62			1·68

Chicken rearing

In the first year the chickens used were 192 Brown Leghorn × Rhode Island Red with a few Brown Leghorn × Light Sussex and Rhode Island Red × Light Sussex of mixed sexes; in the second year, 186 Rhode Island Red × Light Sussex and Brown Leghorn × Light Sussex pullets, and in the third year, 162 Rhode Island Red × Light Sussex pullets.

These various hatches were divided into three broods each containing an equal number of each cross. The birds were reared in small portable houses with heating units of pyramid hovers and double-burner oil lamps. When 10 days old the chicks had access to small grass pens and later the area of pasture was increased to approximately 510 sq. yd. per pen. The food consisted of dry mash and grain.

In the first year there were mixed sexes in the groups until the cockerels were removed at the end of the 4th period (16 weeks).

Laying period

At the age of 24 weeks (end of 6th period) the birds were transferred to laying quarters consisting of three slatted-floor houses all of the same design. Each house stood in a grass run

which on the basis of 50 birds per house allowed about 31 sq. yd. per bird. The runs were mown or grazed by sheep when required. The pasture, sown in 1939, was not of high quality.

The birds in all groups grazed the runs freely. In the first year the effect on the grass appeared to be similar in each pen, but in the following years the amount of wear and tear was relative to the amount of protein in the diet, the birds receiving no protein supplement consuming more grass and wearing down the pen more than the other birds. The contrast in the appearance of the pens, greatest in the third year, was more apparent in January and February but was still noticeable at the end of the summer. The same group did not occupy the same pen in successive years.

The birds had a constant supply of dry mash fed in hoppers in the houses, with a weighed grain feed of 2 oz. per head in the late evening. Occasionally, the full quantity of grain was not consumed.

Figures are given in Table III showing the average weights and gain in weights over the monthly periods of the birds studied.

The Laying Trial was continued for 52 weeks in the first year and 48 weeks in the second and third years. Table IV shows the average monthly egg production per pullet for each period. The periods were all of four weeks' duration, commencing in late April and terminating in mid September of the following year.

Table III

Weights of birds in growing period

Period	Age in weeks	Body weights in ounces Average of 3 years			Average weight gains for each period in ounces Average of 3 years		
		Group 'A'	Group 'B'	Group 'C'	Group 'A'	Group 'B'	Group 'C'
	Day old	1·49	1·48	1·51			
1	4	4·68	4·53	7·34	3·19	3·04	5·83
2	8	12·46	12·83	21·89	7·77	8·31	14·55
3	12	26·25	27·12	38·20	13·79	14·28	16·31
4	16	39·72	42·57	53·75	13·47	15·45	15·55
5	20	53·63	58·04	67·27	13·91	15·47	13·52
6	24	68·81	71·28	78·46	15·18	13·24	11·19

Table IV

Average monthly egg production per pullet

Period no.	Group 'A' Average of 3 years	Group 'B' Average of 3 years	Group 'C' Average of 3 years
6	—	—	0·69
7	0·21	0·39	4·33
8	5·08	5·89	13·09
9	13·88	14·58	15·17
10	17·24	17·46	16·06
11	17·64	17·62	16·75
12	19·74	19·43	18·76
13	20·66	19·35	19·40
14	19·73	18·45	18·72
15	16·39	16·45	16·98
16	15·56	14·82	15·86
17	15·98	14·25	14·74
18	15·42	13·24	14·85
Average total production (hen-day basis)	177·53	171·93	185·40
Average total production based on number of birds originally housed	174·04	161·41	177·69

The rearing mortality is given in Table V. Groups A and B showed a somewhat similar mortality rate in each of the three years, but, except for the first year, group C gave better results than the other groups.

Table V

Mortality figures

Year	During rearing period			During laying period		
	Group 'A' %	Group 'B' %	Group 'C' %	Group 'A' %	Group 'B' %	Group 'C' %
1949–50	7·8	9·4	10·9	3·2	17·2	19·2
1950–51	14·5	16·1	9·7	6·0	10·0	8·0
1951–52	7·4	7·4	1·9	10·0	2·0	7·5

In the first year considerable trouble was caused by the group B chicks not liking the high proportion of bean meal, and the mash intake was too low particularly during the early stages. As a result of this experience, the quantity of bean meal was reduced by half in the second and third years, and made up with Sussex ground oats. This improved the palatability, the chicks consumed more mash than in the first year and seemed more satisfied with the ration.

Results

The growth rate of group C was consistently better throughout the Trials. Except that group C ate more in the growing stage, the food consumption of the three groups was not greatly different, but the food-conversion rate (Table VI) was widely different at 12 weeks, with group C easily the best and B and A following in that order. After 12 weeks, groups B and A improved slightly, and all groups were practically equal at 32 weeks by which time egg production had commenced.

Table VI

Food conversion rates

Group		During growing stage Average for three years Lb. of food to produce 1 lb. live-weight gain	During egg production Average for three years Lb. of food to produce 1 dozen eggs
A	to 12 weeks	5·09	
	,, 16 ,,	5·48	7·34
	,, 24 ,,	6·57	
B	to 12 weeks	4·26	
	,, 16 ,,	5·24	7·78
	,, 24 ,,	6·19	
C	to 12 weeks	3·77	
	,, 16 ,,	4·63	7·12
	,, 24 ,,	6·24	

The group having the animal protein supplement developed more rapidly each year, and maintained the lead throughout the growing period, but Table III does show that the other two groups gained more weight than group C between 16 and 24 weeks of age. The difference in rate of development during the growing stage did not appear to have any effect on the birds during their laying life.

Body weights during the remainder of the laying period fluctuated from month to month but at the end of the Trial period there was little difference between the various groups.

In each of the three years the high-protein group matured more quickly than either of the other groups and one or two birds commenced to lay before the end of the sixth period. The groups receiving vegetable protein and no protein started three to four weeks later, and in all groups the production rose very steeply in the second month after production had started. Spring and summer production in the no-protein group was better than in the other groups, whereas the animal-protein group gave better autumn results, largely because of earlier maturity.

It is probable that autumn production could be stepped up considerably if chickens to be given a low-protein diet later were hatched out about three weeks earlier than was the case with the experimental groups. The pullets in groups A and B have demonstrated their ability to lay well during the months of December, January and February and, as normally these are rather difficult months for high egg production, particularly when birds are forced to try and obtain nutritional help from grass and grubs, it is likely that the same birds could give a good performance during the autumn.

The total number of eggs produced in the three years by the birds on the various rations showed little difference, group B being slightly below the other two groups. Group A (no protein supplement) proved much superior in the first year, but did less well in the following years. The main point of interest, however, is that the group A birds running in rather ordinary semi-intensive pens gave an average production in the three years of 187·6, 167·2 and 177·8 eggs per bird, or an overall average of 177·5 eggs for the three years (Table IV). There can be little doubt that the egg prices ruling during these three years allowed a good margin of profit from the group A (no-protein supplement) birds.

In considering performance and profitability in the case of the group B birds, it is best to disregard the first-year results since it has been shown that the large amount of bean meal used in that year depressed food consumption and egg production. In the second and third years, the average production was 176·9 and 179·95. This again shows that a worth-while level of egg production is possible without the use of animal protein. Bean meal, however, was high in price and because of this it was found in the 1950–51 experiment that the no-protein group showed a larger margin of profit than the bean meal group, despite the higher egg production of the latter. The production of group C was sufficiently high to offset the cost of the seemingly expensive fish meal. The latter group averaged 185·4 eggs over the three years.

It is well to keep in mind that the type of house used in these experiments is not reputed to facilitate high egg production in the winter months.

The total food intake showed a remarkable similarity, with group B having the greatest consumption.

The food-conversion rate per dozen eggs (Table VI) showed a small difference of 0·22 lb. in favour of the animal-protein group over the no-protein groups, but the vegetable-protein group consumed 0·44 lb. more per dozen eggs than the no-protein group, which in view of the higher cost of the vegetable protein mash is of some importance.

The egg weight was good in all groups ; the average for each group over the three years was approximately 2·2 oz.

The final body weight of each bird over the three years averaged : group A 6 lb. 5·5 oz., group B 6 lb. 3·9 oz., group C 6 lb. 3·2 oz.

PART II

The feeding of a no-protein-supplement ration to laying stock in fold units

The results achieved with birds in slatted-floor houses located in grass pens prompted us to do similar work with laying stock folded over grassland in units of twenty-five birds.

It was decided to provide a ration resembling the one given to the main group of fold birds except that half of the birds would have no fish meal in their mash. The compositions of the rations for the birds receiving no protein supplement and animal protein supplement, respectively, were as follows : ground wheat 28, 27 ; ground barley 21, 21 ; ground oats 33, 32 ; grass meal 8, 8 ; fish meal 0, 7 ; sterilized bone flour 5, 2 ; manganized salt 0·5, 0·5 ; limestone flour 4·5, 2·5 lb. ; cod-liver oil, ½, ½ pint. In addition, 2 oz. of equal parts wheat and barley were given to each bird per day.

Table VII

Chemical analysis of mashes used in fold units

	No protein supplement				Animal protein supplement			
	Feb. 1952 %	July 1952 %	Nov. 1952 %	June 1953 %	Feb. 1952 %	July 1952 %	Nov. 1952 %	June 1953 %
Moisture	10·78	11·1	10·9	12·9	12·05	11·2	11·1	13·4
Crude protein	11·1	10·6	10·4	10·2	14·9	15·3	15·5	13·3
Crude fibre	7·4	7·1	7·7	7·8	7·4	7·2	9·0	5·3
Ether extract (fat)	2·2	2·9	3·2		3·0	2·6	2·8	
Nitrogen-free extractives (soluble carbohydrates)		58·2	57·6			55·1	53·7	
Total ash (minerals)	12·0	10·1	10·2	10·5	9·2	8·6	7·9	8·1
Acid-insoluble ash (silica)			0·7	0·6			0·7	0·5
Silica-free ash			9·5	9·9			7·2	7·6
Calcium (as CaO)			4·14	4·28			2·74	3·22

The stock used for the experiments was as follows:

1950–51 50 Brown Leghorn × Light Sussex pullets on each ration
1951–52 25 White Leghorn × Rhode Island Red and 25 White Leghorn × Light Sussex pullets on each ration
1952–53 75 Rhode Island Red × Light Sussex pullets on each ration

The birds reared on a normal ration were all April-hatched and there was no more than a week's difference in age between any of the pullets. An equal number of each age was put into each group and altogether the groups were made as similar as possible each year.

Results

The egg production for the three Trials is shown in Table VIII.

Table VIII

Egg production: average per bird on hen day basis

1950–51		1951–52		1952–53	
No protein	Protein	No protein	Protein	No protein	Protein
181·0	175·5	191·6	183·7	130·9	150·2
(47 weeks)		(48 weeks)		(39 weeks)	

Although the differences in production are not great, the no-protein-supplement groups laid at a higher level than did the protein supplement groups in the first two years. In the third year there was a swing the other way and the birds with the protein supplement laid about twenty eggs more than the other birds. Quite apart from this comparison, however, there are indications that fold birds can be distinctly profitable without the addition of animal protein to their ration. It is remarkable to find birds on a ration of this kind averaging as high as 19·8 eggs in December and 19·1 eggs in January.

There were no appreciable differences in mortality and the losses could not be related to feeding.

PART III

The use of home-grown food without the addition of animal protein in laying battery house

In continuation of our work on the use of home-grown foods, there was a desire to determine whether it is possible to obtain satisfactory egg production in battery cages without the inclusion of an animal or vegetable protein supplement.

To obtain some preliminary information, a very small trial involving twelve birds was carried out from 15 July to 13 September, 1950. The conditions were not entirely satisfactory as these birds had been in the cages for ten months and the mere fact of changing the diet may have had an adverse effect on production. No pronounced effect either good or bad was found from the use of the ration made up of home-grown foods without any protein supplement. It was decided to try the same rations on a larger number of birds for a longer period.

In all the three trials here described a record of food consumption was kept and the birds were weighed at the beginning and end of the trial. Dry mash only was fed. The birds occupied one tier of a battery unit.

Experimental

First trial

This trial was for 48 weeks from 26 September, 1950, to 27 August, 1951. Forty pullets were used, twenty on a normal high-protein level ration and twenty on a low-protein home-grown feeding stuffs ration. Each group contained ten Light Sussex and ten Rhode Island Red pullets hatched the previous March, suitably divided up with regard to parentage.

The management for all birds was the same throughout the trial. The only addition to the dry mash was a handful, once a week, of a mixture of shell and grit (3 shell to 1 of grit).

The compositions of the ration with no added protein supplement and of the normal mash were respectively : coarse ground wheat 28, nil ; fine ground barley 21, 22 ; fine ground oats 33, 22 ; grass meal 8, 8 ; sterilized bone flour 5, nil ; manganized salt 0·5, nil ; limestone flour 4·5, 4 ; fine wheat offals nil, 22 ; fish meal nil, 7 ; maize meal nil, 15 lb. ; cod-liver oil, $\frac{1}{3}$, $\frac{1}{3}$ pint.

The differences in average weight gain of the groups was the small amount of 1·06 oz. per bird in favour of the high-protein group.

In the matter of food consumption the difference was again small, the high-protein group taking 0·6 lb. per bird more than the low-protein group. In the 48 weeks the low-protein group showed average food consumption of 101·8 lb. per bird and the high-protein group 102·4 lb. per bird.

Egg production throughout was higher in the case of the high-protein group, the averages per bird for the whole period being 204·8 for the high-protein group and 171·6 for the low-protein group. Differences in egg weight and quality were very slight.

Mortality was higher in the low-protein group, but on examining the carcasses there was nothing to suggest that the deaths were in any way connected with the nature of the ration.

The number of birds involved was too small to give conclusive results, but there were indications that profitable egg production could be obtained by feeding home-grown foods, unaided by a protein supplement, to pullets in a battery house. Although the birds on the normal ration produced considerably more eggs, many farmers who are without a supply of protein would be well satisfied with an average of 171·65 in 48 weeks and with averages of over 14 eggs per bird per 28 days during the November to February period.

Second trial

This trial also lasted for 48 weeks from 16 October, 1951, to 15 September, 1952. The experiment consisted of 40 pullets in battery cages divided into two groups of 20 birds, known as group A and group B. Half the birds in each group were Light Sussex and half Rhode Island Red. Group A birds were fed on a ration composed entirely of home-grown cereals with the addition of minerals and cod-liver oil. Group B birds had a ration similar to group A but with 7% fish meal added. The rations for group A and group B respectively were as follows : coarse ground wheat 28, 27 ; fine ground barley 26·5, 24·5 ; fine ground oats 30, 28 ; grass meal 7, 7 ; sterilized bone flour 4, 2 ; manganized salt 0·5, 0·5 ; limestone flour 4, 4 ; fish meal nil, 7 lb. ; cod-liver oil $\frac{1}{3}$, $\frac{1}{3}$ pint. The chemical analyses of these rations are shown in Table IX, and the results obtained in this test are shown in Table X.

Table IX

Chemical analysis of battery mashes fed in 1952 and 1953

	No added protein supplement				Animal protein supplement			
	Feb. 1952 %	June 1952 %	Nov. 1952 %	June 1953 %	Feb. 1952 %	June 1952 %	Nov. 1952 %	June 1953 %
Moisture	10·25	10·6	11·2	12·5	11·09	10·4	10·9	12·1
Crude protein	11·4	10·4	11·1	11·2	16·0	15·1	15·0	14·0
Crude fibre	5·3	7·1	6·8	8·7	6·0	6·3	5·9	5·6
Ether extract (fat)	3·3	2·9	3·4		3·1	3·2	3·8	
Total ash(minerals)	10·8	14·6	8·8	9·8	12·6	11·8	9·2	10·5
Nitrogen-free extractives (soluble carbohydrates)			58·7				55·2	
Acid-insoluble ash (silica)			0·6	1·3			0·5	1·0
Silica-free ash			8·2	8·5			8·7	9·5
Calcium (as CaO)			3·50	3·61			3·61	4·09

Table X

Results of second battery trial

	Group 'A' No protein supplement	Group 'B' Protein supplement
Average egg production per bird (hen day)	160·1	194·1
Lb. food consumed to produce 1 doz. eggs	8·4 lb.	7·6 lb.
Average weight of birds at beginning	5 lb. 15·2 oz.	6 lb. 1·1 oz.
Average weight of birds at end	5 lb. 12·2 oz.	6 lb. 14·3 oz.
Mortality, no. of birds	1	4

The egg production shown in Table X was considerably less in both groups than in the previous year. Even so, the birds receiving no added protein in their ration again produced profitably, aided by the cheaper ration and the lower consumption of it compared with the other groups and despite the poorer food-conversion rate. The birds receiving an animal protein supplement produced at a higher rate throughout the 48 weeks and at the end of the period had produced 34 more eggs per bird.

It will be seen also that the birds receiving additional protein gained substantially in body weight whereas the other birds lost weight to the extent of an average of 3 oz. per bird.

The differences between the cost of feeding of the birds and the cash returns from the sale of the eggs were £32 6*s*. 0*d*. for the group receiving no supplement and £39 4*s*. 9*d*. for that receiving the protein supplement, or based on the average number of birds per group £1 15*s*. 5*d*. and £2 4*s*. 9*d*. per bird, respectively.

Third trial

This trial lasted 36 weeks from 9 October, 1952, to 17 June, 1953. This experiment was undertaken to produce further information on the feeding of a low-protein diet.

Forty in-lay pullets were divided into two groups each consisting of 10 Rhode Island Red and 10 Light Sussex. Group A was fed entirely on a dry mash mixture which contained no high-protein food and group B received a similar basic mash + 7% fish meal. The compositions of the rations are shown in Table XI.

At the end of 14 weeks it was obvious that group A was doing very badly and it was decided to add 3½% fish meal to their mash to determine to what extent such an amount would meet their requirements. Furthermore, this information would perhaps provide a pointer to the objective for the next experiment.

Production in group A rose during the next period of 22 weeks (January 15 to June 17) from 40·3% to 52·3%. As over a period of years the birds in our battery house have increased their production very little in the spring, it is fairly safe to assume that the rise in production of group A was due to the alteration in the diet.

Table XI

Battery mashes

	Group 'A' First period No fish meal (14 weeks) lb.	Group 'A' Second period 3½% fish meal (22 weeks) lb.	Group 'B' Throughout 7% fish meal (36 weeks) lb.
Ground wheat	28	28	27
Ground barley	26½	26	24½
Ground oats	30	28	28
Grass meal	7	7	7
Sterilized bone flour	4	3	2
Manganized salt	½	½	½
Limestone flour	4	4	4
Fish meal	—	3½	7
Cod-liver oil	⅓ pint	⅓ pint	⅓ pint
Cost per cwt	£1 14*s.* 3*d.*	£1 15*s.* 0*d.*	£1 15*s.* 8*d.*

At the beginning of the trial the average weight of group A was 5 lb. 14·8 oz. and group B 6 lb. 3·84 oz. The final weights were group A 6 lb. 8·5 oz. and group B 6 lb. 14·5 oz.

Results

During the first period of 14 weeks when group A was on a no-protein-supplement diet, the margin per bird over cost of food was only about half that of group B (Table XII). There was a striking improvement in the food conversion rate from 9·1% to 7·3% per dozen eggs following the addition of fish meal to the group A mash even though the food consumption rate was increased. Table XII shows that the addition of 3½% fish meal to the diet of group A brought the rate of egg production and margin of income over food costs much nearer to that of group B (7% fish meal). The cash return in favour of group B over group A was 5*d.* per bird compared with the previous figure of 10*s.* 5½*d.*

Table XII

Food consumption and egg production

	14 weeks		22 weeks	
	Group 'A' No fish meal	Group 'B' 7% fish meal	Group 'A' 3½% fish meal	Group 'B' 7% fish meal
	Lb. oz.	Lb. oz.	Lb. oz.	Lb. oz.
Average total food	30 7	31 —	52 1	49 15
Average food per day	4·90	5·06	5·40	5·10
Average production	40	61·80	80·40	84·90
Percentage production	40·30	63·00	52·30	55·10
Lb. of food to produce 1 doz. eggs	9·10	6·01	7·30	7·05
Income from eggs	£1 0*s.* 2*d.*	£1 11*s.* 2¼*d.*	£1 11*s.* 0*d.*	£1 11*s.* 1*d.*
Margin over food costs (per bird)	10*s.* 10½*d.*	£1 1*s.* 3¾*d.*	14*s.* 9*d.*	15*s.* 2*d.*

Conclusions

It would seem that when birds are housed intensively some high-protein food is necessary to obtain maximum financial returns. The correct amount of protein supplement under our conditions has yet to be determined, but the results of this small trial indicate that perhaps the fish-meal content of our mash for layers in battery cages could be reduced with advantage. The customary amount has been 7% in a mash containing cereals and wheat offals.

Quality of eggs

In order to ascertain if any of the rations used had a bad influence on the internal quality of the eggs, some eggs from each group of birds were candled on several occasions during the trials by a Ministry of Food Officer.

In testing the yolk quality, patchy yolks were found in greater numbers in the no-animal-protein groups than in the animal-protein groups in so far as the fold- and slatted-floor-house-birds were concerned. The only other faults mentioned were blood and meat spots with percentages as follows:

Type of house	Ration supplement	Blood spots %	Meat spots %	Total eggs tested
Fold	No protein		1·04	286
Fold	Animal protein		1·40	214
Slatted floor	No protein		1·61	186
Slatted floor	Animal protein	1·61	·46	216
Slatted floor	Vegetable protein		1·98	202
Battery	No protein	2·70		74
Battery	Protein	2·77	1·33	72

Discussion of results

It has been shown that pullets can be reared satisfactorily on home-grown foods without the addition of animal protein. This leads to lower cost per cwt. of food and, except for the purchase of minerals and vitamins, the farmer can be independent of outside supplies. Against these advantages must be weighed the fact that the pullets grow more slowly and if hatched in late April they do not contribute sufficiently to the autumn egg basket. It is thought that this fault could be remedied by hatching the pullets about three weeks earlier, but this has not been determined experimentally.

Apart from the lateness in coming into production, the pullets on the no-protein-supplement ration did remarkably well and averaged on a hen day basis 177·5 eggs per bird during the trials over an average period of 49·3 weeks, in the three years. If the food analysis figures for 1952 can be accepted as representative of the whole period of the trials then the birds did this on a mash which contained on an average less than 11% crude protein (see chemical analysis, Table II). The birds receiving bean meal gave an average of 171·9 eggs during the same period and those receiving 7% fish meal 185·4 eggs in an average period of 51 weeks.

The lower cost of the no-protein-supplement ration did allow a worth-while profit to be made, although not as high as was obtained from birds receiving fish meal.

In the initial year it was found that the high proportion of bean meal in the mash used for the B group was somewhat unpalatable, but in the two succeeding years when the proportion was much reduced the usefulness of this food for egg production was demonstrated, although its high cost adversely affected financial profit. If the results of the first year are disregarded, the average production from group B becomes 178·4 which is very close to the average over three years of the no-protein-supplement groups.

In the case of layers housed in folds the results were more striking, in that two years out of three the birds without any protein supplement in their diet produced more eggs than the birds having fish meal; the mash in this case averaging about 10·6% crude protein. The eggs were not weighed but, from observation, it can be said that the eggs from the no-protein-supplement groups were not inferior in size and shell texture to the eggs from the other groups.

The pullets in battery cages succeeded in producing a good number of eggs without the aid of animal protein, but fell so far short of the production of the birds having fish meal that it was decided after a time to introduce 3½% of fish meal to the diet. This brought about a great improvement in production and the results were almost as good as those achieved by the 7%-fish-meal group.

The indications seem to be that birds with access to grassland can often augment their non-animal protein ration sufficiently to produce eggs as well as, or better than, birds receiving fish meal, whereas birds housed in battery cages are unable to do so. Even when birds on grassland fail to achieve this, there is a probability that their production will be profitable. This can be a matter of economic importance when animal protein is in short supply or is costly.

In considering the number of eggs produced under the different systems of housing, it is not possible to make an accurate comparison because of variations in the periods of production and in the diet, but approximate figures have been obtained by calculating, where required, the

probable production over a 48-week period (Table XIII). According to these figures the production from the birds in slatted-floor houses in grass pens and from birds in fold units was very

Table XIII

Egg production under all three systems of housing (48 *weeks*) (*calculated on hen-day basis*)

	No-protein-supplement-groups	Animal-protein supplement-groups
Slatted floor houses in large grass runs (3 years average)	177·5	184·7
Fold units moved daily (3 years average)	178·75	181·05
Laying battery house (2 years average)	165·9	199·3

similar, particularly on the no-protein-supplement diet, but the egg yield from the occupants of the battery cages was much below that of the other birds when the no-protein-supplement groups are compared and well in excess of the other birds when the results from the groups having animal protein are compared. These latter figures provide striking evidence of the beneficial effect of adding animal protein to the diet of pullets kept in cages.

Assuming that the varying results from the birds in grass pens are not, or are only to a minor degree, caused by a difference in the laying capabilities of the groups, there are indications that laying stock restricted to a ration to which no animal protein has been added are on a marginal diet giving varying results over a period of years. The variation may be influenced by the weather, the quality of the grassland, and even more by the protein content or general quality of the cereals incorporated in the diet. It may be that to ensure maximum results every year some animal protein must be added to the diet particularly during the first few months of production when the body is still developing. What is the optimum amount of protein is a matter for further investigation. There are indications that in the past protein has been used too liberally.

What do the birds find on grassland that is so helpful to them ? At first one is inclined to give credit to the grass, but there is strong evidence that the birds find what they want in the soil (? worms or grubs). The many holes made in the runs in the earlier experiments carried out here and the results obtained at Hillsborough[2] and Reading[5] where the grass was removed from the pen before the experiments started, seem to supply this evidence.

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University of Nottingham
School of Agriculture
Sutton Bonington
Loughborough
Leics.

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THROUGH-CIRCULATION DRYING OF SEAWEED. V.*—*Ascophyllum nodosum*; *Fucus serratus*; *Fucus vesiculosus*

By T. J. MITCHELL and C. S. POTTS

The drying characteristics of freshly harvested *Ascophyllum nodosum*, *Fucus vesiculosus* and *F. serratus* have been investigated in a through-circulation dryer. All tests were carried out with minced seaweed. Variables studied were bed depth (0·5–6 in. approx.), air temperature (100–220° F), air wet-bulb depression (30–115° F), air mass velocity (5–11 lb./sq. ft. min., and static pressure drops of air through beds of wet and dry weed. Bed-depth experiments have given equations relating drying times, constant drying rates and outputs to loading. The output *versus* loading curve shows a well-defined optimum value for each species of seaweed. Empirical equations have been derived, relating drying times (between definite water content limits) and initial constant drying rates to air mass flow. It has been shown that the drying rates, at average water contents of 3·0 to 0·2, 2·7 to 0·2, and 3·5 to 0·15 lb./lb. of bone-dry solids (for *A. nodosum*, *F. vesiculosus* and *F. serratus* respectively), are directly proportional and the drying times inversely proportional to the wet-bulb depression of the air. A study of the water content of various layers in a seaweed bed has been made. A typical drying rate *versus* water content curve is shown, and a mechanism of drying of deep beds has been postulated. A section is included dealing with the prediction of approximate drying times and rates.

Introduction

The main reasons for drying seaweed are to reduce transport costs, to enable the material to be stored without bacterial decomposition, and to allow it to be compounded more easily with other products (e.g. animal feeding-stuffs). The extraction of the constituents of seaweed is usually preceded by drying and grinding.

Search for a cheap and efficient method of drying has revealed that a through-circulation conveyor dryer is probably best for seaweed. Gardner & Mitchell[1] have summarized the results of the main volume of work published on through-circulation drying. Simmonds, Ward & McEwen[2] have since published an account of their investigations into the through-drying of wheat grain, both in single layers and deep beds. The rate of drying of single layers has been found to be independent of air-velocity in the range 30–160 ft./min., to depend sharply on the air-temperature 70–170° F, and to be only slightly diminished by a fourfold increase in air-humidity. The rate of drying is also proportional to the free moisture content of the grain, while the grain temperature is related to the moisture content at a given stage in the drying process by a simple equation. A method of predicting the rate of drying of wheat grain in beds 3–12 in. deep is proposed, for air velocities of 20–130 ft./min. and temperatures 70–170° F, with an accuracy of ± 10%.

Previous work in this laboratory has been concerned primarily with the sub-littoral weeds *Laminaria cloustoni*, *L. digitata* and *L. saccharina*. Preliminary studies on the drying of these weeds have been carried out by Black & Duthie[3] and McLean & White.[4] Gardner & Mitchell[1, 5, 6] have investigated the through-circulation drying characteristics of the above seaweeds and have suggested a graphical method for predicting the drying times and rates of seaweed beds. Hyndman, McEwen & Mitchell[7] have conducted tests on a mixture of *L. cloustoni* stipe and frond and have also carried out initial investigations into the drying of the littoral weeds *Ascophyllum nodosum*, *Fucus vesiculosus* and *F. serratus* at different bed loadings. The effect of agitation of the bed has been studied by Rankin[8] for the above rock seaweeds.

The use of rotary dryers for the drying of seaweeds has met with limited success, owing to the excessive mucilage content of the weed. Gardner, Mitchell & Scott,[9] using a radioactive-tracer technique, have shown that *Laminaria cloustoni* frond did not receive uniform treatment in a pilot plant rotary louvre dryer, since frond particles stuck to the inside of the drum. *L. saccharina* frond at an initial moisture content of 50% has been successfully dried in such a dryer.[10] A rotary dryer has been described by Clark *et al.*[11] for drying *Macrocystis pyrifera*, a seaweed found off the Californian coast, from a moisture content of 87% to 40–65%. Drying to lower moisture content (5–15%) was effected on a conveyor dryer with a seaweed bed-depth of 2–3 in.

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Gardner[12] has described a test on a large-scale grass drier (Pehrson Dual Process) using *L. cloustoni* as feed. This dryer had a pneumatic drying tower followed by two rotary drying sections. A description of some of the industrial uses of red and brown seaweeds and a comparison of the methods of drying seaweed with those used for grass and vegetables, has been made by Mitchell.[13]

Raw material

Most of the seaweed used was harvested in the Firth of Forth area with a few samples from the Oban area. A two-day supply of weed was harvested one day and despatched that day, arriving at the laboratory the following day. Tests on the weed were thus completed within 48 hours of harvesting.

A. nodosum, *F. vesiculosus* and *F. serratus* belong to the *Fucaceae* family of the *Phaeophyceae* group which covers a large area of the tidal rocks of Great Britain, and all attach themselves to rocks by a discoid holdfast or hapteron.

A. nodosum occurs on rocks and boulders from high-water mark to half-tide level and is abundant on rocky shores. It is distinguished by air vesicles or bladders formed at intervals on the whole plant, the fronds of which grow from 12 to 60 in. in length, and are tough and leathery.

F. vesiculosus is a rock-weed growing up to 3 ft. in length with the fronds $\frac{1}{4}$–1 in. in width. It has a flat thallus with a distinct midrib and branches out in one plane, with air bladders formed at intervals on either side of the midrib. The weed grows freely on rocks and stones between high- and low-tide marks.

F. serratus is of similar form to *F. vesiculosus* with the distinction that the air bladders are absent and that the margin of the frond is serrated. It grows to a maximum length of 6 ft. and is very common on rocks from half-tide level to low-water mark.

The size of the weeds harvested was about 1 ft. in length for *F. serratus* and *F. vesiculosus*, and approx. 2 ft. in the case of *A. nodosum*, i.e. considerably smaller than the largest plants.

Experimental procedure

The dryer used has been described by Gardner & Mitchell ;[1] it operates by means of a centrifugal fan blowing air over electric heating elements and thence vertically through the static seaweed bed contained in a removable basket.

The experimental procedure was similar to that described in the above paper, with one major exception. In previous tests a mean air mass flow was taken throughout the whole test period. This was not completely satisfactory since any change in flow made comparison of tests more difficult. Hyndman, McEwan & Mitchell[7] have therefore constructed a triangular chart which can be used to maintain the air mass flow at a steady value throughout a test. The chart relates the exit dry- and wet-bulb temperatures to the air velocity. By measuring the two temperatures, the true air velocity at the desired mass flow can be read from the chart, and then any adjustment in fan speed required can be made.

The prepared weed was weighed into the basket with random packing, and the bed levelled off without any unnecessary pressure being applied. No great change in colour during drying was noted, but when steam injection was used to humidify the inlet air, the colour of the weed changed initially to bright green which gradually became darker as the test proceeded.

Identical shrinkage and matting effects to those described by Gardner & Mitchell[5] were noted in all tests, causing part of the air to short-circuit the bed.

Tests on the effect of one variable were performed consecutively so as to reduce to a minimum the seasonal variation in the biological nature of the material.

Effect of operating variables

(1) *Bed-depth.*—The obvious advantage of through-circulation drying is that the drying air is much more economically used than in tray drying, i.e. cross-circulation drying, since more intimate contact is made between the air and the particles of the bed. Thus in contrast to cross-circulation drying, much heavier loading is possible.

The minced weed was dried by air at 160° F at an air mass flow of 7·5 lb./sq. ft. min., using thermostatic control on one of the heating elements.

(a) *Ascophyllum nodosum*

Fig. 1 indicates the values of temperature and humidity for inlet and exit air and of

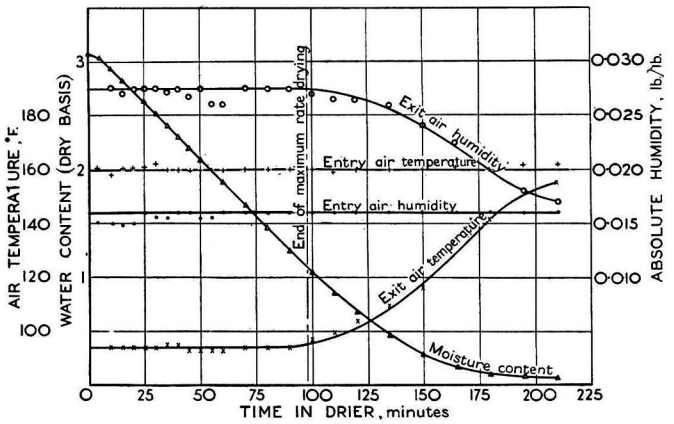

FIG. 1.—*Drying of seaweed;* Ascophyllum nodosum
L_d = 2·26 lb./sq. ft.

water content *versus* drying time for a typical drying run on *A. nodosum.* The time required to dry the minced weed between a water ratio of 3·2 and 0·15 was plotted against the dry loading L_d. The curve, in which drying time rapidly increases above a dry loading of 2·0 lb./sq. ft., has the empirical equation :

$$\theta = 77{\cdot}5 - 27{\cdot}9 \log_e (2{\cdot}62 - L_d) \text{ for } L_d < 20 \qquad \text{(Fig. 3)}$$

The constant drying rate plotted against the dry loading gives a curve represented by the equation :

$$dW/d\theta = \exp 2{\cdot}54 - 0{\cdot}755L_d \qquad \text{(Fig. 4)}$$

The output of commercial dry seaweed (0·15 lb./lb. B.D.S.) from seaweed of initial moisture 3·2 is expressed as :

$$R = (L_d/\theta) \times 69 \qquad \text{(Fig. 5)}$$

A plot of output *versus* dry loading shows a well-defined optimum value for output at L_d = 2·0 lb./sq. ft. ($3\frac{1}{2}$ in. bed-depth), above which the output decreases markedly. All further tests on the influence of other drying variables were carried out at slightly below this loading.

(b) *Fucus vesiculosus*

The drying time ($T = 2{\cdot}7 - 0{\cdot}10$) *versus* dry loading can be represented by the equation :

$$\theta = \exp 0{\cdot}67L_d + 3{\cdot}28 \qquad \text{(Fig. 3)}$$

The constant drying rate *versus* L_d can be expressed as :

$$dW/d\theta = 5{\cdot}51L_d^{-1{\cdot}1} \qquad \text{(Fig. 4)}$$

The output of commercial dry seaweed (C.D.S.) (0·10 lb./lb./lb. B.D.S.) from minced weed of initial water ratio 2·7, has an optimum value at L_d = 1·6, the equation of the curve being

$$R = 66L_d/\theta \qquad \text{(Fig. 5)}$$

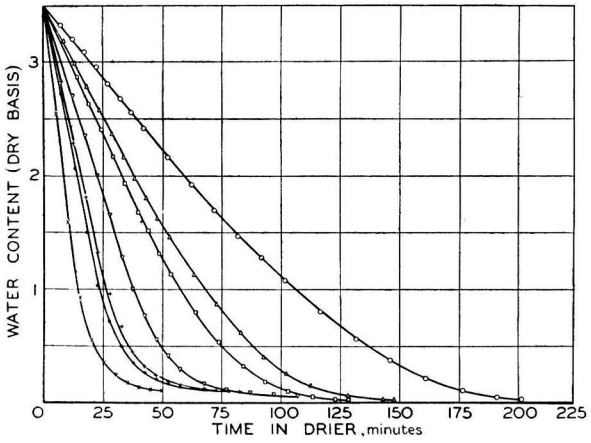

FIG. 2.—F. serratus—*effect of bed-depth*

D.B.T., 160° F. W.B.D., 67° F. *G*, 7·5 lb./sq. ft./min.

Run	*L*d
×	0·36
●	0·66
+	0·86
▽	1·22
□	1·54
△	1·73
○	2·26

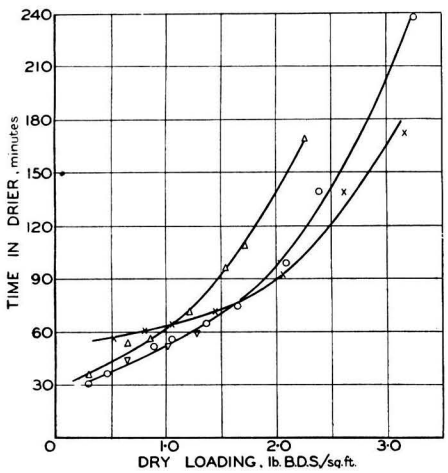

FIG. 3.—*Drying time* versus *bed-depth*

D.B.T., 160° F. W.B.D., 67° F. *G*, 7·5 lb./sq. ft./min.

△ *F. serratus*	October–January	*T*, 3·5–0·15
+ *A. nodosum*	October–January	*T*, 3·2–0·15
○ *F. vesiculosus*	October–January	*T*, 2·7–0·10
▽ *F. vesiculosus*	April–June	*T*, 2·7–0·10

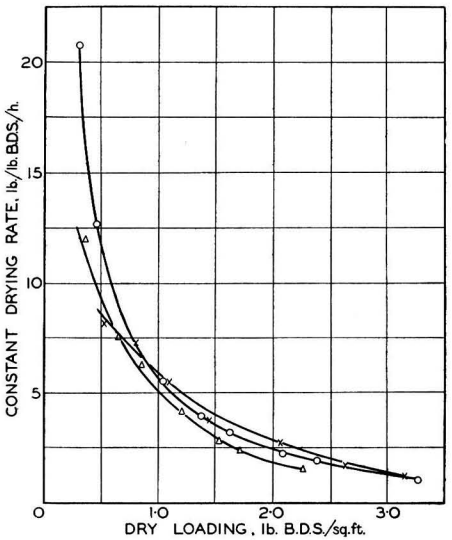

FIG. 4.—*Constant-drying rate* versus *bed-depth*

D.B.T., 160° F. W.B.D., 67° F. *G*, 7·5 lb/sq. ft./min.

△ *F. serratus*	October–January
× *A. nodosum*	October–January
○ *F. vesiculosus*	October–January

(c) *Fucus serratus*

Fig. 2 shows typical curves for water content *versus* drying time for bed-depth tests on *F. serratus*. The equation for drying ($T = 3{\cdot}5 - 0{\cdot}15$) *versus* dry loading is of similar form to that for *F. vesiculosus*:

$$\theta = \exp 0{\cdot}78L_d + 3{\cdot}37 \qquad \text{(Fig. 3)}$$

The constant drying rate *versus* L_d has the equation:

$$dW/d\theta = \exp 2{\cdot}68 - 1{\cdot}02L_d \qquad \text{(Fig. 4)}$$

The output of C.D.S. (0·15 lb./lb. B.D.S.) from seaweed of initial water ratio 3·5, has an optimum value at $L_d = 1{\cdot}25$, and is related to L_d by:

$$R = 66L_d/\theta \qquad \text{(Fig. 5)}$$

(2) *Air velocity.*—In this series of tests, the air dry-bulb temperature was maintained constant at 160° F and the air mass velocity was varied from 5–11 lb. d.a./sq. ft. min., each flow-rate being kept steady at the predetermined value as in the loading tests. This method of control was independent of any variation in inlet air humidity, but did not include a correction factor for any 'edge effects' taking place in the tests, or channelling of the air-stream.

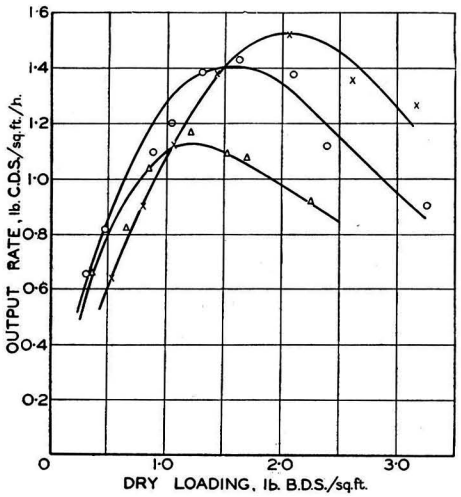

FIG. 5.—*Output* versus *bed-depth*

D.B.T., 160° F. W.B.D., 67° F. *G*, 7·5 lb./sq. ft./min.

△ *F. serratus* October–January
× *A. nodosum* October–January
○ *F. vesiculosus* October–January

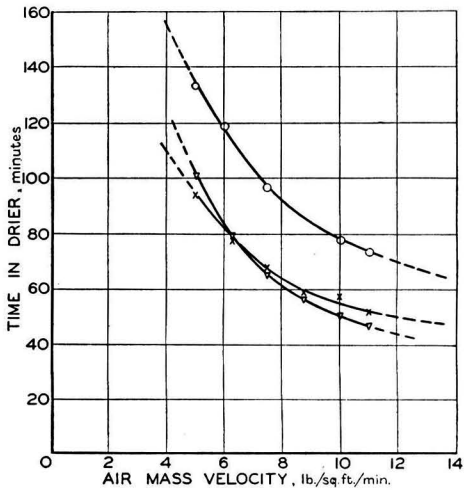

FIG. 6.—*Drying time* versus *air mass velocity*

D.B.T., 160° F. W.B.D., 67–70° F.

▽ *F. serratus* May–June *Ld*, 1·40 lb./sq. ft. *T*, 3·5–0·15
○ *A. nodosum* October–January *Ld*, 1·75 lb./sq. ft. *T*, 2·7–0·10
× *F. vesiculosus* May–June *Ld*, 1·52 lb./sq. ft. *T*, 3·2–0·15

Fig. 6 shows the results of three series of tests for *A. nodosum*, *F. vesiculosus* and *F. serratus* respectively. The curves may be represented by the equations:

$$\theta = 479G^{-0.79} \quad (A.\ nodosum \quad T = 3{\cdot}2 - 0{\cdot}15)$$
$$\theta = 385G^{-0.864} \quad (F.\ vesiculosus \quad T = 2{\cdot}7 - 0{\cdot}1)$$
$$\theta = 531G^{-1.038} \quad (F.\ serratus \quad T = 3{\cdot}5 - 0{\cdot}15)$$

These equations are of the same form as those obtained by Gardner & Mitchell[6] for *L. digitata* and *L. cloustoni* fronds, in which case the drying times were proportional to the — 1·17 and — 1·40 powers of the air-velocity respectively, for the approximate range $G = 4 - 9{\cdot}5$ lb./sq. ft. min. These figures are confirmed by those of other workers. The 'minimum time' of drying for hops was found by Burgess[14] to be related to the — 0·39 power of the air-flow, while Brown & Van Arsdel[15] found that the velocity index for the drying time was — 0·4 for potato strips. Coles[16] obtained an index of — 1·25 for the time required to dry viscose staple fibre.

From Fig. 6 it can be seen that no great decrease in drying time can be effected by increasing the air-flow above 10 lb./sq. ft. min.

The data for constant drying rate *versus* air-flow is represented by a straight-line plot (Fig. 7) for each seaweed, giving the equations:

$$dW/d\theta = 0{\cdot}354G + 0{\cdot}415 \quad (A.\ nodosum)$$
$$dW/d\theta = 0{\cdot}448G + 0{\cdot}10 \quad (F.\ vesiculosus)$$
$$dW/d\theta = 0{\cdot}437G + 0{\cdot}05 \quad (F.\ serratus)$$

Allowing for the change in loading, the value of the constant drying rate for *L. cloustoni* stipe[1] is higher than for fronds or rock-weeds. This is due to the soft flexible particles being compressed, preventing free access of air through the bed. Obviously, the deeper the bed, the more compressed are the lower layers and the more resistance is made to the drying air. This compressibility factor largely controls the drying rate. The smaller the particle size then the more compressible is the bed. Thus, while small particles are the basis of spray-drying and air-suspension techniques, they are probably not suitable for through-circulation work. Conversely, it is seldom economic to dry whole plants or vegetables (e.g. seaweed stipe, carrots), due to the excessively long drying times required. In industrial drying a compromise is made between the size of the product required by the consumer and the economy needed in drying time. Consequently in seaweed drying, stipes have been sliced at an optimum thickness, whereas fronds and rock-weeds have been minced to give suitable particle sizes of approximately $\frac{3}{8}$ in. $\times$ $\frac{1}{2}$ in. $\times$ $\frac{1}{32}$ in.

(3) *Temperature and humidity.*—Investigations of the effect of temperature and humidity have been made by measuring the time of drying, for a fixed loading and air-velocity, against the wet-bulb depression of the drying air.

For the three seaweeds under test, it was found that $\theta \propto 1/(t_d - t_w)$, i.e. the drying time was inversely proportional to the W.B.D. A series of tests was carried out for each seaweed, the dry-bulb temperature alone being varied, thus giving different values of W.B.D. (Fig. 8), although the absolute humidity of the drying air was that of the atmosphere.

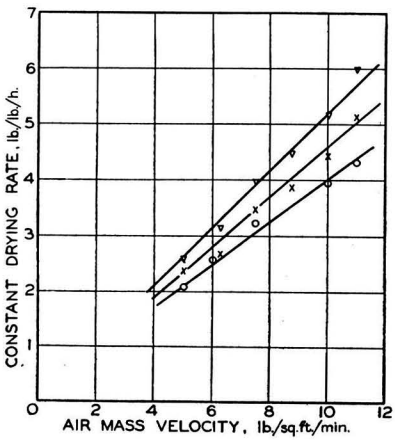

FIG. 7.—*Air mass velocity* versus *constant rate*

D.B.T., 160° F. W.B.D., 67–70° F.

▽ *F. serratus* May–June *Ld*, 1·40 lb./sq. ft.
○ *A. nodosum* October–January *Ld*, 1·75 lb./sq. ft.
× *F. vesiculosus* May–June *Ld*, 1·52 lb./sq. ft.

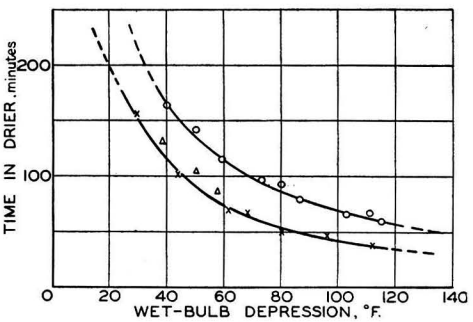

FIG. 8.—*Effect of D.B.T. and W.B.T. on drying time*

○ *A. nodosum* *G*, 7·5 lb./sq. ft./min. *Ld*, 1·75 lb./sq. ft.
× *F. vesiculosus* *G*, 7·5 lb./sq. ft./min. *Ld*, 1·52 lb./sq. ft.
△ *F. vesiculosus* Steam injection tests

An attempt was made to vary the wet-bulb depression, while maintaining the D.B.T. constant, by steam injection into the air stream. Van Arsdel[17] found in the drying of potato half-dice that a rise in air-temperature at constant wet-bulb depression increases the rate of drying. This was attributed to the fact that in the low moisture end of the run, when internal

diffusion controls the rate of moisture removal, the higher internal temperature of the material increased the rate of internal diffusion of moisture. This theory should also apply to the drying of seaweed, but in fact did not appear to when steam was injected to raise the wet-bulb temperature of the air. This anomaly was apparently due to considerable matting of the bed taking place in the steam injection tests, and to areas of the basket mesh being clogged with mucilage, both resulting in an increase in drying time. When tests using very low wet-bulb depressions were attempted by steam injection it was found that the weight of the seaweed bed increased initially due to condensation of water-vapour on the lower layers. This condensation ceased as the bed temperature rose, and gradually the weight decreased as drying commenced.

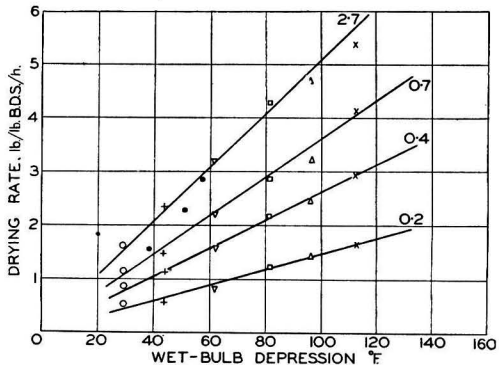

FIG. 9.—*Effect of D.B.T. and W.B.T. on drying rate*
F. vesiculosus

*L*d, 1·52 lb./sq. ft. *G*, 7·5 lb./sq. ft./min.
D.B.T., °F: ○ 100; + 125; ▽ 150; □ 175; △ 200; × 220.
● Steam injection tests

No great reliance could therefore be placed on the findings of the tests in which this happened and variation of W.B.D. by altering the D.B.T. was alone found to give accurate results.

The drying rates *versus* W.B.D. for *F. vesiculosus* at average water contents of 2·7 to 0·2 lb./lb., give a straight-line relationship passing through the origin,

$$\text{i.e. } dW/d\theta = K(t_d - t_w) \quad \text{where } K = \text{constant.}$$

Similar results have been found for *A. nodosum* and *F. serratus* (see Table I).

Table I

Seaweed	*T* lb./lb.	L_d lb./sq. ft.	*K* in equation (for constant-rate drying)
A. nodosum	3·0	1·715	0·04
F. vesiculosus	2·7	1·52	0·05
F. serratus	3·5	1·30	0·066

Below this range of water contents (0·2 lb./lb. B.D.S.) the D.B.T. becomes increasingly important, as has already been stated, and the W.B.D. will therefore not be directly proportional to the drying rate.

Drying mechanism

A constant drying-rate period was observed for the bed-depths of above 1 in. This rate is largely governed by the amount of water which the drying air can take up, and this ' water capacity ' depends on the degree of saturation of the air. Allerton, Brownell & Katz[18] found that in the drying of filter-cakes, drying took place in a narrow zone of vaporization which

gradually moved up through the wet-bed, while Simmonds, Ward & McEwen[2] found that for wheat-grain drying, this zone extended throughout the bed of material. An examination of the layer drying of minced *F. serratus* (Fig. 10) suggests that the zone is deeper than in the case of filter-cake drying, the depth being controlled by the water capacity of the air and its velocity. Fig. 10 shows that the water contents varied widely throughout three layers during drying and that maximum deviation occurred at an average of 1·5 (lb./lb.), with condensation taking place initially in the upper layer.

Thus it cannot be said that there is a true constant drying rate (Fig. 10) ; rather is there an average maximum rate of evaporation. This rate is maintained constant for the period known as the constant-rate period, by combination of high rates of drying in the lower layers and low rates in the upper layers initially, this being reversed in the latter stages of the period. The falling-rate period commences when the depth of the drying zone begins to decrease on reaching the top of the bed. The drying air is therefore used to a less efficient degree, its exit temperature increasing and its outlet humidity decreasing. Drying is then largely controlled by the rate of internal movement of the moisture to the surface of the material. The drying rate of the composite seaweed bed is mainly dependent upon the air dry-bulb temperature and therefore the particle surface temperature. Particle size also controls this rate, and obviously the larger the particles, the longer will the moisture take to move to the surface and the longer will the falling-rate period last.

It must be added that the mucilage content of rock seaweeds has a great effect on the drying period. It has been found that the weed, on drying, sticks together and prevents ready access of air in certain parts of the bed. This indicates that the agitation of the bed at intervals would be very beneficial to drying, tending to expose fresh surfaces to the air, with consequent shortening of the drying time.

It is evident that the lower layers are dry and are being subjected to the full heat of the incoming air in the latter stages of drying. This is undesirable and in many dryers the flow of air is reversed about midway through the drying process.

Fig. 11 shows a plot of drying rate *versus* water content characteristic of the three seaweeds under investigation. The curve, although for a deep bed of material, is of similar form to typical curves for unit layers, showing the marked change from ' constant-rate ' drying to falling-rate drying at a critical value of water content.

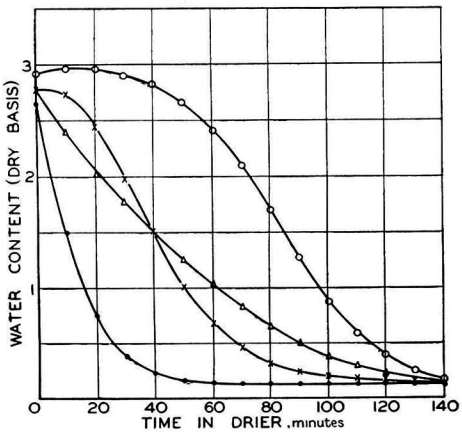

FIG. 10.—F. serratus ; *water content of various layers in seaweed bed*

D.B.T., 160° F. *G*, 7·5 lb./sq. ft./min.

Top layer	0·392
Middle layer	0·413
Bottom layer	0·429
Composite layer	1·234

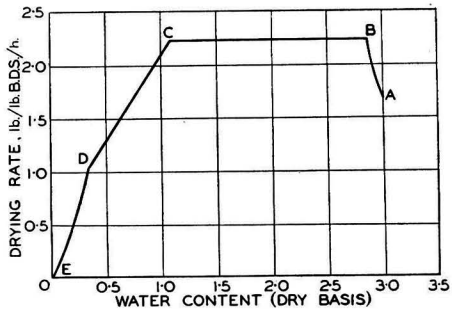

FIG. 11.—A. nodosum ; *variation of drying rate throughout test*

D.B.T., 160° F. *G*, 7·5 lb./sq. ft./min.

In conclusion, it seems that high air-velocities and air-temperatures may be used in the initial stages of drying, while the surface of the particles is covered with moisture, and in the falling-rate period lower air-velocities and higher air-temperatures are suitable. Economy of the drying air may be made by agitation of the bed, reversal of the air-flow and recirculation of the air especially in the latter stages of drying when the air has not reached its maximum 'water capacity', on passing through the bed.

Static pressure tests

Static pressure-drops across beds of wet and dry seaweed have been measured by Gardner & Mitchell.[5]

Similar measurements have been made for *A. nodosum*, *F. serratus* and *F. vesiculosus*. Examples of the linear relationship found by a logarithmic plot of static pressure-drop *versus* air-flow are shown in Figs. 12 and 13. The family of straight lines all have equations of the form :

$$Q = a.G^n$$

where a and n are experimental constants, and Q = pressure-drop in in. of water/ft. of bed-depth.

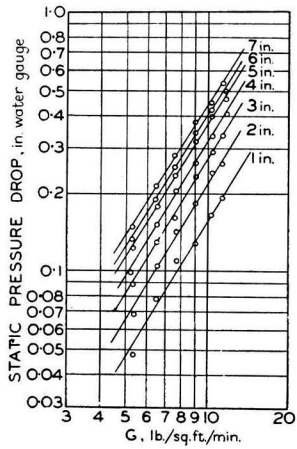

FIG. 12.—F. serratus ; *pressure drop* versus *air flow*

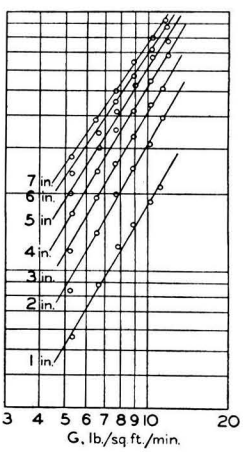

FIG. 13.—F. serratus fresh ; *pressure drop* versus *air flow*

The velocity index (n) tends to a constant value (approximately 1·8 for both wet and dry minced *F. serratus*) at the deepest loadings (7 in.), as does the static pressure-drop per unit of bed-depth. The results of these tests can be used in the selection of fans and design of finishing bins.

Equations for pressure-drops for the deepest beds are derived from the average value of the exponents and are :

$$Q = 0{\cdot}015G^{1{\cdot}82}, \text{ for dried } F. \textit{ serratus},$$

and

$$Q = 0{\cdot}030G^{1{\cdot}81}, \text{ for wet } F. \textit{ serratus}.$$

Prediction of drying times

No simple method of calculating mathematically the time of drying of the three weeds under investigation has been found. It is therefore thought that the graphical method proposed by Gardner & Mitchell[19] is the most reliable for rock seaweeds. This method is based on the unit wet-bulb depression curves (Figs. 14 and 15) for drying times and rates *versus* water contents.

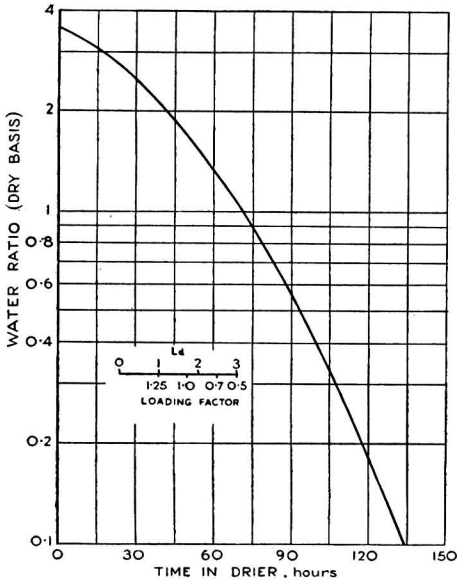

FIG. 14.—A. nodosum; *drying times for unit W.B.D.*, °F

Ld, 1·715 lb./sq. ft. *G*, 7·5 lb./sq. ft./min.

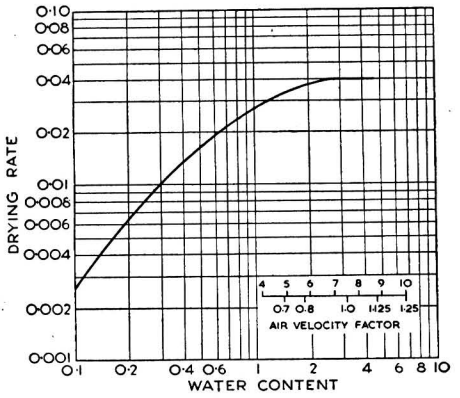

FIG. 15.—A. nodosum; *drying rates for unit W.B.D.*, °F

Ld, 1·715 lb./sq. ft. *G*, 7·5 lb./sq. ft./min.

Certain optimum values for variables have been found by bed-depth and air-velocity experiments (Table II).

Table II

Seaweed	Bed-depth in.	Air-flow *G* lb./sq. ft./min.
A. nodosum	3·5 (L_d = 2·0)	10
F. vesiculosus	3 (L_d = 1·6)	10
F. serratus	3 (L_d = 1·25)	10

Above a dry-bulb temperature of 225° F, static beds of rock seaweeds are scorched, and temperatures should never exceed this value.

Design of multi-stage through-circulation dryers for *A. nodosum*, *F. vesiculosus* and *F. serratus* can therefore be made on the principles laid down by Gardner & Mitchell.[19] Shrinkage and edge effects are thought to be negligible, where wide conveyor belts are in use, while deepening of the beds on completion of shrinkage (at approx. T = 1·5) should be economic, since better use is made of the drying air.

Calibration of the dryer

Hyndman, McEwan & Mitchell[7] found the ratio (air through bed)/(air through outlet) to be 1·41. This value was checked by twelve test runs (four for each seaweed). The check showed that in the majority of these tests the above ratio was within ± 5% of 1·41, and it was concluded that this value was sufficiently accurate.

Nomenclature

B.D.S. = bone-dry solid.
C.D.S. = commercial dry solid. The term is used in this work to denote seaweed having a water ratio of 0·15, 0·15 and 0·10 in the case of *A. nodosus*, *F. serratus* and *F. vesiculosus*, respectively.
T = total water content, lb. of water/lb. of B.D.S.
G = mass air flow, lb. of dry air/min. sq. ft. of bed cross-section.
L_d = dry loading, lb. of B.D.S./sq. ft.
R = output rate, lb. of C.D.S./sq. ft. h.
θ = drying time, min.
$dW/d\theta$ = constant drying rate, lb. of water/lb. of B.D.S. h.
t_d = D.B.T. = dry-bulb temperature, ° F.
t_w = W.B.T. = wet-bulb temperature, ° F.
$t_d - t_w$ = W.B.D. = wet-bulb depression, ° F.
P = static pressure-drop, in water/ft. of bed-depth.
m.c. = moisture content.

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Technical Chemistry Dept.
Royal Technical College
Glasgow

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ERRATUM

In the paper entitled ' Fluoroacetamide as a Rodenticide ' by C. Chapman and M. A. Phillips, *J. Sci. Fd Agric.*, 1955, **6**, 231, for ' 4 mg./kg.' read ' 14 mg./kg.' on p. 231, bottom line.

JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

JULY, 1955

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

JULY, 1955

I.—AGRICULTURE AND HORTICULTURE

Research for living. G. C. Holm (*N. Dakota agric. Exp. Sta.*, 1955, *Bull.* 396, 39 pp.).—The annual report of the N. Dakota Agricultural Experiment Station for 1954. A. H. CORNFIELD.

Environment and land utilisation on Accra Plains. H. P. White (*J. West Afr. Sci. Ass.*, 1954, **1**, 46—62).—The Accra Plains are part of the dry zone of the Guinea coast and thus availability of water is the limiting factor in land utilisation. The environment results in grassland with thicket clumps and occasional trees. The chief occupations are cultivation, stock rearing, and fishing. Eight regions are described. R. H. HURST.

Fertility of West African soils. P. H. Nye (*J. West Afr. Sci. Ass.*, 1954, **1**, 18—25).—Recent work is reviewed. Results from the forest and coastal thicket zones, which support tree crops, are separated from those of the savannah zone, which virtually produces only annual crops. Results obtained in one territory are largely applicable to places in the same climatic zone. R. H. HURST.

Estimation of the specific surface of a soil from mechanical analysis data. J. R. H. Coutts (*Brit. J. appl. Phys.*, 1955, **6**, 90—91).—A method for the approx. calculation of the sp. surface of a soil from particle-size distribution data is described. Factors affecting the accuracy of the results are discussed. A. JOBLING.

Changes in porosity of soil on heating and the relation between porosity and permeability changes. P. T. Ramacharlu and K. Subba Rao (*J. Indian Soc. Soil Sci.*, 1954, **2**, 89—97).—The effects of prior heating of a Gangetic alluvial soil to temp. ranging from 60° to 1000° on some physical properties were studied. Total porosity increased up to 500° and remained unchanged with higher temp. Capillary porosity increased up to 60° and then decreased with rising temp. Non-capillary porosity decreased up to 60° and then increased with rising temp. Permeability coeff. decreased up to 60°, then increased up to 650°, and again decreased at higher temp. A. H. CORNFIELD.

Effect of oxidation of organic matter on the permeability of heated soil. K. Subba Rao and S. K. Wakhawan (*J. Indian Soc. Soil Sci.*, 1954, **2**, 81—87).—Heating an alluvial soil in water at 60° reduced its permeability considerably. Destruction of org. matter with H_2O_2 further reduced permeability to a small extent. When normal, water-treated, and H_2O_2-treated soils were heated to temp. ranging from 60° to 1000° permeability decreased up to 60°, then increased up to 650°, and again decreased up to 1000°. A. H. CORNFIELD.

Extraction of organic matter from podsolic B horizons with organic reagents. A. E. Martin and R. Reeve (*Chem. & Ind.*, 1955, 356).—Aq. or aq.-acetone solutions of certain org. complexing agents (cupferron, 8-hydroxyquinoline, acetylacetone) are capable of extracting considerable amounts of org. matter from podsol B horizons. The extracts are freed from excess reagent and metal–reagent complexes by extraction with diethyl ether in a liquid–liquid extractor. Entrained solvent is removed from the resulting aq. suspension, which is then analysed for org. C. J. M. JACOBS.

Effect of synthetic soil conditioners on plant nutrient uptake. K. J. McNaught (*N.Z. J. Sci. Tech.*, 1955, **36, A**, 450—453).—Based on pot experiments on mustard, the improved structure resulting from the use of soil conditioners (Krilium and Flotal) probably had little effect on nutrient concentrations in plant tissues, even when total nutrient uptake was greatly increased because of marked yield responses. K concentration was greatly increased in plants in K-deficient soil which received potash fertiliser and which showed large yield responses to a *poly*acrylonitrile conditioner (Krilium); other differences were not significant. S. C. JOLLY.

Potash release from exchangeable and non-exchangeable forms in Ohio soils. P. F. Pratt and H. H. Morse (*Ohio agric. Exp. Sta.*, 1954, *Res. Bull.* 747, 20 pp.).—The exchangeable K and K sol. in N-HNO_3 of the 0–6-in. and 6–12-in. layers of the 46 important soil series of Ohio are presented. There was poor correlation between exchangeable K and HNO_3-sol. K in either layer or between exchangeable K in the top and that in the lower layer. HNO_3-sol. K in the top was highly correlated with that in the lower layer. HNO_3-sol. K was lowest in sandy lakebed soils and highest in fine-textured lakebed soils. A. H. CORNFIELD.

Phosphate relations of soil and plant. XI. Amphoteric behaviour and solubility relations of iron and aluminium phosphates. XII. Salt and dilution effects in Brännalt podsol soil. R. B. Miller (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 161—175, 177—187).—XI. The isoelectric point of the phosphates of Fe and Al may be varied over wide pH ranges by altering the composition of their surface layers. The concepts of the Donnan equilibrium are applied to account for the reactions observed. The PO_4''' solubility is increased by salts and by SO_4'' more than by Cl'. Under soil conditions, the properties of the phosphates of Ca, Al, and Fe are related more to the position on the pH scale of the amphoteric points of the soil complex than to the binding to di- or tri-valent bases.

XII. Tests were made in which phosphate was added to the soil at rates of 200, 20, 10 mg. respectively of P_2O_5 per 100 g. of soil. The addition of smaller amounts of PO_4''' leads to greater dilution effects over wider pH ranges, and the elimination of changes in salt concn. entirely removes the dilution effect. The dilution effect is a redistribution of PO_4''' between "inside" (*i*) and "outside" (*o*) solutions caused by changes in salt concn. Above the isoelectric point in the absence of free salt there is a Donnan distribution of PO_4''' in which the $[phosphate]_o$ is greater than $[phosphate]_i$. The addition of salt suppresses this difference by reducing $[phosphate]_o$. When the salt system is diluted, $[phosphate]_o$ becomes large compared with $[phosphate]_i$ and causes the dilution effect. R. H. HURST.

Zinc sorption and release by soils and clays. J. L. Nelson (*Dissert. Abstr.*, 1955, **15**, 2—3).—In hydrogen-soil systems nearly all, and in Ca-soil systems only part, of the Zn taken up by the soils during contact with a solution containing ^{65}Zn was replaceable by NH_4 acetate. The non-replaceable Zn was removed by successive leaching with 0·1N-HCl. The amount of acid-sol. Zn increased with increasing contact time between soil and Zn solution; as smaller quantities of Zn were added an increasing proportion of Zn was in the acid-sol. form. This was apparently an independent form of Zn, since it did not occupy exchange sites on the soil. S. C. JOLLY.

Accumulation of DDT in soils from spray practices. J. M. Ginsburg (*J. Agric. Food Chem.*, 1955, **3**, 322—325).—Samples of soil from apple and peach orchards, maize fields, and potato farms where DDT commercial sprays and dusts had been applied during 1947—53 were analysed in 1953 and in 1954. The largest quantities of DDT (62·2 lb. per acre) were found in apple orchards, especially under the trees, and least in soils from potato crops; the DDT accumulated in soil horizons corresponding to cultivation depths of about 4 in. in orchards and 9 in. in soils from maize (13·7 lb. per acre) and potatoes (2-year rotation, 3·2 lb. per acre). (34 references.) E. M. J.

Rôle of organic matter in soil fertility. N. R. Dhar (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 105—160).—The fixation of atm. N_2 is markedly stimulated when org. matter (molasses, cow dung, wheat straw, etc.) is mixed with soil, more particularly in sunlight than in the dark. Neither soil nor micro-organisms are essential for N fixation. There is marked loss of humus-N from soils fertilised by large amounts of mineral-N compounds. Org. substances (farmyard manure, grass, green manure, straw, etc.) form reactive humus and prevent soil deterioration. A mixture of $CaHPO_4$ and $CaCO_3$ and an org. substance like straw can remove the defects of peat, forest, and other org. soils and make them suitable for growing crops about 6—8 months after application. Mixtures of grasses and legumes with a C : N ratio greater than that in legumes alone, increase the fertility of the land. R. H. HURST.

Acid–base condition in vegetation, litter, and humus. XI. Acid and base in decomposing litter. S. Mattson and E. Koutler-Andersson (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 389—400).—Data are presented on the decomposition of litter in cylinder experiments. The acidity of humus is discussed in relation to leaching, base status, and autoxidation. R. H. HURST.

Influence of organic matter on copper fixation in soil. J. S. Kanwar (*J. Indian Soc. Soil Sci.*, 1954, **2**, 73—80).—The silt and

clay separates (org. matter not removed) of soil fixed virtually all added Cu^{++} against extraction with 0·0005N-HCl; the coarse and fine sand separates released much of the fixed Cu. Topsoil separates had a greater Cu fixing power than had corresponding subsoil separates. The Cu-extracting power of neutral salt solutions was increased by acidifying them. Na Versenate was the most effective solvent for extracting fixed Cu from soil. The Cu fixing capacity of soil was reduced considerably after destruction of org. matter with H_2O_2. The extent of Cu fixation by soil was dependent on both the quantity and quality of the org. matter present.
A. H. CORNFIELD.

Comparison of microbial activity in an Ontario forest soil under pine, hemlock, and maple cover. F. E. Chase and G. Baker (*Canad. J. Microbiol.*, 1954, **1**, 45—54).—In these forest soils plate counts of bacteria, actinomycetes, and fungi were highest in the org. layer, fungi predominating under conifers and bacteria under maple. Nitrification in the soils was very limited. Liming caused some nitrification but the rate was very low unless the soil was inoculated with small amounts of garden soil. A. G. POLLARD.

Value of calcium phosphate in atmospheric nitrogen fixation, etc., soil fertility and crop production. N. R. Dhar (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 49—79).—Application to the soil of a mixture of org. substances (*e.g.*, farmyard manure, straw, and plant leaves) and Ca phosphate builds up soil fertility by decreasing acidity, fixing atm. N, and supplying available P, K, and trace elements. (32 references.) R. H. HURST.

Occurrence in [Russian] soils of bacteria antagonistic to *Actinomycetes*. N. A. Krassilnikow, A. I. Korenjako, and O. A. Artamonowa (*Mitt. VersSta. Gärungsgew.*, 1954, **8**, 151—155).—Counts of the antagonistic bacteria (determined by agar-plate or -cylinder methods) are for different soils in the (ascending) order: peat soils, podsols, brown soils, and humus or grey soils. The counts are unaffected by the nature of the crop. The presence of natural salt in soils tends to depress the no. of *Actinomycetes*, and to increase the no. of the antagonistic bacteria.
P. S. ARUP.

Effect of mercapto-compounds on soil nitrification. W. T. Brown, J. H. Quastel, and P. G. Scholefield (*Appl. Microbiol.*, 1954, **2**, 235—239).—Mercapto, sulphoxide, and sulphone derivatives of alkyl *S*-homocysteine examined inhibited the nitrification of NH_4^+, the most active being mercapto-compounds and the Et derivatives of each series. Alkylmercapto-acetic and -propionic acids prolong the lag period preceding nitrification; in this respect the activities of DL-ethionine, β-ethylpropionic acid, and Et mercaptan decreased in the order named. DL-Methionine was more active than the corresponding α-hydroxy- and α-keto-compounds. Mercapto-acids probably restrict the proliferation of NH_3-oxidising and nitrifying organisms. The production of NO_2' from pyruvic oxime was not inhibited by any of the compounds examined.
A. G. POLLARD.

The pigment of *Streptomyces cœlicolor*. A. Sanchez-Marroquin and M. Zapata (*Appl. Microbiol.*, 1954, **2**, 102—107).—A strain of *S. cœlicolor* isolated from a Mexican soil and producing a blue pigment (cf. A. E. Oxford, *J. Bact.*, 1946, **51**, 267) is examined. The purified pigment has an antibiotic action on some species of *Rhizobium*. A. G. POLLARD.

Metabolism of several oximino-compounds by plant tissues. W. W. Heck (*Dissert. Abstr.*, 1955, **15**, 15—16).—A method has been developed for determining oximino-compounds. Some utilisation of oxime occurred when α-oximinobutyric acid was supplied to excised wheat roots. With intact maize plants conversion of oximinobutyric-acid-N to amino-acid- and protein-N occurred. Et α-oximino*iso*caproate killed the roots but increased both sol.- and protein-N in the shoots. More N occurred in various nitrogenous fractions from roots and shoots of maize plants cultured in Et α-oximinoglutarate (**I**) or in NH_4Cl or $(NH_4)_2SO_4$ solution than in fractions from control plants. Root and shoot extracts differed mainly in alanine, glutamic and aspartic acids, asparagine and glutamine contents; those of plants grown in **I** showed extremely large increases in alanine. Glutamic acid usually decreased in oxime-treated plants. Toxic symptoms occurred in plants grown for 24 hr. in solutions $1·4 \times 10^{-3}$M. with respect to **I**. **I** is not apparently reduced directly to glutamic acid. S. C. JOLLY.

Translocation of the flowering effect in photoperiodically-induced plants. W. A. Brun (*Dissert. Abstr.*, 1955, **15**, 13—14).—Transmission of the flower-inducing agent (*F*) in the short-day plants, *Xanthium commune* and *Glycine max*, occurs in tissue external to the cambium (probably in the phloem), but not in dead tissues; in some circumstances it can be transmitted through root tissue of *Xanthium*. The transmission rate through a stem segment is not affected by O_2 deficiency or by cooling to 3—5°, although transmission of elaborated food materials, and possibly also the amount of *F* is considerably inhibited. *F* can be transmitted from one side of a cocklebur stem to the other. In 6—8 hr. from the end of a single dark period sufficient *F* is transmitted from the leaves to cause initiation of flower primordia. The average transmission rate of *F* in cocklebur petioles is approx. 8 cm. per 24 hr.
S. C. JOLLY.

Relation of chlorosis to concentration of iron in citrus leaves. E. F. Wallihan (*Amer. J. Bot.*, 1955, **42**, 101—104).—In citrus leaves Fe chlorosis results from a simple deficiency of Fe: the critical concn. of Fe is about 80 p.p.m. of the dry matter. The pattern of chlorosis, as judged by the colour of veins and of interveinal tissue, affords only an approx. indication of the degree of Fe deficiency, and then only in advanced stages.
A. G. POLLARD.

Chelated iron compounds for the correction of lime-induced chlorosis in fruit. C. Bould (*Nature, Lond.*, 1954, **174**, 90).—Control is possible with the Fe compounds of ethylenediaminetetra-acetic and ethylethylenediaminetriacetic acid provided sufficient is used and that it is transported to the roots by rain or heavy watering. For plums and peaches the foliage spray method of application is satisfactory. E. G. BRICKELL.

Rôle of molybdenum in nitrate reduction in higher plants. D. Spencer and J. G. Wood (*Aust. J. biol. Sci.*, 1954, **7**, 425—434).—In the intact plant Mo is essential for a reaction involved in the reduction of NO_3' to NO_2' probably as a component of the NO_3'-reductase system. The known metabolic functions of Mo are discussed briefly. E. G. BRICKELL.

Relation of nitrogen supply to the molybdenum requirement of tomato plants grown in sand culture. E. J. Hewitt and C. C. McCready (*Nature, Lond.*, 1954, **174**, 186).—Mo is essential for tomato plants irrespective of whether N is given as NO_3' or in a number of other forms at different stages of reduction but relative requirements depend on the N source. E. G. BRICKELL.

Ammonium- and nitrate-nitrogen absorption by young apple trees in soil or artificial nutrient media of varying acidity. D. Zimerman (*Dissert. Abstr.*, 1955, **15**, 10—11).—In greenhouse experiments seedlings and young apple trees responded markedly to applications of lime and K, Mg, and P fertilisers to Dunkirk silty clay loam orchard soil (pH 3·5) in which NH_4^+-N was the predominant form or inorg. N. Seedling growth in unlimed or limed (pH 5·7) soil was not limited by available NH_4^+ or NO_3'-N. In limed soil the N content of seedlings was increased more by $(NH_4)_2SO_4$ than by equiv. amounts of $Ca(NO_3)_2$. Application of $(NH_4)_2SO_4$ to unlimed soil caused the death of many seedlings. Decreases in NH_4^+- and NO_3'-N in the soil were not accompanied by quantitative increases in plant N. Sand-culture and water-culture studies indicated that at pH 4·0 and 6·0 NH_4^+-N was more rapidly adsorbed by young seedlings than was NO_3'-N. S. C. JOLLY.

Catalyst in the Kjeldahl procedure for [determining] nitrogen in fertilisers. H. R. Allen (*J. Ass. off. agric. Chem.*, 1955, **38**, 185).—For routine determinations of N in fertilisers a catalyst composed of five parts of copper sulphate (dried at 110°) and one part of selenium powder is placed in the digestion flask before digestion is started. K_2SO_4 is not used. Unsatisfactory samples are rechecked using Hg or $CuSO_4$, with K_2SO_4, and adding the catalyst after the preliminary digestion. In the analysis of organic materials the modified procedure gives results ~0·1% lower than those obtained by the usual procedure. A. A. ELDRIDGE.

Chemico-biological ripening of manure integrated with mineral phosphate fertilisers. G. Chisci (*Ric. sci.*, 1955, **25**, 263—280).—The physico-chemical nature of manure mixed with various phosphate fertilisers is studied, and the fundamental function of humus in the process of ripening and preservation of the nutritive principles is shown. With a control sample containing 100% humus, the humus content decreases to 90·77% with basic slag, to 82·24% with phosphate rock Italia, to 71·14% with organic phosphate rock Reno, and to 64·95% with superphosphate. Similar figures are obtained taking nitrogen or K_2O as control. The influence of the sampled phosphatic fertilisers on the humification and ripening of manure is negative. The deterioration of biological ripening might be a cause of the lowered production found on the permanent polyphytic grassland fertilised with composts treated with phosphate fertilisers, in comparison with the use of manure only.
C. A. FINCH.

Denigès' method for determination of phosphate, with special reference to soil solutions and extracts. S. H. Yuen and A. G. Pollard (*J. Sci. Food Agric.*, 1955, **6**, 223—229).—A modified method involving the reduction of phosphomolybdic acid by $SnCl_2$ is described for the determination of phosphate in soil solutions and soil extracts. The main points considered were: (i) the concentration of molybdate, which should be low in order to minimise the effect

of silicate, arsenate and Fe^{***}; (ii) the acidity of the test solution, and (iii) the concentration of $SnCl_2$, the procedure eventually adopted being based on the final concentrations: 0·3N-H_2SO_4, NH_4 molybdate 0·05%, and $SnCl_2$ 0·01%. Various ions commonly occurring in soil solutions and some soil extracts did not affect the accuracy of direct determinations of phosphate. Fe^{***} up to 15, and Fe^{**} up to 200 p.p.m. had no ill effect. Arsenate which formed a blue colour similar to that produced by phosphate, should be absent from the test. (20 references.) E. M. J.

Reliability of chemical analyses for fertilisers and feeds. S. R. Miles and F. W. Quackenbush (*J. Ass. off. agric. Chem.*, 1955, **38,** 108—130).—Factors affecting the precision of chemical analyses of commercial lots of fertiliser or feed are discussed, and sample analyses are tabulated. Deviations of results for N, P, and K in fertilisers, and of protein, fat, fibre, and ash in feeds, under varying conditions, are also tabulated. A. A. ELDRIDGE.

Foliar manuring of vines during 1954. J. Lafon and P. Couillaud (*C. R. Acad. Agric. Fr.*, 1955, **41,** 96—103).—Spraying with aq. 1% KNO_3 has given satisfactory results. It is recommended to use a hygroscopic salt and to give ⩽5 sprayings per month, using ⩽10 hectolitres of liquid per hectare. The treatment is more rapid in action than manuring through the soil. P. S. ARUP.

Plant proteins. II. Amino-acid content of the seed protein of *Trigonella fœnum græcum*, L. and of the seed protein and thallus protein of *Galega officianalis*, L. J. Kolouŝek and C. B. Coulson (*J. Sci. Food Agric.*, 1955, **6,** 203—206).—The proteins were isolated from the seeds and thallus of galega and the seeds of fenugreek, and the amino-acids were determined by a paper-chromatographic method. Routine analyses of the plant materials are given: the seed proteins have a balanced amino-acid composition which may be compared with that of the seed proteins of dicotyledonous plants. (24 references.) E. M. J.

Auxin and anti-auxin-induced changes in the utilisation of ^{14}C-labelled acetate and pyruvate by plant tissues. I. B. Perlis (*Dissert. Abstr.*, 1955, **15,** 20).—The effects of indolylacetic acid and *trans*-cinnamic acid on the utilisation of 1-^{14}C-acetate by pea stems and the effect of the former on the utilisation of 1-^{14}C-acetate and 2-^{14}C-pyruvate by wheat roots are reported. Results confirm many chemical effects previously reported or postulated as a result of auxin activity. S. C. JOLLY.

Wounds [of rubber trees] and their treatment. Anon. (*Rubb. Res. Inst. Malaya Plant. Bull.*, 1955, No. 17, 27—30).—Crude petrolatum is an excellent protective agent for stem-wounds, and roots damaged by fungi respond well to coal tar applications. Trees damaged by lightning should be cut down to healthy tissue and water-miscible tar-acid fungicide applied, followed by petrolatum. L. G. L. UNSTEAD-JOSS.

Plant growth regulators. X. Reproducibility of root growth results. B. Aberg (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21,** 197—211).—The flax root test (using flax seedlings of 7 mm. root length placed in the test solution for 18 hr. at 25°, in darkness, and growth measured to nearest mm.) has been used for about five years for measurement of more than 300,000 roots. It is impossible to obtain an absolute constancy in the growth of the control roots lasting over a period of several years, during which different seed batches have been used. Statistical analysis of the results indicates that inter-experimental variation occurring during longer periods is probably caused mainly by varying sensitivity of the roots to growth regulators. Results are compared with data for cress, wheat, tomato, and pea roots. The effects of different auxins and anti-auxins are generally of a similar type for different kinds of roots, indicating a common basic mechanism, probably of a competitive nature. R. H. HURST.

Plant growth regulators. XI. Experimants with pea roots, including observations on destruction of indolylacetic acid by different types of roots. B. Aberg and E. Jönsson (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21,** 401—416).—The effects of two auxins (IAA and 2:4-D), an anti-auxin [α-(1-naphthylmethylthio)-propionic acid (NMSP)], and a substance with combined synergistic and anti-auxin properties on the growth of pea roots are discussed. Results similar to those previously described for flax were obtained, the most conspicuous difference being the very weak restorative effects of NMSP on IAA-inhibited pea roots. This phenomenon may be connected with the presence of a highly active IAA oxidase system in the pea roots. R. H. HURST.

Use of chemical thinning sprays on apple trees in New Zealand. I. Preliminary experiments in Hawke's Bay and Nelson. R. M. Davison (*N.Z. J. Sci. Tech.*, 1955, **36, A,** 506—515).—Both Na dinitro-*o*-cresylate (DNOC) and α-naphthylacetic acid (ANA) were effective thinning agents for Dougherty, Jonathan, and Sturmer apple varieties, but 4-chloro-2-methylphenoxyacetic acid (MCPA) was unsatisfactory. Concentrations of DNOC and ANA suitable in Hawke's Bay for Sturmer tended to overthin in Nelson. Jonathan was slightly easier to thin than was Sturmer, but Dougherty was more difficult. Generally, effective treatments significantly increased fruit size. All three chemicals cause some foliage injury, the severity of which depended on concentration, time of application, variety, and tree vigour. In Hawke's Bay early thinning by DNOC and ANA on Sturmer and Dougherty induced heavier blossoming in the following year. S. C. JOLLY.

Crop rotation, tillage, and fertility experiments at the Lawton (Okla.) Field Station, 1917—49. W. M. Osborn and O. R. Mathews (*U.S. Dep. Agric.*, 1955, *Circ.* 951, 58 pp.).—A review of climate, soil characteristics, crop hazards, procedure in rotation and tillage experiments, tillage and sequence results for winter wheat, cotton, sorghums, cowpeas, corn, oats and barley, and lucerne and sweet clover, seeding and variety tests of winter barley, tests with commercial fertilisers, and cropping systems adapted to the area. (32 references, and 30 tables.) E. G. BRICKELL.

Nine years' crop tests on the North-Central Agricultural Experiment Station, N. Dakota. G. N. Geiszler (*N. Dakota agric. Exp. Sta.*, 1954, *Bull.* 389, 59 pp.).—The soils, topography, and climate of the area are described. Details of yields obtained with many varieties of crops are presented. A. H. CORNFIELD.

Quality, maturity, and yield measurements of 12 sweet maize varieties, 1951—1953. D. W. Barton (*N.Y. agric. Exp. Sta.*, 1954, *Bull.* 765, 22 pp.).—Field and husked yields, plant and ear characteristics, % moisture, succulometer values, and % of pericarp in 12 varieties of sweet maize at three stages of maturity over three years was studied. The "heat unit" system was no better than the "no. of days" system for predicting maturity. There were varietal differences in the rate of quality changes with time, and in quality at a given moisture level. A. H. CORNFIELD.

Numbers and weights of earthworms under a highly productive pasture. R. A. S. Waters (*N.Z. J. Sci. Tech.*, 1955, **36, A,** 516—525).—Seasonal variations over 2½ years in the total wt. of earthworms per sq. ft., and in the wt., no., and average wt. of *Allolobophora caliginosa* and *Lumbricus rubellus* in a highly productive pasture at Grasslands Division, Palmerston North, are reported. Seasonal variations in temp. had a negligible effect on these species, but soil conditions associated with high soil moisture probably had an adverse effect. Seasonal increases in earthworm wt. and no. were caused chiefly by seasonal flushes of dead root, and to a lesser extent, of dead herbage debris; seasonal decreases were due to natural exhaustion of these flushes and to the adverse effect of poor aëration accompanying high soil moisture. S. C. JOLLY.

Effects and interactions of sulphur, phosphorus and molybdenum on growth and composition of clovers. T. W. Walker, A. F. R. Adams, and H. D. Orchiston (*N.Z. J. Sci. Tech.*, 1955, **36, A,** 470—482).—Generally, S was more important than P, but both were needed for good establishment and growth of oversown clovers in the Canterbury (N.Z.) foothills. Mo had no significant effect on growth in the first year, but it markedly increased the Mo content of herbage in some cases. "Available" soil P correlated well with responses to P but not to P + S. Gypsum depressed the yield of clovers on one soil, probably due to increase in Mn uptake and intensified Mn–Mo antagonism. The significance of S in N.Z. pastoral farming is discussed. (34 references.) S. C. JOLLY.

Urea and calcium cyanamide in tobacco plant beds. C. B. McCants and W. G. Woltz (*N. Carolina agric. Exp. Sta.*, 1954, *Tech. Bull.* 105, 31 pp.).—Application of urea (1 lb.), cyanamide (1 lb.), or urea (1 lb.) + cyanamide (0·5 lb. per sq. yd.) in the autumn greatly increased the stand of transplantable tobacco plants sown in the spring and also reduced weed populations. Additional N at seeding time reduced plant stands in many cases. Autumn application of P and K gave better results than did application at seeding time. Although 75% of the applied CN_2'' was decomposed within two weeks of application, significant amounts were present in the soil even 95 days later. There was no trace of $(H_2CN_2)_2$ in the soil five weeks after applying cyanamide. A. H. CORNFIELD.

Storage of ear maize on the farm in the North Central States [of U.S.A.]. C. K. Shedd (*U.S. Dep. Agric., Fmrs Bull.* 2076).—The construction of cribs for the curing of (damp) maize ears after harvest, with limiting dimensions with and without heating, is described and illustrated. L. G. L. UNSTEAD-JOSS.

Yeasts from freshly combined rough rice stored in a sealed bin. D. J. Teunisson (*Appl. Microbiol.*, 1954, **2,** 215—220).—During the storage of freshly combined rough rice in sealed containers there was a gradual inhibition of mould growth and an increase in yeasts. The latter were of oxidative types but survived exposure to low

O_2-tensions and also to temp. up to 38·9°. The yeasts may be a cause of spoilage and/or of off-flavours or odours in stored rough rice. A. G. POLLARD.

Evaluation of lima bean varieties for dehydration. H. D. Brown, G. Peters, and W. A. Gould (*Ohio agric. Exp. Sta.*, 1954, *Res. Bull.* 751, 13 pp.).—Of several methods tested the most satisfactory was that in which blanching and freezing was practised prior to dehydration. There were varietal differences in the taste score of rehydrated beans. Rehydrated beans were often rated better than canned samples. A. H. CORNFIELD.

Effect of various freezing temperatures on the behaviour of the strawberry plant. John Fanton Brown (*Dissert. Abstr.*, 1955, **15**, 13).—Fully hardened dormant strawberry plants of the Premier variety were not injured by freezing until the temp. fell to 21°F., below which injury increased proportionately until death occurred at 14—15°F. At this temp. respiration was no longer stimulated, but was depressed, the depression increasing as temp. fell to 0—4°F. The amount of solutes lost to the bathing solution at the lethal temp. does not apparently change, as the effect of temp. showed a straight-line relation between 21° and 0°F. Freezing reduced the ability of the plants to accumulate radioactive P. S. C. JOLLY.

Chemical composition and freezing adaptability of raspberries. F. A. Lee and G. A. Slate (*N.Y. agric. Exp. Sta.*, 1954, *Bull.* 761, 12 pp.).—Red raspberries contained a higher % of ascorbic acid than did black or purple raspberries. With certain exceptions, varieties suited to preservation by freezing had relatively high sol. solids, ascorbic acid, and free acid (as citric acid) contents and relatively low pH. A. H. CORNFIELD.

Chemical composition and freezing adaptability of peach varieties grown in Western New York. F. A. Lee, G. Oberle, and J. Whitcombe (*N.Y. agric. Exp. Sta.*, 1954, *Bull.* 768, 13 pp.).—No relationship was found between the freezing adaptability of peach varieties (59 varieties and seedlings of yellow peaches and 22 varieties of white peaches) and ascorbic acid, carotene, sol. solids, and free acids contents or pH. A. H. CORNFIELD.

Change in redox potential during ripening of grapes. L. Deibner (*C. R. Acad. Agric. Fr.*, 1955, **41**, 106—108).—The redox potential of juice from two varieties of black grapes showed a steady increase during the development of colour (during Aug., 1954), and a decrease during Sept., whilst sugar contents continued to increase. P. S. ARUP.

Factors affecting the vitamin contents and palatability of cabbage. M. B. Patton and M. E. Green (*Ohio agric. Exp. Sta.*, 1954, *Res. Bull.* 742, 96 pp.).—An extensive review of the vitamin contents and palatability of raw, cooked, and dehydrated cabbage as affected by variety, season, cultural practices, storage, and method of cooking. A. H. CORNFIELD.

Further legume cover crops. Anon. (*Rubber Res. Inst. Malaya Plant. Bull.*, 1955, No. 17, 31—38).—*Mimosa invisa* var. *inermis*, *Clitoria laurifolia*, *Flemingia congesta*, *Stylosanthes gracilis* (*S. guianensis*), *Desmodium ovalifolium*, are recommended and described (cf. *ibid.*, 1954, No. 14). L. G. L. UNSTEAD-JOSS.

Cotton mechanisation in North Carolina. J. G. Sutherland and H. B. James (*N. Carolina agric. Exp. Sta.*, 1954, *Tech. Bull.* 104, 62 pp.).—Progress in the mechanisation of cotton growing is described. A. H. CORNFIELD.

An adaptation of commercial shearing equipment for sampling range vegetation. E. J. Hinman (*J. econ. Ent.*, 1954, **47**, 1133—1136).—The adaptation of a commercial, electrically driven sheep-shearer as a clipper for harvesting grass samples is described and illustrated. A. A. MARSDEN.

Evaluation of herbicidal materials and their effects on the yield and botanical composition of forage legumes, with special reference to control of yellow rocket (*Barbarea vulgaris*). M. M. Schrieber (*Dissert. Abstr.*, 1955, **15**, 8—9).—The effects are reported of 2 : 4- and 3 : 4-dichloro- (2 : 4-D and 3 : 4-D respectively), 4-chloro-2-methyl- (MCP), and 4-chloro-**phenoxyacetic acid** (4 Chloro), 6-*sec.*-butyl-2 : 4-dinitrophenol (DNOSBP) and *iso*propyl *N*-(3-chlorophenyl)carbamate (CIPC) applied at various concn. and at various stages of growth to the four legume species, lucerne, birdsfoot trefoil, medium red clover, and ladino clover. Recovery from initial injury depended on both concn. and stage of growth. A procedure for the control of yellow rocket in lucerne is suggested. S. C. JOLLY.

Different isomers of phenoxyacetic acid and phenols ; effect and value as weed killers. E. Aberg (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 213—260).—Chlorinated methylphenoxyacetic acids have a stronger effect on weeds and cultivated plants than have chlorinated methylphenols, methylphenoxyacetic acid, or methylphenol. The 4-chloro-2-methylphenoxyacetic acid is the most effective. R. H. HURST.

Controlling weeds and algæ in farm ponds. W. F. Clark (*Cornell agric. Exp. Sta.*, 1954, *Bull.* 910, 15 pp.).—Application of aq. Na_2AsO_3 as a spray so as to give a concn. in the pond water of 3—4 p.p.m. (5—6 p.p.m. in hard water) gives satisfactory control of most submerged rooted plants. Addition of $CuSO_4$ to give 0·5 p.p.m. concn. will control algæ. Application of 5% 2 : 4-D sprays in paraffin will control most plants emerging from the water. Cattails and water lilies require repeated applications of 10% 2 : 4-D in paraffin for effective control. A. H. CORNFIELD.

Four years' experiments on chemical weed-killing by pre-emergence treatment of sugar-beet fields. P. Poignant and M. Chaffard (*C. R. Acad. Agric. Fr.*, 1955, **41**, 74—81).—Satisfactory results can be obtained, without injury to the beet seedlings, by application of NH_4 2 : 4-dinitrophenate or Na pentachlorophenate at the rate of 10 kg. of active material per hectare. The application should be made preferably on damp soil, and within 3—5 days after sowing (at ⅓ its usual depth) of the beet seed. Na monochloroacetate has no residual effects, whilst endothal and CMU are injurious to beet seedlings. P. S. ARUP.

Poisoning *Hevea* with 2 : 4 : 5-T. Anon. (*Rubb. Res. Inst. Malaya Plant. Bull.*, 1955, No. 17, 41).—2 : 4 : 5-T [5% free acid equivalent in gas oil (Diesel oil)] is recommended for application to the bark of unwanted *Hevea* as a selective poison. L. G. L. UNSTEAD-JOSS.

Chemical control of *Cirsium arvense*, Scop. B. Granström (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 281—285).—Sprays containing salts of 2 : 4-D were more effective than those containing salts and esters of MCPA, esters of 2 : 4-D, and esters of 2 : 4 : 5-T. The most suitable time for spraying is immediately before the flowering period, when the amount of reserve carbohydrates of the plant is at a min. R. H. HURST.

Ecological aspects of the resistance of crop plants to insects. R. H. Painter (*J. econ. Ent.*, 1954, **47**, 1036—1040).—Physical, biotic, and edaphic factors all affect the heritable characters of a plant that influence its resistance to insect damage. The partially resistant variety of wheat, Pawnee, combined with unfavourable ecological conditions, had a greater effect in lowering hessian fly populations than was expected. A. A. MARSDEN.

Determination of the uniformity of deposits on glass ; apparatus for the laboratory determination of fungicidal activity. P. Fontana and L. Pastorelli (*Ann. Chim., Roma*, 1954, **44**, 982—987).—The apparatus is calibrated to spray suspensions of the fungicide on to a plane surface such that the fine drops are reflected back on to a rotating disc containing the test slides. The uniformity of distribution of the spray on the slides is determined microchemically for salts of Cu and Zn ethylenebisdithiocarbamate, and is generally satisfactory within a single series of sprayings, but with an average of one anomalous result in five. No difference in uniformity was observed between the two materials but deposits from the latter changed within a few hours. L. A. O'NEILL.

Equipment and technique used in laboratory evaluation of pesticide dusts in toxicological studies with honeybees. E. L. Atkins, jun., L. D. Anderson, and T. O. Tuft (*J. econ. Ent.*, 1954, **47**, 965—969).—Laboratory uses of the bell-jar vacuum duster, holding and dusting cages, stock bee cages, and aspirating apparatus are described. Technique in using this equipment is discussed and precautions to avoid contamination are given. A. A. MARSDEN.

Toxicity of pesticide dusts to honeybees. E. L. Atkins, jun., and L. D. Anderson (*J. econ. Ent.*, 1954, **47**, 969—972).—Tests of the relative toxicity to honeybees of 55 pesticide dusts are reported. When compared with a standard 5% DDT dust, the following materials were highly toxic to honeybees: DNOSOBP (2 : 4-dinitro-*o-sec.*-butylphenol), EPN, sabadilla, lindane, γ-$C_6H_6Cl_6$, heptachlor, Chlorthion, Metacide, Aldrin, Dieldrin, Diazinon, Malathion, Methyl parathion, parathion, TEPP, Compound A-42 (arsenomethane *As*-1 : 2-disulphide), Compound 340 (1-*iso*propyl-3-methylpyrazol-5-yldimethylcarbamate), Endrin, and chlordane. Twenty-one other materials were moderately toxic, whilst relatively safe materials were: S, rotenone, Ovotran, chlorinated terpene, Compound Q128 [1 : 1 : 1-trichloro-2 : 2-bis-(*p*-ethylphenyl)ethane], pyrethrins, Compound 923, Neotran, CMU [3-(*p*-chlorophenyl)-ethynylcarbinol], Demeton, allethrin, DMC, Cunilate, CS-708, and nicotine. A. A. MARSDEN.

Laboratory apparatus for determining repellency of pyrethrum when applied to grain. H. Landani and G. R. Swank (*J. econ. Ent.*, 1954, **47**, 1104—1107).—The apparatus described had 12 cups holding samples of treated and untreated grain in an enclosure in which the insects were liberated. The relative no. present in the various

samples showed the degree of repellency. Adult flour beetles (*Tribolium* spp.) were repelled by pyrethrins-treated maize. These insects detected the differences between 0·1 and 0·3 and between 0·25 and 0·37 p.p.m. of pyrethrins. A. A. MARSDEN.

Iridomyrmecin, a natural insecticide from *Iridomyrmex humilis*, Mayr. F. Fusco, R. Trave, and A. Vercellone (*Chim. e Industr.*, 1955, **37**, 251—258).—Studies on iridomyrmecin, a new insecticide extracted from the common Argentine ant, *Iridomyrmex humilis*, Mayr, are reported. The compound, $C_{10}H_{16}O_2$, is an optically active lactone of a cycloparaffin, yielding a dicarboxylic acid, $C_{10}H_{16}O_4$, on oxidation. Windaus degradation affords a lactone, $C_9H_{14}O_2$, with a 6- or 7-membered ring. Other non-conclusive data, including the action of Grignard reagents, and C-Me determinations are reported. C. A. FINCH.

p-Chlorobenzyl p-chlorophenyl sulphide. Further aspects of field use. J. E. Cranham and B. A. Stevenson (*Chem. & Ind.*, 1955, 383).—Field trials of the title compound (Chlorbenside) sprayed on to the buds of apple, pear, and plum in concn. of 0·02% as dispersible powder and 0·0125% as miscible oil, are reported. These rates, followed by a second application at similar concn. in June or July, normally give control throughout the season against *Metatetranychus ulmi*, Koch. Lower rates of application of *p*-chlorobenzyl *p*-chlorophenyl sulphide may be used in conjunction with petroleum emulsions. C. A. FINCH.

Screening tests with insecticides for control of red spider-mite (*Tetranychus urticæ*, Koch) on beans. H. Jacks (*N.Z. J. Sci. Tech.*, 1955, **36, A,** 454—459).—Of the 41 insecticides tested in the glasshouse for control of red spider-mite on beans, the following substances were effective: (*a*) contact effect—materials based on mipafox, TEPP, Malathion, and butylphenoxy*iso*propyl chloroethyl sulphite; (*b*) residual effect—material based on Chloroparacide; (*c*) contact and residual effect—materials based on ethyl *p*-nitrophenylbenzenethiophosphonate, parathion, dimefox, schradan, petroleum oil, and Demeton. S. C. JOLLY.

Laboratory evaluation of fungicidal activity per unit of copper in various oxychlorides of copper and calcium. R. Radoni and S. di Caro (*Ann. Chim., Roma*, 1954, **44**, 956—959).—A series of Cu/Ca oxychlorides of varying basicity were examined using *Alternaria* as test fungus. Activity per unit of Cu increases with increasing Ca content up to a max. at ~7·3% Ca and then falls rapidly. L. A. O'NEILL.

A power-driven self-propelled soil sifter for subterranean insects. W. H. Lange, N. B. Akesson, and E. C. Carlson (*J. econ. Ent.*, 1954, **47**, 1006—1009).—A soil sifter designed to determine quickly and accurately the population of soil insects, especially wireworms, is described. A detailed drawing is given. A. A. MARSDEN.

Distribution of third instar larvæ of the European chafer and the efficiency of various sampling units for estimating their populations. R. H. Burrage and G. G. Gyrisco (*J. econ. Ent.*, 1954, **47**, 1009—1014).—Counts of third instar larvæ from foot-square sampling units showed a tendency for larvæ to be scattered in clumps: this resulted in more high and low counts of larvæ than would be expected in random distributions. Counts were more closely approximated by a negative binomial series than by a Poisson series. The 1-sq. ft. unit was more efficient than the 4-sq. ft., which in turn was better than the 9-sq. ft. sampling unit. A. A. MARSDEN.

Synthesis and chromatographic purification of radioactive allethrin. F. Acree, jun., C. C. Roan, and F. H. Bakers (*J. econ. Ent.*, 1954, **47**, 1066—1070).—The compound DL-*cis,trans*-^{14}C-allethrin (DL-allethrolone ester of DL-*cis,trans*-2-^{14}C-chrysanthemumic acid) was prepared to facilitate the study of the penetration and metabolic fate of toxic esters of chrysanthemumic acid after their application to house flies and cockroaches. Purification by chromatography resulted in approx. 98% pure radioactive allethrin. A. A. MARSDEN.

Behaviour of Systox-isomers in bean and citrus plants. R. L. Metcalf, R. B. March, T. R. Fukuto, and M. Maxon (*J. econ. Ent.*, 1954, **47**, 1045—1055).—The insecticidal behaviour of the ^{32}P-labelled Systox isomers, *OO*-diethyl *O*-ethyl-β-mercaptoethyl thionophosphate (thiono-isomer), and *OO*-diethyl *S*-2-ethylthioethyl thiophosphate (thiol-isomer) were compared in lemon and bean plants. Both isomers were readily absorbed by roots and stems of lemon plants. After topical application of the thiol-isomer to the stems of bean and lemon plants, radioactivity accumulated in the upper leaves 5—10 times as fast as when the thiono-isomer was applied. Paper chromatographic studies in bean and lemon leaves showed a rapid metabolism of both isomers. In contact toxicity tests, the thiol isomer was 3—5 times as toxic as was the thiono-isomer to the greenhouse thrips and citrus red mite. The pure thiono-isomer had little activity as an inhibitor of fly-brain choline-esterase, but the thiol-isomer and the principal metabolites of both isomers were highly active inhibitors. No radioactive vapours were detected from leaves of bean or lemon plants topically treated on the stem by both these isomers. A. A. MARSDEN.

Hazards involved when animals are exposed to organic insecticidal residues. D. M. DeLong and P. Ludwig (*J. econ. Ent.*, 1954, **47**, 1056—1057).—Dog pellets exposed to deposits from sprays of lindane, chlordane, and Compound G22008 (3-methyl-1-phenylpyrazol-5-yldimethylcarbamate) were fed to white rats for five months. Each rat consumed an average of toxic residue of 1·2 mg. per kg. body wt. per day. Subsequent autopsy showed no abnormality of any organs. Rabbits, guinea pigs, rats, mice, and poultry exposed to 7% chlordane fog applications for >1 hour showed no apparent injury or reactions. Repeated 15-min. exposures to the vapours of 7% chlordane had no toxic effects on one of the authors of this paper. A. A. MARSDEN.

Subchronic toxicity of four chlorinated dimethanonaphthalene insecticides to chicks. M. Sherman and M. M. Rosenberg (*J. econ. Ent.*, 1954, **47**, 1082—1083).—When given to 7-day-old chicks for 42 days, Aldrin and Dieldrin caused 20% mortality when fed at 50 p.p.m. Their respective stereoisomers, Isodrin and Endrin when fed at 12 p.p.m. caused over 90% mortality. Wt. gains, feed consumption, and efficiency of feed conversion data are tabulated. A. A. MARSDEN.

Fungicidal activity, persistence and migration of zinc ethylenebisdithiocarbamate on vines. P. Fontana and G. Zampighi (*Ann. Chim., Roma*, 1954, **44**, 988—996).—The fungicidal film is stable to atm. chemical action but is easily washed off in heavy rain, *e.g.*, in a dry period the loss in 10 days was 3·5%, but in heavy rain 86%; 0·015—0·26 mg./g. of zinc ethylenebisdithiocarbamate (**I**) (or a material reacting similarly on analysis) occurred in young leaves tested therewith, the amount depending on the time of year. At the concn. used the activity of **I** is comparable with that of Cu salts and is not enhanced or reduced in presence of Cu salts. L. A. O'NEILL.

Determination of salts of ethylenebisdithiocarbamic acid in presence of copper salts. P. Fontana and R. Martelli (*Ann. Chim., Roma*, 1954, **44**, 978—981).—In the analysis of solutions containing Cu salts and ethylenebisdithiocarbamic acid (**I**), the method of Clarke (*Anal. Chem.*, 1951, **23**, 1842) cannot be used on account of the influence of $Cu^{\cdot\cdot}$ on the acid decomposition of **I**. A modified procedure, using the same apparatus, is employed in which the **I** is decomposed with ferrocyanic acid, the Cu being pptd. as ferrocyanide. The CS_2 evolved is passed through aq. Pb acetate (to remove H_2S or SO_2 arising from impurities in the product) and then absorbed in methanolic KOH and titrated iodimetrically. As an alternative to ferrocyanic acid, a mixture of H_2SO_4 and sufficient K ferrocyanide to precipitate all the $Cu^{\cdot\cdot}$ may be used. L. A. O'NEILL.

Biological oxidation of naphthalene. R. J. Strawinski and R. W. Stone (*Canad. J. Microbiol.*, 1954, **1**, 206—210).—The oxidation of $C_{10}H_8$ by a pseudomonad is examined. The principal product is salicylic acid. The process is favoured by aëration, by pH ~ 8 and by presence of Ca and Cu. A. G. POLLARD.

Flavour and benzene hexachloride content of peanuts, grown in rotation with cotton dusted with the insecticide. H. Reynolds, G. L. Gilpin, and I. Hornstein (*U.S. Dep. Agric.*, 1954, *Circ.* 952, 26 pp.).—BHC in quantities detectable organoleptically and by analysis was found only in groundnuts following cotton on experimental plots treated with 3·8—5·1 lb. of γ-isomer per acre as technical BHC of 13% γ-content. Smaller doses and purer BHC produced no off-flavours. L. G. L. UNSTEAD-JOSS.

Effect of certain metabolites and fungicides on *Stemphylium* spp. Patrick Martin Miller (*Dissert. Abstr.*, 1955, **15**, 19—20).—The relative responses of *Stemphylium sarcinæforme* and *S. solani* to proprietary fungicides (zineb and ziram), metabolites, and metabolic inhibitors are reported. *S. solani* was generally the more resistant to toxicants. Extracts and fractions from spores, mycelium, pork liver, tomato tissues, and germination water markedly affected the fungitoxicity of zineb and ziram. Pork liver contains anti-fungal substances. S. C. JOLLY.

Flexible-outlet mist sprayer. R. E. Adams, C. W. Terry, K. G. Parker, L. R. Brown, and J. E. Dewey (*Cornell agric. Exp. Sta.*, 1954, *Bull.* 904, 15 pp.).—A small orchard sprayer suitable for use as a mist concentrate sprayer or as a dil. sprayer, in which the direction of the outlet can be altered manually, is described. A. H. CORNFIELD.

Save stored grain products from insect pests. W. M. Kulash (*N. Carolina agric. Exp. Sta.*, 1954, *Bull.* 389, 24 pp.).—A general account of the principal insect pests of stored grain and methods of their control. A. H. CORNFIELD.

Nutrition of *Helminthosporium sativum* and certain related species. E. A. Peterson and H. Katznelson (*Canad. J. Microbiol.*, 1954, **1**, 190—197).—Nitrate, NH_4 salts, and a wide range of NH_2-acids were

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satisfactory sources of N for *H. sativum*. Trace elements, notably Zn, and also Mn, Fe, and B, were important for the growth of *H. sativum* and related species. The form of growth and pigmentation were influenced by the N source and by the supply of trace elements.
A. G. POLLARD.

Effect of certain insecticides and fungicides on plant emergence and control of the seed-maize maggot. M. H. Frost, jun., L. D. Anderson, and J. C. Elmore (*J. econ. Ent.*, 1954, **47**, 1040—1045).—Lindane and Dieldrin were equally effective in controlling *Hylemya cilicrura* at the three dosages tested ($\frac{1}{2}$, $\frac{3}{4}$, and $1\frac{1}{2}$ oz. per 100 lb. of seed). Machine-delinted cotton seed germinated better than did acid-delinted seed regardless of treatments. Emergence of spinach, pea, and onion seeds was not adversely affected by dry treatments of lindane or Dieldrin plus thiram or an inert carrier. Lindane–thiram combinations gave the best seed protection.
A. A. MARSDEN.

Control of maize earworm and stored grain insects in single-cross maize. W. G. Eden (*J. econ. Ent.*, 1954, **47**, 1124—1126).—Six or seven applications of DDT (2 lb. plus 1·4 gal. of mineral oil per acre) gave the best control of earworms, *Heliothis armigera*, in single-cross maize. Four to seven applications of DDT (2 lb. per acre) alone or with mineral oil gave good control of the rice weevil, *Sitophilus oryza*, and the Angoumois grain moth, *Sitotroga cerealella* attacking single-cross maize. Plots receiving four applications of DDT without mineral oil gave the highest yield of clean seed maize: the mineral oil appeared to have a detrimental effect on the yield of maize. A. A. MARSDEN.

Control of the sugar-cane beetle in maize. W. G. Eden (*J. econ. Ent.*, 1954, **47**, 1155—1156).—An Aldrin emulsion or granules (0·5, 1·0, and 2·0 lb. per acre) applied in an 8-in. band on top of the rows immediately after the maize was planted was effective against *Enetheola rugiceps* for about one month after planting. Dieldrin (1 lb.) and toxaphene (8 lb. per acre) granules were rather less effective in preventing damage to maize. A. A. MARSDEN.

Effects of second generation European maize borer on field maize. H. C. Chiang, L. K. Cutkomp, and A. C. Hodson (*J. econ. Ent.*, 1954, **47**, 1015—1020).—Second generation borers had little effect on ear growth but were responsible for stalk breakage and ear dropping. For control purposes during a growing season, the populations of first and second generation borers must be distinguished and their separate effects in the total loss in yield from damage by borers must be assessed. A. A. MARSDEN.

Kernel smut of Kaffir corn. G. J. M. A. Gorter (*Fmg S. Afr.*, 1954, **29**, 494, 502).—The disease, due to *Sphacelotheca sorghi*, is described. It is controlled by Hg or Cu seed dressings (except Lunasan) at the rate of 4 oz. per 100 lb. of seed. Good results have been obtained by treating diseased seed with S although no protection is thus afforded to seed if sown in cold or otherwise unfavourable conditions.
A. G. POLLARD.

Tutsan rust in New Zealand. Shirley D. Baker (*N.Z. J. Sci. Tech.*, 1955, **36, A**, 483—484).—The occurrence, symptoms, and possible use of the rust, *Melampsora hypericorum*, for the control of tutsan (*Hypericum androsæmum*) are discussed briefly. S. C. JOLLY.

Sub-units of sample for estimating aphid abundance on potatoes. W. A. Shands, G. W. Simpson, and L. B. Reed (*J. econ. Ent.*, 1954, **47**, 1024—1027).—In making field population counts of wingless aphids on potato plants, one sub-unit of sample consisted of the terminal and two opposite basal leaflets of three leaves per sample plant. The other sub-unit consisted of one half of each of these leaflets. This procedure required only 42·9% as many leaflets to observe and 38% as many aphids to count as did the use of the whole-leaf sample. Conversion factors for expressing the population estimates on a whole-leaf basis are given. A. A. MARSDEN.

Ecological studies on the potato psyllid as a pest of potatoes. R. L. Wallis (*U.S. Dep. Agric.*, 1955, *Tech. Bull.* 1107, 25 pp.).—The life history, habits, and overwintering of *Paratrioza cockerelli*, (Sulc.) are described, together with surveys of the movement during the spring and within the summer breeding areas. Annual pre-season surveys of adult psyllids on non-economic host plants will indicate the expected population on potatoes for the growing season.
E. G. BRICKELL.

[Control of] the yellow clover aphid—a new lucerne pest in the southwest. D. M. Tuttle and G. D. Butler, jun. (*J. econ. Ent.*, 1954, **47**, 1157).—The yellow clover aphid, *Therioaphis ononidis*, was effectively controlled on lucerne with all insecticides tested. For hay crops the org. phosphates were the most suitable compounds due to their lack of residual toxicity. DDT and/or toxaphene–S formulations gave good protection of lucerne grown for seed.
A. A. MARSDEN.

Meadow spittlebug, *Philænus leucophthalmus*, L. C. R. Weaver and D. R. King (*Ohio agric. Exp. Sta.*, 1954, *Res. Bull.* 741, 99 pp.).—The taxonomic position, biology, ecology, and methods of control of the meadow spittlebug are presented. Excellent control of nymphs has been obtained with $C_6H_6Cl_6$, toxaphene, methoxychlor, and Endrin, and of adults with DDT and methoxychlor. Perthane, TDE, and Endrin have also given good control of adults.
A. H. CORNFIELD.

The white-fringed beetle, *Graphognathus leucoloma*. C. J. Joubert (*Fmg S. Afr.*, 1954, **29**, 504, 507).—The insect, larvæ of which feed on roots of many plant species, notably lucerne, is described. The spread of the pest is favoured by a deficiency of org. matter in soil. Suggested control methods include a no. of cultural practices, spraying the crop with DDT for adult beetles, and the application of Aldrin to recently ploughed soil or soil fumigation with DD to destroy larvæ. A. G. POLLARD.

Control of army cutworms. C. C. Burkhardt (*J. econ. Ent.*, 1954, **47**, 1156—1157).—Sprays of Endrin (0·1 and 0·2 lb. per acre) gave the best control (88—89%) of army cutworms, *Chorizagrotis auxiliaris*, infesting lucerne. Aldrin, heptachlor, and Dieldrin gave 80—86% control. Toxaphene (2 lb. per acre) was considerably less effective. A. A. MARSDEN.

Apple spray information. C. N. Clayton, H. C. Fink, C. F. Smith, and G. F. Turnipseed (*N. Carolina agric. Exp. Sta.*, 1954, *Sp. Circ.* 19, 16 pp.).—A general account of insecticides and fungicides used for controlling pests and diseases on apple trees. A no. of apple spray programmes are described. A. H. CORNFIELD.

Field evaluation of insecticides against codling moth. E. H. Glass (*J. econ. Ent.*, 1954, **47**, 1093—1101).—DDT (2 lb. of 50% wettable powder) gave consistently excellent control of codling moth. CS-708 was nearly equal to DDT but methoxychlor and DDD were less effective. Parathion was the most effective org. phosphate tested, followed by EPN and Malathion. The org. phosphates were usually inferior to DDT for the prevention of late season entries. Diazinon and 4389 [*S*-(1 : 2-dicarbethoxyethyl) *OO*-dimethyl thiophosphate] were excellent in preliminary tests. DDT appeared to be the best insecticide tested against codling moth in New York State.
A. A. MARSDEN.

Insecticides. C. Avila (*Afinidad*, **32**, 1—5).—A review of DDT, Gammexane, and more recent insecticides including S and P derivatives. T. R. MANLEY.

Rapid test for the detection of toxaphene in agricultural formulations. Delwin P. Johnson (*J. Ass. off. agric. Chem.*, 1955, **38**, 153—156).—The toxaphene is extracted from the insecticide by shaking with *n*-hexane. A mixture of the extract with pyridine and methanolic N-KOH is heated at 100° for 15 sec., then cooled at 0° for 1 min. If toxaphene is present a pink to rusty-red colour develops within 10 sec. after heat is applied. If S is present the sample is first extracted at 0° with methanol, and the residue after evaporation is employed for the test. Interference by parathion can be prevented by washing the hexane extract with aqueous Na_2CO_3. Some interfering materials may be eliminated by partition chromatography, using *n*-hexane and nitromethane as solvents and silicic acid as the supporting medium. A. A. ELDRIDGE.

Summer control of pear leaf blister mite. H. P. Lanchester (*J. econ. Ent.*, 1954, **47**, 1020—1021).—Demeton (Systox) sprays gave good control of *Eriophyes pyri* attacking young pear trees. Both parathion and lime–S reduced mite populations, probably by killing the mites as they tried to migrate from the blisters to the buds.
A. A. MARSDEN.

Soil application of insecticides to control plum curculio. C. L. Fluke and D. A. Dever (*J. econ. Ent.*, 1954, **47**, 1115—1117).—Aldrin or Dieldrin applied to the soil (3 or 6 lb. per acre) was toxic to curculio adults. Both insecticides when applied at 6 lb. per acre had a residual toxicity after three years in the soil. Chlordane and lindane gave erratic results in these experiments. Aldrin, Dieldrin, and heptachlor were effective in orchards with a previous history of high curculio infestations. None of the insecticides tested, with the possible exception of Dieldrin, was toxic to the apple maggot when applied to the soil. A. A. MARSDEN.

Peach spray information. C. F. Smith and C. N. Clayton (*N. Carolina agric. Exp. Sta.*, 1954, *Sp. Circ.* 20, 12 pp.).—Insects and diseases attacking peach trees are described and detailed recommendations for their control are given. A. H. CORNFIELD.

Dichloropropane–dichloropropene mixtures of different composition as soil fumigants in pineapple land. W. Carter (*J. econ. Ent.*, 1954, **47**, 1101—1103).—Three series of formulations of dichloropropane with dichloropropene were tested in comparison with the standard commercial formulation (D–D mixture). Growth response (measured by fruit wt.) showed that 1 : 3-dichloropropene was an essential component for soil fumigation but not necessarily in specific proportions. Further tests with mixtures of compounds in the boiling

range of 21—60° having an approx. min. of 30% 1 : 3-dichloropropene are recommended. A. A. MARSDEN.

Residues of *p*-chlorophenyl *p*-chlorobenzenesulphonate (Compound K-6451) on and in lemons and oranges. F. A. Gunther and L. R. Jeppson (*J. econ. Ent.*, 1954, **47**, 1027—1032).—Soon after application residues of this acaricide applied to oranges and lemons were present almost entirely in the cuticular waxes : very little of the material penetrated to the juice of either fruit. The half-life value for Compound K-6451 in citrus peel was approx. 10 days. Details of analytical methods used to determine Compound K-6451 residues are given. A. A. MARSDEN.

Harvest residues of apparent Dieldrin in peel and juice of navel oranges. F. A. Gunther, J. H. Barkley, and W. H. Ewart (*J. econ. Ent.*, 1954, **47**, 1033—1035).—Fruit from plots sprayed in May showed no Dieldrin. In oranges from plots sprayed in May and August 0·08 p.p.m. of apparent Dieldrin was found in the peel and <0·01 p.p.m. in the juice. A. A. MARSDEN.

Malathion and Malathion–parathion sprays for control of the soft scale on citrus in California. H. S. Elmer and W. H. Ewart (*J. econ. Ent.*, 1954, **47**, 1131—1133).—Various spray formulations of Malathion alone and with parathion were applied to citrus groves for the control of soft scale, *Coccus hesperidum*, during the winter months of little parasite activity. Malathion–parathion spray mixtures were more effective than was Malathion alone. Malathion wettable powder (25%) 1·5 lb.–parathion W.P. (25%) 0·5 lb. per 100 gal. of spray gave the most effective results. A. A. MARSDEN.

Control of the strawberry weevil in blackberries. W. G. Eden (*J. econ. Ent.*, 1954, **47**, 1150—1151).—Toxaphene, chlordane and DDT sprays all effectively controlled the strawberry weevil, *Anthonomus signatus*, with consequent increases in berry yields. Toxaphene was the most effective insecticide, followed by DDT and chlordane, in that order. A. A. MARSDEN.

The tomato russet mite in the United States. L. D. Anderson (*J. econ. Ent.*, 1954, **47**, 1001—1005).—The history and biology of the tomato russet mite, *Vasates lycopersici*, are reported. One or two treatments with S dust (⩽10 lb. per acre) gave good control of this pest. Preliminary field tests showed that parathion and toxaphene gave good results and may prove to be suitable substitutes for S. A. A. MARSDEN.

Cross-protection by strains of tomato spotted wilt virus and a new theory to explain it. R. J. Best (*Aust. J. biol. Sci.*, 1954, **7**, 415—424).—Mild strains C and E protect plants against the severe strains A and B, respectively, whether inoculated before or after systemic symptoms of the mild strain appear. It is suggested that a transfer of character determinants between virus particles takes place at some stage while they are multiplying in the cells they mixedly infect. E. G. BRICKELL.

Insecticide tests with cabbage caterpillars and aphids. L. E. Dills and M. L. Odland (*J. econ. Ent.*, 1954, **47**, 992—995).—The use of TDE resulted in less caterpillar damage than that of any of the insecticides tested for > one year. TDE was significantly better than DDT or Dieldrin. Preliminary tests with Isodrin showed that it was equal in toxicity to TDE ; heptachlor was rather less effective. Lindane (1%) and ryania (15%) with 0·5% *n*-propyl isomer as a synergist, 1 : 1-bis-(*p*-ethylphenyl)-2 : 2-dichloroethane, and methoxychlor were all moderately toxic to cabbage caterpillars. Lindane (1%) was the most effective material for aphid control. A. A. MARSDEN.

Control of the pepper weevil. J. C. Elmore and R. E. Campbell (*J. econ. Ent.*, 1954, **47**, 1141—1143).—Three applications of a DDT (10%) dust at 7-day intervals followed by two applications 10 days apart are recommended for the control of heavy infestations of *Anthonomus eugenii*. DDT was at least as effective as any of the following insecticides tested : Aldrin, heptachlor, TDE, Malathion, parathion, and Q-137. A. A. MARSDEN.

Effect of systemic insecticides upon certain groundnut insects and upon groundnuts. B. W. Arthur and F. S. Arant (*J. econ. Ent.*, 1954, **47**, 1111—1114).—Soil or foliage applications of Demeton gave better control of thrips (*Frankliniella fusca*) attacking groundnuts than did schradan, Chlorthion, or compound 21/116 (the dimethyl analogue of Demeton : *O*-2-ethylmercaptoethyl *OO*-dimethyl thiophosphate). Demeton was as effective in thrips control as DDT or toxaphene, and gave ~2 months control after soil application. None of the systemic insecticides tested controlled the maize earworm, *Heliothis armigera*, or the fall armyworm, *Laphygma frugiperda*. Demeton retarded the growth of groundnut plants, and Demeton, schradan, and Chlorthion caused some foliage burning of young plants. DDT and toxaphene treatments gave increased yields of groundnuts, but although systemic insecticides produced significant reductions in thrips populations no increase in yield of groundnuts was noted. A. A. MARSDEN.

Aërial oil-spraying of wattle plantation against bogworm. L. B. Ripley and D. v. W. Webb (*Emg S. Afr.*, 1954, **29**, 495—498).—Promising results were obtained by spraying with mineral oil containing $C_6H_6Cl_6$ or toxaphene (Diesel oil 2·5 gal., toxaphene 1·5—3·0 lb. per acre) applied by aircraft flying 10—15 ft. above the treetops. A. G. POLLARD.

Pattern of damage produced on vegetation by smog. W. M. Noble (*J. Agric. Food Chem.*, 1955, **3**, 330—332).—The injury caused by smog is assessed on three general types of observations : (*a*) macroscopical, the silvering, glazing, streaking, or speckling occurring on leaves of plants ; (*b*) microscopical, the cells become enlarged and turgid, plasmolysis occurs, the chloroplasts concentrate in the middle of the cell and disintegrate, followed by dehydration and collapse of the cells without rupturing the walls, further dehydration and enlargement of the intercellular spaces between the collapsed cells causing the macroscopic effects ; and (*c*) the distribution of damage on the leaf indicated by a pattern related to the differential maturity of the leaf. Illustrations are given of four light bands of injury to a mimulus leaf caused by four successive days of smog ; of two *Poa annua* plants exposed simultaneously to a single day of natural smog, and of sugar beet leaves fumigated with light petroleum, ozone, and oxides of N. The use of the damage pattern is helpful in determining the effects of exhaust fumes from cars etc. on plants. (15 references.) E. M. J.

Effects of ionising radiations, ultrasound, and several chemicals on the oak wilt fungus. B. M. Zuckerman (*Dissert. Abstr.*, 1955, **15**, 21).—Growth of the fungus in a liquid medium and its ability to produce a metabolite toxic to oak and tomato cuttings were not affected by *X*-irradiation. Reproductive capacity was inhibited at dosages permitting growth. Irradiation with a source of mixed α-rays (^{238}U) killed the fungus, but therapy with uranium nitrate as an external source of radiation was unsuccessful. Injection of uranium nitrate in wilt-infected seedling oats did not halt the disease, but apparently retarded initial symptoms. Leaf injury resulted from lowest concn. used, but the host was not killed. Ultrasound had no effect on the fungus. Of three chemotherapeutic agents tested only M4367 showed fungitoxicity, the fungus being completely inhibited by concn. of 5 p.p.m. Growth, exometabolite production, pathogenicity, and ability to form fertile perithecia of the fungus reisolated from the year-old wood of a tree successfully treated with M4367 were not changed by the contact with this chemical. S. C. JOLLY.

Application schedules for control of cotton insects. R. L. Hanna (*J. econ. Ent.*, 1954, **47**, 1129—1131).—Small plat tests showed a significantly lower thrips population and a higher yield of seed cotton after three early season applications of insecticide (2% Dieldrin dust at 5 lb. per acre). Seven late-season applications at 5-day intervals gave higher yields than did five late-season applications at 7-day intervals. Large plat tests showed a good reduction of thrips after three early season applications of toxaphene, but no significant increase in yield. A. A. MARSDEN.

Three new phosphate insecticides for the systemic control of cotton insects. E. E. Ivy, A. L. Scales, and L. J. Gorzycki (*J. econ. Ent.*, 1954, **47**, 1148—1149).—The following compounds were applied to cotton seed at the rate of 4 lb. per 100 lb. of seed : *OO*-diethyl *S*-*iso*propyl mercaptomethyl dithiophosphate (**I**), *OO*-diethyl *S*-propyl mercaptomethyl dithiophosphate (**II**), and *OO*-di*iso*propyl *S*-*iso*propyl mercaptomethyl dithiophosphate (**III**). All three compounds were highly effective on seedlings infested one week after treatment but **I** retained its toxicity for the longest time. Three weeks after treatment all three compounds killed all cotton aphids, desert spider mites, and cotton fleahoppers placed on the plants. **I** and **II** killed larvæ of newly-hatched cotton leaf perforators, *Bucculatrix thurberiella*, and of salt-marsh caterpillars, *Estigmene acrea*, but **III** was only slightly effective. **I** was effective and **II** less effective against flower thrips, *Frankliniella tritici*. None of these compounds was effective against bollworms. A. A. MARSDEN.

[Control of] a new pest of cotton in Texas. D. F. Martin and W. J. Mistric, jun. (*J. econ. Ent.*, 1954, **47**, 1149—1150).—A brown cotton leafworm, *Acontia dacia*, Druce, causing considerable " ragging " of cotton was effectively controlled by sprays of parathion (0·25 lb.) or Endrin (0·33 lb. per acre) applied by aeroplane. A. A. MARSDEN.

Are cotton insects becoming resistant to insecticides? E. E. Ivy and A. L. Scales (*J. econ. Ent.*, 1954, **47**, 981—984).—After five years of treatments with toxaphene field cage tests showed that cotton leafworms, *Alabama argileacea*, suddenly became much more resistant to this insecticide although nearly complete control was still obtained with Ca arsenate (10 lb.) or parathion (0·1 lb. per acre). Resistance to parathion and to other P compounds of the tumid Spider mite, *Tetranychus tumidus*, Banks, was also observed. No

resistance to γ-$C_6H_6Cl_6$ was encountered with cotton aphids, or with bollworms and boll weevils to DDT or toxaphene.
A. A. MARSDEN.

Tests of the dielectric treatment of cotton seed for destroying pink bollworms. W. L. Lowry, A. J. Chapman, F. T. Wratten, and J. P. Hollingsworth (*J. econ. Ent.*, 1954, **47,** 1022—1023).—Dielectric treatment technique to destroy pink bollworms, *Pectinophora gossypiella*, in cotton seed is described. A field intensity of 1300 to 2040 volts per in., with exposure time of 14—29 sec., giving a final temp. of 71·5—80° gave complete kill of larvæ. This treatment did not affect germination or chemical composition of the seed, but there was a risk of fire at such high voltage gradients. A. A. MARSDEN.

Feeding molasses to livestock. G. L. Walker (*U.S. Dep. Agric.*, 1955, *Leafl.* 352, 8 pp.).—A review of feeding tests and farmers' experiences. E. G. BRICKELL.

Value of certain agricultural, marine, and industrial products and by-products in livestock feeding. I. J. Duckworth (*J. Sci. Food Agric.*, 1955, **6,** 177—185).—A review covering: the market values of feeding stuffs in relation to their nutritional values; measurement of nutritional value; nature of nutritional studies; nature of feeding trials; measurement of market value. For ruminants, energy sources, straw and straw pulp, oat-mill feed and oat hulls, fodder cellulose from wood and straw, seaweed and seaweed meal, and N-sources are discussed. (39 references.) E. M. J.

Determination of antibiotic content in supplemented feeding stuff. S. J. Edwards and M. D. Haskins (*J. Sci. Food Agric.*, 1955, **6,** 218—223).—Two tests are described for the assay of penicillin and aureomycin in supplemented meals used for feeding pigs. An aq. extract of the meal is prepared and the concentration is determined by comparing its inhibitory end-point in serial dilution tests with that of extracts prepared from standard control meals containing known amounts of antibiotic, the test organism being *Streptococcus agalactiæ*. In this way a concentration value within narrow range can be assigned to meals under test, and the results are not influenced by non-specific substances in the meal. In the second test the meal is extracted with a volatile solvent and the amount of antibiotic is assayed by the paper-disc method giving a single value which is reasonably accurate, but the technique is more difficult than that of the serial dilution test. E. M. J.

Determination of moisture in gluten and sweetened feeds. W. R. Fetzer and L. C. Kirst (*J. Ass. off. agric. Chem.*, 1955, **38,** 130—140).—Procedures for the determination of moisture in a component of a feed may not be satisfactory when applied to the compounded feed. For heat-sensitive mixtures or materials, *e.g.*, gluten feed or sweetened feed, distillation with benzene gives more accurate results than that with toluene. The sweetened feed, mixed with water and Filter-cel, may also be heated in a vacuum oven at 70° for 20 hr. to give a reproducible loss in weight. A. A. ELDRIDGE.

Determination of Nicarbazin in feeds. C. R. Szalkowski, M. G. O'Brien, C. W. Stewart, and W. J. Mader (*J. Ass. off. agric. Chem.*, 1955, **38,** 140—146).—Nicarbazin (a complex of 4 : 4′-dinitrocarbanilide with 2-hydroxy-4 : 6-dimethylpyrimidine) is extracted from chicken feed with hot dimethylformamide. Substances which resemble dinitrocarbanilide in giving a yellow colour with alcoholic NaOH, and inhibit the colour reaction of hydroxy dimethylpyrimidine with sulphanilic and nitrous acids, are removed chromatographically with Al_2O_3. Procedure for the spectrophotometric determination of the two components is detailed. Recoveries of 97·0 to 103·0% of Nicarbazin added to blended feeds are reported.
A. A. ELDRIDGE.

Determination of small amounts of diethylstilbœstrol in feeds. Edmund W. Cheng and Wise Burroughs (*J. Ass. off. agric. Chem.*, 1955, **38,** 146—150).—The sample (prepared by mixing a solution of diethylstilbœstrol in maize oil with soya-bean oil meal) was extracted with benzene, and the concentrated extract was mixed with Skellysolve B, the mixture being then passed through a column of Celite wetted with NaOH and Skellysolve B. The diethylstilbœstrol, which is retained, was eluted with alcoholic HCl and determined (*a*) colorimetrically with a solution of $SbCl_5$ in ethylene chloride or (*b*) after evaporation and dissolution in acetic acid and irradiation with ultra-violet light, by determination of absorbance. A Coleman colorimeter, with filters respectively 525 and 430 mμ., was used. The $SbCl_5$ reaction method is the more sensitive; average recoveries by the two methods were respectively 98 and 94%. Some interfering substances may not be removed by the chromatographic procedure, and the method is not necessarily applicable without modification to other mixes. A. A. ELDRIDGE.

Nutritional value of prepress-solvent cottonseed meals. Wan-Yuin Chang, J. R. Couch, C. M. Lyman, W. L. Hunter, Van P. Entwistle, William C. Green, A. B. Watts, C. W. Pope, C. A. Cabell, and I. P. Earle (*J. Amer. Oil Chem. Soc.*, 1955, **32,** 103—109).—Determinations of the nutritive values of nine prepress-solvent-extracted cottonseed meals by four independent laboratories are compared. Wide differences in results are attributed to the type of test used, but average values show a clear-cut relationship between protein quality and solubility of N in 0·02N-NaOH, whilst a high (70% or higher) solubility of N corresponds with a protein efficiency index number >80. Correlation coeff. by all laboratories indicate that solubility of N in 0·02N-NaOH is a better measure of protein quality in cottonseed meal than is the solubility test with dil. NaCl, whilst total gossypol content and solubility of N in 0·02N-NaOH are approx. equal as indicators of protein quality. D. BAILEY.

Effect of time and temperature of storage on the free and total gossypol content of cottonseed meals and of mixed diets. R. P. Kupperman and M. L. Karon (*J. Amer. Oil Chem. Soc.*, 1955, **32,** 54—57).—Storage of commercially processed cottonseed meals at low and moderate temp. for extended periods of time has little effect on the free or total gossypol contents of the meals but at temp. >37·5° the loss of both is considerable. The rate of disappearance of gossypol depends upon the type of cottonseed material and the temp. and length of storage. When gossypol is incorporated into different types of animal feeding stuffs there is an immediate loss or inactivation of some of the added gossypol and a further loss on storage. Factors which may contribute to the loss include the components of the feeding stuff, temp. and period of storage and the concn. of the gossypol in the mixture. The apparent loss of gossypol during storage is probably due to combination with some soluble constituent of the diet which is extracted or digested along with the gossypol. D. BAILEY.

Prepress-solvent extraction of cottonseed, processing conditions, and characteristics of products. W. A. Pons, jun., F. H. Thurber, and C. L. Hoffpauir (*J. Amer. Oil Chem. Soc.*, 1955, **32,** 98—103).—This survey deals with the influence of processing conditions on the chemical properties of meals and oils and on the nutritive value of the meals. Cooking conditions are responsible for the distribution of gossypol between the meal and oil and for reduction in solubility of N. Diminution in free gossypol during cooking is due to combination with meal components, whilst that occurring during prepressing and solvent extraction results from actual removal in the extracted oils. Prepressed oils give lower refining losses, lower refined and bleached colour and less bleach colour reversion than do solvent-extracted oils. Meals are mainly of good protein quality. Protein denaturation is lower than in screw-pressing methods. D. BAILEY.

Effect of wilting and addition of kofa salt and molasses on ensiled clover. J. Axelsson and A. Kivimäe (*K. Lantbruks-Hogskol. Ann., Uppsala*, 1954, **21,** 41—48).—The use of wilted material reduced the loss of dry matter in the silos, while improving the quality of the silage. Addition of kofa salt was as effective as that of molasses in improving the quality of the silage. R. H. HURST.

Digestibility experiments with pigs. S. Nordfeldt (*K. Lantbruks-Hogskol. Ann., Uppsala*, 1954, **21,** 1—29).—Study of the literature from 1900 to 1951 indicates that with increasing age (wt.) the pigs' digestive ability increased significantly. The digestibility of org. matter and crude fibre increased, that of protein was variable, and that of fat decreased. The amount of crude fibre in the feed influenced, significantly, the digestibility of org. matter. (Long bibliography.) R. H. HURST.

Comparison of urea and protein as nitrogen sources for rumen micro-organisms: production of volatile fatty acids. I. J. Belasco (*J. Anim. Sci.*, 1954, **13,** 748—757).—In tests made with the artificial rumen, urea, as sole source of N, produced more propionic acid and less butyric and valeric acids than did an equivalent amount of N in soya-bean, linseed, cottonseed, or maize gluten meal. The form of N supplied did not affect the production of acetic acid. Increased formation of propionic acid is associated with the more rapid digestion of cellulose promoted by N in the more readily available form.
A. G. POLLARD.

Comparison of urea and protein meals as nitrogen sources for rumen micro-organisms: urea utilisation and cellulose digestion. I. J. Belasco (*J. Anim. Sci.*, 1954, **13,** 739—747).—In the digestion of cellulose in artificial rumen tests urea was a more effective source of N than was soya-bean, linseed or cottonseed meal, or maize gluten. Mixtures of the seed meals with urea (9 : 1) were very effective. With urea as sole source of N, digestion of cellulose increased with the amount of urea given up to a max. with about 35% protein equivalent, beyond which the increased concn. of NH_3 produced inhibited both urea utilisation and cellulose digestion. A. G. POLLARD.

Metabolism of sulphur amino-acids in higher animals and micro-organisms. F. Chatagner and B. Bergeret (*Ann. Nutr., Paris*, 1955, **9,** 93—130).—A review with 216 references. S. C. JOLLY.

Effect of added fat on the digestion of cellulose and protein by ovine rumen micro-organisms. C. C. Brooks, G. B. Garner, C. W. Gehrke, M. E. Muhrer, and W. H. Pfander (*J. Anim. Sci.*, 1954, **13,** 758—764). —Addition of maize oil (10—170 mg. per g. of dry matter) to a filter paper–casein–urea–NH_4 carbonate mixture (50% of cellulose) in an artificial rumen lowered the digestion of cellulose by 40—94%. In digestibility trials with sheep addition of 64 g. of maize oil daily to a basal cottonseed hull–casein ration reduced the digestion of cellulose and protein. Rumen ingesta had a putrid odour and a lowered content of volatile fatty acids. Lard (32—64 g. daily) also lowered cellulose digestion. Feeding lucerne ash (18 g. daily) partly counteracted the effects of the fats. A. G. POLLARD.

***In vitro* cellulose digestion by rumen organisms and its stimulation by fishery by-products.** R. A. MacLeod and C. A. Brumwell (*Appl. Microbiol.*, 1954, **2,** 130—135).—In tests with the artificial rumen, cellulose digestion was stimulated by certain fish products (whale " solubles ", herring " solubles ", herring stickwater, halibut muscle hydrolysate). This activity is associated with the amino-acids, carbohydrates, and possibly other growth stimulants required by the rumen micro-organisms, but not with ash constituents, water-sol. vitamins, cysteine or methionine contents of the materials. Use of stimulants to improve the digestion of low-grade forages by ruminants is considered. A. G. POLLARD.

Magnitude of microbial fermentation in the bovine rumen. E. J. Carroll and R. E. Hungate (*Appl. Microbiol.*, 1954, **2,** 205—214).—Rates of production of volatile acids in isolated rumen contents are determined and the data is used to calculate the actual rates of formation in the rumen. The rates of production of acetic, propionic, and butyric acids differed according to the nutritional regime adopted in the order, grain > hay > pasture. The proportions in which the three acids were formed were similar for all types of feeding. The relative amount in which either individual acid was produced was inversely related to the proportion in which it was present initially. A. G. POLLARD.

Effect of certain adsorbents and mineral mixtures on the availability of riboflavin and other B-vitamins in rations. C. H. Hunt, T. V. Hershberger, O. G. Bentley, and A. L. Moxon (*Ohio agric. Exp. Sta.*, 1954, *Res. Bull.* 748, 15 pp.).—When riboflavin in solution was mixed with bone meal, limestone, $CaHPO_4$, and one brand of fuller's earth it was readily available for growth of laboratory animals and micro-organisms. When mixed with Norite A, bone black, or two other brands of fuller's earth riboflavin was not appreciably available to animals. The deleterious effects of some of the adsorbents could be overcome by supplying higher levels of the vitamin in the feeds. The availability of pantothenic acid and niacin was reduced by admixture with one of the two trace mineral mixtures tested. Salts of Fe, Mn, Cu, and Co, individually or in combination, did not affect the availability of pantothenic acid. A. H. CORNFIELD.

Use of distillery potato slop silage and chicory–potato slop silage for fattening young cattle. S. Seidler (*Roczn. Nauk rol.*, 1954, **68, B,** 235—252).—The two silages together with hay, straw, dried sugar-beet pulp, and concentrates gave satisfactory results in fattening young (1—2½ years) steers. A. G. POLLARD.

Utilisation of carotene from hay and sugar-beet top silage by dairy cows. F. Jarl and V. Hellström (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21,** 31—39).—Cows fed with hay secreted a greater quantity of carotene in their milk than did those fed with silage. R. H. HURST.

Œstrogens and New Zealand dairy pastures. E. G. Bassett and E. P. White (*N.Z. J. Sci. Tech.*, 1955, **36, A,** 485—492).—The literature concerning œstrogens and other hormones from pasture plants is reviewed. Although a sharp increase occurred in milk production of cows under two different grazing regimes on typical N.Z. dairy pasture during lush spring growth period, no œstrogenic activity was found in pasture samples. Some subterranean and red clover had high œstrogenic activity; all the activity in red clover was in the leave. A strong biological response was given by a sample of suckling clover. No activity occurred in a no. of pure samples of grasses, clovers, and other pasture plants. (38 references.) S. C. JOLLY.

Galactopoietic role of growth hormone in dairy cattle. P. J. Brumby and J. Hancock (*N.Z. J. Sci. Tech.*, 1955, **36, A,** 417—436). —Milk and butterfat production by dairy cattle were markedly increased by daily subcutaneous injection of growth hormone during both the peak and the latter end of lactation; efficiency of production was also increased apparently. Neither blood nor milk composition was changed by the treatment *per se*. The mechanism of the response and the physiological rôle that the growth hormone may play in lactation are discussed. (18 references.) S. C. JOLLY.

Effect of vitamin-A stores and carotene intake of beef cows on the vitamin-A content of the liver and plasma of their calves. F. H. Baker, L. S. Pope, and R. MacVicar (*J. Anim. Sci.*, 1954, **13,** 802—807).—Lactating cows on a low-carotene diet failed to provide sufficient vitamin A from liver reserves for their calves. The vitamin-A and, to a smaller extent, the carotene content of the milk was more closely related to the dietary level of carotene than to liver stores accumulated from pre-partum rations. Supplements of 300 mg. of carotene daily maintained adequate levels of carotene and vitamin A in the plasma and liver of suckling calves. A. G. POLLARD.

Effect of trace minerals on growth performance and vitamin-B_{12} synthesis of steers. O. G. Bentley, M. Moinuddin, T. V. Hershberger, E. W. Klosterman, and A. L. Moxon (*J. Anim. Sci.*, 1954, **13,** 789—801).—Steers receiving a ration of timothy hay, broken maize in cob, urea, cerelose, Ca, P, iodised salt, and vitamin A increased in daily food intake and in gain in wt. on supplementary feeding with minerals (Co, Mn, Zn, Fe, Cu) or lucerne ash. The major effect was attributable to Co. Addition of Co (0·5 mg. daily) to the basal diet increased the Co and vitamin B_{12} content of the liver and also the fæcal Co. A. G. POLLARD.

Absorption and tissue distribution of radio-zinc in steers fed high-zinc rations. J. P. Feaster, S. L. Hansard, J. T. McCall, F. H. Skipper, and G. K. Davis (*J. Anim. Sci.*, 1954, **13,** 781—788).—Steers from one month of age given $ZnCO_3$ (1000 p.p.m. of the ration) excreted 65—72% of the Zn in fæces and traces in urine. Of intravenously injected Zn 20% was excreted in fæces; blood–Zn reached equilibrium levels in 6—10 hr. Zn retained in the body accumulated mainly in soft tissues, highest concn. occurring in the pancreas, liver, kidneys, and adrenals. A. G. POLLARD.

Use of beef-cattle feeding data in evaluating mountain meadow management practices. F. M. Willhite, H. K. Rouse, and D. E. Miller (*J. Anim. Sci.*, 1954, **13,** 808—816).—Comparison is made of the analyses and feeding values (heifers) of hay cut at mid-season with that cut much later. In one season the difference between early- and late-season hay could be represented as equivalent to 1 lb. of cattle cake (protein 43%) per head daily. A mathematical relationship is established between crude protein in the feed and the rate of gain in wt. of the cattle and is used to convert yield and protein content of hay into estimates of beef production in relation to various aspects of grassland management. A. G. POLLARD.

Acre yields of beef from maize and meadow crops. E. W. Klosterman and L. E. Kunkle (*Ohio agric. Exp. Sta.*, 1954, *Res. Bull.* **753,** 18 pp.).—When fed to yearling steers an acre of maize was superior to an acre of meadow crops in value of beef returned. Returns from maize were increased when part of the crop was fed as silage. Hay silage from a given area produced more beef than did a similar area utilised as pasture. Yearling steers were fattened satisfactorily on hay silage + ground ear maize without addition of supplemental protein. A. H. CORNFIELD.

Effect of age and grade on the collagen and elastin content of beef and veal. G. D. Wilson, R. W. Bray, and P. H. Phillips (*J. Anim. Sci.*, 1954, **13,** 826—831).—No relationship was apparent between the collagen and the elastin contents of the *longissimus dorsi* of cows or steers and carcass grades or amounts of intramuscular fat. There was no consistent difference in values for cows and steers but all values were significantly lower than those for veal. A. G. POLLARD.

Individuality of the level of blood-glutathione in young beef cattle. H. O. Kunkel, E. C. Stutts, and R. R. Shrode (*J. Anim. Sci.*, 1954, **13,** 852—858).—Data from numerous animals of various breeds affords evidence that the reduced-glutathione content of the blood is an individual characteristic of young cattle. A. G. POLLARD.

Effect of age of castration on rate and economy of gain and carcass quality of beef calves. E. W. Klosterman, L. E. Kunkle, P. Gerlaugh, and V. R. Cahill (*J. Anim. Sci.*, 1954, **13,** 817—825).—Steers castrated at one or at seven months of age showed similar rates of gain in wt. and similar carcass qualities. Bulls gained wt. more rapidly and with greater feed efficiency but yielded carcasses of lower quality. A. G. POLLARD.

Relation between rate and efficiency of gain and type in breeding beef cattle. M. A. MacDonald and R. Bogart (*N.Z. J. Sci. Tech.*, 1955, **36, A,** 460—469).—Analysis of the results of type classification and performance tests involving 42 purebred bulls and heifers of Hereford and Aberdeen Angus breeding is reported. Factors studied were birth wt., weaning wt., rate of gain, efficiency of gain, and type classification at 500 lb. and at 800 lb. body wt. (24 references.) S. C. JOLLY.

Psychrophilic bacterium causing ropiness in milk. I. Morphology and physiology. II. Chemical nature of the capsular polysaccharide. D. E. Wegemer and C. Gainor (*Appl. Microbiol.*, 1954, **2,** 95—97,

97—99).—I. The organism described (possibly a variant of *Alcaligenes viscosus*) is unlike *A. viscosus* in that it does not hydrolyse fat but ferments arabinose, glucose, galactose, and xylose producing a final pH (14 days) of 4·6—5·6 : it grows well at 4·5° but not at >35°.

II. The capsular polysaccharide of the organism is of the levan type. A. G. POLLARD.

Excretion of Dieldrin in the milk of cows fed Dieldrin-sprayed forage and technical Dieldrin. R. E. Ely, L. A. Moore, R. H. Carter, P. E. Hubanks, and F. W. Poos (*J. Dairy Sci.*, 1954, **37**, 1461—1465).—The fat-corrected milk of cows receiving 0·10 and 0·75 mg. of Dieldrin (**I**) per kg. of body wt., due to feeding hay (~0·4 and 2·9 p.p.m. of **I** when fed) made from forage sprayed with 3·5 and 7·0 oz. of **I** per acre 7 days before harvesting, contained 0·7—1·0 and 1·4—2·2 p.p.m. of **I**, respectively. The concn. of **I** in the milk was 1·7—13·1 p.p.m. when 0·11 to 2·3 mg. of **I** per kg. of body wt. was administered in oil solution in capsules. **I** was excreted in the milk for >47 days after cessation of feeding in animals fed 100—1000 mg. of **I** daily. S. C. JOLLY.

Milk yield in the Egyptian cow as affected by age, dry period, and month of calving. M. T. Ragab, A. A. Asker, and S. A. Hilmy (*Indian J. Dairy Sci.*, 1954, **7**, 171—177).—Using data comprising 520 lactations of 177 cows no correlation was found between the age at first calving and milk yield at first lactation. Milk yield increased with advance in age, but at a decreasing rate, the max. milk yield being reached at the fifth or sixth lactation. Month of calving has little effect on milk yield. Correlation between dry period and lactation period was highly significant. Regression of dry period on milk yield was significant, being −0·519.

L. G. L. UNSTEAD-JOSS.

Non-protein nitrogenous constituents of milk. II. Effect of feeding high and low protein rations to cows and of putting the cows to work. V. Venkatappaiah and K. P. Basu (*Indian J. Dairy Sci.*, 1954, **7**, 213—218).—The average increase in non-protein N was 10·16 mg. per 100 ml. of milk (36·81% of the initial value) on changing the cows' rations from normal (nutritive ratio 1 : 6·7) to high (nutritive ratio 1 : 4·7) protein diets, 72% of the increase being the result of increase in urea N and 13·19% in amino-acid N. No significant differences in total and non-protein N contents were observed between milk samples from a group of cows given daily 2 lb. extra concentrate and put to light ploughing, and unworked controls.

L. G. L. UNSTEAD-JOSS.

Changes in capacity of udder of dairy cow during the course of lactation. H. G. Turner (*Aust. J. agric. Res.*, 1955, **6**, 145—160).—Seven cows were each milked at different intervals at each of several stages of lactation. The net capacity of the udder declined during lactation. The decline in " physical capacity " (volume contained at given intra-mammary pressure) and decline in max. pressure (secretion pressure), both contributed to the decline in max. yield. In early lactation, decline in secretion pressure contributed most to decline in max. yield, loss of physical capacity becoming important in late lactation. R. H. HURST.

Comparison of two methods for determining fat content in cows' milk. L. Lassota, J. Kielanowski, and I. Tabiszewska (*Roczn. Nauk rol.*, 1954, **69**, 79—89).—The Burat method, in which the casein is dissolved in a solution of borax with the addition of EtOH and amyl alcohol, although giving slightly higher results, is equal in accuracy to that of Gerber and has the advantage of being safe, simple, and cheaper to use. E. G. BRICKELL.

Nature of bacterial lipins in the rumen of hay-fed sheep. G. A. Garton and A. E. Oxford (*J. Sci. Food Agric.*, 1955, **6**, 142—148).—The lipins examined were derived from bacterial species which are found free in the rumen liquor of mature, hay-fed sheep. The ethanol-ether extract of the dried organisms consisted of : phospholipins 39·2, neutral fat 38·2, fatty acid of lower mol. wt. 12·4, unsaponifiable matter 10·1, and steam volatile neutral solid 0·1% in addition to 47% of salts of steam volatile fatty acids—acetate, propionate, etc. The true lipins amounted to 9% of the dry weight of the bacteria. The N : P ratio of the phospholipins indicated the presence of mono- and diaminophosphatides. The unsaponifiable matter contained carotenoid pigments and a steroid-like substance (16·1%) having an approx. empirical formula $C_{27}H_{48}O_2$, m.p. 130—132°, but not identical with cholesterol monohydrate. (27 references.) E. M. J.

Value of production from a clipped measured area as an index of fleece wt. F. H. W. Morley, L. W. Lockart, and E. C. Davis (*Aust. J. agric. Res.*, 1955, **6**, 91—98).—The greasy fleece wt., *W* lb., may be predicted from the equation : $W = P/110 + B_1/12$, where *P* is production of greasy wool over 11 months (mg. per sq. cm.) and B_1 is 11-months' body wt. (lb.). R. H. HURST.

Effects of ration on vitamin synthesis in rumen of sheep. L. Hollis, C. F. Chappel, R. MacVicar, and C. K. Whitehair (*J. Anim. Sci.*, 1954, **13**, 732—738).—Addition of N (soya-bean meal, urea) and maize to a ration of pasture hay for sheep increased the synthesis of riboflavin, nicotinic acid, and pantothenic acid by sheep rumen micro-organisms. Replacement of prairie hay by sorghum silage or lucerne hay did not affect the amounts of the vitamins in the rumen. With a ration containing maize cobs as the main roughage addition of lucerne ash increased vitamin synthesis. A. G. POLLARD.

Effect of lucerne ash on digestibility and utilisation of cottonseed hulls by sheep. A. D. Tillman, R. J. Sirny, and R. MacVicar (*J. Anim. Sci.*, 1954, **13**, 726—731).—With a sheep ration in which all minerals except Ca, P, Na, Cl, and S were supplied as cottonseed meal, the digestibility was improved by addition of lucerne ash. Sheep which were losing wt. on the basal ration gained after supplementation with lucerne ash. Addition of Co to the ration had no beneficial effect. A. G. POLLARD.

Fattening of wethers on sugar-beet pulp silage. K. Bieliński, A. Szyfter-Ziolecka, and Kr. Bielińska (*Roczn. Nauk rol.*, 1954, **68, B**, 218—233).—Addition of ground barley to a ration of straw hay, and sugar-beet pulp silage accelerated the fattening of the sheep and improved carcass quality but lowered the efficiency of food utilisation. The silage had no ill-effects on the health or rate of fattening of the animals when given in amounts up to 6—8 kg. per head daily. A. G. POLLARD.

Antibiotic supplements in rations for growing and fattening lambs. E. E. Hatfield, U. S. Garrigus, and H. W. Norton (*J. Anim. Sci.*, 1954, **13**, 713—725).—Inclusion of aureomycin HCl (**I**) in rations for lambs increased the mean daily gain in wt. and the feed efficiency and also improved the carcass quality. Aurofac and **I** produced similar results. Prep. of Terramycin or of diamine penicillin had no significant effects. At the rate of 7·2 mg. per lb. of ration **I** did not prevent loss of lambs from enterotoxæmia. A. G. POLLARD.

Utilisation of varied sulphur sources in urea-containing rations fed to lambs. W. W. Albert (*Dissert. Abstr.*, 1955, **15**, 3).—The effects on wt. gains and wool yields of supplementary urea, with and without added elemental S, fed to lambs on a wintering roughage of maize silage, are reported. The S requirement of growing fattening lambs is ~0·471, 1·76, and 0·638% of the ration for elemental S, SO_4'', and methionine respectively. No off-flavours were detectable in the lean or fat from lambs on a high-urea diet.

S. C. JOLLY.

Unidentified factors in swine nutrition. D. I. Gard (*Dissert. Abstr.*, 1955, **15**, 4).—The gestation–lactation performance is reported of swine on a semi-purified (fortified maize starch–isolated soya-bean protein) diet and the diet supplemented with 10% of dehydrated lucerne meal (*A*) or 3% of fish solubles (*B*). A grass-juice concentrate (*C*), dried brewers' yeast, dried whey with whey fermentation solubles, a streptomycin residue, and a " vitamin-B_{12} " concentrate, *A*, and *B* were tested as possible sources of unidentified growth factors. *C* may provide such a factor. The œstrogenic activity of *C* was approx. equiv. to 0·016 mg. of œstradiol benzoate per ml. S. C. JOLLY.

Effect of antibiotics on the intestinal and cæcal microflora of baby pigs fed a " synthetic milk." H. E. Schendel, A. F. Borg, and B. Connor Johnson (*J. Anim. Sci.*, 1954, **13**, 904—911).—In 5-week pigs given, and responding to, dietary Terramycin the no. of micro-organisms in the intestines and cæcum increased about 10-fold without any notable change in type-species.

A. G. POLLARD.

Quantitative phenylalanine requirement of the weanling pig. E. T. Mertz, J. N. Henson, and W. M. Beeson (*J. Anim. Sci.*, 1954, **13**, 927—932).—Using a semi-purified ration supplemented with DL-phenylalanine, max. growth and feed efficiency was obtained with a level of utilisable phenylalanine + tyrosine of 0·46% (tyrosine being 0·14% throughout). A. G. POLLARD.

Dehydrated potato pulp for fattening pigs. K. Bieliński and Kr. Bielińska (*Roczn. Nauk rol.*, 1954, **68, B**, 297—308).—Normal growth rates of bacon pigs were maintained when dried potato pulp or flakes was included (up to 21%) in the ration. For pigs of 40 kg. live-wt., 350 g. of dried pulp were given per head daily, this being increased up to 800 g. daily towards the end of the fattening period.

A. G. POLLARD.

Salt poisoning of pigs. G. Bohstedt and R. H. Grummer (*J. Anim. Sci.*, 1954, **13**, 933—939).—Salt-poisoning was induced by preliminary " salt-starvation " over several months followed by additional salt (1·5—2·0% of the customary swill) for several meals without provision of additional drinking water. The importance of adequate salt contents of rations at all times is stressed.

A. G. POLLARD.

Vitamin, amino-acid, and antibiotic supplementation of maize–meat by-product rations for swine. J. N. Henson, W. M. Beeson, and T. W. Perry (*J. Anim. Sci.*, 1954, **13**, 885—898).—Addition

of vitamin B_{12} or Terramycin (**I**) to a maize–meat scrap ration stimulated the growth of pigs; a combination of riboflavin, Ca pantothenate, and niacin produced greater effects. Symptoms of pantothenic acid (**II**) deficiency appeared in pigs receiving vitamin B_{12} or **I** and in those fed the unsupplemented basal ration; addition of **II** to the ration eliminated the symptoms in the latter case but only partially corrected the condition in the former. Maize–tankage rations provide sufficient lysine and methionine but are deficient in tryptophan. Meat scrap as sole protein in the ration failed to produce optimum growth. A. G. POLLARD.

Effect of penicillin and B-vitamins on growth of pigs fed different levels of protein. R. C. Wahlstrom (*J. Anim. Sci.*, 1954, **13**, 918—926).—The ration for growing pigs was supplemented with penicillin (5 mg. per lb.) or B-vitamins (riboflavin, niacin, pantothenic acid, B_{12} and choline). Both supplements separately or in combination increased the rate of gain in wt. with all levels (9—18%) of protein in the rations used. Use of B-vitamins resulted in leaner (loin) carcasses. The protein level of the supplemented rations had little influence on the rate of gain in wt. of the pigs or on feed efficiency. A. G. POLLARD.

Effects of source of protein and an antibiotic on reproductive performance in gilts. S. H. Fowler and G. L. Robertson (*J. Anim. Sci.*, 1954, **13**, 949—954).—Animal protein favoured an earlier age of puberty in gilts than did vegetable protein: there was also a tendency towards higher ovulation rates. No significant effects of chloromycetin on reproductive performance were apparent although there were indications of a favourable influence on embryo survival. Chloromycetin had no ill-effects on hæmoglobin levels. A. G. POLLARD.

Effects of bacitracin, penicillin, and arsanilic acid on growth rate and feed efficiency in swine. J. H. Bridges, F. Hall, H. O. Kunkel, and C. M. Lyman (*J. Anim. Sci.*, 1954, **13**, 912—917).—Weanling pigs were given a milo–soya-bean meal ration supplemented with bacitracin (**I**), penicillin (**II**), and arsanilic acid (**III**) singly or in combination. Feed efficiency was significantly increased by **III** alone, **II** alone, **I** + **III** and **I** + **II**. After administration of **III** the accumulation of As in the liver was considerably greater than that in the kidneys or muscle; the accumulation in liver disappeared about five days after cessation of feeding **III**. A. G. POLLARD.

Effect of three levels of a new antibiotic, tetracycline, in a swine ration. D. J. Horvath and G. W. Vander Noot (*J. Anim. Sci.*, 1954, **13**, 899—903).—Tetracycline (10·8—19·2 g. per ton of feed) lowered the amount of food required to produce unit gain in live wt. but did not increase the rate of gain in wt. of pigs. The optimum dosage was 15 g./ton of feed. A. G. POLLARD.

Effect of adding penicillin to the ration of Large White piglets suffering from cold. M. Stolzman (*Roczn. Nauk rol.*, 1954, **68, B**, 409—415).—Oral administration of 100 i.u. of non-cryst. penicillin daily to pigs of 2½—3 months until reaching the bacon stage diminished mortality due to colds and induced normal rates of growth. Similar treatment of healthy animals did not produce any increase in growth rate. A. G. POLLARD.

Hay as a food for swine. S. Seidler (*Roczn. Nauk rol.*, 1954, **69**, 105—128).—Tabular data are presented and discussed. E. G. BRICKELL.

Sweet lupin seed in swine feeding. S. Seidler (*Roczn. Nauk rol.*, 1954, **69**, 129—151).—Chemical composition, nutritive value, and methods of removal of poisonous matter are detailed for various lupins. The seed is a highly valuable food and can replace approx. ⅔ of the animal protein of the ration. E. G. BRICKELL.

Antibiotics in swine rations. J. Lasley, L. F. Tribble, and A. G. Hogan (*Missouri agric. Exp. Sta.*, 1954, *Res. Bull.* 543, 55 pp.).—Addition of aureomycin, penicillin, streptomycin, or chloromycetin to a maize–soya-bean meal ration increased wt. gains and feed efficiency of pigs in dry-lot. Aureomycin was the most effective of the treatments. Aureomycin and penicillin additions had little effect on growth rate, but improved feed efficiency, when added to a maize–tankage ration or to a maize–soya-bean meal ration of pigs on rape or rye pasture. A. H. CORNFIELD.

Impaired reproduction in the rabbit fed supplemented diets containing soya-bean hay. K. H. Kendall, R. L. Hays, and G. D. Rolleri (*J. Anim. Sci.*, 1954, **13**, 859—866).—The sterility syndrome found in rabbits given a soya-bean hay–wheat ration was not alleviated by supplements of DL-methionine, carotene, α-tocopherol, 2-methyl naphthaquinone, vitamin A, progesterone, vitamin B_{12}, choline, or steamed bone meal. Affected animals showed normal levels of plasma-tocopherol and liver- and plasma-vitamin A. Autoclaving soya-bean hay at 120° for 30 min. did not prevent the syndrome. A. G. POLLARD.

Energy requirement for maintenance of adult hens. S. Eriksson (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 385—388).—For non-laying Rhode Island Red hens the maintenance requirement for metabolisable energy was 160 kg.-cal. per bird daily at 20°, and a body wt. of 2·0 kg. At 15° the requirement was about 12% higher. R. H. HURST.

Effect of plane of nutrition on growth and sexual development of Barred Plymouth Rock cockerels. J. M. Fransen, F. N. Andrews, and C. W. Carrick (*Poultry Sci.*, 1955, **34**, 205—209).—The comparative effects of an "old"-type ration (as used in 1937 and having maize, wheat bran, wheat middlings, and meat and bone meal as the main ingredients) and a "new"-type ration (having as main ingredients maize, soya-bean oil meal, maize gluten meal, condensed fish solubles, and various vitamins) on growth and development of cockerels to 10 weeks of age were studied. Growth rate, feed efficiency, testis wt., and comb wt. were greater with the new- than with the old-type ration. At four and six weeks of age seminiferous tubule diam. was greater and stage of spermatogenesis was more advanced with the new- than with the old-type ration. Body, comb, and testis wt. were significantly correlated with each other. A. H. CORNFIELD.

Unsuitability of the chick weight : egg weight ratio as an indicator of post-natal growth. G. F. Godfrey and C. Williams (*Poultry Sci.*, 1955, **34**, 164—166).—The ratio chick wt. at hatch : egg wt. was of no value in predicting body wt. of the birds at 12 weeks of age. A. H. CORNFIELD.

Pellets *vs.* mash plus pellets *vs.* mash for broiler feeding. R. K. Lanson and J. R. Smyth (*Poultry Sci.*, 1955, **34**, 234—235).—Wt. gains and performance and feed efficiency were better over 4—10 weeks of age when broilers were fed a pelleted mash than when fed ordinary mash or mash + pellets. A. H. CORNFIELD.

Animal fat in combination with various other ingredients in broiler rations. T. D. Runnels (*Poultry Sci.*, 1955, **34**, 140—144).—Addition of 3% of animal grease, 1·5% of dried sardine fish solubles, 6% of condensed hydrolysed whey, and 2·5% of dehydrated lucerne meal singly or in all possible combinations to a maize–soya-bean oil meal diet had no significant effect on growth rate of male birds to 10 weeks of age. The addition of animal grease improved, whilst the other additives had no effect on, feed efficiency. A. H. CORNFIELD.

Breed and strain differences in shank pigmentation in growing chickens. W. M. Collins, S. C. Thayer, and W. C. Skoglund (*Poultry Sci.*, 1955, **34**, 223—228).—Shank colour of New Hampshires was darker than that of White Plymouth Rocks. There were differences in shank colour between strains within a breed, as well as between sexes. Environment markedly influenced shank colour. A. H. CORNFIELD.

Influence of protein source on consumption and excretion of water voided by broiler chickens. H. Patrick (*Poultry Sci.*, 1955, **34**, 155—157).—The wt. of droppings per unit of feed supplied increased with the protein content of the diet, and was not related to feed efficiency. The water requirement of broilers was increased by adding some types of protein (meat scraps, soya-bean oil meal) and reduced by adding others (fish meal, casein) to the diet. A. H. CORNFIELD.

Effect of arginine and glycine on the growth of chicks receiving complete, purified diets. W. J. Monson, A. E. Harper, D. A. Benton, M. Winje, and C. A. Elvehjem (*Poultry Sci.*, 1955, **34**, 186—190).—Chicks fed synthetic diets containing sucrose and various levels of casein grew more rapidly during the first 2—3 weeks when the gelatin of the diets (10%) was replaced with 1·6% arginine + 1·5% glycine. No significant growth improvement was obtained at four weeks when the arginine + glycine were added in the presence of 5—10% gelatin. When an antibiotic mixture was included in the sucrose diets or when the sucrose was replaced by dextrin, gelatin supported growth as good as or better than did arginine + glycine. A. H. CORNFIELD.

Effect of added methionine in broiler diets containing high levels of fish meal. H. R. Rosenberg, J. Waddell, and J. T. Baldini (*Poultry Sci.*, 1955, **34**, 114—117).—Addition of 0·05% of methionine to starter rations containing 5—15% of fish meal improved the growth of chicks even though the basal rations contained apparently adequate (National Research Council allowances) amounts of bound sulphur NH_2-acids. The improvement due to methionine addition was greatest where 15% of fish meal was present in the diet. Increasing the level of fish meal did not affect growth rate but improved feed efficiency. A. H. CORNFIELD.

Level of protein in the diet of laying White Leghorns during hot weather. B. W. Heywang, H. R. Bird, and M. G. Vavich (*Poultry Sci.*, 1955, **34**, 148—152).—Egg production and feed consumption of birds during hot weather (average mean temp. 31·1°) over 112 days were of the same order with diets containing 13·0 to 19·3% protein; both factors were reduced when only 11·5% protein was

supplied. In another test where a period of hot weather was preceded by a relatively cool period, 15% of protein in the diet was adequate for optimum egg production during both periods. A. H. CORNFIELD.

Response of chicks to graded concentrations of cane final molasses. M. M. Rosenberg (*Poultry Sci.*, 1955, **34,** 133—140).—The optimum level of cane final molasses, as determined by growth rate and cost of feed per lb. of gain, in the diet of 1—42-day-old birds ranged from 7·5% to 23·0%, although a 34·5% level could be fed safely. Feed efficiency decreased with increasing level of cane final molasses in the feed, but livability was not affected. A. H. CORNFIELD.

Irradiated fodder yeast in autumn and winter feeding of laying hens. K. Gawęcki and T. Ponikiewska (*Roczn. Nauk rol.*, 1954, **68, B,** 253—270).—No beneficial effects followed the irradiation of yeast included in the ration of laying hens. Use of fodder yeast (10% of the ration), even without supplementation with cod-liver oil, resulted in normal laying. A. G. POLLARD.

High-efficiency rations for poultry. R. W. Gerry (*Maine agric. Exp. Sta.*, 1954, *Bull.* 523, 26 pp.).—High-efficiency rations (containing a relatively high proportion of ground yellow maize and having a low fibre content) fed throughout the rearing season gave greater returns than did conventional low-efficiency rations. Egg production and egg size were similar with either type of ration, but feed efficiency with respect to egg production was greater with the high-efficiency ration. Mortality during growing and laying was slightly lower with the high-efficiency rations and the litter in the pens of birds receiving this type of ration was drier than where low-efficiency rations were given. A. H. CORNFIELD.

B-grade molasses in starter, grower, and layer rations for chickens. M. M. Rosenberg (*Hawaii agric. Exp. Sta.*, 1954, *Bull.* 109, 26 pp.).—Satisfactory performance of chicks, growing cockerels, and laying pullets was obtained when all the cereal grain in the feed was replaced by B-grade molasses. 46% of a starter ration, 54% of a grower ration, and 62% of a layers' ration could be provided by B-grade molasses. Feed efficiency decreased with increasing level of molasses in the feed. Addition of 4·5—9·0% of bagasses pith to a diet reduced the growth rate of chicks and young cockerels. A. H. CORNFIELD.

Milo in egg-laying rations. L. N. Berry (*New Mexico agric. Exp. Sta.*, 1954, *Bull.* 392, 13 pp.).—White or red milo could replace a maize–wheat–oats scratch grain without reduction in egg production. When milo replaced yellow maize in a mash extra vitamin A was required for optimum growth. Where cannibalism is a problem oats should not be replaced by milo. A. H. CORNFIELD.

Influence of irradiated yeast on hatchability of eggs from hens of different breeds. K. Gawęcki, M. Neuman, and T. Ponikiewska (*Roczn. Nauk rol.*, 1954, **68, B,** 475—488).—Irradiation of the yeast used in hen rations did not affect the fertilisation of the eggs but increased the % of fertile eggs which hatched. A. G. POLLARD.

Effect of nettle meal on egg production and hatchability. G. Znaniecka, J. Wodzinowski, H. Ciechanowska, H. Korzeniewska, and H. Węckowicz (*Roczn. Nauk rol.*, 1954, **68, B,** 271—281).—Replacement of lucerne meal by an equal wt. of nettle meal in a layers' ration for hens did not increase egg production, slightly lowered the average wt. per egg but markedly increased the live-wt. of the hens. The fertility of the eggs was unaffected but hatchability was improved by the nettle meal. A. G. POLLARD.

Phosphorus requirements of growing chickens and laying pullets fed practical rations. W. F. O'Rourke, P. H. Phillips, and W. W. Cravens (*Poultry Sci.*, 1955, **34,** 47—54).—Chickens fed rations in which the P level was varied by addition of bone meal or $CaHPO_4$ required for normal growth at least 0·73% of P to 3 weeks and 0·6% from 4—10 weeks of age and not more than 0·42% from 10 weeks of age to sexual maturity. The 0·35% of P in the basal diet, although inadequate for max. growth, was sufficient to maintain the normal date of first egg and egg production. A. H. CORNFIELD.

Effect of free gossypol on chick growth. J. R. Couch, W. Y. Chang, and C. M. Lyman (*Poultry Sci.*, 1955, **34,** 178—183).—Addition of up to 0·06% of free gossypol (as pigment gland) to chicks' diets had no effect on growth rate, mortality, or feed efficiency. Growth rate and mortality increased and feed efficiency decreased as the gossypol content of the diet increased above 0·06%. Addition of 1% of lysine hydrochloride increased growth rate at all levels of gossypol, but did not alter the level of tolerance to gossypol. A. H. CORNFIELD.

Meat yield from live, dressed, and eviscerated Rhode Island Red chickens during growth and at maturity. E. H. McNally and N. H. Spicknall (*Poultry Sci.*, 1955, **34,** 145—148).—The interrelationships between the wts. of live, dressed, and eviscerated chickens and meat yields for pullets 10—16 weeks of age and for cocks and hens 38 weeks of age are reported. A. H. CORNFIELD.

Calculation of the moisture and protein contents of market chickens from their fat content. E. H. McNally (*Poultry Sci.*, 1955, **34,** 152—155).—The relationships between the fat content and the crude chemical composition (moisture, protein, and ash contents) of the breast and leg muscles and total edible meat of poultry flesh are presented. The crude chemical composition of the total edible meat and of the leg muscle can be forecast with a fair degree of accuracy from a knowledge of their fat content. A. H. CORNFIELD.

Fat studies in poultry. III. Folic acid and fat tolerance in the chick. B. E. March and J. Biely (*Poultry Sci.*, 1955, **34,** 39—44).—The chick is able to tolerate a higher level of fat than is normally present in practical diets. Addition of fat to standard chick diets improved both growth and feed efficiency, but also increased the folic acid requirements of the birds. The depressing effect on growth arising from addition of over-heated herring oil to a folic acid-deficient diet was overcome by adding extra folic acid. There was no evidence that folic acid aided fat adsorption or had a lipotropic effect. A. H. CORNFIELD.

Unidentified growth factor in grass juice required by chicks and poults. L. S. Jensen (*Dissert. Abstr.*, 1955, **15,** 5).—The properties and concentration of the unidentified growth factor(s) in grass juice are reported. Marked growth responses were obtained with certain fractions contributing as little as 30 mg. to 100 g. of diet. A growth inhibitor is also present in the juice. A complete mutual sparing action between the juice and an antibiotic occurred with turkeys on a diet of crude feeding stuffs; no such action occurred with chicks on a semi-purified diet. The requirements of turkeys for methionine and of chicks for arginine were reduced by diets containing grass juice. Chicks require <3 different unidentified growth factors. Grass juice is a potent source, dried whey a variable source, and dehydrated lucerne meal a poor source, of one factor. S. C. JOLLY.

Nicotinic acid and tryptophan metabolism in the chick. Hans Fisher (*Dissert. Abstr.*, 1955, **15,** 3—4).—The major urinary metabolites of nicotinic acid (**I**) were **I** and nicotinamide. The L-tryptophan requirement was met by 0·15% of the diet, at which level **I** requirement was 2·5—10 mg. per 100 g. depending on the presence of certain stress factors. In the absence of stress factors, 0·20% of L-tryptophan completely spared the **I** requirement, but larger amounts are necessary in presence of supplementary amino-acids or maize. Small amounts of histidine, leucine, and threonine increased the **I** requirement for perosis prevention. There was no correlation between liver-pyridine nucleotide (**II**) level and growth rate. At equimol. levels **I** was more efficient than was L-tryptophan in increasing **II** storage. Glycine did not decrease growth rates when added at 4% level to diets already containing <1—1·5%, but it increased feed utilisation, especially in young birds. S. C. JOLLY.

Homocystine, vitamin B_{12}, choline, and methionine in the nutrition of the laying fowl. B. E. Welch and J. R. Couch (*Poultry Sci.*, 1955, **34,** 217—222).—Addition of vitamin B_{12} (50 μg.) or homocystine (6 g. per kg. of feed) to the diet of laying hens had no effect on, whilst addition of both supplements together improved, egg production. Addition of choline (2 g. per kg. of feed), alone or with vitamin B_{12}, increased egg production only when homocystine was also added. This increase was similar to that obtained when methionine (6 g. per kg. of feed) was added. Highest egg production was obtained when vitamin B_{12} + choline + methionine were added. The effects of the treatment on the vitamin B_{12} content of the hen's liver and egg yolk and on the methionine content of the plasma are reported. Homocystine is probably methylated in the bird's body to form methionine; vitamin B_{12} probably plays an important part in this process. A. H. CORNFIELD.

Effect of additions of vitamin B_{12}, DL-methionine, and procaine penicillin, singly and in combination, to maize–soya-bean diets for young growing chicks. H. W. Titus, J. H. Brumbaugh, and A. L. Mehring, jun. (*Poultry Sci.*, 1955, **34,** 167—177).—Addition of vitamin B_{12} (10 μg. per lb.) or procaine penicillin (0·0025 g. per lb. of feed) to a "high soya-bean" (46% soya-bean meal) diet increased wt. gains and feed efficiency of chicks to four weeks of age. Addition of 0·05% of DL-methionine had no effect on feed efficiency of males or females or on wt. gains of males, but decreased the wt. gains of females. Addition of either purified or feeding-grade methionine at the 0·05% level to a diet containing 35% of soya-bean meal had no effect on wt. gains or feed efficiency of either males or females in absence of added penicillin, but slightly increased wt. gains of females when penicillin (0·00125 g. per lb. of feed) was supplied. The penicillin addition had no effect on wt. gains or feed efficiency. A. H. CORNFIELD.

Vitamin K activity in vitamin B_{12}-antibiotic supplements. P. Griminger, W. D. Morrison, and H. M. Scott (*Poultry Sci.*, 1955, **34,** 243—245).—Two out of six commercial vitamin B_{12}-antibiotic supplements tested were as effective as was Klotogen F (vitamin K) in

promoting normal blood-clotting times of chicks fed vitamin K-deficient diets. A. H. CORNFIELD.

Antibiotics and nitrogen utilisation in growing cockerels. R. H. Thayer and V. G. Heller (*Poultry Sci.*, 1955, **34,** 97—102).—Addition of penicillin or aureomycin (0·02 g. per lb. of feed) to the diet of cockerels from four to eight weeks of age increased the % of dietary protein-N retained by the birds. A. H. CORNFIELD.

Antibiotics in chick starter rations. A. L. Palafox and M. M. Rosenberg (*Hawaii agric. Exp. Sta.*, 1954, *Tech. Bull.* 25, 16 pp.).—Both Terramycin and a combination of aureomycin and vitamin B_{12} improved the growth of male, but not of female, chicks when added to a soya-bean–fish starter ration. Penicillin, Terramycin, and vitamin-B_{12} did not improve the growth of chicks fed a soya-bean basal diet. Growth on an all-vegetable diet containing 36% of soya-bean oil-meal was improved by adding vitamin B_{12} together with Terramycin, aureomycin, or penicillin. Feed efficiency was improved when antibiotics and vitamin B_{12} were added to all-vegetable diets or diets containing animal protein. A. H. CORNFIELD.

Basal metabolism of chicks as affected by aureomycin. W. D. Morrison, T. S. Hamilton, and H. M. Scott (*Poultry Sci.*, 1955, **34,** 78—81).—Addition of aureomycin (0·015 g. per kg. of feed) to the diet of chicks had no effect on their basal metabolism. A. H. CORNFIELD.

Relative non-toxicity of diphenyl-*p*-phenylenediamine to chicks when fed continuously for 12 weeks at the 1% level. L. D. Matterson, L. M. Potter, A. Kozeff, and E. L. Jungherr (*Poultry Sci.*, 1955, **34,** 239—240).—Addition of 1% diphenyl-*p*-phenylenediamine (80 times the recommended dosage) to chick diets over 12 weeks had no deleterious effect on growth. Although there were small quant. changes in the liver and in the Purkinje cells of the cerebellum, there were no major evidences of toxicity. A. H. CORNFIELD.

Failure of chickens to respond to arsanilic acid. M. W. McDonald (*Poultry Sci.*, 1955, **34,** 55—56).—Addition of arsanilic acid (4·5 g. per 100 lb. of feed) to a wheat–meat meal type diet had no effect on growth or feed efficiency of pullets to 35 days of age either in the absence or presence of added penicillin. Addition of penicillin (0·16 g. per 100 lb.) improved growth and feed efficiency both in the absence and presence of added arsanilic acid. A. H. CORNFIELD.

Effect of quaternary ammonium derivatives on chick growth. S. L. Balloun (*Poultry Sci.*, 1955, **34,** 191—196).—Addition of any one of four alkyl quaternary ammonium derivatives (trimethyl-octadecylammonium dodecyl sulphate, etc.) to the feed consistently improved the growth rate of chicks to eight weeks of age in an "old", but not in a "new", environment. Feed efficiency was improved in both environments. The best growth responses were obtained when the materials were supplied at a low level (0·035—0·050 g. per lb.) initially, followed by a high level (0·075—0·150 g. per lb. of feed) during the later stages of growth. A. H. CORNFIELD.

Effects of cortisone on the White Leghorn cockerel and capon. W. E. Dulin (*Poultry Sci.*, 1955, **34,** 73—77).—Wt. gains of cockerels were not affected by daily subcutaneous injections of cortisone (100—1000 μg.) from 20 to 40 days of age. Wt. gains of capons were reduced in proportion to the dosage given. The treatments reduced testis growth of cockerels and increased comb growth of capons, but did not affect pituitary wt., gonadotrophic potency, or adrenal wt. of either type of bird. Cortisone injections prevented adrenal enlargement resulting from epinephrine injections. A. H. CORNFIELD.

Interactions of the gonadal hormones in the chicken. J. L. Adams and R. B. Herrick (*Poultry Sci.*, 1955, **34,** 117—121).—Growth rate of male birds from 6 to 11 weeks of age was depressed by diethylstilbœstrol (**I**) + testosterone (**II**) (both as 0·015-g. pellets implanted subcutaneously) and by **I** + progesterone (**III**) (0·002 g. every 3·5 days). **I** + **II** improved the growth rate of capons. None of the materials, either singly or in two-way combinations, affected the growth rate of females. A synergistic interaction between **I** and both **II** and **III** occurred with respect to oviduct wt. of females. Antagonistic interactions occurred between **I** and **II** with respect to comb wt. of males. None of the treatments affected testes wt. **III** alone had no effect on female mating behaviour, but augmented the effect of **I**. A. H. CORNFIELD.

Presence of *Salmonella* and other enteric organisms in prepared poultry feeds. L. E. Erwin (*Poultry Sci.*, 1955, **34,** 215—216).—Of 206 samples of commercially-prepared poultry feeds examined by culture methods 60% of the mash samples, 25% of the pelleted samples, 15% of the granulated samples, and 61% of the concentrate samples yielded *Salmonella* and other enteric organisms. A. H. CORNFIELD.

Serological studies on egg production in the fowl. I. Locus of serum-vitellin production. T. Hosoda, T. Kaneko, K. Mogi, and T. Abe (*Poultry Sci.*, 1955, **34,** 9—15).—Injections of œstrogen into normal, ovariectomised, and splenectomised birds followed by serum-vitellin reaction tests indicated that the liver is the locus of serum-vitellin production. Neither the ovary nor the spleen produce serum-vitellin. A. H. CORNFIELD.

Influence of oxygen concentration on hatchability and on selecting for hatchability. George T. Davis (*Poultry Sci.*, 1955, **34,** 107—113).—A higher % of hatchability was obtained at high altitude (7200 ft.) when the air in the incubator was supplemented with O_2 than when no extra O_2 was supplied. Genetic improvement in hatchability resulted in the line where successive hatches were made without O_2 supplementation, but not in the line receiving extra O_2. The improvement was due to natural selection and to higher heritability of hatchability in the unsupplemented line. A. H. CORNFIELD.

Breeding for egg quality. III. Genetic differences in shell characteristics and other egg quality factors. G. M. Farnsworth, jun. and A. W. Nordskog (*Poultry Sci.*, 1955, **34,** 16—26).—There were significant differences between years, over four years, in shell thickness, yolk colour, and shell colour for eggs from White Leghorns. There were significant differences between breeds in egg wt., shell thickness, and albumin height in one year, in shell texture in two years and in shell colour in three years. There were significant differences between lines for most of the characteristics measured in either one or two years. Considerable improvements in egg wt., yolk colour, albumin height, shell thickness, and shell colour are possible by mass selection. A. H. CORNFIELD.

Relationship between discolorations in eggs and dietary free gossypol supplied by different cottonseed products. B. W. Heywang, H. R. Bird, and A. M. Altschul (*Poultry Sci.*, 1955, **34,** 81—90).—Both the % of eggs with discoloured yolks and the degree of yolk discoloration increased with the free gossypol content (0·001—0·008%) of the diet of the dams. Both factors increased with the length of time the eggs were in cold storage. The effects of gossypol were not so severe when it was supplied in solvent-extracted cottonseed meal as when it was supplied in raw decorticated cottonseed, or screw-press, hydraulic, or pre-press solvent-extracted cottonseed meal. The % of eggs with pink albumin increased with the length of time the eggs were in cold storage. The factor(s) causing pink albumin was related to the free gossypol content of raw cottonseed and of screw-press and hydraulic cottonseed meals. A. H. CORNFIELD.

Distribution of radioactive phosphorus in the electrophoretic components of egg yolk proteins. R. E. Clegg, R. E. Hein, C. H. Suelter, and R. H. McFarland (*Poultry Sci.*, 1955, **34,** 210—214).—Electrophoretic patterns of solutions of yolk proteins in borate–citrate (pH 7·5) and glycine–phosphate (pH 9·4) buffers are presented. The distribution of P in the electrophoretic components of yolk protein was studied by supplying the hens with labelled P. A. H. CORNFIELD.

Calcium and phosphorus metabolism and egg shell formation in Egyptian birds. H. Salem and H. Reda (*Poultry Sci.*, 1955, **34,** 197—205).—The daily retention of Ca (intake minus droppings) by laying birds was inversely related to the daily intake of Ca. When dietary Ca was in excess blood-Ca was slightly depressed and retention of P was reduced. Blood-Ca was high during shell formation and low when the shell was complete. Blood-P was particularly high on days eggs were laid. Administration of diethylstilbœstrol increased the mean blood-Ca level, but had no effect on the blood-P level. A. H. CORNFIELD.

Effect of No. 2 tallow in poultry rations on the flavour of fresh and stored eggs. D. S. Carver, E. E. Rice, R. E. Gray, and P. E. Mone (*Poultry Sci.*, 1955, **34,** 131—132).—The colour of the yolk and the flavour of fresh eggs or of eggs stored for 1—2 months was not affected by inclusion of 3% of No. 2 tallow (feeding grade) in the hen's diet. A. H. CORNFIELD.

Crude fibre digestion in 12-week-old turkeys. H. Dymsza, R. V. Boucher, and M. G. McCartney (*Poultry Sci.*, 1955, **34,** 240—242).—A 5-day digestion trial with 12-weeks-old turkeys showed that they had a negligible ability to digest the fibre of diets containing 5—15% of fibre. A. H. CORNFIELD.

Duration of fertility and hatchability following natural matings in turkeys. E. B. Hale (*Poultry Sci.*, 1955, **34,** 228—233).—Although the average duration of fertility of turkey hens' eggs was 43 days (range 7 to 62 days) matings at intervals of not more than four weeks are necessary for max. fertility. Hatchability of fertile eggs remained at approx. the same level for seven weeks after mating and then decreased rapidly to zero over the next two weeks. There were seasonal declines in fertility and hatchability independent of mating. A. H. CORNFIELD.

Pantothenic acid requirement of turkey hens. F. H. Kratzer, P. N. Davis, B. J. Marshall, and D. E. Williams (*Poultry Sci.*, 1955, **34**, 68—72).—Turkey hens required 0·016 g. pantothenic acid (**I**) per kg. of diet to produce eggs of high hatchability. Hatchability was reduced, although egg production was unaffected, when the dam received lower levels of **I**. The % of **I** in eggs and the survival of poults from birds deficient in **I** were directly related to the level of **I** in the diet of the dams. Embryos, from birds receiving a diet deficient in **I**, which failed to hatch were smaller than normal and showed wiry-down symptoms. A. H. CORNFIELD.

Value of pasture in the production of goose broilers. E. S. Snyder, W. F. Pepper, S. J. Slinger, and H. L. Orr (*Poultry Sci.*, 1955, **34**, 35—38).—Goslings reared in confinement from 3 to 14 weeks of age on a pelleted mash-grain diet showed better wt. gains and higher market quality, but consumed much more mash and showed lower feed efficiency, than did comparable birds which had access to pasture during the period. A. H. CORNFIELD.

Influence of feed on the quality of fat in geese. M. Chomyszyn (*Roczn. Nauk rol.*, 1954, **69**, 91—104).—Geese were fed exclusively on barley during the preparatory stage, then for 16 days with the addition of 40 c.c. of rape-seed oil daily and lastly for 12 days only with barley. Qualitative changes of the reserve fat in such factors as iodine val., *n*, m.p., consistency, and odour were noted up to eight days after the change of feed. E. G. BRICKELL.

Effect of penicillin on the growth of pheasants. H. G. Jukes, D. C. Hill, and H. D. Branion (*Poultry Sci.*, 1955, **34**, 235—236).—Addition of procaine penicillin *G* (10 p.p.m.) to the diet of pheasants from 0 to 4 weeks of age increased wt. gains by 13% over the control group and slightly improved feed efficiency. There was a lower incidence of a leg weakness defect in birds given the antibiotic. A. H. CORNFIELD.

Milk fever in dairy cows. IV. Prevention by short-time prepartum feeding of massive doses of vitamin D. J. W. Hibbs and W. D. Pounden (*J. Dairy Sci.*, 1955, **38**, 65—72).—Feeding 30 million units of vitamin D daily for $\leqslant 3$ and $\geqslant 7$ days prepartum and 1 day postpartum effectively prevented the occurrence of milk fever in dairy cows. The min. effective dosage has not been determined. The physiological basis for the maintenance of high blood serum-Ca and -P levels by this treatment is discussed. S. C. JOLLY.

Sorbitol metabolism in alloxan-diabetic animals as compared with fructose and glucose. A. N. Wick, Toshiko N. Morita, and H. N. Barnet (*Food Res.*, 1955, **20**, 66—70).—The glucose and fructose used were uniformly labelled with ^{14}C and the sorbitol was prepared by the reduction of the labelled glucose. The rate of oxidation of sorbitol, fructose, and glucose, judged by the appearance of the orally administered ^{14}C in the expired air, was examined in alloxan-diabetic rats. On a diet containing 68% of sucrose, 50% of the administered sorbitol and fructose C was recovered in expired air, whereas for glucose 26% of the ingested ^{14}C was oxidised. Maintained on a 68% fructose diet, fructose was no better oxidised than was glucose, but the oxidation of sorbitol was not reduced. The evaluation of alternate pathways of oxidation of sorbitol and fructose is discussed. (15 references.) E. M. J.

Deutectomy of newly-hatched chicks, and the effects of the operation on their development. J. D. Harvey, D. B. Parrish, and P. E. Sanford (*Poultry Sci.*, 1955, **34**, 3—8).—Modifications in the technique of deutectomy of newly-hatched chicks are described. Survival after the operation ranged from 80 to 100% of the controls for a no. of experiments. The operation slightly reduced growth and feed efficiency and consumption during the first two weeks, but not from 3 to 8 weeks of age, in comparison with controls. A. H. CORNFIELD.

Case of paired oviducts in the chicken. L. R. Champion (*Poultry Sci.*, 1955, **34**, 184—186).—Characteristics of this unusual anatomical peculiarity are described. A. H. CORNFIELD.

Heritable crippling anomaly in the fowl. G. V. Morejohn (*Poultry Sci.*, 1955, **34**, 64—67).—Characteristics of the anomaly, which is inheritable, are described. A. H. CORNFIELD.

Tumour incidence in the progeny of hens repeatedly injected as adults with visceral lymphomatosis virus. R. F. Gentry and B. R. Burmester (*Poultry Sci.*, 1955, **34**, 44—47).—The occurrence of visceral lymphomatosis among 70 progeny hatched from eggs laid during a 5-week period when the dams received 28 intravenous injections of the virus of this disease was no greater than among 77 progeny of the same dams from eggs laid prior to the injection period. A. H. CORNFIELD.

Comparative resistance of imported standard breeds and native Egyptian strains of poultry to *Ascaridia galli*. W. M. Reid (*Poultry Sci.*, 1955, **34**, 30—35).—In Egypt native breeds of poultry showed no greater resistance to infection, when inoculated with *A. galli*, than did Barred Plymouth Rocks or Rhode Island Reds. The size and no. of worms found were similar in both native and imported breeds. A. H. CORNFIELD.

***In vitro* action of various chemical agents on *Trichomonas gallinæ*.** Y. Samberg and S. Bornstein (*Poultry Sci.*, 1955, **34**, 157—164).—Of 30 chemicals tested *in vitro*, Brilliant green, chinosol, and trypaflavine had high trichomonostatic action at high dilution (1 : 20,000—50,000) indicating that they may be useful for treating the drinking water of pigeons so as to prevent or even cure trichomoniasis. 0·1% $CuSO_4$, 0·5% HCl, 10% Lugol's solution, and 0·02% $HgCl_2$ should be useful for treating affected birds, whilst 10% "Ama," 0·2% chloramine, 0·03% HCHO, 1% "Hexalon," 2% lysol, and 0·05% NaOH should prove useful as general disinfectants of birds' living quarters. A. H. CORNFIELD.

Electron microscopy of erythrocytes from chickens affected with chronic respiratory disease. R. L. Reagan, J. E. Porter, E. C. Delaha, S. R. Cook, and A. L. Brueckner (*Poultry Sci.*, 1955, **34**, 103—106).—Electron micrographs of blood samples from chickens (naturally infected with chronic respiratory disease) showed the presence of X-body agents of chronic respiratory disease on and at a distance from the erythrocytes only when samples were taken 12 days after the symptoms appeared. A. H. CORNFIELD.

Dangers of using inorganic antimony salts to produce fattened livers in poultry. R. Fabre, R. Truhaut, S. Laham, and L. Vallery (*Ann. pharm. franç.*, 1954, **12**, 698—700).—Feeding a goose with pills containing vitamin D, $FeCO_3$ and Sb_2S_3 led to the presence of 3·8 mg. of Sb per 100 g. of liver. The danger of such pills in relation to the consumption of foie gras and the flesh of animals fed with such pills is discussed. E. J. H. BIRCH.

Control of the northern feather mite, *Bdellonyssus sylviarum*, on chickens in cages and on litter. S. A. Edgar and B. D. McAnnally (*Poultry Sci.*, 1955, **34**, 91—96).—Of 12 materials tested on dry litter S (two applications of 4 lb. per 100 sq. ft.) gave the best control of the mite on laying hens. For control of the pests on birds in wire cages two sprayings with 16% nicotine sulphate (2·5 ml. per bird) or one spraying with 1% toxaphene (2—4 ml. per bird) gave the best results. None of the materials tested appeared to affect the performance of the hens. A. H. CORNFIELD.

The fowl tick. Anon. (*U.S. Dep. Agric.*, 1955, *Leafl.* 382).—*Argas persicus* is described. 0·5% lindane, toxaphene, or chlordane, or 5% DDT, as a spray, gives control. E. G. BRICKELL.

Control of hæmorrhagic condition in chickens with menadione sodium bisulphite. D. V. Frost and H. C. Spruth (*Poultry Sci.*, 1955, **34**, 56—64).—Addition of arsanilic acid (90—450 g.) or sulphaquinoxaline (270 g. per ton of feed) to vitamin K-deficient chick diets did not reduce the long blood-clotting time. Addition of menadione sodium bisulphite (0·5 g. per ton of feed) reduced blood-clotting times to normal. Menadione sodium bisulphite was four times as potent as was menadione in reducing blood-clotting times. Addition of 0·1% sulphaquinoxaline to a vitamin K-deficient diet greatly increased the requirement for the vitamin. A. H. CORNFIELD.

House fly control in dairies near Savannah, Georgia, with residual applications of CS-708, NPD, and Malathion. J. W. Kilpatrick and H. F. Schoof (*J. econ. Ent.*, 1954, **47**, 999—1001).—Residual deposits from CS-708–cottonseed oil emulsions, alone and with DDT, gave eight weeks of excellent fly control. Emulsions of Malathion (2·5 and 5%) with a sugar additive gave good fly control for 1—3 weeks, but a Malathion suspension gave relatively poor results : in general, the duration of residual effectiveness of this material was erratic. NPD (tetra-*n*-propyl dithionopyrophosphate) was inferior to CS-708 as a residual treatment but was about equal in effectiveness to Malathion. A. A. MARSDEN.

Use of wettable powder or emulsion formulations compared with mineral seal oil on calves. W. G. Hoekstra, R. J. Dicke, and P. H. Phillips (*J. econ. Ent.*, 1954, **47**, 1144—1145).—Methoxychlor, lindane, and pyrethrin–sulphoxide sprays had no adverse effects on calves, even when applied in excess of normal practice. Sprays of mineral seal oil produced a definite hyperkeratosis (thickened skin) along the neck and shoulders of calves. Appetite and growth were not greatly retarded but a slight transitory depression in blood plasma-vitamin A occurred upon application of this oil. A. A. MARSDEN.

Effectiveness and limitations of home-made self-treatment rubbing devices for louse control on cattle. R. A. Hoffman (*J. econ. Ent.*, 1954, **47**, 1151—1153).—The self-application methods described using DDT, toxaphene, chlordane, and methoxychlor (5% solutions) gave good practical control of lice (*Bovicola bovis* and *Linognathus vituli*) under favourable conditions. However, this method is not considered to be a satisfactory substitute for spraying or dipping. Only methoxychlor is recommended for use on cows in milk. A. A. MARSDEN.

Bacterial oxidation of arsenite. I. Description of bacteria isolated from arsenical cattle-dipping fluids. A. W. Turner (*Aust. J. biol. Sci.*, 1954, **7**, 452—478).—Characteristics, taxonomy, and some factors influencing arsenite-oxidising activity, are described for some 15 strains of bacteria. They are regarded as constituting five species, three in the genus *Pseudomonas* and the others in *Xanthomonas* and *Achromobacter*. E. G. BRICKELL.

2.—FOODS

Commercial methods of parboiling paddy and improving the quality of parboiled rice. V. Subrahmanyan, H. S. R. Desikachar, and D. S. Bhatia (*J. sci. industr. Res., India*, 1955, **14, A**, 110—114).—The necessity of commercially improving the quality of parboiled rice in India, without introducing mechanisation, increased costs of production and unemployment of manual labour, is discussed with special reference to conditions in the Madras State. It is pointed out that off-flavours in parboiled rice, caused by fermentation of the paddy, can be avoided in all mills which use the double-boiling method by applying preheated water for soaking. A light coloured product resembling raw rice, but with all the nutritional advantages of parboiled rice, can be obtained by partial gelatinisation of the rice grains. L. S.

Catalase in relation to the unsaturated fat oxidase of wheat flour. J. Hawthorn and J. P. Todd (*Chem. & Ind.*, 1955, 446—447).—Catalytic action of lipoxidase and hæmatin compounds on the oxidation of unsaturated fats are discussed with special reference to the properties of catalase (as destructor of carotenoid pigments) and the possibility of a catalase contribution to the activity of the lipoxidase system of wheat flour. Tests carried out with specially prepared animal catalase confirm this possibility. Attention is drawn to the importance of anatomical catalase distribution in the wheat berry. L. S.

Fumigation of flour with methyl bromide. W. Burns Brown, J. B. M. Coppock, G. H. Edwards, E. N. Greer, J. G. Hay, and H. K. Heseltine (*Chem. & Ind.*, 1955, 324—325).—Jute bags containing: (*a*) National flour, (*b*) Premium White flour, were subjected to methyl bromide fumigation tests at two levels of dosage in order to determine residual bromide and residual taint. The high dosage tests for 25·75 hr. on four bags of each type of flour in a chamber of 3000 l. capacity showed 49—53 p.p.m. bromide residues in (*a*), 41—49 p.p.m. in (*b*). The average bromide residues of low dosages (35 g./19·50 hr.) were below 20 p.p.m. The residual taint in bread, prepared from the above flour by independent operators and examined organoleptically was found to be insignificant. L. S.

Refining of starch. M. Samec (*Öst. Chem. Ztg*, 1955, **56**, 66—71).—After an introductory review of biological and chemical data on the structure of starch and formation of micelles, various modified starch preparations are discussed in detail: starch forming cold-water pastes; starch with high viscosity, obtained by esterifying the substance with phosphoric acid, treatment with hypochlorites or Cl_2, addition of alkaline salts, etc.; pudding starch, *i.e.*, plastic gels obtained with hydrolysing agents; thin-boiling starch, degraded to low viscosity; micelle-starch, soluble starch, etc. It is pointed out how molecular changes in starch may be utilised to adapt the product to various requirements. L. S.

Amino-acid content of West Indies sugar cane. L. F. Wiggins and J. H. Williams (*J. Agric. Food Chem.*, 1955, **3**, 341—345).—Of the 11 amino-acids found by chromatographic techniques in sugar cane juice of different varieties of cane, the quantity varies in the different varieties, decreasing with age and increasing markedly with drought conditions. Cane juices of high amino-acid content on lime–heat treatment give very small flocs with poor settling characteristics, and are difficult to deal with in the clarifying process. E. M. J.

Application of compositional knowledge to beet sugar technology. H. S. Owens, J. B. Stark, A. E. Goodban, and H. G. Walker, jun. (*J. Agric. Food Chem.*, 1955, **3**, 350—353).—Recent studies during the last five years on the composition of beets and their processing liquors are reviewed covering: marc analysis, prep. of juice samples, amino-acids, non-amino-org. acids and inorg. anions, alcohol-insoluble compounds, inorg. cationic constituents, importance of composition studies, composition and processing qualities of sugar beets, by-products from sugar beets. (19 references.) E. M. J.

Non-sucrose constituents of beet sugar processing liquors of the Rocky Mountain area. Robert J. Brown (*J. Agric. Food Chem.*, 1955, **3**, 346—350).—The ratio of types of non-sucrose constituents, *e.g.*, mineral, nitrogenous, and carbohydrate, in the beet sugar processing liquors vary widely from season to season, but the compositions of the individual groups tend to remain constant; the ratio of quantity of mineral group to nitrogenous group has tended to decrease with the increasing use of N-fertilisers. Data on the composition of non-sucrose components of beet sugar factory processing liquors are presented in non-Steffen and Steffen molasses in addition to those of normal beet liquors of the Rocky Mountain area. The Steffen and Ba saccharate waste waters are of interest because they can be used to provide valuable nitrogenous concentrates for stock feed. (11 references.) E. M. J.

Phase equilibria in sugar solutions. VIII. The quaternary system sucrose–fructose–glucose–water. IX. The quaternary system glucose–fructose–KCl–water. F. H. C. Kelly (*J. appl. Chem., Lond.*, 1955, **5**, 120—122, 123—124).—The equilibrium phase relationships for these two quaternary systems are determined at 30° and are illustrated with a Jänecke type of projection diagram in each case. Diagrams of the solubility-coefficient relationships are also given for each of the systems at 30° to show the salting out (and salting in) influences of the various solutes over different areas of the diagrams. The results and diagrams are discussed in detail. No formation of a double compound is observed in the second of the systems. H. L. WHITEHEAD.

Fermentation of sugars by an ultramicrotechnique prior to paper chromatography. K. J. Williams and A. Bevenue (*Anal. Chem.*, 1955, **27**, 331).—A technique, for the fermentation of small volumes of sugar solution (0·01—0·05 ml.) with commercial bakers' yeast, is described. The micro test tubes used enable the direct application of the fermentation liquid to chromatographic paper. G. P. COOK.

Starch-syrup: use in the food industry. H. Roederer (*Stärke*, 1954, **6**, 298—303).—It is suggested that starch syrups can be used instead of cane sugar as sweetening agents in the manufacture of certain foodstuffs, such as marzipan, ice-cream, and non-alcoholic beverages. Starch syrups are equivalent to sugar in every respect, and, in particular, both the physiological properties and viscosities are satisfactory. E. DUX.

Some aspects of the composition, nutritive value, and medicinal properties of honey. I. S. Bhatia, V. Subrahmanyan, and M. Srinivasan (*J. sci. industr. Res. India*, 1955, **14, A**, 73—79).—A review of the literature on the composition and nutritive and medicinal properties of honey is presented. An examination of its composition provides no information on the unique position popularly ascribed to honey as a food and as a medicine, although this may well be due to the incompleteness of the assay. (85 references.) G. C. JONES.

Determination of mono- and di-*iso*propylidene sorbose present together, and preparation of mono*iso*propylidenesorbose. T. I. Temnikova and V. V. Sklyarova (*Zh. prikl. Khim.*, 1954, **27**, 1131—1132).—2 : 3-4 : 6-Di*iso*propylidenesorbose is dissolved in 12% H_2SO_4 at room temp., the solution is made neutral after 1 hr., concentrated to small vol. *in vacuo* at $\gtrsim 30°$, separated from Na_2SO_4 crystallising out, and extracted with ethyl acetate, from which 2 : 3-*iso*propylidene-L-sorbofuranose is isolated. This is hydrolysed to acetone and sorbose by 40% H_2SO_4 (2 hr. at 18—20°). About 3 g. of mixture containing acetone, sorbose, and its mono- and di-*iso*propylidene derivatives are dissolved in 200 ml. of water. Free acetone and sorbose are determined in aliquots by standard methods, and combined acetone and sorbose after two-stage hydrolysis, as above. R. TRUSCOE.

Formation of furfural from polyuronic acids. V. P. Kiseleva, A. A. Konkin, and Z. A. Rogovin (*Zh. prikl. Khim.*, 1954, **27**, 1133—1136).—The velocity of decarboxylation of polyuronic acids in boiling 20·2% HCl (110°) is greater than that of dehydration, as a result of which formation of pentose precursors of furfural is retarded, and the final yields of furfural are reduced, owing to side-reactions of the intermediate carboxylic products, with formation of humins. R. TRUSCOE.

Decrease of viscosity by *aci*-reductones. H. v. Euler and Maria L. Stein (*Makromol. Chem.*, 1955, **15**, 60—68).—Reductones capable of reducing Tillman's reagent in acid as well as in alkaline solution (*e.g.*, ascorbic acid) are defined as *aci*-reductones. It was found that the viscosity of pectins is considerably decreased by incubation with *aci*-reductones. The loss of viscosity in test solution of pH 4, containing equimolecular quantities of ascorbic acid and pectin, was 28·34% after 1 hr., 84% after 24 hr. With Na ascorbate of pH 6·8 the loss was 22·42% after 1 hr. and 69·7% after 24 hr. The biological significance of these effects, particularly on the permeability of tumour-cell membranes, is discussed. L. S.

Mexico freezes strawberries for the U.S. A. M. Gomez (*Foreign Agric.*, 1955, **19**, 3—9).—A review of the frozen strawberry industry at Guanajuato and Michoacán. E. G. BRICKELL.

Changes in the enzymic browning of Bramley's Seedling apples during their development. C. Weurman and T. Swain (*J. Sci. Food Agric.*, 1955, **6**, 186—192).—Prepared minced tissue of the apples

from three trees was used; 500 mg. were suspended in 10 ml. of 0·2M-phosphate buffer, in presence of 0·13% wt. by vol. of $CuSO_4$ solution (0·1 ml.) and 2 ml. of buffer were added. The suspension was shaken and the optical density at 480 mμ. set at zero. Air was bubbled through at the rate of 600 ml. per min. and the resulting browning was measured at intervals against a blank. A similar test was made in presence of catechol, and determinations were made of enzyme activity, of the total amount of phenols and of ascorbic acid. By comparing (*a*) the browning of the tissue with and without catechol, (*b*) the activity of the responsible enzymes, and (*c*) the amount of the total phenols and ascorbic acid, it was found that the intensity of the browning depends on the activity of the enzyme system. Naturally occurring enzyme inhibitors, compounds containing an SH-group, such as cysteine and glutathione, are also important factors in determining the amount of browning after injury. (21 references.) E. M. J.

Water-soluble constituents of fruit. I. Occurrence of free galacturonic acid in fruit. A. S. F. Ash and T. M. Reynolds (*Aust. J. biol. Sci.*, 1954, **7**, 435—443).—A free uronic acid was detected in several varieties of pears after ripening at 20° but not in green or tree-ripened fruit. Similar results were obtained with freestone peaches but not with apricots. The acid from pears was identified as galacturonic acid, the strongest concn. being 350 μg./g. fresh fruit. E. G. Brickell.

The clarification methods, storage, and preservation of citrus fruit juices. G. Hartmann (*Riechstoffe u. Aromen*, 1955, **5**, 75—77).—A discussion is given of the clarification of crude citrus fruit juices by enzyme treatment, separation by centrifuging, filtration (after flocculation with albumin), deep cooling, use of EtOH, and natural clarification. The operation and advantages of each of the methods are discussed in detail. The storage and preservation of fruit juices are discussed. H. L. Whitehead.

Tomato-juice film deposition on heat-exchanger coils. Harold Willard Adams (*Dissert. Abstr.*, 1955, **15**, 105—106).—Film deposition on steam-heated coils during atm. concentration of high-temp. hot-broken tomato juice was prevented by preliminary heating for 1 min. with direct steam injection at a temp. equiv. to 40 lb. per sq. in. Treatment with pectic enzymes, although preventing film deposition, reduced viscosity and increased weeping of the conc. product; proteolytic enzymes were ineffective. Other procedures are described which, although not preventing film deposition, aided film removal or improved heat transfer from the coils. Film deposition was reduced with hot-breaking temp. of >180°F. and heat transfer was improved as the temp. was reduced to 140°F. S. C. Jolly.

Bacterial flora (of significance in food preservation) associated with vegetables grown in India. I. A. N. Bose and J. M. Ayan Dutt (*J. sci. industr. Res. India*, 1955, **14, C**, 53—55).—Bacterial flora associated with potato, beet, carrot, squash, radish, and patal, supplied to the canning industry in West Bengal, have been isolated and identified. Of the bacteria isolated from potato is a species belonging to *Bacillus cereus* var. *mycoides*, which is a spore-former and exhibits a thermal death point above 100°. This organism is therefore of significance in the canning of vegetables. For products heated by conduction, strains of *Bacterium zopfi* and *Alcaligenes viscosus* isolated may be of significance. G. C. Jones.

Solanine, glycoside of the potato. III. An improved method of extraction and determination. L. C. Baker, L. H. Lampitt, and O. B. Meredith (*J. Sci. Food Chem.*, 1955, **6**, 197—202).—The colorimetric method for the determination of solanine and solanidine has been standardised, and the mol. extinction coeff. of the coloured solutions at wavelength 570 mμ. have been determined. A technique using a Soxhlet apparatus was devised for the extraction of the solanine from potato, and results were consistently higher than those obtained by the method of Rooke *et al.* (*J. Soc. chem. Ind. Lond.*, 1943, **62**, 20). The two methods are compared and data are discussed. The Soxhlet-extraction method may be used also for cooked potato. E. M. J.

Preparation of phosphatides from Indian pulses. S. Ghatak and C. R. Krishna Murti (*J. sci. industr. Res. India*, 1955, **14, C**, 58—59).—In order to find suitable vegetable sources for the preparation of lecithins, crude phosphatides have been isolated from four common Indian pulses. The procedure is outlined and the chemical compositions of the preparations are tabulated. The results indicate that the yields (1·3—2·2%) of phosphatides of fairly high purity and the compositions approximate to those of the best commercial brands of animal lecithin. G. C. Jones.

Seaweeds from Sierra Leone. G. W. Lawson (*J. West Afr. Sci. Ass.*, 1954, **1**, 63—67).—Species collected, mostly in 1953, from various zones are noted. R. H. Hurst.

South African seaweeds: seasonal variations in the chemical composition of some Phæophyceæ. M. M. von Holdt, S. P. Ligthelm, and J. R. Nunn (*J. Sci. Food Agric.*, 1955, **6**, 193—197).—In *Ecklonia maxima, Laminaria pallida*, and *Bifurcaria brassicæformis*, common in Cape Waters, there were seasonal variations in the main constituents, ash, alginic acid, and mannitol, but only small changes in laminarin, combined fucose, and org. N. Only *E. maxima* contained any appreciable quantity of laminarin, the concentration being greater in winter than in summer. E. M. J.

Ammonia content of wines, and its variation during fermentation. P. Achinard and J. Boudot (*Ann. Falsif., Paris*, 1955, **48**, 17—21).—Conditions for the formation of NH_3 in maturing wines, and its consequences are discussed. Considerable amounts of NH_3 are formed during the malo-lactic acid fermentation by *Bacillus gracile*. P. S. Arup.

Problem of grape juice in France. M. Flanzy (*C. R. Acad. Agric. Fr.*, 1955, **41**, 89—96).—A review of the possibilities of increasing the sale of grape juice, with special reference to problems of stocking, preservation, and marketing. P. S. Arup.

Microflora of Bordeaux musts and wines. M. E. Peynaud and S. Doumercq (*C. R. Acad. Agric. Fr.*, 1955, **41**, 103—106).—A survey including the enumeration of 29 species of yeast (comprising ~200 strains) isolated from musts, and 29 species isolated from wines. P. S. Arup.

Theory and practice of alcohol determination. I and II. K. Rokitansky, A. Foramitti, and K. Schaden. **III.** K. Rokitansky (*Mitt. VersSta. Gärungsgew.*, 1954, **8**, 160—185; 1955, **9**, 23—30).—The distillation theory is discussed graphically and mathematically. E. M. J.

Problems arising out of recent [German] legislation as affecting breweries. G. Nowak (*Brauwelt*, 1955, **B**, 285—288, 301—304).—The proposed legislation is criticised with respect to points adverse to brewing interests, and proposals are made concerning rights to the continued use of ground water from privately owned wells, the protection of wells from pollution, disposal of waste water, and physical, chemical, and bacteriological requirements for brewing water. P. S. Arup.

Blood alcohol in relation to driving convictions. G. H. Bonn (*Brauwelt*, 1955, **B**, 341—342).—In reply to a ministerial questionnaire, a recent driving safety conference in Bonn has confirmed the validity of the Widmark test and of the 1·5% blood-EtOH limit. Further recommendations are: confirmation of results of the above test by the ADH ferment method, the use of the "Alco" breath test for preliminary examination, and the legal standardisation of testing methods. P. S. Arup.

Composition and characteristics of substitutes used in brewing. I. A. Preece (*Brass. et Malt.*, 1955, **5**, 5—11).—A review covering sugars, special malt extracts, unmalted cereals, oat products, and colouring matters. P. S. Arup.

Quality of barleys at present cultivated by Secobrah. Anon. (*Brasserie*, 1955, **10**, 26—28).—The tendency to choose for brewing purposes the "best lots" of forage barley is deprecated. Average data extending over 2—4 years for extract and protein contents in dry matter of nine new varieties are given, and discussed in connexion with outstanding characteristics. Varietal characteristics have remained constant at six widely separated French experimental stations. P. S. Arup.

Microscopical control of saccharification. L. Macher (*Brauwelt*, 1955, **B**, 273—277).—Microscopical examination of a drop of the mashing liquid (containing a min. of solid matter) mixed with a drop of 0·05N-I gives more complete information as to the course of saccharification than can be obtained by means of the usual tests with I. The state and approx. no. of surviving starch grains can be observed, and the origin of mixed colorations can be determined in doubtful cases. Routine and special cases are cited in which the superiority of the method is demonstrated. The method is also useful for the examination of spent grains. P. S. Arup.

Determination of bitter substances in wort and beer. W. Katte and W. Specht (*Schweiz. Brauerei Rdsch.*, 1955, **66**, 38—42).—On evaporation to dryness of the $CHCl_3$ extracts of bitter substances obtained by Kolbach's method, the absorption max. (at 243 and 278 mμ.) of the residue are reduced, due to the loss of a volatile fraction which shows comparatively high max. at 245 and 265—275 mμ. One extraction with $CHCl_3$ (as in Kolbach's method) is insufficient to extract >~66% of the total $CHCl_3$-sol. matter; the united extracts from three extractions yield absorption values which are increased by 60%. Shaking of the $CHCl_3$ extract with 0·1N-NaOH yields an extract having max. at 253 and 260—280 mμ.; the change in absorption max. is reversed on acidification. Absorption values at 278 mμ. cannot be used for the quant. determination of bitter com-

ponents, but the values at 253 mμ. obtained on extraction with 0·1N-NaOH may (after further investigation) prove applicable. P. S. ARUP.

Membrane-filter method for rapid detection of micro-organisms in beer. E. Probst (*Schweiz. Brauerei Rdsch.*, 1955, **66**, 35—37).—A known vol. of beer is filtered by suction through a 5-cm. membrane-filter resting on a sintered-glass plate; the membrane is then incubated during 20—24 hr., either at 37° while resting on the surface of hopped beer-wort-agar, or at 22—30° on cardboard moistened with the liquid wort. Directions are given for sterile working. The colonies on the membrane, after sampling for microscopical examination, can be fixed by drying at 60°, and then stained with methylene blue. Typical illustrations of membrane-discs with colonies are given. P. S. ARUP.

Experience with a vacuum rotary filter in manufacture of bakers' yeast. E. Küstler and K. Rokitansky (*Mitt. VersSta. Gärungsgew.*, 1954, **8**, 155—160).—The SJA (Stockholm) filter compares very favourably with the filter-press in all technical and economical respects, excepting that the product contains too much extracellular moisture. This defect can, however, be remedied and controlled by a process devised by the Mautner Markhof yeast factory of Vienna (Ger. P. appl., 3.2.54), which consists in adding NaCl to the yeast suspension before filtration, and washing with water afterwards. The theory and practice of the process are described. Contents of extracellular moisture can be checked by plasticity measurements by means of a plunger apparatus. (14 references.) P. S. ARUP.

[A] **Autolysis of bakers' yeast.** [B] **Autolysis of several pure-culture yeasts.** D. C. Vosti and M. A. Joslyn (*Appl. Microbiol.*, 1954, **2**, 70—78, 79—84).—[A] Fresh compressed bakers' yeast was examined during autolysis in a buffered medium in the starved condition. Products of autolysis appeared after 8—24 hr. at 52—54°; PO_4''' and nucleic acid were released more rapidly than were N products. The amount of NH_2-acids appearing in the hydrolysate was max. at pH 7·0. The course of hydrolysis at different pH and temp. is examined. Low-temp. autolysis (33°) was increased by dinitrophenol (0·01M.) or by a detergent but not by smaller concn. of dinitrophenol or by NaN_3, Na_3AsO_3, NaF, or KCN.

[B] In the autolysis of *Saccharomyces carlsbergensis* under starvation conditions the release of PO_4''' and N from the cells began suddenly after 12 hr., PO_4''' appearing more readily than N compounds. The optimum pH for the autolytic release of P and N from *S. carlsbergensis*, *Candida lipolytica*, and a Spanish sherry flor yeast (*Torulopsis*) are determined. A. G. POLLARD.

Yeasts occurring on apples and in apple cider. D. S. Clark, R. H. Wallace, and J. J. David (*Canad. J. Microbiol.*, 1954, **1**, 145—149).—Yeasts isolated from apples were of the family *Cryptococcaceæ* (*Candida*, *Cryptococcus*, *Rhodotorula*, *Torulopsis*). *Candida* spp. were dominant. Yeasts in cider were of the genera *Debaryomyces*, *Pichia*, and *Saccharomyces*. Of the cider yeasts 50%, and of the apple yeasts all, were non-fermenters. A. G. POLLARD.

History of technical microbiology in U.S.S.R. I. Brewing. Anon. (*Mitt. VersSta. Gärungsgew.*, 1955, **9**, 20—22).—A review with 23 references. P. S. ARUP.

Mechanism of alcoholic fermentation by yeasts. M. E. Urion (*Brass. et Malt.*, 1955, **5**, 56—60).—A review covering available knowledge of the subject, and its importance in brewing. P. S. ARUP.

Utilisation by yeasts of the carbohydrates of wort. A. W. Phillips (*J. Inst. Brew.*, 1955, **61**, 122—126).—Paper-chromatographic investigations reveal preferences by brewing yeasts in the (descending) order: sucrose, monosaccharides, maltose, and maltotriose. Other yeasts show widely differing preferences, including the ready utilisation of maltotriose and maltotetraose, and other complex carbohydrates which are not appreciably attacked by brewing yeasts. The attack on dextrins by *Schizosaccharomyces pombé* results in the appearance in the wort of glucose, and the biosynthesis of *iso*maltose and (probably) of panose. Wild yeasts generally fail to attack dextrins. (17 references.) P. S. ARUP.

Effect of seeding rate and sugar concentration on yeast growth and fermentation in aërated glucose worts. J. White (*J. Inst. Brew.*, 1955, **61**, 146—150).—With different seeding rates, the growth coeff. (r) increases from a low value at low sugar concn. to a max. at 3—7% of glucose, and decreases at higher concn. Max. fermentation coeff. (s) and total sugar usage ($s + 0{\cdot}476r$) are reached at 15 and 10—15% of glucose, respectively. Increases in seeding rates cause gradual decreases in r; they cause slight increases in s up to a max. of 25 g. per l., and decreases at higher rates. Sugar usage varies but little with seeding rates at $\geqslant$30 g. per l., but beyond this, it decreases rapidly. P. S. ARUP.

Storage of yeast. L. R. Bishop, W. Hickson, A. Alexander, and F. H. M. Cory (*J. Inst. Brew.*, 1955, **61**, 150—160).—The ecology and physiology of yeast are considered in relation to optimum conditions for storage. Yeast stirred with 2% (w/v) aq. KH_2PO_4 remains fully viable after storage during five weeks at 0 to −1°, and gives results equivalent to those obtained with fresh brewers' yeast. In an emergency, the yeast would be usable after storage during 13 weeks. P. S. ARUP.

Culture and improvement of hops in Belgium. F. Hoed (*Brass. e Malt.*, 1955, **5**, 61—64).—A review of the activities of the Belgian National Institute for hop culture. P. S. ARUP.

General composition of non-biological hazes of beers and some factors in their formation. I. W. I. Bengough and G. Harris (*J. Inst. Brew.*, 1955, **61**, 134—145).—Chill- and oxidation hazes are heterogeneous mixtures containing proteins (~40), ash (1—3), carbohydrates (2—4%), and (for the remainder) condensed tannins derived from both hops and malt; the ash contains heavy metals (especially Cu, Al, and Fe) in concn. much higher than those found in the ash from beer. Hazes are dissolved on heating the beer for 10 min. at 70°; on cooling, the rate of re-disposition is slower after rapid than after slow cooling, and is largely unaffected by the amount of haze which may previously have been separated from the beer. Prolonged heating of hazy beer at 40—70° dissolves the haze, and subsequently causes the slow and continuous deposition of a further haze of different composition. (24 references.) P. S. ARUP.

Spectrographic determination of metals in brewing materials and beer hazes. J. R. Hudson (*J. Inst. Brew.*, 1955, **61**, 127—133).—In preparation for quant. analysis by the C-arc cathode layer technique, the ash from beer or wort (200 ml., preferably freeze-dried before ashing), malt (10 g.), or hops (2 g.) is fused with K_2CO_3 + Na_2CO_3 (2 g.), and the trace metals are concentrated on a matrix of Al_2O_3 (containing ~5% of Fe_2O_3) by application of the pptn. method of Mitchell and Scott (cf. *J. Soc. chem. Ind., Lond.*, 1947, **66**, 330) to an acid aq. solution of the melt. The concentration of Cu, Al, and Fe is effected by the addition to the acid solution of 8-hydroxyquinoline and pure SiO_2 (25 g.) and adjusting the pH to 5·0—5·2 by the addition of aq. NH_3 and 2N-NH_4 acetate (50 ml.); in this case, Co is used as an internal standard (cf. Farmer, *Spectrochim. Acta*, 1950, **4**, 224). Details are given for qual., semi-quant., and quant. procedures. The concentration in beer hazes of Cu, Fe, Sn, Al, Pb, Ni, V, and Mo are very greatly in excess of those found in whole beer. (21 references.) P. S. ARUP.

Continuous and simultaneous micro-determination of carbon dioxide and oxygen by a modified Warburg apparatus. L. Chapon (*Brasserie*, 1955, **10**, 43—47).—The method is applicable in all cases in which the maintenance of a concn. of CO_2 over the respiring tissue is unnecessary and depends on the periodic micromanometric measurement at constant pressure of the O_2, and the determination of CO_2 by changes in electrical conductivity of approx. 0·05N-$Ba(OH)_2$. The modifications in the apparatus consist in the fitting of the leads for a pair of Pt electrodes through the vertical neck of the Warburg flask, the provision of a small centrally pivoted tubular vessel which contains the aq. $Ba(OH)_2$ (0·6 ml.) in which the electrodes are immersed, and a pivoting pin fused into the centre of the base of the flask. The continuous breaking of the film of $BaCO_3$ forming on the surface of the aq. $Ba(OH)_2$ is ensured by the attachment to the side of the tubular vessel of weight which causes adequate agitation of the contents while the flask is being regularly oscillated. Experimental confirmation of the accuracy of the method, directions for the calibration of the apparatus, and working details are given. P. S. ARUP.

Mineral nutrients in coffee brew. M. Kantharaj Urs, C. P. Natarajan, and D. S. Bhatia (*J. sci. industr. Res. India*, 1955, **14, C**, 60).—In a study of the nutritionally important mineral constituents present in brewed coffee, the Ca, P, and Fe contents of several coffee powders and brews have been determined. P and Fe were leached into the brew to the extent of 67—76% and 40% respectively. Very little Ca was present. G. C. JONES.

Aroma of coffee. T. Reichstein and H. Staudinger (*Perfum. essent. oil Rec.*, 1955, **46**, 86—88).—By heating roasted ground coffee at 100° under vacuum (3 min.) and collecting and cooling the gases at −180°, a yellow oil was obtained which had an intensive coffee odour. The oil is unstable at room temp. By storing at −80° and using a variety of separating techniques, 70 substances were isolated and characterised chemically. None of the substances possessed coffee odour which depends on a nicely balanced ratio of components. Of the specific components of paramount importance, one is a new compound, furfuryl mercaptan, which when highly "thinned" has an aroma reminiscent of coffee. Methyl mercaptan was also present. Blending of over 40 compounds yielded a product with a typical coffee odour but poorer in quality than that of the natural product. (18 references.) G. HELMS.

Detection of hydrogen peroxide in milk in presence of dichromate. A. Rouquette (*Ann. Falsif., Paris,* 1955, **48,** 4—8).—By means of the perchromic acid reaction, H_2O_2 (<2 ml. of 12-vol. solution per l.) can be detected, provided that the sample (2 ml.) is shaken with ether (2 ml.) and dil. H_2SO_4 (5 drops) immediately after addition of the dichromate. A blue tint is sometimes observable in the milk after addition of the dichromate, in which case the presence of H_2O_2 can be confirmed by the addition of the ether. The reaction is less sensitive to oxidising agents than that depending on the liberation of I from KI, but it gives negative results in presence of ClO_3', BrO_3', IO_3', S_2O_8'', Cr_2O_7'', and ClO'. P. S. Arup.

Temperature coefficient of expansion of raw milk. A. L. Short (*J. Dairy Res.*, 1955, **22,** 69—73).—The density of raw milk between 10° and 45° and the effect of composition on the expansion of raw milk are examined. The variation of the density–temp. coeff. is quoted for different values of milk composition. N. M. Waller.

Colour changes in heated and unheated milk. II. The whitening of milk on heating. H. Burton (*J. Dairy Res.*, 1955, **22,** 74—81).—The initial whitening of milk on heating to above 60° is examined and shown to be independent of the subsequent browning. From experiments reported it is concluded that the whitening is caused by the denaturation of the soluble proteins and their subsequent coagulation into particles large enough to reflect light. N. M. Waller.

Colour changes in heated and unheated milk. III. Effect of variation in milk composition on the whitening and browning of separated milk on heating. H. Burton and S. J. Rowland (*J. Dairy Res.*, 1955, **22,** 82—90).—Milk samples from individual cows are studied to give information on the variation in susceptibility to whitening and browning of bulk milk supplies. The rate of browning depends on the pH of the milk and varies over a range of 2 : 1 for the samples examined. The whitening is affected by soluble protein content, pH, and a third factor which was not covered by the chemical analyses made. The rate of whitening is variable for the same samples over a range 5·5 : 1. N. M. Waller.

Heat coagulation of milk. G. T. Pyne and K. A. McHenry (*J. Dairy Res.*, 1955, **22,** 60—68).—A study of the compositional factors affecting the heat coagulation of milk is reported. Calcium-ion concn. and colloidal phosphate content are the chief controlling factors, acidity and heat denaturation of casein being supplementary factors which develop during heating. A theory of the process based on these facts, and the application to evaporated milk practice are discussed. (21 references.) N. M. Waller.

Medium for the simultaneous enumeration and preliminary identification of milk microflora. K. O. Donovan and J. M. Vincent (*J. Dairy Res.*, 1955, **22,** 43—47).—A medium is developed to permit the viable count of milk bacteria to be combined with the determination of biochemical properties likely to be important in milk itself. Standard glucose–tryptone–skim-milk agar is modified by incorporating two indicators to detect alkali and acid production, substituting lactose for glucose, and increasing the quantity of skim-milk for the detection of proteolysis and casein precipitation. N. M. Waller.

Acetate and citrate metabolism of *Streptococcus lactis* and *Streptococcus cremoris*. D. E. Kizer and M. L. Speck (*J. Dairy Sci.*, 1955, **38,** 96—102).—*Streptococcus cremoris* strains responded significantly to addition of acetate (10 mg. per ml.) to the culture medium ; the same concentration of citrate was generally non-stimulatory but was inhibitory for some strains. *Strept. lactis* strains responded significantly to either ion, but particularly to acetate. These data support the contention that two distinct species exist in the lactic group of streptococci. All strains required pantothenate, coenzyme A being a considerably less effective source than Ca pantothenate. S. C. Jolly.

The recorded butterfat content of bulk milk from a herd of White Fulani cattle. N. Tasker (*J. Dairy Res.*, 1955, **22,** 16—21).—The fat contents of morning and evening samples of milk from a herd of White Fulani cattle are recorded daily over a period of one year. Variations extend over a range of 4% with individual cows. The highest fat contents and lowest variation between morning and evening figures coincide with the period of maximum available grazing. N. M. Waller.

The rate of secretion of milk and fat. G. L. Bailey, P. A. Clough, and F. H. Dodd (*J. Dairy Res.*, 1955, **22,** 22—36).—Experiments are reported which give evidence of the effects of residual milk on the yield and composition of the milk obtained at subsequent milkings, also a measure of the true rate of milk and fat secretion after these residual effects have been eliminated. N. M. Waller.

Comparison of the diagnostic value of the total and differential cell counts of bovine milk. P. S. Blackburn, C. M. Laing, and D. F. Malcolm (*J. Dairy Res.*, 1955, **22,** 37—42).—Total and differential cell counts and bacteriological examinations were made on 1710 milk samples. The two cell counts considered together show no marked advantage over the total cell count alone in the diagnosis of mastitis, except in milk of late lactation. N. M. Waller.

Critical analytical chemical study of light-activated flavour in milk. S. A. Bartkiewicz (*Dissert. Abstr.*, 1955, **15,** 22).—The photochemical deterioration of milk when irradiated by strong sunlight, and particularly the possible formation of H_2S, have been investigated using the method whereby methylene blue is formed when H_2S reacts with *p*-aminodimethylaniline and $FeCl_3$. Interference by the milk proteins could not be overcome, however, and, whereas 3·5 μg. of H_2S were found per 500 ml. of pasteurised-homogenised milk, no increase in H_2S concn. upon radiation could be detected. An aq. solution of the lactoglobulin fraction was irradiated in sunlight and developed the odour and taste of irradiated milk but no H_2S was detected, whilst ruby-glass containers for the solution inhibited the development of a burnt flavour and odour. The S-like odour of irradiated milk is attributed to decomposition products other than H_2S. L. F. Taylor.

Volatile compounds associated with oxidised flavour in skim milk. D. A. Forss, E. G. Pont, and W. Stark (*J. Dairy Res.*, 1955, **22,** 91—102).—Using chromatographic methods a number of compounds are isolated from the steam distillates of skim milk containing oxidised flavour, in an attempt to identify the compounds responsible. Definite identification is obtained of acetone, acetaldehyde, *n*-hexanal, crotonaldehyde, and the C_5–C_{11} 2-unsaturated aldehydes, also presumptive evidence for the presence of several 2 : 4-diunsaturated aldehydes of medium chain length. 2-Enals, particularly C_8 and C_9, are considered to be the principal flavour-determining compounds. (37 references.) N. M. Waller.

Improving curd-forming properties of homogenised milk. R. B. Maxcy, W. V. Price, and D. M. Irvine (*J. Dairy Sci.*, 1955, **38,** 80—86).—Curd-making properties of homogenised milk can be returned almost to normal by concentration or by the addition of low-heat non-fat dry milk solids or low-heat conc. skim milk. Reduction of curd tension by homogenisation may be caused by casein adsorption on the newly formed fat surfaces. S. C. Jolly.

Frozen homogenised milk. IX. Freezing characteristics of homogenised and unhomogenised milk. C. J. Babcock, D. R. Strobel, R. H. Yager, and E. S. Windham (*J. Dairy Sci.*, 1954, **37,** 1416—1419).—During freezing at −20° the protein, total solids, and ash concn. in the top, middle, and bottom sections of homogenised (*H*) and unhomogenised (*U*) milk were similar, but the fat contents differed in the middle section. After freezing, the concn. of protein and constituents that would constitute the ash were similar in the bottom sections for *H* and *U*, but the fat content of *U* concentrated in the top section. S. C. Jolly.

An ion-exchange resin–contact time method for the study of inorganic equilibria in milk. J. M. Baker, C. W. Gehrke, and H. E. Affsprung (*J. Dairy Sci.*, 1954, **37,** 1409—1415).—An ion-exchange procedure has been developed for studying the inorg. equilibria of cations and anions in raw skim milk and processed milks. With this method the effect of processing conditions on changes in the cation–anion components and the various phases involved can be studied directly. During a 10-sec. contact, 36% of the total Ca and ~44% of the total P was exchanged. The removal " rate constant " for Ca was constant up to the 90% level and then decreased ; that for P was approx. constant up to 65—68% removal and then levelled off. Slopes of the curves for contact times of 10—180 sec. are presumably due to exchange of Ca from ionic and dissolved complexes ; those for contact times of 3—5 min. are due to exchanges from colloidal phases. S. C. Jolly.

Use of ion-exchange resin membrane solutions in the study of the inorganic equilibria of milk. H. E. Affsprung (*Dissert. Abstr.*, 1955, **15,** 23).—The direct influence of the salts found in milk upon the colloidal stability of casein and interactions of Ca ions with casein have been investigated. Satisfactory cation-sensitive membrane electrodes were prepared, whilst the anion-sensitive membranes were less successful, although enabling estimation of the anionic activity ; clay membranes selective for monovalent cations also were used. Potential measurements indicated that (i) the phosphate in true solution in milk (~$\frac{1}{6}$ of the total) is present as the mono-H ion, (ii) milk contains a reservoir of inorg. materials and a 5% dilution with water can be detected, whilst 8% dilution produces a significant decrease in potential, (iii) KCl, NaCl, and $CaCl_2$ added in the concn. range 0·02—0·20 equiv./l. did not react with other constituents, (iv) the pH of solutions of 0·002—0·01M-$CaCl_2$, CaHCit, $Ca(H_2Cit)_2$ (Cit = citrate ion), and $Ca(H_2PO_4)_2$ in ion-free casein suspensions varied from 3·5 to 4·9, and the effect of the Ca ion on casein is small and similar to that of any divalent ion upon a hydrophobic colloid, and (v) the increase in cationic activity with addition of citrate and

phosphate salts is probably due to anion-exchange between the multivalent ions and chloride ions from the casein surface particles. Results indicate that the addition of an excess of Ca ions affects the stability of milk indirectly in that the Ca ions remove or complex the stabilising citrate and phosphate ions and reduce the ζ-potential to the point where the casein coagulates. L. F. TAYLOR.

Browning reaction of milk and milk products. III. Action of urea in the heated urea-lactose system with reference to the heat-browning of milk. S. Adachi (*Tohoku J. agric. Res.*, 1954, **4**, 223—237; cf. J.S.F.A. Abstr., 1955, i, 322).—The formation of heat-labile compounds from lactose and compounds having the urea structure is demonstrated as the cause of browning in heated milk. The active deriv. of urea are those capable of showing amide–imidol tautomerism. The $(NH_4)_2CO_3$ formed from urea acts as an accelerator in colour formation. In acid, but not in alkaline media, an inductive period preceding colour formation is distinguishable. (43 references.) P. S. ARUP.

Spectrographic method for the determination of tin, copper, iron, and lead in milk and milk products; effect of storage on the concentration of these metals in evaporated milk. C. W. Gehrke, C. V. Runyon, and E. E. Pickett (*J. Dairy Sci.*, 1954, **37**, 1401—1408).—A rapid and accurate spectrographic method is described for the simultaneous quantitative determination of Sn, Cu, Fe, and Pb in milk and evaporated milk. The concn. of Sn in evaporated milk stored at room temp. or 37° in either electrolytic (*E*) or hot-dipped plated cans increased rapidly, particularly in the *E*-type cans at 37° (from 20 to 215 p.p.m. in 340 days). The Fe content increased much less rapidly (from 6·5 to 16·5 p.p.m. in 340 days). The concn. of Cu and Pb were fairly constant (~0·7 and 0·35 p.p.m. respectively). The pH changed from 6·20 to 5·55 in 300 days at 37°. Flippers developed more rapidly in *E*-type cans. In both types of can at 37° darkening and fat separation occurred in 81 days and after ~300 days all the tin coating had disappeared. S. C. JOLLY.

Methods for the sampling and chemical analysis of acid casein. (Brit. Stand. Instn, B.S. 1955, 1417, 16 pp.).—The gross sample must be collected by taking increments at regular intervals throughout the consignment, and ≮100 g. of sample for each 50 kg. of the material must be taken from each sack by means of a sampling tube (described). The accumulated samples are reduced by quartering. The analyses are carried out as follows. *Moisture.* A 3-g. sample is heated for 5 hr. at 101—102° and then until the wt. is constant to 1 mg. *Ash.* 5 ml. of 12% Mg acetate solution are added to 2—3 g. of casein and the mixture is dried, heated carefully until charring is complete, and the residue is then ignited to constant wt. at 850 ± 20°, the equiv. of MgO being determined similarly. *Fat.* Approx. 5 g. of casein are treated by the Werner–Schmidt method. *Iron* is determined colorimetrically with quinol and *o*-phenanthroline, using 2M-Na acetate to adjust the solution to pH 3·5. *Nitrogen* is determined by the Kjeldahl method. J. M. JACOBS.

Chemical composition of the colostrum and milk of the sow. D. R. Perrin (*J. Dairy Res.*, 1955, **22**, 103—107).—Detailed analyses of the colostrum and milk of four sows are reported in terms of fat, solids-not-fat, protein, lactose, ash, and mineral constituents. N. M. WALLER.

Composition of the milk of the blue whale. M. E. Gregory, S. K. Kon, S. J. Rowland, and S. Y. Thompson (*J. Dairy Res.*, 1955, **22**, 108—111).—The composition of milk from three blue whales is reported in terms of fat, solids-not-fat, casein, soluble protein, non-protein N, lactose, ash, mineral constituents, and vitamin constituents. (23 references.) N. M. WALLER.

Reviews of the progress of dairy science. Section F. Milk-borne disease. J. Smith (*J. Dairy Res.*, 1955, **22**, 113—125).—A review of the incidence of milk-borne diseases during recent years. (63 references.) N. M. WALLER.

Vitamin D content of irradiated milk. C. Engel (*Milchwissenschaft*, 1954, **9**, 378—379).—Milk which had been irradiated, evaporated, and tinned was found by means of rat and chick feeding tests to contain 400—500 i.u. of vitamin D. P. S. ARUP.

Biological availability of vitamin B_6 of heated milk. R. M. Tomarelli, E. R. Spence, and F. W. Bernhart (*J. Agric. Food Chem.*, 1955, **3**, 338—341).—The heat processing necessary for the sterilisation of canned liquid milk products destroys part of the vitamin-B_6 content as measured microbiologically and decreases the biological response of the remaining vitamin, such products having 33—64% of the vitamin-B_6 activity of fresh milk as measured by the *Saccharomyces carlsbergensis* assay, and in rat growth tests only about half of this activity is biologically available. In spray-dried milk the microbiological method is in agreement with the bioassay. (22 references.) E. M. J.

Reducing properties of milk: rôle of xanthine oxidase. G. Nilsson (*K. Lantbruks-Högskol. Ann., Uppsala*, 1954, **21**, 445—456).—Milk from cows with mastitis has a higher content of xanthine oxidase than has normal milk. The possibility of using the Schardinger test for rapid detection of an admixture of mastitis milk in the dairy supplies is discussed. R. H. HURST.

[A] **General methods of modern milk sterilising procedures.** —. Becholey, —. Breil, —. Carvallo, —. Jaton, —. Lancelot, —. Mocquot, and J. Pien. [B] **Properties of sterilised milk.** H. Gounelle and M. Demarchi. [C] **Discussion.** (*Ann. Nutr., Paris*, 1955, **9**, 11—29, 31—42, 45—111).—[A] A review covering preliminary treatment, homogenisation, and methods for sterilisation.

[B] A review covering advantages and disadvantages of sterilised milk, physical, organoleptic, and hygienic properties, and nutritive value.

[C] The discussion is largely devoted to considerations of the material and dimensions of containers for sterilised milk, and of problems of supply, consumption, distribution, and control. P. S. ARUP.

Bacteriological requirements for, and testing of sterilised milk and sterilised milk products. D. A. A. Mossel and E. F. Drion (*Neth. Milk Dairy J.*, 1954, **8**, 106—114).—The possibility of delayed spore germination can be discounted in the case of sterilised milk; "commercially sterilised" milk can therefore be accepted as sterile. Statistical considerations show that reasonable protection for the consumer can be achieved by requiring that not less than seven samples per batch shall be sterile. A testing procedure is recommended in which the unopened bottles are incubated for 7 days at 32° (or for 10 days at 55° for milk destined for the tropics), and then, if unaltered, sampled for anaërobic plate culture on a medium to which 0·1% of sol. starch has been added. (24 references.) P. S. ARUP.

Differences in rates of deterioration of inoculated milk during summer and winter. T. J. Claydon (*Appl. Microbiol.*, 1954, **2**, 221—223)—Rates of development of defects in sterilised milk, following inoculation with various possible sources of contamination in practice, were examined during winter and summer. With the same holding temp. the lower keeping quality of milk in summer than in winter is probably influenced by unknown factors in addition to temp. before storage. A. G. POLLARD.

Quantitative determination of antibiotics in milk. L. R. Mattick (*Dissert. Abstr.*, 1955, **15**, 1—2).—A method is described for the determination of antibiotics in milk based on inhibition of the reduction of NO_3' to NO_2' by *Micrococcus pyogenes* var. *aureus*. Complete inhibition of a lactic acid starter culture was caused by concn. of 0·5, 1·0, and 0·9 μg. of aureomycin, streptomycin, and oxytetracycline respectively, and by 0·5 and 10 units of penicillin and bacitracin, respectively, per ml. of milk. S. C. JOLLY.

Influence of temperature on the development of several psychrophilic bacteria of dairy origin. V. W. Greene and J. J. Jezeski (*Appl. Microbiol.*, 1954, **2**, 110—117).—Biochemical characteristics of organisms which attack milk at refrigerator temp. are examined. A. G. POLLARD.

Centrifuge tubes and sedimentation vessels for the determination of visible dirt in milk. (*Brit. Stand. Instn*, B.S., 1955, 736, 11 pp.).—The dimensions of the centrifuge tubes, graduations, tolerances on capacity (which must be calibrated at 20°), etc., and the dimensions and construction of the sedimentation vessels, are specified. J. M. JACOBS.

Rapid method for [determining] water-insoluble acids in butter. L. G. Ensminger (*J. Ass. off. agric. Chem.*, 1955, **38**, 183—184).—The sample of butter is shaken several times with hot water, then dissolved in ether, and titrated with 0·05N-sodium ethoxide solution, using phenolphthalein as indicator. Satisfactory results are recorded. The procedure is not suitable for the analysis of cream. A. A. ELDRIDGE.

Nutritive value of whey powder protein. L. K. Riggs, A. Beaty, and B. Mallow (*J. Agric. Food Chem.*, 1955, **3**, 333—337).—The nutritive value of the protein was expressed as gain per g. of protein consumed by young rats. Three spray-dried whey powders promoted growth, and gain per g. of protein consumed ranged from 1·32 to 1·57 g. Of three roller-dried whey powders, two failed to promote growth, the animals lost weight, and the third promoted a slow rate of growth. Neither type of whey powder protein was equal to lactalbumin in nutritive value, but the value of both was improved by lactalbumin supplement. Lysine supplementation partially corrected for the deficiency in roller-dried whey protein. Protein concentrates prepared by heat coagulation or methanol extraction of spray-dried whey were equal to lactalbumin, but both types of concentrates prepared from roller-dried whey were inferior to lactalbumin in nutritive value. (18 references.) E. M. J.

Natural occurrence of *para*hydroxybenzoic acid as a ripening product in cheese. R. Jarczynski and F. Kiermeier (with I. Gössel) (*Z. LebensmittUntersuch.*, 1955, **100**, 195—200).—Recognisable traces

(> 0·01%) of naturally produced *p*-hydroxybenzoic acid (**I**) can be chromatographically detected in ripe Romadur cheese. The addition to the cheese of 0·02 to 0·05% of **I** (inadequate amounts for preservation) cause a marked intensification of the spots on the chromatogram due to natural **I**. Amounts of **I** found in ripe Camembert or Tilsit cheese are less than those found in Romadur. P. S. ARUP.

Biochemistry of cheese ripening. XI. Transaminase activity in ripening sour-milk cheese, with special reference to the glutamic acid–aspartic acid system. J. Schormüller and W. Gellrich (*Z. LebensmittUntersuch.*, 1955, **100**, 200—218).—Transamination activity as estimated by the method of Tonhazy *et al.* (cf. Brit. Abstr., C, 1951, 16) does not occur in the fresh curd, but increases, due to bacterial activity, to a max. during 24 days. The enzymic activity is reduced by 50% by heating for 10—20 min. at 50—55°, and by 100% at 67—73°. Special sensitivity of the enzyme to inhibition by quinone and compounds of Ag and Hg probably characterises it as thiol-enzyme. The application of the above analytical method to the investigation is described in detail. (180 references.) P. S. ARUP.

Seasonal "slit-openness" defect in Cheddar cheese. T. W. Albrecht and F. E. Ashe (*J. Dairy Sci.*, 1955, **38**, 29—33).—The salts in milk as related to the period of lactation had no effect on the seasonableness of this open-texture defect. Varying the pasteurising temp. of the cheese milk, cooking procedures, and curd acidity at the time of milking was ineffective in controlling the defect. In finished cheeses containing 1·60 to 1·70% of salt the defect was significantly minimised. S. C. JOLLY.

Lipase systems used in the manufacture of Italian cheese. I. General characteristics. W. J. Harper and I. A. Gould (*J. Dairy Sci.*, 1955, **38**, 87—95).—Each of 10 enzyme prep. used in the manufacture of Italian cheese probably contained a multiple lipase system, the characteristics of which were similar for prep. from the same animal source. S. C. JOLLY.

Lecithinase activity of egg yolk and dried egg. C. H. Lea and R. A. L. Wilson (*J. Sci. Food Agric.*, 1955, **6**, 153—157). The reported lecithinase activity of egg yolk and dried egg with liberation of choline, but not of fatty acids as observed by Acker *et al.* (cf. J.S.F.A. Abstr., 1954, i, 197) and the similarity of the enzyme to phospholipase D recently discovered in carrots and other vegetables (*Biochem. Z.*, 1952, **322**, 471) are discussed. The existence of any considerable lecithinase activity in fresh egg yolk or in spray-dried whole egg of good quality was not confirmed, and it is suggested that the results obtained by the German workers may have been caused by the action of microbial enzymes, possibly phospholipase C, present in the samples. (19 references.) E. M. J.

Effect of washing and oiling on storability of eggs. J. Kuprianoff (*Kältetechnik*, 1955, **7**, 38—44).—Clean eggs can be stored at −1° with very little spoilage. Washing dirty eggs is harmful. Oiling with a min. quantity of sterilised paraffin oil (η 8—10 centipoises at 38°) prevents weight loss and minimises deterioration during distribution. The oil can be applied by dipping or by spraying an emulsion, and if hot it sterilises the shell and underlying layers. Similarly eggs can be "thermostabilised" by dipping in hot water for 2—3 sec. (34 references.) A. R. PEARSON.

Spoilage of shell eggs by Pseudomonads. R. P. Elliott (*Appl. Microbiol.*, 1954, **2**, 158—164).—Infection of eggs by *Pseudomonas ovalis* increased after storage at 85—87% R.H. The course of infection and penetration of the inner membrane by the organism, preceded by the diffusion of a black-light-fluorescent pigment, is examined. Rates of development of perceptible odours of decomposition from fully fluorescent eggs, when whole, soft-boiled or when opened aseptically are determined. Odorous compounds may sometimes evaporate through the shell. Shell eggs which were only partially fluorescent had no apparent odour of decomposition. A. G. POLLARD.

Precipitin test in the detection of horse meat. L. Tammemagi (*Qd J. agric. Sci.*, 1954, **11**, 83—97).—Prep. of antiserum and its application in the precipitin test for the detection of horse meat are described. A. H. CORNFIELD.

Use of antibiotics in meat processing. H. H. Weiser, L. E. Kunkle, and F. E. Deatherage (*Appl. Microbiol.*, 1954, **2**, 88—94).—Infusion of aureomycin (50 p.p.m. in physiological saline) into beef followed by storage in a refrigerator for 48 hr. markedly lowered bacterial populations and prevented spoilage without affecting flavour: the tenderness of the joints increased. Delay in transfer to refrigerators caused an increase in bacterial flora but this diminished again during subsequent refrigeration. Aureomycin (2 p.p.m.) in beef disappeared in approx. four days. The numerical distribution of Gram-positive cocci, Gram-positive and -negative rods in beef after treatment with penicillin, chloramphenicol or aureomycin (2 p.p.m. in each case) was similar, Gram-positive rods tending to dominate in all cases. The bearing of these observations on the handling, storage, and processing of meat is considered. Infusion of whole carcasses with antibiotics before dressing out is practicable. A. G. POLLARD.

Investigation into the suitability of Pulawy and Large White swine for canning purposes. M. A. Janicki (*Roczn. Nauk rol.*, 1954, **69**, 45—63).—In the main, Large Whites are superior. To increase the industrial suitability of the Pulawy breed the following requirements need to be met: (*a*) fat content, particularly in the back, should be lowered, (*b*) the dorsal muscle developed, particularly in length of the eye of loin, and (*c*) belly muscle content increased and fatness decreased. E. G. BRICKELL.

Application of paper partition chromatography to identify off-flavour and odour constituents in stored dehydrated pork. H. N. Fukui (*Dissert. Abstr.*, 1955, **15**, 25—26).—The average reducing-sugar and carbonyl-N contents of dehydrated pork stored for two years were 67 and 12—46 mg. per 100 g. of meat respectively. Among the volatile constituents, methylamine, NH_3, and carbonyl compounds were identified; no volatile org. acids were detected. Acetaldehyde, lactic acid, and an unidentified carbonyl compound were found in meat stored at −20° and 100°F. Chromatographic methods used to study the various classes of compounds are outlined The sugars and NH_3-acids detected are reported. S. C. JOLLY.

Use of an ion-exchange resin for tissue hydrolysis in the determination of hexosamine. P. A. Anastassiadis and R. H. Common (*J. Sci. Food Agric.*, 1955, **6**, 229—231).—Hydrolysis of (*e.g.*, avian) tissue samples with 0·05N-HCl and Dowex-50 resin by heating in a sealed tube at 105—107° for 24 hr. followed by elution of the hexosamine from the resin with 2N-HCl and direct application of the modified Elson and Morgan (*Biochem. J.*, 1933, **27**, 1824) procedure gave results comparable to, but about 10% lower than those obtained by tissue hydrolysis with 4N-HCl for 4 hr. and subsequent application of a modified Elson and Morgan procedure already described (*Canad. J. Chem.*, 1953, **31**, 1093), which included corrections for interference by sugars and by humin. In the first mentioned method the necessity of correcting for interference by interactions between sugars and amino-acids and by humin is reduced or avoided. E. M. J.

Volatile bases and sensory quality-factors in iced white fish. A. S. C. Ehrenberg and J. M. Shewan (*J. Sci. Food Agric.*, 1955, **6**, 207—217).—Three catches of cod stored in ice for various periods under identical conditions were examined to ascertain the precision with which changes in total volatile-base (T.V.B.) content, and in trimethylamine (T.M.A.) content specifically, and in the sensorily perceptible quality-factors of the fish might be observed, and also the consistency with which such changes are inter-related. The spoilage rates of the sensory variables and the logarithmic spoilage rates of the chemical variables are approximately linear, but differ in the three catches. There was a close relationship between the odour and flavour scores of the cooked fish, and both variables are related to T.V.B. content by relations such as: Flavour + 6·2 log (1 + T.V.B.) = 15·0. There was also a striking correlation between the quality-factors of the raw fish during the course of spoilage in general. The large increases in T.V.B. during storage are principally accounted for by the increase in T.M.A. (14 references.) E. M. J.

Changes in Dutch salted matjesherring during storage and spoilage. A. F. M. G. Luijpen (*Centr. Inst. Voedingsonder. T.N.O.*, Publ. No. 190, 12 pp.).—Relationships are found between spoilage and contents of tyrosine, NH_3, or trimethylamine, but these are not definite enough to allow of the fixing of permissible max. The connexion between volatile acid content and spoilage is probably more definite, and worthy of further investigation. The type of spoilage undergone depends largely on the NaCl content. No connexion is found between spoilage and bacterial counts, pH, or peroxide values. P. S. ARUP.

Application of high-speed centrifugation to studies of plastic spreads. N. N. Hellman, H. F. Zobel, G. E. Babcock, and F. R. Senti (*J. Amer. Oil Chem. Soc.*, 1955, **32**, 73—77).—The analytical ultracentrifuge is used to determine the rate of separation of a plastic spread into liquid and solid phases and the proportion of each phase present. Incomplete separation, however, complicates the estimate of amount of true solids and the chemical characterisation of the solid component. Improved separation of the solid phase is obtained by centrifuging the plastic spread with a layer of aq. alcohol of density intermediate between those of the oil and solids. Chemical analysis of the oil and centrifugation of the spread at each of several temp. followed by analysis of the oil and solids phases leads to a characterisation of the different oil components. D. BAILEY.

Consistency changes in global spread caused by tempering. N. N. Hellman, H. F. Zobel, and F. R. Senti (*J. Amer. Oil Chem. Soc.*, 1955, **32**, 110—114).—Consistency changes in global spreads caused by

tempering are described and the underlying mechanism of these changes is discussed. Global edible spreads become firmer in consistency subsequent to their manufacture due to the combination of existing aggregates by slow deposition of monoglyceride in the supercooled mixture. Tempering global spread at 95°F. or above causes softening initially, followed by hardening on prolonged tempering and this is more rapid as the temp. increases. Physical studies of spreads suggest that consistency changes are a consequence of recrystallisation of solid components. Softening occurring in initial stages of tempering results from weakening of aggregate structure present in untempered spread and recrystallisation of solids into more perfectly ordered and sharply defined crystals. Hardening after prolonged tempering results from further recrystallisation of solids into needle-like and plate-like forms. D. BAILEY.

Identification of fats by urea fractionation. W. F. Shipe (*J. Ass. off. agric. Chem.*, 1955, **38**, 156—165).—Experimental procedure for the fractionation of fatty acids prepared from butter and other fats is detailed; three fractions are obtained by the use of 10% or 20% urea solution, and the refractive indices of the samples of fatty acids so obtained are measured. Results obtained for various fats and oils are tabulated. Various differences provide evidence for the presence of individual fats; thus for butter fat the refractive indices of the *B* and *C* fractions are greater than that of the *A* fraction, whilst for coconut oil the *C* values are greater and the *B* values less than the *A* value. For the analysis of many samples, after eliminating grossly adulterated samples by determining the refractive index of the original oil, a screening technique is suggested. A. A. ELDRIDGE.

Detection of adulterants in olive oil using chromatographic methods. C. Petronici (*Chim. e Industr.*, 1955, **37**, 273—275).—Linseed oil added to pure olive oil is determined by absorption chromatography on Al_2O_3. The detection of adulterants is based on the different positions of rings and bands in the alumina column viewed under u.v. light. The presence of up to 5% of extraneous oils can be detected, but a quant. analysis is only possible when extraneous oils are present in quantities above 15—20%. The appearance of several oils on the absorption column is illustrated in colour. C. A. FINCH.

Cacao polyphenolic substances. III. Separation and determination on paper chromatograms. W. G. C. Forsyth (*Biochem. J.*, 1955, **60**, 108—111).—Two-way and quant. paper chromatography are applied to the polyphenols of the cacao bean. The bean contains four catechins, of which 92% is (−)*epi*catechin, as well as at least three leucocyanidin compounds and two cyanidin glycosides. The freshly dried bean contains ~3% of catechins and 2·5% of leucocyanidins. J. N. ASHLEY.

Public health aspects of addition of non-nutrient chemicals to food. F. A. Nelemans (*Ned. Tijdsskr. Geneesk.*, 1954, **98**, 2577—2588).—A review covering public health problems arising from the additions to food of preservatives, antioxidants, and binding, emulsifying, and flavouring agents. P. S. ARUP.

Polymeric phosphates in foods. K. W. Gerritsma (*Voeding*, 1954, **15**, 293—303).—A review covering chemical composition, prep., analysis, physiological activity, and harmful impurities of polymeric phosphates. (48 references.) P. S. ARUP.

Monetary evaluation of calories and proteins; the "monetary food value." J. Straub and A. Schoustra (*Voeding*, 1954, **15**, 210—218).—A consideration of relative costs permits of the approx. calculation of monetary food values on the basis of 1 cent (Dutch) per g. of animal, or 2 g. of vegetable protein, and 1 cent per 50 cal. (whether derived from fat or sugar). The values are compared with retail prices in Holland of a comprehensive list of foods. The relationship between the calculated values and prices is further analysed by means of graphs. P. S. ARUP.

Dangers of cancer growth caused by the presence of foreign substances in food. R. Truhaut (*Ann. Nutr., Paris*, 1955, **9**, 5—37).—The origin in food of carcinogenic substances is reviewed and principles for restricting their use are suggested. (157 references.) S. C. JOLLY.

Iron and nutrition. G. Schapira and J. C. Dreyfus (*Ann. Nutr., Paris*, 1955, **9**, 39—92).—A review with 250 references. S. C. JOLLY.

Bisphenol derivatives as antioxidants for carotene. E. M. Bickoff, A. L. Livingston, and C. R. Thompson (*J. Amer. Oil Chem. Soc.*, 1955, **32**, 64—68).—Relative values for the carotene-stabilising effects in mineral oil solution of 42 bisphenol derivatives are determined and compared with corresponding values in lucerne meal. High activities are obtained with bisphenols linked by methylene or S but this activity is markedly decreased when the H of methylene group in 2 : 2′-methylene-bisphenols is substituted. Alkyl substitution in the reactive *o*- and *p*-positions improves the stabilising efficiency of the compounds studied. D. BAILEY.

Colour in foods. Symposium, 1953. [Edited by] K. T. Farrell, J. R. Wagner, M. S. Peterson, and G. Mackinney (*Quartermaster Food and Container Inst. for the Armed Forces, Chicago; Nat. Acad. Sci., Nat. Res. Council, Wash.*, 1954, pp. vi + 186).—This symposium was arranged primarily to discuss problems which were of concern to the American Armed Forces, but as an informative cross-section of the current status of research on colour in foods and its application to practice the results should be of interest to all workers in this field. The subject matter is divided into five sections: (*a*) opening remarks and introduction; (*b*) colour and its relationship to food investigations; (*c*) colour measurement in relation to commodities and consumer interest; (*d*) instruments for the study of colour; (*e*) measurement of colour and colour differences in relation to quality. There is continuous reference to relevant literature throughout and the symposium concluded with a general discussion. There are many diagrams, graphs, tables, and other illustrations in the text.

A. **Instruments for the study of colour. Colour measurements with tomatoes.** N. W. Desrosier (pp. 57—67).—The difficulties associated with the assessment of "90% good red colour," by different inspectors, in various regions, from day to day, month to month, etc., and the need for colour-grading instruments are discussed. Three instruments of interest to the tomato industry are the Hunter tristimulus colour and colour-difference meter (more useful for research than for field work), the Purdue colour-ratio meter, and the Agtron; details of these and results obtained are given. The most accurate estimate of colour of tomato is obtained from the extracted juice. For particular food colour evaluation, relatively simple electronic devices such as the Purdue colour-ratio meter and the Agtron may be constructed which would have good accuracy for quality control type of examinations.

B. **Potential application of the rapid scanning spectrophotometer for the objective evaluation of food colour.** R. Pomerantz (pp. 67—84).—The instrument used, the American optical rapid scanning spectrophotometer equipped with reflection attachment is figured and described. Complete spectrophotometric curves in the visible region (400 mμ. to 700 mμ.) are instantaneously produced on the face of a cathode ray tube. In selecting the food items to be studied, the following factors were considered: importance of colour in grading the product, tendency of the product to be adulterated; importance of colour in specification purchasing; availability of a wide variety of commercial samples; an official type test so that the scores could be correlated with scores obtained in accordance with current U.S. Government standards. Transmission (*e.g.*, vanilla, olive oil) and reflectance studies (*e.g.*, tomato catsup, tomato juice) are described. The spectrophotometer appears to possess a high degree of potential application in the olive oil industry. The advantages of its general use are summarised.

C. **Comparison of colour-measuring instruments.** C. O. Chichester (pp. 84—91).—Basically the ultimate standard is not the spectrophotometer, but the human eye. The oldest colour-determining instruments are the additive visual colorimeters, *e.g.*, the Munsell colour collection. The Lovibond tintometer is probably the most widely used substractive colorimeter today. These two types have the ability to give a reproducible specification to a fluorescent material. The comparators are used to compare a standard colour with that of an unknown. The American Society for the Testing of Materials has designated the spectrophotometer as the ultimate in the specification of colour. Spectrophotometers and the tristimulus filter colorimeter are discussed. Instruments such as the Agtron and the Purdue colorimeter are used specifically for abridged spectrophotometry of particular products. Finally it has been observed that in the examination of a large no. of tomato purées, while most of them could be evaluated for appearance from hue and brightness, their precise classification required consideration of all three attributes.

D. **Measurement of colour and colour differences in relation to quality. Colour inspection—California Department of Agriculture.** S. R. Whipple (pp. 92—102).—By legal specification in the California Agricultural Code, strawberries, cherries, oranges, grapefruit, Elberta peaches, nectarines, Bartlett pears, persimmons, pomegranates, watermelons, apples, honey, and canning tomatoes are required to meet a specific colour requirement at harvest. The methods of applying colour standards are (*a*), 1953 season, a plastic disc that was a good visual match to a painted disc specially prepared to match peach flesh. The purpose of the plastic disc was to provide a uniform standard of min. maturity for fresh canning cling peaches. (*b*) A colour photograph is used as a standard for a cut surface such as that of a canning tomato. (*c*) An electronic method is described involving the use of the Agtron which is figured, the first season being 1953.

E. **Colour changes during storage of foods.** G. E. Livingston and C. R. Fellers (pp. 103—109).—A study of the reactions involved in the discoloration of puréed fruit and vegetable products and fruit preserves is described. They represent systems containing very small

amounts of protein or N constituents, and generally are highly pigmented products containing chlorophyll, carotenoid, and anthocyanin pigments. The possibility of colour formation from colourless precursors, and that of changes due to pigment degradations are discussed; in products which do not contain anthocyanin pigments, there is no significant pigment degradation in course of storage. In the course of adequate sterilisation of commercial comminuted foods enough damage to plant tissues occurs to visibly affect its colour. The colour changes in, *e.g.*, strawberry preserves and in the non-pigmented constituents of fruit jellies are discussed.

F. **Colour measurement in strawberry preserves.** E. E. Meschter (pp. 110—118).—A method is described whereby the transmittancy of a strawberry preserve can be numerically evaluated closely approximating the visual appearance. As the spectra change with deterioration of red colour, a brown pigment also develops. There is a peak at 500 mμ. and a plateau at 420—440 mμ. Units are defined: viz., 1 unit of red or brown pigment is that quantity which produces an absorbance of 1·0 in a 1-mm. cell at 500 mμ. or 420 mμ. respectively. Details are given of the use of a standard data sheet and equations in the development of a nomograph. From the study of spectral properties of any anthocyanin fruit pigment, similar formulæ could be developed to evaluate the colour of other preserves.

G. **Colour differences in the quality evaluation of processed fruits and vegetables.** O. J. Worthington (pp. 119—128).—Correlation of an instrumental colour analysis with visual or flavour scores is discussed. Results of experiments with canned Italian prunes and strawberry samples are presented and discussed, such instruments as the Lumetron filter photometer and the Hunter colour difference meter being used. The use of the photovolt reflection meter with prunes is described. Eight stages in the study are detailed. With strawberries there is high correlation between the scales of different instruments. For quality evaluation practice the choice of an instrument may be determined by factors other than precision, so long as the best measure for each instrument is utilised.

H. **Colour measurement in other products.** J. B. Moster and A. N. Prater (pp. 129—135).—Several techniques and principles employed in developing methods for the measurement of colour of capsicum spices are presented. The colour is extracted with ethanol or *iso*-propanol and is measured with a Beckman DU spectrophotometer. The effect of pigment concentration on colour is considered. The spectrophotometric method was developed to closely correlate with the Lovibond method. An attempt to develop a linear colour scale is described.

I. **Effect of heat treatment on plant carotenoids.** A. Joyce (pp. 136—160).—The occurrence, functions, synthesis, and degradation of these pigments are briefly reviewed including the effects of processing and destruction, leading to deterioration in colour and flavour, *e.g.*, β-carotene. Lycopene, which belongs to the C_{40} polyene group of carotenoids is studied in detail, with discussion of structure of the molecule. In processing plant tissues containing carotenoid, the molecular shape of the pigment changes, unstable poly-*cis* forms give all-*trans*, di- and mono-*cis* forms with alteration in the colour of the tissue; the all-*trans* form gives mono- and di-*cis* forms presumably with loss of provitamin A activity. The carotenoid is destroyed and there is deterioration in culinary quality. (86 references.)

J. **Pigment changes in tomatoes ripened at 90°F.** F. J. Francis (pp. 160—162).—Temp. ~90°F. inhibit the formation of lycopene, the chief pigment in commercial varieties of tomato, but data obtained indicate that in tomatoes ripened at 90°F. the formation of all pigments is markedly inhibited. The carotenoid and colourless polyene contents of tomato fruits ripened under different conditions are tabulated. E. M. J.

Methods for evaluation of nutritional adequacy and status. Symposium, 1954. [Edited by] H. Spector, M. S. Peterson, and T. E. Friedemann (*Quartermaster Food and Container Inst. for the Armed Forces, Chicago, and the Med. Nutr. Lab., Office of the Surgeon General. Nat. Acad. Sci., Nat. Res. Council, Wash.*, 1954, pp. vii + 313).—The accomplished objectives of this symposium were: (*a*) the merits of existing methods were critically evaluated, (*b*) the needs for special methods not now available were emphasised, and (*c*) the possibilities for developing such methods in the near future were constructively considered by appropriate suggestions. The complexity of the relationships of food composition to body composition and function was considered, and the evaluation of the nutritional status of individuals or surveys of population groups by combining clinical examination with biochemical assessment. The subject matter of the text comprises seven sections: introduction, three sections on evaluation of (*a*) protein, (*b*) vitamin, (*c*) mineral adequacy, evaluation of military rations by animal experimentation, evaluation of nutritional status of populations, round-table discussion on body composition. There are 27 contributions in addition to the three introductory papers, all of nutritional, physiological, and medical interest. E. M. J.

Mobile kitchens. J. P. van Loon (*Conserva*, 1955, **3**, 262—267).—Descriptions and plans are given of the lay-out and functioning of the eight vans making up the kitchen train. P. S. Arup.

Preservation of foods. VII. Preservation by heating. A. Clarenburg and D. A. A. Mossel (*Conserva*, 1955, **3**, 273—280).—A review covering principles involved in sterilisation and pasteurisation and the destruction of micro-organisms, types of spoilage organisms and their heat-resisting capacity, and types of perishable foods. P. S. Arup.

Storage of apples and pears. C. A. S. Padfield (*N.Z. Dep. sci. industr. Res.*, 1954, *Bull.* 111, 96 pp.).—A synopsis of fruit storing practices, based on experimental results, for the benefit of storage operators. The work is divided into three parts, comprising: (*a*) Pre-storage conditions for different varieties of apples and pears and the influence of factors like climate, soil, fertilisers, pests, diseases, maturity, harvesting, etc., pp. 11—31. (*b*) Conditions in the store (humidity, ventilation, sanitation etc.) and various types of shed-, orchard-, cool-, and refrigerated gas-storage, pp. 32—48. (*c*) Physiological disorders and fungus rots of stored fruit, their causes, symptoms, and control, pp. 49—94. A bibliography of relevant N.Z. literature is added. L. S.

Apparatus for the aëration of barley and like cereals. G. Porteus, jun. (B.P. 721,581, 25.10.49).—Aëration of barley etc. in steeping cisterns at predetermined intervals of time, in the production of beer and spirits, is effected automatically. The valve in the air supply pipe is operated by an electric motor controlled by a time switch which also controls the compressor. Three-way switches can be fitted allowing time switch control, no running, or continuous running without the action of a time switch. J. Roberts.

Inhibiting the sprouting of potatoes. National Research Development Corp. (Inventor: W. G. Burton) (B.P. 721,208, 17.9.51).—Potatoes are stored in an atmosphere of air with CO_2 content below 1%, and containing a small proportion of either the accumulated volatile products of respiration of potatoes or the vapour of an aliphatic alcohol (0·001 g./l.). The atmosphere is scrubbed (*e.g.*, through NaOH) and recirculated to maintain the correct CO_2 content. J. Roberts.

Improved dairy wax composition. Standard Oil Development Co. (Inventors: R. M. Bailly and H. F. Hitchcox) (B.P. 720,354, 29.10.52).—Refined paraffin wax, b.p. spread between 5% and 95% b.p. $\geq$50 (28)°/10 mm., *e.g.*, 5% of b.p. 220—225°, 95% of b.p. 245—250°/10 mm., containing <0·5 (<0·3) wt.-% of oil, is compounded with microcrystalline wax 0·1—10 (1—10)% and/or *poly*-ethylene (mol. wt. 4000—22,000, preferably 10,000—14,000) 0·1—3%, to provide a wax composition for coating paperboard milk containers. F. R. Basford.

[Support or cover] for cooking meat. R. Greenwood (B.P. 721,331, 1.10.52). K. Ridgway.

[Preparation of] modified lard. Swift & Co. (Inventors: F. A. Norris, K. F. Mattil, Dewitte Nelson, and W. E. Dominick) (B.P. 721,493, 15.7.52).—A lard prep. of increased resistance to deterioration of appearance and texture, with an *X*-ray diffraction pattern similar to that of hydrogenated vegetable shortening, is obtained by heating rendered lard in presence of 0·01—3 wt.-% of a catalyst, viz., an inorg. compound [*e.g.*, $SnCl_2$ or Sn hydroxide, or NaOH, during 0·5—6 hr. at 150—260°], an org. salt [*e.g.*, Na alkoxide (ethoxide or methoxide), at 60—120° during 3—240 min. until reddish-brown]; alkali metal (Na) or Na amide or hydride, *e.g.*, at 50—175 (80—100)°. F. R. Basford.

Manufacture of fat emulsion. Weston Condensing Co. (Inventors: D. D. Peebles and M. D. Girvin) (B.P. 721,499, 25.8.52).—Semi-solid fat 10—52 (35—52), *e.g.*, hydrogenated vegetable oil, is emulsified in water 45—89 (62)% at pH 6·8—7·2 in presence of Na caseinate 1·2—3·1 wt.-%, and the resulting emulsion is sterilised (at 115°, after packaging), to give a prep. suitable for use in the production of fat-containing food products (reconstituted milk). Thus, a mixture of edible casein (1280), water (32,300), and $NaHCO_3$ (62 g.) is heated during 1 hr. at 90°, then melted hydrogenated cottonseed oil (22,700 g.), Na alginate (40), butter flavouring (2·1 g.), and vitamin concentrate (viz., carotene 12,000, vitamin A 3000, and vitamin D 5000 i.u. per lb.) are added. After homogenisation at 60°, the emulsion is poured into cans, heated during 14 min. at 115° while sealed, then cooled to ~20° during 6 min., to give a homogeneous product. F. R. Basford.

Production of ingredients for foodstuffs. P. S. Jewell and James G. T. King (B.P. 721,057, 2.7.52).—Gluten or flour containing it is treated with yeast (or an inoculation emulsion thereof) in presence of water at emulsion-forming temp. (>36°), under such conditions (at

>42° or in sterile media), to give a stable emulsion free from off-odour and suitable for use as foodstuff. F. R. BASFORD.

Device for signalling the boiling of milk or other liquid in a pan. C. Willber (B.P. 720,063, 22.7.52).—An inverted cup-shaped member rests on the base of the pan. It has fixed-diameter or adjustable notches or holes, allowing escape of small quantities of vapour, but when boiling commences it is raised and dropped by the escaping vapour and knocks the pan to give an audible signal. A handle is fitted to project above the liquid surface for easy removal. K. RIDGWAY.

Sterilisation of foodstuffs packed in containers. Gebr. Stork & Co.'s Apparatenfabriek N.V. (B.P. 721,322, 22.5.52. Neth., 29.5.51). —Cans are mounted in cylindrical rotatable bodies, carried on shafts between two endless chains, the cans forming an annular ring around the shafts. They pass through a pressure steam steriliser and are rotated by a second chain system engaging toothed wheels, travelling with the carrying chain but at a different speed. At the loading and unloading points this second chain follows a different path so that the cylindrical bodies are freed and can be easily rotated for loading or unloading. K. RIDGWAY.

3.—SANITATION

Method for *in vivo* evaluation of skin sanitising soaps. H. Quinn, J. G. Voss, and H. S. Whitehouse (*Appl. Microbiol.*, 1954, **2**, 202—204).—Comparison is made of the "split use" and Price (*Ann. Surg.*, 1951, **134**, 476) methods for evaluating detergents. Both were applicable to the testing of antibacterial soaps. Tests with Hexachlorophene (3 : 5 : 6-trichloro-2-hydroxyphenylmethane), bis-(3 : 5-dichloro-2-hydroxyphenyl)methane, Bithionol [bis-(3 : 5-dichloro-2-hydroxyphenyl) sulphide], Na pentachlorophenate, and Zn dimethyl dithiocarbamate are recorded. A. G. POLLARD.

Efficiencies of disinfectants for use on inanimate objects. I. Relative activities on a stainless steel surface using a new performance test method. R. L. Stedman, E. Kranitz, and H. Bell (*Appl. Microbiol.*, 1954, **2**, 119—124).—The proposed technique is based on the drying of suspensions of organisms on squares of stainless steel, applying the disinfectant material and collecting quantitatively the surviving organisms. Typical test organisms, selected for their resistance to drying, were *Micrococcus pyogenes* var. *aureus*, *Salmonella schottmuelleri*, and *Trichophyton interdigitale*. Data obtained for the relative efficiency of various types of disinfectants (phenolic, Cl_2 producers, quaternary salts) are recorded. A. G. POLLARD.

Chronic toxicity for rats of food treated with hydrogen cyanide. J. W. Howard and R. F. Hanzal (*J. Agric. Food Chem.*, 1955, **3**, 325—329).—Diets fumigated with and containing concentrations of 100 and 300 p.p.m. of HCN are non-toxic to male and female albino rats over a two-year period. Increased values of thiocyanate found in the tissues of the test animals indicated that the cyanide is readily detoxified to thiocyanate. Growth curves for male and female rats are given. (14 references.) E. M. J.

Fluoroacetamide as a rodenticide. C. Chapman and M. A. Phillips (*J. Sci. Food Agric.*, 1955, **6**, 231—232).—Fluoroacetamide is available commercially in large quantities. It appears to be a safer material to handle than is Na fluoroacetate and might be preferable for use against ship rats and the common rat. The amide is transformed only slowly in the animal's body to the free acetate, so that high concentrations causing toxic convulsions are never attained. Fluoroacetamide is a well-defined crystalline compound, characterised by m.p. (109°) and mixed m.p. E. M. J.

Toxicity of choline-esterase inhibitor insecticides. L. W. Hazleton (*J. Agric. Food Chem.*, 1955, **3**, 312—319).—The common property of the org. phosphate-type of insecticides to inhibit choline-esterase is reviewed. The acute toxicity as indicated by the enzyme-inhibiting action varies among different members of the group, and a subacute toxic condition arises when inhibition exceeds choline-esterase regeneration rate. Complete recovery may be made without residual tissue storage or pathology. Adequate industrial hygiene conditions have eliminated hazards of use, *e.g.*, time of exposure, by oral or dermal absorption or inhalation. Details are given of the structure and properties of: parathion, methyl parathion, tetraethyl pyrophosphate, ethyl *p*-nitrophenyl thionobenzenephosphonate, Malathion, Diazinon, octamethylpyrophosphoramide, and Systox. (80 references.) E. M. J.

Organophosphorus insecticides, dimethyl 2 : 2-dichlorovinyl phosphate (DDVP), an organic phosphorus compound highly toxic to insects. A. M. Mattson, J. T. Spillane, and G. W. Pearce (*J. Agric. Food Chem.*, 1955, **3**, 319—321).—Traces of a highly toxic impurity were found in a technical grade of the insecticide *OO*-dimethyl 2 : 2 : 2-dichloro-1-hydroxyethyl phosphonate. By the addition of 1 mol. of NaOH to 1 mol. of *OO*-dimethyl 2 : 2 : 2-trichloro-1-hydroxyethyl phosphonate, an alkaline degradation product with the loss of one atom of Cl and probably one atom of H was formed having toxic properties similar to those of the impurity observed. At the same time there was rearrangement within the mol. the configurations of which are discussed. The toxicity of the new substance was about equivalent to that of parathion. (11 references.) E. M. J.

Cyclethrin: a new synthetic insecticide. H. L. Haynes, H. R. Guest, H. A. Stansbury, A. A. Sousa, and A. J. Borash (*Soap, N.Y.*, 1955, **31**, No. 2, 141, 143, 147, 151, 160—161).—Cyclethrin, which is related to allethrin, has the composition 3-(2-*cyclo*pentenyl)-2-methyl-4-oxo-2-*cyclo*pentyl chrysanthemum-monocarboxylate. It possesses many of the attributes of the natural pyrethrins and is synergised by them more readily than is allethrin. Techniques whereby cyclethrin has been tested against house flies, red spider, and rice weevil are described; and the comparative results of the space spray tests, on flies, with cyclethrin and allethrin in conjunction with four types of synergist, and with standard pyrethrin as control, are given. G. HELMS.

Paper chromatography of some organic phosphate insecticides. IV. Spot test for *in vitro* choline-esterase inhibitors. J. W. Cook (*J. Ass. off. agric. Chem.*, 1955, **38**, 150—153).—Visual location of the inhibitors along the chromatogram (*ibid.*, 1954, **37**, 989) is accomplished by placing in contact four prepared paper strips in the order: substrate, enzyme + bromothymol blue, chromatogram, water. The enzyme preparation consists of alkaline blood plasma, and the substrate is acetylcholine chloride. Tests with organic phosphate insecticides show that the technique is frequently highly sensitive. A. A. ELDRIDGE.

Distribution of radioactive phosphorus in susceptible and resistant house flies. F. H. Babers and C. C. Roan (*J. econ. Ent.*, 1954, **47**, 973—975).—Both susceptible and resistant strains of house-fly larvæ utilised inorg. P to synthesise numerous P compounds. The necessity for routine chemical procedures supplementing radioisotopic methods in bioassay work is emphasised. A. A. MARSDEN.

Factors influencing the efficiency of insecticide-impregnated cords for house-fly control. R. W. Fay and D. A. Lindquist (*J. econ. Ent.*, 1954, **47**, 975—980).—Sisal or cotton cords were more attractive to house flies than were jute or wool cords: red or black cords were preferred to green, blue, yellow, or white cords. Cords dipped in parathion (5 or 10%)-xylene gave complete mortalities of DDT-resistant flies; cords treated with Diazinon–xylene gave >90% kill. Treatment of cords with parathion (5%) and Diazinon (5%) resulted in high mortality and rapid knockdown. Parathion and Diazinon used in this manner were more effective than were CS-708, DDT, NPD, nicotine, A-42, Malathion, EPN, Bayer 21/199 (3-chloro-4-methylumbelliferone *OO*-diethyl thiophosphate), and Bayer L13/59. A. A. MARSDEN.

Correlation between the length of the larval period of *Musca domestica*, L. and resistance of adult flies to insecticides. R. E. McKenzie and W. M. Hoskins (*J. econ. Ent.*, 1954, **47**, 984—992).—Selection of late pupæ led to a slow decrease in resistance to DDT and after 53 generations the flies were more susceptible than an unselected check strain. Changes in susceptibility to DDD were more marked than to DDT, but were slight to methoxychlor, and absent with lindane, Aldrin, Dieldrin, and pyrethrins. A. A. MARSDEN.

Adsorption, distribution, and site of action of DDT in DDT-resistant and DDT-susceptible house flies using ^{14}C-labelled DDT. E. J. LeRoux and F. O. Morrison (*J. econ. Ent.*, 1954, **47**, 1058—1066).—The site of application of topically-applied DDT greatly influenced rate of penetration, distribution, and accumulation at the site of action. DDT in the body of the fly was distributed from the point of application by the hæmolymph. The site of action of DDT appeared to lie within the head of the adult fly. Resistant flies absorbed externally-applied DDT much more slowly than did a susceptible strain. Various factors in the phenomenon of DDT resistance in house flies are discussed. The nearer the DDT application was to the inside of the head, the lower was the observed LD_{50}. A. A. MARSDEN.

Effects of red, white, and South American cedar chests on the various stages of the webbing clothes moth and the black carpet beetle. H. Landani and P. H. Clark (*J. econ. Ent.*, 1954, **47**, 1107—1111).—The toxicities of chests made from red cedar (*Juniperus virginiana*), white cedar (*Chamæcyparis thyoides*), and South American cedar (*Cedrella odorata*) wood were determined on all stages of the black carpet beetle, *Attagenus piceus*, and the webbing clothes moth, *Tineola bisselliella*. All cedar chests inhibited hatching of eggs of both insect species when laid in these chests but had little effect on eggs introduced after oviposition. In general the young larvæ were much more susceptible to exposure in the cedar

chests than were mature larvæ, pupæ, or adults. Adult clothes moths showed some susceptibility to exposure but these insects mated and laid viable eggs in the chests. All cedar chests showed a sharp decline in effectiveness after 16 to 24 months of ageing. A. A. MARSDEN.

Biological and toxicological studies of the little house fly. L. L. Lewallen (*J. econ. Ent.*, 1954, **47**, 1137—1141).—A laboratory method of rearing *Fannia canicularis* is reported. Female adults of *F. canicularis* were 85, 76, and 2 times more tolerant to DDT, lindane, and methoxychlor, respectively, than were house flies. Dieldrin and pyrethrins were ten and four times, respectively, more toxic to *F. canicularis* than they were house flies. Org. P insecticides tested on *F. canicularis* were in the following order of decreasing toxicity: Chlorthion, Diazinon, Malathion. A. A. MARSDEN.

Hazards of spores in floor coverings; sawdust. J. H. Richardson, V. J. Del Guidice, and C. K. Wiesman (*Appl. Microbiol.*, 1954, **2**, 177—182).—Means of preventing mould contamination by sawdust spread on floors, *e.g.*, food packing factories, are examined. Cu 8-hydroxyquinolate (0·07—0·14% of sawdust) in certain forms was fungicidal; a dry powder and an emulsified prep. left no apparent odour. Dimethyldodecylamine was fungistatic at a concn. of 2·8%. A. G. POLLARD.

Microbial cross-resistance to toxic agents. IV. Cross-resistance of *Bacillus megatherium* to forty-four antimicrobial drugs. W. Szybolski (*Appl. Microbiol.*, 1954, **2**, 57—63).—The production of strains of *B. megatherium* showing resistance to numerous toxic agents is examined with a view to elucidating the phenomena of cross-resistance. A classification of toxic substances on this basis is described. A. G. POLLARD.

Effects of ultraviolet irradiation on large populations of certain water-borne bacteria in motion. I. Development of adequate agitation to provide an effective exposure period. J. R. Cortelyon, M. A. McWhinnie, M. S. Riddiford, and J. E. Semrad (*Appl. Microbiol.*, 1954, **2**, 227—235).—With apparatus described a stream of water is agitated sufficiently to ensure that exposure to u.v. light is adequate to eliminate *E. coli* and *Salmonella typhosa*. A. G. POLLARD.

Microbiological factors in the treatment of phenolic wastes. M. K. Hamdy, E. L. Sherrer, H. H. Weiser, and W. D. Sheets (*Appl. Microbiol.*, 1954, **2**, 143—148).—In a trickling filter system the presence of phenol induced the establishment of a phenol-resistant microflora capable of reducing phenol in concn. up to 400 p.p.m. at the rate of 0·9—1·2 lb. per sq. yd. daily. The activity of reduction was lowered in presence of lactose but favoured by NH_4NO_3, K phosphate, $FeCl_3$, and $MgSO_4$ and by aërobic conditions; it was optimum at 37—55°. Preliminary characterisation of three strains of bacteria (originating from domestic sewage) effecting the reduction of phenol is recorded. A. G. POLLARD.

Sludge treatment and pathogenic organisms. W. Müller (*Gesundheitsing.*, 1954, **75**, 187—189).—Ascarid eggs are more resistant than other parasitic and pathogenic organisms and can therefore be used as test organisms for the safety of a treated sludge. The results of various investigations into the viability of the eggs in digested and dried sludge are quoted. Sludge to be used as fertiliser can be rendered as safe as possible either by digestion at the usual mesophilic temp. of 15—35° for a min. period of six months followed by drying for ≮ six months, or by heating the sludge, fresh, digested, or dried, to 55° for ≮ 2 hr. The operation of both methods and the plant requirements are discussed. WAT. POLLUT. ABSTR. (R. B. C.).

Treatment of sewage with hexachloro*cyclo*pentadiene. E. J. Cole (*Appl. Microbiol.*, 1954, **2**, 198—199).—At the rate of 5 and 10 p.p.m. of sewage hexachloro*cyclo*pentadiene lowered total bacterial counts more quickly and more effectively than did Cl_2 (10 p.p.m.). Similar results were obtained for coliform organisms and for *Salmonella typhosa* suspended in sewage effluent. A. G. POLLARD.

Methane bacteria in [sewage] sludge. R. L. Mylroie (*Canad. J. Microbiol.*, 1954, **1**, 55—64).—A method described for enumerating CH_4-producing bacteria in sewage sludge involves the use of an agar–mineral salt medium with an atm. of H_2 and CO_2 and Pd as a reduction catalyst. Strains of *Methanobacterium formicum* (total no. 10^5—10^8 per ml. of sludge) were isolated and their characteristics were described. Other species, *e.g.*, *M. söhngenii* (which ferments acetate) are probably present in sludge. A. G. POLLARD.

Evaluation of odours. C. W. Beardsley and N. J. Krotinger (*Sewage industr. Wastes*, 1955, **27**, 157—160).—Suggestions are made for methods for evaluation of odours from sewage sludge. A sampling bag in which the sample can be transported for distances up to 20 miles is described. A. WEBSTER.

Effect of dried sewage sludge on nitrification in soil. J. E. Fuller and G. W. Jourdian (*Sewage industr. Wastes*, 1955, **27**, 161—165).—Various combinations of soil with and without dried sewage sludge have been compared for nitrification in soil, and the results indicate that the added sludge gives nitrate values equal to and usually greater than the same combinations without sludge. The sludge used contained no industrial wastes. A. WEBSTER.

Effect of bacterial flora on deoxygenation. W. L. Tidwell and J. H. Sorrels (*Sewage industr. Wastes*, 1955, **27**, 166—171).—The special two-day B.O.D. technique of Zehnpfennig and Nichols (*ibid.*, 1953, **25**, 1, 61) is shown to be more reproducible than the standard two-day and five-day B.O.D. tests. This technique has been used for studying the changes in microbial flora. The B.O.D. of a given sewage varies not only with the amount of organic matter, but with the probable number of organisms present. A. WEBSTER.

House-fly breeding in sewage sludge. H. W. Wolf (*Sewage industr. Wastes*, 1955, **27**, 172—176).—The breeding of house flies in sewage sludge has been investigated. There appears to be a relationship between the percentage of volatile solids and pupal size. The amount of nutrient available appears to be reduced by the digestion process. A. WEBSTER.

Statistical analysis of coliform data. Harold A. Thomas, jun. (*Sewage industr. Wastes*, 1955, **27**, 212—222).—The use of statistical analysis of coliform data as a means of assessing probable health hazards, particularly with respect to probable contraction of typhoid, is described, and techniques for estimating coliform density are given. On the basis of determinations made, a suggested coliform standard for the Ohio River is given, and the method of calculation detailed. It is indicated that any administrative action should be withheld until sufficient data have been accumulated to ensure their accuracy. A. WEBSTER.

Use of ultraviolet irradiation in a room air-conditioner for removal of bacteria. J. B. Harstad, H. M. Decker, and A. G. Wedum (*Appl. Microbiol.*, 1954, **2**, 148—151).—Suitable equipment is described and some operational data is given. A. G. POLLARD.

Laboratory equipment for testing filtering materials for air sterilisation. L. E. McDaniel and R. A. Long (*Appl. Microbiol.*, 1954, **2**, 240—242).—Suitable apparatus is described and comparative tests with a no. of filtering materials are recorded. Of these an asbestos–cellulose combination was the most effective. A. G. POLLARD.

Chloroalkyloxy ketones and their thio-analogues and pest control compositions containing them. A. Boehringer, E. Boehringer, I. Liebrecht, and J. Liebrecht, trading as C. H. Boehringer Sohn (B.P. 721,263, 4.12.52. Ger., 4.12.51).—Reacting an alkali metal salt of a chlorinated phenol or thiophenol of the general formula $MY{\cdot}C_6H_{6-5}Cl_{5-0}$ wherein Y is O or S and M is an atom of an alkali metal) with a chlorinated ketone $CH_2Cl{\cdot}COR$ (wherein R is an alkyl group with 1—5 C atoms) gives compounds $Cl_{5-0}C_6H_{6-5}Y{\cdot}CH_2{\cdot}COR$. The new compounds of this series have valuable pest-control properties, particularly against fungi and acarina. Typical pest control-preparations contain: active substance 10, kaolin 20, emulsifier 2, methylcellulose 5, water 63%. The agents may also be used as dusting powders, *e.g.*, powdered substance, ~10, talcum ~90%. Dropwise addition of chloroacetone to a solution of 2 : 4-dichlorophenol and NaOH in boiling EtOH affords 2 : 4-*dichlorophenoxyacetone*, b.p. 160—162°/13 mm. in 70% yield. The following compounds are prepared: 2 : 3 : 5 : 6-*tetrachlorophenoxy-*, m.p. 100°, p-*chlorophenoxy-*, b.p. 143—145°/13 mm., 2 : 4 : 6-*trichlorophenoxy-*, b.p. 170—174°/13 mm., 2 : 6-*dichlorophenoxy-***acetone,** b.p. 165—167°/13 mm., 2 : 4-*dichlorophenoxymethyl*, b.p. 170°/13 mm., and *pentachlorophenoxymethyl* **ethyl ketone,** m.p. 130°, 2 : 4-*dichlorophenoxymethyl*, b.p. 155—160°/3 mm., and *pentachlorophenoxymethyl* **propyl ketone,** m.p. 148°, p-*chlorophenyl-*, m.p. 31°, b.p. 170—173°/13 mm., 2 : 3-*dichlorophenyl-*, b.p. 115°/3 mm., 2 : 4 : 5-*trichlorophenyl-*, m.p. 99°, *pentachlorophenyl* **-thioacetone,** m.p. 82°, p-*chlorophenylthiomethyl ethyl ketone*, b.p. 147—151°/4·5 mm., p-*chlorophenylthiomethyl propyl ketone*, b.p. 155—160°/3 mm. H. WREN.

4.—APPARATUS AND UNCLASSIFIED

Production of carbon-disulphide gasification cylinders for pest control agents. K. Weigel (*Prakt. Chem.*, 1955, **6**, 59—63).—In the use of CS_2 as vermin-killer and insecticide in agriculture, the cylinders used for vaporisation are made of insoluble absorbent material like diatomaceous earth and are filled with a 1 : 1 : 1 mixture of CCl_4, CH_2Cl_2, and CS_2, while a blast of cold air prevents evaporation of CS_2. The receptacle is then immediately dipped into a solution of waterglass and $CaCO_3$, containing 5% of sodium methylsiliconate, to cover the cylinder with a stable gas- and moisture-proof coating. L. S.

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