JOURNAL
OF THE
SCIENCE OF FOOD AND AGRICULTURE
(INCLUDING ABSTRACTS)

Published by the Society of Chemical Industry

Volume 12 | No. 7 | July, 1961

Printed in Great Britain by Butler & Tanner Ltd., Frome and London

FERTILISER RESPONSES OF MAINCROP POTATOES : A RE-EXAMINATION OF THE EXPERIMENTAL EVIDENCE*

By D. A. BOYD

The results of recent manurial experiments on maincrop potatoes were re-examined to determine (i) what general changes in level of response had occurred since the summary of Crowther & Yates in 1940, and (ii) the nature of the interactions between nutrients and their influence on the form of the fertiliser response curve and on optimal fertiliser dressings.

Average responses to N 0·8 cwt., P_2O_5 1·0 cwt. and K_2O 1·5 cwt. per acre in over 100 experiments done since 1940 were 1·8, 1·4 and 2·0 tons per acre respectively, and these do not differ by more than 0·2 ton per acre from the figures of Crowther & Yates.

Most of the recent experiments on mineral soils showed large interactions between nutrients which affected both the magnitude of the response to a given dressing and the degree to which the response fell off with increasing levels of dressing. The concept of a 'standard' response curve of exponential form did not adequately describe the response surface revealed in these experiments. Evidence is presented that, for any nutrient, the response curve rises to a maximum and then begins to fall, and that the level of dressing at which the fall begins depends on the amounts of the nutrient present in the soil, on the supply of the other plant nutrients both by the soil and from fertilisers and farmyard manure, and on other factors such as the method of fertiliser application.

For fertiliser applied over the ridges at planting, optimal dressings were estimated to be N and P_2O_5 1·0–1·2 cwt. per acre and K_2O 1·5–2·0 cwt. per acre, but the optima were ill determined because the fertiliser rates tested in most of the experiments were too low.

Introduction

The results of many experiments showing the effects of fertilisers and farmyard manure (FYM) on the yields of the potato crop have been published in recent years; these allow the manurial requirements of the crop to be re-assessed, not merely by extending our knowledge of fertiliser responses under a variety of soil and climatic conditions but also by throwing new light on the form of the fertiliser/yield response curve, on the interactions between fertiliser nutrients, and on the effect of FYM on fertiliser responses.

The fertiliser responses of the potato crop in the United Kingdom were summarised by Drs. Crowther & Yates[1] in 1941, as part of a general review of the fertiliser requirements of arable crops. This was of very great value to farmers and their advisers during and after the 1939–45 war, but these older experiments may now have only limited applicability to modern conditions. Indeed, of the experiments on potatoes used by Crowther & Yates, two-thirds were done before 1930 and over half before 1914. Rates of fertiliser tested were low by modern standards, particularly for N and K, for which the mean experimental dressings (Table I, footnote) were about N 0·4 cwt., and K_2O 0·8 cwt. per acre, less than half the average amounts applied commercially today. This is not surprising when it is considered that, in the last 20 years, the average rate of application of fertiliser to potatoes has increased by a factor of 3 for N, 2 for P and 2½ for K. The greatly increased use of fertiliser on all crops must in turn have led to changes in the nutrient status of soils. At the same time there have been major changes in methods of planting and fertiliser application for potatoes, in addition to those more general changes in husbandry, such as, for example, increased mechanisation, which must have affected fertiliser responses indirectly through its influence on depth of ploughing and date of planting.

Résumé of work of Crowther & Yates

The work of Crowther & Yates consisted of three main steps. First, all available experimental results giving responses to three or more levels of any nutrient were assembled. Inspection showed that the data did not conflict with the hypothesis that the response curve was an exponential, and, following the earlier work of Mitscherlich, standard response curves were adopted for each nutrient of the form

$$y = y_0 + d(1 - 10^{-kx})$$

where y_0 represents the untreated yield, y is the yield with a dressing of the nutrient of amount x

* Based on lecture to Agriculture Group, 13 October, 1959

and d is the limiting response (the maximum response which could be obtained with a very large dressing). The constant k determines the rate at which the response falls off with successive doses of the nutrient. In the absence of more detailed information, the same value of k was assumed for all crops.

In the second step of the investigation, the response curves were used to convert the responses obtained in the many two-level experiments at varying rates per acre to the response to a standard dressing of each nutrient. Taking all the experimental results together, the mean response at the standard dressing could then be used in conjunction with the standard response curve and the prices of crop and fertiliser for the third step of the investigation, namely, calculation of an average optimal or most profitable dressing.

The fertiliser responses of potatoes with and without farmyard manure (FYM) taken from the paper of Crowther & Yates are reproduced in Table I. No large regional variations in

Table I

Fertiliser responses of potatoes in Great Britain

(Crowther & Yates[1])

	No. of experiments		Response (tons per acre)	
	No FYM	With FYM	No FYM	With FYM
Response to N				
All centres	212	284	1·98	1·58
Response to P				
S. & E. England	80	68	1·30	0·50
W. Midlands & N. England	105	104	0·92	0·36
S.W. England, Wales & Scotland	18	75	2·07	1·65
All centres	203	247	1·18	0·77
Response to K				
S. England	127	103	1·62	0·70
W. Midlands & N. England & Wales	103*	136	2·15	0·53
Scotland	12	66	3·06	2·06
All centres	242*	305	1·92	0·86

Note: The responses shown above are to dressings of N 0·8 cwt., P_2O_5 1·0 cwt. and K_2O 1·50 cwt. per acre, amounts fairly close to the average dressings applied in Great Britain today; they were obtained from Table I of Crowther & Yates' paper[1] using their standard response curves. Means of the dressings actually tested were:

No FYM, N 0·4 cwt., P_2O_5 0·7 cwt. and K_2O 0·8 cwt. per acre.
With FYM, N 0·3 cwt., P_2O_5 0·6 cwt. and K_2O 0·7 cwt. per acre.

* The entries 123 and 262 in the original paper were incorrect

response were found for N; for P, responses in S.W. England, Wales and Scotland were larger than in the rest of the country; for K, there was a general trend of responses from south to north, but this was associated with differences in type of experiment which would favour high responses for the northern centres. The basal treatments differed a good deal from experiment to experiment, but it would be approximately correct to regard the figures of Table I as substantially equivalent to the main effects shown in the experiments below.

Responses obtained in recent series of experiments

In the 20 years since the paper of Crowther & Yates, not only has the volume of results from fertiliser experiments greatly increased but their quality has also improved. In particular, the number of experiments testing nutrients at three or more levels, often, as in the 3^3 design, giving the effect of several nutrients simultaneously, has given very much fuller information both on the nature of the response curve and on the extent of interactions between the nutrients.

Experiments in Scotland have been reported by Simpson and his colleagues[2–4] and in Northern Ireland by McAllister & McConaghy.[5] The bulk of the recent manurial experiments in England and Wales has been done by the Regional Soil Chemists of the N.A.A.S.: some factorial experiments with N, P and K in the West Midlands, Yorkshire and Lancashire and

Wales have been reported by Edwards *et al.*,[6] and a series of 36 experiments on peaty soils by Pizer *et al.*;[7] the results of a large series of experiments begun in 1955 are likely to become available soon. Experiments from Rothamsted have been reported by Cooke *et al.*[8] and Widdowson *et al.*,[9] and a small series has been reported by the Norfolk Agricultural Station.[10] The effect of FYM on the fertiliser responses of the potato crop has been examined in a number of recent papers, e.g., [6, 11–13].

The published results include seven groups of series of experiments in which N, P and K have been tested simultaneously in 2^3 or 3^3 factorial experiments, together with three series each covering one nutrient only. The total number of experiments on mineral soils in Great Britain is 92 for N, 84 for P and 80 for K, plus the series of 36 experiments with NPK on fen peat soils in the east of England.

Table II

Main effects and linear interactions of N, P and K on potatoes

Year	Series	Ref.	No. of centres	Mean yield (tons of total tubers per acre)	N	P	K	NP	NK	PK	NPK	Rates (cwt. per acre) N	P_2O_5	K_2O
1950–51	Yorks & Lancs I	6	10	9·77*	2·16	0·71	2·85	0·48	1·14	0·31	—	0·8	0·9	1·4
1951–54	,, ,, II	17	8	7·35	1·67	1·59	3·70	0·65	0·93	0·79	0·37	0·8	0·9	1·5
1949–52	West Midlands I	6	16	10·22*	2·73	0·34	2·39	0·30	0·11	0·15	—	1·0	0·9	1·4
1949–52	,, ,, II	18	6	9·16	2·15	0·50	2·58	0·12	0·84	0·23	−0·06	0·8	0·7	0·7
1950–53	Wales	6	25	10·33*	1·80	1·70	2·60	0·39	0·70	0·76	—	1·0	1·2	1·8
1941–46	Rothamsted	23	6	7·48	1·25	0·44	3·32	0·25	0·58	0·61	0·33	0·6	0·6	1·0
1952–56	Fen peat soils	7	36	11·02*	1·20	2·00	0·50	0·15	0·05	0·13	—	0·8†	1·5	1·2
General mean (excluding Fen peat soils)			71	(9·55)	2·03	1·03	2·77	0·38	0·66	0·51	0(·23)			

* Mean yield over three levels of N, P and K † Mean of rates: 1952–54 N 0·6 cwt. per acre, 1955–56 N 1·0 cwt. per acre

Table II shows the main effects and interactions for seven series of experiments with N, P and K for potatoes. The peaty soils are sharply distinguished from the rest in that P was the most important nutrient, whereas on mineral soils the main effects of N and K were in each series larger than for P. Having regard to the differences in rates tested, the mean responses to N and K were fairly consistent from series to series; for P, responses in the Rothamsted and West Midland series were much lower than the others. Interactions were small for the peaty soil series but were substantial for the series on mineral soils.

The mean responses of Table II may be compared with those of Crowther & Yates (Table I, excluding 4 Scottish centres for P and 12 Scottish centres for K), as follows:

	Mean responses (tons per acre) N	P_2O_5	K_2O
Dressing (cwt. per acre)	0·8	1·0	1·5
Crowther & Yates	1·98	1·16	1·86
Recent series: Mineral soils only	1·97	1·03	2·77
All centres	1·75	1·36	2·00

There was remarkably little difference between the two sets of responses for N and P or, if the peaty soils are included, for K; the mineral soils included in the recent series tended to be deficient in K and this is reflected in their much larger potash responses, which are probably not typical of potato-growing land as a whole. Nevertheless the recent series of experiments give no evidence of any important general reduction in response up to the year 1955, such as fertiliser consumption figures might have led us to expect. The effect of the higher level of fertiliser use may well have been offset by changes in other factors favouring higher responses, for example, earlier planting, deeper ploughing, better control of blight and by a general improvement in potato husbandry.

Interactions between nutrients

In the foregoing summary of mean fertiliser responses interactions between nutrients have been ignored. The general importance of the interactions is shown by a comparison based on the results in Table II for the average response (weighted by number of centres) to each

nutrient applied alone and in the presence of a basal dressing of the other two nutrients.

	Tons per acre		
	N	P	K
Without basal dressing	1·22	0·37	1·83
With basal dressing	3·30	2·15	4·17

Thus the response to each nutrient applied singly was quite small, particularly for P; in the presence of basal dressings of the other nutrients, responses to each nutrient were very approximately 2 tons per acre higher than when applied alone. The sum of the single applications was only 3·4 tons; the effect of the three nutrients in a combined dressing was 6·1 tons per acre.

Table III

Response of potatoes to fertilisers

(tons of total tubers per acre)

Amount of fertiliser per acre				0·8 cwt. N	1·0 cwt. P_2O_5	1·5 cwt. K_2O
Basal manuring				PK	NK	NP
Year	Series	Reference	No. of centres			
1950	E. of Scotland	2	9	—	—	3·26
1946–55	,, ,, ,,	3	13	—	2·10	—
1950–51	Yorks & Lancs I	6	10	3·78	1·58	4·39
1951–54	,, ,, II	21	8	3·62	3·60	5·79
1949–52	West Midlands I	6	16	2·87	0·83	2·71
1949–52	,, ,, II	22	6	3·05	0·96	5·07
1950–53	Wales	6	25	2·65	2·61	3·86
1941–46	Rothamsted	23	6	2·78	2·19	5·70
1953–55	Herts & Beds	9	21	1·70	—	—
			92	2·71	—	—
			84	—	2·02	—
			80	—	—	4·00
1952–56	Fen peat soils	7	36	1·40	2·20	0·86

Table III shows for each series the mean response to each nutrient in the presence of a basal dressing of the other two nutrients including three series which could not be shown in Table II. The responses to the dressing actually tested have been adjusted to give estimated responses to N 0·8 cwt., P_2O_5 1·0 cwt. and K_2O 1·5 cwt., quantities fairly close both to the actual dressing (except in two small series) and very similar to the average quantities applied to potatoes in Great Britain in the period 1956–60. In making the adjustment an exponential response curve was assumed having values of k of 0·8 for N and 0·55 for P and K; the adjustment required was small, however, apart from the two series just mentioned. The mean responses for all centres on mineral soils are very close to 2·7, 2·0 and 4·0 tons per acre for N, P and K respectively. Having regard to the range of districts, soils and seasons covered and the relatively small numbers of experiments in each series, the mean responses to N and K on mineral soils did not vary greatly, all lying within about $\pm$1·0 tons per acre of the overall mean; the variation was somewhat greater for P, the West Midland experiments being less responsive.

Response curves

For crops such as potatoes, which have high requirements for all three major nutrients, the response to any one of them depends largely on the supply of the other two nutrients either by the soil or as a basal dressing. Except where the soil itself can supply most of the requirements of the crop, interactions between the nutrients will substantially affect the amount of the response to any given level of a nutrient. Experiments on sugar beet (Boyd[14]) have shown that the interactions also affect the degree to which the response falls off as the amount of the nutrient is increased, i.e., the constant k of the equation of Crowther & Yates.

Fig. 1 shows results of two recent series of experiments which illustrate this. [The author is indebted to Dr. Rice Williams and Dr. J. E. Watkin for permission to use data from a series of 30 factorial experiments done in Wales in the years 1950–56 (see Edwards, Watkin & Webber[6]).] The figures show the responses to each nutrient at three levels of basal nutrients; thus

the nitrogen responses are shown in the presence of P_0K_0, P_1K_1 and P_2K_2 and are typical of the results from many other series. In Fig. 1*a* there was only a moderate response (0·5 tons per acre) to N_1 in the absence of basal nutrients, and yield began to fall off again before the N_2 level was reached. With basal P_1K_1 the response to N_1 was doubled and there was a small further response (0·2 tons per acre) to N_2. At the P_2K_2 level, there was some further increase in the response to N_1 (1·3 tons per acre) and a much larger further response to N_2 (0·5 tons per acre). With higher levels of PK the responses to the second levels of N would probably have been still greater. Broadly similar results are shown for P and K in Figs. 1*b* and 1*c*. The Fen peat soils (Pizer *et al.*, Fig 1) furnish a further example.

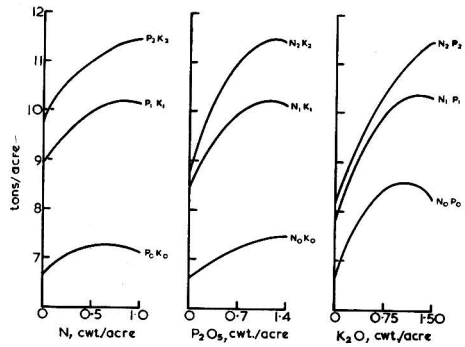


FIG. 1.—*Effect of level of basal nutrients on fertiliser response curve*
(*a*) response to N (*b*) response to P (*c*) response to K

In the formula of Crowther & Yates for the exponential response curve quoted above,

$$k = \frac{1}{x} \cdot \log \frac{y_1 - y_0}{y_2 - y_1}$$

where the yields in tons per acre at levels 0, 1, 2 of a fertiliser are denoted by y_0, y_1, y_2 and x is the amount of fertiliser nutrient in cwt. of N, P_2O_5 and K_2O per acre. Thus k depends upon the rate at which the response falls off with increasing levels of dressings. Table IV shows values of k at different levels of basal nutrients for both series of experiments, except for K on the Fen peat soils for which responses were small. Except for P in the Welsh experiments the value of k in the presence of the double level of basal nutrient was substantially less than the mean over all three levels, and also less than the standard values of Crowther & Yates, $k_N = 1{\cdot}1$ and k_P and $k_K = 0{\cdot}8$.

Table IV

Effect of level of basal nutrients on fertiliser response curves
values of the constant k (tons/acre)$^{-1}$

Level of basal nutrients	Wales 1950–56			Fen peat soils 1952–56	
	N	P	K	N	P
00	*	0·2	*	1·7	1·1
11	1·4	1·4	1·0	1·3	1·7
22	0·8	1·1	0·4	0·3	0·5
Mean	1·3	1·1	0·9	0·8	0·8

* Negative response to higher rate

Until recently, manurial recommendations to farmers were based mainly on optimal dressings obtained by extrapolation from experimental results with much lower rates of dressing, using ' standard ' response curves and main effects; the true requirements of the crop must

therefore have been underestimated. As a result of this underestimation of fertiliser responses, advice to farmers has often been unduly conservative, and the range of treatments tested in experiments has sometimes been unduly restricted. In the last few years, however, many experiments, including the recent series of experiments undertaken by the soil chemists of the N.A.A.S., a similar series on sugar beet initiated by the Sugar Beet Research & Education Committee, and a series of experiments in the East of Scotland (Simpson & Crooks[4]) have been done with high rates of application. These have been valuable in showing that the exponential type of response curve, in which responses to increasing dressings rise asymptotically to a maximum, can give an erroneous impression of the returns from high levels of manuring.

The pattern of responses indicated by Fig. 1, in which increased basal dressing leads to increased responses and a progressive steepening in the response curve, can only be characteristic of a limited portion of the whole response surface. Indeed, the notion of an asymptotic curve has, in this country, usually been recognised as a convenient approximation rather than a fundamental biological law, and any recommendations for the use of the exponential has usually been prefaced with such a phrase as ' within the range of dressings normally encountered in practice . . .' On the basis of the exponential response curve it has often been said that there is a very broad region lying on either side of the optimum dressings of any nutrient within which the monetary losses due to under- or over-manuring the crop will be trivial, and this attitude to potato manuring is strengthened by consideration of the cheapness of fertilisers (at subsidised prices) in relation to the prices of potatoes. However, the recent experimental material which is now coming to hand shows that for some soils and in some seasons, even within the range of normal fertiliser practice, the response curve rises to a maximum and then begins to fall off again, and that serious losses of crop can occur when the levels of manuring exceed the optimum for a given soil and season. The point at which the response curve for any nutrient reaches a maximum will depend upon the particular characteristics of the crop, the season and the soil, and will be influenced by the supply of other nutrients as fertilisers and by the soil, as well as by other factors such as cultivations and fertiliser placement, sowing and harvesting dates, disease incidence, etc.

The fact that some experiments gave negative responses itself threw doubt on the general validity of the exponential response curve. Pizer *et al.*[7] showed that on organic mineral soils containing a high proportion of clay the application of fertiliser K decreased yield ; similar results had been obtained for sugar beet on Chalky Boulder Clay soils in Essex and East Suffolk (Boyd *et al.*[15]). These authors also showed that negative responses to N and P occurred for sugar beet on soils well supplied with these nutrients. When only a single nutrient is applied, effects of this kind tend to occur at quite low levels of dressing ; thus in Figs. 1*a* and 1*c* the effects of N and K, although very large in the presence of other nutrients, fell off at the high level when no basal nutrients were applied. The West Midland experiments (Series I) can be subdivided into two groups each of eight centres for which the level of available soil P was ' satisfactory ', ' high ' and ' very high ' or else ' moderate ' or ' low '. With adequate N and K, responses to P reached a maximum at about 0·7 cwt. of P_2O_5 per acre on the ' low P ' soils, and at about 0·45 cwt. of P_2O_5 on the ' high-P ' group ; in this latter group the decrease from the additional 0·45 cwt. of P_2O_5 provided by the P_2 level was 0·50 $\pm$ 0·28 tons per acre. Simpson[2] has reported small decreases in yield from the use of more than about 0·5 cwt. of P_2O_5 on soils high in P in the East of Scotland. In a recent paper covering 17 sites with basal FYM in the same area, Simpson & Crooks[4] have shown that the first level of N (60 lb. per acre) increased the mean yield of total tubers but the higher level caused yield to fall off sharply. For K there was a small increase in yield up to the K_2 level on soils low in K, but for soils high in K there was evidence of a reduction in yield at high levels of dressing. There was little indication of a depression in yield from P up to the highest rate tested (120 lb. per acre).

Optimal dressings

If, as seems probable, responses can in some circumstances fall off at high levels of fertiliser application, extrapolation from experimental results at lower rates can be misleading. It is unfortunate therefore that, in all the series indicated in Table III, one or more of the nutrients tested have been at rates too low to give a clear indication of the optimum. Excluding the series

in which only two levels were tested, estimated optimal dressings are given in Table V. The figures for peaty soils are based on the recommendations made by Pizer *et al.*[7] and those for the East of Scotland are taken from Smith & Simpson.[3] Optima at or above the highest level tested are marked (?). For all English series the optimal dressing of N was up to or a little above 1·0 cwt. of N per acre, the highest rate tested. For K, the optimum appeared to be at least 1·5 and, in some series, possibly 2·0 cwt. of K_2O per acre, except for the organic mineral soils among the Fen peat soils, for which responses were usually small, and, on sites with a high proportion of clay, negative. Optima for P varied from 1·5 cwt. of P_2O_5 per acre or more in the Fens and Wales to about 1·0 cwt. in the Yorks and Lancs series and only 0·5 cwt. of P_2O_5 per acre in the West Midlands and the East of Scotland. In these latter series, soils high in P had slightly lower optima (about 0·3 cwt. of P_2O_5 per acre) than those low in P (optima about 0·6 cwt. of P_2O_5 per acre).

Table V

Estimated optimal dressings for potatoes

(N, P_2O_5 and K_2O cwt. per acre)

	Fen peat soils		Yorks & Lancs		West Midland	Wales	E. of Scotland
	Peat and peaty mineral soils	Organic mineral soils	Series I	Series II	Series I		
Ref. (Table III)	7	7	6	21	6	6	7, 8
N	? 1·0–1·2	? 1·2	? 1·2	? 1·2	? 1·2	? 1·2	0·9
P_2O_5	? 1·5–1·8	? 1·8	? 1·0	? 1·0	0·5	1·5	0·5
K_2O	? 1·8–2·0	0–1·2	? 2·0	? 2·0	? 1·5	? 2·0	? 1·65

Note. Optimal dressings estimated to be at or above the highest rate tested are marked with a query.

The requirements of the potato crop for P and K evidently vary from very small to very large dressings according to the ability of the soils to supply these nutrients ; the requirements can be forecast in a general way by soil analysis. Compared with the variation between soils, year-to-year differences in response appear to be of secondary importance.

For nitrogen, by contrast, there is little indication from the present data of large differences between soils, even including the peaty soils of the Fenland. However, the two West Midland sites, where potatoes followed several years in grass, showed small responses to N (0·12 and 0·40 tons per acre), compared with the average of 14 sites after arable of 1·24 tons per acre). A similar effect of long leys and old grass on N responses was found for sugar beet (Boyd *et al.*[15]).

Experiments at the Grassland Research Station (Williams[16]), Rothamsted (Cooke[17]) and on the Ministry of Agriculture's Experimental Husbandry Farms have shown similar effects of leys in lowering the N requirements of the following crops. The amounts of N provided by the grass depend upon the type, age and management of the sward and on the number of arable crops taken since it was ploughed. In contrast with the other major nutrients, nitrogen responses varied substantially from year to year. Pizer *et al.* presented evidence that N responses in two ' blight ' years (1953, 1956) were about half those in years when blight was slight or absent (1952, 1955).

Taking all the centres together, the average optimal dressing of N and K was 1·0–1·2 cwt. of N and 1·5–2·0 cwt. of K_2O per acre, and only the Fenland organic mineral soils differed materially from these general figures. For P, the general average was about 1·0 cwt. of P_2O_5 per acre, but the optima for the individual soils differed substantially from the mean. For the West Midland experiments the average loss in yield due to adopting the general optimum instead of the local optimum given in Table V was 0·16 ton per acre ; on soils low in P the extra crop from applying 1·0 cwt. compared with 0·5 cwt. of P_2O_5 per acre just equalled the extra cost of the fertiliser, but on soils well supplied with P the loss due to reduction in crop and cost of fertiliser amounted at current prices to about £5 per acre. The use of the general optima in the Fenland and Welsh series would probably result in quite small losses in yield ; thus, for P, about 90% of the total possible response would have been obtained from a dressing of 1·0 cwt. of P_2O_5 per acre.

Farmyard manure and fertiliser responses

As a result of the closer attention paid to interactions between nutrients, the effect of FYM on the fertiliser requirements of the potato crop is now more fully understood. As about half the crop receives FYM, the determination of its effect on fertiliser responses is of some importance. Crowther & Yates[1] showed that FYM substantially decreased the need of crops for P and K, but they claimed that, in some way not fully explained, nitrogen responses were much the same whether or not FYM was also applied, and later workers[6, 11] supported their thesis. However, when due regard is paid to interactions between nutrients, the effect of FYM on the fertiliser responses of the potato crop can be very largely explained in terms of the nutrients which it provides (Boyd[12]).

The mean results for P and K of an interesting pioneer series of eight factorial experiments with DNPK carried out by Mr. J. Webber,[21] Regional Soil chemist in the Yorks and Lancs region of the N.A.A.S., are given in Fig. 2; each point on the graph is a mean of eight individual plot yields (corrected for block effects) and has a pooled experimental error of $\pm 0{\cdot}33$ tons per acre. Fig. 2B shows responses to P for three levels of basal NK, and Fig. 2A responses to K for three levels of basal NP. The single levels of fertiliser were N 0·40 cwt., P_2O_5 0·45 cwt. and K_2O 0·75 cwt. per acre. In drawing the graphs the FYM itself has been assumed to supply the equivalent of 0·5 cwt. of P_2O_5 and 0·75 cwt. of K_2O per acre.

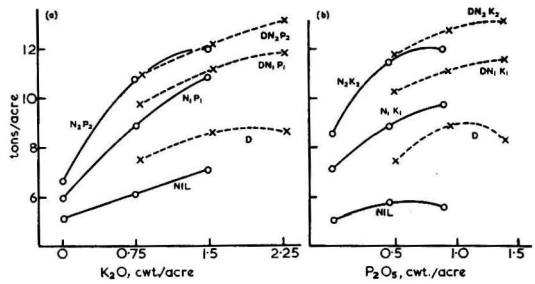


FIG. 2.—*Effect of* (A) *potash and* (B) *phosphate in presence and absence of dung on yield of potatoes*
(mean of 8 experiments in Yorks & Lancs 1950–54)
——— response without farmyard manure
- - - - - - - - " with " "
D = dung

Considering first the responses without FYM, 0·9 cwt. of P_2O_5 without other fertiliser nutrients increased the yield by only 0·5 tons per acre, whereas the same level of dressing in the presence of moderate dressings of N and K gave 2·3 tons per acre and at higher levels of N and K 3·4 tons per acre; it seems likely that at even higher levels of basal NK substantial further responses would have been obtained from more P. The response to P in the presence of FYM (No NK) was actually greater than the response to P alone, despite the fact that FYM itself supplies a substantial amount of readily available P. The response curve to P alone was a very flat one, N and K being limiting factors, whereas, with FYM, N and K were no longer limiting and the response is measured on a different and steeper response curve. By contrast, when the same comparison is made in the presence of basal NK, both responses are being measured on what is virtually the same response curve, in which the P supplied by the FYM effectively reduced the response to fertiliser P. The results for N were closely similar to those for P; the results for K are given in Fig. 2, and show a similar association of response with basal manuring.

As a result of an investigation of the results of 62 experiments in which FYM and fertilisers were applied factorially, on the average 10 tons of FYM provided the equivalent of N 0·3 cwt., P_2O_5 0·4 cwt. and K_2O 0·75 cwt. to the potato crop to which it is applied; an appropriate reduction should be made in the fertiliser dressing for dunged land. The results refer to crops

in which both FYM and fertilisers are applied in the ridges at planting; it must be expected that the nutrients in FYM would have been used less effectively had they been ploughed in for the potato crop. This might not be so for crops with a different habit of growth, such as sugar beet, for which the nutrients in ploughed-in FYM may in some circumstances be more readily available than those in fertilisers applied on the surface and lightly cultivated in. Thus, Rothamsted experiments with FYM and NPK reported by Patterson & Watson[13] confirmed the equivalents just quoted for potatoes, but, for sugar beet, the increase of total sugar given by FYM was somewhat greater than that given by the above fertiliser equivalent.

Fertiliser placement

The results already discussed refer solely to experiments in which the fertilisers were distributed in or over the furrows on land already ridged; this traditional method, which used to be followed on the great majority of farms growing potatoes, has on many farms been replaced by other methods, mainly as a result of machine planting. Although few experiments have been done with these other methods, several series compare them with the traditional method. Cooke[18] showed that fertiliser broadcast over the ridges or placed in contact with the seed was used much more efficiently than when broadcast before ridging, 8 cwt. of a compound fertiliser over the ridges giving as good a response as 12 cwt. broadcast. The traditional method carries a real risk of 'scorch', with delay in emergence, if heavy dressings are applied and dry weather follows planting, particularly if the ridges have been allowed to dry out before planting.

Many planting machines work on flat land, the seed being covered by shallow ridges formed by ridging bodies or discs; for such a machine Cooke *et al.*[19] compared the effects of a compound fertiliser applied in the seed-shoe, and in a band alongside the seed, with broadcasting before planting and placement in front of the seed-shoe. Band and contact placement were of about equal efficiency and it would be reasonable to assume that the results described in this paper can be broadly applied to these methods also. Placement in front of the seed-shoe gave much the same results as broadcasting before planting and both were much less efficient than band or contact placement. The authors suggest that for both of these inefficient methods most of the fertiliser was concentrated in the upper part of the ridge above the tubers. Application of 4 cwt. of fertiliser by band or contact placement was as efficient as 8 cwt. broadcast; at higher rates the advantage of placement began to decline but was still considerable, 10 cwt. of fertiliser placed giving the same yield as 14–15 cwt. broadcast.

The fertilisers used in these trials were granular compounds having a ratio of $N : P_2O_5 : K_2O$ of $7 : 7 : 10\frac{1}{2}$ or $8 : 6 : 10\frac{1}{2}$. There is little information on the use of the more concentrated compound fertilisers, but it seems probable that, for any given quantity of nutrients per acre, they are rather less likely to lead to 'scorch' and delayed emergence. Widdowson[20] recommends that where large dressings of fertiliser are applied by a planter with a fertiliser attachment, the machine should be modified to allow the fertiliser to be applied in one or two bands instead of in contact with the seed.

Rothamsted Experimental Station
Harpenden
Herts.

Received 16 November, 1960

References

[1] Crowther, E. M., & Yates, F., *Emp. J. exp. Agric.*, 1941, **9**, 77
[2] Simpson, K., *J. Sci. Fd Agric.*, 1957, **8**, 297
[3] Smith, A. M., & Simpson, K., *Scot. Agric.*, 1957, **36**, 201
[4] Simpson, K., & Crooks, P., *J. Sci. Fd Agric.*, 1961, **12**, 131
[5] McAllister, J. S. V., & McConaghy, S., *Res. Exp. Rev. Min. Agric. N. Ireland*, **7**, 84
[6] Edwards, G. H. A., Watkin, J. E., & Webber, J., *Exp. Husb.*, 1956, (1), 25
[7] Pizer, N. H., Wright, H. A., Caldwell, T. H., Hargrave, J., Burgess, G. R., Cory, V., & Boyd, D. A., *J. agric. Sci.*, 1961, **56**, 197
[8] Cooke, G. W., Widdowson, F. V., & Wilcox, J. C., *J. agric. Sci.*, 1956, **49**, 81
[9] *Rothamsted Rep.*, 1957, p. 47
[10] *Norfolk agric. Sta. Rep.*, 1956–7, p. 7
[11] Reith, J. W. S., & Inkson, R. H. E., *J. agric. Sci.*, 1958 **51**, 218
[12] Boyd, D. A., *J. agric. Sci.*, 1959, **52**, 384

References (*cont.*)

[13] Patterson, H. D., & Watson, D. J., *Rothamsted Rep.*, 1959, pp. 164–8
[14] Boyd, D. A., *Potassium Symposium 1956*, p. 143
[15] Boyd, D. A., Garner, H. V., & Haines, W. B., *J. agric. Sci.*, 1957, **48**, 464
[16] Williams, T. E., *J. Brit. Grassl. Soc.*, 1959, **15**, 189
[17] Cooke, G. W., *J. Farmers' Club*, 1959, (5), 50
[18] Cooke, G. W., *J. agric. Sci.*, 1949, **39**, 96
[19] Cooke, G. W., Jackson, M. V., & Widdowson, F. V., *J. agric. Sci.*, 1954, **44**, 327
[20] Widdowson, F. V., *N.A.A.S. quart. Rev.*, **48**, 147
[21] Webber, J., private communication

THE ISOLATION OF LEAF COMPONENTS. I.

By I. H. CHAYEN, R. H. SMITH, G. R. TRISTRAM, D. THIRKELL and T. WEBB

The disintegration of leaf materials has been effected by the impulse rendering process. Various components, protein, lipids, water-soluble matter and fibre have been isolated in amounts which would appear to merit investigation and exploitation.

As the first of a series of papers, the present one deals with the methods used in the disintegration of leaf material and the isolation of protein.

Introduction

Proteins in higher plants occur in two main forms, seed protein and leaf protein. Seed proteins have been and are utilised as foodstuffs for humans and animals but, in general, are inferior to those of animal origin, although recent work has confirmed the long-held view that mixtures of plant proteins provide a more adequate protein source than do the individual components. This is demonstrated in Table I which gives the essential amino-acid content of selected seed proteins.

Table I

Essential amino-acid composition of some vegetable proteins, compared with whole egg protein and egg albumin

Values are given as weight of amino-acid in 100 g. of protein containing 16% of N

	Egg (Hen)		Arachis	Cotton-	Soya-	Wheat	Mixed	Lucerne
	Whole	Albumin	(meal)	seed	bean	gluten	grass	
Lysine	7·2	6·3	3·1	4·9	7·2	0·8	4·8	5·0
Histidine	2·1	2·1	2·0	2·9	2·4	2·2	1·7	2·0
Valine	4·0	7·5	4·7	5·0	4·9	4·2	6·8	6·1
Phenylalanine	6·3	7·2	5·4	5·4	4·8	6·4	5·8	5·4
Tryptophan	1·5	1·3	1·3	1·1	1·1	0·7	2·1	2·1
Leucine	9·2	9·4	6·7	6·1	7·5	9·2	8·4	10·2
Isoleucine	4·1	7·4	4·0	3·5	4·9	3·7	5·7	4·8
Methionine	4·1	4·4	1·1	1·5	1·0	1·5	2·3	1·6
Threonine	4·3	4·5	3·4	3·7	4·6	4·1	4·7	6·5

[From Block & Weiss, 'Amino Acid Handbook', 1956 (Illinois, U.S.A.: Thomas)]

From limited amino-acid analyses Chibnall[1] concluded that 'the excellent nutritive value of the leaf proteins is very clearly evident'. Leaf proteins are only utilised in the natural form by ruminants (cattle and sheep) when the fibrous component is digested by the rumen flora. These animals will convert 7–11% of leaf protein ingested into meat and the cow up to 18% as milk. More efficient converters (Table II) of vegetable protein, such as the fowl and man, are incapable of utilising leafy material as a major protein source, but the use of leaf protein for such animals would be possible if the protein could be separated from fibre; such preparations of protein would also be of value in the supplementation (fortification) of vegetable seed foodstuffs. Indeed the supplementation of other protein foodstuffs would appear to be the greatest potential value of leaf protein preparations.

The isolation of leaf proteins was carried out by Chibnall[1] and his school who obtained fractions which they assigned to the cytoplasm and chloroplasts. The limited amino-acid analyses of these preparations (Table III) indicated that the basic, sulphur and aromatic amino-acids were adequate for nutritional purposes. The high nitrogen content (Table III) of many of these preparations approached an ideal which the industrial process would hope to emulate. Chibnall showed that the major problem in isolating leaf protein in high yield was the difficulty in breaking up the leaf cells, and made use of plasmolysis with ether–water, and mechanical treatment (mincing or grinding) to increase the degree of destruction.

Table II

Efficiency of domestic animals in the conversion of vegetable protein to animal's protein

	Efficiency, %	
	Dry matter	Protein
Milk—whole life	7·5	18·1
Beef—Baby (to 7 cwt.)	3·7	15·3
Fat bullock (12–15 cwt.)	2·9	8·7
Lamb	6·3	13·2
Bacon (restricted feeding)	12·1	15·2
Pork ,, ,,	12·2	19·0
Poultry—table	4·5	21–26
Eggs—Medium light bird (1 egg daily)	10·0	39·7
(200 eggs/year)	6·7	26·4

(Leitch & Godden[1a])

Table III

Partial amino-acid analyses of leaf proteins
(after Chibnall ;[1] Tristram ;[2] Lugg[3])

(a) *Some typical leaf proteins*

Values quoted are weight of amino-acid per 100 g. of protein

	Total protein N	Lysine	Histidine	Methionine	Tryptophan
Cocksfoot	13·1–14·1	5·5	1·5	2·3	2·2
Italian rye		5·2	1·5	2·5	2·2
Perennial rye		5·5	1·5	2·2	2·2
Lucerne	15·76	6·2	1·5	2·3	2·4
Clover (white)		5·8	1·0	2·2	2·4
,, (red)	16·25	5·2	1·3	2·2	2·0

(b) *Comparison of the amino-acid contents of the protein attributed to chloroplast and cytoplasm (spinach)*
Values quoted are amino-acid N in 100 g. of protein-N

	Chloroplast	Cytoplasm
Total N in protein	6·3	15·45
Lysine	4·7	6·2
Histidine	3·3	2·2
Tryptophan	1·7	1·7
Methionine	1·3	1·3
Ash	16·9	1·6
Lipid	25·1	1·9
Ratio	2·3	1

Many attempts have been made to obtain protein concentrates from leaf material (for a general review, see Tilley & Raymond[4]) but there has been limited success owing to the low yields of protein and to mechanical difficulties.

In 1953 Chayen & Ashworth[5] published details of an Impulse Rendering (hereafter called I.R.) process for the cold aqueous degreasing of bone and skin. This process involved the passage of bone, in a stream of water, through a mill containing beaters (a modified hammer mill in principle). The shock or impulse set up by the beater is transmitted through the water ; cell rupture occurs and fat is removed without causing any serious reduction of size in the bone or skin.

The process has since been tried on other materials and it is now possible to couple the separation of oil from such seeds as ground-nuts, cottonseed, etc., with the preparation of protein. In many cases starch is obtained as a by-product (Table IV).

Table IV

Preparation of protein isolates from seeds

(1000 g. of seed milled at 8000 r.p.m., $\frac{1}{32}$ in. grids, in 5 volumes of 0·1N-NaOH)

	Meal			Protein			Total lipid	Starch, g.	Recovery,[a] %
	Wt., g.	% N	% Ash	Wt., g.	% N	% Ash			
Rice	52·9	1·1	0·1	1·81	13·2	0·2	1·7	32·6	89·0
Wheat	22·7	2·0	2·1	3·3	12·85	0·1	1·8	49·1	
Oats	31·6	0·8	2·5	5·0	12·2	2·3	7·4	41·0	85·0
Barley	51·0	1·6	0·9	3·1	10·0	0·5	1·0	28·0	83·1
Lentil	37·0	2·2	0·9	1·0	12·5	0·3		20·4	
Pea	52·0	1·7	1·4	11·4	8·2	1·1	1·4	18·2	83·0
Groundnut	18·0	1·5	1·5	23·0	15·5	1·5	45·0	[b]	86·0
Cotton (delintered, undecorticated)	53·0	1·2	4·5	17·0	13·3	2·0	17·0	[b]	87·0
Sunflower	61·9	1·0	1·2	7·7	11·5	0·8		2·2	

[a] Does not include water-soluble non-protein solids
[b] Included in meal

In adapting the I.R. process to the separation of leaf protein from attendant fibre and other polysaccharides and in obtaining protein in good yield the following problems had to be overcome :

(1) to solubilise the protein ;
(2) to extract the protein ;
(3) to obtain maximal yields of dry protein of good colour and of high biological value ;
(4) to recover, in useful form, the chlorophyll, lipid and polysaccharide components.

Experimental

Impulse rendering

The experimental machine had 8-in. blades or beaters and grids of various sizes ($\frac{3}{4}$–$\frac{1}{64}$ in.) could be fitted into the outlet. Although it was possible to run the mill at various speeds, it was normally operated at 8000 r.p.m. and driven by a $\frac{1}{2}$–1 h.p. motor. In the experimental machine(s) the material and water were fed in axially, the effluent being ejected almost tangentially through the vanes of the effluent grids (Fig. 1).

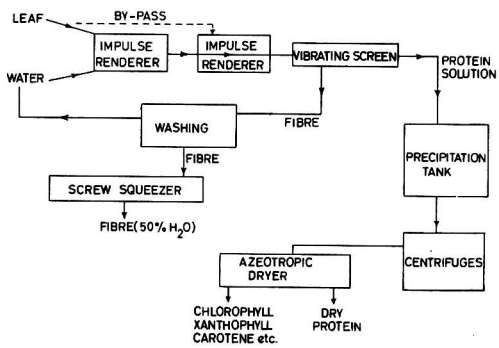


FIG. 1.—*Diagram of Impulse Rendering process*

A range of liquid to solid ratios (5–15 : 1) was used and it was important to feed the leaf and liquid in at a rate which did not reduce the speed of the machine if maximal disintegration

was to be achieved. Disintegration was also dependent upon leaf size and it was found that a minimum length of 2 in. was necessary for efficient operation.

Drying procedures

In the laboratory, moist protein was stirred into 5 volumes of acetone and filtered. The process was repeated and the precipitate washed once with ether. The protein was then freed from solvent by grinding, gentle heat being applied to counter cooling due to evaporation of solvent and the associated condensation of moisture. The presence of moisture at this stage resulted invariably in secondary changes which led to the production of a hard, dark material. Once the protein became friable, drying was completed *in vacuo*.

A variety of drying procedures, e.g., drum drying, spray drying, azeotropic distillation and solvent extraction, has been used for drying leaf protein on a large scale. With the exception of azeotropic distillation or solvent extraction all the procedures employed may give products with lowered biological values (cf. Part II of this series).

Azeotropic drying.—This has been effected with toluene, its azeotrope with water boiling at 84°. When the removal of water was complete the hydrocarbon was pumped away and the dried protein washed with two further charges of hydrocarbon to remove pigments. Residual solvent was removed by admitting a small amount of steam to the extractor, then applying vacuum at a temperature of 80°.

Solvent drying.—The wet cake (25% dry wt.) was vigorously stirred into 5 volumes of hexane (7 parts) and 96% ethyl alcohol (3 parts). The protein was separated by centrifugation or filtration and the operation repeated three times or until no further colour was extracted. The solvent-wet precipitate was then dried, similar precautions being taken to those used on the laboratory scale to prevent hardening and darkening.

Analytical techniques

Total nitrogen: by the method of Chibnall *et al.*[6]

Ash and moisture: by the method used by Chibnall *et al.*[6] (cf. Tristram[7]).

Chlorophyll: by the method given in 'Official Methods of Analysis' of the A.O.A.C.[8]

Non-protein nitrogen.—Protein was precipitated at pH 4·3–4·5 by the addition of HCl and washed with water adjusted to the same pH. Non-protein nitrogen was determined on the soluble fraction by the micro-kjeldahl procedure.

Separation of the chloroplast fraction.—That fraction of the effluent nitrogen which remained suspended at 3000 *g* but which sedimented in a gravitational field in excess of 15,000 *g*, after 30 min., was attributed to chloroplasts although it may have contained other cell debris. The sedimented material was washed by re-suspension in water at pH 9·5.

Results

Impulse rendering

Chibnall had showed that alkaline solutions would solubilise leaf protein and this has been confirmed in the present work. The yield of 'soluble' nitrogen from a leaf remains fairly constant at 75–85% when alkaline solution is used as extractant. In the initial experiments the alkali used was sodium bicarbonate but it was replaced later by sodium hydroxide. The recovery of nitrogen (soluble plus chloroplast) under a variety of conditions is shown in Table V.

Disintegration of material occurs during an estimated contact time of $\frac{2}{3}$ sec. The impulse process was described by Chayen & Ashworth[5] as 'a mechanical rupture of the membranes of the . . . cells by a series of high-speed impulses through the medium of the liquid. The amount of liquid used can be varied widely but it is always necessary to surround the material with liquid in order to transmit the impulses'. Although the process is widely used, 'the theory and mechanism have still to be worked out' (Chayen & Ashworth[5]). Practical experience with the process suggests that disintegration may be attributed to physical contact at the surface of the blades, to impulses set up in the aqueous phase and to the passage of the material (obviously under some pressure) through the effluent grids. A variety of grid sizes has been used ($\frac{3}{4}$ in. to $\frac{1}{64}$ in.) the choice depending upon a number of factors among which are the fibre

Table V

Effect of solvent on solubilisation of leaf protein

(I.R. conditions: 8 in. blades; 8000 r.p.m.; repeated once)

Leaf	Solvent system	Liquid/ Leaf ratio	Grid size, in.	Wt. of leaf	Distribution of nitrogen		
					N.P.N.	Protein	Residue
Sugar beet	Water	15	1/64	100	73		25
,, ,,	,,	15	1/64	100	52		49
,, ,,	Water–ether	10	1/64	100	50		49·5
Mixed grass	Water–ether	15	1/64	50	52		—
Sugar beet	Water + 0·005% Brij 35	15	1/64	100	80		19
Italian rye	,, + 0·005% Brij 35	10	1/64	100	31	36	30
Sugar beet	1% $NaHCO_3$ + 0·005% Brij 35	10	1/64	100	72·5		26·8
,, ,,	,, ,, ,,	10	1/64	100	65		—
Lucerne	1% $NaHCO_3$	10	1/32	200	80·5		19·0
,,	,, ,,	10	1/32	500	74·5		23·9
,,	,, ,,	10	1/32	500	24	60	14·9
Sugar beet	,, ,,	5	1/64	500	84·5		14·1
,, ,,	,, ,, –ether	25	1/64	100	79		20·5
,, ,,	5% $NaHCO_3$–ether	15	1/64	100	79		18·5
,, ,,	1% KH_2PO_4	10	1/64	100	78·5		20·8
Kale	1% $NaHCO_3$	5	1/64	400	81		—
,,	,, ,,	5	1/64	400	46	35·5	20·4
,,	0·005% cetylpyridinium bromide	5	1/64	400	47	37·6	14·9
Spinach beet	0·1N-HCl + 0·005% cetylammonium bromide	5	1/32	500	73·5		27·2
,, ,,	0·1N-NaOH	5	1/32	500	23·0	49·5*	27·5
,, ,,	,,	5	1/32	500	15	82·0 67·0*	15·0

* In these experiments the chloroplast content of the protein fraction was found by high-speed centrifugation prior to precipitation and was 22–30% of the total protein.

content and the initial size of the leaf. With very fibrous materials it is necessary to use a coarse grid, otherwise fibre blocks the grid; it may be advisable to repeat the I.R. process, with, if necessary, a finer grid for the second run. This is essentially the procedure used in processing grass in the pilot plant, which will be described later. With very coarse leaves, particularly grass, a coarse grid, e.g., $\frac{1}{8}$ in., is suitable. Leaf material such as sugar beet, lucerne, brassica, etc., cause no trouble and almost any grid may be used.

Factors influencing yield in the I.R. process

(a) *Leaf size.*—In early experiments with fine-leafed grass grown under glass the recovery of nitrogen rarely exceeded 50%; similar results were obtained in the pilot plant with the fine mowings from a bowling green. In neither case was the extraction rate increased by repeated I.R. treatments. These observations suggest that the I.R. process is effective only when the material is of a size sufficient to resist movement in the mill. Leaf size should not be less than 2 in. for the laboratory mill and 6–8 in. for the mill used in the pilot plant (see Fig. 1).

(b) *Species.*—In the work so far carried out leaves of all species have proved capable of I.R. disintegration. Certain species, e.g., beet, kale and lucerne, contain less fibre than does grass and tend to produce effluents that foam; this is very marked with lucerne leaf of high nitrogen content. The foaming may be controlled by the addition of suitable anti-foaming agents.

(c) *Anatomical effects.*—The yield of extractable nitrogen and the nitrogen content of the protein preparation were maximal when the material was at leaf stage. When the plant became stalky, as in grass at the flower stage, both the yield and nitrogen content of the protein fell sharply. The effect of the seasonal variation on the yield is shown in Table VI; these values should not be regarded as typical, as they were obtained during the summer of 1959 and in part reflected drought conditions.

Degree of disintegration

(a) *Chemical studies.*—Table V shows 15–25% of the leaf nitrogen remained in the residue even after repeated washing and even when disintegration appeared to be virtually complete.

Table VI

Yield of crude protein (cytoplasmic and chloroplasts) from cocksfoot, Italian rye and lucerne

	May	June	July	August	September	October
Cocksfoot						
Wt. of protein per 100 g. (as from fresh leaf)	5·1	6·4	6·8	5·7	5·3	5·2
N content of protein	9·8	6·1	3·7	4·7	4·2	4·3
% of N isolated	83·5	80·8	66·3	72·7	69·6	77·7
As protein	68·0	70·4	59·8	64·9	57·8	66·7
As non-protein N	15·5	10·4	6·5	7·8	11·8	11·0
Lucerne						
Wt. of protein per 100 g. (as from fresh leaf)	4·1	7·6	8·6	6·2	5·7	
N content of protein	6·9	5·3	5·9	6·6	5·5	2·8
% of N isolated	82·2	80·9	72·5	75·0	76·0	74·7
As protein	51·8	63·6	56·3	51·8	44·2	21·7
As non-protein N	30·4	17·3	16·2	23·2	31·8	53·0
Italian rye						
Wt. of protein per 100 g. (as from fresh leaf)	3·4	5·6	4·6	9·7*		†
N content of protein	6·8	7·5	6·2	2·0		5·1
% of N isolated	73·0	83·7	73·6	70·5	No grass	76·5
As protein	58·1	72·0	67·3	45·7	available	48·4
As non-protein N	14·9	11·7	6·3	24·8		28·0

* Plants in a very stalky state
† New growth

Several experiments have shown that repetition of the I.R. process does not materially increase the yield of nitrogen, while sodium salicylate and protein-dispersing agents do not increase the yield of nitrogen (Table VII). In order to confirm that the unextracted nitrogen was protein, the leaf residues were treated with trypsin. The solubilisation of nitrogen then became almost complete and this confirmed that the residual nitrogen was contained in protein (see Fig. 2). After successive treatments of the fibrous residue with trypsin, about 3–5% of the nitrogen remains in the residue and may be present in undamaged cells.

Table VII

Nature of the residual nitrogen in leaf residues after impulse treatment

Leaf material—Brassica

(a) *Effect of sodium salicylate and trypsin*

1. Control treatment I.R. at 8000 r.p.m. ; $\frac{1}{32}$ in. grids ; 5 vol. of 1% NaOH, exhaustive washing
2. As above in presence of 0·5M-sodium salicylate

	1		2	
	Extract	Residue	Extract	Residue
% of total N	84·5	15·5	83·0	17·0
After 2nd treatment	86·0	14·0	85·0	15·0

(b) *Effect of varying concentrations of sodium salicylate*

	1	2	3	4	5	6
Concn. of salicylate	0	0·25	0·5	1·0	0	0
% Total N in 1st extract	80·0	80·0	78·5	77·5	77·0	76·5
Trypsin added, mg.	0	0	0	0	2	6
% Total N in 2nd extract (2nd I.R.)	2·2	2·0	2·2	1·5	15·7	16·5
% Total N in residue	17·4	18·0	19·3	21·0	—	—
mg. trypsin added to 2nd residue					10	20
% Total N in 3rd extract					2·2	1·8
% Total N in 3rd residue					4·8	5·1
% Total N removed from residue	82·2	82·0	80·7	79·0	94·9	94·8

(b) *Histological studies.*—The microscopical appearance of the effluent emerging from the machines varies considerably with leaf species. Thus, with lucerne few unbroken cells are seen, the greater part of the visible structures of the effluent being in the form of particles, 1–10 μ in diameter, many of which are chloroplasts or chloroplast fragments. In all species, occasional tissue fragments with apparently undamaged chloroplast-containing cells may be

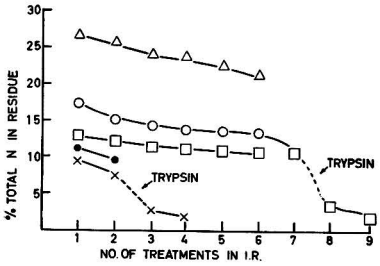


FIG. 2.—*Effect of treatment of leaf residues with trypsin*

△ Cocksfoot, autumn grass
○ Lucerne, spring leaves
□ ,, ,, ,,
● ,, ,, ,,
× ,, trypsin added

detected in the effluent, while with most grasses, the effluent contains a somewhat higher proportion of fragments containing protein-rich undamaged cells. With such an effluent, low-speed centrifugation or sieving through a fine mesh screen separates a fibrous fraction which contains about 20% of the original protein nitrogen of the fresh plant.

Microscopical examination of the fibrous residue was made either on teased preparations or on microtome sections cut after embedding. Both preparations were stained to reveal the presence of protein, the Sakaguchi technique (Chayen *et al.*[9]) and the Naphthalene Black stain being used. The most conclusive indication of the presence of protein in the fibrous residue was obtained with teased preparations stained with Naphthalene Black. In all tests, the stain was taken up by the same regions of the section. The bulk of the fibrous tissue was composed of remnants of vascular bundles; the specific protein-staining elements were the young xylem, xylem parenchyma, cambium, phloem and companion cells.

Examination of the ' chloroplast ' fraction, separated in the ultra-centrifuge, was carried out in the electron microscope by Dr. J. Crawley. The principal component seen in thin sections of this fraction was identified as osmotically-swollen lamellae. On this evidence it seems that the impulse process leads to the disruption of part, at least, of the chloroplasts.

Solubilisation of protein

When organically bound nitrogen is separated from the fibre, some is present as non-protein compounds, some as protein in solution and some as protein in particulate form. Chibnall classified these two forms of protein as cytoplasmic and chloroplastic.

The estimation of chloroplast and cytoplasmic protein and water-soluble nitrogen was carried out as follows. A sample of leaf was milled by the normal procedure (I.R. 6000 r.p.m.; $\frac{1}{64}$ in. grids, 5 volumes of 1% NaOH). After removal of the fibre the extract was centrifuged at low speed to remove coarse particles and suspended solids. The ' chloroplast ' fraction was then sedimented at 10,000 *g*. Water-soluble nitrogen was estimated by acid coagulation of an independent sample of extract after centrifugation at low speed. The results are given in Table VIII.

Table VIII

Distribution of nitrogen in leaf extracts

(treatment—see text: spinach beet leaf)

Month	% Water in fresh leaf	% N in fresh leaf	% Total N in residue	% Total N isolated	% Non-protein N	% Total N in extract protein	
						Cytoplasmic	Chloroplast
February	84·3	0·65	13·6	86·4	21·5	53·3	9·6
March	85·6	0·51	13·3	86·7	12·4	60·3	4·0
April	84·9	0·41	18·0	82·0	21·7	55·8	4·5
May	83·8	0·55	17·1	82·9	13·8	59·9	9·3
June	89·5	0·37	8·1	91·9	18·5	60·4	13·0
July	86·4	0·33	9·7	90·3	14·8	58·8	16·9

No particular significance is attached to the variation in the individual fractions because of the ' bolting ' of the plants and of the difficult conditions brought about by continued drought June–September 1959. Table IX*b* shows the nitrogen, chlorophyll and ash contents of the fibre, ' chloroplast ' and soluble protein fractions. The protein fraction was of fairly constant nitrogen content and the ash content was not abnormal. The nitrogen (3·0–5·0%) and ash content (11·9–19·8%) of the chloroplastic fractions illustrated that the lowered nitrogen content and raised

Table IX*a*

Distribution composition of cytoplasm and chloroplasts

	Spinach (Chibnall[1])		Mixed grass
	Cytoplasm, %	Chloroplast, %	(present work) Chloroplast, %
Protein (N × 6·25)	96·5	39·6	50–53
Lipid	1·9	25·1	40–44
Ash	1·6	16·9	16·9

Table IX*b*

Composition of freeze-dried fraction isolated from spinach beet

Month	February	March	April	May	June	July
			Fibre fraction			
Total N (ash free)	3·3	2·5	1·9	2·1	2·0	1·8
Ash	9·1	6·2	6·2	6·5	8·0	7·3
Chlorophyll (g.-%)	0·073	0·076	0·133	0·069	0·041	0·041
% of fresh leaf	3·15	3·26	4·67	5·22	1·89	2·11
			Chloroplastic fraction			
Total N (ash free)	3·5	4·6	5·2	5·9	5·6	5·0
Ash	13·8	15·3	15·4	14·8	11·9	19·8
Chlorophyll (g.-%)	2·2	1·1	1·48	1·6	0·9	0·9
% of fresh leaf	2·3	0·6	0·7	1·1	1·1	1·5
			Protein fraction			
Total N (ash free)	9·5	8·35	8·14	9·1	9·7	9·75
Ash	5·5	4·4	3·9	3·5	2·8	3·4
Chlorophyll (g.-%)	0·51	0·65	0·35	0·78	0·49	0·77
% of fresh leaf	4·4	4·3	3·3	4·2	2·7	2·3

ash content of crude protein as prepared in the pilot plant were due to the presence of the chloroplastic fraction (cf. Table IX*a*).

Attempts have been made to plasmolyse the chloroplast fractions by treatment with a variety of reagents. The results of these experiments are given in Table X and Table XI.

At 40° (Table X) all of the reagents, with the exception of Tergitol 7, reduced the amount of nitrogen held in particulate form when treatment was restricted to 2 h. Longer periods had the reverse effect and this is thought to be due to coagulation. Prolonged treatment at 40° led to changes in the protein which was recovered as a gum, rather than a flocculent precipitate.

At 25° (Table XI) similar effects were observed, the amount of protein held in particulate form being considerably reduced. At this temperature longer periods of treatment (up to 24 h.) reduced the amount of particulate nitrogen: in all instances protein precipitated normally at pH 4·5 to 5·0.

The reduction in the amount of protein held in particulate form means that it should be possible to obtain samples of protein free from contaminating cell debris by high-speed centrifugation. On the laboratory scale this is possible, and higher yields of protein are obtained after treatment with sodium dodecyl sulphate, etc. In large-scale preparation, however, it is not possible to separate particulate matter by high-speed centrifugation. In consequence preparations made on the pilot plant include soluble protein and particulate protein and no work has yet been carried out on the effect of surface-active reagents on the pilot plant scale.

Alternative procedure for the disruption of chloroplasts

A sample of liquor, after being freed from coarse residues, was incubated at 21° with trypsin (1 mg. of crystalline enzyme per 100 g. of leaf). Changes in protein content after 60 min. are recorded in Fig. 3. In a further experiment the protein content and chlorophyll in free solution were followed. At 21°, 80% of the protein remained unchanged after 1 h. whereas the chlorophyll had been almost completely liberated into solution. At higher temperatures the residual protein after 60 min. was 75% (at 31°) and 60% (at 40°), while the chlorophyll did not increase

Table X

Influence of surface-active reagents on the chloroplast fraction of leaf extracts

Conditions: 8000 r.p.m., $\frac{1}{32}$ in. grids, 5 vol. of 0·05N-NaOH. Fibre removed by filtration. Particulate fraction sedimented after treatment with surface-active reagents (0·5% final concentration). Temperature 40°

Reagent	Time, h.	% of total extract N	
		Soluble	Particulate
Blank	—	69·8 69·2	30·2 30·8
Tergitol 7 (C_{17}-secondary alkyl sulphate)	3	74·4	25·6
	5	75·4	24·6
	24	73·9	26·1
Tween 20 (sorbitol monolaurate)	3	86·0	14·0
	5	86·2	13·8
	24	81·4	18·6
Crill 56 (polyoxyethylene derivative)	2	—	13·5
	5	—	16·3
	24	—	17·3
Leek 2053 (glyceryl sorbitan monolaurate)	2	—	24·6
	24	—	21·2
Manoxol-OT (dioctyl ester of sodium sulphosuccinic acid)	3		23·6
	5		19·7
	24		15·4
Sodium dodecyl sulphate	3		6·3
	10		10·1
	24		11·0
S.Q. 12 (polyoxyethylene sorbitan monolaurate)	2		23·1
	10		18·8
	24		

Table XI

Effect of surface active reagents on the particulate fraction of Italian rye

(Temperature 25°; 0·05N-NaOH; initial particulate N 21%; surface-active reagent 0·5%)

Particulate N, %

(Initial value of total N 21%)

Reagent	2 h.	5 h.	24 h.
Tween 20	8·2	7·2	9·6
Crill S6	8·9	8·9	8·9
S.Q. 12	8·2	8·9	10·8
Teepol XL	10·1	8·2	8·2
S.D.S.	11·8	10·7	8·2
Blank	18·5	18·7	19·0

correspondingly. At these higher temperatures there was evidence of auto-precipitation and this may explain the lower yields of soluble chlorophyll.

Large-scale process

The impulse process is one which tends to become more efficient as the scale of operation increases. Large machines have ample power and high leaf/liquid ratios are obtained by the re-use of wash liquors; the washing of the residues is continuous and handling is eliminated.

The pilot plant now in operation is a two-stage 18 in. × 12 in. machine. The first stage has an outlet at the exit side of the grids, while the second stage completes the disintegration in the effluent stream from the primary mill. As it is assembled at present the pilot plant has a throughput of one ton of leaf per hour.

After leaving the I.R. the effluent is freed from coarse residues by passing over a 100-mesh vibrating screen and the residue is washed in a horizontal rotary counter-current washer, the wash liquor being fed back to the first stage I.R. (Fig. 1). The washed residues are passed

through a screw press and the effluent fed back to the first I.R. The residue, containing 70% moisture, is allowed to air dry, a process which would present no problem in the tropics.

The liquor is centrifuged at low speed (600 *g*) in a bowl centrifuge to remove coarse debris and the protein is precipitated by adjustment of pH with sulphuric acid, pH 4·8–5·0 for lucerne, sugar beet, kale, etc., pH 4·3–4·5 for most grasses. After settling for 12 h. in a stainless steel or wooden tank, the supernatant is pumped off and the protein slurry heated to 60–70° to assist flocculation. The heated protein is then pumped into a Broadbent bowl-type centrifuge and spun at 900 *g* for 10 min. The green cake thus obtained, which contains about 20% solids, is scraped from the centrifuge bowl and transferred to the solvent plant for drying.

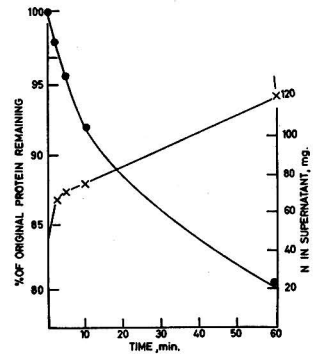


FIG. 3.—*Disappearance of protein under action of trypsin at 20°*
(100 g. of cocksfoot grass milled under laboratory conditions; 3·6 g. of protein isolated)
● cytoplasmic + chloroplastic protein
× supernatant N

Somewhat different treatments, for example leaf/liquid ratios and rate of feed, are demanded by leaves of different ages and types. With leaves of low fibre and high nitrogen content such as lucerne for example, it is convenient to add a defoamer. By virtue of its surface activity this compound may tend to plasmolyse cells and chloroplasts and thus lead to an increase in the nitrogen content of the protein.

The following leaves have been successfully processed on a large-scale plant; cocksfoot grass, mixed forage grass, lucerne, maize, manioc, kale, spinach beet, sugar beet. Other materials which have been processed include groundnuts, cottonseed, wheat, maize and potatoes. Good yields of high-quality starch are easily obtained when starchy materials are processed by this method.

Discussion

The application of the Impulse Rendering process to the isolation of protein from leaves and other plant materials is in many ways the logical outcome of the work of Chibnall and his group. The process is capable of continuous working and the extraction of protein becomes more efficient with increasing scale of operation. This is in part due to the ability to use adequate power in large-scale plant and to the ability to wash residues efficiently. The latter is achieved without a significant increase in the leaf/water ratio by feeding the washings back to the primary impulse stage.

The protein isolate is a mixture of protein in true solution and of protein in suspension. The former corresponds largely to the cytoplasmic fraction of Chibnall but some chloroplast protein is also present in this fraction; the latter consists mainly of chloroplasts together with fine debris of xylem and phloem, etc. These fractions vary in proportion during the growing season (owing to the abnormal conditions obtaining during 1959 the results are not necessarily typical).

The high ash content of the chloroplast fraction compares with that found by Chibnall[1] (cf. Table IX*a*), which contains a recent analysis of the cytoplasmic and chloroplastic fractions which were separated in the high-speed centrifuge at 40,000 *g*.

Nature of the residual nitrogen

Under normal conditions the I.R. process will separate upwards of 80% of the nitrogen from good quality leaf. Yields of protein are lowered when poor quality leaf, for example late autumn grass or low-nitrogen sugar beet, is used.

After impulse rendering, up to 20% of the leaf nitrogen remains in the residue (made up of fibre, intact cells and cell debris, etc.). Repetition of impulse treatment and extraction with alkaline solutions does not solubilise a significant amount of this residual nitrogen which was shown to be protein by the action of trypsin (cf. Fig. 4) and by selective staining techniques, the latter indicating that at least some of this protein was associated with structural components

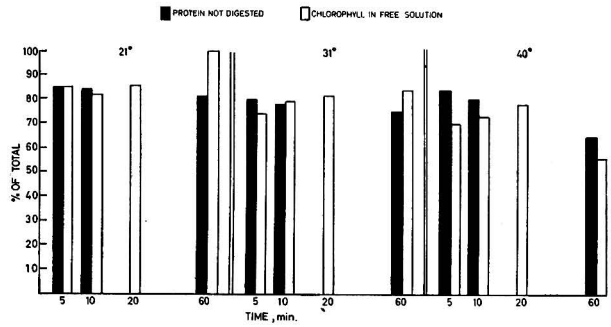


FIG. 4.—*Action of trypsin on chloroplasts*
■ protein not digested □ chlorophyll in free solutions

of the leaf. The presence of protein may indicate that it is itself a structural component or that it is in physical association with structural components. The latter possibility is considered to be unlikely because protein-dispersing agents, such as sodium salicylate, urea, guanidine, etc., do not solubilise the residual protein.

Botanists hold the view that the protein is held inside young xylem, xylem, parenchyma, etc., and is thus not free to diffuse, but such a view does not explain the ease with which the protein is hydrolysed by trypsin. There is now considerable evidence (Northcote[10]) that protein is an integral component of plant cell walls and the protein which remains with the leaf residues may, in part, represent this structural component.

The attempt to equate protein yield and purity with season was not very satisfactory, but there is ample evidence (Reports from the Hannah Dairy Research Institute) to suggest that

(*a*) high-quality grass is high in protein;
(*b*) high protein yields are obtained by adequate treatment with fertilisers;
(*c*) maximal returns of protein are obtained by rotational cropping in which the grass is cut at about 8–10 in. with the cutting edge 2 in. from the ground;
(*d*) the yield of protein falls when grass reaches the flower stage.

It is our experience that I.R. becomes more difficult, and the yield and purity of the protein preparations much reduced, when stalky rather than leafy materials are used.

British Glues & Chemicals Ltd.
London, W.C.1
and
Dept. of Biochemistry
The University
St. Andrews

Received 1 December, 1960

References

[1] Chibnall, A. C., 'Nitrogen Metabolism in the Plant', 1939 (Yale University Press)
[1a] Leitch, I. & Godden, W., *Commonw. Bur. Anim. Nutr.*, 1952, Tech. Commun., No. 14
[2] Tristram, G. R., *Biochem. J.*, 1939, **33**, 1271; see also reference [1]
[3] Lugg, J. W. H., *Biochem. J.*, 1939, **33**, 110
[4] Tilley, J. M. A., & Raymond, W. F., *Herbage Abstr.*, 1957, **27**, 235
[5] Chayen, I. H., & Ashworth, D. R., *J. appl. Chem.*, 1953, **3**, 529
[6] Chibnall, A. C., Rees, M. W., & Williams, E. T., *Biochem. J.*, 1943, **37**, 354
[7] Tristram, G. R., *Advances in Protein Chem.*, 1949, **5**, 83
[8] 'Official Methods of Analysis of the Association of Official Agricultural Chemists', 1950 (Washington, D.C.: The Association)
[9] McLeish, J., Bell, L. G. E., La Cour, L. F., & Chayen, J., *Exp. Cell Res.*, 1957, **12**, 120
[10] Northcote, D. H., & Home, R. W., *Biochem. J.*, 1951, **51**, 232; Northcote, D. H., Goulding, K. J., & Home, R. W., *ibid.*, 1958, **70**, 391

FUNDAMENTAL STUDIES ON DOUGH WITH THE BRABENDER EXTENSOGRAPH. I.—Determination of Stress–Strain Curves

By H. G. MULLER, MARY V. WILLIAMS, P. W. RUSSELL EGGITT and J. B. M. COPPOCK

A method is described for converting the empirical load–extension diagrams obtained by stretching flour–water–salt doughs on the Brabender Extensograph, into stress–strain curves plotted in absolute units. Probable errors are defined and assessed.

Introduction

Load–extension tests on dough are among the most important techniques used to evaluate flour quality. As the results obtained with all available instruments are empirical,[1] an evaluation in fundamental terms of one of them of good sensitivity,[2] the Brabender Extensograph, has been attempted.

Stress–strain data on dough were first recorded by Kosutany[3] in 1907 and more recently by Rada[4] with the Neolaborograph. Nevertheless, despite better control of temperature, dough handling and extension with this instrument, the results obtained and their evaluation were still closely similar.

One of the difficulties in the interpretation of dough stress–strain curves is the separation of the viscous from the elastic element. Rada's assumption that the first part of the curve shows perfectly elastic behaviour and the second perfectly viscous behaviour is open to doubt because the yield value of dough is so low that the two phenomena are coincident. Although stress–strain curves are of limited value, their determination has necessitated a more thorough study of the mechanism of dough extension with the Extensograph than has hitherto been attempted.

Measurement of dough properties on the Extensograph depends on the prior, and again empirical, determination of water absorption in the Farinograph. This affects the composition of the dough piece. Accordingly, flour–water–salt dough pieces of constant weight and of the appropriate water absorption are prepared for the Extensograph test by rounding and then moulding into a cylinder under constant conditions. Each piece is then pegged into a cradle and after a definite period of rest at a controlled temperature, the piece is extended by a hook which travels downwards at a constant rate. The load on the dough piece is recorded on a kymograph and the curve obtained is referred to as a load–extension curve (Fig. 1).

The usefulness of this curve has been assessed in two ways. First, attempts have been made to correlate its shape with the characteristics of the baked product.[1, 2, 5] Second, several suggestions have been put forward to assess the significance of its dimensions in relation to fundamental dough properties. This study will deal only with the second aspect.

Fig. 1 illustrates the terms and abbreviations used in this paper:

E_{tot} = a d = Total extensibility
E_{max} = a e = Extensibility to maximum resistance
R_{max} = c e = Maximum resistance
R_{const} = b f = Resistance at constant extensibility (or ' constant sample deformation ')
A_{max} = a b c e f = Area to maximum resistance
A_{tot} = a b c d e f = Total area

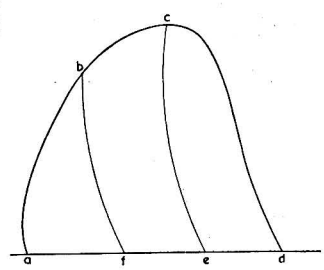


FIG. 1.—*Typical load-extension curve*

Purely geometrical criteria were used by Mueller[6] to evaluate the curve, namely, E_{tot} and R_{max}. To these Munz & Brabender[7] added A_{tot}. They were also the first to introduce two derived magnitudes, the ' visco-elastic ratio ' R_{max}/E_{tot} and the ' Oxynumber ' $\frac{A_{tot}}{R_{max}/E_{tot} \times 10}$. Various forms of this ratio R/E are widely used today in interpreting the properties of flour in relation to its suitability for bread making and biscuit baking.

Although definition of the curve by means of these geometrical figures is reasonably adequate, Merritt & Bailey[8] pointed out that the part c d of the curve should be neglected because of the irregular manner in which the extended cylinder of dough breaks and they preferred to use E_{max}, R_{max} and A_{max}. As is apparent from Table I, cereal chemists are not agreed on the most suitable method of evaluation, but the tendency in control laboratories is to use A_{tot}, E_{tot} and either R_{max} or R_{const} as well as the derived quotient R/E.

Although Fisher *et al.*[9] realised that both elasticity and viscosity are involved in the extension, their studies on the effect of water and salt on the dough made them suggest that E_{max} might be a better index of elasticity than E_{tot}. Dempster *et al.*[10] introduced the concept R_{const} believing that the load equivalent at constant sample deformation provided a better value than the maximum load which the dough could support. Unfortunately it is not yet agreed at which extension the resistance reading is best taken. The original extension of 11 cm. was later reduced by Dempster[10, 11] to 7 cm., the former value being unsuitable for weaker flours. Under European conditions, 5 cm. is frequently used, compared with 7–10 cm. in the U.S.A. and Canada, and this figure is generally satisfactory for routine purposes. The present authors have occasionally found it necessary to reduce this figure further when assessing the effect of chemical flour treatment and prefer to record resistance as R_2 (for 2 cm.), R_5 (for 5 cm.), etc. In 1953 Dempster *et al.*[12] allowed for the cradle depression during the extension, but this correction is not generally made.

Table I

Methods of evaluation of Extensometer readings by various authors

Readings taken	Author
E_{tot}, R_{max}	Mueller[6]
R_{max}/E_{tot}, A_{tot}, $\frac{A_{tot}}{R_{tot}/E_{tot} \times 10}$	Munz & Brabender[7]
R_{max}, E_{max}, A_{max}	Merritt & Bailey[8]
E_{tot}, R_{max}, A_{tot}	Johnson *et al.* [13]
E_{max}, E_{tot}, R_{max}	Fisher *et al.*[9]
R_{max}, E_{tot}	Hlynka[14]
A_{tot}	Wöstmann[15]
E_{tot}, R_{max}	Larsen *et al.* [16]
R_{const} 11 cm.	Dempster *et al.*[10]
R_{const} 11 cm. Cradle correction	Dempster *et al.*[12]
R_{const} 7 cm. ,, ,,	Dempster *et al.* [11]
R_{const} 10 cm. ,, ,,	Hlynka[17]
R_{const} 5 cm., A_{tot}, E_{tot}, R_{const} 5 cm./E_{tot}	Brabender[18]

Basically, however, there are only two ways of evaluating the Brabender curve numerically. The first is based on the geometrical shape of the curve without any reference to the underlying phenomena. For this, A_{tot}, R_{max}, E_{tot} and E_{max} are adequate. This approach is satisfactory but a more relevant terminology is height, H, for R_{max}, length, L_1 and L_2, for E_{max} and E_{tot} respectively; although area, A, could be retained for A_{tot}, the term ' energy ' for A_{tot} is best avoided.

The second type of evaluation attempts to correlate curve characteristics with the mechanism of dough deformation and dough properties, and is more complicated. It is with this problem that the present work is concerned.

Experimental and results

(a) *The calibration of the Brabender Extensograph*

The Extensograph used was a standard instrument, of German manufacture; it was calibrated as follows:

Of six dough cradles used, five weighed 350 g. and the sixth 349 g.; such a difference has no effect on the sensitivity of the instrument. The horizontal distance between the lower ridges of all dough cradles was (mean value) 3·75 cm.

A test in triplicate of the chart speed showed that the chart travelled 20·0 cm. in 30·5 sec., i.e., avoiding the initial acceleration the speed was 0·655 cm./sec. The corresponding figure for the speed of descent of the dough hook was 1·442 cm./sec. When loaded with 1 kg. over a pulley, the hook speed remained unaltered showing that this speed was unaffected by the resistance which might be encountered by the hook.

To convert Extensograph units (E.U.) into units of weight (g.), a cradle weighing 350 g. was loaded with 150 g. (normal dough weight) and the position of the pen adjusted to zero. Successive weights were added to the centre of the cradle and the chart allowed to run for 5 cm. to allow the trace to level out and avoid errors due to the pen sticking on the chart. Table II gives the weight in g. and corresponding Extensograph units. The former may be converted into dynes by multiplying by 981.

Since the resistance is measured on the Extensograph by magnification of the displacement of the dough cradle as the dough piece extends, the extension as measured on the kymograph chart includes the depression of the cradle.[12] This depression, which appeared unaffected by the damper mechanism, was measured for various loads and the results were as shown in Table III.

Table II

Weight equivalents of Extensograph units

g. weight (x)	Extensograph units (y)
0	0
200·0	135
400·0	310
500·0	390
700·0	555
1006·0	810
1100·0	870

The line of best fit gives the expression
$y = 0{\cdot}79x$

Table III

Cradle depression equivalents of Extensograph units

Cradle depression (cm.) (z)	Extensograph units (y)
0	0
0·3	200
0·7	400
1·05	600
1·4	800

The line of best fit gives the expression
$z = 0{\cdot}00174y$

The chart length requires conversion into the distance between dough hook and cradle (h in Fig. 2). In time t the chart moved $0{\cdot}655t$ cm., the hook $1{\cdot}442t$ cm. and the cradle depression was $1{\cdot}74y \times 10^{-3}$, so that

$$h = 2{\cdot}20 \times \text{chart length (cm.)} - 1{\cdot}74y \times 10^{-3} \quad . \quad . \quad . \quad (1)$$

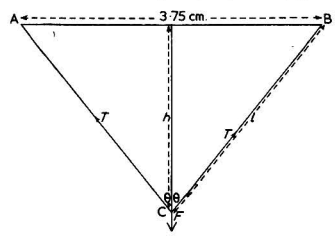


FIG. 2

As the horizontal distance between the lower ridges of the dough cradle was 3·75 cm. and the dough assumes approximately a V-shape on extension, the hook descent h and the effective half-strand of dough, l, are related by the expression:

$$l = \sqrt{h^2 + \left(\frac{3{\cdot}75}{2}\right)^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

(b) *The formulation of stress*

Stress is defined as tension per unit area of cross-section and can be obtained from $F = 2T \cos \theta$ where F is the force applied by the hook, T is the tension when the half-strand length of the dough is l and $\cos \theta$ is h/l.

The area of cross-section is given by the effective volume of the dough, V, divided by twice the half-strand length. The effective volume of the dough is the effective mass or the mass, M, of dough actually taking part in the extension, divided by its density, d. Thus, neglecting the effect of gravity, the stress is $T / \frac{M}{2ld}$.

To allow for gravity, half the dough mass should be added to the force applied by the hook.

$$F + 0{\cdot}5M = 2T' \cos \theta \qquad \text{or} \qquad T' = \frac{2F + M}{4 \cos \theta}$$

where T' is the average tension.

Therefore the average stress becomes

$$\frac{2F + M}{4 \cos \theta} \Big/ \frac{M}{2dl} = \frac{l^2(2F + M)d}{2hM} \text{ g./cm.}^2$$

or

$$\frac{(2F + M)d(h^2 + 3{\cdot}52)}{2Mh} \times g \text{ dynes/cm.}^2$$

To obtain the shear or rigidity stress, the above stress is divided by 3 (see Schofield & Scott-Blair[19]).

$$\frac{(2F + M)d}{2Mh}(h^2 + 3{\cdot}52)\frac{g}{3} \text{ dynes/cm.}^2 \qquad . \quad . \quad . \quad . \quad (3)$$

The density of dough was found in the following manner.

Flour of known moisture content (300 g.) was mixed in the Farinograph in the usual way, with measured volumes of water and 6 g. of sodium chloride. Three dough cylinders were moulded from each sample on the Extensograph and their densities determined by displacement of olive oil in a 250-ml. measuring cylinder. Liquid paraffin was too viscous because occluded air bubbles rose to the surface only slowly and the paraffin took a long time to drain off the walls of the cylinder. The results shown in Table IV were obtained with three dough cylinders for each of three flours.

Table IV

Density of doughs with different water contents

Water content, % (flour moisture 14%)	Density of dough		
	Soft	Medium	Strong flour
55		1·16	
58	1·17	1·18	1·17
60			1·16
61		1·18	
62			1·18
63		1·17	
64			1·18

From these results it was concluded that the variation in density was too small to warrant a correction either when using different flours or with water contents within the range indicated. As an average figure, $d = 1{\cdot}17$ g./c.c. was used in the formula for stress.

The determination of the effective dough mass M provides a greater problem. As it is of fundamental importance to the proper understanding of load–extension curves of dough, it is remarkable that its measurement has not been attempted before.

The effective dough mass M is always much less than the total dough mass and depends on two factors. First, the original thickness of the dough cylinder is involved. Depending on the type of dough, the length and subsequent elastic contraction when leaving the moulder vary to give a dough piece between 11 and 16 cm. long. Assuming the dough piece to consist

of a cylinder with hemispherical ends, its area of cross-section can easily be calculated. Second, the stretching process itself causes changes in the effective mass of the dough.

The variation of the effective mass M during the extension was determined by cutting the dough along the inner edges of the cradle and removing and weighing the middle piece at different stages of extension. It was thought that the slight inaccuracy due to end effects could be ignored.

Several test-pieces from the same dough were extended to a given resistance reading (Extensograph units). When the required extension was reached, the dough hook was reversed and the stretched dough piece cut off and weighed. (The hook was painted with liquid paraffin to avoid adherence of the dough.) There was good agreement between the masses of individual test-pieces from the same dough when stretched to the same extent. The results are given in Table V.

Table V

Masses of test-pieces of stretched dough

Bread flour		Strong flour		English biscuit flour	
EU, y	Mass, g.	EU, y	Mass, g.	EU, y	Mass, g.
105	62·5 ± 0·5	200	52·0 ± 1	100	70·0 ± 1
140	60·0 ± 1	260	55·0 ± 3	120	68·5 ± 0·5
160	62·5 ± 0·5	310	58·5 ± 1·5	140	73·0 ± 2
200	66·5 ± 0·5	380	67·0 ± 0	160	77·0 ± 3·5
240	74·0 ± 3	445	70·0 ± 0	180	81·0 ± 3
250	76·0 ± 0	500	73·0 ± 0·25	200	81·0 ± 1
260	79·0 ± 2				
300	83·0 ± 2				
340	83·5 ± 0·5				
380	87·0 ± 1				

Effective mass is plotted against the resistance reading in Extensograph units for the three flours in Fig. 3.

The extension process was studied more closely when it was discovered that these curves are all sigmoid. Equidistant lines were printed on the underside of each dough piece with an inked wire grid (Fig. 4*a*). When stretched, the dough between the inner cradle edges was relatively evenly extended at first (Fig. 4*b*). The distance between the printed lines then remained almost unchanged while dough was pulled forcibly over the inner cradle edges (Fig. 4*b et seq.*). The latter caused serious tearing of the dough surface. The effective dough mass increased rapidly with the resistance reading as shown by the rapid rise of the curves in Fig. 3. The dough invariably tore on further extension where the surface had been damaged (Fig. 4*d* and *e*). When the dough strand was about to tear, little further dough was pulled over the edge of the cradle so that the curves in Fig. 3 flattened. The sigmoid shape of the curves is thus explained. The importance of smooth cradle edges is also amply demonstrated. By marking the top surface of the dough piece it was shown that no flow took place between the outer pegs and the outer edges of the cradle although some dough was pulled from the area between the two rows of pegs tethering the dough.

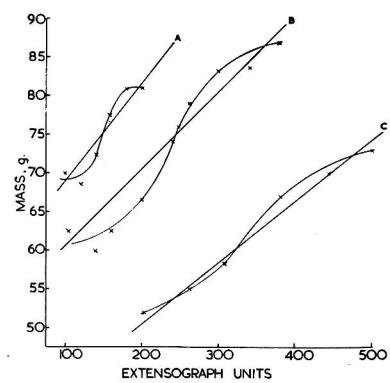


FIG. 3.—*Plot of effective mass vs. Extensograph units*

A strong flour B bread flour C biscuit flour

Table V shows that the stronger the flour, the lower is the effective dough mass corresponding to a given resistance. This is partly because a stronger dough reaches a certain resistance reading in less time than a weaker dough, thus allowing less time for flow to occur.

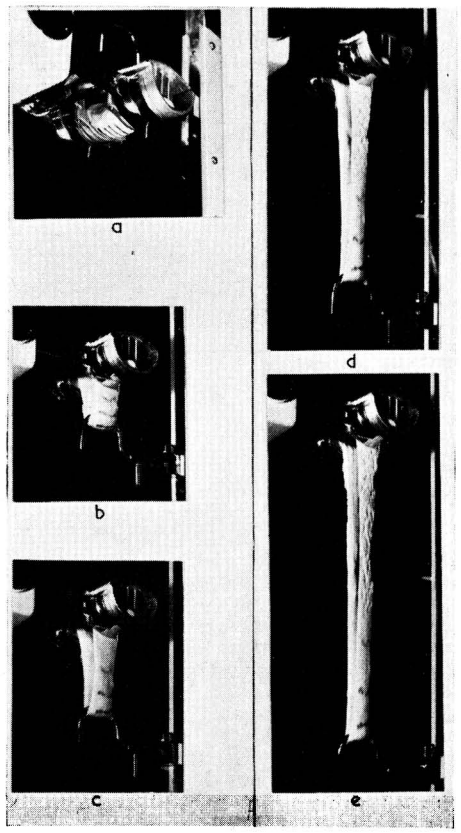


FIG. 4.—*Dough pieces being stretched on Extensograph*
a–e see text

It would not be convenient to cut off the dough piece for each extension when deriving a stress–strain curve from an extensogram; an approximation was therefore used in order to find the weight corresponding to each extension. When the line of best fit was calculated for each of the three curves shown in Fig. 3, it was found that the slopes were 0·10, 0·08 and 0·13, the mean slope representing all doughs in the experimental range being 0·10. Using this slope and knowing only the effective mass of dough corresponding to one extension (preferably in mid-range), one can deduce the effective mass for any degree of extension.

(c) *The formulation of strain*

Strain is defined in classical terms as the extension per unit length. With dough, the difficulty arises as to the length on which the extension occurs since permanent extension occurs at very low stresses.

If it be assumed that the extension takes place on the original unstretched dough length,

namely between the inner edges of the cradle, the strain is

$$\frac{2l_t - 2l_0}{2l_0} = \frac{l_t - l_0}{l_0} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

where l_t is the half-length of the dough at time t and l_0 the half-length of the unstretched dough strand, i.e., half the distance between the inner edges of the cradle. l_t was obtained by converting the measurement of extensibility, E, on the kymograph chart by using equations (1) and (2) above.

If, on the other hand, the permanent elongations were incorporated into l_0, then an extension dl would be assumed to have taken place between times t and $t + dt$ on a dough strand of length l_t. Thus the strain would be:

$$\frac{l(t + dt) - l_t}{l_t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

When used, this equation (5) gave no advantage over equation (4) and the results obtained with it are therefore not reported.

(d) *The determination of stress–strain curves*

The doughs were mixed in the usual way on the Farinograph (1 min. mixing, 5 min. resting, 2 min. final mixing). Six g. of salt were dissolved and added to 300 g. of flour. The soft flour was used with 55%, the other flours with 58% of water. After being moulded, the doughs were rested for 45 min. and then stretched in the usual way.

Readings of resistance (EU) and extensibility (cm.) were taken at intervals of 0·5 cm. on the extensogram and converted into stress–strain values by substitution into equations (3) and (4). The effective dough mass was found by a further extension to a fixed resistance reading in mid-range and weighing the dough after cutting at the cradle. From this value and the slope of 0·10 the mass at any other resistance reading was deduced as already described. The stress-strain curves of the three flours are shown in Fig. 5. The initial downward trend of the curves is probably an artefact due to the sudden large change in the angle of the dough strands with the vertical. The cosine of the angle almost doubles and is not compensated for by the change in the force on the dough.

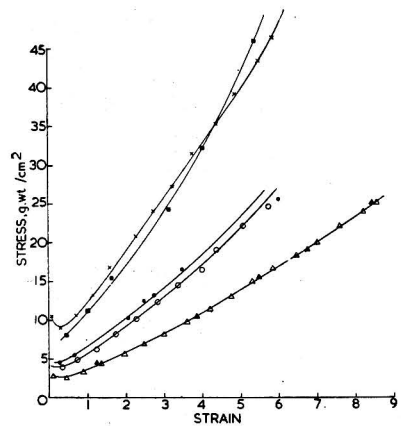


FIG. 5.—*Stress–strain curves for flour doughs*

Strong flour	×	one mass	■	individual masses
Bread flour	○	,, ,,	●	,, ,,
Biscuit flour	△	,, ,,	▲	,, ,,

(e) *The errors involved in the determination*

The errors involved in the measurements are conveniently divided into those which do not lend themselves readily to mathematical analysis and those which do.

Among the former are the slight elastic recovery of the dough when the hook is reversed during the determination of effective mass and the fact that the stretched dough strand is not strictly uniform (Fig. 4). This error is greatest near the breaking point (no measurements were made in this region).

The remaining errors have been assessed below on the principle that errors in a product are the sum of the individual errors, whereas errors in a sum are given by the square root of the sum of the squares of the individual errors. The estimate has been made on a set of figures from the mid-range of a bread flour.

The errors are conveniently divided into those affecting the stress relationship and those referring to the strain part of the diagram.

As shear stress $= \frac{(2F + M) \times d \times (h^2 + 3{\cdot}52)}{6M \times h}$ g./cm.^{2} the errors involved are as follows:

Errors in density d

The error in density is the sum of the individual errors in the mass and volume of the dough used in the density measurement, namely 0·08% + 0·8% = 0·88%.

Error in (2F + M)

Denoting the error in $2F$ by $\delta 2F$ and that in M by δM the error in

$$(2F + M) = \delta(2F + M) = \sqrt{(\delta 2F)^2 + (\delta M)^2}.$$

It will be recalled that $F = y/0{\cdot}79$. The estimated error in reading the Extensograph unit is 2·5 or 3 g. The standard error in the slope of 0·79 is 0·008 giving an error of 3 g. on a force of 323 g. Thus the total error in $2F$ is about 12 g.

Considering M, there is an error of 1–2 g. between duplicate readings and a probable error of 1–2 g. in assuming a linear relation between mass and Extensograph units. The total error in M is thus about 3 g. Taking the mass as 79·5 g. the error is 4%. The error

$$\delta(2F + M) = \sqrt{12^2 + 3^2} = 12.4 \text{ g.}$$

Taking F as 323 g., $2F + M = 725{\cdot}5$ g. and the error is, therefore, about 1·7%.

Stress–strain curves constructed using individually measured mass values for each extension were compared with those obtained with calculated mass values. The agreement between the two sets of graphs is very close. Comparing the curves, it is apparent that the initial dip is absent in the latter set. At these very low stresses it was not possible to cut off the effective dough mass and thus obtain the corresponding values of stress.

Error in ($h^2 + 3{\cdot}52$)

The error in $(h^2 + 3{\cdot}52)$ is $\sqrt{[\delta(h^2)]^2 + [\delta(3{\cdot}52)]^2}$.

As
$$h = (2{\cdot}2e) - 1{\cdot}74y \times 10^{-3} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where e is the chart length in cm.,

$$\delta h = \sqrt{(\text{error in } 2{\cdot}2 + \delta e)^2 + (1{\cdot}74 \times 10^{-3}\delta y)^2}.$$

The error in measuring the hook and chart velocities amounts to about 0·4% giving an error of 0·009 in 2·2. The probable error in measuring e of a magnitude of 4·35 cm. is estimated at 0·025 cm. or 0·57%. The total error in $(2{\cdot}2e)$ is about 1%.

Therefore
$$\delta h = \sqrt{(0{\cdot}09)^2 + (1{\cdot}74 \times 10^{-3} \times 2{\cdot}5)^2}.$$

Thus the error involved in making the cradle depression correction is not significant as compared with that in measuring e.

Therefore
$$\delta h = 0{\cdot}09.$$

Taking e as 4·35 cm., h as 9·13 cm. and the error in h as 0·97%, the error in h^2 will be 1·9%. The distance between the inner edges of the cradles was measured for all cradles and the error found to be negligible. There is thus no error in the figure of 3·52 appearing in the equation. The error in $(h^2 + 3{\cdot}52)$ is therefore 1·9%.

The total error in the numerator of equation (3) is therefore

$1{\cdot}7 + 0{\cdot}88 + 1{\cdot}9 = 4{\cdot}48\%$ and that in the denominator $4{\cdot}0 + 0{\cdot}97 = 4{\cdot}97\%$.

Consequently the total error on a stress reading of 18·4 g.wt./cm.^{2} is about 9·5%.

The probable error in the strain reading was calculated in a similar manner.

If the value for l_0 is substituted in equation (4), the strain equals

$$\frac{l - 1{\cdot}875}{1{\cdot}875} = \frac{1}{1{\cdot}875} - 1,$$

where $l = \sqrt{h^2 + 3{\cdot}52}$.

As determined above, the error in $(h^2 + 3{\cdot}52)$ is about 1·9%. Thus the error in

$$l = \sqrt{h^2 + 3{\cdot}52} = 0{\cdot}95\%.$$

Taking l as 9·32 cm. and the error in l as 0·09 then the strain equals 2·7 and the error will be

$$\frac{0{\cdot}09}{2{\cdot}7} \times 100 = 3\%.$$

A large part of the error in this measurement is due to the measurement of the effective mass but this is of fundamental importance in the derivation of stress–strain curves.

Discussion

An interesting parallel to this work is that of Halton[20] in his attempt to convert load–extension curves obtained by means of the Extensometer into approximate stress–strain curves. He assumed, however, that the volume of the dough piece being stretched remained unchanged during the extension, i.e.,

$$V_1 = V_2,$$

where V_1 and V_2 are the volumes of the dough corresponding to lengths l_1 and l_2. If x is the cross-section of the dough piece, then

$$x_1 l_1 = x_2 l_2 \qquad \text{or} \qquad x_2 = x_1 l_1 / l_2.$$

As $x_1 l_1$ is assumed constant, x_2 is inversely proportional to the length of the dough piece. Thus as the shear stress is equal to $\frac{1}{3}$ the load divided by the area of cross-section,

$$\text{stress} = \tfrac{1}{3} \text{ load} \times \frac{\text{length}}{\text{volume}} = \text{K} \times \text{load} \times \text{length, where K is a constant.}$$

In applying these equations to the Extensometer, Halton substituted the resistance R for the load and the extensibility E for the length of the dough piece. As the strain was assumed proportional to E an approximate stress–strain curve was obtained by plotting $R \times E/100$ against E.

By expanding the stress formula derived in this paper and expressing all the terms in values of R, E and M as shown below, it can be seen that the first and largest term, constant $\times$ RE/M, bears a significant resemblance to the expression derived by Halton. The mass M is absent from his formula as it is assumed to remain unchanged and is contained in the constant.

With the usual notation

$$\begin{aligned}\text{stress} &= \frac{1}{3} \cdot \frac{(2F + M)d(h^2 + 3{\cdot}52)}{2Mh} \\ &= \frac{d}{6}\left[\frac{2Fh^2}{Mh} + \frac{7{\cdot}04F}{Mh} + \frac{Mh^2}{Mh} + \frac{M \times 3{\cdot}52}{Mh}\right] \\ &= \frac{d}{6}\left[\frac{2Fh}{M} + \frac{7{\cdot}04F}{Mh} + h + \frac{3{\cdot}52}{h}\right]\end{aligned}$$

Substituting $R/0{\cdot}79$ for F and $2{\cdot}2E$ for h (neglecting the cradle depression), then the stress becomes

$$\begin{aligned}&\frac{1{\cdot}17}{6}\left[\frac{4{\cdot}4}{0{\cdot}79}\left(\frac{R \times E}{M}\right) + \frac{7{\cdot}04}{0{\cdot}79 \times 2{\cdot}2}\left(\frac{R}{E \times M}\right) + 2{\cdot}2E + \frac{3{\cdot}52}{2{\cdot}2} \cdot \frac{1}{E}\right] \\ &\qquad = 1{\cdot}09\frac{R \times E}{M} + 0{\cdot}79\frac{R}{E \times M} + 0{\cdot}43E + 0{\cdot}31\frac{1}{E},\end{aligned}$$

where the first term is the largest and increases with time, the second depends on the ratio R/E, the third increases with time and the fourth decreases with time and is only significant at very low extensions.

An equivalent expression was derived for the strain by using the binomial expansion.

This is a good approximation for all values of E greater than 0·86 but for $E < 0{\cdot}86$ the formula does not hold.

As is apparent from equation (4),

$$\text{strain} = \frac{l - 1{\cdot}875}{1{\cdot}875} = \frac{l}{1{\cdot}875} - 1 = \frac{\sqrt{h^2 + 3{\cdot}52}}{1{\cdot}875} - 1.$$

Substituting $2{\cdot}2E$ for h, the strain then becomes

$$\frac{\sqrt{(2{\cdot}2E)^2 + 3{\cdot}52}}{1{\cdot}875} - 1 = \frac{2{\cdot}2E}{1{\cdot}875}\left[1 + \frac{0{\cdot}73}{E^2}\right]^{\frac{1}{2}}.$$

Expanding this, the strain equals

$$\frac{2{\cdot}2E}{1{\cdot}875}\left[1 + \frac{1}{2}\left(\frac{0{\cdot}73}{E^2}\right) - \frac{1}{2} \times \frac{1}{4}\left(\frac{0{\cdot}73}{E^2}\right)^2 + \ldots\right] - 1.$$

$$= 1{\cdot}17E\left[1 + \frac{0{\cdot}365}{E^2} - \frac{1}{8} \times \frac{0{\cdot}73^2}{E^4} + \ldots\right] - 1.$$

For $E > 2$ cm. the third term inside the bracket may be neglected.

Again the first term ($1{\cdot}17E$) is equivalent to Halton's expression.

To compare the formula derived in this paper with Halton's approximation, stress–strain curves for the same extensograms were drawn by plotting $R \times E/100$ against E as suggested by Halton for the Extensometer. The results are shown in Fig. 6. Although the two sets of curves in Fig. 5 are similar, they differ from Fig. 6 especially at low strains. The Halton equation gives a curve which passes through the origin whereas equations (3) and (4) give a curve which has a stress value corresponding to zero strain due to the weight of the dough itself. It should, of course, be noted that whereas the plot obtained by the use of equations (3) and (4) gives absolute, if approximate, values of stress and strain, those obtained by Halton's formula are empirically based.

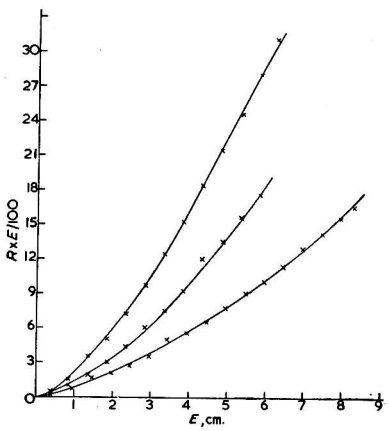


FIG. 6.—*Stress–strain curves*
bottom curve—strong flour middle curve—bread flour
top curve—biscuit flour

The stress–strain curves apply specifically to the Extensograph in that they have been determined at a constant rate of strain. Although they apply only to this instrument and to a single, fixed rate of strain, similar methods may be used with other load extension instruments. The work has revealed that variation in the effective mass, hence variation in stress during extension, is a major deficiency of this type of instrument. The weaker the flour, the greater is the flow and the consequent increase in effective dough mass. The instruments, therefore, tend to misrepresent differences between strong and weak flours. It will be seen therefore why instrumental and baking tests on individual flours are, on occasion, at variance.

Technological Research Station
Spillers Ltd.
Station Road
Cambridge

Received 1 December, 1960

References

[1] Amos, A. J., *Analyst*, 1949, **74**, 392
[2] Bennett, R., & Coppock, J. B. M., *J. Sci. Fd Agric.*, 1956, **7**, 754
[3] Kosutany, T., 'Der ungarische Weizen und das ungarische Mehl', 1907 (Molnarok Lapja)
[4] Rada, I. T., *Die Mühle*, 1956, **93**, 495

References (*cont.*)

[5] Fuchs, H., *Die Müllerei*, 1959, **12**, 41, 58
[6] Mueller, G., *Z. ges. Getreiden.*, 1936, **6**, 1
[7] Munz, E., & Brabender, C. W., *Cereal Chem.*, 1940, **17**, 313
[8] Merritt, P. P., & Bailey, C. H., *Cereal Chem.*, 1945, **22**, 372
[9] Fisher, M. H., Aitken, T. R., & Anderson, J. A., *Cereal Chem.*, 1949, **26**, 81
[10] Dempster, C. J., Hlynka, I., & Winkler, C. A., *Cereal Chem.*, 1952, **29**, 39
[11] Dempster, C. J., Hlynka, I., & Anderson, J. A., *Cereal Chem.*, 1955, **32**, 241
[12] Dempster, C. J., Hlynka, I., & Anderson, J. A., *Cereal Chem.*, 1953, **30**, 492
[13] Johnson, J. A., Shellenberger, J. A., & Swanson, C. O., *Cereal Chem.*, 1946, **23**, 400
[14] Hlynka, I., *Cereal Chem.*, 1949, **26**, 307
[15] Wöstmann, B., *Cereal Chem.*, 1950, **27**, 391
[16] Larsen, B. L., Jenness, R., Geddes, W. F., & Coulter, S. T., *Cereal Chem.*, 1951, **28**, 351
[17] Hlynka, I., *Bakers' Dig.* 1955, **29**, 27
[18] Brabender, O. H., 'Instructions for erection and maintenance of the Brabender Extensograph', Duisburg, 1957
[19] Schofield, R. K., & Scott-Blair, G. W., *Proc. roy. Soc.*, [A] 1932, **138**, 707
[20] Halton, P., *Res. Ass. Brit. Flour Millers Bull.*, 1949, **6**, 81

NUTRITIONAL VALUE AS PROTEIN OF SOME OF THE NITROGENOUS CONSTITUENTS OF TWO MARINE ALGAE, *CHONDRUS CRISPUS* AND *LAMINARIA DIGITATA**

By B. A. LARSEN† and W. W. HAWKINS

Samples of two seaweeds, *Chondrus crispus* and *Laminaria digitata*, were dried and extracted to increase their concentration of nitrogen. These preparations were fed to young rats as sole sources of nitrogen at levels representing 7–10% crude protein in the diets.

The digestibility of the nitrogenous constituents was low in both cases. The metabolic utilisation of absorbed nitrogen was good in the case of *C. crispus*, and poor in the case of *L. digitata*. The nitrogenous constituents of the preparations were defective for the support of adequate growth.

Introduction

In some parts of the world certain seaweeds are used as food for men and domestic animals, consequently there is interest in their nutritional qualities and experimental investigations on them have been made with animals during the past decade.

Dried meals of *Ascophyllum nodosum* and of *Laminaria cloustoni* have been fed to dairy cattle in proportions of 10% of the ration, with neither deleterious nor beneficial effects,[1] although there is one report[2] that the addition of *A. nodosum* to the diet increased the fat content of the milk.

Similar preparations of *A. nodosum* and *Fucus vesiculosus* have been fed to pigs[3] in amounts up to 6% of an otherwise balanced ration, with no adverse effects, and no differences in weight gains from animals on a comparable ration without them.

When dried meals of *A. nodosum* and *F. vesiculosus* were fed to laying hens at levels of up to 50% of the ration,[4] they were not readily accepted, and examination of the excreta revealed that generally the constituents of the seaweed were poorly digested. When under other conditions[5] kelp (probably *Laminaria*) meal was accepted by laying hens and growing chickens at a level of 10% in an otherwise balanced ration, it conferred no advantages or defects.

In other experiments with poultry[6] dried meals of species of *Ascophyllum*, *Esculenta* and *Laminaria* were accepted by chicks and laying hens at levels of 3–8% in a variety of diets. In two experiments out of many there were apparent benefits associated with the seaweed constituent of the diet. In one case there was an enhancement of growth in chicks, and in another

* Issued as N.R.C. No. 6387
† Present address: Norwegian Institute of Seaweed Research, NTH, Trondheim, Norway

there was an increase in the hatchability of eggs; but it was indicated that similar responses occurred when grass was substituted for the seaweed. The authors concluded[6] that there were no special effects from the feeding of these levels of seaweed meals if the diets were well balanced otherwise.

In a review of the usefulness of seaweed in animal feeds Black[7] noted the results of most of these trials, and made the point that the only benefit from the use of the seaweed products is that in certain proportions they may replace an equal amount of dietary material which cannot be improved by any supplement. It is implied that any benefit from their use is economic.

The nitrogen content of seaweeds varies widely,[8, 9] and in some it is remarkably high at certain times of the year. It is possible that some seaweeds can be used as sources of protein.

Bender *et al.*[10] investigated the nutritional quality of the nitrogenous constituents of a number of seaweeds in feeding tests with rats, but they worked with whole dried meals. For this purpose it is difficult to formulate diets with such preparations without including undesirable amounts of some of the other constituents of the algae. A pronounced difficulty is that even though the nitrogen content of the meal may be high compared with that of similar preparations from many other plants, it may not be sufficiently high to allow for dilution with supporting nutrients, and even then other constituents of the seaweed may be present in quantities unacceptable to rats. Bender *et al.*[10] encountered these difficulties and consequently could obtain no information on some of their preparations. Very limited information was obtained on others when they were used in conjunction with casein. One preparation of *Rhodymenia palmata*, however, was sufficiently high in nitrogen to make a feeding test possible, and results were obtained which indicated that the quality of the nitrogenous constituents ranked with that of fairly good vegetable proteins.

There have been several studies of the amino-acid composition of the proteins or the nitrogenous constituents of seaweeds.[9, 11–14] In general these have shown a wide array of amino-acids, including those essential for monogastric animals, in amounts which suggest at least fair quality as protein. This can be measured by Oser's essential amino-acid index,[15a] which numerically relates proteins in terms of their essential amino-acid content to whole egg protein. We have calculated this in cases where the data are adequate. The figures are shown in Table I with those of some well-known food proteins for comparison.

Table I

Essential amino-acid indices of some plant and animal materials*

Material and source of data	Index
Cod and haddock muscle[17]	92
Mammalian muscle[18a]	99
Dried skim milk[14]	87
Selkirk wheat[14]	66
Peas and beans[18b]	78
Potato[19]	79
Seaweeds	
Rhodymenia palmata[14]	74
,, ,, [13]	67
Ascophyllum nodosum[13]	58
Fucus vesiculosus[13]	61
Sargassum sp.[11]	57
Laminaria sp.[11]	60
,, *cloustoni*[14]	49
,, ,, [12]	54
Chondrus crispus[13]	48
Ulva lactuca[13]	68

* Calculated according to Oser[15a] (whole egg = 100)

The figures in Table I show that in amino-acid composition the proteins or nitrogenous constituents of seaweeds in general compare favourably with vegetable proteins of fairly good nutritional quality, and therefore could be expected to complement vegetable proteins of poor quality in feeds for monogastric animals (provided the essential amino-acids are available). In the case of *Rhodymenia palmata*[13, 14] the amino-acid composition is not inconsistent with the result of the biological test by Bender *et al.*[10] In this regard, however, there is the complicating factor of digestibility. Regardless of the composition of a dietary protein, sufficient amino-acids for physiological needs, including those which are essential, must be released from it during digestion, and absorbed by the animal. It is noteworthy that MacIntyre[4] found that the nitrogenous constituents of *A. nodosum* and *F. vesiculosus* were not well digested by hens. This type of information can be obtained only from feeding tests with animals.

As the possible protein value for monogastric animals of the nitrogenous constituents of seaweeds has interested us for some time, experiments similar to those of Bender *et al.*[10] have been attempted with whole dried meals, but the difficulties attendant upon the use of these preparations were too great to allow adequate and reliable tests. It was suggested that if a treatment could be devised which would remove much of the polysaccharide and minerals by washing, and so increase the concentration of nitrogen, the preparations might be suitable. From a commercial or economic standpoint, and with a view to possible use in the feed industry, the advantages of simplicity in such a procedure may be realised, even though it might involve the loss of some nitrogen.

With this objective in mind, two preparations were made from *Chondrus crispus* and one from *Laminaria digitata* which could be tested in rats for the protein quality of their nitrogenous constituents. Since the principal polysaccharides of seaweeds are acidic, extraction with weak alkali was applied in two cases.

There are two commonly used measures of the nutritional value of a protein which are obtained from feeding experiments with rats. The *protein efficiency ratio* expresses the rate of growth in proportion to the intake of protein. The *biological value* expresses the degree of utilisation of the nitrogen absorbed during digestion. It is apparent that these values may be at variance with one another, depending upon the factor of digestibility. The biological value may be high, but the digestibility may not be sufficiently good to confer a comparable protein efficiency ratio. The biological value is ordinarily proportional to the essential amino-acid index.[15b]

In these present tests separate determinations were made of the nitrogen in the faeces and urine, so that digestibility could be measured, and other results were obtained to allow measurement of the nutritional quality as protein of the nitrogenous constituents of the seaweed preparations.

Experimental

Materials used

The seaweeds were gathered from the south shore of Nova Scotia near Halifax.

The first lot of *C. crispus* was gathered in the summer of 1957, dried and ground. The nitrogen content was 4·62%. A suspension of 1500 g. of this material in 60 l. of 0·2M-sodium acetate solution was autoclaved at 105° for 1 h. This treatment was applied again with sodium acetate, then twice with 40 l. of water for 30 min. The product was dried and ground (yield 305 g.). The nitrogen content was 7·53%, which represented 33% retention of the original nitrogen. This preparation was used in the diet for the animals of Group I (see Table II).

A second lot of *C. crispus* was gathered in the early spring of 1959. The nitrogen content of the dried and ground material was 4·24%. Since it has been demonstrated[16] that the rat can tolerate a considerable amount of carrageenin in the diet, the treatment of this lot was devised as an attempt to remove principally minerals, and to leave more of the polysaccharide and nitrogenous materials in the residue. Eight hundred g. of the material were treated with 2·5 l. of boiling 40% isopropanol (in water) under reflux for 2 h. This treatment was repeated and was followed by two washings in 5 l. of water. The product was dried and ground (yield 700 g.). The nitrogen content was 3·29%, which represented 70% retention of the original nitrogen. This preparation was used in the diet for the animals of Group VI (see Table II).

A batch of *L. digitata*, gathered in the spring of 1959, was dried and ground. The nitrogen content was 2·46%. Four kg. of this material were mixed with an equal quantity of water and autoclaved for 30 min. The extract was discarded and the residue was treated with 60 l. of 20% sodium carbonate solution for 48 h. with occasional stirring. This treatment was repeated. The residue was then suspended in 15 l. of water, neutralised with dilute hydrochloric acid, dried and ground (yield 770 g.). Its nitrogen content was 4·12%, which represented 32% retention of the original nitrogen. This preparation was used in the diet for the animals of Group IV (see Table II).

(Dried preparations of *A. nodosum* and of *F. vesiculosus* which had been gathered late in the spring of 1959 were treated in the same way as the preparation of *L. digitata*. The original

Table II

Composition of diets with extracted seaweeds, etc.

Experiment	1			2		3	
Group	I	II	III	IV	V	VI	VII
Source of nitrogen	*C. crispus*	Egg albumin	Casein	*L. digitata*	Egg albumin	*C. crispus*	Egg albumin
	21	10	10	39	10·3	35	8
Maize oil	10	10·2	10	10	10	10	10
Salt mixture*	4	4·1	4	4	4	2	4
Sucrose	64·7	65·9	64·7	47·1	47·1	53·4	53·4
Cellulose	0	9·3	9·7	0	25·9	0	22·1
Total	99·7	99·5	98·4	100·1	97·3	100·4	97·5
Nitrogen, %	1·45	1·42	1·42	1·53	1·64	1·15	1·31
Crude protein (N × 6·25), %	9	9	9	10	10	7	8

Supplements added per kg. :

Cod liver oil concentrate†	2 mg. (400 i.u. vitamin A + 100 i.u. vitamin D)		
α-Tocopherol acetate	30 mg.	Pyridoxin hydrochloride	2 mg.
2-Methylnaphthaquinone	1 mg.	Calcium pantothenate	15 mg.
Choline chloride	1 g.	Nicotinic acid	2 mg.
Inositol	200 mg.	*p*-Aminobenzoic acid	1 mg.
Thiamine hydrochloride	2 mg.	Biotin	0·3 mg.
Riboflavin	3 mg.	Folic acid	0·3 mg.

* Wesson's[20] modification of the Osborne & Mendel salt mixture, purchased as Salt Mixture W from Nutritional Biochemicals Corp., Cleveland, Ohio

† Ayerst, McKenna & Harrison Ltd. (Montreal) Special Formula No. 33101, containing 200,000 i.u. of vitamin A and 50,000 i.u. of vitamin D per g.

nitrogen contents of these plants were lower than those of the *Chondrus* and *Laminaria*, and the residual nitrogen contents of the final preparations were not sufficiently high to allow the preparation of diets suitable for testing.)

Feeding trials

Diets containing 7–10% of nitrogenous material calculated as protein (N × 6·25) were used in the tests, egg albumin and casein being the reference proteins. The diets were diluted with cellulose to give essentially the same nitrogen content and caloric value as those in which the nitrogen was supplied by the seaweed preparations. Table II shows the composition of the diets.

The rats weighed between 72 and 78 g. They were divided into seven groups of 10, 5 of each sex per group, with an average individual body weight of 75 g. During the experiments they were accommodated individually in cages with wire mesh bottoms. Water was allowed *ad libitum*. They were weighed twice a week.

In Expt. 1 Groups I, II and III were used for testing the preparation from *C. crispus* with the higher nitrogen content. The individual consumption of food by the rats was 8–15 g. per day. An accurate record was kept of the amount consumed by each animal throughout the experimental period of 12 days.

In Expt. 2 Groups IV and V were used for testing the preparation from *L. digitata*. These animals ate 9–19 g. of food per day, but an accurate record was kept only on the last (15th) day of the experiment.

In Expt. 3 Groups VI and VII were used for testing the preparation from *C. crispus* with the lower nitrogen content. Food consumption per day by these animals was 6–20 g., and an accurate record was kept only on the last (14th) day of the experiment.

In Expt. 1 results for the intake of nitrogen over the entire period and of growth were used to calculate measures of the protein efficiency ratio. In all the experiments the rats were put individually into metabolism cages on the last day, and the faeces and urine for 24 h. collected (see Appendix). From data on the ingestion and excretion of nitrogen on that day, calculations were made of the nitrogen balance, and of the digestibility and biological value as protein of the nitrogenous constituents of the diets.

Nitrogen was determined in food, faeces and urine by a titrimetric micro-Kjeldahl procedure.[21, 22]

Results

The results are shown in Table III. The proportion of the ingested nitrogen which is absorbed is a measure of the digestibility of a protein or nitrogenous material. These values were high and essentially the same for egg albumin and casein. In the case of the *C. crispus* preparations they were 33% (Expt. 1) and 11% (Expt. 3) lower, and for the *L. digitata* preparation 33% lower. These values were reflected in the amounts of nitrogen in the faeces, and in the nitrogen balances.

Table III

Utilisation of nitrogen by rats

	Entire period				Last day					
	(Ranges, averages, and standard deviations : N = 10)									
Group and source of nitrogen	Av. wt. gain/day, g.	Total wt. gain, g.	Total N ingested, g.	g. wt. gain/g. N ingested	Intake of N, mg.	N in faeces, mg.	N in urine, mg.	N balance,* mg.	% of ingested N absorbed	% of absorbed N retained
Experiment 1, 12 days										
I	0·3–1·4,	4–17,	1·33–1·73,	3·0–10·4,	160–210,	59–86,	35–48,	49–83,	53–65,	53–68,
C. crispus	1·0±0·35	12±4·2	1·55±0·12	7·5±2·38	177±15·9	71±7·7	40±4·8	66±10·8	60±4·2	63±4·5
II	2·8–3·9,	33–47,	1·81–1·91,	18·3–25·0,	135–213,	17–27,	45–79,	71–148,	87–91,	58–77,
Egg albumin	3·3±0·39	39±5·4	1·87±0·03	20·8±2·69	204±24·6	22±3·5	56±10·7	126±21·8	89±1·5	69±6·4
III	1·3–3·1,	15–37,	1·56–1·92,	9·6–16·4,	167–213,	11–29,	20–93,	50–145,	86–95,	35–90,
Casein	2·1±0·44	25±6·1	1·75±0·11	14·2±2·99	203±18·0	21±5·0	59±20·2	123±32·5	90±2·7	67±4·6
Experiment 2, 15 days										
IV	(−0·5)–1·4,	(−7)–21,			133–202,	44–97,	40–55,	15–69,	41–73,	27–59,
L. digitata	0·7±0·53	11±8·0			169±21·9	74±15·3	50±4·6	46±16·9	56±8·9	46±9·5
V	2·2–3·7,	33–55,			177–307,	27–65,	42–107,	55–200,	74–88,	39–83,
Egg albumin	3·2±0·47	47±7·1			234±40·8	38±11·5	74±19·6	121±41·1	84±3·2	61±12·9
Experiment 3, 14 days										
VI	(−0·9)–0·6,	(−12)–9,			72–199,	8–81,	11–31,	32–147,	61–95,	52–91,
C. crispus	0·1±0·48	2±6·8			144±43·4	33±23·8	24±8·0	88±40·3	76±13·4	77±12·0
VII	2·1–3·3,	29–46,			137–262,	23–41,	30–53,	80–182,	80–90,	65–80,
Egg albumin	2·7±0·43	38±6·0			202±41·1	29±5·5	44±8·0	129±35·6	85±3·7	74±5·2

* (Ingested N) − (Faecal + urinary N)

The amount of nitrogen retained in relation to that absorbed indicated essentially no difference from egg albumin for the *C. crispus* preparations, but for the *L. digitata* preparation this figure was 25% lower. These biological values gave the nitrogenous constituents of the *Chondrus* preparations a good rating, and those of the *Laminaria* preparation a fair one.

The gain in body weight relative to the nitrogen consumption, a measure of the protein efficiency ratio, was for the *C. crispus* preparation in Expt. 1 half that of casein and one-third that of egg albumin. This measurement therefore gave this *Chondrus* preparation a poor rating, not in accord with its biological value. The preparation from *L. digitata* was likewise deficient for the support of growth.

Discussion

It must be emphasised that the preparations which were tested contained in each case only a fraction and not a true sample of the native nitrogenous constituents of the plants. They represent, however, fractions which may be fairly easily prepared, and which can contribute important amounts of nitrogen to animal diets. Such fractions could be of practical value.

The results of the tests indicated that an important defect in the nutritional quality as protein of the nitrogenous constituents of these preparations is their low digestibility. This appears to be the most important limiting factor in the case of the *Chondrus* preparations, because the nitrogen absorbed from them was retained approximately to the same extent as that from protein of high quality. In other words, the nitrogen which is absorbed is well utilised in metabolism, but insufficient is absorbed to support growth. Thus there is a difference between the biological value and the protein efficiency ratio.

In the case of the *Laminaria* preparation both poor digestibility and low biological value of the nitrogenous material appear to contribute largely to the poor support of growth.

There were quantitative differences in the utilisation by the animals of the nitrogen in the two preparations from *C. crispus*. Both the digestibility and the utilisation of the nitrogen was greater from the preparation with the lower concentration of nitrogen (Expt. 3). In the case of digestion the amount consumed could be important. It is also possible that the nitrogenous constituents of these two preparations were qualitatively different.

It is noteworthy that the essential amino-acid indices for *Chondrus crispus* and *Laminaria* sp. (Table I) do not indicate the difference in biological value found for our particular preparations. This is very likely because of differences in amino-acid composition between the materials which were analysed and those which we used in the biological tests. It may also be that there are fluctuations not only in the amount but in the type and relative proportions of the nitrogenous constituents of a marine alga.

Summary

Standard tests with young rats were applied to investigate the digestibility and the nutritional quality as protein of the nitrogenous constituents of alkali-extracted *Chondrus crispus* and *Laminaria digitata*, and of isopropanol-extracted *C. crispus*, which were incorporated into diets at levels of 7–10% crude protein.

The digestibility of the nitrogenous constituents of all was considerably lower than that of egg albumin.

The biological value, as measured by the retention of absorbed nitrogen, was for the *L. digitata* preparation 75% that of egg albumin, and for the *C. crispus* preparations about the same as that of egg albumin.

None of the preparations supported an adequate rate of growth. In the case of *L. digitata* this could be explained by a combination of poor digestibility and low biological value. In the case of *C. crispus* it was apparently mainly the result of poor digestibility.

Acknowledgments

The authors were assisted in these experiments by Mr. M. W. McLeod, Miss Joan Armstrong and Miss Verna Leonard, whose competent and careful work is acknowledged with gratitude.

Atlantic Regional Laboratory
National Research Council of Canada
Halifax, Nova Scotia

Received 25 July, 1960; amended manuscript 19 December, 1960

References

[1] Burt, A. W. A., Bartlett, S., & Rowland, S. J., *J. Dairy Res.*, 1954, **21**, 299
[2] Dunlop, G., *Nature, Lond.*, 1953, **171**, 439
[3] Cameron, C. D. T., *Canad. J. agric. Sci.*, 1954, **34**, 181
[4] MacIntyre, T. M., *Canad. J. agric. Sci.*, 1955, **35**, 168
[5] MacIntyre, T. M., & Jenkins, M. H., *Sci. Agric.*, 1952, **32**, 559
[6] Høie, J., & Sandvik, Ø., 'Experiments with Seaweed Meals as Supplements to Rations for Chicks and Laying Hens', 8th Rep. Inst. of Poultry and Fur Animals, Agric. College of Norway (Vollebeck, Norway), 1955, pp. 122–169
[7] Black, W. A. P., *Agriculture, Lond.*, 1955, **62**, 57
[8] Coulson, C. B., *Chem. & Ind.*, 1953, p. 997
[9] Channing, D. M., & Young, G. T., *J. chem. Soc.*, 1953, p. 2481
[10] Bender, A. E., Miller, D. S., Tunnah, E. J., & Black, W. A. P., *Chem. & Ind.*, 1953, p. 1340
[11] Mazur, A., & Clarke, H. T., *J. biol. Chem.*, 1938, **123**, 729
[12] Coulson, C. B., *J. Sci. Fd Agric.*, 1955, **6**, 674
[13] Smith, D. G., & Young, E. G., *J. biol. Chem.*, 1955, **217**, 845
[14] Lyman, C. M., Kuiken, K. A., & Hale, F., *J. agric. Fd Chem.*, 1956, **4**, 1008
[15] Oser, B. L., in 'Protein and Amino Acid Nutrition', Ed. Albanese, A. A., 1959 (New York: Academic Press), (*a*) p. 284, (*b*) p. 288
[16] Nilson, H. W., & Wagner, J. A., *Food Res.*, 1959, **24**, 235
[17] Guttmann, A., & Vandenheuvel, F. A., *Progr. Rep. Atl. Coast Stas, Fish Res. Bd Can.*, 1957, No. 67, p. 29
[18] Block, R. J., & Bolling, D., 'The Amino Acid Composition of Proteins and Foods', 1951, 2nd Edn (Springfield, Ill.: Chas. C. Thomas), (*a*) p. 489, (*b*) p. 491
[19] Schuphan, W., & Weinmann, I., *Ann. Nutr. Aliment*, 1960, **14**, 177
[20] Wesson, L. G., *Science*, 1932, **75**, 339
[21] Hiller, J. A., Plazin, A., & Van Slyke, D. D., *J. biol. Chem.*, 1948, **176**, 1401
[22] Sobel, A. E., Mayer, M., & Gottfried, S. P., *J. biol. Chem.*, 1944, **156**, 355

APPENDIX

Six rats were fed for 6 days a diet containing 16% of casein as the sole protein. For the last 3 days they were kept in metabolism cages, and the urine and faeces for each day were collected. The results of a study of the nitrogen balance are shown in the table. They show that data based upon the nitrogen intake and excretion for one day indicate the state of nitrogen balance as well as those based upon figures for 3 days.

Ranges, averages, and standard deviations

Values for six rats for three separate days

Daily N intake, mg.	Daily N excretion, mg.	N balance (positive), mg.	% of ingested N retained
203–244, 237±16·7	121–187, 170±25·4	57–82, 67±11·1	23–40, 29±6·6
232–244, 242±4·9	127–190, 170±23·6	54–105, 72±19·3	22–41, 29±7·2
223–244, 241±8·6	130–202, 173±25·4	42–93, 68±18·9	17–42, 29±8·9

Values for six rats for three days combined

219–244, 240±10·2	126–190, 171±24·1	54–93, 69±15·3	22–41, 29±7·3

PRESERVATION OF CUSTARD APPLE *(ANONA SQUAMOSA)* PULP

By B. S. BHATIA, L. V. L. SASTRY, G. V. KRISHNAMURTHY, K. G. NAIR and GIRDHARI LAL

Custard apple pulp, when exposed to air, turns pink due to peroxidase activity and becomes bitter when heated above 55°, which renders preservation by heat treatment inapplicable. To preserve the pulp, it is necessary to add 1% of citric acid together with 0·1% of sodium benzoate, while addition of 50–100 p.p.m. of sulphur dioxide checks the pink discoloration due to enzymic activity.

Introduction

A large quantity of custard apple is available in India especially in Andhra Pradesh, and as the season is very short, fruit gluts are frequent. The fruit pulp, which is of excellent quality, has a characteristic flavour and is consumed as a dessert or used as a base in ice-creams. The results of systematic trials to preserve this pulp are presented in this communication.

Experimental

The pulp and seeds, which are scooped out with stainless steel spoons from the cut halves of the fruit of eating-ripe stage of maturity are passed through a pulping machine fitted with 30-mesh sieve and then through 60-mesh stainless steel sieve. The yield of pulp so obtained varied from 20–25% in six batches each of about 300-lb. weight.

The pulp contains about 20% of sugar and 0·3% of acid (as anhydrous citric acid). It has a pH value of 5·5. It is of creamy white colour and has a thick consistency. When the pulp is heated above 55°, even for a short time, it develops a bitter after-taste thus making the conventional method of preservation by heat impracticable. Pulp of a few other varieties, namely, *Atemoya, Red Sitaphal, British Guinea, Mamoth, Balanagar* were also found to become bitter on heat treatment. An important factor making the preservation of this pulp difficult

is the presence of peroxidase which turns the pulp pink. The characteristics of this enzyme are described elsewhere.[1] It can be inactivated without subsequent regeneration by heating the pulp at 98° for 30 min. Since heating makes the pulp bitter, experiments were conducted to control the pink discoloration by (i) adjustment of pH by addition of citric acid, and (ii) addition of borax and ascorbic acid. Preservation by puff drying in a vacuum shelf dryer was also tried. For this purpose, the Brix density of the pulp was raised to 40, 50, 60 and 80° and the pulp dried with and without the addition of skim milk powder. The material was spread on aluminium trays at the rate of 2 lb. per sq. ft., the temperature was raised to 55° and a vacuum of about 27 in. applied quickly to induce puffing.

Both crown-cork glass bottles and tin containers (plain and lacquered) were tried. In the case of cans sealing was done under mechanical vacuum after filling them three-quarters full.

To evaluate the colour of the stored samples, 10 g. of the pulp were mixed with 15 ml. of 95% alcohol and the mixture filtered. The optical density of the filtrate was measured using a No. 42 filter in a Lumetron photoelectric colorimeter.

Results and discussion

1. *Control of pink discoloration*

At pH between 5·50 and 3·50 addition of 0·05 or 0·1% sodium benzoate to the pulp was not effective in controlling the pink discoloration which developed on exposure of pulp to the air for 16 h. Addition of 0·1% of ascorbic acid at all these pH levels inhibited the enzymic discoloration. Even lower concentration of ascorbic acid (0·05%) was effective below pH 3·9 and slight further improvement resulted after addition of 50 p.p.m. of sulphur dioxide. Sulphur dioxide was effective below pH 4·0 and 4·5 when present in concentrations of 50 and 100 p.p.m. respectively. Borax (not legally permitted as a preservative[2]) inhibited the formation of the pink colour at all pH levels when added at the rate of 0·5% in combination with 100 p.p.m. of SO_2, but 1000 p.p.m. SO_2 alone did not inactivate the enzyme, which could be detected by the characteristic colour produced with guaiacol and hydrogen peroxide.

Control of bitterness and preservation of pulp

From the above observations, it was concluded that to preserve the pulp free from bitterness, packing without heat treatment with added preservatives is desirable. To ensure reasonable shelf-life in the canned product, an initial vacuum of about 30 in. is necessary and de-aeration at room temperature or at 55° is advantageous. Organoleptic evaluation of the canned and bottled products opened 3 days after packing showed that unheated pulps were the best in taste and flavour, while in the heat-treated samples, the flavour was impaired, although they were almost free from bitterness. Even processing at 55° for 1 h. was inadequate to preserve the pulp in the presence of 0·5% citric acid and 0·1% of sodium benzoate, or 0·05% of sorbic acid, but 1% citric acid with 0·1% sodium benzoate was satisfactory. This, however, made the product highly acidic and to obtain acceptable flavour, it was necessary to raise the density of the pulp to 40° Brix by addition of solid sugar or syrup of 80° Brix. Addition of sugar gives a free-flowing product facilitating easier filling into containers and also helps to retard enzymic activity.[1]

Experiments on the preservation of pulp by puff drying showed that it was necessary to raise the density to 60° Brix for efficient puffing and reduce the drying time to about 8 h. At lower concentrations of sugar, the finished product was sticky and was difficult to remove from trays. Addition of skim milk powder improved the flavour of the product to some extent but it was still impaired as with heat-processed cans.

Storage studies

Products examined after 5 months' storage at 37° showed no enzymic pink discoloration in bottles with 100 p.p.m. of added sulphur dioxide. Addition of 350 p.p.m. of SO_2 imparted unacceptable sulphite taste to the product although it controlled non-enzymic browning. Lacquered cans imparted a resinous taste to the pulp, although no bitterness was perceptible in stored samples.

Results on non-enzymic browning in some of the stored samples are given in Table I, which shows that the product stored at room temperature for 6 months remained acceptable although the colour was slightly brownish. Storage at 37° for 14 weeks caused considerable non-enzymic browning, whereas samples stored at 2–5° retained their original appearance for more than a year. Storage at 37° increases the non-enzymic browning about three times compared with that at room temperature.

Table I

Effect of storage of custard apple pulp on non-enzymic browning

(Optical density measured with No. 42 filter)

Time of storage, weeks	40° Brix with added sugar + 100 p.p.m. SO_2		40° Brix with added syrup of 80° Brix + 50 p.p.m. SO_2		40° Brix with added syrup of 80° Brix + 100 p.p.m. SO_2	
	Room temp. (24–30°)	37°	Room temp. (24–30°)	37°	Room temp. (24–30°)	37°
0	0·15	0·15	0·14	0·14	0·13	0·13
4	—	0·24	—	0·19	—	0·18
14	0·29	0·46	0·27	0·46	0·24	0·45
18	0·29	0·66	0·28	0·58	0·25	0·60
24	0·30	—	0·31	—	0·30	

In another set of experiments where the sugar concentration was kept at 30° Brix, the optical densities after storage for 7 weeks at room temperature and at 37° increased to 0·17 and 0·20, respectively, from an initial value of 0·15. This shows that non-enzymic browning can to some extent be controlled by reducing the sugar concentration. Samples with no added sugar and preserved with 350 p.p.m. of sulphur dioxide retained their original colour after storage at room temperature for about a year.

It appears therefore that, to preserve the flavour and colour of this product during storage, it is necessary to add both benzoate and sulphur dioxide, a practice which is not permitted by the Food Laws of some countries.

It was noted earlier that the addition of ascorbic acid (0·05%) will suppress enzymic discoloration, but its use is not desirable as this acid is known to accelerate non-enzymic browning.[3]

Organoleptic evaluation:

Samples of pulp of density 40° Brix, containing 1% of citric acid, 0·1% of sodium benzoate and 100 p.p.m. of sulphur dioxide stored at 2–5°, room temperature (24–30°) and at 37°, were evaluated organoleptically when used at 25% level in ice-creams, using a recipe containing 9 oz. of milk, 1¼ oz. of cream, 1 g. of gelatin, 1 oz. of sugar and 5 oz. of custard apple pulp to which 1 g. of sodium bicarbonate was added. The last named neutralised excess of acidity due to citric acid, so enhancing the characteristic custard apple flavour. While the ice-cream prepared from the pulp stored at 2–5° had no cooked fruit flavour, samples of the pulp stored at room temperature and more so those at 37° imparted the characteristic cooked custard apple flavour. This flavour, although different from the fresh fruit flavour, was acceptable, however. The colour of the ice-cream samples prepared with pulps stored at 37° was light brown.

Conclusions

Attempts have been made to preserve custard apple pulp which forms a good base in ice-creams. On exposing the pulp to air, it turns pink due to peroxidase activity, while heating beyond 55° even for a short time develops a bitter taste making preservation by heat treatment inapplicable in this product. To preserve the pulp, it is necessary to add 1% of citric acid together with 0·1% of sodium benzoate, and 50–100 p.p.m. SO_2 to check the pink discoloration due to enzymic activity. Raising the sugar concentration to 40° Brix also helps in retarding enzymic activity. To preserve the pulp by puff drying in a vacuum shelf dryer it is necessary to raise the density to 60° Brix before drying.

The product is acceptable when stored at room temperature for 6 months.

Acknowledgments

The authors wish to express their grateful thanks to Dr. V. Subrahmanyan, Director, for his keen interest in this investigation, and to the Horticulturist, Fruit Research Station, Sangamreddy, Andhra Pradesh, for supplying different varieties of custard apples.

Central Food Technological Research Institute
Mysore, 2
India

Received 12 September, 1960; amended manuscript 28 November, 1960

References

[1] Sastry, L. V. L., Bhatia, B. S., & Lal, Girdhari, *J. Fd Sci.*, in the press
[2] Bedrosian, K., Nelson, A. I., & Steinberg, M. P., *Food Tech.*, 1959, **13**, 722
[3] Joslyn, M. A., *Food Res.*, 1957, **22**, 1; Siddappa, G. S., Bhatia, B. S., & Lal, Girdhari, *Indian J. appl. Chem.*, 1959, **22**, 199

PRODUCTION OF VOLATILE COMPOUNDS RELATED TO THE FLAVOUR OF FOODS FROM THE STRECKER DEGRADATION OF DL-METHIONINE

By P. E. BALLANCE

A qualitative investigation of the volatile compounds formed during the Strecker degradation of DL-methionine has been carried out. The volatile products were condensed in cold traps and analysed by gas–liquid chromatography. The condensate was shown to consist chiefly of methyl mercaptan, together with traces of other compounds including acrolein and dimethyl sulphide. The suggestion that degradation of methionine first gives rise to methional is supported by the identification of this compound and the demonstration of its decomposition with ninhydrin to methyl mercaptan and acrolein. These findings are discussed in relation to the importance of methionine as a source of flavour in food.

Introduction

The importance of the Strecker degradation[1] of amino-acids in the development of flavour in food has recently been discussed by Keeney & Day.[2] These workers reported a 'broth- or cheese-like' smell resulting from the reaction of methionine with ninhydrin (indanetrione hydrate). The development of the broth-like odour would be consistent with the formation of methional (3-methylthiopropionaldehyde), the strong odour of which has been recently affirmed by several workers.[3–5]

The suggestion that methional is formed by the breakdown of methionine is supported by the experimental work of Hunter & Potter[6] who obtained 100% yields of methional from methionine treated with ninhydrin. Bayer[7] has claimed, without giving any experimental details, that propionaldehyde is the major volatile product of the hypochlorite breakdown of methionine. In view of these conflicting reports a detailed qualitative examination of the volatile products of methionine degradation was undertaken.

Experimental

Physical trapping of volatile compounds

DL-Methionine (40 mg., California Foundation for Biochemical Research, Los Angeles, California, U.S.A.) was warmed (80°) with ninhydrin (200 mg.), water (10 ml.), sodium chloride (2 g.) and sodium dihydrogen phosphate (1 g.), for 2 h. A stream of nitrogen was drawn through the reactants at slightly reduced pressure (200 mm.); the emergent gas stream was led through two traps cooled in solid carbon dioxide, into a U-tube (trap A) cooled with liquid nitrogen.

An alternative method involved the removal of water from the emergent nitrogen stream by passing it through warmed (80°) calcium chloride, and trapping the volatile compounds in a Y-shaped trap (B) cooled in liquid nitrogen. Trap B was constructed of tubing with 4 mm. i.d. with the short 14-cm. limb entering the long (17-cm.) limb 3 cm. from the base: condensed vapour collected in the base of the long limb.

Chemical trapping of volatile compounds

To obtain further information concerning the identity of the volatile compounds the emergent nitrogen stream was bubbled through particular reagents. A white precipitate is formed if dimethyl sulphide or dimethyl disulphide is present in a gas stream bubbled through mercuric chloride (3% w/v) solution: a precipitate is also formed if methyl mercaptan is present, but this compound can be removed by passage of the gas stream through mercuric cyanide solution (4% w/v). The details of these methods of trapping volatile sulphur compounds have been described by Challenger & Charlton,[8] and Challenger.[9]

Aldehydes or ketones react with 2,4-dinitrophenylhydrazine reagent (0·2% w/v solution in 2N-HCl) to form 2,4-dinitrophenylhydrazones, which are identified either by determination of melting point or by regeneration of the carbonyl compound with levulinic reagent, followed by gas–liquid chromatography.

Regeneration of carbonyl compounds

The 2,4-dinitrophenylhydrazones (100 mg.) were treated with levulinic reagent (1 vol. levulinic acid : 9 vol. N-H_2SO_4) according to the method of Keeney.[10] The carbonyl compounds evolved were condensed at liquid-nitrogen temperature in trap B. The condensate was dissolved in 1 ml. of ether, and 0·025 μl. samples of the ether solution removed by micropipette for analysis by gas–liquid chromatography.

Following levulinic regeneration the more volatile carbonyl compounds were collected in trap A (by the method previously described). The U-tube was warmed to room temperature and 0·5-ml. vapour samples removed for gas–liquid chromatographic analysis.

Gas–liquid chromatography

The Pye Argon Chromatograph was used for gas–liquid chromatographic analyses. All columns (glass) were 4 ft. long and 4–5 mm. i.d., and were packed with Celite (Gas Chromatography Ltd., G-cel 100–120 mesh) impregnated with stationary liquid. For high-temperature analyses (100°) the stationary liquid was 5% polypropylene adipate (Briggs & Townsend Ltd.), for low-temperature analyses (22°) 5% dinonyl phthalate (May & Baker Ltd.) or 10% polyethylene glycol 400 (L. Light & Co. Ltd.) were used. The stationary liquids were dissolved in a volatile solvent, mixed with Celite and the solvent was evaporated while stirring. The resulting powder was introduced into the columns and packed down by vigorous tapping.

For low-temperature separation 0·5-ml. vapour samples were introduced by means of an Agla syringe equipped with a fine hypodermic needle. The needle was inserted into the rubber tubing conveying argon to the top of the column. Liquid samples for the high-temperature column were placed directly into the top of the column by micropipette. For all analyses the argon flow rate was 40–45 ml./min.

All qualitative results are presented as relative retention volumes. Values obtained with low-temperature columns are related to isobutyraldehyde; methyl n-heptanoate (prepared by diazomethane treatment of n-heptanoic acid) was selected as internal standard for the polypropylene adipate column. Methyl mercaptan was obtained from Eastman Organic

Chemicals, Rochester 3, New York, U.S.A. : pure methional was prepared by the method of Pierson *et al.*[11]

Results

Degradation of DL-*methionine*

The volatile compounds collected in trap A from a warmed mixture of methionine with ninhydrin in the presence of water, sodium chloride and sodium dihydrogen phosphate, were analysed by gas–liquid chromatography on the low-temperature columns. On both dinonyl phthalate and polyethylene glycol columns one large constituent was found, the relative retention volume of which corresponded with that of methyl mercaptan (Table I). Trace amounts of other volatile compounds, acrolein, isobutyraldehyde, dimethyl sulphide and dimethyl disulphide were identified by comparison with known compounds. The finding of a compound having the same relative retention volume as isobutyraldehyde might well be due to a trace of valine as an impurity in the methionine. An unknown compound was also detected. It was possible to confirm the identification of methyl mercaptan, a white precipitate being formed when the emergent gas stream was led through a mercuric cyanide solution. The precipitate was boiled with a quantity of water to remove any combined mercuric cyanide,[8, 9] dried in a desiccator : it melted with decomposition at 174° (m.p. of pure mercury dimethyl mercaptide, 174–175°[9]).

Table I

Relative retention volumes (R.R.V.s) of the volatile products of the Strecker degradation of methionine

Internal standard isobutyraldehyde = 1

Unknown volatile compounds				Known compounds		
Peak position	Peak size	No. of observations	Mean R.R.V.	Suspected compound	No. of observations	Mean R.R.V.
			Dinonyl phthalate column			
1	v. large	15	0·17	Methyl mercaptan	7	0·18
2	trace	4	0·47	Dimethyl sulphide	8	0·48
3	trace	13	0·58	Acrolein	5	0·58
4	trace	10	1·00	Isobutyraldehyde	18	1·00
				Dimethyl disulphide	1	7·29
			Polyethylene glycol column			
1	v. large	11	0·29	Methyl mercaptan	4	0·28
2	trace	8	1·40	Acrolein	2	1·42
3	trace	7	1·05	Isobutyraldehyde	17	1·00
4	small	4	5·89	Unknown	—	—
5	small	2	7·53	Dimethyl disulphide	1	7·18

To explain the preponderance of methyl mercaptan it was assumed that the initial step in the reaction sequence was the formation of methional, which subsequently gave rise to acrolein and methyl mercaptan : the tendency of acrolein to polymerise would account for its being found only in trace amounts. In an attempt to establish the presence of methional the degradation of methionine was repeated and the emergent gas stream passed through 2,4-dinitrophenylhydrazine solution. A heavy yellow precipitate of a 2,4-dinitrophenylhydrazone formed, was filtered off, recrystallised and its melting point (and a mixed melting point) found to correspond with the value 123° obtained with crystals of the 2,4-dinitrophenylhydrazone of pure methional. As a further check the hydrazone was treated with levulinic reagent and the volatile compounds produced were dried ($CaCl_2$) and condensed in trap B. The condensate was chromatographed at 100° on the polypropylene adipate column and a component was detected having the same relative retention volume (2·09) as a sample of pure methional.

The breakdown of methional

As the presence of methional had been established, the possibility that it decomposes under certain conditions was investigated. Methional, prepared from acrolein and methyl

mercaptan,[11] was twice distilled and its purity determined by gas–liquid chromatography on polyethylene glycol. Nitrogen was swept (2 h.) through the methional and the condensate obtained by passage of the emergent gas through a U-tube cooled in liquid nitrogen was shown to consist of very slight traces (peak heights 3–4 mm.) of acrolein and methyl mercaptan. Heating the methional (0·4 ml.) in the presence of water (10 ml.) did not bring about any significant decomposition; acrolein and methyl mercaptan peaks (heights 1·1–1·2 cm.) were revealed with the polyethylene glycol column.

Methional (0·4 ml.) was heated (2 h.) with 1·124 g. of dry ninhydrin, a nitrogen stream was swept through the apparatus and volatile matter collected in trap A. Gas–liquid chromatography on both polyethylene glycol and dinonyl phthalate columns (Table II) showed the presence of methyl mercaptan, dimethyl sulphide and acrolein (the peak heights were greater than 10 cm.). These volatile reaction products were also identified chemically; the emergent gas stream, when passed through a train of three pairs of reagent solutions, produced a white precipitate (methyl mercaptan) in mercuric cyanide solution, an orange precipitate (acrolein) in 2,4-dinitrophenylhydrazine reagent, and a white precipitate due to dimethyl sulphide in mercuric chloride solution. The latter precipitate was warmed with 5N-NaOH and the volatile material bubbled through a solution of mercuric cyanide, in which no precipitate formed, and then through mercuric chloride solution where the presence of dimethyl sulphide was revealed by the formation of a white precipitate (Challenger & Charlton[8]). Treatment of the orange 2,4-dinitrophenylhydrazone with levulinic reagent and chromatography of the volatile material on polyethylene glycol established the identity of acrolein (relative retention volume 1·41).

Table II

Identification of the volatile products from the reaction of methional and dry ninhydrin

Relative retention volumes (R.R.V.s) based on isobutyraldehyde = 1

Column	Peak position	R.R.V.	Suspected compound	R.R.V. of suspected compound
Polyethylene glycol 400, 10%	1	0·26	Methyl mercaptan	0·26
	2	0·47	Dimethyl sulphide	0·48
	3	1·40	Acrolein	1·40
Dinonyl phthalate, 5%	1	0·16	Methyl mercaptan	0·18
	2	0·47	Dimethyl sulphide	0·48
	3	0·61	Acrolein	0·61

The similarity of the volatile products of methional breakdown (Table II) and the compounds produced by ninhydrin treatment of methionine (Table I) leaves little doubt that methional is the first recognisable product of the Strecker degradation of methionine, in agreement with the work of Hunter & Potter.[6]

Although Bayer[7] reported the evolution of propionaldehyde following hypochlorite breakdown of methionine, at no time under the conditions used in the present work was propionaldehyde found in any of the volatile mixtures. Even heating methionine with sodium hypochlorite solution, according to the method of Langheld,[12] gave rise to no identifiable quantities of volatile materials. Using the same conditions, however, copious amounts of acetaldehyde were produced from alanine.

The finding that the Strecker degradation of methionine gave rise to methyl mercaptan as the major volatile product is consistent with reports that methyl mercaptan is produced during breakdown of methionine by micro-organisms.[13]

Discussion

The present investigation has emphasised the importance of methionine as a source of volatile sulphur compounds, all of which have been associated with the flavours of foodstuffs. Methional, the first volatile product of methionine degradation, has been associated with the 'sunlight' flavour of milk.[14] Although Day *et al.*[4] have examined the rôle of methional as a flavour compound it appears capable of further breakdown to the more strongly odorous[15] methyl mercaptan. By the use of gas–liquid chromatography and mass spectrometry this

mercaptan has been identified as a constituent of meat flavour by Stahl[16] and Merritt *et al.*[17] The latter workers also detected dimethyl sulphide in meat odour, whereas previously it had been found only in the volatile compounds from irradiated milk[18] and meat.[16] Dimethyl disulphide, formed by the oxidation of traces of methyl mercaptan, has been shown to be a constituent of cooked cabbage flavour ;[19] in the cabbage, however, the presence of dimethyl disulphide has been attributed to the decomposition of *S*-methyl-L-cysteine sulphoxide, which would almost certainly yield methyl mercaptan as a primary product.[9, 20]

Although the experimental conditions employed in the present work differed considerably from those discussed by Challenger[9] when considering the origin of dimethyl sulphide from a thetin-like structure, no other explanation can be suggested to account for the production of dimethyl sulphide.

It is clear that the Strecker degradation of methionine might well, to some extent, be responsible for the volatile sulphur compounds found in the odours from non-irradiated foods.

Acknowledgments

The author thanks Mr. E. Adams for critical discussions, Mr. J. Ridgwell for the construction of trap B, and Miss A. P. Baskett for technical assistance throughout this work.

Research Dept.
Bovril Limited
London, E.C.1

Received 15 August, 1960; amended manuscript 15 November, 1960

References

[1] Schönberg, A., & Moubacher, R., *Chem. Rev.*, 1952, **50,** 261

[2] Keeney, M., & Day, E. A., *J. Dairy Sci.*, 1957, **40,** 874

[3] Patton, S., & Barnes, I., *Food Res.*, 1958, **23,** 221

[4] Day, E. A., Keeney, M., & Stahl, W., *Food Res.*, 1958, **23,** 130

[5] Oro, J. F., Guidry, C. L., & Zlatkis, A., *Food Res.*, 1959, **24,** 240

[6] Hunter, I. R., & Potter, E. F., *Analyt. Chem.*, 1958, **30,** 293

[7] Bayer, E., 'Gas Chromatography', ed. Desty, D. H., 1958, p. 333 (London : Butterworths)

[8] Challenger, F., & Charlton, P. T., *J. chem. Soc.*, 1947, p. 424

[9] Challenger, F., 'Aspects of the Organic Chemistry of Sulphur', 1959, pp. 16–19, 37–40, 50 (London : Butterworths)

[10] Keeney, M., *Analyt. Chem.*, 1957, **29,** 1489

[11] Pierson, E., Giella, M., & Tishler, M., *J. Amer. chem. Soc.*, 1948, **70,** 1450

[12] Langheld, K., *Ber. dtsch. chem. Ges.*, 1909, **42,** 392, 2360

[13] Segal, W., & Starkey, R. L., *Analyt. Chem.*, 1953, **25,** 1645 ; Miwatani, T., Omnkai, Y., & Nakada, D., *Med. J. Osaka Univ.*, 1954, **5,** 347

[14] Patton, S., *J. Dairy Sci.*, 1954, **37,** 446

[15] Patton, S., & Josephson, D. V., *Food Res.*, 1957, **22,** 316

[16] Stahl, W. H., 'Chemistry of Natural Food Flavours', eds. Mitchell, J. H., jun., *et al.*, 1957, p. 58 (Washington, D.C., U.S.A. : Dept. of the Army Research & Development Command, Quartermaster Food & Container Inst. for the Armed Forces)

[17] Merritt, C., jun., Bresnick, S. R., Bazinet, M. L., Walsh, J. T., & Angelini, P., *J. agric. Fd Chem.*, 1959, **7,** 784

[18] Day, E. A., Forss, D. A., & Patton, S., *J. Dairy Sci.*, 1957, **40,** 932

[19] Dateo, G. P., Clapp, R. C., MacKay, D. A. M., Hewitt, E. J., & Hasselstrom, T., *Food Res.*, 1957, **22,** 440

[20] Synge, R. L. M., & Wood, J. C., *Biochem. J.*, 1956, **64,** 252

JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

JULY, 1961

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

INDEX OF AUTHORS' NAMES

JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

JULY, 1961

I.—AGRICULTURE AND HORTICULTURE

General: Soils and Fertilisers

Farming organisation in Central Iraq. P. E. Naylor (*Empire J. exp. Agric.*, 1961, **29**, 19—34).—The farming organisation prior to recent land reforms is described and discussed. Its resemblance to the strip farming practised in England until the end of the 18th century is noted. M. LONG.

Influence of confining pressure and bulk density on soil water matric (matrix) potential. S. A. Taylor and J. E. Box (*Soil Sci.*, 1961, **91**, 6—10).—Soil wetted to different moisture levels was subjected to various pressures at 40° in an apparatus in which changes in vol. due to the pressure variations could be measured. The affinity of the soil matrix for water (the matrix potential) was measured by means of a tensiometer. At all moisture contents an increase in bulk density almost invariably caused a rise in soil matrix potential. Release of the pressure increased the bulk vol. and decreased the matrix potential. At different temp. similar results were found but the slopes of the correlations varied. T. G. MORRIS.

Rainfall and soil structure. C. W. Rose (*Soil Sci.*, 1961, **91**, 49—54).—Seven tropical soils were sieved into four structural fractions and then subjected to artificial rainfall, the detachment being measured. Both soil type and aggregate size had a very great influence on the amount and rate of detachment. For sand with no aggregates there was a linear relationship between rainfall and the amount detached. With a soil, there was only a linear relationship between rainfall and detachment in the case of the largest fraction which offered resistance to breakdown. On soil in good structural condition in the field there was much less detachment than on soil in poor cultural condition. T. G. MORRIS.

Influence of sugar cane, paddy and jute on soil aggregation. M. A. Islam and W. Islam (*Soil Sci.*, 1961, **91**, 19—21).—Sugar cane, paddy and jute were grown on a lateritic soil deficient in N, org. matter, P and lime and also on an alluvial soil of high lime content. Sugar cane significantly increased soil aggregation but paddy and jute had little effect. T. G. MORRIS.

Soil moisture use by soya-beans. D. B. Peters and L. C. Johnson (*Agron. J.*, 1960, **52**, 687—689).—Evaporation from the soil surface accounted for 50% or more of the total moisture lost from the soil under a soya-bean crop when the soil surface was kept moist, and for 25—50% of the total moisture lost in a dry season. A considerable part of the moisture used by the crop was from the lower depths of soil even under irrigation. A. H. CORNFIELD.

Spring removal by winter cover crops of moisture from a compacted soil. W. J. Flocker (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 705—709).—Heavy agricultural equipment causes soil compaction, the effect being greatest when the soil is near to field capacity. The compaction is restricted to the upper 6—8 in. of soil but can reduce growth of leguminous cover crops to such an extent that they fail to alleviate the compacted condition. Cereals and grasses are less affected by the soil compaction. L. G. G. WARNE.

Maximum-minimum temperatures as a basis for computing heat units. C. Y. Arnold (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 682—692).—A discussion of the possibility of calculating " degree days " when only max. and min. temp. are known. L. G. G. WARNE.

Effects of soil sterilants upon the wind erodibility of Pullman silty clay loam. A. F. Wiese and H. E. Rea (*Agron. J.*, 1960, **52**, 707—710).—Application of a no. of herbicides in Sept. had little effect on soil erodibility the first winter after treatment. Where monuron had been used wind erodibility was high the second and third winters after treatment and fairly high the fourth winter. Where borax, borax-$NaClO_3$ or $NaClO_3$ had been used as herbicides the soil was moderately erosive the second winter and only slightly erosive the third and fourth winters after application. A. H. CORNFIELD.

Spontaneous alteration of hydrogen clay. N. T. Coleman and D. Craig (*Soil Sci.*, 1961, **91**, 14—18).—Two bentonites and a kaolinite were largely saturated with H^+ and stored in aq. suspensions for various times at various temp. After storage the titration curves (NaOH) were similar for all clays, showing an initial fall as the exchangeable H was neutralised, followed by a rise as exchangeable Al was hydrolysed and a steep rise. The decomposition reactions for the clays depended to varying degrees on temp. When the moist clays were stored at 90°, then leached with N-KCl to remove exchangeable H, Al and Mg and then resaturated with H^+ and stored moist for 24 h. at 90° again and the cycle of leaching, resaturation and storing was repeated up to five times, each time the clay was stored H^+ was lost from exchange sites and Al and Mg appeared, in the approximate proportions in which they occurred in the clay crystals. T. G. MORRIS.

Mineralogical and chemical characteristics of a glauconitic soil of the Hageland region (Belgium). P. Cloos, J. J. Fripiat and L. Vielvoye (*Soil Sci.*, 1961, **91**, 55—65).—Chemical, *X*-ray, infra-red and thermal analyses are reported and discussed. T. G. MORRIS.

Influence of nitrogen on uptake of calcium. M. Drake and J. M. White (*Soil Sci.*, 1961, **91**, 66—69).—Buckwheat, tomatoes and oats were grown in pots in soil low in Ca and treated with K, N, P, S, Mg and B. Limestone (30—50 mesh) was placed in a 2-in. band 1—3 in. below the soil surface and N was added periodically during growth. Tomatoes with a root cation-exchange capacity (C.E.C.) of 35 mequiv. per 100 g. showed a five-fold increase in yield with limestone. There was no yield response to N without limestone, and with N only the lowest increment increased yields. Buckwheat (C.E.C. 40 mequiv. per 100 g.) showed a yield response to limestone and to the second level of N. Oats (C.E.C. 20 mequiv. per 100 g.) showed increased yield and Ca uptake due to limestone. Yield response to N was variable. In tomatoes and buckwheat increased N applications gave increased Ca levels in the plant. T. G. MORRIS.

Dynamic character of potassium release and fixation. M. M. Mortland (*Soil Sci.*, 1961, **91**, 11—13).—Five different Na-saturated soil clays ($<2\mu$) were mixed with equal wt. of biotite in suspension and left for 21 days. Subsequently the coarse biotite particles were sieved out and the K content of the clay determined. The clays were enriched with K and the biotite depleted by a similar amount. The rate of fixation of K was inversely related to the initial K content of the clays. T. G. MORRIS.

Retention of potassium meta- and ortho-phosphates by soils and minerals. R. M. Thorup and A. Mehlich (*Soil Sci.*, 1961, **91**, 38—43).—Soils differing widely in type of colloid, cation- and anion-exchange capacities together with homoionic prep. (Al, Ca, Mg, K, Na, NH_4 and H) from them were treated with the phosphates and K and PO_4^{3-} retentions were determined. Max. retention of PO_3^- or PO_4^{3-} was obtained in 24 h. Bentonite retained more PO_4^{3-} and halloysite more PO_3^-. Soils varied in their retention; which tended to increase with temp. In virtually all homoionic systems the retention of PO_4^{3-} exceeded that of PO_3^- especially with Al soils. When soils were treated with mixtures of PO_4^{3-} and PO_3^-, retention of PO_4^{3-} greatly exceeded that of PO_3^- in bentonite while the reverse occurred in halloysite and kaolinite. In all soils, leaching of K from KPO_3 was considerably less than from other K sources; it was greatest from KNO_3 and KH_2PO_4. T. G. MORRIS.

Use of cation-exchange resins in evaluating soil salinity. A. A. Tabikh and J. C. Russel (*Soil Sci.*, 1961, **91**, 70—73).—Saturation extracts from soil were passed through a Dowex-50 column and the H^+ liberated by the ions in solution was titrated in the effluent with NaOH. The correlation between salinity measured by this method and by the electrical conductivity method on 35 Iraqi soils was slightly curvilinear but the line could be divided into three sections each straight and computable by ordinary methods. Salinity can be measured adequately by this method. T. G. MORRIS.

Effects of saline irrigation water and exchangeable sodium on soil properties and growth of lucerne. C. W. Chang (*Soil Sci.*, 1961, **91**, 29—37).—Lucerne was grown on soils containing exchangeable Na adjusted to four different levels. Irrigation waters differing in their total solid and ionic content, were applied at intervals during the growing season. Yields of lucerne were reduced by high-salt irrigation water on low-Na soils and by moderate-salt irrigation on high-Na soils. With intermediate levels of salt in irrigation water and of exchangeable Na % (ESP) in soil the depressing effect of the two appeared to be additive; reduction in growth was accompanied by chlorosis, leaf burn and thickened leaves. Effects of different

[Na^+] and Na/Ca ratios in soils and water on alkalisation and de-alkalisation in the soil are examined. Relationships between the ESP and the sol. Na % and between the ESP and Na adsorption ratio are indicated. Lucerne yields correlated most satisfactorily with an integrated single-val. expression consisting of twice the pH of the saturated soil minus the negative log of the electrical conductivity of the saturated extract of the soil. T. G. MORRIS.

Soil chemistry of radio-iodine. M. E. Raja and K. L. Babcock (*Soil Sci.*, 1961, **91**, 1—5).—Two soils, a kaolinite and a bentonite were treated with ^{131}I in water to form a paste. Portions were (*a*) autoclaved, (*b*) digested on a steam bath, (*c*) digested with H_2O_2, (*d*) treated with alcohol or (*e*) digested at different pH levels, and then extracted with either water or salt solutions and the leachates tested for ^{131}I. Untreated soils retained large amounts of ^{131}I. Digestion tended to reduce the fixation and autoclaving gave pronounced reductions. The amounts of ^{131}I extracted by salt solutions and by water were similar. Fixation was greatly reduced by H_2O_2 but not when alcohol was present. Living organisms were not responsible for the fixation, which is ascribed to non-living org. matter. There was little fixation with bentonite or kaolinite. Peat soil and demineralised peat soil retained large amounts of ^{131}I. T. G. MORRIS.

An all-round soil percolator. K. Gundersen (*Science*, 1960, **132**, 224—225).—The apparatus permits percolation at controlled rates, recirculation of the percolate and aeration of the soil. T. G. MORRIS.

Mobilisation of trace elements in waterlogged soils. Ng Siew Kee and C. Bloomfield (*Chem. & Ind.*, 1961, 252—253).—The solution of several minor element oxides and their mobilisation in soils by anaerobically decomposing plant material and by sterile aq. extracts of undecomposed plant material are reported. Oxides of Cu, Zn, Pb, Co, Ni and Mn are readily dissolved, sterile extracts being less active than non-sterile systems. Mo and V are readily mobilised from Fe_2O_3 containing co-pptd. Mo or V. E. G. BRICKELL.

Comparative evaluation of the total and various fractional tests for diagnosing plant potassium and magnesium status. F. H. Emmert (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 700—704).—Estimations of K and Mg extracted by ethanol, isopropanol and light petroleum are no better than estimates of total K and Mg as indicators of the K- and Mg-status of plant tissue. L. G. G. WARNE.

Fractionation of fulvic acids from the B horizon of a podsol. F. J. Sowden and H. Deuel (*Soil Sci.*, 1961, **91**, 44—48).—Soil from the B horizon of a podsol was exhaustively extracted with cold $HClO_4$. The extract, which contained 67% of the total N and C, was treated with KOH to precipitate the Al and Fe. The ppt. was redissolved in $HClO_4$ and passed through an ion-exchange column to remove Al and Fe, the eluate concentrated, dialysed and freeze-dried to give a fraction which was studied further by chromatographic and other methods. Characterisation by various standard techniques was not very successful but indications of the presence of keto-acids were obtained. T. G. MORRIS.

Antibiotics in soils. I. Physico-chemical studies of antibiotic–clay complexes. L. A. Pinck, W. F. Holton and F. E. Allison (*Soil Sci.*, 1961, **91**, 22—28).—Adsorption of ten antibiotics by montmorillonite, vermiculite, illite and kaolinite from aq. solution varied with their reaction. Strongly basic (streptomycin, dihydrostreptomycin, neomycin and kanamycin), amphoteric (bacitracin, Aureomycin and Terramycin) and acidic or neutral (penicillin, chloramphenicol and cycloheximide) groups are distinguished. The amphoteric and strongly basic materials form complexes with all four minerals; acidic types react only with montmorillonite. *X*-Ray diffraction data indicated that basic and amphoteric antibiotics were adsorbed in mono- and bi-layers respectively. T. G. MORRIS.

Fertiliser practice in England and Wales. I. General features of fertiliser consumption 1956—7. D. A. Boyd, B. M. Church and M. G. Hills (*Empire J. exp. Agric.*, 1961, **29**, 35—44).—Four to five times as much N and K are used per acre in arable districts than in upland districts and two to three times in lowland grassland. Similar figures are found with water-sol. P, but not total P; basic slag and rock phosphate are widely used on grassland. N and K usage increased between 1953 and 1957. Where compound fertilisers replaced "straight" P, the rates of P applied were much reduced. About 2 tons/acre of farmyard manure per acre of arable and grass were produced. M. LONG.

Nature and fate of chemicals applied to soils, plants and animals. H. S. Rodenhiser (*Agron. J.*, 1960, **52**, 712—715).—An address. A. H. CORNFIELD.

Importance of modern ion-exchangers in agricultural chemistry. W. Bergmann (*Nahrung*, 1960, **4**, 417—425).—A review covering applications to the determination of nutrient requirements of soils, mineral requirements of plants by means of resins with adsorbed nutrients, and the possibility of using ion-exchangers as nutrient carriers in agriculture. P. S. ARUP.

Mineral composition of farmyard manure. R. G. Hemingway (*Empire J. exp. Agric.*, 1961, **29**, 14—18).—The average % of minerals in 50 samples of manure were, N 1·73, P 0·24, K 1·29, Ca 0·74 and Mg 0·34 (dry basis). Trace elements were (p.p.m.), Mn 182, B 23·5, Cu 19·8, Co 1·66, Mo 2·32. M. LONG.

Urea compositions. Imperial Chemical Industries Ltd. (Inventor: P. E. Curry) (B.P. 837,163, 31.1. and 26.11.58).—Urea (cryst., granular or pelleted) is admixed with 0·5—3 wt.-% of activated $CaCO_3$ to provide a non-caking, free-flowing product for use especially as fertiliser. F. R. BASFORD.

Plant Physiology, Nutrition and Biochemistry

Botanical prospecting in ore deposits. H. L. Cannon (*Science*, 1960, **132**, 591—598).—A review covering the uses of various plants as indicators of the status of elements in the soil. T. G. MORRIS.

Photoperiodism in plants. H. A. Borthwick and S. B. Hendricks (*Science*, 1960, **132**, 1223—1228).—A review. T. G. MORRIS.

Improved chlorophyll extraction method. D. J. Nelson (*Science*, 1960, **132**, 351).—Treatment of plankton for 9 min. with a 9 kV. sonic oscillator enabled 11—30% more chlorophyll-*a* to be extracted from plankton samples than from similar untreated samples. T. G. MORRIS.

Experimental control of sexuality and inflorescence structure in *Zea mays* (maize). J. Heslop-Harrison (*Proc. Linn. Soc. Lond.*, 1961, **172**, 108—123).—Low night temp. (10°) and short days (8 h.) encourage the formation of female flowers in the male inflorescence. Indolylacetic acid sprays had no effect on the no. of leaves produced on the main stem except with long days but caused earlier initiation of female inflorescences under long but not under short days. The sprays also reduced branching of, and increased the production of female flowers in, the male inflorescence. L. G. G. WARNE.

Effect of photoperiod, kind of supplemental light and temperature on growth and flowering of petunia plants. A. A. Piringer and H. M. Cathey (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 649—660).—Petunias flowered at all photoperiods between 8 and 16 h. but flowering occurred first under the long days. At 21° short photoperiods decreased stem length and increased branching. Incandescent light caused earlier flowering than did fluorescent light when used to extend 8 h. of natural light to a 16-h. photoperiod. At 10° (night temp.) and with long days the plants were branched but had single stems when the night temp. was 16—27°, but with short photoperiods branching occurred at all temp. L. G. G. WARNE.

Potassium in plant metabolism. III. Some carbohydrate changes in the wheat seedling associated with varying rates of potassium supply. G. M. Ward (*Canad. J. Plant Sci.*, 1960, **40**, 729—735).—Reducing sugars accumulate and invertase activity increases with decreasing K. The seedling press juice pH and K_m of invertase activity decreases with decreasing K. K added to the enzyme digest has no effect on invertase activity. M. LONG.

Molybdenum as a factor limiting primary productivity in Castle Lake, California. C. R. Goldman (*Science*, 1960, **132**, 1016—1017).—Cultures in the lake water showed marked increases in C fixation when trace elements were added. The element responsible was Mo. T. G. MORRIS.

Some effects of ionising radiation on translocation in plants. K. L. Webb and R. H. Hodgson (*Science*, 1960, **132**, 1762—1763).—Bean plants (*Phaseolus vulgaris*) were irradiated with doses of 1000—50,000 r. and the translocation measured using ^{32}P. No differences could be found when the petioles were irradiated, but treatment of the meristem resulted in temporary reduction in growth and reduction of translocation; this was counteracted appreciably by treatment with auxin. T. G. MORRIS.

Ten heritable mutations found in the tomato following irradiation with *X*-rays and thermal neutrons. Shih-an Yu and A. F. Yeager (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 538—542).—The products of 12,000 irradiated tomato seeds were examined. About 10 visible mutations were selected for study but none appeared to be of any direct value horticulturally. L. G. G. WARNE.

Dark carbon dioxide fixation of virus-diseased, iron-chlorotic and genetic-chlorotic leaves. A. Wallace, R. T. Mueller, D. van Noort and C. P. North (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 679—681).—

Generally chlorotic leaves had a higher content of org. acids and exhibited a higher rate of dark CO_2 fixation than did green healthy leaves. L. G. G. WARNE.

Prevention of plant damage from air-borne oxidising agents. H. T. Freebairn and O. C. Taylor (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 693—699).—Sprays of K ascorbate reduced damage to a great variety of plants by polluted air from the Los Angeles neighbourhood. L. G. G. WARNE.

Seleno-amino-acid found in *Astralgus bisulcatus*. S. F. Trelease, A. A. di Somma and A. L. Jacobs (*Science*, 1960, **132**, 618).—Dried leaves of the plant were ground and extracted with water. Neutral amino-acids were separated from the other compounds on Amberlite columns and further separated on Dowex columns into an S- and an Se-fraction. There was no Se in the S fraction but some S was found in the Se fraction. Further separation of the S fraction gave an amino-acid identical with *S*-methylcysteine. The same procedure used on the Se fraction gave a compound thought to be a mixture of *Se*-methylselenocysteine and *S*-methylcysteine. T. G. MORRIS.

Extractive studies of the roots of *Pteryxia terebinthina* var. *terebinthina* and the isolation of pteryxin. T. G. Call and E. B. Fischer (*Econ. Bot.*, 1961, **15**, 104—109).—Extracts with 22 org. solvents were made. From a light petroleum extract large prismatic crystals were obtained, for which the name pteryxin is proposed. Solubility and other data for these crystals are given. Powdered root increased the blood coagulation time of mice and pteryxin was spasmolytic to isolated rat uteri. L. G. G. WARNE.

Phytotoxic action of enniatine. E. Gäumann, S. Naef-Roth and H. Kern (*Phytopath. Z.*, 1960, **40**, 45—51).—The product Baccatin A (m.p. 135°) found in culture filtrates of *Giberella baccata* (Wallr.) Sacc. is shown to be a mixture of enniatine A and B (~1 : 2·5). The combined phytotoxic effect on tomato plants of the two components is synergistic. (12 references.) P. S. ARUP.

Effect of synthetic polylysine on fungi. D. J. Buchanan-Davidson, D. C. Deese, I. Uritani and M. A. Stahmann (*Science*, 1960, **132**, 1664—1666).—Polylysine (100 μg. per ml. of medium) inhibited the growth in Czapek's salt solution of *Fusarium oxysporum* sp., for 2·5 weeks, of *Verticillium albo-atrum* sp., for 3 weeks to 2 months, and of *Ceratocystis fimbriata* for 2 months. Sterile, cut surfaces of sweet potatoes were streaked with spore suspension of *C. fimbriata* and then covered with paper containing 0—10 mg. of polylysine. Fungal growth was the same in controls and treated potatoes but there was less penetration of the potato and less formation of polyphenol after treatment. *In vivo*, using tomato plants, polylysine was inhibitory to *F. oxysporum* f. *lycopersici* and to the human pathogenic fungi *Trichophyton mentagrophytes* and *T. rubrum*. T. G. MORRIS.

Effectiveness of a quaternary ammonium carbamate and a phosphonium in controlling growth of *Chrysanthemum morifolium* (Ramat. H. M. Cathey and P. C. Marth (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 609—619).—4-Hydroxy-5-isopropyl-2-methylphenyltrimethylammonium chloride 1-piperidinecarboxylate mixed with soil, used as a dip for basal ends of cuttings or applied as a spray to growing points retarded the growth of *Chrysanthemum morifolium*, the retarded plants producing extremely dark green leaves. The iodine salt of this compound was phytotoxic at the concn. used but 2,4-dichlorobenzyltributylphosphonium chloride had effects similar to those of the quaternary ammonium carbamate. L. G. G. WARNE.

Effect of 3-amino-1,2,4-triazole [3-AT] on the synthesis of riboflavin. K. A. Sund and H. N. Little (*Science*, 1960, **132**, 622).—Yeast was grown in media with various amounts of 3-AT added. After growth the amount of riboflavin in the culture was estimated. 10^{-5}, 10^{-4} and 10^{-3}M-3-AT inhibited the production of riboflavin by 17·5, 46·2 and 83·2% respectively, but growth of the culture was significantly inhibited only at the highest 3-AT level. Pea and maize seedlings were grown in vermiculite moistened with mineral nutrient with and without 3-AT in lighting conditions which resulted in albinistic tissue. This tissue contained in the case of peas less, and in the case of maize almost zero amounts of riboflavin compared with untreated tissue. T. G. MORRIS.

Suppressive effects of 2-thiouracil on differentiation and flowering in *Cannabis sativa*. J. Heslop-Harrison (*Science*, 1960, **132**, 1943—1944).—*C. sativa* plants were grown in a controlled environment and kept in a vegetative condition by a day length of 18 h. for 3—4 weeks, after which photoperiodic induction was induced by transfer to a day length of 8 h. 2-Thiouracil, painted on the upper surface of the youngest leaves, followed by subjection to short days, induced the formation of fertile flowers. Daily dosages of 2-thiouracil (15—30 μg. per plant) just before the onset of the dark period severely reduced the flowering response of male plants to an induction period of 10 short days, and almost abolished that of female plants; aberrations in cellular differentiation also occurred. Labelled 2-thiouracil spread rapidly throughout all tissues above the level of application, the bulk being in the ribonucleic acid fraction. T. G. MORRIS.

Seedling emergence and growth responses of dwarf grain sorghum as affected by gibberellic acid. F. P. Gardner and M. J. Kasperbauer (*Iowa St. J. Sci.*, 1961, **35**, 311—318).—Gibberellic acid (**I**) (10 or 100 p.p.m.) hastened emergence and increased initial height of the plants, but after a few days the emergence from untreated equalled that from treated seeds. **I** applied as seed treatment had no effect on mature height, lodging, maturity or yield of seed; and as a foliar spray had no effect on growth of the plants, mature height, etc. Except in the early seedling stages the dwarf sorghums were completely non-responsive to **I**. E. M. J.

Response of *Cupressus funebris* tissue cultures to gibberellins. J. Straus and R. R. Epp (*Science*, 1960, **131**, 1806—1807).—Tissue cultures of *C. funebris* showed marked response to additions of gibberellin (0·5—2·0 mg./l.) to the growth medium, the effect on growth being greater when acid casein hydrolysate than when coconut milk was used in the medium. Indolylacetic acid added to the medium together with gibberellin inhibited growth. Casein hydrolysate without gibberellin gave growth almost equal to that given by gibberellin alone. T. G. MORRIS.

Effects of cracking, after-ripening and gibberellin on germination of Lambert cherry seeds. H. W. Fogle and C. S. McCrory (*Proc. Amer. Soc. hort. Sci.*, 1960, **76**, 134—138).—Soaking of cherry stones for 24 h. in water containing 400 p.p.m. of gibberellin gave better germination than treatment with 200 p.p.m. provided the stones had been cracked. Without cracking gibberellin has no effect as penetration through the outer stone wall is not appreciable. One month after-ripening plus gibberellin treatment is insufficient but 2 months plus gibberellin is enough to give higher germination. Without gibberellin 4 months of after-ripening is needed. If the after-ripening period is short the gibberellin treatment does not prevent rosetting. L. G. G. WARNE.

Effect of gibberellic acid on seedling emergence of slow- and fast-emerging wheat varieties. R. E. Allan, O. A. Vogel and J. C. Craddock, jun. (*Agron. J.*, 1961, **53**, 30—32).—Soaking the seed of eight varieties of wheat in 20—200 p.p.m. gibberellic acid for 4 h. stimulated the rate of emergence of slow-emerging varieties to that comparable with the rate of emergence of rapid-emerging varieties. The treatment had little effect on the rate of emergence of rapid-emerging varieties; one of these was inhibited. The treatment had an adverse effect on seedling survival of three rapidly-emerging but not on that of two slowly-emerging varieties. A. H. CORNFIELD.

Methods for determination of potassium, calcium and magnesium in plant materials. G. M. Ward and H. B. Heeney (*Canad. J. Plant Sci.*, 1960, **40**, 589—595).—The flame photometric method is recommended for K, but not for Ca or Mg even when attempts are made to eliminate disturbances due to P. The EDTA titration is recommended for Ca and Mg using Eriochrome-black-T and Cal-red as indicators in preference to a turbidimetric procedure involving the formation of a Ca soap for Ca and a colorimetric thiazole yellow method for Mg. M. LONG.

Crops and Cropping

Plant competition in relation to nitrogen economy. M. L. Peterson and L. E. Bendixen (*Agron. J.*, 1961, **53**, 45—49).—Yields of orchardgrass forage on a fine sandy loam increased considerably with increasing rates of application of N (80—160 lb./acre), whilst those of ladino clover and a ladino clover–orchardgrass mixture were unaffected. Yields of the grass portion of the mixed sward increased whilst those of the clover portion decreased with increasing rate of N. This response lasted 30—50 days after fertilisation. In the mixed sward 72% of the fertiliser N + clover-N was recovered in the forage of the grass. A. H. CORNFIELD.

Mineral protein content of wheat grain as influenced by variety, soil and fertiliser. H. G. Singh and C. A. Lamb (*Agron. J.*, 1960, **52**, 678—680).—There were significant differences due to variety, treatment and location in the protein, ash, and major and trace element contents of wheat grain. A. H. CORNFIELD.

Development and composition of spring wheat as influenced by nitrogen and phosphorus fertilisation. G. O. Boatwright and H. J. Haas (*Agron. J.*, 1961, **53**, 33—36).—Application of N to spring wheat hastened maturity and increased the growth of and nutrient uptake by the plant, whilst application of N + P increased these factors further. Max. dry wt. and N uptake from N + P, N and control plots occurred at the heading, soft dough and maturity stages respectively. Max. P uptake occurred by heading irrespective of treatment. A. H. CORNFIELD.

Experiments with urea on spring barley. F. V. Widdowson and A. Penny (*Exp. Husbandry*, 1960, No. 5, 22—25).—The effects of equiv. combine drilled dressings of $(NH_4)_2SO_4$ and urea on early growth and yields at harvest were compared. Combine drilling of 0·25, 0·5 or 0·75 cwt. of N/acre, as urea was consistently inferior to that as $(NH_4)_2SO_4$; early growth was checked (severely) at the highest level. The % of N in grain was similar whether urea or $(NH_4)_2SO_4$ was applied at 0·25 or 0·5 cwt. of N/acre; with 0·75 cwt. N/acre, urea gave grain containing more N. E. M. J.

Effect of cultural treatments on the yield and protein content of oats cut for silage. J. W. Pendleton and C. M. Brown (*Agron. J.*, 1961, **53,** 41—42).—Oat forage yields were favoured by an early seeding date, heavy seeding rate, N applications, and the growing of a medium- or late-maturing variety. Crude protein % in the forage increased with N rate (30—60 lb./acre), with decreasing seeding rate (4 or 2 bushels/acre), and with delayed planting date. At the early dough stage the dry matter of the plant was made up of stems 35, leaves 31 and grain (including glumes) 34%. The total protein was made up from leaves 37, stems 21 and grain 42%. A. H. CORNFIELD.

Response of spring oat varieties to different planting dates and soil fertility levels. D. R. Schmidt (*Agron. J.*, 1960, **52,** 695—696).—Delaying planting after the end of April resulted in reduced yields of grain from 3 varieties of oats on a silt loam. All varieties responded similarly to fertiliser (300—600 lb. 5–20–20, N–P_2O_5–K_2O per acre), giving slightly increased yields with increasing rate of application. The varieties responded somewhat differently to planting dates and season. A. H. CORNFIELD.

Seed rate and nitrogeneous manuring for spring cereals on a chalk soil. R. W. Shepherd (*Exp. Husbandry*, 1960, No. 5, 7—21).—On chalk soils, Proctor barley consistently outyielded Herta at all levels of manuring and at all seed rates. Proctor, owing to its better tillering capacity, is less affected by adverse growing conditions. Drilling seed with a N–P–K fertiliser giving ~30 lb. of N/acre and then top dressing as soon as possible afterwards with a further 30 lb. of N/acre is recommended. E. M. J.

Evaluating new sweet maize varieties. J. A. Sacklin, J. H. Kyle and E. R. Wolford (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 436—441).—A determination of sol. solids by refractive index allows the moisture content of the grains to be estimated rapidly and accurately. Moisture equals 98·92 – 0·975 (% of sol. solids). This regression holds over the whole range of cultivars tested. L. G. G. WARNE.

Interactions of plant populations and nutritional levels on the production of sweet maize. E. W. Chipman and D. C. MacKay (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 442—447).—Spacing and fertiliser applications interact and optimum spacing depends on the level of nutrient supply. L. G. G. WARNE.

Winter hardiness evaluation in lucerne. D. H. Heinrichs, J. E. Troelsen and K. W. Clark (*Canad. J. Plant Sci.*, 1960, **40,** 638—644).—Hardier varieties develop fewer roots and contain a lower hexosan content. Pentosan content is no guide to hardiness. Slow recovery is coupled with hardiness. The hexosan content is considered to be of use in breeding trials to estimate hardiness. M. LONG.

Effects of compaction, depth of planting, and soil moisture tension on seedling emergence of lucerne. G. B. Triplett, jun., and M. B. Tesar (*Agron. J.*, 1960, **52,** 681—684).—With no irrigation following seeding, initial emergence of lucerne seedlings on a silt loam and a sandy loam increased with depth of planting (0—1 in.) and with soil compaction (0—12 p.s.i.). When 0·5 in. water was applied after seeding, max. emergence was obtained from the 0·5 in. seeding depth and with soil compaction of 6—12 lb. per sq. in. Compaction was less beneficial to emergence as seeding depth increased beyond 0·25 in., especially when irrigation followed seeding. A. H. CORNFIELD.

Bromegrass and bromegrass–lucerne yields as influenced by moisture level, fertiliser rates and harvest frequency. R. J. Lorenz, C. W. Carlson, G. A. Rogler and H. Holmen (*Agron. J.*, 1961, **53,** 49—52).—Dry-matter yields of bromegrass and a bromegrass–lucerne mixture were increased by application of irrigation water. The % of lucerne in the mixed forage increased with irrigation. Yields increased with rate of application of N (40—200 lb./acre) at all levels of soil moisture regardless of whether the forage was harvested at the hay stage or clipped frequently to simulate grazing. Frequent clipping produced lower total yields than did cutting at the hay stage and also resulted in a lower % of lucerne in the mixture. A. H. CORNFIELD.

Effect of irrigation on nodulation of some leguminous crops. G. B. Masefield (*Empire J. exp. Agric.*, 1961, **29,** 51—59).—On a clay soil the no. and size of nodules and plant wt. are increased in most cases by irrigation. Irrigation may be more beneficial to a leguminous than to a non-leguminous crop in some circumstances. M. LONG.

Respiration of forage seed in hermetically-sealed cans. T. M. Ching (*Agron. J.*, 1961, **53,** 6—8).—Crimson clover seed respired less than perennial ryegrass seed stored under similar moisture and temp. conditions. Seed respiration was affected more by moisture content than by temp. CO_2 fixation was indicated by viable seed stored in sealed cans. Seed respiration decreased with increasing length of storage period. A. H. CORNFIELD.

Sterilisation of grass seed with peracetic acid. L. J. Gawell and W. B. Bollen (*Agron. J.*, 1960, **52,** 718—719).—The optimum conditions for sterilising tall fescue seed without affecting germination adversely were 55 h. steeping in H_2O_2 0·5% followed by 5·5 h. steeping in peracetic acid (200 p.p.m.). A. H. CORNFIELD.

Effect of season, nitrogen fertilisation and management on the productivity of five tropical grasses. R. Caro-Costas and J. Vicente-Chandler (*Agron. J.*, 1961, **53,** 59).—Yields of five tropical grasses over 2 years on a latosol, limed to pH 6·5, as affected by N fertilisation and two methods of harvesting were studied. Dry matter yields and protein % increased with level of applied N. Yields at all N levels were greater when the grass was harvested by cutting every 60 days than when harvested by simulated grazing every 40 days. Protein % in the grasses was highest during periods of slow growth. A. H. CORNFIELD.

Performance of bromegrass, orchardgrass and timothy in Northern Wisconsin. D. R. Schmidt and G. H. Tenpas (*Agron. J.*, 1960, **52,** 689—692).—When grown in pure stand with application of 200 lb. of N/acre all grasses gave approx. the same dry matter yields when cut at the hay stage, whilst yields when cut at the pasture stage decreased in the order orchardgrass, bromegrass, timothy. Protein yields were of the same order for all three grasses when they were cut at either stage. Protein yields were higher when the grasses were grown in association with lucerne–ladino clover than with trefoil–red clover, although these yields were lower than those given by the pure grasses with applied N. Bromegrass and timothy gave somewhat higher protein yields than did orchardgrass when grown with the legumes. A. H. CORNFIELD.

Yields and stands of orchardgrass compared under different clipping and grazing intensities. H. T. Bryant and R. E. Blaser (*Agron. J.*, 1961, **53,** 9—11).—Yields of orchardgrass forage over 3 years on a loam were 31—41% higher when clipped than when grazed. Yields from the first spring cuttings were similar under both systems. Yields were higher when the grass was cut at 11 in. than when at 5 in. high. A. H. CORNFIELD.

Effect of nitrogen fertilisation on winter growth of rye-grass, *Lolium multiflorum*. R. M. Weihing and N. S. Evatt (*Agron. J.*, 1960, **52,** 720).—Rye-grass forage yields from seed sown on Oct. 8th on a a clay loam were increased greatly from all cuttings made from late Dec. to late March by fine application of 30 lb. of N as $(NH_4)_2SO_4$ from Oct. to Feb. N applied (90 lb.) in Oct. was somewhat less effective in increasing yields. A. H. CORNFIELD.

Border and competition effects in millet and Sudan grass plots characterised by different levels of nitrogen fertilisation. W. J. Drapala and C. M. Johnson (*Agron. J.*, 1961, **53,** 17—19).—When 100 lb. of N (NH_4NO_3) per acre were applied after seeding millet and Sudan grass on a fine sandy loam in rows ranging from 3 in. to 39 in. away from the boundaries of adjacent plots, there were no significant border effects providing the edge row of fertilised plots was 15 in. or more from the borders of adjacent check plots. A. H. CORNFIELD.

Maize–foxtail competition under various production conditions. Jorge Nieto H. and D. W. Staniforth (*Agron. J.*, 1961, **53,** 1—5).—Maize yield reductions caused by mature foxtail infestations were on average 20, 14 and 10 bushels/acre, respectively, with applications of 0, 70 and 140 lb. of N/acre. Growth of foxtail was also depressed by the higher maize plant populations. A. H. CORNFIELD.

Comparison of rock phosphate and concentrated superphosphate for forage crops. J. E. Jackson and G. W. Burton (*Agron. J.*, 1960, **52,** 692—694).—Total uptake of P over 5 years by four legumes grown in association with grasses on limed soil was of the same order whether rock phosphate was applied initially at 1200 lb. of P_2O_5 or conc. superphosphate at 300 lb. of P_2O_5/acre. P_2O_5 (300—600 lb.) as rock phosphate was more effective than 75 lb. of P_2O_5 applied initially or 15 lb. applied annually as conc. superphosphate. The efficiency of utilisation of P from rock phosphate by legumes decreased in the order sweet clover, crimson clover, ladino clover, big trefoil. A. H. CORNFIELD.

Influence of temperature on the rate of acid loss in McIntosh apples. P. A. Poapst and W. R. Phillips (*Canad. J. Plant Sci.*,

1960, **40,** 736—744).—The rate of acid loss is given by $\ln C = b - D_e^{E\Delta T}t$, where C is titratable acidity, b, D and E are constants and ΔT is the difference between the freezing-point of the apple and storage temperature at any one time *t*. M. LONG.

Relative and absolute electrolytic conductance tests for frost hardiness of apple varieties. J. Wilner (*Canad. J. Plant Sci.*, 1960, **40,** 630—637).—The conductance of electrolytes diffusing from sliced twigs is a measure of frost hardiness. With values of 200–250 μmhos little frost injury is experienced, but with >350 μmhos total killing is general. Prehardening by subjection to temp. at or near freezing increases frost hardiness. M. LONG.

Selection of a tissue for use in strawberry nutritional studies. W. E. Ballinger and D. D. Mason (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 359—365).—Leaflets appear to be the best index of the N and K, crowns of the P, petioles for K and roots for the Mg status of the plants. When only one tissue can be sampled the use of leaflets is suggested. L. G. G. WARNE.

Nature and distribution of silica in strawberry plants. F. C. Lanning (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 349—358).—Si was present in all parts of 3 species and 8 cultivars of *Fragaria* and there were big varietal differences. SiO_2 deposited in strawberries occurs as both opal and quartz and the particles are scattered irregularly throughout the tissue. Silicified cell walls occur in the leaf teeth and the Si content of all parts increases with age. L. G. G. WARNE.

Effects of environment and age in flowering in raspberries. J. P. Hudson and J. H. Williams (*Proc. Linn. Soc. Lond.*, 1961, **172,** 101—108).—At all day lengths raspberry canes elongated at 21° but failed to elongate and formed terminal rosettes of leaves at 10°. At 15° cane elongation took place only in long days. Terminal buds of rosetted canes gradually became dormant and after 10 weeks failed to grow when temp. and day length caused growth of the basal buds. Low temp. (3°) broke the dormancy of the terminal buds. In canes with 20 nodes no flower initiation occurred at 15°. At 13° a few flowers were initiated with 9- but not with 16-h. days whilst at 10° flowers were initiated at all day lengths but most rapidly when the days were short (9 h.). Flower buds do not grow immediately after initiation unless subjected to low temp. No flowers were initiated under any conditions in canes with only 5—10 nodes and few in canes with 15 nodes. Canes with 30 nodes initiated flowers even more readily than those with 20 nodes. L. G. G. WARNE.

Partial chemical analysis of two varieties of raspberry canes which differ in winter hardiness. E. Bennett and W. D. Weeks (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 366—368).—Hardiness was not related to the contents of sol. sugars, total N, pectic compounds, ether extract or moisture in the canes. L. G. G. WARNE.

Determination of sugar and starch content of vines with the anthrone reagent. M. Pánczél and J. Eifert (*Mitt. Wein- u. Obstbau, Wien,* 1960, **10 A,** 102—110).—The determinations serve to assess the nutrient content of 1-year-old shoots used for propagation. A sample of the dried and finely ground material is extracted with four portions of hot 80% EtOH (the first portion being ground in the mill with the sample); the combined centrifuged extracts are treated first with aq. neutral Pb acetate (to remove polyphenols), and then with aq. Na_2HPO_4 (to remove excess of Pb); the sugars are determined colorimetrically in the (filtered and diluted) extract by Clegg's anthrone method. Starch is similarly determined in an aq. 52% $HClO_4$ extract from the residue obtained from the previous operation. In both cases, the colorimetric comparison is made with standard solutions of glucose. Determinations by these methods are more accurate and expeditious than those made by the three principal current methods. The accuracy is within ±0·18% for sugar and ±0·17% for starch. (27 references.) P. S. ARUP.

Fruit and vegetative responses of the Mission fig to gibberellin. J. C. Crane and N. Grossi (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 139—145).—Aq. sprays of gibberellin (20—80 p.p.m.) applied to Mission figs gave increased shoot elongation but a decreased rate of fruit expansion, the decrease being greatest at the highest concentration. The sprays, however, accelerated fruit maturity but decreased sweetness of the fruit. L. G. G. WARNE.

Influence of potassium gibberellate on Valencia orange trees and fruit. C. W. Coggins, jun., H. Z. Hield and M. J. Garber (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 193—198).—Gibberellin sprays were applied to mature orange trees carrying small fruit of the current season and mature orange coloured fruit of the previous season. The sprays increased leaf drop and induced formation of thorns and long pedicels. Drop of mature fruit was not affected but subsequent drop of the current season's fruit was increased. Fruit colour was decreased as was juice content but rind thickness was increased. L. G. G. WARNE.

* *

Effects of biuret on nitrogen status of Washington navel and Valencia orange leaves. R. L. Impey and W. W. Jones (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 186—192).—In orange trees damaged by sprays of urea containing biuret, free biuret was present in apices of damaged leaves eight months after spraying. Injured leaf tips showed decreased total N, protein N, chlorophyll and lipoid N and increased water-sol. N. Amino-acids accumulated in the injured leaf tips. L. G. G. WARNE.

Rate of absorption of urea by intact leaves of Washington navel orange. R. L. Impey and W. W. Jones (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 181—185).—Urea given as an aq. spray was neither hydrolysed nor absorbed on the leaf surface. Absorption by the lower leaf surface was rapid for 2 h. and then proceeded slowly, being complete in 30 h. On the upper surface initial absorption was slower but continued (even when the deposit was dry) for the 30 h. period when it was almost complete. Young and old leaves absorbed urea at the same rate. L. G. G. WARNE.

Effect of phosphorus placement on uptake of phosphorus and growth of direct-seeded tomatoes. S. J. Locascio, G. F. Warren and G. E. Wilcox (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 503—514).—Seed coatings of KH_2PO_4 or $(NH_4)H_2PO_4$ (5 lb. of P/acre) gave yield responses comparable with those obtained by much higher broadcast dressings of fertiliser. Band placement of 30 lb. of P/acre 1—1½ in. below the seed was superior to other placings. L. G. G. WARNE.

Effect of maturation, ripening and truss position on the free amino-acid content in tomato fruits. J. A. Freeman and C. G. Woodbridge (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 515—523).—Alanine, arginine, asparagine, aspartic acid, γ-aminobutyric acid, glutamic acid, leucine, serine, threonine and valine were all relatively abundant in tomato fruits, but only traces of lysine, glycine and tyrosine were generally present. Glutamic and aspartic acids increased in amount as the fruit ripened but the total amino-acid content remained constant throughout ripening. Total amino-acid was greater in fruit ripened off than in that ripened on the plant. L. G. G. WARNE.

Effect of ripeness and harvest dates on quality and composition of fresh canning tomatoes. M. Yamagughi, F. D. Howard, B. S. Luh and S. J. Leonard (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 560—567).—Between the "pink" and "soft ripe" stages of ripening, field tomatoes in California showed a rise in pH, a slight increase or no change in sol. solids, a decrease in total acidity and an increase in reducing sugars. The β-carotene content showed no change; ascorbic acid contents fluctuated irregularly. L. G. G. WARNE.

Cultivation of *Vicia faba*, L. in Northern Sudan. F. T. Last and M. A. Nour (*Empire J. exp. Agric.*, 1961, **29,** 60—72).—Winter-sown broad beans become heavily infected with *Leveillula taurica, Erisyphe umbelliferarum* and *E. polygoni* which are controlled by 2—3 lime-S sprays or S, but not by Karathane. The concn. of the spray has no effect nor has increase in the no. of applications. N fertilisers increase the yield as do combined P and K. Yields are higher on sprayed than on unsprayed plots. M. LONG.

Plot technique for field evaluation of earliness, pod number and total yield in the lima bean. M. Holle and L. C. Peirce (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 403—408).—A uniformity trial of lima beans suggested optimum plot sizes of 15 sq. ft. for total yield, 26 sq. ft. for no. of pods and 21 sq. ft. for earliness. A single row plot could meet the small area requirement for total yield but for no. of pods and earliness one or two row plots were equally efficient. Replication appeared to be unnecessary for an assessment of earliness. L. G. G. WARNE.

Effect of irrigation, mulch and time of harvest on certain chemical and physical changes in fresh and processed green beans. W. A. Sistrunk, W. A. Frazier, V. A. Clarkson and R. F. Cain (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 389—396).—Irrigation, mulching and time of harvest of green beans all affected the quality of the final canned product. Mulching increased the sugar concn. but had no effect on the alcohol-insol. solids, starch or pectin. Irrigation reduced the water-sol. solids in the liquid of the canned beans, whilst late harvesting increased the amount of sloughing off of seed coats. L. G. G. WARNE.

Relationship of phosphorus, potassium and calcium to yield of shelled peas in Central Maine. F. E. Hutchinson, H. J. Murphy and H. W. Gausman (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 470—474).—The amount of soil P deemed to be recoverable by the crop was positively correlated with the yield of peas for the three seasons of the test. Recoverable K had a significant effect on yield in two and recoverable Ca in one year out of the three. L. G. G. WARNE.

Relation between number of seeds per pod, seed size and oil content and the effects of selection for these characters in *Brassica* and *Sinapis*.

G. Olsson (*Hereditas*, 1960, **46,** 29—70).—Pod no. more than no. of seeds per pod and seed size influences seed yield. Seed size and oil content are negatively correlated in rape and turnip rape. The level of oil content tends to be inherited and selection for oil content is effective. The oil content of white mustard seed is governed by the genetical constitution of the seed-bearing plant and not by that of the seed. L. G. G. WARNE.

Influence of nitrogenous fertiliser applied at different stages of growth on seed production in cabbage and Chinese cabbage. T. Eguchi (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 425—435).—N applied at bolting increased inflorescence branching and flower and fruit production. Applied at flowering N increased fruit setting. L. G. G. WARNE.

Variability in the mineral composition of red beet (*Beta vulgaris* L.) varieties in relation to boron nutrition. J. F. Kelly and W. H. Gabelman (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 416—424).—Cultivars of red garden beet which in the field accumulated large amounts of B in mature leaves generally exhibited no B-deficiency symptoms. The B content of young leaves of either seedlings or of mature plants was not related to susceptibility to B deficiency. L. G. G. WARNE.

Variability in the tolerance of varieties and strains of red beet (*Beta vulgaris* L.) to boron deficiency. J. F. Kelly and W. H. Gabelman (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 409—415).—Sixty-seven cultivars of red garden beet when grown in the field had an incidence of black rot (due to B-deficiency) that varied from 0 to 76%. In the greenhouse the cultivars did not differ in their tolerance of low B in the seedling stage. L. G. G. WARNE.

Some effects of nitrogen and phosphoric acid on premature seed-stalk development, yield and composition of three onion varieties. D. R. Paterson, H. T. Blackhurst and S. H. Siddiqui (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 460—467).—On a silty clay loam in Texas, P increased onion yields in the two years and N in one year of the test. P fertiliser increased the P content of the bulbs which was decreased by N fertilising. High-P and -N fertilising both increased the K content of the bulbs. N alone or with P decreased the incidence of bolting whereas P alone increased it. L. G. G. WARNE.

Effect of time of infection by lettuce mosaic virus on rate of growth and yield in Great Lakes lettuce. F. W. Zink and K. A. Kimble (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 448—454).—Infection of lettuce with lettuce mosaic as little as 20 days before harvest reduces yields appreciably. Earlier infection produces stunted non-heading unmarketable plants. L. G. G. WARNE.

Estimating comparative yields of asparagus strains without full season harvest records. J. H. Ellison, G. B. Reynard, D. F. Scheer and J. J. Wagner (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 376—381).—Reliable comparative estimates of asparagus yields may be based on either early yield or on vigour of shoot growth in the previous season. L. G. G. WARNE.

Moisture stress as a requirement for flowering of coffee. P. de T. Alvim (*Science*, 1960, **132,** 354).—Plants in the rainless coastal area of Peru were used. Two groups of plants were subjected to irrigation (*a*) weekly or (*b*) when the soil moisture at a depth of 1 ft. reached wilting level. Treatments were applied from Sept. 1958 to Mar. 1959 and from Oct. 1959 to Jan. 1960. With weekly irrigation the soil moisture was always 15% (60% available); no buds opened during treatment. Plants under (*b*) treatment flowered 10—11 days after each watering, indicating that moisture stress is necessary to break dormancy. T. G. MORRIS.

Manuring of cotton in West Pakistan. V. Effect of nitrogen, phosphorus and potassium, alone and in combination, on the yield of seed cotton. A. Wahhab and Riaz Ahmad (*Empire J. exp. Agric.*, 1961, **29,** 73—78).—Responses to treatments are variable. A general need for P is indicated but at present P fertilisers are uneconomic. NP and NPK are also effective in some districts. M. LONG.

Effect of high-temperature pre-treatment on germination of oil-palm seed. A. R. Rees (*Nature, Lond.*, 1961, **189,** 74—75).—Batches of *dura* (thick-shelled) seed were kept at 39·5° for 80 days with various moisture contents and then some batches were soaked for 5 days and dried slightly to optimum moisture content. Excellent germination was obtained from heat-treated air-dried seed afterwards cooled at optimum moisture content. Watering during the heat-treatment period is therefore unnecessary. S. A. BROOKS.

Study of germinating soya-beans. K. J. Steinbach and C. Franzke (*Nahrung*, 1960, **4,** 490—496).—Decreases in the principal nutrients (as g. per 1000 seeds) are observed when the values are tabulated against the length of the embryo (0—8 cm.). The sol. carbohydrates are progressively consumed, whilst considerable new reserves of starch are produced. As regards the fat, oleic and linolic acids are consumed in preference to the saturated acids. Consumption of proteins is relatively smaller than that of the carbohydrates. (16 references.) P. S. ARUP.

Okra pod growth habits. W. A. Sistrunk, L. G. Jones and J. C. Miller (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 486—491).—Dry matter content of the pods was similar in five cultivars of Okra (*Hibiscus esculentum*). The fibre content of the pods (which may be inedible before this) increased rapidly after the 13th day from flowering and the edible stage is closely related to a fall in the dry matter content of the pod. The fall ceases about the 8th day after flowering and this marks the point at which quality begins to decrease rapidly. L. G. G. WARNE.

Use of gibberellic acid to break flower-bud dormancy in azaleas. L. W. Martin, S. C. Wiggans and R. N. Payne (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 590—593).—Sprays of gibberellic acid (100, 500 and 1000 p.p.m.) given from 1 to 14 times over a 6-week period were, at the higher concn. and the more frequent sprayings, as effective as 6-weeks' low-temp. treatment in breaking the dormancy of azaleas. L. G. G. WARNE.

Colour of *Hydrangea macrophylla* sepals as influenced by the carry-over effects from summer applications of nitrogen, phosphorus and potassium. S. Asen, N. W. Stuart and A. W. Specht (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 631—636).—The colour of the sepals of forced hydrangeas is influenced by the nutrients with which they have been supplied during the previous summer as well as by those supplied during the forcing period. L. G. G. WARNE.

Effect of supplementary light on growth and flowering of carnations (*Dianthus carophyllus*). H. E. White (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 594—598).—Carnations with day length (in Massachusetts) extended to 14 h. by supplementary lighting showed increased growth and more rapid flower bud production, the effect being greater at 13° than at 17°. Flowering was accelerated but the total number of blooms produced was unaltered. L. G. G. WARNE.

Relationship and severity of several soil-borne carnation diseases as affected by root medium and fertilisation. K. C. Sanderson, J. B. Shanks and C. B. Link (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 599—608).—The presence of several pathogens (*Pseudomonas caryophylli*, *Rhizoctonia solani* and nematodes including *Paratylenchus dianthus*) caused no more damage to carnations than could be ascribed to one of them. Resistance to *R. solani* was greatest when drainage was good, and to *P. caryophylli* when Ca supplies were good and N low, but when N was high low P increased resistance. Root wounding increased susceptibility to *P. caryophylli*. L. G. G. WARNE.

Response of *Lilium longiflorum* var. Croft to high salt and boron concentrations. H. C. Kohl, jun., O. R. Lunt and A. M. Kofranek (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 644—648).—*L. longiflorum* in sandy loam supplied with culture solution tolerated in the solution NaCl, $CaCl_2$, and B equal to 90, 90 and 9·5 mequiv. per l., respectively, during the pre-forcing period but were damaged by these concn. during the forcing period. L. G. G. WARNE.

Influence of progressive increase in soil moisture tension on growth and water balance of gladiolus leaves and development of physiological indicators for irrigation. A. H. Halevy (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 620—630).—Transpiration (i), leaf water content (ii), leaf elongation (iii), saturation deficit (iv), osmotic pressure (v), and stomatal aperture (vi) were measured in gladioli as soil moisture decreased from field capacity to the stage at which the plants dried out. (ii), (iv) and (vi) all showed a marked change when soil-moisture tension reached a critical value and the use of stomatal aperture is suggested for indicating irrigation needs. L. G. G. WARNE.

Nutrient-element composition of leaves from selected species of woody ornamental plants. H. Davidson (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 667—672).—Leaves or shoot tips of *Gleditsia triacanthos*, *Acer platanoides*, *Syringa vulgaris*, *Euonymus alatus*, *Juniperus chinensis pfitzeriana*, *Taxus cuspidata expansa* and *Euonymus fortunei* were analysed for nutrients at intervals from June to August. N in the leaves decreased throughout this period and was highest for *Gleditsia* and lowest for *E. alatus*. *Syringa* leaves had noticeably high and *Taxus* a low P content, and leaf P did not change over the sampling period. *Acer* and *E. alatus* were low and *Taxus* high in K and K values in all types fell with time. Ca was very low in the two coniferous species; it increased with time except in *Acer*, *E. alatus*, *Juniperus* and *Taxus*. Mg was high in *Syringa* and low in the conifers. B was noticeably high in *Taxus* and *Acer* and Cu in *E. fortunei*. Mn was exceptionally high in *Acer* and *Taxus* and like Fe concn. increased with time but Fe showed no variation with species. L. G. G. WARNE.

Nutrient element status of some ornamental trees. T. F. Cannon, L. C. Chadwick and K. W. Reisch (*Proc. Amer. Soc. hort. Sci.*, 1960,

76, 661—666).—Leaf analyses for *Crataegus phaenopyrum, Quercus palustris* and *Gleditsia triancanthos inermis* are given. In *Crataegus* leaf-N fell and leaf-Ca and -Mg rose as the season progressed. Leaf-N of the other two species also fell. L. G. G. WARNE.

Pest Control

Rôle of genetics in the use of agricultural chemicals. G. A. Wiebe and J. D. Hayes (*Agron. J.*, 1960, **52,** 685—686).—The resistance of certain barley varieties to foliar applications of DDT was genetically controlled by a single major recessive gene. Of the commercially grown varieties in the U.S. and Canada 5% and of the world barleys 10% were resistant to DDT. Six-rowed types showed a much higher frequency of resistance than did two-rowed types. The results are discussed in relation to natural selection, hybrid barley and variety purity. A. H. CORNFIELD.

Organic fungicides. I. Trichloromethylsulphenyl derivatives. C. Barbera (*Quím. e Ind., Bilbao*, 1960, **7,** 183—189).—Review. (60 references.) L. A. O'NEILL.

Loss of parathion and DDT to soil from aqueous dispersions and vermiculite granules. D. E. Weidhaas, M. C. Bowman and C. H. Schmidt (*J. econ. Ent.*, 1960, **54,** 175—177).—^{32}P-Parathion and ^{14}C-DDT solutions were added to a sandy soil to give 0·02 p.p.m. The amount of insecticide transferred from water to soil increased with time. Not all the insecticide could be accounted for by chemical extraction but bioassay showed that any derivatives were of equal toxicity. When brackish water was used losses of DDT by co-distillation in 24 h. were 60—70%. Parathion on vermiculite granules was almost completely released into water but only a small percentage was in solution. Increase of depth or vol. increased the % released in a given time. The lack of increase of release of DDT from granules with time suggested it was sloughed off the granules when placed in water. C. M. HARDWICK.

Metabolism of injected proline in DDT-poisoned german cockroaches. W. Hoy and H. T. Gordon (*J. econ. Ent.*, 1961, **54,** 198—199).—Topical application of 20 mg. of DDT to male cockroaches greatly lowered the total body-proline within a few h. C. M. HARDWICK.

Modes of fungicidal action of copper–calcium compounds. R. Tröger (*Phytopath. Z.*, 1960, **40,** 91—106).—In continuation of previous work (cf. *Arch. Mikrobiol.*, 1960, **37,** 134), the uptake of Cu by the conidia of *Fusarium decemcellulare* from aq. $CuSO_4$ (3 μg./ml.) is shown to be greatly accelerated by the presence of Ca^{2+} ions added as $Ca(OH)_2$ up to a limiting concn. giving pH = 6·9. When the Ca^{2+} is added as $CaCl_2$, the max. uptake occurs at a concn. of 10^{-5}M for Ca. Conidia in contact with dry Bordeaux mixture residues can readily absorb Cu provided that the hygroscopic constituents of the cell-wall are able to function. (28 references.) P. S. ARUP.

Effect of alcohols on spores of *Sclerotinia fructicola* and other peach fruit-rotting fungi in California. J. M. Ogawa and S. D. Lyda (*Phytopathology*, 1960, **50,** 790—792).—Spores of *S. fructicola, Rhizopus stolonifer* and *Gilbertella persicaria*, were killed by immersion in aq. alcohols, the order of toxicity of which was propanol > isopropanol > ethanol > methanol. The relative toxicities of aq. alcohols (5—60%) are determined. A. G. POLLARD.

Toxicity of acetic acid to *Cladosporium cucumerinum*. D. L. Strider and N. N. Winstead (*Phytopathology*, 1960, **50,** 781—784).—At pH 6·1, acetic acid (0·25M) in a synthetic medium was fungicidal to *C. cucumerinum*. Concn. of 0·01M was fungicidal at pH 4·0 but not at pH 6·0. Similar effects were obtained with propionic and butyric but not with fumaric, oxalic, tartaric, succinic or malic acids. Other fungal species responded in a similar way. A. G. POLLARD.

Evidence of fungistatic action of petroleum oil against *Mycosphaerella musicola* inside banana leaves. L. Calponzos, A. Santiago, T. Theis and C. Colberg (*Phytopathology*, 1960, **50,** 865—866).—The fungistatic action of the oil (viscosity 88·5 S.U.S. at 100°F; sp. gr. 0·85; unsaponifiable matter 100%) is confirmed. A. G. POLLARD.

Mechanism of fungitoxic action of n-dodecylguanidine acetate. I. F. Brown and H. D. Sisler (*Phytopathology*, 1960, **50,** 830—839).—Among an homologous series of n-alkylguanidine acetates max. toxicity to *Saccharomyces pastorianus* and conidia of *Monilinia fructicola* was shown by the C_{12-14}-alkyl members and that to *Nicotiana glutinosa* by the C_{10}-alkyl member. The toxicity of the C_{12}-member (Dodine) to *Sacch. pastorianus*, which was associated with its inhibitory action on the oxidation of glucose phosphate, increased with the pH of the culture media in the range 5·1—7·8. A. G. POLLARD.

Uptake and metabolism of parathion by insect eggs. R. D. O'Brien and E. H. Smith (*J. econ. Ent.*, 1961, **54,** 187—191).—Eggs of *Sanninoidea exitiosa* took up three times as much parathion (**I**) as did those of *Oncopeltus fasciatus* when exposed to **I** vapour. 79% of this was external and unchanged in *S. exitiosa* compared with 92% for *O. fasciatus*. Of the internal **I** 30% and 25% respectively was converted to paraoxon. Uptake of **I** by *Epilachia varivestis* was similar to that of *O. fasciatus* but only 50% was external. *Prodenia eridaria* eggs had a low uptake of which 25% was internal. No single factor was found to account for variations in susceptibility. C. M. HARDWICK.

Translocation and stability of Chipman R-6199 in *Pinus strobus* as related to its control of the introduced pine sawfly, *Diprion similis*. D. M. Norris jun., and H. C. Coppel (*J. econ. Ent.*, 1961, **54,** 159—161).—The day after implanting 8 g. of Chipman R-6199 [*OO*-diethyl *S*-(2-diethylamino)ethyl phosphorothiolate] (H oxalate salt) into holes in the trunk, 15 p.p.m. was present in the previous year's needles. After 5 weeks 34 p.p.m. was present in both years' needles; after 11 weeks 254 p.p.m. was present in the lower crown and ½ of this in the middle and upper crown. A peak concn. in the needles was observed 1 year after implantation. C. M. HARDWICK.

Synergism of carbamate insecticides with octachlorodipropyl ether. G. P. Georghiou and R. L. Metcalf (*J. econ. Ent.*, 1961, **54,** 150—152).—Synergism occurred between octachlorodipropyl ether and Compound III (3-isopropylphenyl *N*-methylcarbamate) at ratios as low as 1 : 20. This effect was not due to greater penetration. Synergism declined slowly as the interval between application of the two compounds increased. Synergism occurred with five other carbamates. C. M. HARDWICK.

Hazards associated with the implantation of Tetram into elm trees for dutch elm disease control. A. F. Al-Azawi, D. M. Norris, jun., and J. E. Casida (*J. econ. Ent.*, 1961, **54,** 127—129).—Tetram [*OO*-diethyl *S*-(β-diethylamino)-ethyl phosphorothiolate] (10 g.) was implanted in the trunks of *Ulmus americana*. The amount in foliage was 1796 p.p.m. at 26 days, rising to 5058 at 143 days and was 3796 p.p.m. at leaf fall. This became partially leached from the leaves but remained stable. Rats fed on a diet containing 1·25% leaf powder had marked cholinesterase depression. The smoke from burned leaves caused plasma-cholinesterase inhibition in mice although most of the Tetram was destroyed by burning. Fallen leaves caused 90% mortality to earthworms in 15 days. C. M. HARDWICK.

Residues in tissues and eggs receiving Co-Ral (Bayer 21/199) in the feed. H. W. Dorough, U. E. Brady jun., J. A. Timmerman and B. W. Arthur (*J. econ. Ent.*, 1961, **54,** 97—100).—Hens fed with mash containing 100 p.p.m. of Co-Ral for 7 days had highest concn. of ^{32}P-residues in the liver and kidney during feeding and in the bone after 10 days; little occurred in the fat. Acetonitrile-sol. residues were highest in the liver, kidney and gizzard but disappeared rapidly when feeding finished. Analysis of eggs showed that most ^{32}P was in yolk 11—15 days after treatment. Small amounts of acetonitrile-sol. material were present 6—8 days after normal feeding was resumed. Of ^{32}P 79% was accounted for in the faeces. Celite and anion chromatography showed that mono- and diethyl phosphoric acids were the predominant water-sol. metabolites. (11 references.) C. M. HARDWICK.

Auxin content and auxin catabolism of stems of *Euphorbia cyparissias* L. infected by *Uromuces pisi* (Pers.). P.-E. Pilet (*Phytopath. Z.*, 1960, **40,** 75—90).—The observed increase in the auxin content of the stems caused by infection by the fungus in the mycelial stage is causally connected with the production of an anti-IAA-oxidase by the fungus. The subsequent marked increase in auxin content during the sporing stage is probably due to another factor, viz. the production of auxins by the fungus, causing a super-optimal concn. The probable effects of other complicating factors are considered. (26 references.) P. S. ARUP.

Tetrin an antifungal antibiotic. D. Gottlieb and H. L. Pote (*Phytopathology*, 1960, **50,** 817—822).—The properties, solubility in org. solvents, chromatography and stability of this tetra-ene, obtained from *Streptomyces* sp. Ill. No. 155—2, are recorded and its inhibitory action on a range of fungi is determined. A. G. POLLARD.

Chemotherapy of cereal rusts with a new antibiotic. D. Davis, L. Chaiet, J. W. Rothrock, J. Deak, S. Halmos and J. D. Garber (*Phytopathology*, 1960, **50,** 841—843).—Preliminary trials of the new antibiotic (P9, Merck, Sharp & Dohme Res. Lab.) using wheat leaf and stem rusts, crown rusts of oats and powdery mildew of wheat and bean, are recorded. A. C. POLLARD.

Influence of cation competition, time and temperature on the uptake of streptomycin by foliage. R. N. Goodman and H. S. Goldberg (*Phytopathology*, 1960, **50,** 851—854).—Competition between metallic cations (K, Na, Mn, Ca, Al) and the streptomycin (**I**) cation for adsorption sites in homogenised plant tissues is demonstrated. The amounts of **I** adsorbed increased with time and temp.

and were greater on the under- than on the upper-side of excised leaves of *Coleus* and bean but greater on the upper side of apple leaves. A. G. POLLARD.

Laboratory and field tests for evaluating the efficiency of wetting agents used in agriculture. R. de B. Ashworth and G. A. Lloyd (*J. Sci. Fd Agric.*, 1961, **12**, 234—240).—With a modified Shapiro's test (wetting of a cotton tape of standard weave) good agreement was obtained between laboratories. Results with anionic and non-ionic wetters were closely related to the wetting of cabbage or other leaves which had been dipped or sprayed at high vol. E. M. J.

Sterilisation of agar media with propylene oxide. W. L. Klarman and J. Craig (*Phytopathology*, 1960, **50**, 868).—The medium in Petri dishes was inoculated with various plant-pathogenic fungi and placed in a 10-l. bell jar together with an open dish containing 10 ml. of propylene oxide, for 24 h. at room temp. No growth developed on the plates 6 days after removal from the bell jar. Normal growth of micro-organisms occurred in the medium on re-inoculation 24 h. after fumigation. A. G. POLLARD.

Effects of chemical treatments and storage on sunflower seeds. W. E. Sackston and B. M. Chernick (*Canad. J. Plant Sci.*, 1960, **40**, 690—699).—Sunflower seeds retain a high viability up to 3 years. All except Hg dressings have no deleterious effects even when applied at 15 oz./bushel. At 1½ oz./bushel mercurials are safe even for long periods of storage, and appear to be the most effective, although some non-mercurials give good control. M. LONG.

Analysis of seed disinfectants based on phenylmercurycatechol. G. Rentsch (*Z. anal. Chem.*) 1960, **178**, 100—103).—After removal of interfering elements by chromatography and extraction of catechol with ether, phenylmercurycatechol is determined in the aq. phase by reaction with 4-aminoantipyrine and K ferricyanide at pH 7·6 and spectrophotometric measurement at 560 mμ. Separation by paper chromatography is also described. P. D. PARR-RICHARD.

Common rootrot and plant development following treatments of wheat seed with aldrin, γ-BHC and heptachlor, with and without mercury fungicides. R. H. Burrage and R. D. Tinline (*Canad. J. Plant Sci.*, 1960, **40**, 672—679).—γ-BHC (**I**) seed dressings are phytotoxic and render wheat plants susceptible to common rootrot, but the reduction in emergence and seedling wt. result from phytotoxicity rather than from rootrot infection, although the latter can produce the same result. Heptachlor (**II**) treatment sometimes has a similar but much reduced effect. Aldrin (**III**) has no such effects. No stimulation of growth by **I** or **III**, increase in rootrot infection severity by **II** nor reduction of same by **III** occurs. Stunting caused by rootrot or phytotoxicity does not decrease yields. M. LONG.

Spontaneous and induced mutations of barley for the reaction to mildew. E. A. Favret (*Hereditas*, 1960, **46**, 20—28).—γ-Rays, fast neutrons and formaldehyde (but not ethylene oxide) induced mutations for immunity or resistance (in susceptibile varieties) to mildew, *Erisiphe graminis*. Mutations for susceptibility (in immune varieties) occurred spontaneously. L. G. G. WARNE.

Insecticide residues in potatoes after soil treatments for control of wireworms. J. A. Begg, P. J. G. Plummer and H. Konst (*Canad. J. Plant Sci.*, 1960, **40**, 680—689).—Residues of aldrin, chlordane, dieldrin and heptachlor (<0·1 p.p.m.) were found in potatoes following treatment for control of wireworm. Dosages of 5 lb./acre were applied 3—27 months before harvesting. No toxic effects in mammals were experienced. M. LONG.

Relationships between Ca/K ratio, pH and prevalence of potato scab. J. J. Doyle and A. A. MacLean (*Canad. J. Plant Sci.*, 1960, **40**, 616—619).—The relationship between Ca/K ratio and scabbiness is not statistically significant with either $CaCO_3$ or $CaSO_4$ as sources of Ca. High soil pH is the main factor. M. LONG.

Behaviour of potato- and tomato-attacking strains of *Phytophora infestans* (Mont.) de Bary towards organic and inorganic fungicides. A Chitzanidis (*Phytopath. Z.*, 1960, **40**, 1—34).—The reported inferiority of zineb to Cu_2OCl_2 against the organism is not confirmed by comparative field, plant or germination tests. No evidence is obtained of any relationship between susceptibility to the fungicides and altered pathogenicity in induced or spontaneous mutants. In the Rhineland, tomato fruits are generally attacked by the potato strains 0 and 4 which do not attack the leaves. (42 references.) P. S. ARUP.

Solubility of turnip mosaic virus at different hydrogen ion concentrations. C. Schade (*Phytopath. Z.*, 1960, **40**, 147—150).—Max. solubility in a borate buffer (as measured by serological activity and infectivity) is observed in the range pH 8·8—9·2. Most of the residue remaining insol. at pH 8·0—8·4 can be dissolved at pH 8·8—9·2. The serological activity of solutions at pH 8·8—9·2 decreases during storage at 2°, whilst the infectivity remains unaltered. P. S. ARUP.

Scabbing of rutabagas after applications of heptachlor, parathion and lime to mineral soils of various acidities. D. C. Read and D. B. Robinson (*J. econ. Ent.*, 1961, **54**, 193—194).—On soils with pH >5·78 there was no scab injury whether or not lime was applied. At pH 5·4—6·4 heptachlor and parathion caused slight scabbing which became severe when lime was also applied. At pH 6·2—6·68 some of the plots treated with both substances were 100% infected. The best rutabagas were produced when the soil had a pH 5·5—6·0. The pathogen was similar to *Streptomyces scabies*. C. M. HARDWICK.

Control of root maggots attacking cruciferous crops, mainly rutabagas, grown in ridges. D. C. Read (*Canad. J. Plant Sci.*, 1960, **40**, 721—728).—Heptachlor, aldrin and chlordane at 5 lb./acre give up to 90% reduction, giving better control with the second than with the first generation of maggots. Nematocide 18,133 at 5 lb./acre gives control throughout the growing season. Thimet gives better control than do chlorinated hydrocarbons. Org. P compounds generally control only the first generation. Diazinon is highly phytotoxic. M. LONG.

Insecticidal control of sugar-beet root maggot and yield of sugar beets. W. R. Allen, W. L. Askew and K. Shreiber (*J. econ. Ent.*, 1961, **54**, 178—181).—Heptachlor (0·5—2 lb./acre as granules or on fertilisers reduced no. of *Tetanops myopaeformis* by 80% Diazinon and Phorate at 1 lb./acre in fertiliser mixtures gave 84% and 48% reductions of maggots respectively but were phytotoxic. Trithon was ineffective. At 1 oz./acre heptachlor and diazinon seed treatments gave a 46% and 43% reduction respectively but Phorate was ineffective. Beets from plots treated at 1 lb./acre showed no detectable residues. The heptachlor–fertiliser mixture applied to seed furrows gave an increased yield of beet. (11 references.) C. M. HARDWICK.

Effect of insecticide–fertiliser mixtures and seed treatment on emergence of sugar beet seedlings. W. R. Allen, W. L. Askew and K. Schreiber (*J. econ. Ent.*, 1961, **54**, 181—187).—In the laboratory root growth was inhibited to varying extents by the solvents, xylene, heavy aromatic naphtha and Velsicols AR-60 and AR-50G. When fertiliser was applied, the reduction of water available to the plants was serious but lower values were tolerated without fertiliser. In field tests Phorate and diazinon were more toxic than Trithion or heptachlor. The use of captan- treated seed improved seedling-stands slightly when used with heptachlor–fertiliser mixtures. (20 references.) C. M. HARDWICK.

Residues of Phosdrin on lucerne and its effectiveness on the insect complex. E. W. Huddleston and G. G. Gyrisco (*J. econ. Ent.*, 1961, **54**, 209—210).—Counts of five species of insects up to 2 weeks after the use of Phosdrin sprays (2—4 oz./acre) are tabulated. No phytotoxicity is recorded. Residues of Phosdrin were dissipated in 4 days. C. M. HARDWICK.

Biochemical response of apple tissues to fungus infection. E. H. Barnes and E. B. Williams (*Phytopathology*, 1960, **50**, 844—846).—In the peel of several varieties of apple infection with *Venturia inaequalis* or *Podosphaera leucotricha* caused the formation of a fluorescent phenolic compound, probably a glycoside. Traces of the compound occur in healthy tissue. A. G. POLLARD.

Further studies of mercury residues on apple fruit. D. K. R. Stewart and R. G. Ross (*Canad. J. Plant. Sci.*, 1960, **40**, 659—665; cf. *ibid.*, p. 177).—Residues from single cover sprays of HgPh acetate decrease until early Aug. and then increase until at harvest they exceed the initial deposit. Mylar bags, encasing the fruit, are more effective than polythene in preventing Hg contamination. M. LONG.

Effectiveness of insecticides against the rusty plum aphid and ants. L. J. Charpentier (*J. econ. Ent.*, 1961, **54**, 204).—*Hysteroneura setariae*, in conjunction with the ants, is an important vector of sugar mosaic in Louisiana. After 48 h., >80% reduction of both insects followed sprays of heptachlor, demeton, Trithion and Dimethoate at 1 lb./acre. Malathion gave >60% reduction. C. M. HARDWICK.

Control of *Phytophthora fragariae* with soil fungicides. R. H. Converse (*Plant Dis. Reptr*, 1960, **44**, 948—951).—Soil treatment with Trizone (propargyl bromide–MeBr–chloropicrin) 14 days prior to planting was very effective in reducing red stele, due to *Phytophthora fragariae*, in strawberry roots. Vapam, Dowfume MC-2, and chloropicrin were somewhat less effective. A. H. CORNFIELD.

Control of European brown snail in citrus groves in southern California with Guthion and metaldehyde sprays. J. L. Pappas and G. E. Carman (*J. econ. Ent.*, 1961, **54**, 152—156).—Sprays of Guthion and metaldehyde caused greater reduction of *Helix aspera* in lemon groves than did tricalcium arsenate–metaldehyde bait. In Valencia orange groves Guthion was as effective as tartar emetic and sugar by the end of the third week. C. M. HARDWICK.

Antagonistic action of *Penicillium chrysogenum* in control of tomato *Fusarium* wilt. Y. A. Youssef (*Phytopath. Z.*, 1960, **40**, 218—220).—The antagonism between the fungi is demonstrated by cultural experiments *in vitro*. Symptoms of wilt in tomato plants can be materially reduced by applications of cultures or culture filtrates of the *Penicillium*. P. S. ARUP.

Control of pea enation mosaic in peas with insecticides. A. C. Davis, F. L. McEwen and W. T. Schroeder (*J. econ. Ent.*, 1961, **54**, 161—166).—Three applications of parathion spray at weekly intervals largely reduced the incidence of pea enation mosaic. Two applications of demeton or parathion needed careful timing to give good results. Stunt and streak viruses were also controlled. The yield of peas increased in treated plots but not in proportion to the suppression of virus diseases. Seed treatment with demeton was not as effective as with a foliar spray. (13 references.) C. M. HARDWICK.

Control of *Cladosporium* spot of southern pea. D. L. Strider (*Plant Dis. Reptr*, 1960, **44**, 955).—Only 2 of 18 varieties of southern pea, *Vigna sinensis*, tested were highly resistant to *Cladosporium* spot, due to *Cladosporium vignae*, Gardner. Of several fungicides tested for control of the disease maneb (1·5 lb. per 100 gal.), applied at bloom and at weekly intervals thereafter, was the most effective. A. H. CORNFIELD.

Incidence of field spread of internal cork of sweet potato in insecticide-treated plots. E. J. Kantack, W. J. Martin and L. D. Newsom (*J. econ. Ent.*, 1961, **54**, 125—127).—The principal vector of internal cork was *Aphis gossypii*. The use of insecticides produced significant results only if 50% of the check plants became infected. C. M. HARDWICK.

Evaluation of chemical and microbial materials for control of cabbage looper. I. M. Hall, R. L. Hale, H. H. Shorey and K. Y. Arakowa (*J. econ. Ent.*, 1961, **54**, 141—146).—The most promising materials for control of *Tricloplusia ni* as dusts and sprays on cabbage, cauliflower and lettuce were 2—3 lb./acre of DDT + toxaphene, 1 lb. parathion, and ½—1 lb. of General Chemicals 3583 [diethyl 1-(2,5-dichlorophenyl)2-chlorovinyl phosphate]. Dibrom, Ethion, Guthion, Malathion, Perthane, Thiodan and Sevin gave fair results. Two of five prep. of *Bacillus thuringiensis* var. *thuringiensis* gave quick and long-lasting results. C. M. HARDWICK.

Mode of action of some antibiotics in their inhibitory effect on tobacco mosaic virus multiplication. T. Hirai and T. Shimomura (*Phytopath. Z.*, 1960, **40**, 35—44).—In tests by the (tobacco) leaf disk-culture method of Hirai *et al.*, mitomycin C is most effective in inhibiting the growth of the virus at the concn. 25 p.p.m.; it inhibits the synthesis of ribonucleic acid, but not that of deoxyribonucleic acid in infected and uninfected tobacco leaf tissue. Naramycin (actidione analogue) or its deriv. inhibit the virus, but not the synthesis of ribonucleic acid. Both fungicides inhibit the assimilation of ^{32}P into the nucleic acid and virus components of infected and uninfected leaves. (26 references.) P. S. ARUP.

Integrated control system for hornworms on tobacco. F. R. Lawson, R. L. Rabb, F. E. Guthrie and T. G. Bowery (*J. econ. Ent.*, 1961, **54**, 93—97).—A technique for transferring colonies of *Polistes* wasps which prey on *Protoparce sexta* and *P. quinquemaculata* was successful and reduced fifth instar populations by 60% but only when populations were low. The wasps did not attack *Heliothis* spp. which caused appreciable tobacco damage. The use of a reduced dosage to the top leaves every 2 weeks or when numbers indicated was more economic than one heavier application of TDE on endrin dust at the fifth instar larvae stage. (12 references.) C. M. HARDWICK.

Evaluation of insecticides for control of the tobacco thrips on groundnuts. J. A. Harding (*J. econ. Ent.*, 1961, **54**, 200—201).—Counts of thrips present 3 and 8 days after spraying showed that Trithion methyl-Trithion, Ethion, SD4402(1,3,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-4,7-menthanophthalan), toxaphene, DDT and parathion gave the most satisfactory results. Residual control with Dibrom, Phosphamidon and Phosdrin was poor. (11 references.) C. M. HARDWICK.

Insecticidal susceptibility of *Nysius raphanus*, a pest of cotton. T. F. Leigh (*J. econ. Ent.*, 1961, **54**, 120—124).—Ground sprays of endrin and heptachlor gave satisfactory control of *Nysius raphanus* which had built up on neighbouring plants. Laboratory tests showed that malathion was 200 times more effective than dieldrin, endrin or Dipterex, while toxaphene and DDT were considerably less effective. Results with Sevin were erratic. C. M. HARDWICK.

Growth and yield of cotton sprayed with DDT in East and North Uganda. J. E. Dale and T. H. Coaker (*Empire J. exp. Agric.*, 1961, **29**, 1—13).—Spraying reduces both leaf tattering by insects and the percentage of fruiting bodies shed. Where continued crop formation does not occur, spraying is likely to produce large increases of yield. When the development of fruiting bodies is rapid, spraying is of little use. (12 references.) M. LONG.

Control of beet armyworm on cotton in Arizona. G. P. Wene and L. W. Sheets (*J. econ. Ent.*, 1961, **54**, 192—193).—Dipterex spray was more effective than dust, and gave good control of *Spodoptera exigua*. Dibrom + endrin, and Dilan + endrin were also effective. Methyl parathion alone or with endrin, Guthion and Sevin were poor. C. M. HARDWICK.

Effects of insecticides on predaceous arthropod fauna of Louisiana sugar-cane fields. S. D. Hensley, W. H. Long, L. R. Roddy, W. J. McCormick and E. J. Concienne (*J. econ. Ent.*, 1961, **54**, 146—149).—The use of heptachlor to control *Solenopsis saevissima* when not followed by adequate applications of endrin led to high populations of *Diatraea saccharalis* due to suppression of its predators. Endrin was toxic to *D. saccharalis* but ryania was not. C. M. HARDWICK.

Diseases of groundnuts in Northern Rhodesia. J. Smartt (*Empire J. exp. Agric.*, 1961, **29**, 79—87).—The most common diseases are rosette virus and leaf spot. Both are controllable by cultural methods. Volunteer plants carry on the diseases. M. LONG.

Control of millipedes in greenhouse soil. T. J. Henneberry and E. A. Taylor (*J. econ. Ent.*, 1961, **54**, 197—198).—Various insecticides were applied as emulsions or suspensions to the soil. Ethion gave a good reduction in millipede populations for the whole experiment. Endrin and Dimethoate gave good results. American Cyanamid 18133 (*OO*-diethyl *O*-2-pyrazinyl phosphorothioate) was effective after the first 2 weeks. Heptachlor, lindane and parathion were ineffective. C. M. HARDWICK.

Isolation of *Fusarium oxysporum* from soils. D. Park (*Trans. Brit. mycol. Soc.*, 1961, **44**, 119—122).—A suitable method is described. L. G. G. WARNE.

Toxicity of TDE to different instars and strains of the red-banded leaf roller and the response of a TDE-resistant strain to parathion and endrin. R. C. Rock, C. H. Hill and J. M. Grayson (*J. econ. Ent.*, 1961, **54**, 88—91).—Larvae of *Argyrotaenia velutinana* were placed inside treated cups inverted over apple foliage. In one orchard third instar larvae showed resistance to TDE 185·1 times that of first instar larvae. Resistance levels in fifth instar larvae were similar to those of third instar. Second instar larvae showed a moderate resistance to parathion which had been used in the orchard for 10 years, but were susceptible to endrin which had never been used. C. M. HARDWICK.

Effect of certain antibiotics and other compounds on the two-spotted spider mite. F. H. Harries (*J. econ. Ent.*, 1961, **54**, 122—124).—Cycloheximide, 3-[2-(3,5-dimethyl-2-oxycyclohexyl)-2-hydroxyethyl] glutarimide) (12·5—200 p.p.m.), on potted peach plants kept egg laying of *Tetranychus telarius* at a low level for up to 5 weeks. It was also effective on apples, pears and roses. Cycloheximide deriv. were less effective than the parent compound. Of a group of antiviral compounds tested cytovirin was the most active. C. M. HARDWICK.

Laboratory evaluation of Ethion with other acaricides against the adult two-spotted spider mite, *Tetranychus telarius*. P. C. Lippold (*J. econ. Ent.*, 1961, **54**, 166—167).—Adult mites were placed on *Phaseolus lunatus* plants which were dipped into insecticidal solutions and the percentage of mite control after 2½ days, noted. With Ethion rated at 100%, Delnav and Tetram had values >60%. Fourteen others, mainly org. P compounds, had values below 30%. (12 references.) C. M. HARDWICK.

Effect of Tedion on the eggs and larvae of three strains of two-spotted mite, *Tetranychus telarius*. T. J. Henneberry, E. A. Taylor and A. L. Boswell (*J. econ. Ent.*, 1961, **54**, 168—169).—Topical application to eggs had little effect but all treated larvae except those of the resistant strain had >80% mortality. Most of the eggs produced 24 h. after treatment were non-viable. When the mites were transferred to clean plants mortality decreased. The resistant strain still produced viable eggs 48 h. after feeding on Tedion-treated plants. C. M. HARDWICK.

Effect of captan on reproduction in two-spotted spider mite (*Tetranychus telarius*). P. E. Hunter (*J. econ. Ent.*, 1961, **54**, 204—206).—No striking changes in fecundity or population structure followed the use of dips containing 2 lb. or 4 lb. of captan per 100 gal. of water. C. M. HARDWICK.

Susceptibility of an eye gnat, *Hippelates pusio*, to residual insecticides. A. Spielman (*J. econ. Ent.*, 1961, **54**, 130—131).—Gnats were exposed for 15 min. to dried insecticide-treated paper in screw-topped phials. DDT produced little knockdown within 6 h., but lindane had a rapid knockdown at low concn. Malathion at fairly high concn. produced a 50% knockdown in 1 h. C. M. HARDWICK.

Laboratory and field tests of new insecticides for grasshopper control. F. E. Skoog, F. T. Cowan and R. V. Connin. (*J. econ. Ent.*, 1961, **54,** 170—174).—Of the compounds tested Bayer 25141 (*OO*-diethyl *O*-*p*-methylsulphinylphenyl phosphorothioate), Bayer 29493 [*OO*-dimethyl *O*-(4-methylthio-*m*-tolyl) phosphorothioate], diazinon, Dibrom, Dimethoate, General Chemicals 3707 [1,3-bis-(methoxycarbonyl)prop-1-en-2-yl dimethyl phosphate], malathion. Monsanto CP-7769 [hexaethyl (ethyl thiomethylidyne) triphosphonate], Phosphamidon and Sevin were the most promising. C. M. HARDWICK.

Control of the mint rust fungus, *Puccinia menthae* by nickel salts. G. L. Farkas, G. Molnár and Z. Kerály (*Phytopathology*, 1960, **50,** 865).—Spraying *Mentha piperita* with aq. $NiCl_2$ or $Ni(NO_3)_2$ (0·1—0·3%) reduced the incidence of rust and increased oil yields, $Ni(NO_3)_2$ being the more effective. The menthol content of the oil was lowered by $Ni(NO_3)_2$ but not by $NiCl_2$. A. C. POLLARD.

Economic losses caused by weed competition in Manitoba grain fields. II. Effect of weed competition on the protein content of cereal crops. G. Friesen, L. H. Shebeski and A. D. Robinson (*Canad. J. Plant Sci.*, 1960, **40,** 652—658).—Both yield and protein content of grains are increased by weed removal, weeds competing with the crop for available N. M. LONG.

Plant growth suppressants with special reference to persistence of Amo-1618 in soil. P. C. Marth and J. W. Mitchell (*Proc. Amer. Soc. hort. Sci.*, 1960, **76,** 673—678).—4-Hydroxy-5-isopropyl-2-methylphenyltrimethylammonium chloride 1-piperidinecarboxylate (AMO-1618) was incorporated in soil at rates of 1—100 lb./acre. Nine years later the depressing effects on the growth of beans was with the heavier applications almost as great as the depressing effect after one year (70—80% reduction in growth). L. G. G. WARNE.

Effect of 3-amino-1,2,4-triazole on the uptake, retention, distribution and utilisation of labelled phosphorus by young barley plants. D. J. Wort and B. C. Loughman (*Canad. J. Bot.*, 1961, **39,** 339—351).—Exposure to 3-amino-1,2,4-triazole (**I**) diminished the uptake of ^{32}P but also decreased subsequent loss to the environment. The activity in acid-sol. (nucleotides, sugar phosphates, inorg. P) fractions and acid-insol. (nucleic acids, phospholipids, phosphoprotein) fractions of the root was reduced by treatment, but exposure to **I** for up to 48 h. increased the amount of ^{32}P translocated to the shoot. The effect of **I** on P metabolism is confined to processes involved in the incorporation of PO_4^{3-} during the synthesis of nucleic acids and is not concerned with oxidative phosphorylation or with glycolysis. (13 references.) E. M. J.

Method and means for maintaining the concentration of volatile substances in liquid mixtures. J. Giladi, F. Rajzman and I. Cohen (B.P. 837,406, 30.12.58).—A method for maintaining constant the concn. of a volatile substance dissolved or dispersed in a liquid (e.g., an aq. solution of ethylene dibromide, for use as insecticide in the treatment of fruit prior to shipping thereof) comprises bubbling therethrough an inert gas, then passing the exit gas containing entrained active ingredient through a detector responsive to deviations of the concentration thereof and capable of operating a device adapted to regulate addition of the active ingredient to the liquid mixture. Apparatus is figured and claimed. F. R. BASFORD.

Derivatives of benzoxazol-2-one. Chemische Werke Albert (B.P. 835,990, 31.10.58. Ger., 31.10.57).—Compounds, characterised by insecticidal and fungicidal activity, comprise 3-(trichloromethylsulphenyl)benzoxazol-2-ones substituted optionally in the benzene ring with NO_2 or aliphatic hydrocarbon radical of 1—6 C. In an example, the prep. is detailed by conventional means of 3-(*trichloromethylsulphenyl*)-*benzoxazol-2-one*, m.p. 103—104°. The product is active against *Alternaria tenuis*. F. R. BASFORD.

Ethylene bisthiuram disulphide. Shell Research Ltd. (Inventor: H. M. Higson) (B.P. 835,960, 1.10.57).—An ethylene bisthiuram disulphide product of high insecticidal activity is obtained by treating an alkali metal or NH_4 salt of ethylene-bisdithiocarbamic acid with $\leqslant$0·8 mol. of alkali metal or NH_4 persulphate in aq. solution or org. solvent (other than an aldehyde or ketone), then isolating the product (in absence of aldehyde or ketone, which otherwise reduces the insecticidal activity). F. R. BASFORD.

Composition for the destruction of slugs. Poudreries Réunies de Belgique S.A. (B.P. 836,893, 20.9.56. Belg., 28.9.55).—A composition for use in the destruction of slugs comprises a dispersion of *o*- and/or *p*-chloronitrobenzene ($\geqslant$10 wt.-%) in an inert solid diluent (talc, sawdust, bentonite, bran, glue and/or dextran) or in aq. emulsion. F. R. BASFORD.

Phosphorus-containing pyridyl alkanol esters. Ruhrchemie A.-G. (B.P. 836,655, 14.10.57. Ger., 31.10.56).—Compounds, useful as pesticidal agents (especially active against *Calandra*, e.g., *C. granaria*), comprise pyridyl alkanol esters of *OO*-dialkyl thionophosphoric acids, viz., $OR(OR')\cdot PS\cdot O\cdot R''\cdot R'''$ (R and R′ are alkyl of 1—4 C; R″ is alkylene; R‴ is pyridyl). They are obtained by treating $OR(OR')\cdot PS\cdot POCl$ with $R'''\cdot R''\cdot OH$ at 20—150 (60—120)° in presence of an acid-binding agent (pyridine or other weak base), preferably in a diluent (e.g., benzene). In an example, details are given for the prep. of *Et*$_2$ *2-(pyrid-4′-yl)ethyl phosphorothionate*, b.p. 118—119°/3 mm. and 119—121°/4 mm. F. R. BASFORD.

1,1-Dimethyl-2,2-di-(1-cyanoethyl)hydrazine. American Cyanamid Co. (B.P. 837,229, 21.3.57. U.S., 26.3.56).—A mixture of $NMe_2\cdot NH_2$ and lactonitrile is stirred at 95—100° for 3 h., then extracted with water; the residue is recrystallised from EtOH, to give 1,1-*dimethyl*-2,2-*di*-(1-*cyanoethyl*)*hydrazine*, m.p. 90—91°. The product has fungicidal and especially nematocidal properties, and a composition containing it (e.g., 25 pt. per 100 pt. of Fuller's earth) for use against nematodes is claimed. F. R. BASFORD.

Weedkillers. Pechiney Compagnie de Produits Chimiques & Electrométallurgiques (B.P. 837,484, 9.7.56. Fr., 12.7.55).—$NaClO_4$ (5) is compounded with NaF ($\sim$1, pt.), to provide an improved herbicidal composition, especially effective (in aq. solution) against couch grass, brambles, ferns, etc. F. R. BASFORD.

Animal Husbandry

Semi-micro technique for crude fibre determination. R. M. Bredon and C. D. Juko (*J. Sci. Fd Agric.*, 1961, **12,** 196—201).—The semi-micro technique (**I**) previously developed by Bredon was adapted to conditions in East Africa and results were compared with those of the standard method (**II**) of the Fertilisers & Feeding Stuffs Regulations. A comparison between these two methods is made at 3750 and 6800 ft. altitude. **I** standardises the procedures for the determination of crude fibre and eliminates many of the errors, the main source of error being the method of sampling. In **II**, crude fibre from six samples can be ready for drying in $<$2 h.; with **I** and a 12-bucket centrifuge, 12 samples can be digested and 24 crude fibre determinations can be ready for drying in 2¼ h. (14 references.) E. M. J.

Comparison of cellulose digestion *in vitro* and *in vivo*. C. F. LeFevre and L. D. Kamstra (*J. Anim. Sci.*, 1960, **19,** 867—872).—Cellulose digestion coeff. as determined by 48-h. methods *in vitro* were similar to those obtained by customary *in vivo* procedures. Values were relatively lower when 24-h. *in vitro* fermentations were adopted. *In vitro* methods gave similar results whether rumen fluid from sheep or cattle was used. Rations containing 25% roughage showed lower coeff. than did those containing 75% roughage by *in vitro* as by *in vivo* methods. A. G. POLLARD.

Utilisation of rations containing different proportions of roughage and concentrate as measured by total digestible nutrient (TDE) and digestible energy (DE). J. D. Hopson, W. S. Tsein, J. A. Joyce, C. S. Menzies and D. Richardson (*J. Anim. Sci.*, 1960, **19,** 910—915).—Significant correlation coeff. for DE and TDN are established. Both values were increased, though not significantly, by pelleting. Utilisation of fattening rations was max. with 30—50% of concentrate in the ration. For practical purposes 1 lb. of TDN $\equiv$ 2000 kcal. A. G. POLLARD.

Effect of chopping vs. grinding on the nutritive value index of early- vs. late-cut red clover and timothy hays. L. E. Lloyd, E. W. Crampton E. Donefer and S. E. Beacom (*J. Anim. Sci.*, 1960, **19,** 859—866).—Grinding as compared with chopping red clover and timothy forages resulted in increased intake by lambs and increased "nutritive value indices" (Crampton *et al.*, *ibid.*, 1960, **19,** 538). The physical form of the forage had a greater effect on its feeding value than had the stage of maturity of the material. A. G. POLLARD.

Value of hay pellets fed with grass silage and mixed hay in wintering rations for steer calves. J. I. Miller, J. J. Drain, R. L. Park and M. V. Wallentine (*J. Anim. Sci.*, 1960, **19,** 715—721).—Hay pellets in proportions providing 25% of the total roughage were fed to calves together with long hay or grass silage as principal roughage. Use of pellets increased the rate of gain in wt. (by 25%) and feed efficiency. A. G. POLLARD.

Effect of pelleting on digestibility of hay by sheep. P. J. Reynolds and I. L. Lindahl (*J. Anim. Sci.*, 1960, **19,** 873—880).—In digestibility trials refusal of long hays was 9—16% of the amount fed, that of ground hay was very small and that of pellets, nil. When calculated on an "as consumed" basis, grinding and pelleting lowered the apparent digestibility of the hays but increased it when calculation was made on an "as fed" basis. The total digestible nutrient content of poorer grade hays was also increased by grinding and pelleting. A. G. POLLARD.

Nutritive value of timothy hay as affected by nitrogen fertilisation. C. G. Woelfel and B. R. Poulton (*J. Anim. Sci.*, 1960, **19**, 695—699).—Application of N to the aftermath of timothy (N, 0—200 lb./acre) increased the dry matter yields of the forage, the % protein in the forage and (slightly) its ash content; the N-free extract diminished and the crude fibre and ether extract were unaffected. The crude protein content and the apparent digestibility of protein were significantly correlated; the latter value was increased by the higher levels of N applied. The apparent digestibility of the N-free extract diminished as the N dressing was increased.
A. G. POLLARD.

Effect of drying on oestrogenic activity of lucerne samples of varying maturity. E. M. Bickoff, A. N. Booth, A. L. Livingston and A. P. Hendrickson (*J. Anim. Sci.*, 1960, **19**, 745—753).—Variations in the oestrogen content of lucerne with advancing growth were of similar type in five successive crops in one season and in the spring crop of the following season. Oestrogenic activity was low during vegetative growth and increased towards maturity to a max. at full bloom. The third (mid-season) crop attained max. activity in the early bud stage and thereafter remained high. The winter crop reached a high level of activity without flowering. The first crop in the next season showed much lower (30%) activity than did the corresponding crop of the first season. The activity of forage fell considerably (up to 75% loss) during drying.
A. G. POLLARD.

Improvement of permanent pasture. R. B. Mair, S. C. Meadowcroft and C. H. Mudd (*Exp. Husbandry*, 1960, No. 5, 32—34).—Liming, harrowing and renovating with seeds resulted in little improvement as shown by determinations of dry matter, crude protein wt. and Ca and P contents of the herbage. E. M. J.

Effect of metabisulphite on the sugar content of ensiled orange peel. H. Neumark and J. Aspridis (*Empire J. exp. Agric.*, 1961, **29**, 49—50).—The sugar content of metabisulphite-treated silages is very much higher than that of untreated; some disaccharides remain in untreated silages, which are more acid. M. LONG.

Preparation and biological testing of a parenteral iron preparation. W. H. Linkenheimer, E. L. Patterson, R. A. Milstrey, J. A. Brockman, jun., and D. D. Johnson (*J. Anim. Sci.*, 1960, **19**, 763—768).—Details are given of the prep. of a dextrin–ferric oxide complex a weak ion-exchange resin (IR-45, OH^- form) being used to obtain the Fe oxide sol from $FeCl_3$. The product is suitable for parenteral administration in treatment of hypochromic anaemia in pigs.
A. G. POLLARD.

Production of isovaleric acid from leucine by *Bacteroides ruminicola*. H. A. Bladen, M. P. Bryant and R. N. Doetsch (*J. Dairy Sci.*, 1961, **44**, 173—174).—Experimental evidence indicates that this bacterium, acting on a casein hydrolysate, produces a factor (or factors) resembling isovaleric acid required by other rumen bacteria, e.g., *Ruminococcus albus*, effecting the decomposition of cellulose. Part at least, of this factor is derived from leucine. P. S. ARUP.

Rearing of calves on skim milk containing formalin. W. M. R. Evans and T. W. Vale (*Exp. Husbandry*, 1960, No. 5, 66—69).—Calves were fed on (*a*), a milk substitute consisting of dried skim milk (80), oat flour (20) and vitamins A and D supplement (1 part); this was mixed with water (1 lb. to 1 gal.) and fed at blood heat or (*b*), the dried skim milk was replaced by formalin (0·1%)-treated skim milk; oatflour (¼ lb.) and vitamin supplement (⅛ oz.) were added to each gal., and fed at blood heat. If the feeding of whole milk does not cease too soon, liquid skim milk containing 0·1% of formalin can be used satisfactorily for calf rearing. The cost is greater than that of rearing a calf on dried skim milk. E. M. J.

Consumption of sodium chloride [-containing] water by heifers. H. J. Weeth, L. H. Haverland and D. W. Cassard (*J. Anim. Sci.*, 1960, **19**, 845—851).—Presence of 1% of NaCl in drinking water for heifers increased water consumption by 53% and lowered blood-urea levels without affecting growth. With 2% of NaCl in the water severe toxic symptoms, loss of wt. and, in some cases, complete collapse occurred. Animals were revived by intravenous injection of Ca, Mg and glucose and by rumen infusion of water and nutrients.
A. G. POLLARD.

Turning out calves to grass in spring. M. V. Jackson, R. W. Shepherd, T. W. Vale and J. E. Whybrew (*Exp. Husbandry*, 1960, No. 5, 35—48).—The effect of turning out autumn-born calves gradually at an early date in their first spring, before the grass begins to grow, was studied. By letting them become gradually accustomed to their new environment, they were better able to utilise the spring grass and make a steady live-wt. gain throughout the grazing season. Calves turned out in late May show a fall in live wt. followed by a period when live wt. gains are negligible.
E. M. J.

Nitrogen metabolism in dairy cattle. I. Influence of grain and meadow crops harvested as hay, silage or soilage on efficiency of nitrogen utilisation. H. R. Conrad, J. W. Hibbs, A. D. Pratt and R. R. Davis (*J. Dairy Sci.*, 1961, **44**, 85—95).—No differences in N-efficiency are observed between hay and silage from legume–grass. Silage and freshly-cut meadow grass (soilage) are equally efficient at $<15\%$ of protein in the total ration, but whereas the relative N-efficiency of soilage remains constant with increasing protein levels, that of silage decreases. Grain added to all-forage rations increases the efficiency and decreases losses by urine; an increase of grain from 33 to 50% of the ration has no further effect. (15 references.) P. S. ARUP.

Part lactations. I. Age-correction factors for monthly milk fat yields. S. R. Searle (*J. Dairy Sci.*, 1961, **44**, 104—114).—Factors are calculated for Jersey cows in New Zealand to correct yields for the purposes of statistical comparisons and the estimation of genetic parameters of monthly production. Corrections for age are given as well as combined corrections for age and for the month in which calving occurs. The calving-month factor differs greatly for 2-year-olds, but not for 3- or 4-year-olds. Higher yields by comparatively long-milking cows are due not only to the longer period of lactation, but also to higher monthly yields commencing with the first month of lactation. (10 references.) P. S. ARUP.

Artificial induction of lactation in buffaloes. M. R. Shalash, A. A. Salama and M. El Guindi (*Empire J. exp. Agric.*, 1961, **29**, 45—48).—Lactation followed in one of two heifers given subcutaneous injections of Hexettes (hexoestrol–stilboestrol). This was maintained after an injection of oxytocic hormone. Lactation started in the other but was not maintained after the first day. The milk obtained was normal. M. LONG.

Effect of long-time feeding of chlortetracycline to dairy cattle. C. F. Foreman, N. L. Jacobson and A. E. Freeman (*J. Dairy Sci.*, 1961, **44**, 141—150).—Supplementation with 240 mg. of the drug per day during ≤ 15 months before calving increases the mean wt. by 44 lb. at 10 days after calving. The reproductive performances of the supplemented and control cows are practically equal; calves from the supplemented cows are slightly larger at birth. The only significant effect of the treatment on milk production is an increase in the fat (by $\sim 9\%$) in the first lactation. P. S. ARUP.

Influence of stilboestrol on pasture-fed Zebu steers and male suckling calves. L. R. Quinn, G. O. Mott and W. V. A. Bisschoff (*IBEC [Amer. int. Ass.] Res. Inst.* 1960, *Bull No.* **23**, 34 pp.).—Steers (2 years old) given implantations of stilboestrol (24 mg.) showed increase in wt. over controls, of 0·33 lb./day during 140 days of winter period and 0·44 lb./day during the 182 days of summer; 3-year steers gave similar results during summer. A single implant (24 mg.) was effective over a 9-month period in steers, 2 and 3 years old; a second implant (24 mg.) during this period gave no significant additional response. Under range conditions a single implant (24 mg.) during the winter period gave a carcass increase over controls of 36·4 lb./head. Male suckling calves given 12-mg. implants at 2—4 weeks of age gave an average increase of 13·7 lb./head over the paired controls in 6½ months. (10 references.)
E. M. J.

Sustained prevention of bloat by feeding antibiotics in rotation or in combination. R. H. Johnson, P. A. Hartman, N. L. Jacobson, L. R. Brown and H. H. van Horn, jun. (*J. Anim. Sci.*, 1960, **19**, 735—744).—In cattle grazing lucerne the period over which bloat was prevented by feeding antibiotics was increased when several antibiotics were fed together or in succession. In this way penicillin (**I**), erythromycin (**II**) and tylosin were particularly effective; chloramphenicol, novobiocin and oxytetracycline were less successful; neomycin and Spontin were of little value. Vancomycin increased bloat in some cases. **I** and **II** showed greater and more prolonged efficiency if used together than if given in rotation.
A. G. POLLARD.

Farm flock creep-feeding tests. D. J. Matthews and M. A. Madsen (*J. Anim. Sci.*, 1960, **19**, 852—858).—Chlortetracycline (10—20 mg./lb. of feed) had no effect on feed consumption or rate of gain in wt. of suckling lambs. Feeding rolled barley to the lambs caused some digestive disturbances. Addition of rolled barley to a ration which included lucerne hay for ewes did not improve the growth rate of the lambs. A. G. POLLARD.

Selective grazing by sheep of two forage species at different stages of growth. G. W. Arnold (*Aust. J. agric Res.*, 1960, **11**, 1026—1033).—Sheep in grazing lucerne or *Phalaris tuberosa*, continuously selected leaf in preference to stem where available, and, of both leaf and stem fractions, material of highest N content was chosen. These selection preferences were shown more strongly the greater the amount of material present per unit area. The process of eating off in a horizontal plane together with selection in a vertical plane is discussed. E. M. J.

Effect of quantity and quality of pasture available to sheep on their grazing behaviour. G. W. Arnold (*Aust. J. agric. Res.*, 1960, **11**,

1034—1043).—Plots of *Phalaris tuberosa*–subterranean clover with a range of levels of pasture availability were grazed by 12, 16, 20 and 24 sheep/acre. As the amount of available pasture decreased, the N content of available material, and in the diet selected by oesophageal-fistulated sheep increased significantly. Grazing time increased linearly but live wt. was not maintained. Differences were observed between sheep in ability to increase grazing times as pasture availability decreased. Practical implications are discussed.
E. M. J.

Availability of copper to sheep from ^{64}Cu-labelled inorganic compounds. J. W. Lassiter and M. C. Bell (*J. Anim. Sci.*, 1960, **19,** 754—762).—Following oral administration to sheep the concn. of ^{64}Cu in blood and plasma was greater when the chloride than when the sulphate, nitrate or oxide was used. Urinary and faecal excretions were similar from the three salts and exceeded those from the oxide. Comparison of oxide and carbonate showed the former to cause the greater faecal excretion whereas the latter induced the higher blood contents and greater urinary excretion of ^{64}Cu. Following intravenous injection, the urinary excretion of ^{64}Cu was greater from the chloride than from the other sources. The bearing of the observations on supplementary feeding of sheep grazing Cu-deficient pasture is considered. A. G. POLLARD.

Hormone implantation in lambs. C. H. Mudd and R. B. Mair (*Exp. Husbandry*, 1960, No. 5, 70—76).—Weaned lambs treated with hexoestrol showed increased live-wt. gains; lower killing-out % compared with controls and a tendency to produce a leaner carcass.
E. M. J.

Value of cross breeding for pork and bacon production. The first cross. W. M. R. Evans, T. W. Vale, A. C. Owers and J. R. Proud (*Exp. Husbandry*, 1960, No. 5, 77—85).—There was a general tendency for the growth rate of cross-bred pigs to be higher than that of pure-bred animals. In food conversion for the period 60—120 lb. live wt. there was no difference between cross-bred and pure-bred pigs but when the feeding period was continued up to bacon wt. the very slight advantage was in favour of cross-bred pigs. Cross-bred vigour had little effect on carcass conformation. E. M. J.

Rôle of cereal fat in the production of nutritional disease in pigs. B. Thafvelin (*Nature, Lond.*, 1960, **188,** 1169—1172).—The occurrence of hepatosis diaetetica (dietetic liver necrosis) and muscular degeneration, forms of nutritional disease giving rise to lesions in pigs fed chiefly on grain, can be coupled with the properties of the cereal fat present. The effects of feeding grain, containing fats of great susceptibility to rancidity, those which had spontaneously oxidised during storage, fresh and rancid vegetable oils, were considered. Grain containing unstable or highly oxidised fats can produce lesions but stabilisation of the fat by preheating reduces this tendency. (17 references.) G. W. DOUGLAS.

Stabilised white grease and maize oil in the diet of baby pigs. J. M. Asplund, R. H. Grummer and P. H. Phillips (*J. Anim. Sci.*, 1960, **19,** 709—714).—White grease or maize oil was used to replace part of the maize in the normal ration (protein/energy ratio constant) for young pigs. The grease-containing ration did not affect the gain in live wt., feed efficiency or energy conversion. The maize oil ration produced slower growth, lower feed efficiency and high I value and saponification val. in the body fat. Both experimental rations increased the blood-fat level, the fat content of the shoulder and lowered the sp. gr. of the carcass. Inclusion of 10 or 20% of grease in rations for 8-week pigs raised the apparent digestibility of the ether extract and protein fractions. A. G. POLLARD.

Enzyme supplementation of baby pig rations containing different sources of carbohydrate and protein. G. E. Combs, W. L. Alsmeyer, H. D. Wallace and M. Koger (*J. Anim. Sci.*, 1960, **19,** 932—937).—Feeding enzyme supplements (diastase, pepsin, pancreatin) separately or in combination, tended slightly to increase feed efficiency, though not significantly. A. G. POLLARD.

Soya-bean oil-meal as a protein source for successive generations of swine. H. S. Teague and E. A. Rutledge (*J. Anim. Sci.*, 1960, **19,** 902—909).—Rations containing all-plant protein or plant + animal protein were fed to pigs through four generations. Breeding performance and the growing-finishing development were unaffected by the type of ration. Wt. and vigour at birth tended to be greater and late pre-natal mortality less with the plant + animal protein source. A. G. POLLARD.

Carcass characteristics of swine as influenced by levels of protein fed on pasture and in dry lot. D. B. Hudman and E. R. Peo, jun. (*J. Anim. Sci.*, 1960, **19,** 943—947).—Pigs receiving rations containing 12 or 14% of protein in dry lot produced greater gains in wt. and also required more food per unit gain than did those on pasture. Neither rate of growth, feed conversion nor the principal carcass characteristics showed significant differences due to level of dietary protein. A. G. POLLARD.

Effects of dietary levels of protein and lucerne meal and of antibiotic supplementation on growth, feed efficiency and carcass characteristics in swine. J. W. Stevenson, R. J. Davey and R. L. Hiner (*J. Anim. Sci.*, 1960, **19,** 887—897).—Increasing the proportions of lucerne in pig rations from 4 to 28% lowered the growth rates and feed efficiency and, in the carcasses diminished the dressing %, thickness of back fat, total fat content % and bacon thickness. The effects were similar whatever the stage of growth at which the additional lucerne was given. Use of 18% as compared with 14% of protein in the ration increased feed efficiency, and yield of preferred cuts; carcass grading was improved, and thickness of back-fat and total fat % were diminished. Chlortetracycline (5·4 mg./lb. of ration) decreased back-fat thickness and increased feed consumption, the effects being limited to animals $>$125 lb. live-wt. A. G. POLLARD.

Effect of spiramycin on growth and feed utilisation of young pigs. V. W. Hays and V. C. Speer (*J. Anim. Sci.*, 1960, **19,** 938—942).—Growth rates and feed efficiency increased with the level (0—50 g./ton) of spiramycin (**I**) in the ration. Differences in responses to **I,** chlortetracycline and oxytetracycline, each at the 50 g. level, were not significant. A. G. POLLARD.

Effect of oleandomycin on performance of young growing pigs. J. A. Hawbaker, F. Diaz, V. C. Speer, V. W. Hays and D. V. Catron (*J. Anim. Sci.*, 1960, **19,** 800—802).—Addition of oleandomycin (**I**) (up to 10 mg./lb. of feed) to the ration for 13-day old pigs, increased growth rates (up to 44%) and improved feed conversion (up to 25%). For 50-day-old pigs the best response (6·9% wt. and 7·2% conversion) was obtained with 5 mg. of **I** per lb. of feed.
A. G. POLLARD.

Effects of stilboestrol and a combination of progesterone and oestradiol on growing-finishing swine. B. N. Day, S. E. Zobrisky, L. F. Tribble and J. F. Lasley (*J. Anim. Sci.*, 1960, **19,** 898—901).—Subcutaneous implants of stilboestrol (6 mg.) or of progesterone (**I**) (167 or 500 mg.) + oestradiol (**II**) (3.3 or 10 mg.) respectively did not affect growth rates significantly. The average depth of back-fat was diminished by the **I** + **II** implants. A. G. POLLARD.

Controlled feeding of laying chickens. D. H. Sherwood and T. T. Milby (*Poultry Sci.*, 1961, **40,** 80—86).—Mechanically limiting feed intake had no significant effect on egg production. Feed required per dozen eggs was lower when feed was limited than when birds were full-fed a high-energy feed. Financial returns were better when a medium-energy feed was full-fed than when a high-energy feed was full-fed or restricted. In two of three tests hatchability was slightly better with limited than with full feeding.
A. H. CORNFIELD.

Response of chickens to temperature and ventilation environments. R. P. Prince, L. M. Potter and W. W. Irish (*Poultry Sci.*, 1961, **40,** 102—108).—Feed consumption by chicks from 4 to 8 weeks of age decreased with increasing temp. (7·2—23·9°) and with decreasing ventilation rate (2 to 0·75 cu. ft. per min. per bird). Neither temp. nor ventilation rate had any significant effect on wt. gains. Feed efficiency increased with temp. A. H. CORNFIELD.

Range versus confinement for growing turkeys. T. T. Milby (*Poultry Sci.*, 1961, **40,** 46—50).—The wt. gains of turkeys to 27 weeks on grass–lucerne range averaged 1·69 lb. and 0·90 lb. less for toms and hens respectively than did gains for birds reared in confinement (pole-type shelters, 5·5 sq. ft. per bird). Feed saving due to range feeding was 7·9%. A. H. CORNFIELD.

Influence of and interactions between feeder and water allowance, sex, and crossbreed on broiler performance. P. B. Siegel, H. S. Siegel, C. Y. Kramer and C. E. Howes (*Poultry Sci.*, 1961, **40,** 201—206).—Broilers made better wt. gains and showed higher feed efficiency during late autumn than during summer. Wt. gains were not affected by variations in waterer space (0·5 or 1·0 in. per bird). Wt. gains increased with feeder space (1·5 in. to 3 weeks and 3·0 in. thereafter to 1·8 in. to 3 weeks and 3·75 in. thereafter). Males and females responded similarly to the treatments. Feeder–breed and feeder–water interactions were significant in most tests.
A. H. CORNFIELD.

Absorption of glucose and xylose from the mouth and crop of the chicken. D. Soedarmo, M. R. Kare and R. H. Wasserman (*Poultry Sci.*, 1961, **40,** 123—128).—Glucose was absorbed readily from the ligated crop, whilst xylose was not absorbed in appreciable amounts. Radioactivity was detected in the circulatory system after labelled glucose was introduced into the crop, but not after introduction of labelled xylose. Both sugars were absorbed from the mouth. The results are discussed in relation to taste preference data where xylose was actively rejected and glucose accepted.
A. H. CORNFIELD.

Effect of adding enzymes to barley diets at different ages of pullets on laying-house performance. L. R. Berg (*Poultry Sci.*, 1961, **40,**

34—39).—The addition of a bacterial enzyme prep. to diets containing 65—78% barley increased the wt. gains of pullets to 8 weeks of age but not from 8 to 21 weeks of age. The treatment had no effect on rate of lay, feed efficiency with respect to egg production, egg wt., Haugh units, sp. gr. of eggs, hatch of fertile eggs or livability of birds. The treatment improved the condition of the litter. A. H. CORNFIELD.

Paper electrophoresis and albumin/globulin ratios of the serum of normal chickens and chickens fed free gossypol in the diet. R. Narain, C. M. Lyman, C. W. Deyoe and J. R. Couch (*Poultry Sci.*, 1961, **40,** 21—25).—Addition of 0·1% of free gossypol (pigment gland) to a practical diet for chicks to 6 weeks of age resulted in poor growth, reduction in total serum protein and a disproportionate decrease in serum-albumin. Addition of 0·1% of free gossypol to chick diets containing varying levels of protein resulted in reduced serum-albumin/globulin ratios at 4 weeks of age with diets containing 17—21% of protein, but not with the diet containing 42% of protein. A. H. CORNFIELD.

Water-soluble growth-promoting factor(s) in soya-bean oil-meal. R. A. Wilcox, C. W. Carlson, W. Kohlmeyer and G. F. Gastler (*Poultry Sci.*, 1961, **40,** 94—102).—Water extraction of soya-bean oil-meal removed material which increased growth rates of poults receiving an isolated soya-bean protein diet. The increased growth appeared to be due to both org. and inorg. components. The active material was not extractable by acetone or ethanol. Thioctic acid (1 g. per 100 lb. feed) had no effect on growth rate of birds. A. H. CORNFIELD.

Serum alkaline-phosphatase response to the injection of thyroxine in young chickens. T. Tonoue and K. Matsumoto (*Poultry Sci.*, 1961, **40,** 206—212).—The rapid rise in serum alkaline-phosphatase activity normally occurring in birds for 10—12 days after hatching was prevented by injection of thyroxine (10 μg. per 100 g. body wt.) every other day. Renal alkaline-phosphatase activity responded similarly, except that there was a slight decrease shortly after injection of thyroxine. A. H. CORNFIELD.

Rôle of zinc in the nutrition of growing pullets. M. M. Rahman, R. E. Davies, C. W. Deyoe, B. L. Reid and J. R. Couch (*Poultry Sci.*, 1961, **40,** 195—200).—Zinc-deficiency symptoms were produced in chicks fed a purified soya-bean protein basal diet containing 14 p.p.m. A no. of physical symptoms are described. In addition deficient birds showed a high rate of respiration and consumed less feed and water and showed a reduction in growth and feed efficiency. Changes in blood cell and serum constituents are also reported. Deficient birds showed delayed sexual maturity. Addition of Zn (20 p.p.m.) to the deficient diet prevented all symptoms of deficiency. Addition of 40 p.p.m. was no more effective and was not toxic. A. H. CORNFIELD.

Effects of soft phosphate and dicalcium phosphate on reproductive performance and egg quality. T. A. Crowley, M. W. Pasvogel, A. R. Kemmerer, M. G. Vavich and A. A. Kurnick (*Poultry Sci.*, 1961, **40,** 74—80).—Addition of 0·3% of P as soft phosphate or $CaHPO_4$ to a basal practical diet, containing 0·41% of total P, had no effect on egg production, feed conversion or hatchability of fertile eggs. Haugh units and the incidence of blood spots were significantly higher in eggs from birds fed the basal diet and that supplemented with soft phosphate. The treatments had no significant effect on bone ash. A. H. CORNFIELD.

Inhibition of the bursa of Fabricius and the stilboestrol-stimulated oviduct of the domestic chick. M. X. Zarrow, D. L. Greenman and L. E. Peters (*Poultry Sci.*, 1961, **40,** 87—93).—Steroids with known activity in the mammal were examined for effectiveness in the chick using the involution of the bursa of Fabricius and the inhibition of the stilboestrol-induced growth of the oviduct. Progesterone (**I**), 17α-hydroxyprogesterone (**II**), hydrocortisone acetate (**III**), 11-deoxycorticosterone acetate (IV), 11-deoxy-17-hydroxycorticosterone (**V**), testosterone (**VI**) and ethynyltestosterone (**VIII**) were effective inhibitors of stilboestrol-stimulated growth of the oviduct, while cortisone acetate (**IX**), 6α-methyl-17α-hydroxyprogesterone acetate (**X**) and both the caproate (**XI**) and acetate (**XII**) of 17α-hydroxyprogesterone were ineffective or only slightly active. **III, IV, V, VI, IX, X,** corticosterone, 17α-ethyl-19-nortestosterone and oestradiol induced marked involution of the bursa of Fabricius, whilst **I, II, XI** and **XII** had no effect. A. H. CORNFIELD.

Effect of reserpine on immersion hypothermia in the hen. H. S. Weiss (*Poultry Sci.*, 1961, **40,** 64—67).—Feeding White Leghorn hens with reserpine (0·0016 g. per kg. feed) for 14 weeks had little effect on body wt., reproductive activity, blood pressure, pulse rate or respiratory rate, but depressed body temp. by 0·6°. After subjection of the birds to immersion hypothermia in water at 15° differences in body temp. between treated and control birds disappeared. There were no significant differences in survival time, body temp. at death or in rate of cooling. A. H. CORNFIELD.

Changes in blood calcium associated with egg shell calcification in the domestic fowl. I. Changes in total calcium. F. Hertelendy and T. G. Taylor. **II. Changes in diffusible calcium.** T. G. Taylor and F. Hertelendy (*Poultry Sci.*, 1961, **40,** 108—114, 115—123).—I. Birds on a normal-Ca (2%) diet showed a fall in total plasma-Ca during shell calcification. When birds on the low-Ca (<0·1%) diet laid two eggs during a 48-h. period there was a progressive fall in blood-Ca and thinning of the egg shell. When the deficient diet was fed for only 24 h. most birds showed a small but significant rise in blood-Ca after oviposition compared with the level during shell formation.

II. Shell calcification was associated with a fall in diffusible plasma-Ca of 0·0001—0·0026 g. per 100 ml. and a decrease in total Ca. Decreases in total plasma-Ca levels of more than 0·002 g. per 100 ml. were associated with decreases in non-diffusible Ca levels, but small decreases in total Ca during shell calcification were frequently associated with increases in non-diffusible Ca. The low-Ca diet accentuated the changes in blood Ca associated with shell formation and after 48 h. on this diet very large decreases in total, diffusible and nondiffusible Ca occurred during shell calcification. Results are discussed in relation to changes in the medullary bone during the laying cycle. A. H. CORNFIELD.

Developing chick embryo lethal response to dose variation of 2-ethyl-5-methylbenziminazole. U. B. Blackwood (*Poultry Sci.*, 1961, **40,** 3—9).—When responses to doses of 2-ethyl-5-methylbenziminazole were based on dose per embryo the results indicated that the embryo became increasingly sensitive up to 2 days of incubation and thereafter became increasingly resistant. Dose response data based on " concentration " of inhibitor in embryonic tissue showed that the embryo became increasingly susceptible to the inhibitor up to 8 days, but at a decreasing rate. Embryonic genetic differences influenced the lethality of the inhibitor at 0—1·5, but not at 2—3, days of incubation. A. H. CORNFIELD.

Relation of semicarbazide, nitrofurazone and related compounds to β-aminopropionitrile toxicity in turkey poults. D. N. Roy, S. H. Lipton, H. R. Bird and F. M. Strong (*Poultry Sci.*, 1961, **40,** 55—60).—High mortality occurred when 0·06% nitrofurazone (**I**) or furazolidone (0·6% in the ration) was fed to turkey poults for 4—5 weeks; 0·03% caused slight toxicity, whilst lower levels were not toxic. β-Aminopropionitrile fumarate (**II**) (0·04%) caused high toxicity whilst 0·02% did not; 0·02% each of **I** and **II** also caused high toxicity. 4,5-Dioxovaleronitrile-5-semicarbazone was non-toxic when fed at 0·005—0·01% levels and was slightly toxic at 0·03%. Semicarbazide hydrochloride (**III**) at 0·03% and 0·045% produced symptoms characteristic of intoxication due to **II**. The toxicity of **III** at 0·045% was not markedly reduced by feeding pyridoxine hydrochloride (0·2%). A. H. CORNFIELD.

Dressing and cooking losses, juiciness and fat content of poultry fed cereal grains. I. Beltsville White turkeys. G. E. Goertz, A. S. Hooper, P. E. Sanford and R. E. Clegg (*Poultry Sci.*, 1961, **40,** 39—45).—Dressing losses for turkeys fed oats were significantly higher than those fed wheat or sorghum grain. Thawing losses were not affected by feed but increased with storage up to 12 months at −16·6°. Total and dripping losses for fresh frozen turkeys, but not for those stored for 6 months, were higher for turkeys fed maize or wheat than for those fed sorghum grain or oats. Juiciness scores for dark (thigh) meat were higher for birds on maize or wheat than for those on oats. Intramuscular fat (ether extract) in the thigh was higher for toms fed maize or wheat than for those fed oats. A. H. CORNFIELD.

Comparison of Ronnel, Dowco 109 and Dowco 105 for systemic control of cattle grubs in Alberta. J. Weintraub and C. O. M. Thompson (*J. econ. Ent.*, 1961, **54,** 79—84).—A simple oral treatment with Dowco 109 (*O*-4-t-butyl-2-chlorophenyl *O*-methyl methylphosphoramidothioate) or Dowco 105 (the ethylphosphoramidothioate analogue) against the combined instars of hypodermal and internal larvae was more effective than Ronnel. Subcutaneous and intramuscular injections of emulsions and solutions were compared. As a low-level feed additive, both compounds were as effective as Ronnel. The natural variation between animals in relation to the build-up and degradation of insecticide is discussed. Some cows showed lack of muscular co-ordination resulting from subcutaneous injection of Dowco 109 or Ronnel at 15 mg./kg. (19 references.) C. M. HARDWICK.

Control of cattle grubs and horn flies by summer dipping with Co-Ral. J. S. Simco and J. L. Lancaster, jun. (*J. econ. Ent.*, 1961, **54,** 208—209).—Three dips in a 0·25% Co-Ral solution gave excellent control of *Hypoderma* spp. in spite of heavy rain. Control of *Siphona irritans* was effective for 3 weeks. C. M. HARDWICK

Field tests with new cattle grub systemics. A. R. Roth and G. W. Eddy (*J. econ. Ent.*, 1961, **54,** 203—204).—Sprays of Bayer 29493

(*OO*-dimethyl *O*-(4-methylthio-*m*-tolyl) phosphorothioate) (0·25%), Ruelene (0·5—1·0%), Co-Ral (0·5%) and Bayer 22408 (*OO*-diethyl *O*-naphthalimido phosphorothioate) applied at the rate of 1 gal. per animal showed efficiencies of control of *Hypoderma* spp. which diminished in the order named. C. M. HARDWICK.

Thiazole compounds. Merck & Co. Inc. (B.P. 835,599, 1.5.57. U.S., 14.5.56).—The *Me* and *Et* esters (m.p. 249—251° and 196—197° respectively of 5-*nitrothiazol*-2-*ylcarbamate* are claimed as effective in the treatment and prevention of turkey blackhead infections. For their prep., $Cl{\cdot}CO_2Et$ is interacted with 2-aminothiazole in benzene and the *Et thiazol*-2-*ylcarbamate*, m.p. 155—156°, formed nitrated in conc. H_2SO_4 solution. F. R. BASFORD.

2.—FOODS

Carbohydrate Materials

Cereals, flours, starches, baking

Biochemical changes in grains. W. H. Hastings and G. D. Miller (*Cereal Sci.*, 1961, **6**, 6—8).—The chemical and physical effects of processing were investigated. Sorghum grain and maize were roll-cracked, hammermill-ground, steam-crimped and pelleted, then analysed. Gas production, total solubles, reducing sugars and sol. starch were highest in pelleted and lowest in steam-crimped grains. Statistical analysis showed that the pelleted material is significantly greater in these values and steam-crimped material significantly lower in total solubles and sol. protein than other processed grains. The sol. protein component for pelleted material was less than for whole material and greater than for steam-crimped material. I. DICKINSON.

Retrogradation of boiled rice. N. Ozaki (*Nippon Nōgei Kagaku Kaishi*, 1960, **34**, 1054—1057).—Retrogradation of starch in boiled rice was studied by artificial digestion with enzyme (Japanese Pharmacopoeia diastase) and with an *X*-ray diffractometer. The lowering of digestibility due to storage was more marked at 2° than at 16°, and more marked when less water was used for cooking. The tests included various kinds of rice (non-glutinous and glutinous, japonica and indica) and some additives (NaCl, AcOH, sucrose, Tween 60, Na hexametaphosphate and soya-bean oil). The retrogradation was observed earlier in the centre than in the outer part in case of canned boiled rice. S. KAWAMURA.

Lower saccharides of maize: fluctuations in content during storage. K. Täufel, J. Steinbach and B. Hartmann (*Nahrung*, 1960, **4**, 452—465).—The presence of sucrose, raffinose, glucose and fructose is confirmed by paper-chromatographic analysis for three types of maize; glucodifructose is found in sweet maize. The content of fructose and (especially) of glucose decreases during normal storage, whilst that of sucrose increases; an overall loss of ~0·5% is observed. Storage at unduly high temp. and R.H. increases the overall loss to ~1%, which in this case includes a loss of sucrose. Germination is accompanied by a rapid disappearance of the raffinose, fluctuations in the sucrose content, and the formation (for the first time) of maltose. The physiological and technical aspects of these findings are considered. (10 references.) P. S. ARUP.

Oat lichenin and its quantitative determination. E. Letzig (*Nahrung*, 1960, **4**, 832—845).—Earlier methods for the determination of oat lichenin, an indigestible glucosan of mechanical-functional importance in digestion, are discussed. A method is described consisting of a preliminary heating of the finely-crushed material for 1 h. at 150° to inactivate enzymes, followed by boiling with water, digestion with pepsin hydrochloride and pancreatin, and pptn. of the lichenin from the solution with an equal vol. of petroleum-denatured ethanol. The ppt. is boiled with acid for 6 h. and the resulting dextrose determined as usual. Results obtained show amounts of 2·5% and higher in the dry matter of the husked oats. Manufacture of oat flakes results in no loss of lichenin, nor does the usual hot kitchen cooking of the flakes. The method appears suitable for application to similar carbohydrates in other cereals. C. L. HINTON.

Total nitrogen in wheat. Examination of the scatter of analytical results. P. Navellier and J. Alegre (*Ann. Falsif., Paris*, 1960, **53**, 542—551).—The causes of discrepancies in N content of various wheats, obtained by different laboratories, when using the Kjeldahl method are discussed. The variation in results due to the method is studied by using $(NH_4)_2SO_4$ and tryptophan as reference substances. Chief variations appear to be caused by heterogeneity of the wheat samples. These can be reduced by more efficient grinding of the wheat, by taking larger assay samples and by increasing replication. J. V. RUSSO.

Detection of rice flour in wheat flour. H. Ludwig (*Dtsch. Lebensmittlrdsch.*, 1960, **56**, 353—354).—The microscopical detection of rice by the appearance of its compound starch granules in prep. in water and chloral hydrate (80 parts in 50 parts of water) is described. E. C. APLING.

Chromatography of the proteins from wheat flour soluble in acetic acid. D. H. Simmonds and D. J. Winzor (*Nature, Lond.*, 1961, **189**, 306—307).—Acetic acid extracts from 12 Australian flours, containing 55—60% of the total protein N, were separated into six components by gradient elution from a carboxymethyl-cellulose column. The initial eluting solvent was 0·005M-NaOAc containing 1·0M dimethyl formamide; NaCl was gradually added to a final concn. of 1·0M and then Na_3PO_4 to a final concn. of 0·005M. (12 references.) S. A. BROOKS.

Effect of extraction rate on the digestibility of rye flour products. J. Bartnik (*Nahrung*, 1960, **4**, 42—51).—The digestibility of the nutritional constituents of 10 flours and four brans of varying extraction rates from a single lot of Polish rye was tested on rats, and the results are discussed in relation to the known analyses of the materials. The coeff. of digestibility in general decreased with rising extraction rate, particularly for fats. In spite of this, the content of digestible fat and protein increased in the flours up to 70% extraction. Regressions between digestibility coeff. and crude fibre content were calculated, and equations are proposed for calcu lating digestibility coeff. of the nutritional constituents from crude fibre content. (14 references.) C. L. HINTON.

Brix factors for determining the solids in starch hydrolysates. W. R. Fetzer and L. C. Kirst (*J. agric. Fd Chem.*, 1960, **8**, 507—510).—Readings by the Brix hydrometer on starch hydrolysates over-estimate the solids, the amount of error increasing as the amount of reducing sugars decreases. The ash of a starch hydrolysate is largely NaCl, which affects the Brix reading more than an equal wt. of syrup solids. Observed Brix values may be converted into true solids by correcting for NaCl as determined by titration with $AgNO_3$. Tables are given for ascertaining the dextrose equivalents of syrups from Brix readings corrected for salts, and Lane and Eynon titrations for reducing sugars. M. D. ANDERSON.

Rôle of disulphide exchange reactions in the relaxation of strains introduced in dough. R. Frater, F. J. R. Hird and H. J. Moss (*J. Sci. Fd Agric.*, 1961, **12**, 269—273).—The rates of relaxation in dough after development of internal strains during mixing were studied. In presence of iodate and *N*-ethylmaleimide such strains relax more slowly; disulphide exchange reactions are prevented or the effect of these reagents is to stabilise the strained structure of the dough produced during shaping. The effect of added thiol groups (cysteine) is not to prevent the introduction of strains but relaxation is quicker than that in controls. These reactions are discussed, e.g., reducing agents increase the rate of relaxation and decrease the strength of the dough, while oxidising agents (improvers) tend to abolish not to enhance the rate-limiting disulphide exchange reactions. (10 references.) E. M. J.

Studies on dough products. III. K. Braunsdorf (*Nahrung*, 1960, **4**, 619—649).—The change on storage (e.g., 1—18 months or more) of the "direct-ether extract" (**I**) and the "titration value" (**II**) according to the method of Strohecker *et al.* is discussed. Data are given on many egg-dough products for **I** and for "decomposition ether extract" (**III**). **III** gives values which are reproducible and independent of storage time, in contrast with methods in which the egg substance is extracted without decomp. and subsequently determined, e.g., as lecithinphosphoric acid or cholesterol. Average and min. values for **III** and average and max. values for **II** of the various egg-dough products are listed. E. M. J.

Bakers' yeast lyophilised or dried over bentonite; survival and conservation of fermentary and respiratory systems with time. P. Brechot and M. Croson (*C. R. Acad. Sci., Paris*, 1961, **252**, 215—217).—Previous measurements (*idem., ibid.*, **247**, 539) were extended to include storage for 2 years (dried yeast) (**I**) and 5 years (lyophilised yeast) (**II**). Rates of survival and conservation of enzyme systems decrease uniformly; after 2 years **II** has retained its activity better than **I**, "*Mist. dessicans*" being more effective than beer-wort up to 5 years. Survival of **I** is controlled by residual water content (W); when $W = 2{\cdot}5$—4 rates of survival and conservation of fermentary and respiratory systems are high, but with $W < 4$ (**I**, or **II** treated with beer-wort plus ascorbic acid) these rates are much reduced. Conservation rates are lowered much more rapidly than survival rates, the respiratory system (O_2 absorption) being destroyed first especially during drying. W. J. BAKER.

Biochemical differentiation of saccharide mixtures by means of pressed yeast. II. Separation of model mixtures. K. Täufel, H. Ruttloff and E. Przyborowski (*Nahrung*, 1960, **4**, 512—527).—The previously observed acceleration of the fermentation of maltose by

yeast due to the presence of readily fermentable sugars (cf. *Ernährungsforschung*, 1960, **5**, 417) is not caused by any decrease in the pH, which remains constant within 0·1 unit. Sucrose can be determined with max. errors of +1·3 to −2·8% in presence of maltose, lactose, glucose and fructose by preferential hydrolysis with citric acid (1%) during 30 min. at 100°. Maltose and lactose can be separated from the more readily fermentable sugars by the action of yeast (5 g. per 100 ml.), provided that the fermentation time is ⩾15 min. Lactose, however, is not affected by prolonging the time to 30 min. For mixtures of maltose and glucose, the max. errors for maltose are +1·9 to −2·5%, but in presence of fructose and/or sucrose the errors are larger if the concn. of these sugars is >100 mg. per 100 ml.
P. S. Arup.

Biochemical study of baking. S. Nishimura, R. Hirai and H. Tokunaga (*Nippon Nôgei Kagaku Kaishi*, 1960, **34**, 1013—1016).—Soluble components of flour were analysed after the baking process. The sugar increased slightly when wheat flour and water only were baked, because of the enzymes in the flour. About 1·0 g. of sugar per 100 g. of flour was fermented by yeast to give a loaf volume similar to that from an ordinary mixture containing no added sucrose. Thus the amount of sugar contained in flour is sufficient as far as the volume of the loaf is concerned. During fermentation, about half of the amino-N was assimilated by yeast. During baking the materials were brought to the optimum temp. of various enzymes, though only for short times; the soluble components of bread therefore increased. Some of the protein was coagulated by baking and the soluble N decreased considerably. Pancreatin and trypsin were different in their behaviour to gluten and more experiments are necessary to select a suitable protease for use in baking. Malt amylase was ineffective in baking. Bacterial β-amylase accelerated considerably saccharification and dextrinisation of starch at concn. of only 0·002%. A small volume increase was noted on addition of 0·06% of Na monoglutamate.
S. Kawamura.

Effect of biochemical properties of grain on the baking value of rye flour. E. Kamiński (*Roczn. Technol. Chem. Żywności*, 1960, **5**, 69—79).—The connexion between protein content of grain and yields of bread was investigated in 11 samples of Polish-grown rye. The proteolytic activity of grain decreased with the increase of protein content, but the effect of climatic conditions, i.e., the harvest year, on this activity was more pronounced than that of protein content. The amylolytic activity was greater in the rye grain containing more protein, but the relation was difficult to establish. Rye grain of high proteolytic activity usually showed low amylolytic activity. Greater vol. of bread was obtained from grain of a relatively lower amylolytic and higher proteolytic activity. The rye grain of 1952 harvest had generally a higher baking value than that of 1953 harvest. The essential criteria of bread baking properties consisted of the biochemical evaluation of the carbohydrate amylose and the albumin proteolytic complexes. The high protein content of the rye grain had no detrimental effect on the vol. of bread output in a properly controlled dough fermentation process. (26 references.)
A. L. Grochowski.

Treatment of grain and composition therefor. Dow Chemical Co. (Inventor: E. E. Kenaga) (B.P. 836,016, 3.7.56).—Grain infested or infected with bacteria, moulds, roundworms, nematodes or insects, is fumigated by exposure to a composition comprising SO_2F_2 and a supplementary toxicant, viz., ethylene bromide, CCl_4, propylene oxide, *iso*propyl formate, HCN, trichlorobromoethane, acrylonitrile, CS_2, trichloroethylene, tetrachloroethylene, propylene dichloride, methyl bromide, chloropicrin, SO_2 or 2,2′-dichlorodiethyl ether. The amount of composition employed should be sufficient to provide ⩽0·1 lb. of SO_2F_2 per 1000 cu. ft. of space occupied by the grain.
F. R. Basford.

Aqueous dispersions of gluten and of dry vital gluten therefrom. P. J. Ferrara (B.P. 837,080, 11.7.58).—Wheat gluten is admixed with an aq. solution pH 2—4·5, containing HCO_2H and preferably alkali metal formate (1—15 pt. per pt. of HCO_2H), to provide a stable aq. dispersion. This may be dried, in the form of dispersed droplets, in air or other inert gas at ⩾120° (during ⩾5 sec.), to give a stable, dry product, suitable for fortifying flour deficient in gluten.
F. R. Basford.

Hydrolysis of starch. A.-B. Separator (B.P. 836,764, 30.10.58. Swe. 30.10.57).—Hydrolysis of starch (to give, e.g., glucose of high purity) is effected by passing an aq. suspension (pH 1·7, 22° Bé) thereof continuously through a rotating chamber whose wall is heated externally, then heating the discharged suspension in a closed vessel at >100°.
F. R. Basford.

Sugars and confectionery

Sugars of locust (carob) bean tree fruits. H. Tinner (*Mitt. Lebensm. Hyg., Bern*, 1960, **51**, 366—372).—Carob syrup was qual. and quant. analysed by chromatographic methods to determine the sugar content. Xylose, fructose, glucose, sucrose and two unknown disaccharides were found. (21 references.)
J. V. Russo.

Luff–Schoorl method for the determination of sugar. A. J. Weide (*Fruchtsaft-Industr.*, 1961, **6**, 25—27).—A modified method by Tanner (J.S.F.A. Abstr., 1960, i, 299) was tested. It is suggested that the Luff–Schoorl tables used were incorrectly interpreted which leads to a higher error than expected. Analytical results are given.
I. Dickinson.

Reply to the publication by A. J. Weide regarding the determination of sugar by Luff–Schoorl. H. Tanner (*Fruchtsaft-Industr.*, 1961, **6**, 28—29).—It is pointed out that the method was developed for the factory floor where neither gas nor water was available and that the method is correct if carried out with the amounts stated. A mistake in the interpretation of the Luff–Schoorl tables had been made, but this is irrelevant as different tables had been worked out and given.
I. Dickinson.

Determination of pectic substances by paper chromatography. R. M. McCready and M. Gee (*J. agric. Fd Chem.*, 1960, **8**, 510—513).—The question whether pectin is a pure galacturonan mixed with araban and galactan, or whether the so-called galacturonan is a complex carbohydrate containing some non-uronide sugars, was investigated on pectic substances from several sources. Apricot pectin has a low content of anhydrouronic acid, and four non-uronide sugars were obtained by partial hydrolysis; these were separated by thick-paper chromatography, and identified by their *X*-ray powder diagrams as arabinose, galactose, rhamnose and xylose. Apricot polysaccharides yielded two widely different mol. species of polymers containing galacturonic acid, (i) a Cu-sol. material with 18·6% of anhydrouronic acid, an intrinsic η of 0·86, and a low mol. wt., and (ii) a Cu-insol. material with 76% of anhydrouronic acid, an intrinsic η of 2·66, and a high mol. wt. Pectins from citrus fruits, figs, apples, peaches, pears, avocados, sugar beet, carrots and pea pods all yielded arabinose, galactose and rhamnose, and xylose was found in all except the citrus fruits, figs and carrots. (24 references.)
M. D. Anderson.

Comparison of methods of determining "pectic" substances. L. Davignon (*Fruits d'outre mer*, 1960, **15**, 469—472).—Three methods of determining "pectic" substances are compared. The reference method consists in determining the Ca in the pptd. Ca pectate. Two other methods giving very close results are: (i) an acidimetric method using a glass electrode in the titration of the pectic acids and (ii) a colorimetric method whereby colour intensity of the carbazol–pectic acid complex is measured at 520—570 mμ on a Bonnet–Maury colorimeter. (14 references.)
J. V. Russo.

Examination and estimation of foreign honey based on the hydroxymethylfurfural (HMF) and diastase contents. H. Hadorn and A. S. Kovacs (*Mitt. Lebensm. Hyg., Bern*, 1960, **51**, 373—390).—The methods of Fiehe and Winkler for detection of HMF in honeys are critically examined. Heating of honey increases the HMF content and decreases the diastatic power; therefore commercial honeys from tropical countries may be expected to have different values from European honeys. More than 80 honeys are analysed and norms are proposed. (14 references.)
J. V. Russo.

Rapid method for determining sucrose in ice-cream. L. Reinhardt (*Nahrung*, 1960, **4**, 533—536).—A filtered aq.-ethanolic extract of the sample, containing the sugars, is treated with aq. $Ba(OH)_2$ at 70—80° during 1 h. The sucrose remaining unaffected after the destruction of the reducing sugars, is then determined polarimetrically in the solution after acidification with AcOH, filtration and dilution. Added sucrose can be determined within ±3·6%.
P. S. Arup.

Crystalline dextrose. A. E. Stanley Mfg Co. (B.P. 837,039, 20.8.57. U.S., 11.3.57).—In a cyclic process a thin starch paste is treated with α-amylase or strong mineral acid and then diluted with dextrose mother liquor. The mixture is treated with a bacterial amyloglucosidase until the dextrose equiv. is ⩽88 (on dry basis). Colour is removed with a suitable adsorbent and inorg. matter removed on ion-exchange resins until the ash content is <3% (dry basis). The liquor is concentrated to 72—80% solids content and seeded with glucose under controlled conditions. After filtration of the dextrose crystals, mother liquor is recycled.
E. Enos Jones.

Refining of sugar solutions. Farbenfabriken Bayer A.-G. (B.P. 836,473, 23.9.57. Ger., 25.9.56).—Run-off liquor from a sugar crystallisation process, which can no longer be boiled to white sugar quality, is refined by desalting (with cation- and anion-exchangers) optionally combined with a decolorising treatment, then the liquor is put through a boiling and crystallisation process, to give a white sugar.
R.F. Basford.

Modifying type-A gelatin and product thereof. C. B. Knox Gelatine Co. Inc. (B.P. 836,082, 17.2.58. U.S., 1.3.57).—The process comprises reacting type-A gelatin at pH 3—8·5 and at 25—90° with sufficient polycarboxylic acid compound selected from succinic, maleic, phthalic, citraconic, itaconic and aconitic anhydrides and succinyl and fumaryl chlorides and mixtures thereof to reduce the isoelectric point of the gelatin within the pH range 4·0—5·5. The product is useful for making marshmallow foam, etc.
E. Enos Jones.

Fermentation and Alcoholic Beverages

Detection of red hybrid characters in juices and wines. G. Reuther (*Z. LebensmittUntersuch.*, 1960, **113**, 480—484).—The method according to J. and P. Ribéreau-Gayon is discussed. Besides the usual reagents for developing the two-dimensional chromatograms, $AlCl_3$ and NH_3, Benedict's reagent is necessary to determine all the wild vine anthocyanins. Extraction with n-butanol removes the troublesome brown breakdown product in old red wines and by this extraction method the anthocyanins are concentrated. The diglucosides of wild vine anthocyanidins in red hybrid wines are essentially more stable than the monoglucosides of red wines from *Vitis vinifera*. Detection of malvin alone is not sufficient for an accurate characterisation of a hybrid or an adulterated wine.
E. M. J.

Microdetermination of metals in wines after treatment with ion-exchange resins. E. Gálvez and J. M. Garrido (*Rev. cienc apl.*, 1960, **14**, 481—489).—The wine is treated with $K_4Fe(CN)_6$ to remove heavy metals. Ca and Mg are then adsorbed on a cation-exchange resin and eluted with HCl. On one portion of the eluate Ca + Mg are determined complexometrically with E.D.T.A. and Eriochrome T black indicator. From another portion Ca is precipitated with NH_4 oxalate and Mg is determined as above (using a blank containing NH_4 oxalate). The Ca is obtained by difference. (19 references.)
L. A. O'Neill.

Paper-electrophoretic detection of sucrose in dessert wines. H. Konrad (*Nahrung*, 1960, **4**, 528—532).—Directions are given for a convenient sorting test with the use of a borate buffer at 10—12 V. per cm. which can be accomplished within 4 h. The dried chromatogram is sprayed with a solution of naphthylresorcin and H_3PO_4 in $COMe_2$ which gives a red-brown coloration with sucrose, blue with glucose, and brown with fructose. The test is not affected by the presence of glucose, fructose, arabinose or xylose. (11 references.)
P. S. Arup.

Polyalcohols in wine. Chromatographic method to reveal addition of cider. E. Emiliani and I. Ucha de Davie (*Rev. Fac. quím. Argent.*, 1959, **28**, 93—104).—Previous methods which were based on the identification of starch or dextrins in the wine and the determination of the alkalinity of the evaporation residues or the types of precipitates obtained with $AgNO_3$, have been superseded by the chromatographic estimation of sorbitol in wine. Grape juice compared with cider contains only small quantities of this substance. Cider additions are shown by a high sorbitol content. (21 references.)
B. F. Fullan.

Cytological and biochemical study of the action of glucose and gibberellin on the disintegration of malt. R. Scriban and B. Vazart (*Brasserie*, 1960, **15**, 344—353).—Cytological studies of the action of glucose and gibberellin on malt are described and illustrated with comparative photomicrographs of treated and control malts. Changes in the starch cells and in the starch grains are noted near the top of the grain and in the aleurone layer, especially when gibberellin is used alone. Depolymerisation of deoxyribonucleic acid and an enrichment of ribonucleic acid occurs. (12 references.)
J. V. Russo.

Anthocyanogens in malting and brewing. J. R. A. Pollock (*Rev. Ferment.*, 1960, **15**, 171—174).—The anthocyanogen content of whole and dehusked barley of various types and at various stages of germination, and of worts and beers, is determined. The relationship between anthocyanogen content and beer turbidity (cold haze) is discussed and the removal of turbidity by treatment with nylon powder is described.
J. V. Russo.

Beer. F. Grossman and R. E. O'Brien (B.P. 837,973, 18.9.56).—Exfoliated or puffed grain (maize or wheat) is converted into finely divided or powder form, then intimately admixed with finely divided malt grain (sprouted maize, wheat, rice or barley) and org. acid or acids (lactic, citric, acetic, tartaric or benzoic acid), to provide a dry composition which is subsequently fermented in water in presence of brewers' yeast (which may be incorporated in the dry mix if desired) and optionally fortifying agents (hydrolysed proteins, selected salts, sugars or molasses) to produce a beer.
F. R. Basford.

Concentrate of hops. Pabst Brewing Co. (B.P. 837,058, 25.2.58).—A concentrate of hops in a wort-sol. form, especially suitable for use in the brewing of beer, is prepared by extracting vine-fresh hops with a solvent in which both α- and β-soft resins and volatile oils are sol., e.g., MeOH, then separating the extract.
F. R. Basford.

Fruits, Vegetables, etc.

Colorimetric estimation of dodecylguanidine acetate residues. W. A. Steller, K. Klotsas, E. J. Kuchar and M. V. Norris (*J. agric. Fd Chem.*, 1960, **8**, 460—464).—The fungicide n-dodecylguanidine acetate is determined by forming the complex with the anionic dye Bromocresol purple in buffered aq. ethanol, extracting the complex into $CHCl_3$, shaking with aq. alkali (which extracts bromocresol purple equivalent to the fungicide), measuring the absorbance of the extract at 590 mμ, and comparing with calibration curves. The method is applicable to residues of 0·2 to 0·6 p.p.m. in a 50-g. sample. Surface residues are separated by tumbling with methanol, total residues by macerating with methanol/$CHCl_3$ (2/1). Determinations on apples, apple leaves and cherries are reported. (13 references.)
M. D. Anderson.

Dodecylguanidine acetate (Dodine) residues on apples. D. E. H. Frear, E. C. Smith and T. G. Bowery (*J. agric. Fd Chem.*, 1960, **8**, 465—466).—Residues of Dodine on apples, after spraying with 0·5 to 1·75 lb. of fungicide per 100 gal. of water, were, on average, 0·28 p.p.m. at harvest, when determined by the method of Steller *et al.*; the highest value was 1·29 p.p.m. Residues of 7·5, 4·2 and 3·6 p.p.m. immediately after application were reduced respectively to 0·6, 0·4 and 0·2 p.p.m. 33 days later. Apparent residue on unsprayed apples was 0·1 p.p.m.
M. D. Anderson.

Application of total organic chlorine method to the determination of endrin and Thiodan residues in blackcurrants. H. Egan and W. H. Evans (*Analyst*, 1960, **85**, 842—843).—Application of the method of Sergeant *et al.* (*Analyst*, 1958, **83**, 335; 1959, **84**, 251) to the determination of endrin in blackcurrants yields recoveries of 97% with 0·98 p.p.m. but 72% with 0·49 p.p.m. The method is modified in that separation of Thiodan from Thiodan alcohol and from interfering substances is achieved by elution from activated alumina with benzene in place of hexane. The total org. Cl is then determined (*loc. cit.*).
A. O. Jones.

Carotenoid pigments of pineapple fruit. I. Acid-catalysed isomerisation of the pigments. V. L. Singleton, W. A. Gortner and H. Y. Young. **II. Influence of fruit ripeness, handling and processing on pigment isomerisation.** W. A. Gortner and V. L. Singleton (*J. Fd Sci.*, 1961, **26**, 49—52, 53—55).—I. The total carotenoid pigments contain a high proportion of epoxide groups readily isomerised to furanoid forms in an acid but not an alkaline environment, causing a characteristic hypsochromic shift in the absorption max. of the pigment extract. The absorbance at 425 mμ remains relatively unchanged but the sharp max. at 466 mμ is lost as isomerisation progresses. The ratio of absorption at 466 and 425 mμ serves as a measure of isomerisation of the pigments.

II. The acid-catalysed isomerisation of the carotenoid pigments is influenced by loss of integrity of the fruit tissue cells. The lower half of a fully ripe fruit contains an appreciable fraction of isomerised pigment. Bruising or canning isomerises the pigments. In frozen fruit (which contains a high proportion of isomerised carotenoids), after thawing, further change occurs until the spectrum is that of the isomerised or " canned " type pigment.
E. M. J.

Brown decay on citrus fruits during storage linked with the state of health of the plantations. C. and M. Moreau (*Fruits d'outre mer*, 1960, **15**, 478—480).—Two lots of fruit, oranges and citrons, were examined after a short time of warehouse storage and were badly attacked with fungi, mainly of two types, *Phytophthora parasitica* and *Phomopsis citri*. These are associated with the place of origin (e.g., the trees on which the fruit was grown) probably far from place of storage.
J. V. Russo.

Tests with volatile fungicides in packages of citrus fruits during shipment to eastern markets. C. N. Roistacher, L. J. Klotz and M. J. Garber (*Phylopathology*, 1960, **50**, 855—860).—Decay of citrus fruit in transit was diminished by treatment with diphenyl or NH_3. Under very moist conditions NH_3 occasionally injured the rind of oranges and lemons; diphenyl had no ill effects of this kind. The relative efficiency of control of decay by the two compounds differed with the variety of fruit.
A. G. Pollard.

Photometric determination of diphenyl and o-hydroxy diphenyl in peel of citrus fruits. H. Böhme and G. Hofmann (*Z. Lebensmitt-Untersuch.*, 1961, **114**, 97—105).—The mixture of diphenyl (**I**) and volatile oils obtained after the distillation of a mixture of the comminuted peel and water, is separated by passage of their solution

in light petroleum through a column of Al_2O_3; the **I** only is (quant.) retained by the column, from which it is subsequently eluted by $CHCl_3$. The **I** is nitrated with HNO_3 (98·6%) in $CHCl_3$ solution; the resulting nitro-compounds are reduced to amino-compounds which are diazotised and coupled with *N*-(1-naphthyl)-ethylenediamine dihydrochloride to form a dye, the concn. of which is measured photometrically or spectrophotometrically at 560 mμ. A method is given for the qual. detection of *o*-hydroxydiphenyl (**II**) in the light petroleum solution by a blue colour reaction given with 2,6-dibromoquinone chlorimide. Steam-distillation is necessary for the separation of **II** with the volatile oils, and continuous extraction with PrⁱOH for the elution of **II** from the Al_2O_3 column. The colorimetric determination depends on the formation of a dye with max. absorption at 480 mμ by coupling **II** with 2,2′-dimethoxydiphenyl-4,4-bis-diazonium chloride (Echtblausalz B). (19 references.) P. S. ARUP.

Sodium content of Hawaii-grown fruits and vegetables in relation to environment. N. S. Wenkam, C. D. Miller and Y. Kanehiro (*J. Fd Sci.*, 1961, **26**, 30—37).—Data on the influence of environment on the Na contents of fruits and vegetables are given. In a few, e.g., papaya, beets, celery, etc., Na contents were high, but were generally low. Na concn. of some varied with soil Na concn. (11 references.) E. M. J.

γ-Radiation effects on fruits and vegetables. D. K. Salunkhe (*Econ. Bot.*, 1961, **15**, 28—56).—Many instances where γ-radiation has increased the " shelf life " of fruits and vegetables are cited as well as examples of prolonging storage life of potatoes by inhibiting sprouting. There is a bibliography of 109 references. L. G. G. WARNE.

Physico-chemical measurements on potatoes during storage. J. Herrmann and H. Donath (*Nahrung*, 1960, **4**, 426—451).—Improved methods are described for determining the constants on the tissue and press-juice; the capacity for repairing wound-damage is measured by a method based on the capacity of excised tissue to form suberin. Minor changes occur during the resting period, the end of which is characterised by min. values for the conductivity, *n* and f.p. depression, and max. val. for η of the press-juice; at this stage max. values are found for the healing capacity. The initiation of physiological activity is marked by changes indicating increases of sol. nutrients in the plasma for transport to the embryos. (28 references.) P. S. ARUP.

Measurement of chipping qualities in Manitoba grown potatoes, R. B. Hyde and A. L. Shewfelt (*Canad. J. Plant Sci.*, 1960, **40**, 607—610).—Reducing sugars content is a reliable index of chip quality, high content giving low quality chips. Sp. gr. is a guide to chip yield, low values producing low yields. M. LONG.

Reflectance colour measurements and judges' scores for frozen cauliflower and spinach. M. M. Boggs, H. C. Lukens, D. W. Venstrom, J. G. Harris, S. Shinoda and B. P. Debeau (*J. Fd Sci.*, 1961, **26**, 26—30).—Of spinach stems, leaves or mixtures, stems changed the most, and most uniformly and correlated best with scores. Cauliflower floret surface gave smallest significant differences by judges. E. M. J.

Tea, coffee, cocoa

Water-soluble coffee concentrate. R. Perech (B.P. 836,464, 29.7.57).—An aq. extract from disintegrated raw coffee beans is heated (but below 100°) with an oxygenating atm., e.g., air (preferably introduced into the extract) for ⩽1 h. until the water-sol. constituents of the coffee are oxidised, then the extract is concentrated and spray-dried to produce a dry, sol. coffee concentrate (" instant coffee ") of improved flavour. F. R. BASFORD.

Milk, Dairy Products, Eggs

Ammonia and volatile amines in milk. D. D. Cole, W. J. Harper and C. L. Hankinson (*J. Dairy Sci.*, 1961, **44**, 171—173).—A procedure is described in which the bases are extracted from whey by ether + light petroleum (in presence of ethanol) and converted into hydrochlorides; the bases are extracted from the (dry) salts by means of ether in the presence of NaOH. The gas-liquid chromatographic analysis is carried out by a modification of the method of James *et al.* and of Hankinson *et al.* Good fresh milk contains traces of NH_3 and the n-amines C_1—C_4 and C_6. Feed-flavoured milk has relatively larger concn. of n-propylamine and n-hexylamine; these substances impart a feed-flavour when added to fresh milk. P. S. ARUP.

Changes in pH of milk during freezing and frozen storage. L. van den Berg (*J. Dairy Sci.*, 1961, **44**, 26—31).—Whilst slow freezing causes decreases in pH to as low as 5·8, rapid freezing causes little change. During the first 2—3 weeks of storage at −7° or −12°, the pH decreases to min. values of 5·8—6·0 in milk with added $CaCl_2$, K phosphate or K citrate, and to 6·1—6·2 in normal milk; a slow increase occurs during further storage. No correlation is found between the amount of pptd. protein and the pH. (10 references.) P. S. ARUP.

Milk phosphatases. Determination of phosphomonoesterases in raw milk. F. Kiermeier and E. Meinl (*Z. LebensmittUntersuch.*, 1961, **114**, 110—127).—The relevant literature is reviewed. For alkaline phosphatase (**I**) the method of Sanders and Sager is critically examined for effects of milk quantity, period of activity, colour, temp. and substrate concn., reaction time; and for acid phosphatase (**II**) factors affecting the method of Hakansson and Sjöström are studied. These comprise inhibitory substances in the substrate, autohydrolysis, light, optimal substrate concn., favourable reaction temp., suitable buffer system and pH, and reaction time. Details are given of proposed modified methods for quant. determination of the activity of **I** and **II** in raw milk. (67 references.) E. M. J.

Comparison of amino-acids yields from the acid and enzyme casein hydrolysates, their optimal composition and flavour. J. Janicki and J. Skupin (*Roczn. Technol. Chem. Żywności*, 1960, **5**, 99—110).—Casein hydrolysates prep. by acid method (Gurnani *et al.*, *Biochim. Biophys. Acta*, 1956, **16**, 553) were compared with those obtained by enzyme methods. In the latter the Willstätter (*Z. Physiol. Chem.*, 1922, **125**, 132) pig's gland enzyme prep. of a determined proteolytic activity was used. The flavour of hydrolysate was improved by decreasing the amount of inorg. P from 0·77 to 0·04% by Carr's method (J.S.F.A. Abstr., 1957, i, 23). Good meaty taste and high amino-acid content was obtained in the 10 : 1 (de-phosphated casein to enzyme prep. ratio) hydrolyses carried out at 45° for 120 h. Detailed amino-acid composition of dehydrated products prep. by the acid and the enzyme hydrolyses is tabulated. (33 references.) A. L. GROCHOWSKI.

Denaturation of protein [in raw milk]. E. Kofranyi (*Milchwissenschaft*, 1961, **16**, 30—31).—A brief general survey; the different meanings of the word " denaturation " are discussed. C. V.

Enzymic degradation of β-casein by a snake venom. E. B. Kalan and M. Telka (*J. Dairy Sci.*, 1961, **44**, 16—25).—The action of a prep. from *Crotalus adamanteus* on β-casein is shown to comprise proteolysis both before and after the development of turbidity, with the formation of at least four ninhydrin-positive fractions. The action resembles that of rennin or pepsin on α-casein; it is inhibited by veronal. The pptd. material is essentially free from P, and comprises 20—30% of the original β-casein. (20 references.) P. S. ARUP.

Comparison of acid and non-acid volumetric methods for determining percentage of butter fat in raw milk. W. T. O'Dell (*J. Dairy Sci.*, 1961, **44**, 47—57).—The Babcock, Gerber and the (non-acid) Dairy Products Section (*DPS*) methods give slightly higher results (non-significant for the *DPS* method), whilst the TeSa and Schain methods (non-acid and requiring no centrifuge) give slightly lower results (non-significant for *DPS*) than those given by the Mojonnier method. The Gerber results exceed the Babcock results by an average of 0·023%. Regarding the non-acid methods, the *DPS* method (requiring a centrifuge) agrees best with the Babcock and the Mojonnier methods; the Schain test shows the greatest average error and lowest correlation with any of the other methods; the TeSa test has promising possibilities with further modification. (39 references.) P. S. ARUP.

Accuracy of graduations of Babcock separated milk test bottles. B. L. Herrington (*J. Dairy Sci.*, 1961, **44**, 173).—The apparatus used for checking the accuracy of Babcock milk bottles (cf. *ibid.*, 1960, **43**, 690) can be adapted for the checking of Babcock separated milk bottles intended for use in the determination of lipids in blood. The errors in such determinations are usually <0·2 of a division. P. S. ARUP.

Excretion of Co-Ral in milk of dairy cattle. R. D. Radeleff and H. V. Claborn (*J. agric. Fd Chem.*, 1960, **8**, 437—439).—Dairy cows were sprayed with 2 l. of emulsion containing 0·5 or 0·75% of the insecticide Co-Ral, (3-chloro-4-methylumbelliferone)*OO*-diethyl phosphorothioate, labelled with ^{32}P. The max. amounts of organosol. ^{32}P found in the milk corresponded respectively to 0·2 and 0·25 p.p.m. of insecticide, at 5 h. after spraying; the level declined gradually to a trace at 10 days. The max. level of organo-insol. ^{32}P was reached at 48 h. after spraying, and declined slowly over 3 weeks. M. D. ANDERSON.

Thermal inactivation studies on pathogenic bacteria in milk and various milk products. I. *Corynebacterium diphtheriae* ATCC No. 296. D. R. Daoust, R. B. Read, jun., and W. Litsky (*J. Dairy Sci.*, 1961, **44**, 32—40). P. S. ARUP.

Routine method for determining sucrose in sweetened condensed milk. F. E. Murphy (*Analyst*, 1960, **85**, 720—723).—To a solution of the sample in hot water citric acid is added and after adjustment to a specified vol. at 20° the solution is filtered (solution A). A portion of this solution is treated with citric acid and boiled ; the cooled liquid is neutralised, diluted to specified vol. (solution B) and its reducing power is determined by the Lane and Eynon method. The reducing power of solution A is determined in presence of Calgon but the final incremental additions are made with solution B. The method of calculation is given. A. O. JONES.

Volatile carbonyl compounds in stored dry whole milk. O. W. Parks and S. Patton (*J. Dairy Sci.*, 1961, **44**, 1—9).—The compounds obtained by distillation at 35—40°/15—20 mm. Hg are converted into their 2,4-dinitrophenylhydrazones which are separated and identified by column-partition chromatography and other methods. Powders of average quality yield n-alkyl-2-ones in the range C_3—C_{15} (chiefly odd-numbered) and alkanals C_1, C_8 and C_9. A deteriorated powder is characterised by the presence of a large no. of saturated aldehydes in the range C_1—C_{12}, some 2-unsaturated aldehydes, and an increased content of the ketones. A powder prepared from deodorised milk fat has a considerably lower content of ketones. (15 references.) P. S. ARUP.

Composition of New Zealand skimmed-milk powder and its influence on determination of milk-solids-not-fat. J. H. Halliday, E. H. W. J. Burden and J. J. Lamont (*Analyst*, 1960, **85**, 839—840). —Use of the commonly accepted values of the Vieth ratio for ash, protein and anhydrous lactose (viz., 2 : 9 : 13) for calculating the non-fatty milk solids in ice cream containing New Zealand skimmed-milk powder usually gave discordant results. Examination of 22 samples of such powder gave an average value for the ratio of non-fatty milk solids to anhydrous lactose to protein to ash of 25·25 : 11·55 : 10·40 : 2·05 and this ratio has been successfully applied to ice cream containing New Zealand skimmed milk powder. Evaporation of lactose solution on the water bath yields a residue containing hydrated lactose and it is suggested that the term " non-fatty milk solids " should include the water of hydration of the lactose. The non-fatty milk solids in ice cream containing New Zealand skimmed-milk powder are calculated by multiplying the anhydrous lactose content by 2·18 or the protein content by 2·43. (11 references.) A. O. JONES.

Manufacturing method for improving physical characteristics of winter butter. E. A. Zottola, G. H. Wilster and R. W. Stein (*J. Dairy Sci.*, 1961, **44**, 41—46).—The cream pasteurised (at 68—71° during 30 min.) is cooled and held at 8° during 2 h., then slowly warmed (during 1 h.) to 19°, held at this temp. during 6 h., and finally cooled to 16°, and held during 15 h. before churning. Butter thus produced has a satisfactory texture and consistency at 8°. Butter produced by holding the pasteurised cream at 8° during 15 h. before churning is much less satisfactory in these respects. (11 references.) P. S. ARUP.

Method of concentrating ripened cheese volatiles for gas chromatography. R. Scarpellino and F. V. Kosikowski (*J. Dairy Sci.*, 1961, **44**, 10—15).—A slurry is prepared by rapidly blending the cheese with water at ~20° and simultaneously adjusting the pH to 4·1—4·2. The dry oil obtained by centrifuging the slurry is distilled under 25—50 μ of Hg, the distillate being collected in a tube cooled with liquid N_2. The org. layer thus obtained from mature blue cheese is easily separated ; that from Cheddar or immature blue cheese is extracted by ether containing a little BzOH ; the BzOH retains the desired compounds during the evaporation of the ether, and acts as a carrier for injection into the gas-chromatographic apparatus. Gas-chromatographic diagrams are given for the products obtained from Cheddar and blue cheese. P. S. ARUP.

Studies on egg shells. XIV. Variations in egg weight, shell thickness and membrane thickness between eggs within a clutch. XV. Critical appraisal of various methods of assessing shell thickness. C. Tyler and F. H. Geake (*J. Sci. Fd Agric.*, 1961, **12**, 273—280, 281—289 ; cf. J.S.F.A. Abstr., 1960, ii, 272).—XIV. Data on egg wt., true shell thickness and membrane thickness are presented. Clutches containing up to five eggs provided sufficient data for detailed study. There is no evidence to suggest that the mean values for successive eggs in a clutch, even if significantly different, can be used as necessarily typical for individual birds or for individual clutches. A no. of mean results agree with those of other workers ; some do not. In all these results there are general averages from which there is a great deal of deviation in individual clutches.

XV. True shell wt. per unit area (mg./sq. cm.) is a very accurate assessment of shell thickness ; for routine purposes, wt. per unit area of shell + membranes (mg./sq. cm.) gives a very good assessment and is easy to measure. % shell and a flotation method are other methods discussed. The flotation method is used for routine work but is not as accurate as the Archimedes method. Grossfeld's hydrometer method is suitable for establishing a broad classification. In direct calculation of sp. gr. from egg wt. and egg vol. (calculated from egg length (L) and breadth (B)) the relationship between LB^2 and vol. while very highly significant is not good enough for prediction purposes. E. M. J.

Edible Oils and Fats

Refining of imported soya-bean oils. R. de Castro Ramos and M. Nosti Vega (*Grasas y Aceites*, 1960, **11**, 213—219).—Examination of a wide range of soya-bean oils showed no relation between acidity of the raw oil and neutralisation loss. The colour of the neutralised oils was satisfactory. Excess of lye increased the neutralisation loss without significant improvement in colour. L. A. O'NEILL.

Molecular distillation for separation of hydrogenation inhibitors of rapeseed oil. H. Niewiadomski and Drozdowski (*Nahrung*, 1960, **4**, 650—660).—Data are presented on the fractions of expressed and extracted rapeseed oils obtained by molecular distillation in the temp. ranges 150—190° and 210—250°. Data are also given on the characteristics of the residue before and after hydrogenation (**I**), the speed of **I**, and the effects of the various fractions on **I** rate of refined groundnut oil. (14 references.) E. M. J.

Effect of the method of neutralisation and bleaching on removal of sterols from rape oil. H. Niewiadomski and A. Klopotek (*Roczn. Technol. Chem. Żywności*, 1960, **5**, 91—98).—Rape oil containing neutral fat 96·37, non-saponifiable substances 1·21, sterols 0·59, and P 0·05% was neutralised with 5, 8, 11 and 18° Bé NaOH solutions, with and without previous hydration. Optimal neutralisation with a small loss of neutral fat and a satisfactory removal of sterols was obtained using the 11° Bé alkali without previous hydration. A more complete removal of P compounds, if necessary, could be effected by a larger excess of alkali of the same concn. The effect of Czech and German bleaching earths was studied on a factory-neutralised rape oil containing 0·523% sterols and bleached at 80°/100 mm. Hg at 1·5% earth concn. over 10, 15, 20, 25 and 30 min. The more acid and more active German bleaching earth gave a lower apparent sterol concn. of the bleached oil, but it was considered likely that some sterols were converted into forms not reacting with digitonine. The control of sterol forms and concn. in refined edible oil by suitable neutralisation and bleaching methods is envisaged together with the means of sterol recovery from the oil refinery soapstocks. (12 references.) A. L. GROCHOWSKI.

Tocopherol content of vegetable oils and hydrogenated fats (Vanaspati). D. Jal Nazir and N. G. Magar (*Indian J. appl. Chem.*, 1960, **23**, 135—138).—The tocopherol contents of ten vegetable oils (206 samples) and 107 samples of Vanaspati have been determined and compared with values previously reported. Total tocopherols in oils of niger, linseed and cottonseed are ~145 mg./100 g., in groundnut, castor, safflower and refined linseed oils 50—75 mg./100 g., in sesame oil and refined or hydrogenated groundnut oils 35—50 mg./100 g., and in coconut oil 7 mg./100 g. (29 references.) O. M. WHITTON.

Reaction mechanism and kinetics of the interesterification of fats. I. Interesterification reactions. J. Baltes (*Nahrung*, 1960, **4**, 1—16). —The mechanism of the interesterification of fats is discussed, especially in regard to the catalyst, and the dynamic balance in a single-phase system when the kind and composition of the basal fatty acids are known is derived. The deducible relations can be applied in the production of fats with particular desirable properties. C. L. HINTON.

Complexometric determination of antioxidants. V. Semimicro determination of ethyl gallate in lard. B. A. J. Sedláček (*Z. Lebensmittlntersuch.*, 1961, **114**, 127—128).—The previously described method for Pr gallate (cf. *ibid.*, 1959, **111**, 108) is modified by prolonging the time of boiling the Et gallate solution with Hg^{2+} acetate solution to 15 min., and by the use of 0·002M-EDTA and -$ZnSO_4$ solutions in the titrations. Recoveries of Et gallate from lard are close to theoretical values. P. S. ARUP.

Effect of feeding butylated hydroxyanisole to dogs. O. H. M. Wilder, P. C. Ostby and B. R. Gregory (*J. agric. Fd Chem.*, 1960, **8**, 504—506).—Groups of weanling puppies were fed butylated hydroxyanisole (BHA) at levels of 0·0, 5·0, 50·0 and 250 mg. per kg. of body wt. for 15 months. General health and gains of wt. were good throughout, and haemoglobin and blood-cell counts were normal. Urine from dogs receiving BHA contained more glucuronates, and had a higher ratio of total to inorg. sulphates, indicating that BHA was excreted by this route. Microscopical examination of tissue sections at autopsy showed no changes beyond normal variations, except in the dogs that received the highest dosage, in

which liver injury had occurred. Present regulations allow the use of BHA in lard at a level not exceeding 0·01%. (14 references.)
M. D. ANDERSON.

Meat and Poultry

Rearing calves for veal. M. V. Jackson (*Exp. Husbandry*, 1960, No. 5, 49—65).—Experiments are described to determine whether a veal animal was fed on whole milk alone, or on a milk substitute and only a very small quantity of whole milk. Four different rations were fed. It is not possible to distinguish with certainty, whether the animal was fed on whole milk alone or on a milk substitute, from the colour of the carcass. E. M. J.

Effects of management practices on chiller beef production in Victoria. I. Liveweight increase and economy of production. T. J. Robinson and N. G. Cameron (*Aust. J. agric. Res.*, 1960, **11**, 1101—1127).—Data are presented on a factorial experiment involving 72 grade cattle and their dams. Relative contribution to daily live wt. increase and economy of production of sex (steer *v.* spayed heifer), sire (stud *v.* grade bull), level of supplementary feeding (high *v.* moderate *v.* low), season of birth (autumn *v.* spring) and year of birth (1954 *v.* 1955 control *v.* 1955 stilboestrol-implanted) was determined. Season of birth was the greatest single factor affecting live-wt. gain, carcass beef production and cash value. The spring-born was much more dependent on heavy supplementary feeding than was the autumn-born calf. Economy of production depended on correct time of calving (autumn) and reduction of supplementary feeding to a min. E. M. J.

Studies on beef quality. IX. Nucleotide breakdown in beef tissue: extent of formation of hypoxanthine during storage as an indicator of degree of ripening. A. Howard, C. A. Lee and H. L. Webster (*Commonw. sci. industr. Res. Org., Aust., Div. Fd Pres. tech. Paper No.* 21, 1960, 14 pp.).—With progressive ageing of two muscles of export-quality beef carcasses, processed under commercial conditions, the hypoxanthine (**I**) levels rose to 1·5—2·0 μmoles/g. of meat. The **I** content is correlated (curvilinearly) with the subjective score for tenderness. The curvilinearity may be caused by initial differences in tenderness between carcasses. The relation between change in **I** content and tenderness is independent of type of muscle, temp. during ageing and whether or not the carcass is frozen after ageing, but the actual levels of **I** and tenderness are dependent on these factors. (16 references.) E. M. J.

Changes in amino-nitrogen, total soluble nitrogen and trichloroacetic acid-soluble nitrogen content of beef as influenced by pre-irradiation heating, irradiation level and storage at 34°F. F. R. Bautista, R. H. Thompson and R. F. Cain (*J. Fd Sci.*, 1961, **26**, 15—20).—The effect of heating slices of beef to 130, 150 and 195°F, of irradiating at 0·1 and 5·0 megarads and storing 60 days at 34°F on free amino-N, total sol. N (TSN) and trichloroacetic acid (TCA) sol. N was determined at 15-day intervals. Increase in temp. reduced rate of release of TSN and TCA-sol. fractions and, at highest temp., of amino-N. Irradiation increased rate of release of these fractions. Amino-N was released immediately on storage of raw beef, major amounts of TSN not until after 15 days of storage and TCA-sol. N not until after 45 days. Successive fragmentation of initially bound protein is suggested. (11 references.)
E. M. J.

Volatile constituents of cooked beef. M. H. Yueh and F. M. Strong (*J. agric. Fd Chem.*, 1960, **8**, 491—494).—Broth from lean beef refluxed with water for 3 h. was distilled at atm. pressure. The distillate contained H_2S, NH_3, traces of dimethyl sulphide, acetaldehyde, acetone and diacetyl. The presence of formic, acetic, propionic, butyric and isobutyric acids was tentatively established by gas chromatography of methyl esters. Volatile alcohols and esters were absent. The amount of H_2S found was 6 to 8 mg. per kg. of beef after 3 h., much increased after boiling for 7 days. M. D. ANDERSON.

Flavour studies on beef and pork. I. Hornstein and P. F. Crowe (*J. agric. Fd Chem.*, 1960, **8**, 494—498).—Freeze-dried cold-water extracts of lean beef and lean pork were heated to 100°, and the volatiles were trapped at liquid-N temp., and fractionated at room temp. under vac. into two major fractions. The less volatile fractions were viscous mixtures with a meaty aroma. The i.r. spectra of these fractions from beef and pork were qual. identical; about 90% of the material was lactic acid and NH_3. The more volatile fractions from the two meats were also similar, containing acetone, acetaldehyde, HCHO, NH_3, H_2S and CO_2. Beef and pork fats gave different aromas on heating, and the amounts of various free fatty acids in the two fats before and after heating also differed, as did the amounts of different carbonyl compounds after heating. The two fats may not only produce flavour compounds in different ratios, but may also act as storage depots for fat-sol. foreign compounds. Experiments with model systems of protein, glucose and amino-acids suggest that lean meat flavour is produced in the low-mol.-wt., water-sol. fractions by interactions between amino-acids, polypeptides and carbohydrates. (14 references.)
M. D. ANDERSON.

Precursors of beef flavour. O. F. Batzer, A. T. Santoro, M. C. Tan, W. A. Landmann and B. S. Schweigert (*J. agric. Fd Chem.*, 1960, **8**, 498—501).—Ground raw beef muscle was fractionated into a no. of water-sol. and water-insol. fractions. A freeze-dried dialysate from the aq. extract gave a "beef broth" odour and flavour when boiled in water, and a "broiled steak" odour when heated with fat. All the other fractions produced no odour on boiling, and were practically tasteless; when heated with fat, they gave an odour of burned protein. The freeze-dried fraction containing the flavour components was very unstable, and quickly changed from a white granular material to a tarry mass even when kept in an evacuated desiccator. Components separated by column chromatography and gel filtration were of relatively low mol. wt., and included peptides, carbohydrates and phosphates, not yet identified. (11 references.) M. D. ANDERSON.

Effect of drying, mincing and cooking techniques on quality of air-dried mutton mince. A. Howard, A. R. Prater and G. G. Coote (*Commonw. sci. industr. Res. Org., Aust., Div. Fd Pres. tech. Paper No.* 20, 1960, 14 pp.).—Change of air temp. from 140 to 135°F during the later stages of drying has no significant effect on the quality of the product or the moisture content after a given time of drying. Of two mince sizes, the smaller mince gives the better product and dries more rapidly. When liquor is not returned before drying, the time of drying for the air conditions used is determined primarily by the fat content, size of mince and methods of cooking (i.e., loss of sol. solids). Increase of tenderness and decrease of woolliness are associated with the smaller particle size obtained when precooked meat is chilled overnight at 0° before mincing. E. M. J.

Accuracy of visual and measurement evaluation of hams. M. A. Janicki and Z. Walczak (*Roczn. Technol. Chem. Żywności*, 1960, **5**, 81—90).—The visual and external measurement, and the weighing methods for estimation of the lean meat content of hams, were checked in detail on 60 Polish hams. The visual methods (New Zealand standard, Peterson and Baird, etc.) were of little practical value, as they bear no relation with the leanness of meat and favour fat hams. Better accuracy was established with the measurement of the thickness of back fat, the circumference of ham, and of the area of lean meat exposed on removal of ham from the carcass. Good correlation was confirmed between the total lean meat contents and the total wt. of two easily dissected muscles, the *semitendinosus* and the *adductor femoris*, or the wt. of *quadriceps femoris* (cf. Hiner and Hankins, *J. Agric. Res.*, 1939, **59**, 293). (14 references.) A. L. GROCHOWSKI.

Effect of different temperatures on various bacteria isolated from frozen meat pies. K. Kereluk, A. C. Peterson and M. F. Gunderson (*J. Fd Sci.*, 1961, **26**, 21—25).—In cultures isolated from chicken pies, *Bacterium coli*, *Streptococcus faecalis*, *Staphylococcus aureus* and *Pseudomonas fluorescens* had a min. growth temp. between 5—10°. At refrigeration temp., growth of psychrophilic, saprophytic species tested was faster than that of bacteria of public health significance. A frozen food on defrosting, in a refrigerator, would become unacceptable (physical appearance, development of off-flavours) before it became a health hazard. (16 references.) E. M. J.

Effect of time, temperature and methods of cutting on dehydration of cut-up poultry. G. J. Mountney and A. R. White (*Poultry Sci.*, 1961, **40**, 25—28).—The rate of dehydration of whole and cut fryers stored for 4—12 days was greater at 4·4° than at 0·6°. Whole carcasses stored at 0·6° lost less wt. than did cut ones, but there were no differences between losses from whole and cut carcasses at 4·4°. A. H. CORNFIELD.

Calcium alginate film for coating cut-up poultry. G. J. Mountney and A. R. Winter (*Poultry Sci.*, 1961, **40**, 28—34).—Coating poultry parts with a film of Ca alginate, by dipping in 2—4% Na alginate followed by saturated $CaCl_2$, prior to cold storage resulted in less loss of moisture during storage. The action of the alginate in reducing dehydration appears to come from its high moisture content, since the coating becomes dehydrated with time. One thick coat was easier to peel off than several thin coats.
A. H. CORNFIELD.

Coating articles of food. Dow Chemical Co. (Inventors: J. R. Wirt and H. C. Kelly) (B.P. 837,410, 24.4.58. Divided out of B.P. 832,449; J.S.F.A. Abstr., 1961, i, 249.—Foodstuff, especially meat, is provided with a tightly-adhering protective coating (which can be readily removed before use by stripping or peeling) by applying thereto (preferably in the frozen state), e.g., by dip coating, a

molten composition consisting of colourless, odourless, non-toxic plasticiser, e.g., acetyl tributyl citrate, butyl phthalyl butyl glycollate, or refined, deodorised castor oil (5—30); a wax ingredient, m.p. >38° (≯5); refined mineral oil, η^{38} 80—400 Saybolt (15—65); and an ethylcellulose (19—70 wt.-%) which is sol. in the plasticiser and which is characterised by OEt content of 47·5—50 wt.-% and η 6—200 centipoises (in 5 wt.-% solution in a 4 : 1 vol.-mixture of toluene and EtOH). The composition may also contain a non-toxic antioxidant for the ethylcellulose (≯3), a hydroxy acid colour stabiliser, e.g., citric or tartaric acid (≯2), and (to inhibit hydrolytic decomposition of the ethylcellulose) an epoxidised long-chain, unsaturated fatty acid (12—22 C) triglyceride, e.g., epoxidised soya-bean oil (≯20 wt.-%). After application, the coating is solidified by cooling. F. R. BASFORD.

Fish

Proximate composition of nine species of rockfish. C. E. Thurston (*J. Fd Sci.*, 1961, **26**, 38—42).—Data are given on rockfish occurring in Pacific Coast waters. E. M. J.

Dried Bombay duck (*Harpoden nehereus*). I. Denaturation of proteins and texture changes during drying. II. Changes in nutritive value during processing. P. L. Sawant and N. G. Magar (*J. Sci. Fd Agric.*, 1961, **12**, 298—302, 302—305).—I. The effects of drying with or without vac. are described. Denaturation of proteins occurs in the actomyosin and sarcoplasmic fractions; loss in apyrase activity and contractility of muscle fibres occur later. The behaviour of the dried products in urea solutions suggests that H bonds and disulphide cross-linkages are formed during drying. The vac.-dried product reconstitutes better than that dried without vac.; water penetrates to the centre of large pieces by diffusion through the protein fibre and not by capillary action.

II. The effects of boiling, steaming and autoclaving and then drying under vac. or without vac. on the nutritive value of Bombay duck are described. Release of amino-acids during pepsin digestion and Pepsin Digest Residue P.D.R. Index increase after pretreatments. Amino-acids released during pepsin digestion of the dried product are less than those released from the fresh product, the decrease being lower when the product is dried without vac. The formation of disulphide cross-linkages during such heat processing is suggested. (12 references.) E. M. J.

Separation and determination of sugar phosphates with particular reference to extracts of fish tissue. N. R. Jones and J. R. Burt (*Analyst*, 1960, **85**, 810—814).—The fish muscle is homogenised with chilled $HClO_4$, the liquid is filtered at 0°, pH is adjusted to 7 with KOH and any pptd. $KClO_4$ is removed. The extract is run through a column of Dowex I (Cl^- form) and the water-washed column is eluted with a liquid in a gradient decreasing in $Na_2B_4O_7$ content and increasing in HCl and NaCl contents. Fractions (140) are collected and the extinctions are measured at 260 mμ to establish the positions of the nucleotide peaks. Aliquots from each fraction are withdrawn for the detection and determination of hexose and pentose phosphates by the anthrone and orcinol tests respectively. (14 references.) A. O. JONES.

Spices, Flavours, etc.

Determination of relative concentrations of major aldehydes in lemon, orange and grape fruit oils by gas chromatography. W. L. Stanley, R. M. Ikeda, S. H. Vannier and L. A. Rolle (*J. Fd Sci.*, 1961, **26**, 43—48).—Basically the method involves conversion of aldehydes into water-sol. Girard deriv., extraction of the aq. mixture with an org. solvent to remove non-carbonyl compounds, regeneration of aldehydes with aq. formaldehyde, recovery of the regenerated carbonyl compounds by extraction and flash evaporation to remove solvent, and gas chromatographic analysis. Typical analyses are given for samples of cold-pressed citrus oils. E. M. J.

Definition of vanillin sugar. H. Viermann (*Dtsch. Lebensmitt-Rdsch.*, 1960, **56**, 356—357).—The legal position in Germany with regard to the status of vanillin sugar is discussed and the arguments of Kloesel (*Dtsch. LebensmittRdsch.*, 1960, **56**, 176) that this material is to be considered as "artificial" are refuted. E. C. APLING.

Production of dense soya sauce. Bun-ichi Toi, M. Takahashi, T. Ogasawara, T. Hino and N. Matsuda (*Nippon Nôgei Kagaku Kaishi*, 1960, **34**, 1017—1022).—The raw materials used were glucose, inorg. matter (KH_2PO_4 and $MgSO_4$), vitamins (B_1, B_2, B_6, biotin, folic acid, nicotinic acid, *p*-aminobenzoic acid and Ca pantothenate) and "combined amino-acids" which comprise the factory product obtained by spray-drying the amino-acids isolated by ion-exchange resin treatment of the hydrolysate of defatted soya-beans with HCl from which a part of glutamic acid has been removed. The mixture was inoculated with saké yeast in five steps as for saké brewing. The product with a fair proportion of kôji gave dense soya sauce after 2 months; it contained twice as much N as ordinary commercial soya sauce and less NaCl. Org. acids in the dense soya sauce were determined by Celite column chromatography with BuOH–$CHCl_3$ as developing solvent. The contents in mg./100 g. were levulinic 30·87, acetic 123·16, pyruvic 2·82, fumaric 3·65, succinic 53·71, lactic 9·18, pyroglutamic 124·10 oxalic 5·84, malic 43·90, citric 77·38 and tartaric acid 408·18. Amino-acids of the product were analysed by microbioassay. (Patent pending.) S. KAWAMURA.

Flavouring substances. Unilever Ltd. (Inventors: I. D. Morton, P. Akroyd and C. G. May) (B.P. 836,694, 7.4.55).—A meat-like flavouring, suitable for incorporation into food products, is obtained by heating a pentose or hexose saccharide (1) with cysteine (0·4—2 pt.) and a large excess of water, such that the final reaction mixture is not alkaline. Preferably there is also present at least one (better still ≮3) additional amino-acid(s), other than phenylalanine and methionine, selected from glutamic acid, glycine, α- and β-alanine, threonine, histidine, lysine, leucine, isoleucine, serine and valine, and the reaction is effected during 0·25—4 h. at the boil and pH 3—6. F. R. BASFORD.

Colouring matters

Declaration of colouring of foodstuffs with coloured vitamins. G. Roeder (*Dtsch. LebensmittRdsch.*, 1960, **56**, 350—353).—A discussion of the legal position in Germany with regard to the use of vitamins (e.g., carotene and lactoflavin) as food colours. (15 references.) E. C. APLING.

Preservatives

Specific colorimetric method for determination of sorbic acid. H. Schmidt (*Z. anal. Chem.*, 1960, **178**, 173—184).—Sorbic acid is isolated by steam distillation and is oxidised with $K_2Cr_2O_7$ in dil. H_2SO_4 to malonaldehyde, which gives a red colour with thiobarbituric acid. This is measured spectrophotometrically at 532 mμ; 1 μg. of sorbic acid per ml. can be determined. Other common preservatives do not interfere. P. D. PARR-RICHARD.

Food Processing, Refrigeration

Antibiotics in fish preservation. H. L. A. Tarr (*Fish. Res. Bd Can.*, 1960, Bull. No. 124, 24 pp.).—The uses of antibiotics, especially chlortetracycline and oxytetracycline, in the last 10 years are briefly reviewed. Methods of application, difficulties encountered and results with salmon, ground fish, refrigerated sea-water storage of fish, dipping whole fish in comparatively strong antibiotic solution followed by icing, treatment of fillets and steaks, preservation of shell fish and marine mammals are discussed. Antibiotic residues in fish flesh, removal by cooking, public health aspects and official regulations are also discussed. (85 references.) E. M. J.

High frequency alternating current for the vacuum drying of fruit juices. I. F. Emch (*Fruchtsaft-Industr.*, 1960, **6**, 7—16).—A survey of the literature dealing with the various known methods of drying is presented. I. DICKINSON.

Influence of radiations on foodstuffs. VI. Influence on meat and meat products. H. Lück and R. Kohn (*Dtsch. LebensmittRdsch.*, 1960, **56**, 343—349).—A review of recent literature. Topics covered include: the use of u.v. light and high energy radiations; the effects of irradiation on colour, fat stability, smell and taste, vitamin content and protein structure; the use of irradiation in combination with other preservative methods; toxicological aspects; and estimates of process costs. (91 references.) E. C. APLING.

Packaging

Some food-chemical problems of modern packaging technique. L. T. Kováts and E. Szilas (*Nahrung*, 1960, **4**, 846—860).—The objects of satisfactory packaging of foodstuffs are discussed in relation to the characters of packaging materials, particularly films, now available. The problems raised by the interrelation of the package and its properties and the packed food are illustrated by reference to the packing of vegetables, raw meat, edible oils, roasted coffee, infants' foods and milk. It is emphasised that in finding an optimal packing the behaviour of the foodstuff to be packed must be related to that of the packing material by practical tests. The lines along which a theoretical approach to the calculation of max. shelf life of a packed food might be made, given the necessary data, are indicated. The mathematics of resistance to moisture penetration are discussed as a pertinent example. The absence of data for the permeability of other substances than water vapour limits this approach at present. (11 references.) C. L. HINTON.

Packaging of butter. G. Stehle (*Milchwissenschaft*, 1961, **16**, 3—15).—Some 100 butter-wrapping materials from 11 European and three overseas countries are examined and discussed. Presentation alone is considered (1 kg. to 20 g. and 1 lb. to ¼ lb.). (41 references.) C. V.

[**Butter**] **packaging in the dairy industry.** Anon. (*Milchwissenschaft*, **16**, 31—33).—Tests and quality of vegetable parchments, plastic-coated parchment, Al-foils and parchment-coated Al-foils are discussed. C. V.

Packaging of fats, especially margarine and vegetable oils. H. Exler (*Fette Seif. Anstrichm.*, 1961, **63**, 153—159).—The use of plasticiser-free PVC film for packaging of margarine and other edible oils is considered, especially from the viewpoint of their moisture-retaining properties. A suggestion is made that manufacturers should produce their own hard type foil and containers; machines are described. The use of PVC in bottles for edible oils and in sterilised milk indicators is also noted. G. R. WHALLEY.

Increasing cooling rates through thermal radiation. S. E. Charm and B. S. Chung (*Food Technol.*, 1961, **15**, 4—5).—The time required to cool the centres of black containers was 20—25% less than the time required to cool those of reflective containers. E. M. J.

Miscellaneous

Nutrition, proteins, amino-acids, vitamins

Complete *versus* total protein in the evaluation of diets. H. W. Howard, C. D. Bauer and R. J. Block (*J. agric. Fd Chem.*, 1960, **8**, 486—488).—Young rats were fed diets of starch, maize oil, minerals and vitamins, with high-protein wheat flour, supplemented with lactalbumin or with lysine (usually with methionine, threonine and tryptophan also), to supply 15% of total protein. Gain of wt. varied from 38 to 134 g. over a 4-week period, and was related not to total protein consumed, but to "complete protein", calculated from the equation $P_c = Q \times A/Ar$, where P_c = % complete protein in food, Q = % total protein (N × 6·25), A = amount of limiting amino-acid in g. per 16 g. N, and Ar = requirement for limiting amino-acid in g. per 16 g. N. The limiting amino-acids in these experiments were assumed to be cystine-methionine in some cases, and lysine in others. (11 references.) M. D. ANDERSON.

Nutritive value of pulse-protein. I. Comparison of Dutch pulse varieties. II. Investigation of pea soups. A. P. de Groot and P. Slump (*Voeding*, 1960, **21**, 307—324, 598—605).—I. The amino-acid composition of the pulses (12) grown for human consumption are in close agreement; the methionine (0·3—1·2 g. per 16 g. N) requires supplementation; losses of amino-acids after cooking are ≯5%. Digestibilities (determined by rat-feeding tests) are generally 84—91% (77% for French beans); and protein utilisation ~50% (33% for brown haricot beans). Normal cooking has no effect on protein utilisation or digestibility. (22 references.)

II. Pea soup made from powder prep. contains less methionine and cystine than does the home-made soup; both show approx. the same digestibility value (81—84%), but the protein utilisation values are 53 and 39%, respectively. Overall protein utilisation values for meals of the soups followed by semolina pudding are 54 and 58%, respectively; these values can, however, be considerably increased by supplementation with methionine. (8 references.) P.S. ARUP.

***Idli* fermentation. I. Changes in batter.** H. S. R. Desikachar, R. Radhakrishna Murty, G. Rama Rao, S. B. Kadkol, M. Srinivasan and V. Subrahmanyan (*J. sci. industr. Res.*, 1960, **19C**, 168—172).—An increase in non-protein N and a decrease in reducing sugars are observed during fementation of *Idli* (breakfast dish of South India) batters. The batters are usually prepared by soaking rice (*Oryza sativum*) and decuticled black gram (*Phaseolus mungo*) dhal in water, grinding them separately, mixing, and allowing the mixture to ferment overnight. Both titratable acidity and the vol. of the batter increase as a result of fermentation, and are used as criteria for progress of fermentation. A temp. range of 25—30° is optimal for the fermentation. Temp. up to 40° accelerate the rate, but undesirable smell occasionally develops at higher temp. Presoaking of black gram dhal prior to grinding in the traditional methods is established as an important step in the fermentation. The possibilities of a "Flour Presoaking Method" and a "Composite Dry Mix Method" for *Idli* making to eliminate the need for wet grinding of black gram dhal and rice are indicated by the data. That both yeasts and bacteria participate in the fermentation is shown by using penicillin G and chlortetracycline as selective inhibitors. Acid and gas production are mostly dependent on the growth of micro-organisms belonging to the bacterial group. I. JONES.

Carbohydrates in protein. II. Hexose, hexosamine, acetyl and amide-nitrogen content of hen's-egg albumin. P. G. Johansen, R. D. Marshall and A. Neuberger (*Biochem. J.*, 1960, **77**, 239—247).—Mannose is the only neutral sugar detected in egg albumin by paper chromatography. The protein contains ~2% of this sugar, or five residues/45,000 g. The glucosamine liberated by hydrolysis of the albumin and the isolated polysaccharide from it is determined by two methods; it represents about 1·2% of the protein (3 residues/mole), but a fourth mol. of this or another amino-sugar may be present. The difficulties which may arise in liberating glucosamine from polysaccharide linkage are discussed. The amide-*N* content of egg albumin is 31 ± 1 residues/mole. Most recorded amde-*N* values of glycoproteins probably need to be revied, because 2-amino-sugars are deaminated under the alkaline conditions used for the liberation of NH_3. Egg albumin contains four acetyl residues and at least three of them are associated with the carbohydrate moiety of the protein. The glucosamine is partly, if not entirely, *N*-acetylated. The possibility is discussed that the substituent at the *N*-terminus of the protein chain is an acetyl group. (61 references.) J. N. ASHLEY.

Rôle of carbohydrates in protein metabolism. M. Bedö and G. Nagy (*Nahrung*, 1960, **4**, 411—416).—In rat-feeding tests on the protein-repletion–depletion system, when one carbohydrate only is administered, lactose is far more efficient than dextrin-maltose, sucrose, glucose or fructose in reducing urinary excretion of milk-protein-N, and increasing N-assimilation. With regard to binary mixtures of carbohydrates, the efficiency of dextrin-maltose is very considerably increased by the addition of glucose. The mixtures give 77—84% N-assimilation as against 45% for lactose alone. (17 references.) P. S. ARUP.

Extraction of proteins from green leaves. G. N. Festenstein (*J. Sci. Fd Agric.*, 1961, **12**, 305—312).—The Pirie press was tested on several different species of leaf and the effect of varying extraction conditions studied with tobacco leaves at approx. the same stage of development. With 10—20-g. quantities the grinding (by pressing through a slot) was satisfactory for tobacco, bean, hogweed, etc., but not for cereals and grasses. When macerated young tobacco leaves were squeezed through cloth, the process was almost as efficient in extraction, as repeated centrifuging at 250*g* and 1500*g*. Extracts were centrifuged at 1500*g* and then at 12,000*g* (15-min. periods) to separate chloroplasts and chloroplast fragments from sol. protein (sol. material being that not sedimenting at 1500*g* for 15 min.). After use of detergents to release extra N from fibre that has been extracted in the press, the same total amount of N (90—95%) was extracted as was obtained by repeated milling. (27 references.) E. M. J.

Physico-chemical studies on indigenous seed proteins. IV. Peptisation of red gram (*Cajanus indicus*) proteins and their characterisation by electrophoresis. S. Tawde and K. V. Giri (*J. sci. industr. Res.*, 1960, **19C**, 190—194).—Red gram contains 23·8% of protein, of which 80% is solubilised in 2 h. by a meal : water extractant ratio of 1 : 5. The effects of the extraction period, pH of extractant and the influence of anions, cations and detergents on the solubilisation were studied. Max. separation of the components, one major and two minor, occurred between pH 7 and 8·6 and ionic strength 0·1. E. M. J.

Proteins of olive seeds. III. Extraction experiments. M. J. Fernández Díez (*Grasas y Aceites*, 1960, **11**, 220—222).—Three fractions of olive-seed proteins have been obtained by agitating (15 min.) and centrifuging (30 min.) successively with water, aq. NaCl (10%) and aq. NaOH (0·2N). The first fraction was usually the largest and the middle fraction the smallest. L. A. O'NEILL.

Nutritional value of fats after use in commercial deep fat frying. C. E. Poling, W. D. Warner, P. E. Mone and E. E. Rice (*J. Nutr.*, 1960, **72**, 109—120).—A short-term feeding test was evolved to detect changes in the 34 samples examined. Little significant change was noted. (14 references.) C. V.

Nutritional evaluation of the replacement of the fat in whole cow's milk by coconut oil. F. E. Rice (*J. agric. Fd Chem.*, 1960, **8**, 488—491).—A review. Coconut oil contains 0·8% linoleic acid and 4·0% oleic acid, compared with values of 3·0 and 35·0% for cow's milk fat, 7·8 and 36·5% for human milk fat, and 54·1 and 30·0% for maize oil. Saturated acids in coconut oil amount to 95·3%, compared with 58·8% in cow's milk fat, 48·2% in human milk fat and 12·4% in maize oil. Milk fats carry with them important nutrients, not found in coconut oil. Feeding experiments with animals and human beings have shown that milk fat rates higher nutritionally than coconut during growth and also when the diet is otherwise marginal. It is concluded that coconut oil mixed with skim milk is not a satisfactory substitute for whole milk in diets for infants and children in milk-deficient areas of the world. (41 references.) M. D. ANDERSON.

Nutritive value of almonds (*Ongokea gore* and *Parinari pumila*). R. de Borger (*Rev. Ferment.*, 1960, **15**, 167—170).—The protein contents of two types of Central African almonds are determined

and their nutritional values derived by the method of Oser, viz., a comparison of the contents of essential amino-acids with those of whole egg. The proteins of the two nuts are of high biological value with an index not as high as those of soya (85) and sesame (75), but approaching that of groundnut (62). J. V. Russo.

New natural source of vitamin A. J. Blattná, C. Blattný, sen., and J. Pozděna (*Nahrung*, 1960, **4**, 816—824).—The greater celandine (*Chelidonium maius*, L.) is proposed as a rich source of carotenes in animal feeding. When fed to guinea-pigs and laying hens in small doses the plant caused no adverse effects. With the hens, high values of vitamin A and provitamins were obtained in the egg-yolk. Notes on natural occurrence, climatic tolerance, etc. are given, with a discussion of the possible development of the plant as a cultivated source. (15 references.) C. L. Hinton.

Content of proteinogenic amino-acids and B-vitamins in maize steep liquor. H. Aurich (*Nahrung*, 1960, **4**, 31—41).—Maize steep liquor was found to contain, in wt./vol. terms, dry matter 45·5, ash 8·9, C 15·4, N 3·5, amino-acids 23·8, lipoids 3·12, reducing sugars 1·59, lactic acid 5·35 and other org. compounds 2·49%. Of 18 proteinogenic amino-acids determined, α-alanine (4·65%), glutamic acid (5·20%) and proline (2·46%) were the chief. Of 11 B-vitamins determined, mesoinositol (160 mg./100 ml.) and choline (92 mg./100 ml.) greatly preponderated. Taking all modifying factors into account, the correspondence with the vitamin content of maize is satisfactory. The use of the steep-liquor in industrial microbiological processes, particularly in activated sludge formation, is discussed briefly. (36 references.) C. L. Hinton.

Determination of vitamin B_1 in foods by paper chromatography. L. Wildemann (*Nahrung*, 1960, **4**, 497—511).—Attention is drawn to discrepancies between data for vitamin B_1 content given in official publications. A description is given of the two-dimensional Kraut-Wildemann and Kaiser-Wildemann method (cf. *Inter. Z. Vitaminforsch.*, 1956, **27**, 122 and 131) in which vitamin B_1 (present as thiamine and its mono-phosphoric acid ester) is determined as thiochrome by photography of the spots in u.v. light, and evaluated by the degree of blackening of the film. Directions, tabulated data and formulae are given for the determination of constants applicable to the photographic apparatus and material. Separate directions are given for the separation of vitamin B_1 from (*a*) vegetables, (*b*) cereals and processed vegetables, etc., (*c*) fish and meat and (*d*) milk, milk products and eggs; the operations include comminution with water, pptn. of proteins by trichloroacetic acid, removal of insol. matter by centrifuging, and (if necessary) fatty or other impurities by extraction with amyl alcohol at 50°, and pptn. of other impurities by MeOH. The reproducibility is satisfactory; recoveries of added vitamin B_1 are generally 94—114%. (11 references.) P. S. Arup.

Quantitative determination of vitamin C in heat-treated materials. K. Szöke (*Nahrung*, 1960, **4**, 825—831).—The osazone formed by 2,4-dinitrophenylhydrazone with the dehydroascorbic acid obtained by oxidation of the ascorbic acid can be separated by filtration from some of the interfering substances which occur in heat-treated materials, and further complete separation is then effected by paper chromatography. Quant. determination can be made either by comparison measurement on the chromatogram or by measurement of extinction after elution. Even with materials yielding only a few mg. of ascorbic acid per 100 g., losses due to solubility of the osazone do not exceed 10%. C. L. Hinton.

Decomposition of vitamin C and its inhibition in the food industry. II. Effect of heating during processing, preservation and storage, and investigation and study of methods for suppression of the effect. F. Balla. **III. Effect of ionising radiation on the content of vitamin C in foods. IV. Effect of ultra-violet radiation on the content of vitamin C in foods.** F. Balla and M. Kiszel (*Acta chim. hung.*, 1960, **24**, 421—435, 437—450).—II. Experiments on the decomposition of ascorbic acid on heating fruit juice and vegetable products are described. The rate of decomposition was more sensitive to temp. in the presence of excess O_2, except 107°, and less for dielectric heating than for conventional heat treatment. Preservation of vitamin C during processing is best secured by aseptic conditions, use of high frequency currents and dehydration by i.r. radiation. (16 references.)

III. IV. The effect of γ- and u.v. radiation on the vitamin C content of paprika puree, tomatoes and rose hips was examined. γ-radiation caused only small changes in ascorbic acid content of heat-inactivated products. Enriched products decomposed more rapidly than un-enriched, due to the protective action of natural materials in the latter. Preserved products showed no significant change in ascorbic acid content. The protective action of natural products can be observed, though to a smaller degree, in the case of u.v. radiation. (15 references.) (In Russian; from English summary.) J. L. Prosser.

Loss of ascorbic acid during estimation by the Roe-Kuether method. C. P. Tewari and P. S. Krishnan (*J. Fd Sci.*, 1961, **26**, 11—14).—When the 2,4-dinitrophenylhydrazine method (Roe *et al.*) was applied to plant extracts in which ascorbic acid (AA) was mainly present as dehydroascorbic acid (DHA) and diketogulonic acid (DKA), the value of AA + DHA + DKA was significantly lower than that of DHA + DKA. Similar discrepancies were encountered on analysis of solutions of DHA. In most of the tests the loss was correlated with duration of H_2S treatment. E. M. J.

Biological significance of chelation: copper protein, ascorbic acid oxidase. C. R. Dawson (*Ann. N.Y. Acad. Sci.*, 1960, **88**, 353—360).—The enzyme-catalysed oxidation of L-ascorbic acid exhibits a different O stoicheiometry than does the Cu^{2+} catalysed reaction. In the latter case twice the amount of O_2 is absorbed and H_2O_2 is detected in the end product and dehydroascorbic acid. The possible rôle of the sulphydryl (**I**) group in ascorbic acid (**II**) oxidase activity is discussed. Inhibition studies suggest that the activity of the pure enzyme is not **I** dependent; this contradicts earlier observations by other workers. No free **I**-groups were determined. Quant. determination of the amino-acid (**III**) composition of **II**-oxidase revealed 18 different **III** and a significant amount (10·6 residues per mol.) of glucosamine. (26 references.) C. V.

New method for qualitative and quantitative analysis of antioxidants. A. Seher (*Nahrung*, 1960, **4**, 466—478).—Greatly improved separation and definition is obtained in the author's thin-layer chromatographic method by making the paste for the plates from a mixture of kiesel-gel and 0·5N-oxalic acid. Chromatograms of the antioxidants, sprayed with the molybdophosphoric acid reagent, are evaluated by planimetric measurement of photographs of the spots in comparison with spots similarly obtained from standard solutions of the pure compounds. The accuracy is within ±5%. The method is applicable to the analysis of mixtures of tocopherols. (16 references.) P. S. Arup.

Polyene aldehydes. F. Hoffmann-La Roche & Co. A.-G. (B.P. 836,961, 28.8.58. Switz., 18.10.57).—Polyene aldehydes, viz., R·(CH:CH·CMe:CH)$_2$·CH:CH(CH:CR′)$_n$·CHO (*n* is 1—7; R′ signifies alternate Me and H, starting with Me) or acetals thereof are obtained by selective hydrogenation of R·(CH:CH·CMe:CH)$_2$C:C(CH:CR′)$_n$·CHO (or its acetals), e.g., in presence of a Pb-poisoned Pd–$CaCO_3$ catalyst and quinoline, at <30° (R is 2,6,6-trimethylcyclohexenyl). The products are orange, red, or violet oily or crystalline substances, characterised by vitamin-A activity and useful as food additives, especially in poultry feeds (to promote pigmentation of egg yolk, etc.). A typical example describes the prep of 13-(2,6,6-*trimethylcyclohex*-1-*enyl*)-2,7,11-*trimethyltridcca*-2,4,6,8,10,12-*hexaen*-1-*al*.

F. R. Basford.

Unclassified

Food. J. C. Cavagnol (*Analyt. Chem.*, 1961, **33**, No. 5, 50R—61).—Food analytical procedure for the 1959—60 period is reviewed, the subject matter covering additives, adulterants, aliphatic, aromatic and heterocyclic compounds, flavours and aromas, colourings, enzymes, fats, oils and fatty acids, gases, moisture, proteins, amino-acids and nitrogen, sugars, starches and carbohydrates, vitamins, etc. (397 references.) C. V.

Composition of various marketed soups. A. M. Le Clerc and J. Siffert (*Ann. Falsif., Paris*, 1960, **53**, 506—511).—The amino-acid and total creatinine contents of 12 samples of soup powders are determined with a view to assessing their nutritional value.

J. V. Russo.

Evaluation and microbiological parameters of dry food concentrates on the example of [Poznań, Poland] buckwheat soup concentrate. J. Janicki and S. Stawicki (*Roczn. Technol. Chem. Żymnosci*, 1960, **5**, 37—68).—The effects of storage at 4—28° and 60—95% R.H. on chemical and microbiological changes in samples of Polish buckwheat soup concentrate were investigated. Determinations were made at intervals of water and fat contents, peroxide and acid no., acidity of the aq. extract, and lipase activity; total no. of bacteria, aerobic- and mould spores. Changes in the type of bacteria were observed in conditions of prolonged storage. The quality of dry food concentrate was best determined by the water content, acid no. of the fat, total no. of the spores of aerobic bacteria, and of mould spores. At 18—28° and 60—65% R.H. the soup concentrate kept well for up to 2 years. For concentrates for immediate consumption and those suitable for storage up to 12 months at 10—15° and 70—75% R.H. the respective data was: water content ⩽16, 10—11%, acid no. of the fat 10—15, ⩽3·5 ml. 0·1N-KOH per g., total no. of bacteria ⩽40,000, ⩽3000 per g., total no. of spores of aerobic bacteria ⩽500, 150 per g., total no. of spores of moulds ⩽1000, 100 per g. (22 references.) A. L. Grochowski.

Determination of aldehydes and ketones in foodstuffs. II. Titrimetric microdetermination of unsaturated aldehydes, ketones and other unsaturated compounds by means of bromate–bromide solution. V. Hamann and A. Herrmann (*Mikrochim. Acta*, 1961, **1**, 105—128).—The quant. isolation of volatile oils by continuous steam distillation is described; recoveries for citral were about 92%. The determination of essential oils, terpenes, unsaturated hydrocarbons, alcohols and acids by reaction with aq. KBr–$KBrO_3$ and back-titration of Br_2 was studied; recoveries were usually good. For hydrocarbons such as octene, Hg^{2+} acetate was used as a catalyst. (In German.) P. D. PARR-RICHARD.

Phosphates and organic phosphorus compounds in foods. VIII. Preparation of inositol phosphoric acid esters. IX. Enzymic hydrolysis of inositol phosphoric acids. J. Schormüller and G. Bressau (*Z. LebensmittUntersuch.*, 1960, **113**, 484—491, 492—501; cf. *ibid.*, 1960, **113**, 387—395).—Phytic acid and inositol phosphoric acid ester were separated by a gradient elution process on a strongly basic ion-exchange chromatographic column and isolated. Besides pure hexaphosphate, the pentaphosphate and isopentaphosphate, isodiphosphate and monophosphate of inositol in pure form as Ba salts were isolated. Details of the prep. are given. (21 references.)

IX. Hydrolysis of inositol phosphoric acids by wheat-bran phytase and other ester-splitting ferments, e.g., wheat germ-, potato- and alkaline intestine phosphatase is described. With a wheat-bran phytase prep. the speed of hydrolysis decreases with increasing no. of phosphate groups in the inositol mol. Inositolmonophosphate, an exception, is hydrolysed very slowly; this is discussed. The plant phosphatases hydrolyse all inositol phosphates if only in small amounts, and gradually, in the same order as phytase. Animal phosphatase (alkaline intestine phosphatase) hydrolyses only inositol-mono- and -diphosphates. (32 references.) E. M. J.

Metabolic studies of the technological foods of important micro-organisms. II. Pathways of amino-acid synthesis in lactic acid bacteria. H.-D. Belitz and J. Schormüller (*Z. LebensmittUntersuch.*, 1960, **113**, 449—453).—Lactic acid bacteria were grown in presence of $NaH^{14}CO_3$, $CH_3{}^{14}COONa$ and $^{14}CH_3COONa$ and out of the ^{14}C-labelled bacterial protein hydrolysates, aspartic acid, glutamic acid, glycine, alanine and serine were isolated. These amino-acids were subjected to suitable breakdown reactions and the distribution of activity over the mol. was determined. The pathways of CO_2 and acetate in individual compounds were noted. The results obtained are not explained by the assumption of a synthesis of the β-carboxylation of pyruvic acid and citric acid cycle alone. Many more reactions are concerned, additional activity in the non-carboxyl C atoms and equal distribution on both carboxyls of aspartic acid. Equilibrium is probably regulated by pyruvic acid oxidase and ketoglutaric acid oxidase. (14 references.) E. M. J.

Chromatography by polyamide powder in flavonoid analysis. J. Davídek (*Nahrung*, 1960, **4**, 661—666).—The chromatographic method described is based on the use of polyamide powder as the absorption material. A standard flavonoid solution (1—2 ml.) is applied to the prepared column, washed with water, the methanolic eluate is collected in a 25 ml. flask and determined colorimetrically with diazotised *p*-aminobenzoic acid. The method, which by comparison with paper chromatography, is quicker and gives better results, was applied to determination of rutin in elderflowers. (21 references.) E. M. J.

Simplified method for bacterial count estimation and biological plant control. H. Lüthi and U. Vetsch (*Mitt. Lebensm. Hyg., Bern*, 1960, **51**, 394—399).—A method for doing a total bacterial count using polyethylene or polyamide tubes in place of Petri dishes is described. The method of inoculation in testing the osmophilic yeast content of a fruit juice concentrate of high η and prep. of a Trypan blue stained culture are illustrated. J. V. RUSSO.

Heat resistance of *Bacillus subtilis* spores. II.—effect of different species. A. N. Bose and A. K. Roy (*J. sci. industr. Res.*, **19 C**, 277—279).—The effect of various spices on the heat resistance of *B. subtilis* spores is discussed and the materials and methods used, are described. Results of heat resistance determinations using suspensions of various spices and a range of heating periods, are tabulated. Of the spices used, chillies and mustard oil are particularly effective in reducing the heat resistance of these spores. A. W. WEBB.

Thermal destruction of *Streptococcus faecalis* in prepared frozen foods. T. M. Ott, H. M. El-Bisi and W. B. Esselen (*J. Fd Sci.*, 1961, **26**, 1—10).—Thermal destruction rates of *S. faecalis*, ATCC 7080, were determined in six meat and fish precooked frozen products. Data on heat transfer through the products when heated in a hot-air electric oven were obtained. Theoretical thermal treatments required to make the products commercially sterile were computed (General method) and subsequently confirmed by trial inoculation tests. The procedure adopted was accurate and feasible for this type of product. The heat treatments recommended on the commercial packages seemed adequate when based on the thermal resistance of the test strain. In one case the recommended heating period fell short of the computed thermal requirement for that product. (24 references.) E. M. J.

Use of bioassay for pesticide residues in foodstuffs. Report to Analytical Methods Committee of Society for Analytical Chemistry. P. H. Needham (*Analyst*, 1960, **85**, 792—809).—The report reviews the methods employed in a number of British and European laboratories. The techniques employed may be divided into three types: (*a*) direct methods in which the test organisms are confined over a pulp of the sample containing the residue; (*b*) film methods in which the test organism is exposed to the residue after its extraction from the sample; and (*c*) aq. methods in which the residue after extraction from the sample is added to water containing an aquatic organism. Applications are described. (98 references.) A. O. JONES.

Meat and milk residues from livestock sprays. H. V. Claborn, R. C. Bushland, H. D. Mann, M. C. Ivey and R. D. Radeleff (*J. agric. Fd Chem.*, 1960, **8**, 439—442).—Studies on insecticide residues in meat and milk after spray treatments of animals are summarised, with details in each case of time of max. residue after spraying, amount of max. residue and duration of detectable residue. All insecticides passed into the body and milk fats. The max. residue was 103 p.p.m. of DDT in the fat of calves sprayed at 2-week intervals. The fat of calves fed on the milk of sprayed mothers contained more DDT than the fat of the mothers. (20 references.) M. D. ANDERSON.

3.—SANITATION

Mecarbam, a new multi-purpose organophosphorus insecticide. M. Pianka (*Chem. & Ind.*, 1961, 324).—Mecarbam [*OO*-diethyl *S*-(*N*-ethoxycarbonyl-*N*-methylcarbamoylmethyl)phosphorothiolothionate], one of a series prepared by condensing carbamates with organo-P compounds, has the formula $(EtO)_2P(:S)\cdot SCH_2CON(CH_3)\cdot CO_2Et$ and is a very low-volatile oil (b.p. 144°) available as emulsions containing 40—80% of technical mecarbam (90% concn.), or as a 6% solution in oil. In concn. of 2—4 p.p.m. it gives complete kill of house-fly pupae and adults, dipterous larvae and fruit-fly adults, besides ensuring effective control of mites, etc. on ground crops and fruit trees (max. 0·04—0·08% spray, 6·4—16 oz./acre). Recovery from inhibition is fairly rapid; acute oral toxicities for small mammals are moderate. W. J. BAKER.

Development and characterisation of resistance to carbamate insecticides in the house fly, *Musca domestica*. G. P. Georghiou, R. L. Metcalf and R. B. March (*J. econ. Ent.*, 1960, **54**, 132—140).—Two strains of house flies, showing a small amount of resistance to Isolan and Compound III (3-isopropylphenyl *N*-methylcarbamate), after 20 generations selection showed a seven-fold and 19·5-fold resistance to Isolan and >50- and 7·5-fold to Compound III in adults and larvae respectively. Levels of cross-resistance to other carbamates are given. Cross-resistance to DDT, Prolan, parathion, chlorthion and Dicaptan was <three-fold but three- to six-fold to methoxychlor, malathion and diazinon. When piperonyl butoxide was added to Isolan and Compound III resistance in all strains was less than six-fold and three-fold respectively and this was not increased by further selection. (26 references.) C. M. HARDWICK.

Control of resistant house flies. H. B. Weinburgh, J. W. Kilpatrick and H. F. Schoaf (*J. econ. Ent.*, 1961, **54**, 114—116).—Bayer 29493 [*OO*-dimethyl *O*-(4-methylthio-*m*-tolyl) phosphorothioate] residual spray gave excellent fly control in dairies for up to 22 weeks, but was not useful as a bait. Malathion or Dibrom sugar emulsions were effective for only 1 and 4 weeks respectively. Dimetilan bands were less active than Ronnel-impregnated cords which gave excellent control for the whole season in dairies. C. M. HARDWICK.

Inhibition of house-fly ali-esterase (Ali-E) and cholinesterase (Che) under *in vivo* conditions by parathion and malathion. F. W. Plapp, jun., and W. S. Bigley (*J. econ. Ent.*, 1961, **54**, 103—108).—In parathion-susceptible and -resistant flies, parathion and malathion inhibited Ali-E activity more rapidly than ChE. Inhibition occurred before symptoms of poisoning. Recovery of Ali-E levels could occur at death. ChE was always related to poisoning, inhibition being slower and less reversible. Max. inhibition was closely correlated with knockdown. C. M. HARDWICK.

Aerosol dispensing system for aircraft disinsectisation. A. H. Yeomans, R. A. Fulton and W. N. Sullivan (*J. econ. Ent.*, 1960, **54**, 199—201).—A system of small one-shot aerosol containers situated throughout the aircraft, but which can be discharged centrally, is described. They contain 5% insecticide in the propellent dichlorodifluoromethane. C. M. HARDWICK.

Water analysis. M. W. Skougstad and M. J. Fishman (*Analyt. Chem.*, 1961, **33**, No. 5, 138R—164).—A very detailed literature review of recent analytical methods. (448 references.) C. V.

Coliform group and faecal coliform organisms as indicators of pollution in drinking water. P. W. Kabler and H. F. Clark (*J. Amer. Wat. Wks Ass.*, 1960, **52**, 1577—1579).—Presence of faecal coliform organisms is an indication of recent and possibly dangerous pollution. Presence of intermediate–aerogenes–cloacae (I.A.C.) subgroups suggests less recent pollution or defects in water treatment or distribution. (32 references.) O. M. WHITTON.

Effect of fish poisons on water supplies. I. Removal of toxic materials. J. M. Cohen, L. J. Kamphake, A. E. Lemke, C. Henderson and R. L. Woodward (*J. Amer. Wat. Wks Ass.*, 1960, **52**, 1551—1566).—The physiological effects of rotenone and toxaphene, the toxic agents used in fish poison formulations, are described. Activated carbon treatment is the most effective method of removal of these agents. Cl_2 and ClO_2 will remove rotenone deriv. only and alum coagulation is useless. A bioassay is used to determine the effectiveness of various treatments. (25 references.) O. M. WHITTON.

Significance of pesticides in water supplies. R. L. Woodward (*J. Amer. Wat. Wks Ass.*, 1960, **52**, 1367—1372).—Likely sources and effects of pesticides in water supplies are discussed. (12 references.) B. F. FULLAN.

Arginine, cystine and glycine metabolism in activated sludge. D. A. Carlson (*Dissert. Abstr.*, 1960, **21**, 569—570).—Investigation showed that with L-cystine or glycine substrates in activated sludge, the rates of O_2 uptake are higher in acclimated than in unacclimated ativated sludges but with L-arginine the rates are about the same. The ultimate total amount of O_2 utilised is nearly the same for acclimated and unacclimated cultures. Canavanine competitively inhibits arginine utilisation in samples both acclimated and unacclimated to L-arginine substrates. O. M. WHITTON.

Iodine-containing disinfectants. A.—B. Ewos (B.P. 836,868, 28.7.58. Swed., 13.8.57).—A complex comprising I bound to a non-ionic surface-active agent, preferably a polyglycol ether, is adsorbed on a dry mixture of a basic salt (bicarbonate, carbonate or phosphate) and an acid salt or an acid (bisulphate, sulphamic acid or sulphonic acid), to provide a non-hygroscopic, water-sol. powder of high bactericidal properties. F. R. BASFORD.

Coumarin derivatives. Farbenfabriken Bayer A.-G. (BP., 836,740, 25.4.57. Ger., 25.4, 4.6, 20.7, 31.8.56).—Compounds useful for the destruction of rodents comprise 4-hydroxycoumarins substituted in the 3-position by CHRR′ (R is alkyl, R′ is aryl or R and R′ together with C form a cycloalkyl or heterocyclic radical). One example given is 4-*hydroxy*-3-(1-*phenylethyl*)*coumarin*, m.p. 208—209°, the prep. of which is described. H. S. R.

Digestive treatment of sewage sludge. S. Nishihara (B.P. 837,561, 28.9.56).—Apparatus is figured and claimed. F. R. BASFORD.

4.—APPARATUS AND UNCLASSIFIED

Zn-65 and chromium-51 in foods and people. R. W. Perkins, J. M. Nielsen, W. C. Roesch and R. C. McCall (*Science*, 1960, **132**, 1895—1897).—Reactor coolant water added to the Columbia river resulted in the introduction of radio-isotopes to the water. The half lives of some of these are long enough to enable them to be traced to food from farms bordering the river. Much higher ^{65}Zn and ^{51}Cr levels were found in farm produce irrigated by the river water than that by water from other areas. Fish from the river also had higher levels and whole body counts of individuals in the area indicated increased absorption of ^{65}Zn. T. G. MORRIS.

Clinical chemistry. G. R. Kingsley (*Analyt. Chem.*, 1961, **33**, No. 5, 13R—32).—Analytical literature for 1959—60 is covered relating to apparatus and equipment, amino-acids, blood preservation and gasometric analysis, carbohydrates, cations and anions, drugs, lipids, enzymes, function tests, haemoglobin, metals, N compounds, hormones, org. acids and compounds, proteins, sterols, toxicology, vitamins, etc. (629 references.) C. V.

Pharmaceuticals and related drugs. G. J. Papariello, S. C. Slack and W. J. Mader (*Analyt. Chem.*, 1961, **33**, No. 5, 113—126).—Analytical procedures during a two-year period, 1958—60 are reported. Antibiotics, carbohydrates and glycosides, steroids and hormones and vitamins are included. (568 references.) C. V.

Plant damage and eye irritation from ozone–hydrocarbon reactions. E. F. Darley, J. T. Middleton and M. J. Garber (*J. agric. Fd Chem.*, 1960, **8**, 483—485).—The gas-phase reaction products of mixtures of ozone and hydrocarbon were assessed for their activity in damaging pinto bean plants, and in causing eye irritation. Plant damage was caused by mixtures of ozone with all hydrocarbons that yielded products with three or more C atoms after cleavage at the double bond (3-methyl-1-butene, 1-pentene, 2-pentene, *cis*-3-methyl-2-pentene, 1-hexene, 2-methyl-1-hexene, *cis*-3-hexene, *trans*-hexene, 3-heptene, 1,3-butadiene, benzene, toluene and cumene). The products of propylene and 2-butene caused no damage to plants. Injury was markedly less when a CH_3 group was attached at the double bond of a straight-chain olefin. *Cis* and *trans* forms of a given olefin were equally damaging. None of the reaction mixtures caused more eye irritation than that recorded for clean filtered air. M. D. ANDERSON.

Determination of fluorine in animal and vegetable tissues and in foodstuffs. E. Matthey, F. Fassa and V. Demole (*Mitt. Lebensm. Hyg. Bern*, 1960, **51**, 339—355).—Banerjee's microcolorimetric method for the determination of F (which depends on the diminution of colour of the complex between 2*p*-sulphophenylazo-1,8-dihydroxy naphthalene 3,6-disulphonate (SPADNS) and Th, in the presence of F^-) gives very precise results on urine, blood, parenchymatous tissues, teeth, bones, water, fruit juices, milk, wine and fruits. J. V. RUSSO.

Quantitative chromatography and electrophoresis of the nucleotides of tissue ribonucleic acids. Chemical relations between ribo- and deoxyribonucleic acids. J. Montreuil, P. Derumez and P. Boulanger (*C. R. Acad. Sci., Paris*, 1960, **251**, 3100—3102).—The procedure given obviates any initial separation of the nucleotides. After defecation and delipidation of the sample, the protein fraction is hydrolysed and proteins plus deoxyribonucleic acids (**I**) are precipitated and centrifuged at pH 4—4·5. The clear liquid is passed through a column of Dowex-50 (H form) from which the ribonucleides are eluted with water. The conc. eluate is submitted either to paper chromatography (phenol–isopropanol–formic acid–water as solvent system) followed by microdetermination of P, or to electrophoretic analysis at pH 3·5 followed by u.v. spectrometry of the nucleotides. Both methods give concordant results (seven different rat-tissues) and show that, like **I**, the four ribonucleic acids (**II**) each have the same composition in each tissue and that the purine/pyrimidine and $6NH_2/CO$ ratios also equal unity. Contents of the separate acids in **II** correlate closely with those in **I**. Biosynthesis of **II** by " moulding " on the mol. of **I** is postulated. W. J. BAKER.

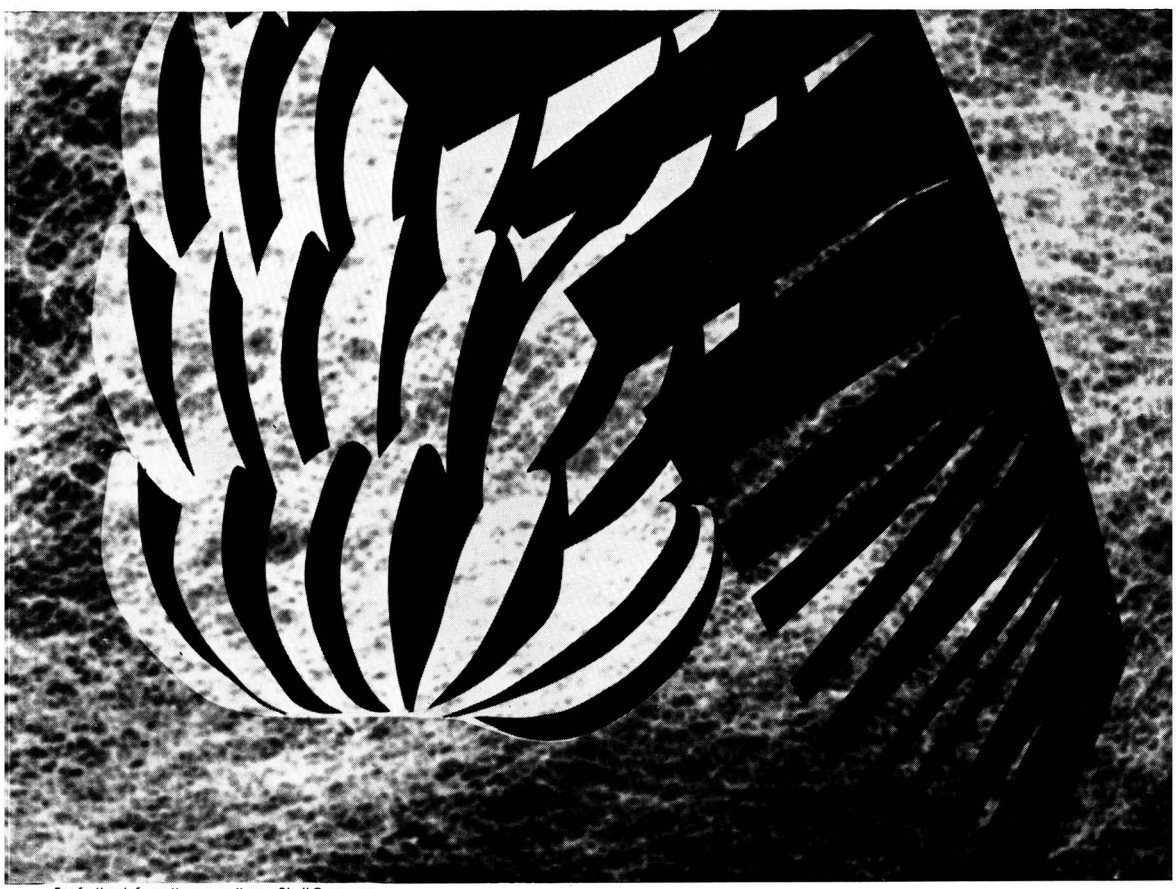
Modified determination of small amounts of arsenic with molybdenum blue. K. Bauer (*Kem. u Industr., Zagreb*, 1960, **9**, 235—238).—The colorimetric determination of As by means of Mo blue was modified and the Lucena–Prat reagent, containing Mo^{6+} and Mo^{6+}, was used in place of the reducing agent. A procedure was established for org. (foods) and inorg. (food additives, e.g. polyphosphates) samples containing 0·3—10 μg. As per g. dry wt. The AsH_3 is evolved in the usual way into aq. $HgCl_2$ and the Lucena–Prat reagent is added. The colour is developed by heating in boiling water, and the extinction at 840 mm is read against a blank. The only interference reported is that of large amounts of heavy metals; these tend to lower the results. A. L. GROCHOWSKI.

Colorimetric determination of triphenyltin residues. H. J. Hardon, H. Brunink and E. W. van der Pol (*Analyst*, 1960, **85**, 847—849).—The sample of plant material is extracted with methylene chloride, the solvent is removed from an aliquot of the extract, the residue is dissolved in $CHCl_3$ and the solution is dried over Na_2SO_4. It is applied to an alumina column in $CHCl_3$ and a specified portion of the eluate is treated with a buffer solution (pH 8·4) and dithizone in $CHCl_3$ in a separator. The extinction of the org. layer is measured at 610 mμ and referred to a calibration graph. Chlorophyll may interfere but may be removed by placing some infusorial earth above the alumina. Recovery ranged from 88 to 102%. A. O. JONES.

Rapid determination of nitrate and nitrite in plant material. J. T. Woolley, G. P. Hicks and R. H. Hageman (*J. agric. Fd Chem.*, 1960, **8**, 481—482).—The method of Nelson, Kurtz and Bray (*Analyt. Chem.*, 1954, **26**, 1081) for determining nitrate and nitrite in plant material involves diazotising nitrite with sulphanilic acid, and coupling with 1-naphthylamine to form a red dye; nitrate is reduced to nitrite before it is determined. The method is improved by using a trace of Cu in the reduction of nitrate to nitrite, by adding rather more of the reagent powder, and by allowing more latitude in the time schedule. M. D. ANDERSON.

Microscope studies on fresh *Hevea* latex. W. A. Southorn (*Rubb Developm.*, 1961, **14**, No. 1, 2—6).—The complexity of fresh rubber latex as shown by high-speed centrifugation and refrigeration methods of analysis are discussed. Wherever possible observations were made by phase contrast microscopy with latex in its original state. The particulate material can be divided into eight particle types and there is a network of threads to which the particles have attachments. The structural findings of greatest significance are detailed and illustrated by photomicrographs. (12 references.) E. M. J.

Banana (bănā·nă): f. Port. and Sp.: derived from native name *banana* in Congo. *Musa* species (family *Musaceae*). 1. A plant cultivated in tropical countries; grows to a height of 20 feet. 2. The fruit grow in clusters of finger-like berries, containing highly nutritious pulp. 3. Subject to nematode infestation of the roots causing 'toppling' of the plant, retarded growth and poor yield. 4. Protection against nematodes: Nemagon injected in soil round roots, during or after planting, without risk of damage to the plant. 5. Nemagon is one of the range of Shell pesticides that makes complete crop protection possible (see also aldrin, dieldrin, endrin, Phosdrin and D-D). **Nemagon** *Trade Mark*



For further information consult your Shell Company.

In agriculture and industry **Shell Chemicals** SHELL

J. Sci. Food Agric., 12, July, 1961

JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

CONTENTS

Offices of the Society: 14 Belgrave Square, S.W.1
Telephone: BELgravia 3681/5

Annual Subscription to the *Journal of the Science of Food and Agriculture*, £15 post free, single copies £1 17s. 6d. post free