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THE BEHAVIOUR OF SYSTEMIC INSECTICIDES IN PLANTS: A SURVEY OF RESULTS OBTAINED WITH ^{32}P-LABELLED SCHRADAN AND DEMETON-S

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Experiments on the behaviour under glasshouse conditions of schradan and demeton-S applied to different species of plants are reviewed.

Following application of schradan to leaves, some was absorbed and some evaporated. Absorption occurred both in light and darkness but higher temperatures accelerated initial absorption. Whilst the two surfaces of broad bean and *Coleus* leaves were equally absorptive, the lower surface of apple and chrysanthemum leaves absorbed more than their upper surface. Application of demeton-S to leaves was followed by three processes—evaporation, change into less volatile, toxic derivatives, and absorption, and the chemical was effectively removed from the leaf surface within a few hours. The products derived from demeton-S were also absorbed but at a slower rate. The evaporation of demeton-S gave rise to a fumigant effect.

Translocation of schradan from treated leaves to other parts of the plant occurred, mainly in an upward direction and in amounts sufficient to kill aphids. Schradan was also found in the nectar of borage and mustard flowers following leaf application before the flowers had opened. The schradan appeared to be translocated in the phloem. Translocation from leaves treated with demeton-S was never sufficient to kill aphids feeding elsewhere on the plant, and no unchanged demeton-S and only small amounts of its toxic derivatives were found in untreated leaves or nectar.

Species differences were found in the rate of breakdown of schradan after absorption from leaves and in the relative rate of breakdown of schradan in treated leaves and in those receiving schradan by translocation. The primary derivatives of demeton-S were retained for several weeks, especially within treated leaves. The breakdown rates of both schradan and demeton-S slowed down towards the end of the growing season.

Following root application to broad beans in sand or soil, unchanged demeton-S was absorbed and detected in the shoot tip where concentrations of demeton-S and its primary derivatives were present in amounts sufficient to kill *Aphis fabae*. Movement in xylem following root application seems to occur freely.

Introduction

THE establishment of the systemic behaviour of certain fluorine and phosphorus compounds by Schrader[1] in 1947 has been followed by extensive research to determine the advantages and limitations of these chemicals when used as insecticides. Evaluation of the merit of any chemical for pest control on a food crop involves considerations of the toxicity of the chemical to the insect, and also an assessment of residue levels likely to be present at harvest for use in conjunction with toxicological data to determine the possible hazards to consumers. Where the insecticide possesses systemic properties, a knowledge of its behaviour within the plant tissues is also clearly desirable. Information of this kind will lead to the more efficient and safe use of the systemics now known, and may help in the development of new ones.

Hazards encountered by spray operators during application of organo-phosphorus compounds are well established and have been the subject of official regulations.[2]

The general pattern of breakdown of schradan within the plant has been determined by Hartley *et al.*[3, 4] who showed that schradan degrades within plant tissue into non-toxic inorganic forms of phosphorus. The active choline-esterase inhibitor, an unstable intermediate product in the degradation, is believed by Casida *et al.*[5] to be the corresponding amine oxide (octamethylpyrophosphoramidic oxide), and by Heath *et al.*[6] to be hydroxymethyl-heptamethylpyrophosphoramide. Dubois *et al.*[7] and Hall *et al.*[8] have shown that the plant can form the active inhibitor, but Duspiva[9] showed that insects are capable of producing it quite readily, and activation within the plant is regarded by Hartley[21] as of little importance in insect control. Demeton-S, which is relatively insoluble, was similarly shown by Heath *et al.*[6, 10] to degrade successively

within plant tissue into intermediate derivatives referred to as D_1, D_2 and D_3; the first two were suggested as being mainly responsible for the systemic behaviour of demeton-S. D_3 represents a mixture of subsequent degradation products which are more hydrophilic, and which are likely to be less toxic than D_1 and D_2. Fukuto *et al.*,[11] using chromatographic techniques, claim that two derived products of demeton-S are the corresponding sulphoxide and sulphone. More recently Heath *et al.*[6] have identified D_1 as the sulphoxide or *OO*-diethyl *S*-ethylsulphinylethyl phosphorothiolate.

Methods

During the period 1950–4 a series of investigations[12–20] was carried out by Dr. S. H. Bennett, Messrs. G. D. Glynne-Jones (then at Seale Hayne Agricultural College), C. P. Lloyd-Jones and the author to obtain information on the behaviour in plants (evaporation, absorption, translocation, degradation and secretion in nectar) of the systemic insecticides schradan and demeton-S. All the experiments were carried out in the glasshouse. The investigations involved the determination of small quantities of the chemicals distributed throughout the plant and the radioactive tracer technique was adopted as the most sensitive analytical method available. Labelled P was used because of the known association of systemic properties with particular molecular configurations involving the P atom.[21] This paper summarizes the results obtained in these investigations, and discusses them in relation to the findings of other workers.

Radioactive ' counts ' on plant digests of extracts indicate only the total ^{32}P present and provide no evidence on the extent of degradation of the original molecule. In our work the procedure of partition distribution recommended by Hartley *et al.*[3, 4] for schradan and by Heath *et al.*[10] for demeton-S, have therefore been used in following the breakdown of the chemicals within the plant. Schradan was prepared as a solution in water and used at various concentrations within the range 0·005–1·0% (w/v); demeton-S was emulsified in water and used at concentrations within the range 0·16–0·24% for leaf application and 0·08–0·4% for soil work.

It was possible in many instances to observe the behaviour of aphids on treated plants, and by analysing plant sections at particular stages of aphid response, to obtain an estimate of the concentration of insecticide necessary to produce aphid kills in a plant section.[18, 20]

Results

A. *Chemical stability of the insecticides in bulk and in soil*

(a) *Schradan.*—Schradan appeared to be chemically stable both when kept as a pure sample and as a solution in water. Park[22] studied its stability in soil and found that in a soil of pH 5·5 and of high organic matter content the decomposition half-life of schradan at 35° is approximately one year; in soils of higher pH and lower organic content the stability is probably greater. Schradan applied to the soil and not absorbed by the plants may therefore be absorbed during the following season by a different crop.

(b) *Demeton-S.*—While pure demeton-S was found to be chemically stable if stored in a sealed ampoule, or as a few drops in a sealed glass flask in daylight, dilute water emulsions of demeton-S (both with and without emulsifier) slowly decomposed both in light and darkness.[20]

Demeton-S emulsions degraded much more rapidly in contact with partially sterilized potting compost; after 26 days only 4% of the recovered ^{32}P was still present as unchanged demeton-S, and it is likely that the soil micro-organisms influence the pattern of decomposition. Degradation of demeton-S water emulsion also appeared to occur in contact with partially sterilized sand, but at a slower rate than in soil.[20]

B. *Behaviour of sprayed deposits on glass and treated leaf surfaces*

(i) *Evaporation*

(a) *Schradan.*—Evaporation of schradan from glass slides was shown[17] to be more dependent on air movement than on increase of temperature (up to temperatures of about 70° F). Evaporation proceeded continuously but at a rate slower than calculated from physical data, probably due to the low vapour pressure (5×10^{-5} mm. at 15°[23]) and the resultant small saturation concentration in air (0·8 μg./litre).

Evaporation from leaf surfaces was accompanied by absorption; even so, evaporation of schradan from leaves occurred at only about one-fifth of the rate from glass slides during the first 48 h. although there was ample material still on the leaf surface. Similarly for apple leaves treated on 1 September and harvested 60 days later, about 20% of the total schradan recovered was found to be on the leaf surface. Even after 7 days in July (with glasshouse temperatures in the range 63–85° F), of the impacted schradan on chrysanthemum leaves which had not been absorbed, a third had failed to evaporate. It was possible that extensive degradation of the schradan film to water-soluble non-volatile derivatives had occurred in 60 days, but tests with beans and *Coleus* indicated that this factor could not have been responsible in short-term experiments. Behaviour of this kind suggests the development of a loose affinity, possibly involving molecular forces between the schradan and the cuticle, sufficient to retard evaporation but insufficient to prevent removal by water.

(b) *Demeton-S.*—Evaporation of demeton-S from glass slides in daylight occurred only during the first few hours after application, after which no further loss took place, suggesting the occurrence of two processes, evaporation and rapid chemical degradation into non-volatile derivatives.[20] This behaviour of these demeton-S films confirms the results of Cook[24] who showed that by exposure of such films on paper to light and air, rapid conversion into more hydrophilic compounds occurred. Cook's infra-red absorption analyses indicated the formation of compounds retaining the P=O link and having a close similarity to the parent compounds, a result of interest in view of later findings of other workers.[6, 11]

Following the deposition and exposure to light of demeton-S as a thin film on leaf surfaces, the three processes—evaporation, absorption and degradation into non-volatile derivatives—effectively removed all unchanged demeton-S from the leaf surface within a few hours after application.[20] Analysis of the data for leaf applications to beans, apples and *Coleus*, under a range of glasshouse conditions (temperature, light and relative humidity), showed that the proportion of initial deposit not accounted for at harvest (and presumed evaporated) was always about 50% for beans and *Coleus* and not very much less for apples. Chemical degradation of the deposited demeton-S films on leaves was also shown to occur both in the presence and absence of the emulsifier, with the formation of the less volatile degradation products D_1, D_2 and D_3.

Evaporation of demeton-S from leaves gave rise to a fumigant effect, which produced aphid kills only during the first few hours after application.[20] The significance of this fumigant effect in the field use of demeton-S cannot be assessed from these experiments, but under favourable conditions (warm weather with no wind) it could effectively clear the plants of susceptible insects at the time of spraying.

(ii) *Absorption and chemical degradation within treated leaves*

Two characteristic features of a systemic insecticide are that absorption into the plant tissue occurs followed by movement away from the site of application. Whilst a complete picture of the mechanism of absorption was not built up during this work, much information on this topic was obtained for both insecticides.

(a) *Schradan.*—The suggestion made by Heath & Llewellyn[23] that the main mode of entry of schradan is cuticular rather than stomatal was supported by data obtained with *Coleus* leaves in which the upper and lower surfaces were found to have equal absorptive powers, despite the absence of stomata on the upper surface.[17] The appreciable absorption shown by broad beans, runner beans and *Coleus* when kept in the dark before and after application of schradan to the leaves gives further support to this suggestion.[17]

Experiments to investigate the role of some physical factors in promoting absorption of schradan showed the importance of both temperature and illumination. Broad and runner beans subjected to different pre- and post-spraying light conditions showed that appreciable absorption occurred at 60–70° F even when the plants had been kept in the dark for 36 h. before treatment, and were replaced in the dark for 72 h. It would also appear that post-spraying is more important than pre-spraying lighting in promoting absorption.[17]

The specific effects of illumination and temperature were further investigated by subjecting bean plants sprayed with schradan (all conditioned in the dark for 24 h. before spraying) to

varying light and temperature exposures in four different compartments in the glasshouse: at harvest the treated leaves were washed with water and the washings and plants radio-assayed. The results are plotted in Fig. 1 and show that whilst the extent of absorption after 72 h. is the same for plants kept in daylight and in the dark, the rates of absorption are different, the higher temperature (80° F) promoting more rapid absorption in the early stages under both light and dark conditions. Under field conditions evaporation would probably have occurred to a greater extent especially at 80° F.

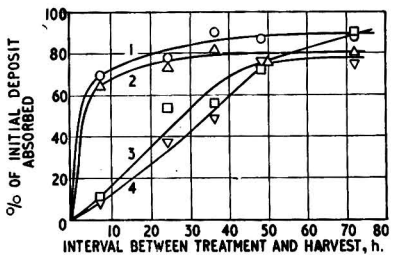

FIG. 1.—*Absorption of schradan by beans under different light and temperature conditions*

○ Daylight at 80° F
△ Dark „ 80° F
□ Daylight „ 50–60° F
▽ Dark „ 50–60° F

Evidence on the age of leaf as a factor in absorption was obtained for chrysanthemum and apple.[17] In both instances the schradan absorbed in 7 or 14 days, when expressed as a ratio of that impacting, was greatest for the youngest leaves and least for the middle section leaves; there were indications that absorption was not only more extensive but also more rapid in the youngest leaves.

Experiments to determine the relative absorption of upper and lower leaf surfaces during the first few days after treatment showed that whilst both leaf surfaces of *Coleus* and broad beans were equally absorptive, with chrysanthemum and apple, absorption was greater on the lower leaf surface.[17]

Within the treated leaves the concentration of schradan is gradually reduced by two processes—breakdown and translocation. The rate of breakdown was found to vary with the species (see section C below), but for all species the rate of breakdown may be appreciably slowed down towards the end of the growing season. In one long-term experiment in which apple leaves were sprayed on 1 September, no increase in breakdown in the treated leaves occurred after 39 days.[18] Data on the breakdown of schradan in treated borage and mustard leaves sprayed at the end of July (Table II) showed that a month later only about half of the absorbed schradan recovered in the treated leaves had broken down.[15] These results lend support to the views of Ripper *et al.*[24a] that the breakdown rate varies with the growth activity of the plant.

(b) *Demeton-S.*—Absorption of demeton-S from emulsion deposits on bean leaves was shown to begin even before the emulsion had dried, the initial rate depending on the rate at which the water phase evaporated. Under normal conditions the proportion absorbed during 25 min. varied up to about 20% of that impacting, while within 2–3 days after spraying between 80 and 95% of the total demeton-S derived compounds recovered in and on the treated leaves had been absorbed. After 17 days only about 2–3% or less of the total derived phosphorus compounds recovered had not been absorbed.[20]

Detailed information on the processes which occur during the first two days after spraying was obtained by washing the treated leaves of bean plants sprayed with demeton-S and analysing the washings and the leaf residues. The results confirmed that no demeton-S remained on the leaf surface but that extensive formation of the less volatile degradation products had occurred, almost certainly during the first few hours after application. The results also showed that after 2 days up to 32% of the total of demeton-S and its derivatives recovered from within the treated leaves was still present as unchanged demeton-S. Clearly therefore demeton-S itself can be absorbed, as can its degradation products D_1, D_2 and D_3, though the latter are probably absorbed at a slower rate than the demeton-S.

It is likely that after this initial period demeton-S does not persist very long within the treated leaves, but the washing of sprayed leaves with *iso*-octane (which extracts demeton-S only) showed that after 4 days at least 5% of that recovered was still present as demeton-S in the leaves.

Further decomposition within the treated leaves of the primary degradation products D_1 and D_2 is not very rapid, and the extent of such decomposition is always less than it is in untreated sections. The data in Table I summarize typical analyses of treated leaves harvested after varying post-spraying intervals.

Table I

Demeton-S and degradation products in sprayed leaves

Species	Date of spraying and section of plant treated		Interval spraying to harvest, days	% of total ^{32}P present in the form of demeton-S	D_1	D_2	D_3
Broad bean[20]	4 June	a	21*	1	38	43	18
	,,	ab	28*	< 2	41	33	24
	,,	a	67	~ 0	11	60	29
Apples[20]	15 June	a	21	< 1	25	42	33
	,,	b	51	< 1	11	36	52
	,,	b	53	< 1	18	29	53
	,,	b	106	~ 0	4	39	57
	,,	a	106	~ 0	5	9	86
Coleus[20]	16 June	b	48	~ 0	26	31	43
Mustard[19]	27–29 July	ab	33	~ 0	3	19	78
Borage[19]	23–24 July	ab	38	~ 0	62	18	20

* Includes stem of treated leaves
a = lower half of plant sprayed
b = top half of plant sprayed

C. *Translocation to and degradation in untreated plant tissues*

(a) *Schradan.*—Radio-assays have confirmed that unchanged schradan can be translocated from treated leaves to other parts of the plant, with the main direction of movement towards the new growth. Spraying of the lowest leaves of apple stocks resulted in the appearance of approximately equal proportions of schradan in the middle and upper sections ; although upward movement was most pronounced, definite evidence has been obtained of the appearance of traces of schradan in the lowest leaves of both apple and chrysanthemum following application to the middle leaves.[18]

As a generalization, it could be said that about 1% of the schradan absorbed was translocated per day in the three species bean, *Coleus*, and chrysanthemum, with values up to four times this proportion in apple. It is likely that the extent of translocation is associated with the physiological activity of the plants, as suggested by Zeid & Cutcomp[25] who, using a bioassay technique, quoted a value of 40% for the extent of translocation of the active schradan toxin into unsprayed leaves of broad bean within 12 days after spraying. Metcalf & March[26] found that between 0·1 and 1·0% of the total dosage of schradan applied to a single lemon leaf appeared in the other leaves on the plant after 17 days.

In any evaluation of a systemic insecticide the final assessment must depend on the effectiveness of the biological control obtained. Whilst schradan is not a fumigant and has only slight, if any, contact effect,[27] the experiments reviewed here have confirmed that biological control of *Aphis fabae* (Scop), *A. pomi* Deg. and *Macrosiphoniella sanborni* (Gill) on untreated parts of beans, apples and chrysanthemums respectively has been obtained following leaf application. Radio-analysis of the infested sections (when approximately 80% kill of the insects had been obtained) gave approximate values for the threshold toxic concentrations of schradan in these plants. The concentrations found varied between 10–15 p.p.m. fresh weight for *A. fabae* to 20–30 p.p.m. fresh weight for *A. pomi* Deg.[18]

It was found that light was probably the most important single factor in promoting translocation, which suggests that movement of schradan may be associated with that of the products of photosynthesis. The effect of light did not however appear to be a simple one and various species responded differently to different pre- and post-treatment light conditions.[18]

Spray application of schradan to mustard and borage plants about to flower resulted in the appearance of significant amounts of schradan in the nectar of flowers which opened several days later, the concentration of the schradan reaching a value of 5·5 p.p.m. in mustard nectar, and 2·5 p.p.m. in that of borage.[14, 15] The flowers of both these species are highly favoured by bees indicating that the nectaries of such plants are supplied by the phloem[28] which probably also conducts the schradan.

Ringing experiments with apple stocks showed that, in this species also, phloem is the main conducting tissue involved in the movement of schradan from the middle and top leaves.[18] Ringing above and below treated lower leaves of apple stocks however stimulated movement of schradan or its derivatives, an observation not easily accounted for. Evidence was also obtained[18] that increase of temperature from the 50–60° F range to 80° F favoured movement of schradan, especially in the dark, supporting Wedding's[29] suggestion that temperature may be an important factor in promoting the transport of organic molecules in phloem. Wedding had also found that following the application of schradan to leaves of beans and lemon whilst the first movement was in phloem, diffusion into xylem occurred later.

The rate of breakdown of schradan appeared to vary with the species and was probably greater in beans than in *Coleus*,[18] and in mustard than in borage ;[15] such comparisons however should be interpreted with caution since the plants were at different stages of growth. Of some interest, and more definitely established, was the variation in the extent of breakdown in the sprayed (treated) leaves and in the leaves receiving schradan by translocation (untreated). With apples and chrysanthemums the extent of breakdown was found to be of the same order in treated and untreated leaves, but with beans and *Coleus* the extent of breakdown was greater in the untreated leaves.[18] Table II gives the breakdown in the treated leaves of borage and mustard plants sprayed with schradan at the end of July (unpublished data) and also the breakdown in the nectar samples from flowers of the same plants which opened after the completion of spraying.[15]

Table II

Extent of breakdown of schradan in nectar and in treated leaves of borage and mustard plants sprayed with 0·16% *schradan at end of July*

Species	Nectar		Treated leaves	
	Date of collecting	% breakdown of schradan	Date of harvesting	% breakdown
Borage	3–7 Aug.	16	7 Aug.	6
	7–11 ,,	20		
	11–14 ,,	60	14 ,,	9
	14–18 ,,	67		
	18–21 ,,	74		
	21–25 ,,	93	21 ,,	15
	25–28 ,,	95	28 ,,	45
Mustard	3–12 Aug.	50	14 Aug.	48
	12–20 ,,	77	21 ,,	55
	21–28 ,,	*	28 ,,	51

* Activity too low to partition

The higher breakdown found in untreated parts of the plants (leaves or nectar) may be due to a preferential movement of degradation products from the treated leaves or to a higher rate of breakdown occurring in the untreated parts of the plants due to greater physiological activity—or to both.

On two occasions bean plants were subdivided at harvest into treated leaves, stem and rest of plant and the extent of breakdown determined in each. The results (unpublished) suggest that the extent of breakdown in untreated sections of the plant is likely to show variations and that breakdown is greater in the stems than in untreated leaves.

Detoxification could occur in several other ways, including root and guttation losses, or dilution within the plant if rapid growth was occurring, but the most important mechanism is probably by chemical degradation to inorganic compounds.

(b) *Demeton-S.*—The investigations reviewed here, carried out between May and September, have failed to show the presence of any unchanged demeton-S, and only minute quantities of the primary degradation products D_1 and D_2 in parts of treated plants other than the treated leaves. At harvest, in most instances only the treated section and that immediately above possessed sufficient radioactivity to permit detailed analysis to be carried out, indicating that translocation of demeton-S degradation products occurred on a much smaller scale than was found with schradan in the same species.[20]

Auto-radiographic tests[20] with individual bean leaves treated with demeton-S and sampled three days later have shown that whilst extensive movement of the insecticide occurred within a treated leaf from the base to the tip, only slight movement occurred in the reverse direction, and passage from one side of the mid-rib to the other occurred only near the tip.[20]

None of the experiments involving leaf application of demeton-S (avoiding fumigation effects) showed translocation of any toxic derivative sufficient to kill aphids feeding on untreated sections of young broad bean (5–6 leaf stage) or apple stocks. Lord[30] has also shown that the only parts of bean plants treated with demeton-S possessing anti-esterase effects were the treated sections. It would appear, therefore, that degradation of demeton-S into D_1, D_2 and D_3 occurs in the treated leaves and that these derivatives are only translocated with difficulty, with relatively more of the further degradation products being preferentially moved, since the extent of degradation in any untreated section of a treated plant is always greater than in the treated section. Thus with apple stocks treated in mid-June, whereas only D_3 could be detected after 7 weeks in untreated leaves, appreciable quantities of D_1 and D_2 were still present in the treated leaves 15 weeks after treatment.[20]

No information was obtained in these investigations regarding the translocation of demeton-S to apple fruit, but some results were recorded on the analyses of bean seeds and pods. Table III shows that traces of the primary degradation products could be found in bean seed several weeks after treatment of the leaves in July.

Table III

Analyses of bean seeds and pods from treated bean plants. (Analysis as p.p.m. fresh weight)

Date of spraying	Interval between treatment and harvest, days	Bean seed			Bean pods		
		Demeton-S	$D_1 + D_2$	D_3	Demeton-S	$D_1 + D_2$	D_3
June[20]	25		2·5			1·5	
End of July[20]	28	~ 0	0·2	5	~ 0	~ 0	2·2
,, [19]	39	< 0·1	0·8	5·7			
,, [19]	45	< 0·1	(0·4)	3·6			

(Value in brackets based on low counts)

Following application of demeton-S to the leaves of mustard and borage plants at the end of July, no unchanged demeton-S and only very small concentrations of D_1 and D_2 (up to 0·7 p.p.m. D_1 and D_2) were found in samples of nectar collected from flowers which opened after the completion of spraying.[19] Leaf samples collected from the same plants at intervals commencing 3 weeks after spraying were analysed to determine the extent of degradation. The data are summarized in Table IV.

The variation in the extent of breakdown between new growth and nectar in both treated borage and mustard plants (Table IV) is of considerable interest. Degradation varied considerably in different parts of the treated plants, and with demeton-S at any rate the more extensive breakdown in untreated sections is associated with preferential movement of the secondary degradation products. This suggestion is confirmed by the greater degradation found not only in the top section but also in the oldest leaves of apple stocks when mid section leaves have been treated.[20]

More extensive data on degradation in broad beans and apple stocks were obtained in which both treated and untreated sections of sprayed plants were assayed at intervals from two days to several weeks after spraying.[20] Appreciable degradation was found in all untreated leaves. All apple stock sprayings were carried out in mid-June, and although spraying of bean plants continued from May to July, only young plants were treated (5–6 leaf stage). The slower rate of degradation which was found in the borage and mustard plants may be related to the later date of application and the age of the plants.

All the experimental data obtained confirm the suggestion that demeton-S molecules are unable to move along phloem tissue, and that the primary degradation products D_1 and D_2 do so only with considerable difficulty. Since movement of unchanged demeton-S following root

Table IV

% of total ^{32}P in the form of demeton-S and degradation products within sections of mustard and borage plants treated at the end of July

Species	Interval between treatment and harvest, days	Sprayed leaves		New growth		Nectar	
		Demeton-S	$D_1 + D_2$	Demeton-S	$D_1 + D_2$	Demeton-S	$D_1 + D_2$
Mustard	6					< 5	25
	10					< 5	12
	20	< 0·5	55	< 2	17		
	33	< 2	22	< 2	8		
Borage	13					< 5	(5)
	16					< 5	(0)
	20					< 5	(0)
	25	(3)	83	(2)	65		
	38	< 2	80	(< 2)	46		
	59	< 2	66	(< 2)	58		
	73	< 2	30				
	80	< 2	46				

(Value in brackets based on low counts)

absorption occurs readily and probably in xylem (see later), it would appear that diffusion into xylem vessels of demeton-S applied to leaves does not occur. Ahmed *et al.*[31] using the mixed isomers of demeton on cotton plants found that translocation of demeton-S occurred only in xylem vessels. Metcalf *et al.*[32] found that rapid translocation occurred when demeton isomers were applied to the stems of Black Valentine bean plants and lemon seedlings, presumably also due to access of demeton to the xylem tissue.

Translocation following root application

(a) *Schradan.*—No investigations were included on this topic but the absorption of schradan by plant roots and its subsequent translocation upwards in concentrations sufficient to produce an effect on aphids is well established.[1, 33, 34]

(b) *Demeton-S.*—Demeton-S emulsion applied to the roots of broad bean growing in potting compost or sand was absorbed and both unchanged demeton-S and its primary degradation products were found in the shoot tips within two days.[20] The concentration of toxic derivatives in the shoot tips was sufficient to kill aphids when precautions were taken to exclude fumigation. By analysis of the shoots when most of the aphids had been killed, concentration values of about 5 p.p.m. in fresh weight of demeton-S + D_1 were tentatively suggested as a threshold toxicity concentration in plant tissue, but considerable variability was found in the biological data possibly because of local variations of concentration.

The mechanism by which demeton-S functioned insecticidally was not established. Tietz[35] suggested that translocated demeton-S is evolved as a fumigant from untreated parts of the plant but Metcalf *et al.*[32] failed to confirm this. In general the concentrations of demeton-S and primary degradation products were greater in the lower parts of the plants than in the plant tip for the first two days, but the total amount absorbed by the plant represented only a few per cent of the amount applied to the soil.[20] In view of the fairly rapid degradation of demeton-S shown to occur in soil, the process of soil application is likely to be inefficient.

It is generally accepted that movement of absorbed material following root application is in the xylem, and it is likely that the rapid upward movement of demeton-S also occurs in xylem. Clearly lateral diffusion from xylem to phloem must occur at the plant tip if phloem-feeding insects are to be killed.

Acknowledgment

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THE EFFECT OF CERTAIN SPROUT-DEPRESSANT TREATMENTS ON SUGAR ACCUMULATION IN STORED POTATOES

By E. G. B. GOODING and A. W. HUBBARD

King Edward potatoes were treated with maleic hydrazide as a pre-harvest foliar spray or with a preparation containing 3% of tetrachloronitrobenzene. In neither case was there any effect on the accumulation of reducing sugars when the potatoes were stored under cool conditions. A second experiment, in which two different maleic hydrazide treatments were given, also showed no effect on reducing sugar or sucrose behaviour during subsequent cool storage of the tubers.

Introduction

It has long been recognized that a low reducing sugar content was desirable in potatoes that were to be used for crisp making or dehydration.[1] It has also been known for many years that, during storage at low temperatures, reducing sugars accumulate in potatoes, and recent work[2] has shown that even under the temperate conditions obtaining in Britain, sugar accumulation during storage in clamps may lead to very serious deterioration in the storage properties of dehydrated potatoes. The possibility of checking by chemical treatment the accumulation of sugars during low temperature storage of potatoes has from time to time been considered, and interest was reawakened by the appearance of a paper[3] in which it was claimed that potatoes, sprayed in the field with maleic hydrazide (MH) before harvesting, were not only free from sprouting, but showed substantially less development of both reducing and non-reducing sugars during cool storage than untreated controls. There has also been some indication from observations made by one of us (E. G. B. G.) that potatoes treated with a commercial preparation containing 3% by weight of 2 : 3 : 5 : 6-tetrachloro-1-nitrobenzene (TCNB) in an inert carrier might be similarly affected.

During the 1954—55 potato season, therefore, the opportunity was taken of carrying out more exact experiments than had hitherto been made. There were two series of experiments, one in conjunction with dehydration trials in Scotland, the other in connexion with sprout-depressant trials in England.

Experimental

1. *In Scotland*

Four acres of potatoes, variety King Edward, growing in a 20-acre field were sprayed with a preparation of sodium-MH, at a rate equivalent to 2·8 lb. of MH per acre, in mid-September, six weeks before the potato haulms were destroyed by pulverization. After lifting, the potatoes were sampled and 2 tons of the unsprayed material were then dusted with technical grade TCNB (10 lb. of the 3% preparation per ton of tubers); the potatoes were then clamped, the control (untreated) tubers in one clamp and the treated in another. The clamps were constructed and the temperatures within the clamps measured in the manner described in a previous paper.[2]

Four batches of potatoes of each type were removed at intervals between March and May, 1955, and brought to the Experimental Factory of the Ministry of Agriculture, Fisheries and Food for processing. Samples of the raw potato were taken for determination of reducing sugars immediately the consignment was received at the Factory.

Sampling and analysis

A sample of 12 tubers was taken from each consignment, e.g., from a three-ton lot, one tuber would be taken from every fifth sack. Two extraction methods were used, one being a simple and rapid procedure, suitable for factory control, and the other a more time-consuming one likely to yield more accurate results.

Method 1 (modified from Ross[4] and Townsend[5]).—A quarter was taken from each potato, the mixed quarters chopped into small pieces and converted to a slurry in a homogenizer. The slurry was centrifuged and 5 ml. of the supernatant liquid (discoloured and not necessarily

clear) were pipetted off and diluted to 100 ml. Two 25-ml. aliquot portions of this solution were further diluted to 100 ml. for the final determination, which was carried out by the Nelson[6] modification of the Somogyi[7] method.

Method 2 (adapted from Laidlaw & Reid[8]).—From a second quarter of each potato a thin slice was removed, and the slices thoroughly mixed. Duplicate samples of 25 g. of the slices were weighed out, homogenized for 5 minutes with 65 ml. of hot 95% ethyl alcohol, transferred to a conical flask, and another 40 ml. of 95% alcohol used to wash out the homogenizing cup. The total volume of 95% alcohol used was thus 105 ml., and with slices containing approximately 80% of water, the final concentration of the alcohol in the extract was about 80%. The material was refluxed on a water-bath for one-hour and the extract filtered through Celite on a No. 3 sinter pad, and the residue thoroughly washed with warm 80% alcohol. Alcohol was removed from the filtrate by heating on a water-bath. If the extract became too syrupy during evaporation, water was added. The aqueous extract remaining was made up to 200 ml. A 50-ml. aliquot portion was taken, neutralized to phenol red by adding 0·1N-NaOH, and cleared with lead acetate and disodium hydrogen phosphate. The final solution was made up to 250 ml. and determination was again by the Nelson modification of the Somogyi method.

Results

Fig. 1 shows the mean weekly temperatures of the atmosphere inside the clamps, and Table I shows the reducing sugar content found in the potatoes sampled on the various occasions throughout the experimental period. After the cold spells of February and March there was a rise in the reducing sugar content (more marked in the analyses by Method 1 than by Method 2) in all three treatments, followed by a decline with the onset of warmer weather. There was nothing to suggest that either maleic hydrazide or TCNB had influenced the behaviour of the reducing sugars during storage.

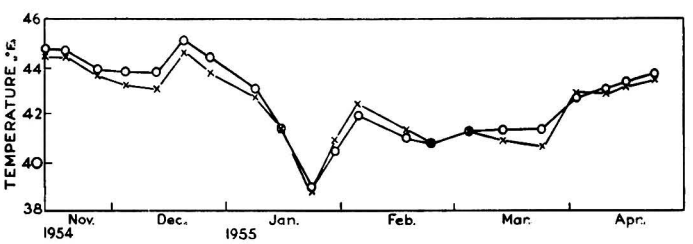

FIG. 1.—*Temperatures in potato clamps at Tarland, 1954–55*

× Control clamp
○ Clamp containing MH-treated and TCNB-treated potatoes

Table I

Effect of maleic hydrazide (MH) and tetrachloronitrobenzene (TCNB) on the reducing sugar of stored potatoes

Potatoes grown and clamped at Tarland, Aberdeenshire

Date taken from clamp	Reducing sugar content (g. glucose per 100 g. dry weight)				
	Method 1			Method 2	
	Control	MH treated	TCNB treated	Control	MH treated
16.11.54	4·7	4·5	—	4·0	4·1
14.3.55	8·4	7·1	7·7	5·4	5·1
31.3.55	—	4·8	6·6	3·0	4·1
26.4.55	4·1	4·2	3·8	2·8	2·8
12.5.55	4·6	4·0	3·5	4·2	3·6

2. *In England*

In the sprout-depressant trials, four MH treatments had been given, of which the following were selected for the present work.

(*a*) Spraying with sodium-MH at a rate equivalent to 2 lb. of MH per acre, 5½ weeks before the haulms were burnt off (Treatment A in Table II).

(*b*) Spraying with sodium-MH at a rate equivalent to 2·8 lb. of MH per acre, 3 weeks before the haulms were burnt off (Treatment D in Table II). In addition there were untreated controls (Treatment G in Table II).

Table II

Effect of maleic hydrazide on sugar content of stored potatoes

Potatoes grown and stored at Sutton Bonington, Leicestershire

(a) *Reducing sugars* (expressed as g. glucose per 100 g. dry weight)

Date of sampling	AC	DC	GC	AN	DN	GN
3.1.55	2·28	2·55	1·94	1·72	1·44	1·27
31.1.55	2·10	2·22	1·72	1·83	1·44	1·77
28.2.55	2·78	2·28	2·38	2·60	2·72	2·28
28.3.55	2·72	3·10	3·38	2·78	2·82	2·38
25.4.55	3·77	3·72	3·72	2·38	2·44	1·94
23.5.55	3·33	3·44	3·76	2·38	2·38	2·82

(b) *Sucrose* (expressed as g. sucrose per 100 g. dry weight)

Date of sampling	AC	DC	GC	AN	DN	GN
3.1.55	0·72	0·61	1·17	0·83	0·83	0·55
31.1.55	0·72	0·67	0·55	1·00	0·72	0·78
28.2.55	0·55	0·55	0·61	0·67	0·61	0·44
28.3.55	1·17	0·78	0·50	0·27	0·72	0·78
25.4.55	1·10	1·00	1·10	0·78	0·78	1·17
23.5.55	0·94	0·94	1·05	0·94	1·17	0·78

Code of treatments

A = Sodium maleic hydrazide at a rate equivalent to 2 lb. per acre applied 5½ weeks before burning off haulms
D = Sodium maleic hydrazide at a rate equivalent to 2·8 lb. per acre applied 3 weeks before burning off haulms
G = Control
C = Normal storage until 4 weeks before sampling, then cool storage
N = Normal storage throughout

After being lifted, the potatoes were stored in sacks on shelves in a brick seed store, the temperature being uncontrolled unless it fell to near freezing point when an electric heater was switched on manually to maintain the temperature at about 40° F. During the storage period the minimum temperature fell as low as 33–35° F on several occasions, although only for short periods. Part of the material was stored continuously in this manner until sampling, but some from each treatment was placed in a cool store, controlled at 36–38° F, four weeks before each sampling date. At four-weekly intervals from January to May, samples of each treatment, from each kind of storage (6 samples in all), were analysed in the Government Laboratory for reducing sugars and sucrose.

(*c*) *Method of analysis.*—The method of extraction followed that recommended by the A.O.A.C.[9] for stock feed and grain, with the exception that dialysed iron was used as the clearing agent. The reducing sugars were estimated by a modified Somogyi method and sucrose was similarly determined after acid inversion.

Results

The sugar contents are shown in Table II. A period of cool storage has, in nearly all cases, led to an increase in reducing sugar content, but to no significant increase in sucrose content. There are no indications that treatment with MH, at either level of dosing, has in any way affected the behaviour of either reducing sugar or sucrose during normal or cool storage.

Discussion

In the Scottish experiments the two methods of extraction gave rather different values for reducing sugar content, and it was thought that non-sugar reducing substances might be exaggerating the values found on the expressed juice. Examination of the juice by paper chromatography, however, gave no grounds for this belief. The alcoholic extraction was not followed by the Soxhlet extraction usually recommended (e.g.,[11]), and it is possible that extraction was not

complete. In each case, however, there were no indications of real differences in reducing sugar content between treated and control potatoes and the results of these two series of experiments fail to substantiate those of Patterson *et al.*,[3] but are in agreement with Highlands, Licciardello & Cunningham,[10] whose paper was received after these experiments had been started.

Acknowledgments

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THE PROXIMATE ANALYSIS OF WHEAT FLOUR CARBOHYDRATES. I.—Methods and Scheme of Analysis

By J. R. FRASER, M. BRANDON-BRAVO and D. C. HOLMES

Methods are given for the determination of the four main classes of carbohydrate in wheat flour, viz., starch, pentosan, sugars and cellulosic material. The sum of the individual classes so found agrees closely with the figures obtained as 'carbohydrate by difference'.

Introduction

In a report[1] published by the Nutrition Division of the Food and Agricultural Organization of the United Nations, it was stressed that there was an urgent need for a better knowledge of the physiological value of the carbohydrate fraction of foodstuffs, especially concerning cereals and their products.

The classical work on the energy of carbohydrates is that of Atwater and co-workers.[2] The factors they derived took into account the digestibility of the carbohydrate and the basis of their estimations was always ' carbohydrate by difference '. This method did not require a precise chemical knowledge as to the origin of the energy.

A second approach is that used by McCance & Widdowson,[3–5] who determine the ' available carbohydrate '. This is the sum of the starch, dextrin and sugar and represents what is known to be completely utilizable. In theory, it does not take into account the partial availability of complex polysaccharides or organic acids which may be glycogenic, but it does make a step towards the assessment of the energy value from a chemical point of view. It must be pointed out, however, that for many foodstuffs it would be illogical to apply the general factor for carbohydrate, as determined by Atwater, to any ' break-down ' portion of the total carbohydrate.

The report[1] also stated that the ideal procedure for giving energy values ' . . . is the separate determination of all substances contained in food, together with the accurate assessment of their individual physiological values and their interrelationships ', but that ' . . . there is at present no general agreement on practical and reliable methods to determine all the separate components of the composite fraction, " carbohydrate by difference " '.

It is, of course, extremely doubtful whether, even with an exact knowledge of the chemical nature of the carbohydrate constituents and a true physiological evaluation of each separate body, the full effect of feeding them together will be the simple sum of their known separate effects.

Animal feeding experiments described by Browne[6] have shown that an amount of ' nitrogen-free extract ' remains undigested, but this is balanced by the amount of fibre which *is* digested—a case of ' compensation '. Recent experiments on the function of the rumen and ruminant nutrition by Moxon & Bentley[7] indicate to what extent the utilization of certain components differs according to the presence or absence of others.

Nevertheless it must be broadly true that material known to be easily broken down to assimilable hexose in the normal human's alimentary system is of greater value than matter which cannot be so converted, and therefore it is of interest to determine the proportion of the total carbohydrate which is definitely known to be glycogenic, as distinct from all the other components such as cellulosic and hemicellulosic material.

In the light of these considerations it was thought desirable for the chemical analysis of the carbohydrate fraction of current flour, as produced and issued in the United Kingdom, to be available for appraisal by the physiologists and the nutritionists.

General survey of the methods

The main carbohydrate constituents of wheat flours are known to be:

1. Starch
2. Sugars
3. Hemicellulosic material
4. Cellulosic material,

none of which can be directly determined by a specific method.

Starch, the principal constituent, has been the subject of endless attention. The various methods evolved have been compared and contrasted from time to time by different workers.[8–17] The method finally selected as the most suitable for the present use was the polarization method of Mannich & Lenz,[18] which itself has been used and modified by many experimenters.[12, 19–25] A slight alteration was made in the manner of making up the dispersing medium (*q.v.*) and, instead of uranyl acetate as the protein precipitant, as used by Clendenning,[24] Carrez's solutions as recommended by Hadorn & Biefer[12] were substituted.

Sugars.—These are troublesome to extract and estimate without interference by diastatic action. Any prolonged soaking in dilute alcohol at ordinary temperatures leads to an appreciable increase in apparent sugar content owing to ' maltase ' activity. The method finally adopted was based on that of the ' A.A.C.C. Cereal Laboratory Methods ',[26] followed by an estimation of

the total reducing value using Fehling's solution and a correction for any pentose present. Acid hydrolysis was necessary as some of the sugars extracted are polysaccharides, such as levosin, sucrose and maltose.[27–31]

Pentosans.—The method adopted was a combination of the process of furfural production and distillation, which has been widely used,[32, 33] with a spectrophotometric estimation of the colour produced by the furfural with orcinol–iron reagent as described by Elder *et al.*[34] and Fernell & King.[35]

Cellulosic material.—This was first based on a method of Weinstock & Benham.[36] As the special preparation they used (Rhozyme S) was not available in this country, attempts were made using two enzymes consecutively: Takadiastase, to solubilize the starch, and then trypsin to deal with the protein. It was found that the final insoluble residue invariably contained some substance suggestive of the ' hemicellulose ' described by Clayson & Schryver,[37] but its reactions with calcium chloride solution, precipitation with alcohol and subsequent solubility in water, colour with iodine, reducing value after hydrolysis, and optical activity showed it as indistinguishable from starch. This conforms with the present views of Schoch[38] that diastatic enzymolysis is only complete for starches which have no protective substances such as fat present. It was accordingly necessary to treat the enzyme digestion residue with calcium chloride solution to remove the starch and finally to determine ash, protein and pentosan in the residue to obtain the cellulosic material present by difference.

This was lengthy and tedious, so an alternative method was evolved using a combination of the preliminary processes described in Pinckney's method for protein estimation,[39, 40] and Frap's method for starch.[41] The residue so obtained was invariably found to contain negligible ash and protein fractions and when corrected for pentosan, agreed very well with the figure obtained by the cumbersome enzyme digestion method referred to above.

The carbohydrate components determined in this manner should agree in total with the amount indicated by the ' difference figure '. ' Carbohydrate by difference ' in the case of flour samples is usually high when the estimates of ' moisture ' and ' fat ' have been by the customary oven drying at atmospheric pressure at 100° and by light petroleum extraction, respectively. By vacuum oven drying, the moisture is usually found to be approx. 1·0% higher,[42, 43] and by acid pretreatment the ' fat ' figure is usually at least 0·5% higher,[44, 45] than the results obtained by the methods first mentioned.

These higher and more correct estimates should be used to calculate the ' carbohydrate by difference ' when comparing with the sum of the separately determined components.

A check on the results is given by determining the total reducing value after acid hydrolysis of the calcium chloride dispersion. This solution, containing all the starch, sugars and part of the pentosan, can be hydrolysed with acid as normally carried out for starch estimations. The work of Lampitt *et al.*[46] and Pirt & Whelan[47] has indicated the course of hydrolysis and the accompanying destruction of glucose, according to the acid concentration and time of refluxing, for certain starch dispersions. With the calcium chloride dispersion it was found that optimum conditions are 0·6N-hydrochloric acid for 1 hour. It is of course necessary to remove calcium from the hydrolysed solution before titration with Fehling's solution and this is efficiently carried out by means of an Amberlite ion-exchange column prepared in the sodium-form.[48]

These methods were tested on thoroughly mixed samples of bulked flours, representing National flour as it was in 1952, i.e., nominal 80% extraction rate. For standardization and control a sample of wheat starch B.P. was used.

Recommended procedure

Scheme of analysis

1. Disperse the sample in calcium chloride and obtain the polarimeter reading. This gives the starch content.

2. Hydrolyse the calcium chloride dispersion and determine the total reducing value. This gives starch + sugars + part of the pentose. Determine the pentose content and so correct the reducing value. The result gives a check on the starch and sugars present in the flour.

3. Distil the sample with hydrochloric acid and estimate the furfural to obtain the total pentosan content.

4. Extract the sugars from the sample with the acid buffer solution, hydrolyse a portion of the filtrate and obtain the total sugars + part pentose. A correction for the pentose gives the sugar content, which is expressed as invert sugar.

5. Treat the sample by the modified fibre method which will give the cellulosic material present.

Methods of analysis

A. *The determination of starch by polarization*

Reagents

1. *Acid calcium chloride solution.*—Dissolve 620 g. of calcium chloride hexahydrate crystals in 180 ml. of distilled water and filter until clear. Add a solution, containing 18 g. of sodium acetate trihydrate in 50 ml. of water, to the clear filtrate and adjust the mixture to pH 2·3 by the addition of glacial acetic acid (A.R.). Make the specific gravity of the solution to 1·30 at 20°. (If a deposit occurs in cold weather, warm in a water-bath until it dissolves.)
2. *Carrez's solutions.*—Solution I. Dissolve 21·9 g. of zinc acetate dihydrate and 3·0 ml. of glacial acetic acid (A.R) in 100 ml. of water.
   Solution II. Dissolve 10·6 g. of potassium ferrocyanide in 100 ml. of water.

Method

Mix 2·50 g. of sample to a smooth paste with 10 ml. of water in a tall 400-ml. beaker. Add 50 ml. of calcium chloride solution and autoclave for 10 min. at 15 lb./sq. in. Cool the mixture by immersion in cold water and transfer to a 100-ml. volumetric flask by means of calcium chloride solution until the volume is approx. 90 ml. Add 2·0 ml. of Carrez's solution I and shake the mixture well before adding 2·0 ml. of Carrez's solution II. Shake the mixture again before diluting to 100 ml. at 20° with calcium chloride solution.

Filter the dispersion through a Whatman No. 541 filter paper. The filtrate should be perfectly clear. Discard the first 15–20 ml. of filtrate and obtain the polarimeter reading at 20° on the subsequent runnings.

If P° is the reading at 20° in a 2-dm. tube and $[\alpha]_D^{20}$ is 203, then:

$$\% \text{ Starch} = \frac{P \times 10^4}{203 \times 5}$$

If the reading is made using a saccharimeter and the reading is V°:

then

$$\% \text{ Starch} = \frac{V \times 0{\cdot}3462 \times 10^4}{203 \times 5}$$

B. *Determination of the total reducing value of the hydrolysed calcium chloride solution*

Reagents

1. N-Hydrochloric acid solution.
2. Fehling's solutions I and II.
3. Calgon solution.—Dissolve 33 g. of sodium hexametaphosphate in 100 ml. of water.
4. Amberlite resin IR–120(H). A.R.
5. Invert sugar solution.—A 0·25% standard solution in water.
6. Methylene blue.—A 1·0% solution in water.
7. Pumice powder.

Preparation of the ion-exchange column

Fill a glass column with Amberlite resin IR–120(H) (see diagram A). Inject water into the column by connecting the jet to the water tap, opening the stopcock D and slowly turning on the water supply. In this way the resin is forced up the column. When the surface has risen to a

position three-quarters of the distance between A and B, close the stopcock and remove the connexion to the tap. As the resin begins to settle down the column, agitate it with a glass rod to remove air bubbles and help pack the resin. Once the resin has settled, open the stopcock D and run 300 ml. of 10% sodium chloride solution through the column, followed by 900 ml. of distilled water. Care must be taken to see that the level of the liquid in the column does not fall below B at any time. On the last running of water, close the stopcock when the level just covers the resin. The column is then ready for use.

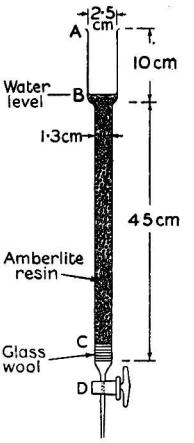


DIAGRAM A

Amberlite ion-exchange column for the removal of calcium

Method

Transfer 20 ml. of calcium chloride dispersion to a 250-ml. conical flask together with 10 ml. of water and 50 ml. of N-hydrochloric acid. Reflux the mixture for one hour, cool and dilute to 200 ml. in a volumetric flask. Pass 25 ml. through the Amberlite column at the rate of one drop per second and collect in a 500-ml. conical flask. As the level of the hydrolysed dispersion passes B, add 25 ml. of distilled water, followed by a further 35 ml. of water once the level of the first washing reaches B again. Allow the column to drain for 5 min. Add to the conical flask 20 ml. of mixed Fehling's solution, a little pumice powder, 10 ml. of Calgon solution, a known amount of water, and just less than the calculated volume of 0·25% invert sugar solution necessary to reduce the excess Fehling's solution. Bring the mixture to the boil and complete the titration with 0·25% invert sugar solution, using methylene blue as indicator.

Run a blank determination at the same time on all the reagents, starting with 20 ml. of calcium chloride solution. Use the volume of the blank after titration to calculate the amount of water to be added to the hydrolysed dispersion above. The blank and the test solution should have the same volume as each other after titration.

Suppose the blank is equivalent to a titre of x ml. of 0·25% invert sugar solution and that the dispersion requires y ml. of 0·25% invert sugar solution, then:

$$\% \text{ Total reducing value} = 4 \times (x - y) \text{ as invert sugar}$$

This reducing value is equivalent to an amount of carbohydrate, as starch, of 0·895 × % total reducing value. If a correction for pentose is made, this method affords a close check on the amount of starch and sugar in the flour.

C. *The determination of pentosans and pentoses in flour*

1. *Total pentosan*

Reagents

1. *Hydrochloric acid* (12% w/w).—Add 720 ml. of hydrochloric acid A.R., sp. gr. 1·16, to 1170 ml. of distilled water.
2. *Standard xylose solution.*—Dissolve 0·500 g. of D-xylose and 1·0 g. of sodium benzoate in water and make up to 500 ml. in a volumetric flask.
3. *Stock iron solution.*—Dissolve 0·990 g. of ferric ammonium sulphate in conc. hydrochloric acid and make up to one litre in the same acid.
4. *Orcinol reagent.*
   333 ml. of stock iron solution.
   467 ml. of conc. hydrochloric acid.
   200 ml. of water.
   2·0 g. of orcinol (recrystallized from hot water with a little charcoal and dried in a vacuum desiccator).
   Dissolve the orcinol in a portion of the water and add to the mixed acid reagents.

Method

Add 0·400 g. of flour to the distillation flask together with some broken porous pot. Introduce 100 ml. of 12% hydrochloric acid and bring the mixture to the boil. Control the heating so that the rate of distillation is 30 ml. every 10 min. and run in fresh 12% hydrochloric acid from the dropping funnel after each 10-min. interval to make up the original volume. Distil 360–400 ml. in this manner, by which time all the furfural produced will have been distilled over. Rinse the condenser down with the 12% hydrochloric acid, cool the distillate, transfer to a 500-ml. flask and make to the mark with 12% hydrochloric acid.

Carry out a duplicate determination in precisely the same manner using 10 ml. standard xylose solution in place of the flour.

For the determination of the furfural, pipette 1·0-ml. and 2·0-ml. aliquot portions of the flour distillate into two test-tubes. Make a standard series by pipetting 0·0, 1·0, 1·5, 2·0 and 2·5 ml. of the xylose distillate into five other test-tubes (this will cover a range from 0·0 to 50 μg. of xylose). Adjust each aliquot to 3·0 ml. with 12% hydrochloric acid and then add 9·0 ml. of orcinol–iron reagent. Close the tubes with small glass bulbs, place in a boiling water-bath for 30 min., cool rapidly under cold running water and read the optical density of the colour formed in a spectrophotometer at 670 mμ. The amount of xylose in the sample can be read off on the graph drawn from the standard data, and the amount so obtained, expressed as a percentage and multiplied by 0·97, is taken as equal to the amount of pentosan in the sample.[55]

In the case of flours of extraction rate 90–100%, the amount of pentosan present makes it necessary for the above distillate to be diluted with 12% hydrochloric acid in the ratio of 1 : 1 before determining the 'xylose equivalent' with the orcinol–iron reagent.

2. *Pentose in the calcium chloride dispersion*

Pipette 10 ml. of the calcium chloride dispersion into the distillation flask and carry out the determination as above. The amount of equivalent xylose × 1·10 gives the amount of pentose present,[55] and the amount of pentose × 1·04 gives the reducing value in terms of invert sugar.

3. *Pentose in the extract used for the sugar determination*

Pipette 10 ml. of the filtered sugar extract into the distillation flask and determine the pentose as before (see section 2 above). The amount of pentose × 1·04 gives the reducing value in terms of invert sugar.

4. *Pentosan in the 'cellulose' residue*

Place the final tared filter paper and residue from the determination of the cellulosic material in the distillation flask and carry out the determination as outlined above.

In the case of the high extraction rate flours of 90–100% extraction, larger amounts of pentosan are associated with the residue. In these cases take 20 ml. of distillate, bulk to 100 ml. with 12% hydrochloric acid and determine the amount of pentosan in this diluted solution.

D. *Total sugar determination*

Reagents

1. *Ethyl alcohol.*—95% by volume.
2. *Acid buffer solution.*—Dissolve 3 ml. of glacial acetic acid, 4·1 g. of anhydrous sodium acetate and 4·5 ml. of conc. sulphuric acid, sp. gr. 1·84, and dilute to one litre with water.
3. *Sodium tungstate.*—A 12% solution in water.
4. *Fehling's solutions I and II.*
5. *Invert sugar solution.*—A standard solution containing 0·25 g. of invert sugar/100 ml.
6. *Methylene blue.*—A 1·0% solution in water.

Method

Transfer 5·675 g. of flour into a 100-ml. conical flask. Tip the flask so that all the flour is at one side and wet the flour with 5 ml. of alcohol. Turn the flask so that the wet flour is at the upper

side and add 50 ml. of acid buffer solution, keeping the solution from coming into contact with the flour until all has been added to the flask. Stopper the flask, shake for 10 min., add 2 ml. of sodium tungstate solution, mix thoroughly and filter through a Whatman No. 4 filter paper, discarding the first 8–10 ml.

Take 25 ml. of the filtrate in a 350-ml. conical flask and reflux for one hour. Cool, neutralize and carry out a determination of total reducing sugar, using 20 ml. of mixed Fehling's solution and back-titrating the excess as in the determination of the reducing value of the calcium chloride dispersion.

Carry out a blank determination at the same time on all the reagents. The final volume of the blank after titration is used to calculate the amount of water to be added to the hydrolysed sugar solution in order that the reduction is carried out under the same conditions.

If the blank requires x ml. 0·25% invert sugar solution and the sample requires y ml. 0·25% invert sugar solution, then the % total sugar, as invert, $= (x - y) \times 0{\cdot}1$.

A correction must then be applied for the amount of pentose present in the hydrolysed solution of flour.

E. *Determination of the cellulosic material*

1. *By enzymolysis*

Reagents

1. *Takadiastase.*—Suspend 0·25 g. of Takadiastase in 50 ml. of distilled water. Stir for 10 min. and filter.
2. *Trypsin.*—Suspend 0·25 g. of trypsin in 50 ml. of water by standing, with frequent stirring, for 30 min. Do not try to dissolve the residue by using heat. Filter before using.
3. *Acid calcium chloride solution.*—Prepared by the method detailed in the determination of starch.
4. *Sodium acetate solution.*—A 2·5M-solution in water.

Method

Autoclave 2·00 g. sample with 150 ml. of water for 10 min. at 15 lb./sq. in. Cool the solution to 45° and add the Takadiastase preparation. Introduce a few drops of chloroform and allow the whole to digest in a water-bath maintained at 45° until a drop of the liquid fails to give a blue colour with iodine.

Adjust the solution to pH 8·0 using 2·5M-sodium acetate solution. Add the trypsin preparation, plus a few drops of chloroform and leave the whole to digest overnight in the water-bath at 45°. Withdraw as much of the supernatant liquor as possible and, after readjusting to pH 8·0, repeat the trypsin digestion for 4 h. at 45°. Again withdraw the clear supernatant liquor and to the residue add 50 ml. of acid calcium chloride solution. Boil the suspension for 10 min. and filter through a dry, tared Whatman No. 541 filter paper. After washing well with hot water, alcohol and ether, dry the filter in an air oven at 100° to constant weight.

A correction for protein, pentosan and ash has to be applied to the residue in order to obtain the cellulosic material. It is therefore necessary to run a duplicate determination at the same time, the ash being determined on one residue and protein and pentosan on the other.

2. *By a modified fibre method*

Reagents

1. Carbon tetrachloride.
2. 0·05N-Potassium hydroxide.
3. Ethyl alcohol, 10% by volume.
4. 0·2N-Hydrochloric acid.

Method

Mix 5 ml. carbon tetrachloride with 2·00 g. of flour in a stoppered bottle and add 50 ml. of potassium hydroxide solution. Shake the mixture for 10 min., transfer to a centrifuge tube and

centrifuge until clear. (10 min. at speeds around 3000 r.p.m. will usually suffice. Ignore a slight turbidity.) Carefully decant the supernatant layer, wash the bottle with 50 ml. of 0·05N-potassium hydroxide and transfer the washings to the centrifuge tube. Close the tube with a bung and shake the whole for 5 min. before re-centrifuging until clear.

Pour off the supernatant layer and to the residue add 50 ml. of 10% alcohol. Close the tube, shake for 5 min. and centrifuge. Decant the supernatant liquor when clear.

By means of 200 ml. of water, wash the residue into a 600-ml. beaker and bring the suspension carefully to the boil. There is a tendency to froth at this stage and constant stirring with a glass rod is necessary. When the solution boils add 20 ml. of 0·2N-hydrochloric acid and continue the boiling for 30 min., any loss of volume being made up by the addition of water. Filter the contents then through a dry, tared Whatman filter paper No. 541, wash the residue well with hot water, alcohol and ether, and dry the filter in an air oven at 100° to constant weight.

It has been found that the protein and ash figures for all types of flour residues obtained by this method are so small as to be negligible. Therefore transfer the filter paper and residue to the apparatus used for the distillation of furfural from pentose and carry out an estimation of pentosan by the method detailed previously. Subtract the amount of pentosan so obtained from the amount of residue to get the cellulosic material.

Results

The effect of using (*a*) uranyl acetate and (*b*) Carrez's solutions as protein precipitants, on the polarization of wheat starch is shown in Table I. The readings are from five separate determinations and each figure is the mean of ten separate readings.

Table I

Comparison of protein precipitants

Protein precipitant	Wt. of starch used, g.	pH	Saccharimeter reading in ° V.				
Uranyl acetate	2·5	2·1	24·3	24·25	24·3	24·35	24·3
Carrez's solutions	2·5	2·1	24·8	24·75	24·8	24·85	24·8

The effect of using calcium chloride solutions of (*a*) pH 2·1 and (*b*) pH 2·3 on the polarization of wheat starch is seen in Table II.

Table II

Effect of pH on polarization of starch in calcium chloride solution

pH used	Protein precipitant	Saccharimeter reading in ° V.				
2·1	Carrez's solutions	24·8	24·75	24·8	24·85	24·8
2·3	Carrez's solutions	25·0	25·0	25·0	25·0	25·0

Tables III and IV illustrate the reproducibility of the results using calcium chloride solution pH 2·3 and Carrez's solutions. The figures are from four separate determinations and each is the average of ten separate readings.

Table III

Reproducibility of saccharimeter readings

Sample used	Saccharimeter reading in ° V.			
Wheat starch	25·00	25·00	24·99	25·00
Low extraction flour	20·86	20·86	20·88	20·89

Results obtained in a study of the effect of varying the method of extraction on the amount of reducing matter obtainable from flour are shown in Table V.

Determinations were made of the amounts of residue obtained from flour after various enzyme treatments. The results are shown in Table VI.

Table IV

Reproducibility of reducing values

Sample used	Reducing value as % invert sugar				
Wheat starch	94·6	94·3	94·4	94·6	94·7
Flour	78·4	78·4	78·8	78·7	78·8

Table V

Effect of method of extraction of flour on amount of reducing matter extracted

Treatment	Total reducing matter as invert sugar, %	Pentose in the extract, %
1. Prolonged soaking in 10% alcohol	2·7	0·7
2. Washed with ether and shaken with 10% alcohol for 2 h.	2·0	0·6
3. Soaked in 10% alcohol for 30 min.	1·9	0·6
4. Shaken with acid buffer for 10 min. (A.A.C.C. method)	1·9	0·6

Table VI

Amount of residue left after varying the enzymic treatment of flour

Treatment	1	2	3	4	5
% Residue after enzymolysis	9·9	4·2	2·6	2·3	1·9
% Protein present	6·6	1·4	0·2	0·1	0·1

Treatment

1. Takadiastase alone on the autoclaved aqueous solution of flour.
2. As treatment 1 after treatment with trypsin.
3. Autoclaved aqueous solution of flour treated with Takadiastase and then with trypsin at pH 8·0 for 4 h.
4. Autoclaved aqueous solution of flour treated with Takadiastase at pH 5·5 and trypsin at pH 8·0 for 4 h.
5. Autoclaved aqueous solution treated with Takadiastase at pH 5·5, followed by trypsin at pH 8·0 for 5 h. and a further digestion with Takadiastase at pH 5·5.

The composition of the residue obtained after treatment with calcium chloride solutions of the insoluble matter from the enzyme digestion is shown in Table VII.

Table VII

The amount and composition of the residue left after treating the enzyme digestion residue with calcium chloride solution

	Residue %	Protein %	Ash %	Pentosan %	Cellulose %
Flour 1 *	1·1	0·1	0·2	0·2	0·6
Flour 2	1·3	0·1	0·2	0·2	0·8
Flour 3	1·2	0·2	0·2	0·2	0·6

* Unless otherwise stated the flours used in these tests were of nominal 80% extraction rate.

Duplicate analyses were made on the residues obtained by the modified method for determination of fibre. The results are shown in Table VIII.

Table VIII

Residue obtained from flour by the modified fibre method

	Residue %	Protein %	Ash %	Pentosan %	Cellulose %
Flour 1	0·83	0·04	0·00	0·20	0·59
Flour 1	0·84	0·04	0·00	0·20	0·60

Results are shown in Table IX of analyses of the residues obtained from high-extraction rate flours by the two methods described.

Table X shows the results obtained in the determination of pentose by the bromine method [33] and the orcinol–iron method.

Table IX

Residues obtained from high-extraction-rate flours

Type of flour	Method of preparation of residue	Amount of residue %	Protein %	Ash %	Pentosan %	Cellulose %
Brown, 93% extraction	Enzymolysis	6·5	0·2	0·3	3·2	2·8
Wholemeal, 100% extraction		9·0	0·4	0·4	4·0	4·2
Brown, 93% extraction	Modified fibre method	4·3	0·0	0·0	1·5	2·8
Wholemeal, 100% extraction		6·4	0·0	0·0	2·2	4·2

Table X

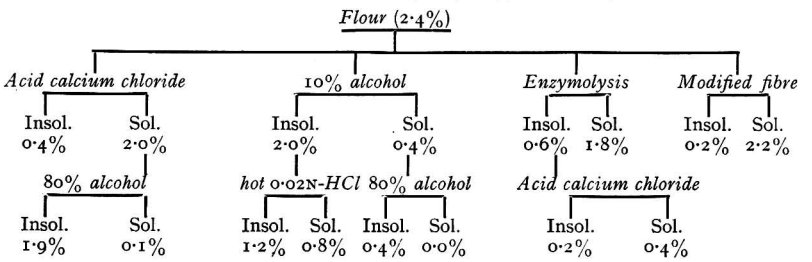
Determination of pentose in flour

Method	% Pentose (as xylose)			
Bromine method	3·2	3·6	3·2	3·3
Orcinol method	2·5	2·5	2·5	2·5

The distribution of pentosan in various fractions obtained from a sample of flour of 80% extraction is illustrated in Table XI.

Table XI

Pentosan distribution in a sample of 80%-extraction flour



Determinations were made by different methods of the amount of starch in the control sample, with the results shown in Table XII.

Table XII

Starch in the control wheat starch as determined by different methods

By difference	By reducing value	By dichromate-sulphuric oxidation	By polarimetry
%	%	%	%
85·0	84·9	85·1	85·2

In Table XIII are shown results which compare the amount of carbohydrate determined ' by difference ' and that determined by the methods outlined in this paper (' by parts ').

Table XIII

Carbohydrate content of 80% extraction flour determined by two methods

By difference		By parts	
Moisture*	14·0%	Starch	67·4%
Ash	0·9%	Sugars	1·3%
Protein	11·6%	Pentosans	2·4%
Fat†	1·9%	Cellulose	0·6%
	28·4		
% Carbohydrate	= 71·6	% Carbohydrate	= 71·7

* Loss in weight in vacuum oven at 100° in 5 hours
† By ether extractions after pre-treatment with acid

Discussion and conclusions

It is seen from Table I that, by using Carrez's solutions as recommended by Hadorn & Biefer,[12] there is less occlusion of starch in the protein precipitant than when uranyl acetate is used.[24]

The findings of Clendenning[22] concerning the effect of pH on the readings of calcium chloride dispersions of starch are confirmed by the results shown in Table II. As the pH falls, the specific rotation is reduced. On the other hand, once the pH of the calcium chloride solution rises above pH 2·5 filtration difficulties increase. pH 2·3 has proved the most satisfactory value.

Reproducibility of results for saccharimeter readings on starch and on a sample of flour is very good (Table III) using the recommended conditions. This also applies to determinations of the reducing value of calcium chloride dispersions. The flour dispersion contains pentose as well as starch and sugars, but a correction is readily made for the pentose, and the method serves as a close check on the starch and sugar fractions as determined separately. From the investigation of the effect of refluxing the dispersion with different concentrations of acid for varying lengths of time (Fig. 1), it was found that there is a maximum recovery of reducing matter when the dispersion is refluxed for one hour with 0·6N-hydrochloric acid.

Various methods of alcoholic extraction were compared with the acid buffer extraction procedure detailed in the laboratory methods of the A.A.C.C.[26] The reducing values due to the hydrolysed sugars obtained (total reducing matter — pentose) for a short extraction time show agreement, but once the extraction time is lengthened there is an increase in the amount of reducing matter. This is probably due to diastatic action on the starch itself. Experiments have shown that two modifications of the A.A.C.C. method were necessary to obtain maximum reducing value after hydrolysis. These were: a 10-min. extraction prior to filtration instead of an immediate filtration, and a hydrolysis of not less than 45 min. instead of 15 min. as described (see Figs. 2 and 3). The factor for converting the pentose in this extract into its invert sugar equivalent is 1·04. This is the average of the reducing powers of xylose and arabinose, which were determined by experiment as 1·03 and 1·05, respectively. These figures are corroborated by the work of Daish,[50] who found that the reducing powers of these two pentoses were practically the same as that of dextrose. The amount of sugar so found agrees closely with published data.[27–31]

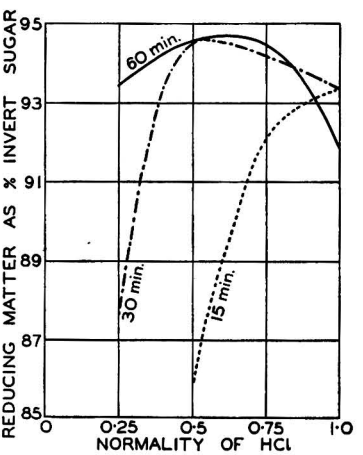


FIG. 1.—*Effect of acid strength and time of hydrolysis on recovery of reducing matter from calcium chloride dispersion of starch*

In the enzymic treatment of flour, a residue below 1·9% could not be obtained by enzymes alone (Table VI). Protein was at a minimum level and a repetition of the trypsin treatment

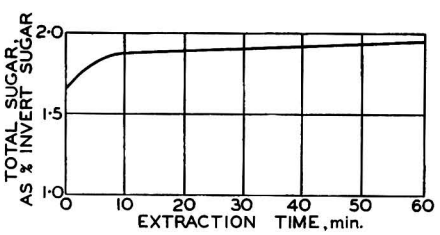


FIG. 2.—*Effect of extraction time on the amount of total sugar, as invert sugar, obtained by using the A.A.C.C. acid buffer extraction.*[26] *(Time of hydrolysis—60 min.)*

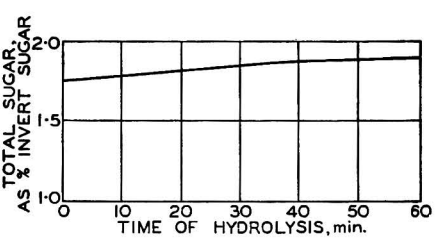


FIG. 3.—*Effect of time of hydrolysis on the amount of total sugar, as invert sugar, obtained by using the A.A.C.C. method of extraction followed by a Fehling's determination of the hydrolysed extract. (Time of extraction—10 min.)*

would not have been worth while for so small an amount. The Takadiastase digestion was only repeated in the hope that some of the protective substances had been removed by the prior use of trypsin. Calcium chloride was finally added to solubilize the remaining starch. Results obtained on three similar flours by the use of this method are shown in Table VII. Good replication of the values for cellulosic material as determined by the modified fibre method is seen in Table VIII. The results should be compared with those set out in Table VII. The advantages of this method are its speed and its reproducibility. Further, its results agree with those found by enzymolysis over the whole range of flour types.

The two methods for the determination of cellulosic material were applied to high-extraction flours (Table IX). Although, as may be expected, the total residues and their constituents as determined by the two methods vary, the final values for cellulosic material are comparable.

In the determination of pentoses by acid distillation, in general the bromine method as used by Vernon & Metzner[33] to determine the furfural so formed gives higher and more variable results than does the method using the orcinol–iron reagent as described by Elder *et al.*[34] (Table X).

Pentosans are determined directly as xylose, but taking into consideration the amounts of xylose and arabinose in various flour extracts recorded in the literature,[34, 51–54] and the different rates of formation of furfural from these pentoses,[32, 55] only a minor error will be introduced into this general examination by taking the amount of xylose multiplied by 0·97 as equal to the amount of pentosan.[55] A more detailed resolution of the pentosan fractions by determining the proportion of arabinose to xylose yielded on hydrolysis is being investigated.

Four methods were used for determination of starch in the control sample of wheat starch (Table XII). The figure obtained by reducing value was arrived at by putting the starch through the dispersion with calcium chloride solution and carrying out the method detailed previously. The dichromate oxidation is a method devised by Launer & Tomimatsu.[49] It is very rapid and gives extremely good replicates with starch. The possibility of using it as a check on the starch and sugars in flour instead of the somewhat lengthy process of ' reducing value ' is also being investigated.

When the methods recommended in this paper were applied to a nominal 80% extraction flour, the results for total carbohydrate content agreed well with those obtained by the usual ' difference ' method (Table XIII).

Conclusion

In this first part of the series, methods have been given for the determination of the four main classes of carbohydrate found in wheat flour. A scheme for applying these methods has also been suggested.

In the second part of this paper, the application of this scheme to the various types of flour as at present available in the United Kingdom will be presented.

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THE PROXIMATE ANALYSIS OF WHEAT FLOUR CARBOHYDRATES. II.*—The Analysis of the Carbohydrate Fractions of Different Flour Types

By J. R. FRASER and D. C. HOLMES

The carbohydrate fractions of various types of flour available in the United Kingdom have been analysed into four main classes, viz., starch, pentosan, sugars and cellulosic material. The sum total of these classes has been found to correspond with the carbohydrate 'by difference'. A correlation was observed between the amount of 'available' carbohydrate and the calculated digestibility of each type of flour.

* Part I: preceding paper.

Introduction

In Part I of this series,[1] methods and a scheme of analysis were presented which gave a practical measure of the four main classes of carbohydrate found in wheat flour. By using this scheme, estimations have been made of the carbohydrate fractions of flour samples representative of the various kinds now supplied in the United Kingdom.

Experimental

For the estimation of carbohydrate ' by difference ' the following techniques were used:

Moisture.—This was estimated in two ways: (*a*) by drying in an air oven for 5 h. at 100°,[2] and (*b*) by drying in a vacuum oven for 5 h. at 100°.[3]

Fat.—This was also estimated in two ways: (*a*) by a Soxhlet extraction with light petroleum,[4] and (*b*) by acid hydrolysis followed with an ether extraction.[5, 6]

Protein.—The nitrogen content, as determined by the Kjeldahl method, was multiplied by 5·7 to give protein content.

Ash.—The sample was charred and heated in a muffle furnace at 600° to constant weight.

Fibre.—The method recommended by the Analytical Methods Committee of the Society of Public Analysts and other Analytical Chemists[6a] was used.

The types of flour were placed in nine groups as described below. These have been used in previous flour surveys.[7]

L.E. means low extraction* flours, i.e. less than 80% extraction rate.
N.S. means National flour of nominal 80% extraction* rate, milled by a straight run process.
N.D. means National flour of nominal 80% extraction* rate, simulated by a divide process.
B.S. <93% } means National Brown flour, produced by straight run milling of less than 93% extraction* rate.
B.S. >93% } means National Brown flour, produced by straight run milling of over 93% extraction* rate.
B.D. means National Brown flour simulated by a divide process.
O.T. means Wholemeal flour, i.e. 100% extraction rate.
I.L. means imported low-extraction flour.
I.N. means imported National flour.

In the case of the low-extraction and National flours, the main groups were split up into five different categories depending on the mill capacity.

A. Up to 5 sacks per hour
B. From 6 to 10 sacks per hour
C. From 11 to 20 sacks per hour
D. From 21 to 50 sacks per hour
E. Over 50 sacks per hour.

To be truly repesentative, the samples analysed were the well-mixed bulks of flours sampled and sent to the Government Laboratory over a period of three months. The number of flour samples represented in each bulk is given in Table I.

These flours were analysed by the methods outlined above and those described in Part I,[1] the results being set out in Tables II and III for carbohydrate ' by difference ' and ' by parts ', respectively. The progressive decrease with rate of extraction of the ' available ' carbohydrates is seen in Table IV, whilst from Table V the correlation between ' available ' carbohydrate and digestibility as calculated from the fibre content, using a table published by Moran & Pace,[8] is demonstrated. Table VI shows the relationship between total pentosan content and total carbohydrate in the various flours.

* It is stressed that the extraction rates quoted are nominal only, and are not vouched for by the authors

Table I

The number of flour samples represented by each bulk

Group	Category	Number of samples in bulk	Group	Category	Number of samples in bulk
L.E.	A.	243	N.D.	A.	33
	B.	316		B.	73
	C.	246		C.	76
	D.	200		D.	78
	E.	185		E.	86
I.L.	—	450	I.N.	—	276
N.S.	A.	182	B.S.	<93%	155
	B.	153		>93%	192
	C.	112			
	D.	88	B.D.	—	84
	E.	99	O.T.	—	201

Discussion of results

From Table II is seen to what extent the carbohydrate ' by difference ' varies with the methods used. Overestimation of carbohydrate always occurs when drying is effected in an air oven at 100° for the moisture content and a straight Soxhlet extraction is employed for the fat content. For the purpose of comparing the carbohydrate by ' parts ' with the carbohydrate ' by difference ', the more accurate methods of vacuum-oven drying and acid hydrolysis should be used for moisture and fat determinations, respectively.

In the case of flours containing the statutory amount of added Creta preparata, i.e. all flours except the wholemeal, there will be 0·31 g. of calcium carbonate per 100 g. of flour. In practice the gain in weight of ash due to the added Creta preparata has been found to be between 0·22% and 0·27%,[9, 10] according to the type of flour and the type of Creta used. The difference between the increase in weight of the ash and the actual weight of added mineral matter does not amount to as much as 0·1% and has been ignored in the tables given.

The figures for the carbohydrate ' by parts ' (Table III) indicate the wide difference between brown and white flours especially in their contents of carbohydrates of doubtful value in human nutrition, viz., the pentosan and cellulosic fractions.[11–14] It is impossible to state categorically as a result of chemical analysis alone what the full nutritive value of mixed carbohydrates may be, but it is reasonable to assume that those known to be glycogenic, such as starch, dextrins and sugars, are more readily available to the human system than cellulose and hemicelluloses. Even assuming the hydrolysis of the latter to pentoses there is only the probability of partial utilization of these.[15, 16] The combined starch and sugar contents have therefore been termed ' available ' only in the sense that they are assumed to be of more direct value than other components, although these may play an important role in nutrition even if not a calorific one.

Previous values for the ' available ' carbohydrate in wheat flours have been given by McCance *et al.*,[17] but any process based on acid extraction or acid hydrolysis of flour will always include some pentose-yielding material and therefore carbohydrate values so obtained are too high. A similar difficulty arises with estimations using precipitation with alcohol or iodine after dispersion of the flour.[18–22]

There is good correlation between the amount of ' available ' carbohydrate in each type of flour and its calculated digestibility (Table V). Digestibility is deduced from the fibre content using a table published by Moran & Pace,[8] which is compiled on the assumption that the fibre content is a sensitive index of the amount of indigestible material in the flour. From data published by Macrae *et al.*[23] and Krebs & Mellanby,[24] Moran and Pace deduced that for every increase in the fibre content of 0·2% above a minimum of 0·15%, there was a decrease in digestibility of 1·1%.

It is not claimed that this correlation is a direct proof of cause and effect. The close agreement may be fortuitously dependent to some extent on ' compensation ' as found in the case of animal feeding experiments.[25] The apparent lowering of digestibility may be attributed to the interference of the unavailable fraction in the ready absorption of the starch and sugars rather than to the complete indigestibility of the cellulosic and hemicellulosic material.

Table II

Determination of carbohydrate by difference on various flours

Flour group	L.E.					I.L.	N.S.					N.D.					I.N.	B.S.		B.D.	O.T.
Category	A.	B.	C.	D.	E.		A.	B.	C.	D.	E.	A.	B.	C.	D.	E.		<93%	>93%		100%
Fat																					
method *a*	1·0	1·0	1·0	1·0	1·0	1·1	1·2	1·2	1·2	1·1	1·1	1·2	1·1	1·1	1·1	1·1	1·2	1·7	1·8	1·7	1·7
method *b*	1·3	1·3	1·3	1·3	1·3	1·4	1·7	1·7	1·7	1·6	1·6	1·7	1·6	1·6	1·6	1·6	1·7	2·3	2·4	2·1	2·3
Protein (N × 5·7)	9·2	9·5	9·7	9·9	9·8	10·9	10·4	10·4	10·3	10·2	10·2	10·9	10·9	11·1	10·8	10·8	11·7	11·6	11·5	12·0	10·4
Moisture																					
method *a*	13·1	13·1	13·0	13·1	13·0	12·4	12·7	12·9	12·7	12·8	12·6	12·7	12·5	12·7	12·7	12·7	12·5	12·8	12·8	12·7	12·9
method *b*	13·9	13·9	13·8	13·9	13·8	13·4	13·6	13·8	13·6	13·7	13·5	13·6	13·5	13·6	13·6	13·6	13·3	13·6	13·7	13·6	13·8
Ash	0·7	0·7	0·7	0·7	0·7	0·7	0·8	0·8	0·8	0·8	0·8	0·8	0·8	0·8	0·8	0·8	0·7	1·4	1·4	1·4	1·4
Total																					
method *a*	24·0	24·3	24·4	24·7	24·5	25·1	25·1	25·3	25·0	24·9	24·7	25·6	25·3	25·7	25·4	25·4	26·1	27·5	27·5	27·8	26·4
method *b*	25·1	25·4	25·5	25·8	25·6	26·4	26·5	26·7	26·4	26·3	26·1	27·0	26·8	27·1	26·8	26·8	27·4	28·9	29·0	29·1	27·9
Carbohydrate by difference																					
method *a*	76·0	75·7	75·6	75·3	75·5	74·9	74·9	74·7	75·0	75·1	75·3	74·4	74·7	74·3	74·6	74·6	73·9	72·5	72·5	72·2	73·6
method *b*	74·9	74·6	74·5	74·2	74·4	73·6	73·5	73·3	73·6	73·7	73·9	73·0	73·2	72·9	73·2	73·2	72·6	71·1	71·0	70·9	72·1

Table III

Determination of total carbohydrate by method described in Part I

Flour group	L.E.					I.L.	N.S.					N.D.					I.N.	B.S.		B.D.	O.T.
Category	A.	B.	C.	D.	E.		A.	B.	C.	D.	E.	A.	B.	C.	D.	E.		<93%	>93%		100%
Starch	71·4	71·4	71·0	71·0	71·0	70·4	69·6	69·6	69·6	70·0	70·0	69·6	69·6	69·3	69·3	69·6	68·9	61·4	61·0	62·0	59·7
Total pentosan	2·1	2·0	2·0	2·0	2·0	2·0	2·1	2·1	2·1	2·1	2·1	2·1	2·1	2·1	2·1	2·1	2·1	4·9	5·2	4·3	5·8
Sugars	0·8	0·8	0·8	0·8	0·8	0·9	1·2	1·2	1·2	1·2	1·2	1·2	1·2	1·2	1·2	1·2	1·3	1·9	2·1	1·9	2·1
Cellulose	0·4	0·4	0·3	0·3	0·4	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	2·8	3·0	2·8	4·4
Total carbohydrate	74·7	74·6	74·1	74·1	74·2	73·8	73·4	73·4	73·4	73·8	73·8	73·4	73·4	73·1	73·1	73·4	72·8	71·0	71·3	71·0	72·0

Table IV

'Available' carbohydrate in the various types of flour

Flour	L.E.	I.L.	N.S.	N.D.	I.N.	B.S. <93%	B.S. >93%	B.D.	O.T. 100%
	%	%	%	%	%	%	%	%	%
Starch + sugars	72·0	71·3	71·0	70·7	70·2	63·3	63·1	63·9	61·8
Total carbohydrate	74·3	73·8	73·6	73·3	72·8	71·0	71·3	71·0	72·0
'Available' carbohydrate as % of total carbohydrate	96·9	96·6	96·5	96·5	96·4	89·2	88·5	90·0	85·8

Table V

Correlation between 'available' carbohydrate as % of total carbohydrate and digestibility calculated from fibre content

Flour	L.E.	I.L.	N.S.	N.D.	I.N.	B.S. <93%	B.S. >93%	B.D.	O.T. 100%
	%	%	%	%	%	%	%	%	%
Fibre content	0·12	0·12	0·15	0·14	0·15	1·44	1·60	1·25	1·99
'Available' carbohydrate as % of total carbohydrate	96·9	96·6	96·5	96·5	96·4	89·2	88·5	90·0	85·8
Calculated digestibility	~97%	~97%	96·1	96·2	96·1	89·0	88·2	90·0	86·1

Table VI

Relationship between total pentosan and total carbohydrate for the various types of flour

Flour	L.E.	I.L.	N.S.	N.D.	I.N.	B.S. <93%	B.S. >93%	B.D.	O.T. 100%
	%	%	%	%	%	%	%	%	%
Total pentosan	2·0	2·0	2·1	2·1	2·1	4·9	5·2	4·3	5·8
Total carbohydrate	74·3	73·8	73·6	73·3	72·8	71·0	71·3	71·0	72·0
Pentosan / Total carbohydrate	2·7	2·7	2·9	2·9	2·9	6·9	7·3	6·1	8·1

Apart from their interest in comparative nutrition studies, the figures in Table VI give some indication of the grade of a flour, particularly when attention is paid to the distribution of pentose-yielding fractions and their relation to the total carbohydrate.

The practical uniformity of the total pentosan in the low-extraction and present-day National flours indicates that there is an irreducible amount of pentosan associated with the endosperm. These values agree with those quoted by Elder *et al.*[9] Amounts of pentosan in excess of 2·0% therefore might be an indication of the inclusion of non-endosperm fractions. The rise in pentosan content of flours over 80% extraction is steep, but below this extraction rate the value remains almost constant. Expressed as a percentage of the total carbohydrate, the pentosan content would appear to lie between 2·7 and 3·0% for flours below 80% extraction, whilst the majority of flours above this value would correspond to values well over 3·0%.

It is important to judge only by reference to the total carbohydrate rather than the flour itself. Variations in protein and moisture content affect the proportion of total carbohydrate so that it is not practicable to assign carbohydrate values to any particular class of flour without regard to these variables.

Conclusion

In Parts I and II of this series, a scheme of analysis has been presented whereby the carbohydrate 'by difference' can be split up into four main classes, viz., starch, pentosan, sugar and cellulosic material. The scheme does not attempt to analyse and determine the separate components of each class; it is a general examination in all respects, but it is one which should be of interest to physiologists and nutritionists. It is also applicable to other foods besides wheat flour.

The samples examined were not merely random or individual samples, they were the bulks of several flours, each bulk being a collection of similar grade flours over a period of three months and so they can be said to be fully representative of the kinds of flour available in the United Kingdom at the present time.

All the estimations of carbohydrate 'by parts' have been checked against carbohydrate 'by difference' and have shown a close agreement.

An interesting outcome of the results is that if, as Moran & Pace maintain,[8] fibre content is an index of indigestible matter and if the digestibilities of certain types of flour as determined by Macrae *et al.*[23] and Krebs & Mellanby[24] are correct, then there is a close correlation between % available carbohydrate and digestibility.

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BEHAVIOUR OF FUMIGANTS DURING VACUUM FUMIGATION. III.*—Penetration of Methyl Bromide into Bagged Whalemeat Meal

By W. BURNS BROWN and S. G. HEUSER

The penetration of methyl bromide into packages during treatment by various methods of vacuum fumigation has been further studied using bagged whalemeat meal of high protein content. Results are compared with those obtained in similar tests on bagged wheatfeed previously described. The time during the fumigation at which restoration of the pressure to atmospheric secures the maximum effective penetration of fumigant is established. Whether or not such enhancement of the effectiveness of penetration is desirable in the case of a highly sorptive product such as whalemeat meal is discussed in the light of evidence that effective concentrations of methyl bromide remain at the centre of the bag for a considerable period after the usual airing procedures. Airing at reduced pressure is suggested as being likely to be more effective than the procedures at present followed.

Introduction

In Parts I and II of this series,[1, 2] tests with methyl bromide have been described in which four methods of vacuum fumigation and also fumigation at atmospheric pressure were compared, using, in the main, boxes of compressed dates and bags of wheatfeed. Wheatfeed was selected as the product for experimental fumigation after the dates had proved to be too unevenly packed for reproducible results to be obtained in replicate tests. With boxes of dates, methyl bromide, although not strongly sorbed, penetrates with difficulty by reason of the tight packing and sticky nature of the commodity. Wheatfeed presents a large surface area of material reactive with methyl bromide which is consequently rapidly sorbed, but, nevertheless, it is easily penetrated by the fumigant as a result of the large intergranular air space of the commodity.

It was considered that a more useful comparison between the methods of fumigation could be obtained in tests with some other product which, while still allowing reproducible results as between packages, would show much slower penetration of methyl bromide. It was desired to test, in particular, the method of vacuum fumigation in which atmospheric pressure is restored part way through the treatment. In this method the optimum time for raising the pressure is dependent upon the amount of penetration which has occurred during the period at reduced pressure. Whalemeat meal as used for animal feeding was thought likely to be a suitable product. The material supplied contained a proportion of bonemeal, but for brevity it will be referred to simply as whalemeat meal.

Experimental

Each fumigation was carried out on a single 168-lb. bag of whalemeat meal in a 1700-l. steel chamber in a room maintained at 15° and 70% R.H. With the exception of Expt. 5 the tests were carried out on successive bags. The different fumigation procedures used were exactly as described for the corresponding tests on bagged wheatfeed and boxes of dates except that in Expt. 7 instead of airing by the method of two airwashes[1] the fumigant was removed from the chamber by forced ventilation at atmospheric pressure for a period of one hour. In some of the tests additional gas samples were taken from within the bag after airing for 24 and 72 hours. Concentrations of methyl bromide in the samples were determined as previously described.[1]

Seven days after each fumigation, samples of meal were taken from the gas-sampling positions for determination of residual bromide. Each sample was further aired for 48 hours by spreading on muslin stretched on a wooden frame so that air circulated freely around the sample. Under these conditions it was assumed that desorption of physically held fumigant would be complete and any residual bromide would be chemically combined. The samples were then treated as described by Lewis & Eccleston[3] and the bromide content of the extract estimated by an oxidation method described by Lewis.[4] In Expt. 5 it was necessary to use, after thorough

* Part II: *J. Sci. Fd Agric.*, 1953, **4**, 378

airing, a bag of whalemeat meal which had been previously fumigated, and residual bromide was not determined after this test.

Moisture content was determined on each bag of whalemeat meal by drying samples at 105° for 2 hours. Two determinations of the nitrogen content of random samples of whalemeat meal were made by the Kjeldahl method, and by use of the factor 6·25 an approximate figure was obtained for the protein content. Solid density measurements on the whalemeat meal were made using the manometric method of Jones,[5] and bulk density measurements were made in a graduated cylinder. From these figures an estimate of the amount of intergranular air space was obtained and these measurements were repeated for wheatfeed to give a comparison of the relative packing and density of the two materials.

Results

Table I shows the results of density measurements and of moisture and protein determinations based on wet weight. For each experimental fumigation on a bag of whalemeat meal curves have been drawn showing the probable variation of concentration with time. The curves for Expts. 1–7 are reproduced in Figs. 1–5. Areas below the curves have been measured to provide estimates of the concentration-time products in mg. h./l. obtained in selected fumigation periods. These are shown in Table II together with the corresponding penetration factors,[1] and the amounts of residual bromide obtained at the points in the bags for which the concentration-time products are shown. Table III shows the gas concentrations at points in bags at the end of the fumigation period and 24 and 72 hours after removal of the bag from the chamber.

Table I

	Whalemeat meal	Wheatfeed
Moisture content, %	5·4	11·0
Nitrogen, %	8·0	—
Protein, %	50	15 (approx.)
Bulk density	0·8	0·39
Solid density	1·45	1·3
Intergranular air space, %	45	70

Discussion

It is of interest to compare the results obtained in this series of experimental fumigations with those reported in similar tests upon bagged wheatfeed.[2] From a consideration of the properties of these commodities it would be expected that on two counts penetration of methyl bromide would be much slower into whalemeat meal than into wheatfeed. Firstly, the intergranular space is much less in the former. Secondly, the protein content of whalemeat meal is much higher, viz. about 50% as compared with about 15% in wheatfeed. It has been shown that the protein fraction of wheat is largely responsible for the physical adsorption and for the chemical decomposition of the adsorbed methyl bromide,[6] and that for a variety of fumigated products the inorganic bromide liberated is proportional to the protein content of the product.[3] Thus sorption of methyl bromide by whalemeat meal would be expected to be high and this should restrict penetration into a mass of the finely divided product. The results of the present tests bear out these expectations.

In Expt. 1 (see Fig. 1) the fumigation was carried out at atmospheric pressure. Penetration was very poor in 4 hours, the amount of gas reaching the centre of the bag in this period being barely measurable, while at a depth of 3 inches into the bag the concentration was little more than a third of that in the free space. While fumigation of this commodity at atmospheric pressure is obviously impracticable in the short periods usual in reduced pressure methods, Expt. 2 (Fig. 2), in which a similar fumigation was carried on for 48 hours, shows that adequate penetration into a bag can be achieved in a 24-hour period and, if the treatment can be continued for 48 hours, the dose can be considerably reduced.

Expt. 3 (Fig. 3), a vacuum fumigation with simultaneous admission of air and fumigant, proved to be very ineffective, giving concentration-time curves and penetration factors similar in all respects to those obtained at atmospheric pressure in Expt: 1. This result agrees with that obtained in tests of the method on bagged wheatfeed. Vacuum fumigation with atmospheric

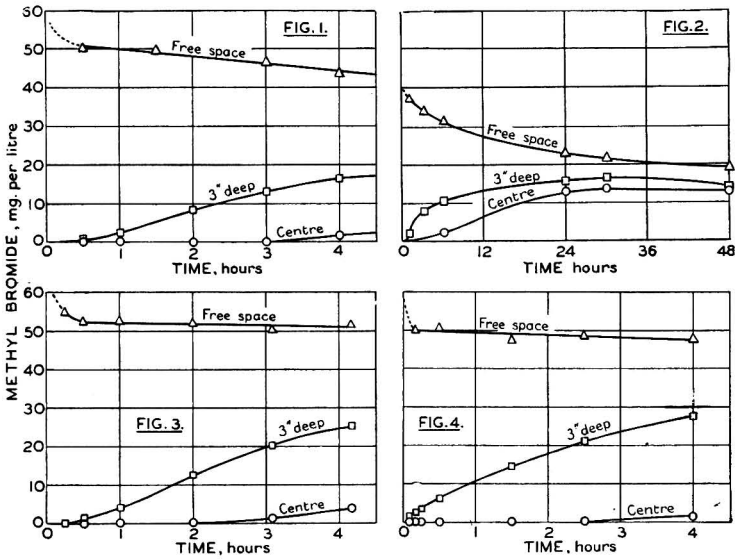

FIG. 1.—*Fumigation at atmospheric pressure. Expt.* 1
FIG. 2.—*Fumigation for* 48 *h. at atmospheric pressure. Expt.* 2
FIG. 3.—*Vacuum fumigation with simultaneous admission of air and fumigant. Expt.* 3
FIG. 4.—*Vacuum fumigation with atmospheric pressure restored immediately after dosage. Expt.* 4

pressure restored immediately after dosage was tested in Expt. 4 (Fig. 4). Again, penetration to the centre of the bag was very similar to that in Expts. 1 and 3. The only advantage of the preliminary reduced pressure appears to have been a slightly more rapid penetration to the 3-in. depth. This is in contrast to the results in a similar test on bagged wheatfeed[2] when high initial concentrations were obtained 3 in. below the surface of the bag. Evidently sorption by the whalemeat meal at the outer layers of the bag is so large and rapid that the fumigant impelled into the bag by sudden restoration of atmospheric pressure is almost all taken up at a depth less than 3 in.

In the three tests, Expts. 1, 3 and 4, in which similar concentration–time products were obtained, amounts of residual bromide determined near the gas sampling points were also very similar (Table II). The residual bromide results are not proportional to the concentration–time products obtained at the centre of the bag and 3 in. deep in the 4-hour period of the fumigation. The disproportionately high residues measured at the centre of bags must be due to fumigant remaining entrapped within the bag for considerable periods after removal from the chamber. Indeed, continued building up of gas concentrations within the bag after the exposure by diffusion of gas inwards from the outer layers is indicated by higher concentrations remaining at the centre of the bags in each case after airing for 24 hours than at the end of the nominal exposure period. If concentration–time products were measured for the whole period during which fumigant concentrations remained in the intergranular spaces of the bag it might be found that for this finely divided product they were proportional to the amounts of residual bromide found.

Expts. 5, 6 and 7 (Fig. 5*a*, *b*, *c*) comprised vacuum fumigations in which atmospheric pressure was restored at various times during the 4-hour exposure period to determine which technique would produce the maximum concentration–time products for the whole period. To obtain by this method of fumigation a better result than is given by the simple method using sustained vacuum, it is necessary that there shall have been sufficient penetration of fumigant into the bulk before restoration of the pressure to atmospheric. It would be expected that the time needed for this would vary for commodities of different sorptive properties. With wheatfeed the highest penetration factors were obtained in the test in which the pressure was restored after one hour. With whalemeat meal, however, the factors obtained in a similar test (Expt. 5, Fig. 5*a*) were less

Table II

Expt. No.	Method	Sampling position	Nominal concn. mg./l.	Period, h.	Concentration–time product, mg.h./l.	Penetration factor	Residual Br, p.p.m.
1	Atmospheric fumigation	Centre	60	4	0·5	0	65
		3 in. deep			32	13	80
2	Atmospheric fumigation	Centre		24	150	16	
		3 in. deep		24	300	32	
		Centre	40	48	480	25	206
		3 in. deep		48	670	35	216
		Surface		48			258
3	Vacuum fumigation with simultaneous admission of air and fumigant	Centre	65	4	3	1	75
		3 in. deep			50	19	80
4	Vacuum fumigation, atmospheric pressure restored immediately after dosage	Centre	60	4	0·7	0	61
		3 in. deep			66	27	89
5	Vacuum fumigation, atmospheric pressure restored after 1 hour	Centre	80	4	100	31	Bag previously fumigated
		3 in. deep			180	57	
6	Vacuum fumigation, atmospheric pressure restored after 2 hours	Centre	85	4	140	42	171
		3 in. deep			200	60	108
7	Vacuum fumigation, atmospheric pressure restored after 3 hours	Centre	70	4	100	36 (34)*	143
		3 in. deep			140	51 (49)*	117

* Estimated for 4-hours sustained vacuum

than those which it was estimated would have been obtained if the reduced pressure had been sustained for the full 4 hours. These latter estimates were obtained by extrapolation of the early part of the curves in Fig. 5*c*. With this product higher penetration factors were obtained in the test in which the pressure was restored after 2 hours (Expt. 6). However, if curves are drawn showing the variation of penetration factor with time of restoring the pressure to atmospheric (Fig. 6), it will be seen that, in spite of the marked difference in rates of penetration into the two commodities, the optimum time for restoring the pressure is probably not very different and lies between one and two hours. The effect at the centre of the bag of restoring atmospheric pressure before the end of the exposure period was, in any case, much less marked for whalemeat meal than for wheatfeed. In each of the Expts. 5, 6 and 7 the concentrations at the 3-in. point in the bags immediately after restoration of atmospheric pressure were in excess of those at the centre of the bags. This is in contrast with the results obtained with bagged wheatfeed.

The concentrations found at the centres of bags 24 hours after the start of the tests, i.e., after airing for 20 hours (Table III), show how ineffective are the usual airing procedures in removing fumigant from the centre of a bag. Comparison of the results in Expts. 6 and 7 shows that the reduced-pressure ' air-washing ' procedure used (two reductions of pressure) was more effective in removing fumigant than the procedure in which the free space fumigant was swept away for one hour at atmospheric pressure. Nevertheless, substantial concentrations remained not only at the centre but at the 3-in. depth even after the reduced pressure treatment.

These concentrations remaining during the period after the nominal exposure are clearly of considerable practical importance in the case of a highly sorptive commodity such as whalemeat meal, since the effectiveness of a treatment will largely depend upon the behaviour of the fumigant in the period after exposure. In Expts. 6 and 7 the total concentration–time product obtained at the centre of the bags in the exposure and post-fumigation periods must have been several times that measured in the 4-hour exposure period alone.

The experiments described in the present paper and in the two previous papers in this

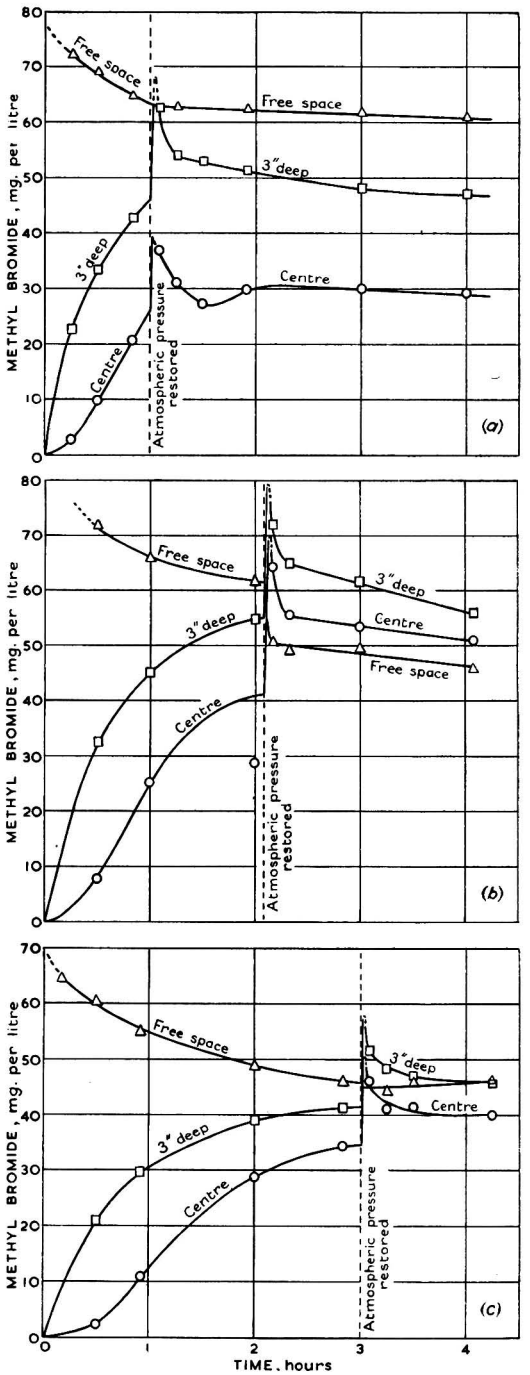

FIG. 5.—*Vacuum fumigation with atmospheric pressure restored after* (a) 1 *h.*, (b) 2 *h.* 5 *min.*, (c) 3 *h.* (*Expt.* 5–7)

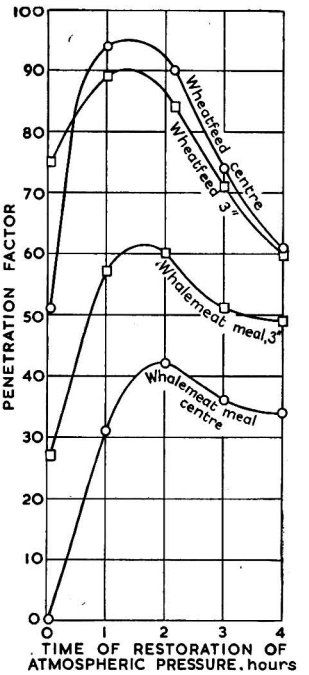

FIG. 6.—*Variation of penetration factor with time of restoring pressure to atmospheric*

Table III

Expt. No.	Sampling point	Concn. at end of exposure period, mg./l.	Method of airing	Concn. after 24 hours, mg./l.	Concn. after 72 hours, mg./l.
3	Centre	3·4	Two airwashes	3·6	0
	3 in. deep	25·1		1·5	0
4	Centre	1·1		6·0	0
	3 in. deep	27·4	" "	2·6	0
6	Centre	50·8		7·3	0
	3 in. deep	55·7	" "	3·0	0
7	Centre	39·8	Blowing out	17·7	0·15
	3 in. deep	45·7	for 1 hour	8·6	0

series,[1, 2] were designed to investigate the behaviour of the fumigant during the exposure period in various techniques of vacuum fumigation, and the effectiveness of each technique from the physico-chemical standpoint was assessed on the basis of the concentration–time products obtained in the exposure period. The results of the few concentration measurements made after 24 hours in the latest tests emphasize the need for a more extensive investigation of the behaviour of the fumigant in the post-fumigation period, before attempting a final assessment of the merits of the different techniques.

In vacuum fumigation tests made under practical conditions on pressed bales of jute bags, using methyl bromide as fumigant, Monro & King[7] have demonstrated by the use of test insects the importance of the post-fumigation effect. Commenting upon the effect of the normal air washing process they suggest that ' the final restoration of atmospheric pressure by the sudden inrush of air serves two purposes : (1) to remove dangerous concentrations of fumigant from the free space so that persons may enter the chamber to unload it ; (2) to leave residual fumigant in the bale where it is available to act in the post-fumigation treatment '. This seems to be a very practical view-point.

However, with a commodity which adsorbs the fumigant as strongly as whalemeat meal adsorbs methyl bromide there may be a danger of excessive treatment at the centre of the bag. This may cause tainting or other damage to the material or may lead to the formation of undesirably high chemical residues. The rather large residues of inorganic bromide found in samples taken from the centres of bags after 24 hours in Expts. 6 and 7 (Table II) are probably very largely the result of continued reaction of adsorbed methyl bromide during the period after 4 hours' fumigation. The dose applied in such a treatment measured as a concentration–time product over the whole fumigation and post-fumigation period may be several times that applied to the surface layer of the bag where the concentration will fall to an ineffective level at the start of airing, and the total concentration–time product is that obtained during the fumigation period alone. The aim in such a treatment should be the production of one selected level of concentration–time product throughout the bag. Ideally, any addition to the concentration–time product at points within the bag during the post-fumigation period should balance out differences in this product as between the surface and the inner parts of the bag developed during the fumigation period. It would seem necessary, in order to avoid excess treatment at the centre of the bag in the case of a commodity like whalemeat meal, to devise a more efficient method of airing.

Since the rapid penetration of fumigant in fumigation at reduced pressures is principally due to the greater rate of diffusion at low total pressure,[2] it would seem reasonable to expect that removal of residual adsorbed fumigant after a fumigation could be effected most efficiently at reduced pressure. This removal could be effected by continuous evacuation of the chamber while allowing a controlled admission of air to sweep away the fumigant from the free space, the absolute pressure in the chamber being maintained at a low level such as 10 cm. Hg. Airing by this means for one or two hours might be necessary to reduce the fumigant concentration throughout the bag to a sufficiently low level, but this procedure might be considered justified in the case of particular products to avoid the possibility of damage or the creation of undesirable residues. In these circumstances it would be advantageous to avoid, at any time during the

fumigation or airing periods, the sudden raising of the pressure to atmospheric until the concentrations throughout the bag have been reduced to a low value. The final restoration to atmospheric pressure at the end of the airing period should not then cause any significant rise in concentration at the centre of the bag, though it will provide the final clearing of the free space noted by Monro & King.

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STUDIES ON COMPOSTS PREPARED FROM WASTE MATERIALS. III.*—Nitrification in Soil

By G. E. G. MATTINGLY†

1. The mean proportion of nitrogen in 23 samples (representing 18 different composts) that nitrified in soil in 5 and 13 weeks was found to be 9·3 and 10·6% of the total nitrogen; this difference was not statistically significant.

2. The amount of nitrogen in composts that nitrified in soil in 5 and 13 weeks correlated significantly with the amount of organic plus inorganic nitrogen in the composts that was soluble in cold 0·1N-hydrochloric acid.

3. The percentage of the total nitrogen that nitrified in soil in 13 weeks was closely correlated with the nitrogen content of the organic matter in the compost for composts prepared from similar materials (sewage sludge and straw). There was no similar correlation, however, for composts from different materials (sewage sludge and town's refuse, coir fibre, cotton-waste, etc.).

Introduction

The amount of nitrogen in organic manures that is mineralized during decomposition in soil has been shown to be approximately inversely related to the carbon : nitrogen ratio of the manure. When this ratio exceeds about 20 : 1, no nitrogen is liberated as nitrate or ammonia on addition of a manure to soil, and in some cases, nitrogen is immobilized by microbial action.[1] If either the nitrogen or carbon compounds or both are not easily broken down in soil, the above relationship does not hold; in such cases Norman[2] suggested using the ratio 'available' carbon : 'available' nitrogen, 'available' carbon and nitrogen compounds being defined as

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chemical forms readily degraded by soil micro-organisms. Bould[3] found that the ratio 'available' carbon : total nitrogen gave a better indication of the amount of nitrogen mineralized in soil from composts of town's refuse and sewage sludge than did the uncorrected carbon : nitrogen ratio. He determined 'available' carbon either as organic carbon by the rapid oxidation method of Walkley & Black[4] or by determining the sum of the carbon present in lignin, cellulose and hemicellulose by chemical methods. In either case he was able to correct the total carbon content, determined by a combustion method, for elementary carbon, mainly coal, in the refuse. Rubins & Bear[5] found a close relationship between nitrification of organic manures, which included sewage sludge products, and a corrected carbon : nitrogen ratio, where the correction involved estimation of non-lignin instead of total carbon.

The carbon content of organic manures can be calculated approximately using 'loss on ignition' at about 500° to estimate organic matter and assuming that 55–60% of the organic matter is carbon. A carbon : nitrogen ratio of 20 : 1 then corresponds to a content of 3% nitrogen in the organic matter. Bould[3] found that in composts from town's refuse and sewage sludge the nitrogen content of the organic matter approached 3·5% in well-matured composts.

Whiting[6] suggested long ago that nitrification of some organic materials depended more on their content of water-soluble nitrogen than on their carbon : nitrogen ratio, and Rubins & Bear[5] found that washed residues of organic manures were much more resistant to breakdown in soil than unwashed materials; recently, the nitrogen availability of bone meal[7] and urea–formaldehyde polymers[8] has been found to depend on their soluble nitrogen content.

Very few investigations have been made of the nitrification of composts in soil. Bould[3] found that little more than the water-soluble nitrogen of the composts he prepared nitrified rapidly. The experiments described in this paper relate nitrification in soil of a number of composts of different materials to (*a*) the amount of nitrogen soluble in 0·1N-hydrochloric acid and (*b*) the nitrogen content of the organic matter in the composts. A brief note on some of the results was published earlier.[9]

Experimental

Materials

Details of the preparation of composts from straw and sewage sludge and straw and ammonium sulphate have been given elsewhere.[10] Composts from straw, town's refuse and sewage sludge were prepared in large cells at Maidenhead Sewage Works following the method developed by Bould.[11] Composts from sewage sludge and sawdust, cotton waste, etc., were prepared in small cells in the manner described by Hoyle.[12] A brief description, and the chemical analysis, of the composts is given in Table I.

Nitrification tests

The soil used in these experiments was from nursery beds at the University Horticultural Station, near Reading. The pH was 7·1 and the carbon and nitrogen contents were 3·06% and 0·173% of the air-dried soil, respectively. Two hundred-g. portions of soil, sieved through a 3-mm. sieve, were weighed into 600-ml. wide-necked bottles and fresh compost, equivalent to 4 g. of dry matter, was added and well mixed. The moisture content was adjusted to 17–20% and the bottles weighed, stoppered with cotton-wool plugs and incubated in a greenhouse. Bottles were shaken frequently throughout the tests to ensure adequate aeration and water was added to maintain constant weight. A separate series of bottles was prepared for each sampling; all treatments and controls (no added compost) were in duplicate or triplicate. The mean recovery of nitrate-nitrogen from ammonium sulphate (15 mg. of N) under these conditions was 86% in 13 weeks.

Analytical methods

Methods used for estimating loss on ignition, nitrogen soluble in 0·1N-hydrochloric acid and total nitrogen and for extracting and estimating nitrate-nitrogen were described in an earlier paper.[10]

Results

Twenty-three samples of 18 different composts were incubated in soil as described above for 5 and 13 weeks. The increase in nitrate production over the nitrate produced in the controls during incubation was determined and expressed as a percentage of the total nitrogen added in the compost. In several cases addition of compost depressed the level of soil nitrate; this results in a negative percentage nitrification (Table I) and indicates that some soil nitrogen was 'immobilized' or synthesized into water-insoluble nitrogen compounds.

Table I

Description and analysis of composts and percentage of total nitrogen nitrified in soil in 5 and 13 weeks.
(The composts are arranged in order of increasing content of soluble nitrogen)

No.	Components	Age (months)	pH	% in dry matter			% of total N nitrified		Notes on method of compost preparation[c]
				Total N	N soluble in 0·1N-HCl	Total N in organic matter[a]	in 5 weeks	in 13 weeks	
1.	Town's refuse–sewage sludge	8	7·0	1·61	0·058	3·66	2·5	10·7	Large cells; not accurately weighed
2.	Town's refuse–sewage sludge	13	—	0·99	0·059	3·47	6·7	—[b]	Large cells; not accurately weighed
3.	Wheat straw–sewage sludge	3	7·2	2·19	0·064	4·25	−0·4	3·3	Straw : sludge, 1 : 1,[d] 2 weeks' aeration
4.	Town's refuse–wheat straw–sewage sludge	8	6·7	1·46	0·065	3·57	3·3	9·3	Large cells; not accurately weighed
5.	Wheat straw–sewage sludge	6	6·6	1·89	0·066	2·96	−1·2	−2·5	Straw : sludge, 3 : 1, 3 weeks' aeration
6.	Coffee waste–sewage sludge	11	5·0	4·82	0·087	5·25	0·8	0·3	Coffee waste : sludge, 11·5 : 1, 20 weeks' aeration
7.	Wheat straw–sewage sludge	6	6·6	1·88	0·092	3·00	1·2	−1·2	Straw : sludge, 3 : 1, 15 weeks' aeration
8.	Wheat straw–sewage sludge	8	6·6	2·13	0·121	4·25	5·7	7·5	Later sample of compost 3
9.	Wheat straw–sewage sludge	6	6·2	2·17	0·140	3·76	5·7	5·9	Straw : sludge, 1·7 : 1, 15 weeks' aeration
10.	Wheat straw–sewage sludge	6	6·1	2·28	0·157	4·04	9·8	8·3	Straw : sludge, 1·7 : 1, 3 weeks' aeration
11.	Wheat straw–sewage sludge	11	6·6	2·23	0·164	3·64	7·0	6·5	Straw : sludge, 3 : 1, 20 weeks' aeration
12.	Cotton waste–sewage sludge	11	7·1	2·81	0·165	4·94	6·8	8·3	Cotton waste : sludge, 5·8 : 1, 20 weeks' aeration
13.	Wheat straw–sewage sludge	8	6·4	2·16	0·173	4·50	7·9	8·8	Straw : sludge, 1 : 1, no aeration
14.	Ammonium sulphate–wheat straw–sewage sludge	3	6·4	2·09	0·174	3·36	4·6	6·6	Straw : sludge, 3·5 : 1 [+4% $(NH_4)_2SO_4$ and 2·8% $CaCO_3$], 2 weeks' aeration
15.	Wheat straw–sewage sludge	5	6·3	2·83	0·198	5·34	7·3	9·6	Straw : sludge, 0·5 : 1, 13 weeks' aeration
16.	Wheat straw–sewage sludge	5	6·4	2·61	0·208	4·77	7·8	9·8	Straw : sludge, 1 : 1, 13 weeks' aeration
17.	Ammonium sulphate–wheat straw–sewage sludge	8	5·9	2·01	0·266	3·27	15·8	18·0	Later sample of compost 14
18.	Coir fibre–sewage sludge	11	5·0	1·63	0·308	2·06	17·3	15·6	Coir fibre : sludge, 1·8 : 1, 20 weeks' aeration
19.	Wheat straw–sewage sludge	16	5·7	3·22	0·418	6·32	19·1	18·9	Later sample of compost 15
20.	Balsa sawdust–sewage sludge	11	5·4	3·22	0·492	4·60	10·3	17·8	Sawdust : sludge, 1 : 1, 20 weeks' aeration
21.	Ammonium sulphate–wheat straw	3	6·6	2·20	0·534	3·18	18·5	21·1	Straw + 5·5% $(NH_4)_2SO_4$ + 5·6% $CaCO_3$, 2 weeks' aeration
22.	Wheat straw–sewage sludge	22	5·8	3·15	0·589	5·96	21·0	20·4	Later sample of compost 16
23.	Ammonium sulphate–wheat straw	8	5·9	2·11	0·676	3·00	36·4	30·5	Later sample of compost 21

(a) Organic matter content determined from 'loss on ignition'. (b) Sample lost. (c) All composts, except Nos. 1, 2 and 4 prepared in small cells (see reference [10]). (d) All ratios are on dry weight basis.

Table II gives a summary of the relationship between the nitrate produced in soil in 5 and 13 weeks (y) and the content of 0·1N-hydrochloric acid-soluble nitrogen in the compost (x). The linear regression coefficients are both highly significant (P = 0·001) and the amount of nitrogen nitrified in soil in 5 and 13 weeks is related to the soluble nitrogen content of the composts by the following equations:

$$5 \text{ weeks} \quad y_1 = 1{\cdot}087x - 1{\cdot}39$$
$$13 \text{ weeks} \quad y_2 = 0{\cdot}947x + 1{\cdot}13$$

Table III summarizes the relationship between the percentage total nitrogen nitrified in soil in 13 weeks (y) and the nitrogen content of the organic matter of the composts (z). The linear regression coefficient was only significant, however, for the samples of 12 straw–sludge composts; the regression equation is

$$y_2 = 5{\cdot}968z - 18{\cdot}31$$

Table II

Relationship between % of total nitrogen nitrified in soil in 5 and 13 weeks (y) *and nitrogen soluble in 0·1N-hydrochloric acid in composts* (x)

Period of incubation, weeks	No. of samples	N soluble in 0·1N-HCl as % of total nitrogen (x) (mean of all composts)	Nitrate produced in soil as % of total nitrogen (y) (mean of all composts)	Regression coefficient (b)	Correlation coefficient (r)
5	23	9·83	9·30 ± 0·622	1·087 ± 0·086	+ 0·942***
13(a)	22	10·01	10·61 ± 0·759	0·947 ± 0·101	+ 0·902***
Difference between means and regression coefficients			1·31 ± 1·15 (n.s.)	− 0·140 ± 0·131 (n.s.)	—

n.s. not significant. *** significant at P = 0·001
(a) one sample lost.

Table III

Relationship between % of total nitrogen nitrified in soil in 13 weeks (y) *and nitrogen content of organic matter of composts* (z)

Compost	No. of samples	Regression coefficient	Correlation coefficient
Straw–sewage sludge	12	+ 5·968 ± 0·716	+ 0·935***
Other composts	10	− 4·855 ± 2·16	− 0·550 (n.s.)

Discussion

The amount of nitrifiable nitrogen in the composts used in these experiments (Tables I and II) did not exceed the amount of ammonia + nitrate + organic nitrogen extracted from the composts by 0·1N-hydrochloric acid.[10] It is apparent from the linear regression equation above that nitrogen is 'immobilized' during the first five weeks in soil if composts contain less than about 1% of their nitrogen in a chemical form that can be extracted by dilute hydrochloric acid. The mean increase in the percentage of total nitrogen that nitrified between 5 and 13 weeks was only 1·3% (Table II) and this increase is not statistically significant. Of the nitrogen ultimately nitrifying in 13 weeks 88% was converted into nitrate during the first five weeks, which agrees with the conclusions of Clark, Gaddy & Jacob[13] who found over 80% of the nitrogen ultimately nitrified in soil from a wide variety of nitrogenous wastes was converted to nitrate in the first three weeks.

It was shown in a previous paper[10] that soluble nitrogen first decreased on composting waste materials and then slowly increased on prolonged storage. In all cases where two samples from the same compost of different ages (Nos 3, 14, 15, 16 and 21 in Table I) were used for nitrification tests, more nitrate was produced from the second than the first. This increase in nitrate production appears to be a consequence of the increase in soluble nitrogen in the compost during storage (Table I) and not primarily the result of further breakdown of organic nitrogen in soil. This

close relationship between soluble nitrogen in a wide variety of composts and the quantity of nitrate produced in soil confirms Bould's results with a more limited range of composts[3] and is in accord with results with other waste materials containing organic nitrogen.[5, 7, 8]

Results discussed above refer to changes in the *mean* percentage of nitrogen in the composts that nitrifies in 5 and 13 weeks. Several composts (Nos. 1, 4 and 20 in Table I), however, nitrified appreciably more during the longer period in soil. Two of these composts, Nos. 1 and 4, were prepared in large heaps which compact and become poorly aerated during storage. The conditions of optimum aeration, moisture and temperature that obtain during nitrification tests probably favour breakdown of organic nitrogen compounds and account for the increased nitrification of these composts in soil. The close agreement between soluble nitrogen and nitrate production established in this work may to some extent be due to the conditions under which the composts prepared in small cells were stored, as nitrate accumulated steadily in the composts during storage.[10]

Hoyle[12] concluded from extensive pot experiments that, in the presence of adequate phosphorus and potassium, crop yield was closely related to the amount of nitrogen in composts that was soluble in 0·1N-hydrochloric acid. She found, however, that both crop yield and nitrogen uptake were greater for some composts than predicted from soluble nitrogen content, presumably because of the further slow release of nitrogen during decomposition in soil. It is doubtful if any analytical method at present gives more than an approximate estimate of crop yield from composts.

The nitrogen content of the organic matter predicts the amount of nitrate released in soil as reliably as does the content of ' soluble ' nitrogen for straw–sludge composts but not for the other composts used in this work (Table III). The absence of any significant correlation between nitrification and nitrogen content of the organic matter for composts of different materials is probably related to differences in the nitrogen compounds present which were not studied. The regression equation for straw–sludge composts shows that no nitrate is produced in soil when the nitrogen content of the organic matter is 3·0% (corresponding to a carbon : nitrogen ratio of 20 : 1) and that about 5% of the total nitrogen nitrifies when the value rises to 4·0%. There is obviously no justification for applying this equation to other composts ; their content of ' soluble ' nitrogen is a better guide to their subsequent nitrification in soil.

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VEGETABLE OILS. V.*—The Component Acids of *Cephalocroton cordofanus* (Muell.-Arg.) Seed Oil

By K. E. BHARUCHA and F. D. GUNSTONE†

Cephalocroton cordofanus seed oil has been examined and found to consist chiefly of *cis*-12 : 13-epoxyoleic acid (62%) along with linoleic (17%), oleic (10%), *threo*-12 : 13-dihydroxyoleic acid (4%) and saturated acids (7%). The structure of the epoxy acid follows from its identity with the acid from *Vernonia anthelmintica* seed oil.

Introduction

Following the discovery of 9-hydroxyoctadec-12-enoic acid in seed oils of the *Strophanthus* genus,[1, 2, 3] a re-investigation has been made of other seed oils reported to contain hydroxy-acids frequently described as ricinoleic acid although the evidence cited seldom indicates more than the presence of a hydroxyoctadecenoic acid. Previous work on *Vernonia anthelmintica* seed oil containing *cis*-12 : 13-epoxyoleic acid[4, 5] and on *Mallotus philippinensis* seed oil containing 18-hydroxyelaeostearic acid[6] has already been reported. An account is now given of work on *Cephalocroton cordofanus* seed soil (Euphorbiaceæ).

Previous study of the fatty acids present in these seeds is confined to the work of Henry & Grindley[7] who also describe the seeds and report on the occurrence of this shrub in the Sudan. These investigators consider that ricinoleic acid or some isomeric compound is present. This work has been made possible through the kind co-operation of Mr. D. N. Grindley who supplied the seeds used. It has been found that this seed oil contains *cis*-12 : 13-epoxyoleic acid identical with that already discovered in *V. anthelmintica* seed oil ; it is probably accompanied by a little *threo*-12 : 13-dihydroxyoleic acid, but no evidence has been found of a monohydroxy acid.

Experimental

C. cordofanus *seed oil*‡

The seeds, of average weight 0·091 g. (0·126 g.), were crushed and extracted with light petroleum (b.p. 40–60°) in a Soxhlet extractor. In this way a green-brown oil, which solidified when kept at 0°, was obtained in 32·7% yield (42%). This oil had iodine value 91·4 (91·4), saponification equivalent 304·9 (304·1), free acidity 6·8% as oleic acid (0·9%), unsaponifiable material 1·2% (0·9%), $\alpha_D^{16\cdot5°}$ + 3·4° in acetic acid, in a 20-cm. tube, (α_D^{23} + 2·70°, 20 cm. tube, solvent not stated), epoxide 61·7% (wt.) as glyceride or 59·2% (wt.) as acid. Apart from the greater yield of oil obtained by Henry & Grindley from their heavier seeds these two sets of values are in close agreement. The acetyl value reported by these workers is probably due to the epoxy-acid which is now considered to be present. Experiments were first carried out to identify the epoxy-acid present but it is more convenient to describe first the component acid analysis of this oil.

The component acids of C. cordofanus *seed oil*

Quantitative examination has been made of the component acids of this oil by the procedure recently described.[5] After treatment first with acetic acid and then with alcoholic potassium hydroxide, the oil was converted into mixed acids in which any epoxy acid was changed to the corresponding dihydroxy acid. These mixed acids were then partitioned between light petroleum (b.p. 40–60°) and 80% methanol, the acids being dissolved in the latter solvent and repeatedly extracted with the petroleum. The combined petroleum extracts were subsequently crystallized at −20° from methanol (10 ml. per g.). Fraction A (see Table I) was methylated and distilled, fraction B was distilled after methylation and acetylation, and the content of dihydroxyoleic acid in fraction C was calculated from its equivalent before and after acetylation. The small amount of non-hydroxy material remaining in fraction C was considered to have the same composition as the petroleum-soluble material (i.e., fractions A and B together). The composition of

* Part IV : *J. Sci. Fd Agric.*, 1955, **6**, 373
† Present address : The University, St. Andrews
‡ Throughout this section values given in parenthesis refer to the data of Henry & Grindley.

fractions A and B was calculated by standard procedures. The results are totalled and the content (mol.-%) of dihydroxyoleic acid so obtained compared with the content of epoxide (mol.-%); since the former exceeds the latter by an amount (3·4%) probably greater than the experimental error it is considered that some dihydroxyoleic acid is originally present. Further evidence of this is given below.

Dihydroxystearic acid was shown to be absent from the epoxide-hydrolysed acids since a concentrate of the dihydroxy-acids gave only a little dihydroxyoleic acid when crystallized from ethyl acetate at 0°; under these conditions Riley[8] reports that dihydroxystearic acid separates quantitatively. When the mixed acids which had not been treated with acetic acid were partitioned between light petroleum (b.p. 40–60°) and 80% methanol, some dihydroxyoleic acid was isolated; this may be formed during alkaline hydrolysis or may be present as such in the seed oil.

Qualitative identification of the acids present

Palmitic acid (Table I, A1, m.p. 62–62·5°) and stearic acid (Table I, A4, m.p. 68·8–69·0°) were isolated from the fractions indicated and their identity confirmed by mixed melting point with authentic samples. Linoleic acid from fractions B3–B9 was converted to 9 : 10 : 12 : 13-tetrabromostearic acid, m.p. and mixed m.p. 113·5–114·5°, and a concentrate of oleic acid obtained from fractions B3–B9 as a complex with urea was oxidized by dilute alkaline permanganate to *erythro*-9 : 10-dihydroxystearic acid, m.p. 129–129·5°, raised to 129·5–130·5° when mixed with an authentic sample.

Attempts to isolate the epoxy-acid by partition between light petroleum (b.p. 40–60°) and 80% methanol were unsuccessful, but the dihydroxyoleic acid (m.p. 51–53°) derived from the epoxy-acid in high yield by acid hydrolysis and then alkaline hydrolysis was identical with the acid similarly obtained from *V. anthelmintica* seed oil and known to be *threo*-12 : 13-dihydroxyoleic acid.[4] The epoxy-acid has also been converted to the *erythro*-dihydroxyoleic acid (m.p. 87–88°), identical products being obtained from the two seed oils. (These experiments were effected in connexion with another problem and have been fully reported elsewhere.[9]) Proof of the structure of the *threo*- and *erythro*-dihydroxy acids rests on degradative studies already reported.[4, 9] Oxidation shows the two hydroxyl groups to be on $C_{(12)}$ and $C_{(13)}$ and the double bond to be $\Delta^{9:10}$; conversion of the epoxy-acid to octadec-*trans*-12-enoic acid proves that the epoxide group has the *cis*-configuration. The chief acid in this seed oil is therefore *cis*-12 : 13-epoxyoleic acid.

The small proportion of dihydroxy-acid which accompanies the large amount of epoxy-acid is *threo*-12 : 13-dihydroxyoleic acid identical with that formed from the epoxy-acid by hydrolysis. This is shown by the melting point of the acid (54–56°), of its *p*-bromophenacyl ester (72–73°), of the corresponding dihydroxystearic acid (95–96°) and of its *p*-bromophenacyl ester (102–105°), all of which remain undepressed when mixed with authentic specimens.

Discussion

It is clear from these studies that *C. cordofanus* seed oil contains mainly epoxyoleic acid (62%) accompanied by smaller amounts of linoleic (17%), oleic (10%), dihydroxyoleic (4%), and saturated acids (7%). These results are very different from those previously reported (oleic 59%, ricinoleic 33%, linoleic 6%, saturated 2%), but this is not surprising in view of the failure of the early investigators to recognize the true nature of the oxygenated acid since the reactivity of the epoxy-acid renders the usual methods of analysis unsuitable.[5] When Henry & Grindley examined this seed oil it was not recognized that epoxy-acids occurred naturally in fats.

Hilditch[10] has drawn attention to the fact that the botanical families Rosaceæ, Euphorbiaceæ, and Cucurbitaceæ differ from others in that while many of their seed fats contain the usual mixture of palmitic, oleic, and linoleic or linolenic acids, several species elaborate some other unusual acid such as ricinoleic, elaeostearic, licanic, parinaric, kamlolenic, or decadienoic acids. This list must now be extended to include 12 : 13-epoxyoleic acid. The presence of this acid in a seed oil of the Compositæ (*V. anthelmintica*) is more unusual in that all the members of this family so far examined contain the usual mixture of saturated and unsaturated acids.

Table I

C. Cordofanus *seed oil*

Separation of acids

		Wt., g.	%, by wt.	Iodine value
Fraction A	Light petroleum extract, insol. in methanol at −20°	9·0	5·9	7·7
Fraction B	Light petroleum extract, sol. in methanol at −20°	36·9	24·1	140·6
Fraction C	Methanol extract	107·1	70·0	91·3

Distillation of Fractions A and B

No.	Wt., g.	Iodine value	Saponification equivalent	No.	Wt., g.	Iodine value	Saponification equivalent
A1	2·01	0·9	271·7	B1	2·84	101·3	289·3
A2	2·11	3·0	276·9	B2	2·73	140·7	293·5
A3	1·92	7·6	293·6	B3	2·86	143·2	294·7
A4	1·26	6·5	298·2	B4	2·98	144·7	294·7
A5	1·48*	10·9	373·6	B5	2·82	144·3	295·2
				B6†	2·76	142·9	293·7
				B7	3·11	142·5	295·0
				B8	2·50	141·5	293·3
				B9	2·88	138·1	294·4
				B10	1·98	125·2	290·7
				B11‡	3·27	88·8	245·4

* 1·279 g. of this fraction contained 0·194 g. of unsaponifiable material.

† B6 acids, iodine value 151·5, $E^{1\%}_{1\,cm.}$ (180°/60min.) at 234 mμ 598, at 268 mμ 5·5.

‡ 2·443 g. of this fraction contained 0·573 g. of unsaponifiable material.

Fraction C

Saponification equivalent of ester before acetylation 326·1 ; after acetylation 141·5 ; whence composition (% by wt.) was calculated to be dihydroxyoleic acid 93·5%, other acids and unsaponifiable material 6·5%.

Component acids

	A	B	C	Total	Excluding unsaponifiable wt.-%	mol.-%	wt.-%*
Palmitic	2·54	0·69	0·48	3·71	3·8	4·4	3·9
Stearic	2·28	—	0·34	2·62	2·6	2·8	2·8
Arachidic	0·61	—	0·09	0·70	0·7	0·7	0·7
Oleic	0·31	7·79	1·21	9·31	9·4	10·0	9·8
Linoleic	—	14·18	2·13	16·31	16·5	17·8	17·1
Dihydroxyoleic	—	0·80	65·45	66·25	67·0	64·3	3·7
Epoxyoleic	—	—	—	—	—	—	62·0
Unsaponifiable	0·16	0·64	0·30	1·10	—	—	—

* The quantity of epoxyoleic glyceride determined directly (60·9 mol. %) is less than the quantity of dihydroxyoleic acid (64·3 mol.-%): the difference is considered to be due to some dihydroxyoleic acid originally present (see text). The final column gives the composition of the original acids on a weight basis.

It is emphasized that it is of importance when investigating the component acids of a fat, to check the identity of the major component acids at least. The computation of analytical results involves certain assumptions (as, for example, that an acid containing eighteen carbon atoms and having two double bonds is linoleic acid) and these should be checked qualitatively if possible. Unless this is done the presence of unusual and interesting acid components may be overlooked. This has recently been found to be so in the seed oils of some *Strophanthus*[2, 3] and *Ximenia* species.[11]

Acknowledgments

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INFRA-RED SPECTROSCOPY OF DAIRY PRODUCTS*

By J. D. S. GOULDEN

The problems involved in the infra-red study of dairy products are considered and a special type of liquid absorption cell for such samples is described. Spectra of various dried products are presented and the effects of protein–carbohydrate interactions upon infra-red spectra are discussed.

Introduction

The study of the infra-red spectra of dairy products presents a number of fundamental difficulties which are not usually encountered in most other fields of application of infra-red spectroscopy. Almost all the materials of interest in this particular field contain water, the most important dairy product, liquid milk, containing more than 85% water. Apart from the problem of finding suitable materials for absorption cell windows, water is probably the strongest known infra-red absorbing compound and even very thin films show intense absorption throughout most of the 2–15 μ region (Fig. 2). This intense absorption of the solvent makes it practically impossible to observe absorption bands in some of the most important regions of the spectrum, even using the double-beam technique to compensate for solvent absorption.

A second major problem arises from the inhomogeneous nature of most dairy products, which leads to a considerable loss of energy in the form of scattered radiation. In the case of separated milk, the scatter is largely determined by the casein micelles which have diameters of the order of 0·1 μ. Since this is less than one-twentieth of the wavelength of the radiation in the 2–15 μ region, the Rayleigh Scattering Theory will apply and the loss of radiation by scatter will fall off rapidly at longer wavelengths according to the λ^{-4} law. The fat globules in whole milk, however, have diameters of the same order as the wavelength of the radiation in the 2–15 μ region, so that the scattering in whole milk will no longer be governed by the λ^{-4} law and will in fact be very much less wavelength-dependent. A further complication is introduced by the presence of small air bubbles which depend very much upon the treatment that the sample has received prior to spectroscopic examination.

In view of these difficulties, the initial work in this field has been confined mainly to dried milk products and to materials like butter which contain relatively smaller amounts of water. A study is now being made of the scattered radiation in order to obtain further information about the physical nature of butter and liquid milk.

* Read at Infra-Red Symposium organized by the London Section, April 9–10, 1956

Experimental

Apparatus

Before attempting quantitative work on milk and butter, it has proved necessary to devise a special type of absorption cell. Owing to the very short optical paths needed (~0·01 mm.), and to the difficulty of cleaning out cells that have been used for the various dairy products, a demountable absorption cell was used. In collaboration with Mr. A. R. Turner, an interferometric method has been developed to enable the cell thickness to be measured.

The cell is shown in Fig. 1 and is based upon the standard Grubb Parsons fixed-thickness cell. Portions of the inside surfaces of the two cell windows are surface-aluminized as shown, and the cell thickness is measured very accurately by using the aluminized regions of the cell as the pair of parallel plates of a Fabry–Perot interferometer. Three adjusting screws set in the locking ring enable the cell windows to be set parallel, this adjustment being carried out whilst observing the form of the interference fringes in monochromatic visible radiation.

Results

Milk and butter

Fig. 2 shows the spectra of water, milk and butter and illustrates the problem of the intense water absorption. All the spectra were obtained with a Grubb Parsons Double Beam S3A Spectrometer fitted with a rock-salt prism. Samples were examined as thin films pressed between barium fluoride plates and although not measured accurately for this series of spectra, the film thicknesses were all of the order of 0·005 mm.

Strong water bands near 3300 cm.$^{-1}$, 2100 cm.$^{-1}$, 1600 cm.$^{-1}$ and 700 cm.$^{-1}$ account largely for the absorption of the milk sample and also show clearly in the butter spectrum where the water content is about 15%. In liquid milk, the methylene-stretching vibrations of the fat show as a pair of weak shoulders near 2900 cm.$^{-1}$ and 2850 cm.$^{-1}$ on the lower frequency side of the intense water band at 3300 cm.$^{-1}$. The intensity of these bands in the protein and carbohydrate components is considerably less than in the fat, since they cannot be distinguished clearly in a spectrum of separated milk. The C=O-stretching vibration of the fat shows at 1740 cm.$^{-1}$, whilst the three characteristic bands at 1245 cm.$^{-1}$, 1170 cm.$^{-1}$ and 1110 cm.$^{-1}$ are usually associated with the C—O-stretching vibrations of triglycerides. A band near 1465 cm.$^{-1}$ in the milk and butter spectra can be assigned to the methylene-bending vibration of the fat component, whilst the hydrogen bending mode of the *trans*-substituted ethylene bands in unsaturated triglycerides can be identified in the butter spectrum near 965 cm.$^{-1}$. Bands in the 1170–1000 cm.$^{-1}$ region are usually associated with the OH-bending vibrations of the lactose, although both the proteins and the fat absorb to a lesser extent in this region of the spectrum.

Dried milk and milk constituents

Fig. 3 shows the spectra of samples of dried full-cream milk, dried separated milk, casein (soluble, commercial product) and lactose (monohydrate), all examined in potassium bromide pressed-discs. A spectrum of butterfat is also included for comparison, the latter sample being examined as a thin film pressed between rock-salt plates. From these spectra, the characteristic bands of the various components can all be identified in the spectrum of the dried milk samples.

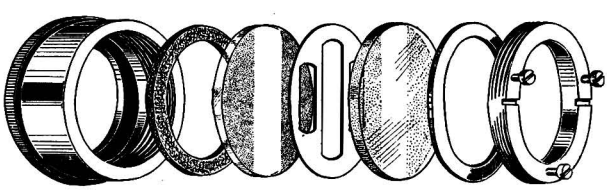

FIG. 1.—*Absorption cell*

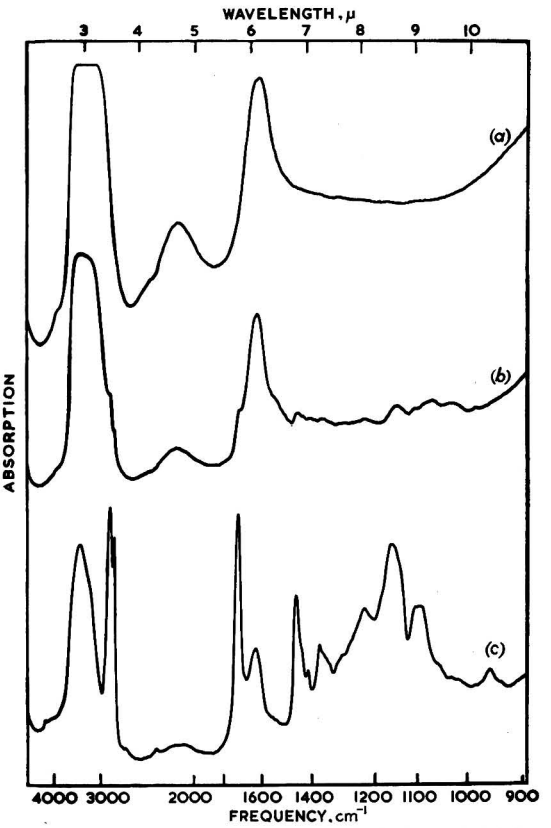

FIG. 2.—*Infra-red spectra of* (a) *water,* (b) *liquid milk,* (c) *butter*

Casein–lactose mixtures

Infra-red spectroscopy is likely to prove of particular value in the examination of protein–carbohydrate systems, since interactions between the two types of compound have already been demonstrated by means of infra-red spectroscopy.[1] Fig. 4 shows the spectrum of a mixture of casein with lactose, both as the dry mixture (*a*) and as the same mixture recovered from aqueous solution by freeze-drying (*b*). Similar results have been found for mixtures of casein with other sugars. In order to demonstrate that these results were not due to peculiarities of the potassium bromide pressed-disc technique,[2, 3] the samples were re-examined as Nujol mulls and similar results were again obtained.

The loss of the fine structure of the carbohydrate bands in the OH-bending region near 1050 cm.$^{-1}$ suggests that the protein and carbohydrate molecules are intimately bound together in aqueous solution. This interaction may be due to direct hydrogen-bonding between the two components, but is more probably due to the presence of residual water molecules which are firmly bound between the protein and carbohydrate molecules. These water molecules are not removed by high vacuum at room temperature and probably require considerably higher temperatures to liberate them from their environment.

The above results are of particular interest in the study of dried milk manufacture, since the infra-red spectra of some samples of commercial heat-dried milk, e.g., Figs. 3 (*a*) and (*b*), show the fine-structure bands of the lactose in the 1050 cm.$^{-1}$ region, whilst a sample of separated milk which has been freeze-dried, e.g. Fig. 4 (*c*), shows only the broader type of absorption bands. This broad structure is also observed in freeze-dried preparations of other biological materials which consist largely of protein and carbohydrate. The rheological properties of uterine cervical secretions are of importance in a study of the physiology of the cow. Fig. 4 (*d*) shows a similar

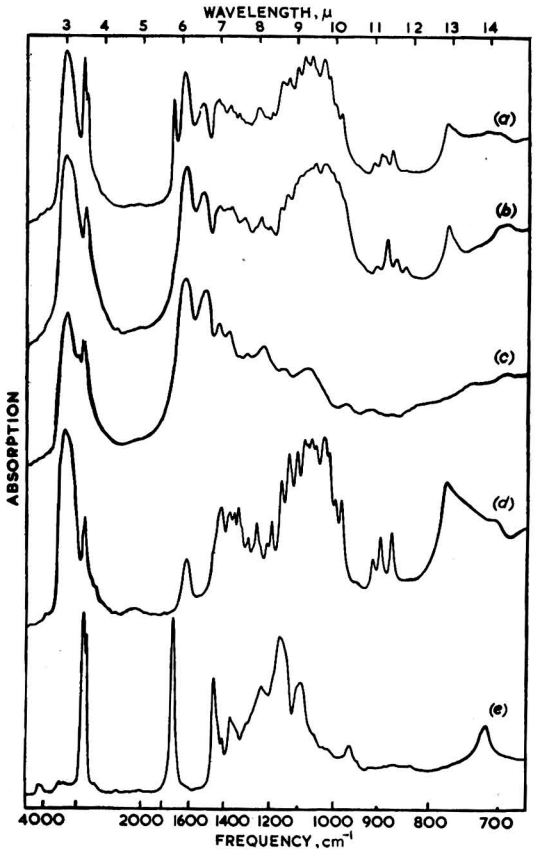

FIG. 3.—*Infra-red spectra of dried materials.* (a) *full-cream milk,* (b) *separated milk,* (c) *casein,* (d) *lactose (monohydrate),* (e) *butterfat*

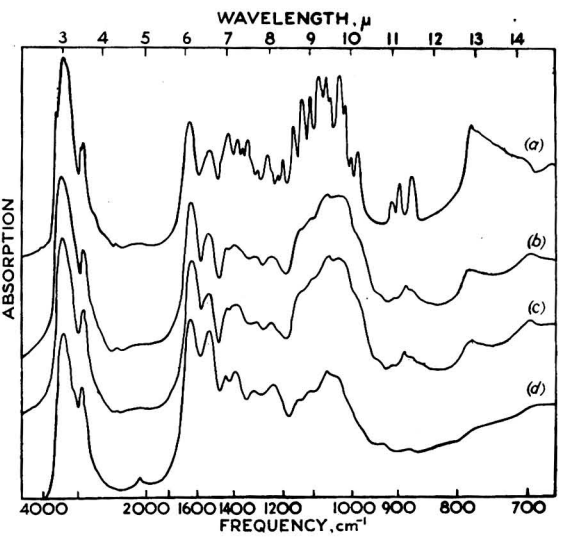

FIG. 4.—*Infra-red spectra of* (a) *dry mixture of casein and lactose,* (b) *freeze-dried solutions of casein and lactose,* (c) *freeze-dried separated milk,* (d) *freeze-dried cervical secretion*

spectrum obtained from a freeze-dried secretion sample, and confirms the muco-protein nature of this material. In this spectrum, the broad structure of the OH-bending vibrations may also be due in part to the complex mixture of sugars which form the polysaccharide parts of the molecules.

Conclusion

As indicated earlier, the quantitative analysis of dairy products by infra-red absorption methods presents a number of special problems. Attempts are being made to study dried materials using the potassium bromide pressed-disc technique, but the preparation of clear uniform discs of materials containing fat often proves difficult. Such samples are not usually hard enough to be ground up to the requisite fine particle size by a vibratory ball-mill operating at room temperature and do not mix intimately with the potassium bromide powder. If the fat content is not very high and the sample has been dried carefully, it is sometimes possible to prepare satisfactory discs, but samples from which the fat has been first removed by a suitable solvent generally provide good potassium bromide discs.

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CARBON-NITROGEN RELATIONSHIPS IN SOIL. III.*— Comparison of Immobilization of Nitrogen in a Range of Soils.

By G. W. WINSOR† and A. G. POLLARD

Immobilization of nitrogen in the presence of sucrose has been compared in 24 soils differing widely in origin and composition. Marked differences were found in the amounts of nitrogen immobilized in the various soils, these being correlated with the pH, phosphate content and carbon/nitrogen ratios of the soils.

Introduction

In previous papers[1] on the immobilization of nitrogen in the presence of added carbon compounds the soils used were mainly taken from glasshouses and a market garden. These intensively cultivated soils showed considerable uniformity in their response to added carbon compounds,[1b] but preliminary experiments with other soils showed marked differences in their

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ability to immobilize nitrogen.[1] Further experiments were therefore made in which immobilization of nitrogen was studied in a wide range of soils, these including not only cultivated soils but also samples from pastures and woodlands.

Experimental methods

Conductivity measurements were made at 25° in soil suspensions prepared at a water/soil ratio of 5 : 1 after shaking for 1 hour. The results are expressed in terms of pC, as defined by Whittles & Schofield-Palmer.[2] All other analytical methods were as previously described.[1, 2]

Samples of each soil in moist condition were weighed into flasks in amounts corresponding to 60 g. of oven-dry material. Flasks of each soil were treated in triplicate with ammonium sulphate supplying 200 p.p.m. of nitrogen, while additional flasks received 200 p.p.m. of nitrogen together with 2000 p.p.m. of carbon supplied in the form of sucrose. The substances added were dissolved in water and added by means of a 5-ml. pipette, the moisture content being adjusted to 90% of the moisture equivalent of the various soils. All samples were incubated at 23·5° for two days, after which duplicate flasks were analysed successively for ammonia and nitrate contents. The remaining flasks were used in the determination of pH, the values shown in Table I being those for the control soils, receiving neither ammonium sulphate nor sucrose.

Table I

Analytical data relating to the soils used in nitrogen-immobilization tests

	Soil	Moisture equivalent	Nitrogen %	Organic carbon %	C/N ratio	Phosphate* % P_2O_5	pH	pC
1	River bank	30·4	0·575	5·79	10·1	0·076	7·49	3·33
2	Low-lying pasture	43·9	0·820	7·38	9·0	0·055	6·51	3·51
3	Woodland	23·4	0·158	2·78	17·6	0·003	4·36	4·09
4	Woodland	19·2	0·092	1·45	15·8	0·002	4·12	4·22
5	Newly ploughed pasture	27·0	0·323	3·21	9·9	0·010	5·08	3·90
6	Under grass	20·4	0·216	2·14	9·9	0·096	7·55	3·79
7	Old pasture	21·4	0·210	3·19	15·2	0·010	6·42	4·13
8	Woodland	21·8	0·202	2·19	10·8	0·012	3·35	3·44
9	Market garden	19·8	0·216	2·03	9·4	0·121	7·70	3·68
10	Market garden	20·8	0·259	2·49	9·6	0·119	7·56	3·72
11	River bank	28·0	0·283	3·45	12·2	0·012	7·58	3·48
12	Woodland	26·0	0·327	4·35	13·3	0·005	4·52	3·60
13	Newly ploughed pasture	24·7	0·245	2·39	9·8	0·005	6·08	3·92
14	Old pasture	27·2	0·294	3·39	11·5	0·010	4·91	3·92
15	Woodland	20·5	0·084	1·63	19·4	0·005	3·92	3·96
16	Woodland	11·0	0·053	0·86	16·2	0·003	4·27	4·50
17	Parkland	24·6	0·213	2·91	13·7	0·011	6·58	3·77
18	Parkland	19·2	0·146	1·53	10·5	0·016	4·51	4·35
19	Glasshouse (tomato)	27·8	0·319	2·87	9·0	0·479	7·83	3·53
20	Glasshouse (tomato)	24·6	0·274	2·23	8·1	0·308	7·52	3·45
21	Glasshouse (cucumber)	26·0	0·471	3·63	7·7	0·474	7·37	2·93
22	Maiden loam	36·6	0·486	3·97	8·2	0·010	4·74	3·46
23	Market garden	20·9	0·269	2·56	9·5	0·155	7·31	3·69
24	Rose soil	19·3	0·132	1·02	7·7	0·400	7·99	3·78

* Soluble in 0·5N-acetic acid

Results

Analytical data for the 24 soils used are given in Table I. The results show marked differences in composition of the soils. Thus the nitrogen contents ranged from 0·05% in a woodland soil to 0·58 and 0·82% in the highly organic soils of a river valley, with pH values from 3·4 to 8·0. Variations in the content of organic matter are reflected in the moisture relationships of the soils, the values for moisture equivalent being significantly correlated with the carbon and nitrogen contents of the soils. In view of the wide range of soil types represented, the values for organic carbon, obtained by the method of Walkley & Black,[3] are regarded as relative values from a standardized procedure rather than as absolute values. A close correlation exists between the contents of nitrogen and organic carbon in the soils, the correlation coefficient being +0·93, significant at P = 0·001. The highest carbon/nitrogen ratios were found in the woodland soils and the lowest in the cultivated soils.

The inorganic nitrogen present in all soils after treatment with ammonium sulphate with and without sucrose and incubation for two days is recorded in Table II, together with the amounts of nitrogen immobilized. All values for inorganic nitrogen are expressed in p.p.m. on the basis of oven-dry soil.

Table II

The total inorganic nitrogen (p.p.m. NH_3-N + NO_3^--N) in soils treated with ammonium sulphate (200 p.p.m. nitrogen) with and without sucrose (2000 p.p.m. carbon), together with the amounts of nitrogen immobilized

Soil	Total nitrogen in soil (present as NH_4^+ and NO_3^- with added N p.p.m.	with added C + N p.p.m.	Nitrogen immobilized p.p.m.	Soil	Total nitrogen in soil (present as NH_4^+ and NO_3^- with added N p.p.m.	with added C + N p.p.m.	Nitrogen immobilized p.p.m.
1	314	162	152	13	242	115	127
2	344	211	133	14	216	79	137
3	207	133	74	15	197	172	25
4	206	142	64	16	201	125	76
5	251	175	76	17	258	112	146
6	221	43	178	18	195	106	89
7	208	79	129	19	225	25	200
8	239	113	126	20	230	24	206
9	237	40	197	21	388	178	210
10	229	41	188	22	422	309	113
11	260	142	118	23	220	39	181
12	213	114	99	24	209	28	181

The amounts of nitrogen immobilized on incubation for two days ranged from 25 to 210 p.p.m., suggesting very different levels of microbiological activity in the various soils. The greatest amounts of nitrogen were immobilized in the glasshouse and other cultivated soils, the least in the maiden and woodland soils. Immobilization of nitrogen was found to be closely related to certain other properties of the soils as recorded in Table I, including pH, phosphate extracted by 0·5N-acetic acid, carbon/nitrogen ratio and conductivity ; the correlation coefficients are given in Table III.

Table III

Correlation between the amounts of nitrogen immobilized in the presence of sucrose and analytical data for 24 soils

	Correlation coefficient r	Level of significance P
Nitrogen immobilized and soil pH	0·841	0·001
,, ,, ,, % P_2O_5	0·890	0·001
,, ,, ,, log (% P_2O_5)	0·890	0·001
,, ,, ,, pC	− 0·606	0·01
,, ,, ,, C/N ratio	− 0·761	0·001
Soil pH and log (% P_2O_5)	0·819	0·001
,, ,, ,, pC	− 0·485	0·05
Log (% P_2O_5) and pC	− 0·608	0·01

Examination of the data for the 24 soils shows that the amount of nitrogen immobilized in the presence of sucrose increased with the pH of the soil, the correlation being significant at P = 0·001. From the linear regression equation it is found that the amounts of nitrogen immobilized increased by approximately 28 p.p.m. for a corresponding increase of one unit of pH. The main deviations from this general relationship were found with soils 8 and 11. Soil 8, the most acid soil in the group (pH 3·35), proved more active than anticipated and may well have a population of soil organisms somewhat different from that present in the other soils.

A highly significant relationship was also found between immobilization of nitrogen and the amount of phosphate in the soil soluble in acetic acid. Although this correlation is significant at P = 0·001, the relationship is not linear, the response to phosphate falling away at the highest concentrations. Several of the soils in Table I probably contained phosphate in excess of the growth requirements of the organisms in this test. Thus there was little evidence for any direct relationship between soluble phosphate and immobilization of nitrogen in soils containing more than 0·1% of phosphate soluble in acetic acid. On transforming the data by plotting the

logarithm of the phosphate values against the amounts of nitrogen immobilized a linear relationship is obtained, the correlation coefficient r being +0·890.

In addition to soil pH and phosphate content, two other factors were found to be correlated with immobilization of nitrogen, these being the carbon/nitrogen ratios of the soils and their salt content as shown by conductivity measurements. The correlation with pC was a negative one, significant at P = 0·01. This implies a positive relationship between immobilization of nitrogen and the amounts of water-soluble salts present. It is unlikely that salt concentration had any direct effect on the micro-organisms in this experiment, and a more likely explanation may be based on the chemical aspects of the soil suspensions. Thus a soil of relatively high salt content is more likely to contain the various inorganic nutrients essential for rapid growth of the soil organisms. This interpretation is supported by the correlation between pC and the content of soluble phosphate in the soils, significant at P = 0·01. It was also found by calculation of the partial correlation coefficients that no correlation remained between pC and immobilization of nitrogen when the effect of phosphate was eliminated.

Discussion

The results obtained in this experiment indicate very marked differences in the ability of the various soils to immobilize inorganic nitrogen in the presence of an added organic substance when tested under comparable conditions. Of the factors found to be related to immobilization of nitrogen the highest correlations were with the pH and phosphate contents of the soils.

In the absence of direct microbiological data for the soils used it is not possible to assess the extent to which the relationship between pH and immobilization of nitrogen is due to differences among the micro-organisms present. There is abundant evidence, however, that the pH of the soil does influence the numbers and types of organism present, and it is generally considered that acid conditions favour fungi rather than bacteria. Thus Waksman[4] showed that addition of lime stimulated the development of bacteria and actinomycetes but not of fungi. Jensen[5] confirmed Waksman's data for the highly significant relationship existing between hydrogen ion concentration and the ratio of fungi to bacteria plus actinomycetes. Jensen also showed that in an acid soil (pH 5·0) the addition of sugar increased the fungal count far more than in the same soil previously treated with calcium carbonate (pH 7·3), whereas the reverse was true for the numbers of bacteria plus actinomycetes. By analogy it is possible that the relationship between pH and immobilization of nitrogen in the present investigation was in part due to differences among the soil organisms present. The fact that pH values of 7–8 favour immobilization of nitrogen in the soil finds some parallel in the work of Norman[6] on the biological decomposition of straw.

A further factor shown to be significantly correlated with the immobilization of nitrogen was the phosphate content of the soils as determined in acetic acid extracts. The stimulation of the soil organisms following the addition of readily assimilable organic matter, accompanied by the immobilization of nitrogen, requires the presence of phosphorus and other elements essential to growth. Thus Chang[7] observed that available phosphorus increased the rate of decomposition of cellulose both by pure cultures of fungi and by a mixed soil population. A close analogy can in fact be drawn between the processes of immobilization and mineralization of both nitrogen and phosphorus.[8, 9] Both elements are essential constituents of the living organism, and both are converted from inorganic to organic forms in the presence of a readily assimilated carbon compound and slowly released again by death and decay of the organisms. On this basis a possible explanation may be given of the relationship between immobilization of nitrogen and the level of soluble phosphate in the soils ; treatment of the soils with sucrose and inorganic nitrogen causes rapid development of the soil organisms, limited in many cases by the supply of other essential elements, notably phosphorus, available in the soil.

The pH and soluble phosphate content of the soils, both of which have been shown to be highly correlated with the amounts of nitrogen immobilized, are themselves closely correlated. The value of the correlation coefficient relating pH and the logarithm of the soluble phosphate was +0·819, significant at P = 0·001. The soils used in this experiment included several known to have received applications of both lime and phosphate. The inclusion of such soils might be

thought to have a major effect on the relationship found between pH and soluble phosphate. Further examination of the data shows, however, that the correlation was not greatly influenced by the inclusion of these cultivated soils. Thus on omitting the three glasshouse soils and soil No. 24, all of which contained over 0·3% of phosphate soluble in acetic acid, the correlation coefficient between pH and phosphate in the remaining 20 soils was +0·84. When the three market garden soils were also omitted, leaving 17 soils with phosphate contents of less than 0·1%, the correlation coefficient was +0·73, still significant at P = 0·001.

A relationship between soil acidity and the availability of phosphate has been noted by other workers.[10–12] Whitson & Stoddart[13, 14] found that acid soils lacked available phosphate, the phosphate present being in the form of relatively insoluble compounds of iron and aluminium. Truog[15] stated that below pH 6·5 phosphate rapidly became less available. Thus apart from any direct effect of pH upon the numbers and types of organisms present in the soils, the effect of pH upon the availability of phosphate is likely to have been an important factor in the immobilization of nitrogen in the various soils tested.

The results given in Table III also show a significant correlation between immobilization of nitrogen and the carbon/nitrogen ratios of the soils. The correlation was a negative one, soils of high carbon/nitrogen ratio being the least active in the immobilization of nitrogen. The relationship is summarized in the following data:

Soil	Number tested	Mean C/N	p.p.m. nitrogen immobilized
Glasshouse	3	8·3	200–210
Market garden	3	9·5	181–197
Maiden and newly ploughed pastures	9	10·9	76–178
Woodland	6	15·5	25–126

The significance of the carbon/nitrogen ratio of the soils in relation to immobilization of nitrogen probably lies in the amounts of readily assimilable organic material present. Soils of high carbon/nitrogen ratio contain organic matter that has not been decomposed to the extent found in old cultivated soils. In contrast, the cultivated soils, unless liberally supplied with manure, compost or crop residues, may contain high levels of mineral nutrients but be lacking in fresh organic matter.

Conclusions

(1) Marked differences were found between the amounts of nitrogen immobilized in different soils after treatment with sucrose as a source of readily assimilable organic matter.

(2) Immobilization of nitrogen was significantly correlated with the pH, phosphate content and carbon/nitrogen ratios of the soils. Microbiological activity in response to added organic material thus appears to be related to both inorganic and organic soil constituents.

(3) A highly significant correlation (r = 0·819) was found between the phosphate extracted by 0·5N-acetic acid and the pH of 24 soils.

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CARBON-NITROGEN RELATIONSHIPS IN SOIL. IV.*— Mineralization of Carbon and Nitrogen

By G. W. WINSOR† and A. G. POLLARD

Production of carbon dioxide and accumulation of inorganic nitrogen have been studied in a group of 27 soils differing widely in origin. Samples of each soil were incubated for 28 days at 23·5° and 30°. Further batches of soil were incubated at 23·5° after partial sterilization by steaming, and others after air-drying and re-moistening.

Significant relationships were found between the carbon and nitrogen mineralized under each of the experimental conditions tested. Steaming and air-drying the soils generally increased the mineralization of both carbon and nitrogen, as compared with untreated soils incubated at the same temperature, and resulted in a lower ratio of carbon to nitrogen mineralized.

The amounts of nitrogen and carbon mineralized were significantly correlated with the total nitrogen and organic carbon contents of the soils. Evidence was obtained that the organic matter of intensively cultivated soils is more resistant than that of maiden soils to further microbiological decomposition.

Introduction

The existence in soils of a population of micro-organisms deriving its energy from the decomposition of organic matter results in the continuous mineralization of carbon and nitrogen. Unless balanced by the accumulation of organic residues from the natural cover or system of cultivation, these mineralization processes can cause an appreciable loss in soil organic matter. Thus Sievers & Holtz[1] showed a marked reduction in the total nitrogen and carbon contents of cultivated soils when compared with adjacent virgin soils.

Russell & Appleyard[2] studied the composition of the soil atmosphere in relation to bacterial numbers and nitrate levels under field conditions. Sufficient resemblance was found between the curves for bacterial numbers, carbon dioxide and nitrate to justify the conclusion that they were all related. Field studies cannot, however, tell us precisely how much carbon dioxide or nitrate are formed, since carbon dioxide diffuses away and nitrate is leached out to an unknown extent.

Under laboratory conditions both the evolution of carbon dioxide and the accumulation of inorganic nitrogen have been studied extensively for many years. As noted by Gainey,[3] however, relatively few studies on the parallel formation of carbon dioxide, ammonia and nitrate in the soil have been recorded. Even where measurements of the mineralization of both carbon and nitrogen have been made, the soils were often treated with organic materials such as lucerne, cotton seed meal or dried blood.[3, 4] Waksman & Starkey[5] showed a relationship between the evolution of carbon dioxide from soils and their nitrifying capacity, the latter being calculated as the average of five different tests including mineralization of the soil's own nitrogen and nitrification of dried blood and ammonium sulphate in both sand and soil.

Sievers & Holtz[1] reported that in four field soils incubated for 142 days the ratios of carbon to nitrogen mineralized ranged from 8·8 to 10·3, the mean value being 9·1. Thompson & Black,[6] studying the mineralization of organic phosphorus, carbon and nitrogen, reported data for six pairs of virgin and cultivated soils. The evolution of carbon dioxide and accumulation of inorganic nitrogen were measured on incubation for 30 days at 30°. Considerably more mineralization occurred in the virgin soils than in the corresponding cultivated soils. The ratios of carbon to nitrogen mineralized ranged from 14·3 to 32·1, with a mean value of 19·0. The carbon/nitrogen ratio of the mineralized elements was in every case higher in the cultivated than in the virgin soils, the mean values being 22·1 and 16·0, respectively. A very close relationship was found between the carbon and nitrogen mineralized, the value of the correlation coefficient being 0·895.

An abstract of further work on the mineralization of carbon and nitrogen in the soil has been given by Thompson[7] for 25 pairs of virgin and cultivated soils incubated at 40°. A highly

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significant relationship was again observed between the amounts of carbon and nitrogen mineralized. The average ratios of carbon to nitrogen mineralized were 9·6 and 10·3, respectively, for the virgin and cultivated soils of Iowa.

Experimental methods

Twenty-seven soils were used in this investigation, determinations of nitrogen, organic carbon, moisture equivalent and pH being made as previously described.[8, 9] The soils used included 8 glasshouse soils and 3 market garden soils, together with other samples from field and woodland. The nitrogen content ranged from 0·14 to 0·57%, and pH values from 3·8 to 8·1.

All soil samples (100–200 g.) were incubated in 1-litre conical flasks equipped for the determination of carbon dioxide evolution,[9] duplicate flasks being used for each treatment. For investigation of the effects of partial sterilization, flasks of soil were steamed for 15 minutes, and after cooling to room temperature were aerated for 10 minutes prior to incubation. Further batches of soil were air-dried for approximately three weeks before weighing into the incubation flasks. Preliminary determinations of ammonia and nitrate were made in duplicate at the same time as incubation commenced, separate initial analyses being made on the untreated, steamed, and air-dried soils.

All soils were incubated at 80% of their moisture equivalents as determined by the method of Bouyoucos.[10] With the exception of the air-dried samples, all soils were weighed into the incubation flasks in moist condition, and only small adjustments of moisture content were necessary before incubation. The air-dried samples were moistened immediately before incubation.

Before commencing the main series of experiments with 27 soils, the effect of different periods of incubation was examined in preliminary trials with a market garden soil.

Results

Mineralization of carbon and nitrogen in relation to period of incubation

Measurements of the carbon dioxide evolved and inorganic nitrogen accumulated were made on duplicate samples of a market garden soil after 7 periods of incubation of from 2 to 28 days. The samples studied included steamed and untreated samples which were incubated at 23·5°, and untreated soil incubated at 30°. The mean daily rates of production of carbon dioxide in the soil are given in Table I. Maximum biological activity in the steamed soil occurred within the first two days of incubation, the rate of mineralization of carbon subsequently decreasing with time. Within 2 to 3 weeks the rate of evolution of carbon dioxide approached that of the untreated soil incubated at the same temperature. Mineralization of carbon was more rapid at 30° than at 23·5°, and at both temperatures the rates were relatively constant throughout the experiment.

Table I

Mean daily rates of evolution of carbon dioxide from soil incubated under various conditions

Sample	Temp. of incubation	Period of incubation, days						
		0–2	2–4	4–7	7–10	10–14	14–21	21–28
		p.p.m. carbon dioxide-carbon per day						
Steamed soil	23·5°	59·7	38·1	16·1	15·0	8·2	7·0	6·8
Untreated soil	23·5°	7·0	6·4	6·3	6·6	6·3	6·2	6·6
Untreated soil	30·0°	12·0	10·9	10·1	10·3	9·9	10·8	10·2

The total carbon dioxide evolved and inorganic nitrogen accumulated for different periods of incubation are shown in Table II. Despite marked changes in the rates of mineralization of both carbon and nitrogen in the steamed soils, the ratio of carbon to nitrogen mineralized was virtually independent of the period of incubation. In the untreated soils mineralization was less rapid, but apart from somewhat low values found at the first period of sampling the ratios of carbon to nitrogen mineralized were again largely independent of the period of incubation. The ratio of carbon to nitrogen mineralized was markedly lower in the steamed soil than in the two untreated samples.

Table II

Mineralization of carbon and nitrogen in soil incubated under various conditions

Time in days	p.p.m. carbon evolved as CO_2	p.p.m. inorganic nitrogen accumulated	C/N ratio
Steamed soil incubated at 23·5°			
2	119	21·1	5·6
4	196	35·3	5·6
7	244	45·2	5·4
10	289	52·9	5·5
14	322	58·9	5·5
21	370	65·9	5·6
28	418	68·8	6·1
		Mean	5·6
Untreated soil incubated at 30°			
2	24	2·7	8·9
4	46	4·9	9·4
7	76	7·6	10·0
10	107	10·9	9·8
14	147	14·4	10·2
21	222	22·6	9·8
28	294	29·8	9·9
		Mean	9·7
Untreated soil incubated at 23·5°			
2	14	1·9	7·4
4	27	2·5	10·7
7	46	4·1	11·2
10	65	6·1	10·7
14	90	9·0	10·0
21	134	12·2	11·0
28	180	15·8	11·4
		Mean	10·3

On the basis of these preliminary experiments, an incubation period of 28 days was adopted for subsequent work on the mineralization of carbon and nitrogen. From the constancy of the ratios of carbon to nitrogen mineralized it would seem that a shorter period of incubation would not have influenced the results obtained. The use of a longer period of incubation does, however, increase the experimental accuracy of the nitrogen determinations, and allows the changes resulting from partial sterilization to approach completion.

Mineralization of carbon and nitrogen in 27 soils

The carbon dioxide evolved and inorganic nitrogen accumulated in the various soils were determined on incubation for 28 days. Untreated samples were incubated at 23·5° and 30°, and both steamed and air-dried samples at 23·5°. The inorganic nitrogen accumulated was calculated from initial and final analyses. Measurements of carbon dioxide evolution were made at weekly intervals, with the exception of four soils which were examined more frequently. In one group of experiments with 7 air-dried and re-moistened samples the final analyses were unavoidably postponed from 28 to 31 days ; in order to facilitate comparison with the rest of the data obtained for a 28-day period of incubation corrections were applied, assuming the constancy of the ratio of carbon to nitrogen mineralized as in Table II.

The relationship between carbon and nitrogen mineralized in the various soils on incubation for 28 days under different conditions is shown in Figs. 1 to 4. In each case the correlation coefficients shown on the graphs were highly significant ($P = 0{\cdot}001$).

Discussion of results

The amounts of carbon and nitrogen mineralized under any one set of conditions varied markedly from soil to soil, as shown in the summary of results given in Table III. After estimation of the missing value for one air-dried soil, statistical analysis of the data for carbon mineralized shows that all differences between treatment means were significant except those between

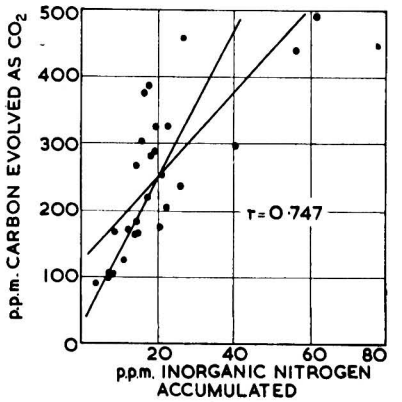

FIG. 1.—*Mineralization of carbon and nitrogen in 27 soils incubated for 28 days at 23·5°*

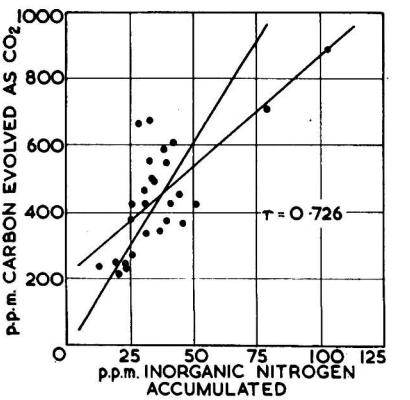

FIG. 2.—*Mineralization of carbon and nitrogen in 27 soils incubated for 28 days at 30°*

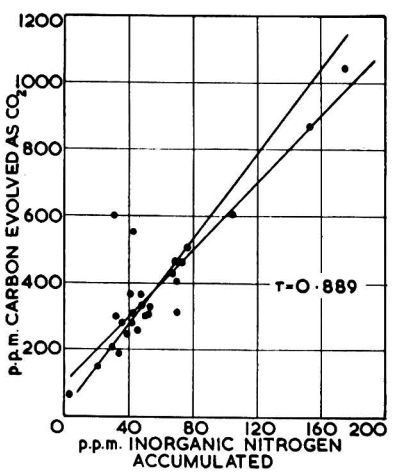

FIG. 3.—*Mineralization of carbon and nitrogen in 27 soils steamed and incubated for 28 days at 23·5°*

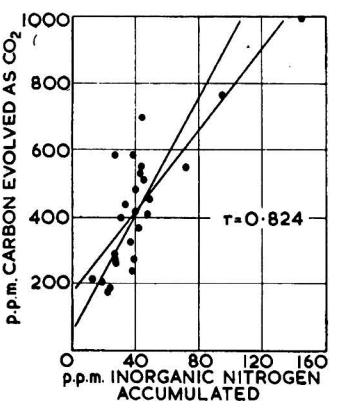

FIG. 4.—*Mineralization of carbon and nitrogen in 26 air-dried soils after re-moistening and incubation for 28 days*

the air-dried and steamed soils and also between the air-dried soils and untreated soils incubated at 30°. A similar analysis of the data for nitrogen mineralized shows that all differences between treatment means were significant (P = 0·001) except that between the air-dried soils and the untreated soils incubated at 30°. It is of interest that the different treatments did not influence mineralization of both carbon and nitrogen to the same extent. Thus mineralization of nitrogen increased in the order (1) untreated soils incubated at 23·5°, (2) untreated soils incubated at 30°, (3) air-dried and re-moistened soils, and (4) steamed soils, whereas for evolution of carbon dioxide the order of the last three treatments was reversed.

The range of values calculated for the carbon/nitrogen ratios of the mineralized elements was relatively wide, as shown in Table IV. The particularly high value of 29 among the steamed soils has little numerical significance, since mineralization of nitrogen in this highly acid soil (pH 3·8) was almost completely suppressed by steaming. The mean ratios of carbon to nitrogen mineralized decreased in the order (1) untreated soils incubated at 23·5°, (2) untreated soils incubated at 30°, (3) air-dried and re-moistened soils and (4) steamed soils. This order is the same as that in which mineralization of nitrogen increased, high values for the carbon/nitrogen ratio of the mineralized elements thus being associated with relatively low mineralization of

Table III

Range of values obtained in the mineralization of carbon and nitrogen in 28 days under various conditions of incubation

Sample	Temp. of incubation	Number of soils	p.p.m. carbon evolved as CO_2		p.p.m. inorganic nitrogen accumulated	
			Range	Mean	Range	Mean
Untreated soil	23·5°	27	90–491	248	4–61	19·8
Untreated soil	30·0°	27	216–886	448	13–102	36·5
Steamed soil	23·5°	27	64–1041	389	2–175	57·4
Air-dried soil	23·5°	26	176–995	428	13–144	42·5

nitrogen. Differences between the mean ratios of carbon to nitrogen mineralized in the various treatments were significant in each case, except between the untreated soils incubated at 23·5° and 30°. Steaming and air-drying the soils thus significantly modified the relationships between carbon and nitrogen in the course of mineralization.

Table IV

Ratios of carbon to nitrogen mineralized in soils incubated under various conditions

Sample	Temp. of incubation	Number of soils	C/N ratio of mineralized elements		
			Range	Mean	S.E.*
Untreated soil	23·5°	27	7·4–23·5	14·1	0·9
Untreated soil	30·0°	27	8·0–23·9	13·1	0·8
Steamed soil	23·5°	27	4·4–29·0	8·1	1·0
Air-dried soil	23·5°	26	6·3–21·4	10·8	0·7

* Standard error of the mean

There is considerable evidence that, quite apart from the different conditions of incubation used, the carbon/nitrogen ratios of the mineralized elements are influenced by the rates of mineralization of nitrogen. Thus from 114 paired values for carbon and nitrogen mineralized on incubation for 28 days, on separating into three groups on the basis of nitrogen mineralized the following results were obtained:

Nitrogen mineralized, p.p.m.	0–25	25–50	> 50
Number of samples	34	57	23
Range of C/N ratios of mineralized elements	7·1–29·0	5·3–23·9	4·4–9·1
Mean C/N ratio	14·6	11·6	6·9
Standard error of mean	0·91	0·56	0·24

Thus ignoring differences in the conditions of incubation, the mean carbon/nitrogen ratio of the mineralized elements decreased as the rate of mineralization of nitrogen increased. High mineralization of nitrogen was also accompanied by greater uniformity of the carbon/nitrogen ratios. On calculating the correlation coefficient between carbon and nitrogen mineralized in the 23 experiments in which more than 50 p.p.m. of nitrogen accumulated, the highly significant value of 0·91 was obtained.

The ratio of carbon to nitrogen mineralized may well be related to the proportion of the different constituents of soil organic matter undergoing decomposition. The organic matter of the soil includes both organic nitrogenous constituents and also non-nitrogenous constituents such as lignin and cellulose. Where microbiological activity is not particularly high it is possible that the soil organisms may slowly decompose carbonaceous materials without appreciable change in the level of inorganic nitrogen, immobilization of nitrogen approximately balancing its mineralization. When, however, the decomposition processes are greatly stimulated by partial sterilization or other means in soils not already exhausted by intensive cultivation, rapid mineralization of organic nitrogenous constituents occurs. In such cases a close relationship between the carbon and nitrogen mineralized may be expected, since a high proportion of the carbon mineralized will have been derived from organic nitrogenous compounds in the soil, themselves having a reasonably constant carbon/nitrogen ratio.

Calculation of the correlation coefficients between carbon dioxide evolved from the various

soils under any pair of conditions of incubation used in these experiments showed highly significant relationships (P = 0·001) ; similar results were obtained for the accumulation of inorganic nitrogen. Mineralization of either carbon or nitrogen in a soil under any one set of experimental conditions is thus related to its response to other conditions of incubation. As an exception to this general relationship, it was found that biological activity in some highly acid soils may be almost completely suppressed by steaming.

The correlations between nitrogen mineralized and total nitrogen, and between carbon evolved as carbon dioxide and the organic carbon content of the soils, are shown in Table V. Although statistically significant, these relationships are not particularly close, thus suggesting differences in ease of decomposition of organic matter in the various soils. There is evidence that the highest percentage mineralization of both carbon and nitrogen occurred in maiden soils and the lowest in intensively cultivated soils. Thus from the results obtained by steaming 8 glasshouse soils the percentages of carbon and nitrogen mineralized in 28 days were 0·82 and 1·03, as compared with 1·50 and 2·33, respectively, for the remaining 19 soils of the group examined. Particularly marked examples of the slow mineralization of the carbon and nitrogen of intensively cultivated soils were found in two glasshouse soils containing over 0·5% of nitrogen. On omitting these two soils the correlations were greatly improved, as shown in the lower half of Table V.

Table V

Correlations between carbon and nitrogen mineralized under various conditions of incubation and the corresponding total nitrogen and organic carbon contents of the soils

Sample	Temp. of incubation	Number of soils	Correlations with total N		Correlations with total C	
			r	P	r	P
Untreated soil	23·5°	27	0·541	0·01	0·763	0·001
Untreated soil	30°	27	0·541	0·01	0·748	0·001
Steamed soil	23·5°	27	0·404	0·05	0·452	0·02
Air-dried soil	23·5°	26	0·519	0·01	0·654	0·001
Untreated soil	23·5°	25*	0·752	0·001	0·837	0·001
Untreated soil	30°	25*	0·766	0·001	0·813	0·001
Steamed soil	23·5°	25*	0·599	0·01	0·666	0·001
Air-dried soil	23·5°	24*	0·727	0·001	0·738	0·001

* Omitting two glasshouse soils

Some analogy may be drawn between the effects of air-drying the soils and of partial sterilization by steaming. Air-drying caused accumulation of ammonia before the start of the experiments, and although some nitrification occurred in all but one soil after re-moistening, appreciable amounts of ammonia accumulated during incubation of five acid soils. Partial sterilization entirely inhibited nitrification in all soils throughout the experiments. Both steaming and the re-moistening of air-dried soils in general markedly stimulated mineralization processes in the early stages of incubation, after which biological activity declined. The results indicate that the general use of air-dried soils in laboratory incubation studies should be avoided.

Conclusions

(1) Mineralization of both carbon and nitrogen in soils was increased by partial sterilization or air-drying followed by re-moistening, and was more rapid at 30° than at 23·5°.

(2) The amounts of carbon and nitrogen mineralized in 27 soils were significantly correlated under all four conditions of incubation used.

(3) The mean ratio of carbon to nitrogen mineralized in the soils decreased in the order (*a*) untreated soils incubated at 23·5°, (*b*) untreated soils incubated at 30°, (*c*) air-dried and re-moistened soils incubated at 23·5°, (*d*) steamed soils incubated at 23·5°, the numerical values being 14·1, 13·1, 10·8 and 8·1, respectively. Differences between these mean values were statistically significant except between conditions (*a*) and (*b*). Both steaming and air-drying the soils thus not only stimulated mineralization of both carbon and nitrogen but also significantly reduced the ratio of carbon to nitrogen mineralized.

(4) The closest relationship between mineralization of carbon and nitrogen was found when the rates of mineralization were high.

(5) The amounts of nitrogen and carbon mineralized in the soils were significantly correlated with the total nitrogen and organic carbon contents of the soils.

(6) The percentages of the total nitrogen and carbon mineralized on incubation were lower in intensively cultivated soils than in the remainder of the soils tested.

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ERRATA

In the paper by Coppock *et al.* (*J. Sci. Fd Agric.*, 1956, **7**, 457–464),

on p. 461, 6th line from bottom, *for* oz. *read* g.
on p. 463, line 13, *for* 36° C *read* 56° C
line 14, *for* 198, 247 and 840 *read* 247, 440 and 840

JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

SEPTEMBER, 1956

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

INDEX OF AUTHORS' NAMES

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JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE

ABSTRACTS

SEPTEMBER, 1956

I.—AGRICULTURE AND HORTICULTURE

General: Soils and Fertilisers

Temperature and pH studies in sulphur- and hot-spring areas of Salvador. W. Lötschert (*Ber. dtsch. bot. Ges.*, 1956, **69**, 21—31).—A survey of vegetation occurring in these soils at various temp. ranges is recorded. In general the pH of the soils was extremely low (1·6—3·0). A. G. POLLARD.

Climate-soil classification of natural oak and beech forests in the central German mountain area. O. Klausing (*Ber. dtsch. bot. Ges.*, 1956, **69**, 3—20).—Relationships between species-distribution, soil pH and type (profiles of 120 sites are shown) and climatic factors are discussed. A diagrammatic representation of the association of ecological factors and dominant species is given. A. G. POLLARD.

Rainfall–run-off relationships on wheat land. M. B. Cox (*Agric. Engng*, 1956, **37**, 117—119).—Rainfall and run-off over 12 years from wheat land at the Wheatland Conservation Exp. Sta., Oklahoma, are reported. Run-off was at its greatest during spring and early summer, during which period rainfall intensity was particularly high. A. H. CORNFIELD.

Lysimeters of various forms. L. Steubing (*Ber. dtsch. bot. Ges.*, 1956, **69**, 35—48).—The construction and operation of laboratory lysimeters for the study of the water economy of soils and of the effects of plant growth are described. Mosses may be used to study plant-soil relationships. A. G. POLLARD.

Tile [drain] flow characteristics. T. Goins (*Agric. Engng*, 1956, **37**, 30—32, 35).—Tile flow characteristics as related to tile depth and spacing are reported. A. H. CORNFIELD.

Subirrigation systems. R. L. Fox, J. T. Phelan and W. D. Criddle (*Agric. Engng*, 1956, **37**, 103—107).—Design features, requirements, and the advantages and disadvantages of sub-irrigation are presented and discussed. A. H. CORNFIELD.

Prefabricated linings for irrigation ditches. V. H. Scott (*Agric. Engng*, 1956, **37**, 113—116, 119).—The performance of a variety of materials (asphalted paper and asbestos, plastic-impregnated wood fibres, vinyl and polyethylene film), used as buried or surface linings to prevent seepage losses from irrigation ditches, is presented. Nearly all the linings prevented penetration by vegetative roots and all linings reduced seepage. Buried linings were less effective than surface linings. A. H. CORNFIELD.

Non-circular orifices for sprinkler irrigation. W. A. Hall and P. A. Boving (*Agric. Engng*, 1956, **37**, 27—29).—The performance of triangular orifices is reported. The main disadvantage of sprays produced from this type of orifice is its susceptibility to wind drift, the extent of which increases with water pressure. However, much greater uniformity of drop size and the ability to control distribution by altering orifice shape indicates that triangular orifices may have a considerable potential value. A. H. CORNFIELD.

Effect of mechanical composition and clay mineral types on the moisture properties of soils. L. H. Stolzy (*Dissert. Abstr.*, 1956, **16**, 422—423).—The following were determined: various tensions from 0 to 1 atm., moisture equiv., mechanical analyses, and wilting point (on stems of tomato plants), of various soil samples, field capacity of different horizons, and (by *X*-ray spectrometer) types and amounts of clay materials present in the soil clay. The results and relationships between them are discussed. O. M. WHITTON.

Three-year trials on seasonal variations in connexion with soil analyses. O. Sauerbeck (*Landw. Forsch. Sonderb.*, 1955, **6**, 32—38).—The lactate-sol. K in soil decreased markedly during the main period of growth. Variations were greater in cropped than in bare soil but there was a positive correlation between the K values and moisture %. Variations in P were less marked and less consistent. SOILS & FERT. (A. G. P.).

Three-chamber cell for electrodialysing exchangeable bases in soils and for preparing hydrogen-clays. B. R. Agarwal and A. G. Pollard (*Sci. J. roy. Coll. Sci. Lond.*, 1955, **25**, 68—71.).—The cell described is based on that of Marsden (*J. Soc. Chem. Ind.*, 1940, **59**, 60), is fitted with a cooling coil and is capable of dialysing 300-g. samples of soil. A. G. POLLARD.

The sorptive complex and the exchangeable cation content of the more important soils of the Warsaw area. A. Musierowicz and K. Konecka-Betley (*Roczn. Nauk rol.*, 1955, **A, 71**, 493—508).—Data for seven profiles of alluvial soils, recorded, include pH_{H_2O}, pH_{KCl} exchangeable bases, exchange capacity, lime requirement, P sol. in 20% HCl and the proportions of kaolin and montmorillonite. A. G. POLLARD.

Colorimetric and volumetric reduction methods for nitrate determination in soils of high nitrate concentration. K. Singh and A. G. Pollard (*Sci. J. roy. Coll. Sci. Lond.*, 1955, **25**, 57—63).—In high-NO_3' soil extracts the phenoldisulphonic acid method gave higher results than did the standard reduction method. Modifications of the customary Devarda technique to ensure complete reduction of NO_3' in these soil extracts are described. A. G. POLLARD.

Comparison of five chemical methods for assessing available phosphate in garden soils. A. H. Cornfield (*Sci. J. roy. Coll. Sci. Lond.*, 1955, **25**, 75—79).—Correlation between the Truog, 1% citric acid, Morgan (1 min. shake), Morgan (Peech and English modification) and Bray (NH_4F) methods is examined in garden soils of pH $<6·5$. Values obtained by the different methods except the 1% citric acid method, were generally correlated. A. G. POLLARD.

Semi-micro routine procedure for the partial fractionation of soil phosphorus. P. J. Rennie (*J. Sci. Food Agric.*, 1956, **7**, 227—232).—A semi-micro procedure for partial-fractionation of soil P compounds, applicable to agricultural, forest and moor soils, is described. Total P is estimated by digestion and extraction with conc. H_2SO_4 and conc. HNO_3. P fractions are prepared by extraction with (1) 8-hydroxyquinoline in acetic acid, and (2) 0·1N-NaOH, in each case for a period of 16 hr. followed by centrifuging. P is estimated in all extracts colorimetrically by reduction of phosphomolybdate with "metol", using a Spekker absorptiometer. Some results obtained on a typical Cleveland (Yorks) *Calluna* podsol soil are reported. (20 references.) J. S. C.

Isotope studies of the equilibria of fixation and liberation of phosphate-ions in the soil. G. Barbier, E. Tyszkiewicz and C. Lesaint (*Bull. Docum. Ass. int. Fabr. Superph.*, 1955, No. 17, 1—13).—Fundamental relationships between diffusible and fixed P in soil as determined by ^{32}P tracer are presented. Fixation and diffusion may be two aspects of ion exchange temporarily extended to surfaces not normally participating in ion-exchange. The lack of residual effects of P fertilisers uniformly distributed in soil as compared with placed fertilisers is probably due to the preferential uptake of P by the first crop from points of contact with sol. fertiliser rather than to fixation of fertiliser P between the two crops. SOILS & FERT. (A. G. P.).

Leaching of boron in soil. K. Scharrer, H. Kühn and J. Luttmer (*Landw. Forsch.*, 1955, **7**, 89—105).—Soils treated with borax were leached slowly in 40-cm. columns with water totalling 500 mm. head during 5 months. Loss of B was highest in an acid moor soil (29%) and in a neutral sand (23%) and least in neutral moor soil (4%) and neutral loam (nil). Fixation of B in soil increased with increase in clay content and in pH but was unaffected by humus levels. SOILS & FERT. (A. G. P.).

Soil degradation and manganese toxicity. P. Prevot, M. Ollagrier, G. Albert *et al.* (*Oléagineux*, 1955, **10**, 239—243).—On groundnut soils of the Middle Congo continuous cultivation leading to poor productivity is associated with increased Mn contents of leaves exceeding 1000 p.p.m. in some cases. Fertilisers other than K and Mg have no marked effects. In this soil Mn is probably combined with org. matter and becomes available to plants as destruction of the org. matter proceeds. Recommendations for the renovation of the soil include application of org. matter, maintenance of fairly high pH and subsoiling to promote oxidation of mobile Mn". SOILS & FERT. (A. G. P.).

Selective enumeration of [soil] actinomycetes in the presence of large numbers of fungi. C. T. Corke and F. E. Chase (*Canad. J. Microbiol.*, 1956, **2**, 12—16).—Addition of actidione to the plating medium, at the rate of 40 μg. per ml., just before pouring the plates, prevented, almost completely, the growth of fungal colonies without inhibiting any of the 85 actinomycetes present in agricultural or forest soils. A. G. POLLARD.

Rôle of micro-organisms in nitrogen transformations taking place in soil and the rhizosphere of oats. W. Myśków (*Roczn. Nauk rol.*, 1955, **A, 71,** 509—532).—In a soil normally containing relatively small no. of micro-organisms the growth of oats increased the no. 5- to 12-fold in the rhizosphere. This effect tended to diminish during rapid stem growth but was again high during the maturation of the plant. Addition to the soil of aq. extracts of fresh compost increased the no. of bacteria and diminished those of fungi but additions of sterilised compost suppressed the development of micro-organisms in the rhizosphere during stem growth. Effects of compost and extract disappeared by the time the plants reached maturity. The amount of org. N in the rhizosphere was 1·5—2·0 times that in the open soil. Yields of grain and straw were highest in soils treated with sterile compost, fresh compost producing only slight increases in yield. A. G. POLLARD.

Increasing soil fertility. A. Vasilin, D. Davidescu, I. Lungu, Gh. Pavlovschi, P. Arram, I. Bratu, E. Miclea, L. Militescu, V. Nicolae, I. Popovici, N. Tănăsescu, E. Tănăsescu, T. Trandrafirescu and Gh. Vines (*Anal. Inst. Cerc. agron. Român*, 1952—3, [1955], **22,** 147—224).—An account is given of a series of investigations, by the Roumanian Institute of Agronomic Research. In dry regions, disc ploughing to a depth of 5 cm. retarded weed growth for 2—3 weeks, during which the soil retained a certain amount of moisture; subsequent tillage to a depth of 20 cm., resulted in improvement of crop yields by 12—60%. Cleaning of the soil with mixed grasses was studied with crops of autumn and spring wheats, flax, hemp, and sugar-beet. The effects of deep manuring and use of mineral fertilisers on crops of autumn wheat, perennial grasses, barley and potatoes and of top dressing with application of fertilisers during crop growth was also studied. On brown chernozem soil, eight different grass mixtures were compared. (From French summary.) (17 references.) J. S. C.

Phytotoxicity as a result of heat treatment of soil. J. Wiebe (*Dissert. Abstr.*, 1956, **16,** 7).—The temporary retardation of plant growth following heat treatment of soil may be caused by production of excess NH_3, higher salt solubility, minor element toxicity, destruction of soil structure and production of " toxin "; the higher solubility of the inorg. and org. soil constituents causes higher osmotic concentration. G. HELMS.

Effects of liquid nitrogen fertilisers on yield and chemical composition of maize, oats and wheat. H. F. Kreizinger (*Dissert. Abstr.*, 1956. **16,** 5).—A two-year study of the effects of various liquid N fertilisers in comparison with that of solid NH_4NO_3 on the yield and chemical composition of maize, oats and wheat revealed no significant differences. G. HELMS.

Pilot plant production and greenhouse tests of fertiliser from ammonia and phosphorus pentoxide vapours. J. M. Stinson, M. M. Striplin, jun., N. A. Brown and L. F. Seatz (*J. agric. Food Chem.*, 1956, **4,** 248—254).—The process consists of burning P with dried air, making the resultant gas containing P_2O_5 vapour react with NH_3 at 600—1000°F. and hydrolysing the product from this reaction with steam at ~250°F. The relatively non-hygroscopic, granular fertiliser contained ~17% of N and 73% of P_2O_5 (90% of plant food); calculations indicated that it contained 80—86% of NH_4 metaphosphate. Potash was added during the hydrolysis step in some of the tests to produce N–P_2O_5–K_2O fertilisers. Greenhouse tests using Sudan grass, red clover and rye-grass indicated that all the experimental products were effective fertilisers. E. M. J.

Availability of the phosphorus in rock phosphate as measured by the phosphorus uptake of lucerne. D. O. Howe (*Dissert. Abstr.*, 1956, **16,** 4).—The differences in availability of P in rock phosphate were determined in relation to (*a*) chemical treatments giving different levels of soluble Ca, Mg, K and Na, and of exchangeable Ca saturation and (*b*) varying quantities of clay and rock phosphate. The concn. of P in plants, but not the yields, increased with increasing levels of sol. P; rock phosphate was a significant source of Ca; addition of $CaSO_4$ to the sand clay cultures had a minor influence on yields but significantly reduced the level of plant P; $MgSO_4$ treatment gave erratic results; K_2SO_4 and K_2CO_3 had little effect but KCl and K acetate reduced P uptake and crop yield; Na_2SO_4 caused greatly reduced yield and had an erratic effect on P uptake. Other information deals with energy exchange in the clay–rock phosphate system. G. HELMS.

Determination of water-soluble phosphorus in fertilisers by repeated washing and by digestion. W. M. Hoffman, B. M. Olive and W. L. Hill (*J. Ass. off. agric. Chem.*, 1955, **38,** 888—897).—Procedures based on (*a*) successive extraction and combination of extracts, and (*b*) single digestion with a specified volume of water were applied to superphosphates and mixed phosphatic fertilisers. The digestion procedure yielded the lower (up to 0·45% P_2O_5) results, but were the more precise; the difference is considered to be within the variation resulting from permissible variations in the official procedure. Acidified extracts of triple superphosphate should be boiled before precipitation of the phosphorus with molybdate. A. A. ELDRIDGE.

Determination of certain elements in agricultural limestones by group separation and spectrography. P. Chichilo, A. W. Specht and C. W. Whittaker (*J. Ass. off. agric. Chem.*, 1955, **38,** 903—912).—Al, Co, Cu, Fe, Mn, Mo, V and Zn, which are determined simultaneously by arc spectrography, are first separated from Ca and Mg by pptn. with oxine and tannic acid from solutions buffered at pH 5·9. The precipitates are ashed and the residue dissolved in HCl for spectrographic determination. In is used as an internal standard for Co, Cu, Mn, Mo and V. Al, Fe and Zn are determined by the comparison standard technique. In cases where comparison results were available, agreement was usually within 15%. A. A. ELDRIDGE.

Plant Physiology, Nutrition and Biochemistry

Method for short-term measurement of water uptake in potometric experiments. H.-J. Küster (*Ber. dtsch. bot. Ges.*, 1956, **69,** 67—74).—The construction and operation of an improved potometer is described by means of which the rate of water uptake can be determined with an accuracy of ±0·005 cu. mm. per min. within the range of 0·02—20 cu. mm. per min. P. S. ARUP.

Effects of a series of cycles of alternating low and high soil water contents on the rate of apparent photosynthesis in sugar cane. F. M. Ashton (*Dissert. Abstr.*, 1956, **16,** 437).—The effects of a series of five cycles of alternating low and high soil water contents on the rate of apparent photosynthesis in sugar cane were studied. In general, a relatively high rate of photosynthesis was maintained until the soil moisture approached the permanent wilting %, and recovery of the original rate of photosynthesis following irrigation required several days. O. M. WHITTON.

Procedure in Alvik's colorimetric determination of carbon dioxide [in assimilation and respiration experiments]. O. Lange (*Ber. dtsch. bot. Ges.*, 1956, **69,** 49—60).—Frenzel's criticisms of the method (cf. *Planta*, 1956, **46,** 447) are largely countered by the establishment of an improved empirical formula expressing the relationship between the content of atm. CO_2 in the apparatus and the pH of the indicator solution. In addition, the use of the new formula admits of the use of smaller plant parts in relation to the vol. of the apparatus, thus reducing fluctuations in atm. CO_2. The risk of creating unnatural conditions by overheating in experiments conducted in sunlight is, however, one which must be taken into account. (26 references.) P. S. ARUP.

Nitrogen compounds in plants. Recent knowledge derived from paper partition chromatography. F. C. Steward, R. M. Zacharius and J. K. Pollard (*Ann. Acad. Sci. fenn. Ser. A*, II. *Chem.*, 1955, **60,** 321—366).—A review. HORT. ABSTR. (A. G. P.).

New nitrogenous constituents of plants: their recognition, identification and metabolic rôle. J. K. Pollard, jun. (*Dissert. Abstr.*, 1956, **16,** 16).—New amino-acids isolated in cryst. form and chemically identified include γ-aminobutyric acid, γ-methyleneglutamine, γ-hydroxy-γ-methylglutamic acid, and a partially identified ester of glutamine. The synthesis, chromatographic characterisation and probable occurrence of γ-guanidobutyric acid are discussed. Other substances identified are γ-hydroxyvaline in tumorous tissue of *Kalanchoe daigremontiana* and αγ-diaminobutyric acid (and possibly cadaverine) in the sol. N fraction of the potato tuber. An unidentified substance occurring in many plants has many of the characteristics of creatinine. Hydroxyproline appears to play a special rôle in the proteins of rapidly growing plants. G. HELMS.

New aminodicarboxylic acid, dihydroxyglutamic acid, in green plants. A. I. Virtanen and T. Ettala (*Acta chem. fenn.*, 1956, **29,** 107).—The hydroxydicarboxylic acid was isolated from *Lepidum sativum* and other plants by paper chromatographic methods and in pure form from *Rheum raponticum*. The conc. alcohol extract was hydrolysed with 6N-HCl, the amino-acids were separated in an Amberlite IR-120 column and in a Dow-50 column. The unknown amino-acid was separated from other acidic amino-acids in a cellulose powder column, using phenol for the elution. On reduction with HI and red P, glutamic acid, serine, glycine and traces of alanine and threonine were found. On the basis of all facts known, the new amino-acid is dihydroxyglutamic acid. E. M. J.

Chemical investigation of the leaves of *Anona senegalensis*. I. Constituents of the leaf wax. A. Mackie and A. L. Misra (*J. Sci. Food Agric.*, 1956, **7,** 203—209).—The leaves of *A. senegalensis* are used as an anthelmintic for horses in Nigeria. The constituents of the

leaf wax were investigated. Extraction with methylated spirit of the dried leaves and distillation of the extract yielded a dark green gum which, on extraction with light petroleum, gave a pale-yellow hard wax (**I**) by pptn. with acetone and a dark green soft wax (**II**) on evaporating the filtrate. Both waxes contained higher saturated fatty acids. **I** contained primary alcohols (C_{28}, C_{30}, C_{32}) and palmitone; **II** contained unsaturated acids, palmitone, and yellow sesquiterpene oils. **II** was potent against the free-living stages of Sclerostomes; **I** was only slowly lethal when tested under the same conditions. (18 references.) J. S. C.

Formation and structure of melanin. G. Lowe (*Sci. J. roy. Coll. Sci. Lond.*, 1955, **25**, 1—27).—A review with 125 references. A. G. POLLARD.

Growth, development and morphine content of opium poppy. E. S. Mika (*Bot. Gaz.*, 1955, **116**, 323—339).—Effects of temp. and photoperiod on the growth of the poppy and on its morphine production are examined, $^{14}CO_2$ being used as a tracer. A. G. POLLARD.

Visual indications of ^{35}S and ^{32}P translocation in the phloem. S. F. Biddulph (*Amer. J. Bot.*, 1956, **43**, 143—148).—Red Kidney bean plants were impregnated with ^{35}S and ^{32}P by the leaf-flap injection method and by a spray on to the lower side of the leaf. Autoradiographs showed that downward movement occurred principally in the phloem. E. G. BRICKELL.

Absorption of ^{60}Co by leaves of young plants and its translocation through the plant. F. G. Gustafson (*Amer. J. Bot.*, 1956, **43**, 157—160).—Bean and cucumber seedlings were studied. Absorption was increased by an increase in light intensity, an increase in temp., and by the addition of S/V Sovaspray 100 to the isotope solution, but wilting of the plants caused a decrease. No translocation took place in plants that had been in the dark from 24 to 72 hr., but it was aided by the addition of glucose, fructose, or maltose to the applied solution. E. G. BRICKELL.

Uptake and localisation of calcium in the pea plant (*Pisum sativum*.).—J. K. Miettinen (*Acta chem. fenn.*, 1956, **29**, 107).—Pea-seedlings grown in Ca-deficient medium have severe damage 4 or 5 mm. below the apical meristem after 4—5 days. Histological data are given. In pea seedlings grown in solution containing ^{45}Ca there was accumulation of Ca in the vascular bundles, in full grown plants there was strong accumulation of Ca in the root nodules, an even distribution in the roots and shoots; at fruit formation the Ca from all parts except the active nodules accumulates in the pericarp of the pods, the seeds remain free except for traces in the epidermis. E. M. J.

Application of rapid chemical tests to the diagnosis of mineral deficiencies in horticultural crops. IV. Comparison between the total nutrients and those extracted by buffer solutions from potato leaves. D. J. D. Nicholas (*J. hort. Sci.*, 1956, **31**, 134—143).—Extraction methods using acetate, citrate, succinate and malonate buffers, are quick in operation and provide as good a correlation with manurial treatments, deficiency symptoms and yield as does the more tedious method of ash analysis, though some anomalous results were obtained with malonate and succinate buffers indicating that they are less suited for determining the mineral status of potato leaves. E. G. BRICKELL.

Influence of external factors on the development of lupins. II. Vernalisation. T. Laczyńska-Hulewiczowa (*Roczn. Nauk rol.*, 1955, **A, 71**, 571—631).—The effect of vernalisation on lupin growth was more marked in early-sown plants. Weather conditions, notably temp. and R.H., were of primary importance. Day length had little influence. A. G. POLLARD.

Physiology of nodulation in *Pisum sativum*, L. P. E. Rudin (*Phytopath. Z.*, 1956, **26**, 57—80).—No nodulation occurred on pea roots detached from shoots even in presence of aq. extracts of green pea shoots, although these extracts favoured nodulation in roots of whole pea plants. Extracts of green maize shoots did not affect nodule formation. The active agent in green pea extracts was sensitive to heat and to acidity: it was not present in extracts of nodule-free pea plants. Nodules were formed only in plants growing in light, regardless of inoculation; in those grown first in darkness and then in light the extent of nodulation depended on the relative lengths of light and dark periods. The substance stimulating nodulation is formed in the aerial parts of plants growing in light. Illumination of the roots of light-grown plants inhibited nodulation, the effect being associated with blue but not with red light. A. G. POLLARD.

Bioassay of auxins in the presence of growth inhibitors. L. C. Luckwill (*J. hort. Sci.*, 1956, **31**, 89—98).—Two methods are described, the first being based on the ability of auxins to delay the abscission of de-bladed petioles of *Coleus blumei* and the second on their ability to promote root formation on the hypocotyls of *Phaseolus vulgaris*. Both tests are relatively insensitive to the growth inhibitors which occur in plant tissue extracts. E. G. BRICKELL.

Possibility of connexion between [growth-substance transport polarity] and flowering. W. Haupt (*Ber. dtsch. bot. Ges.*, 1956, **69**, 61—66).—Experiments with parts of a no. of plants fail to reveal reversal of polarity due to flowering. P. S. ARUP.

Production of indolylacetic acid by the cedar apple rust fungus; identification by paper chromatography. F. T. Wolf (*Phytopath. Z.*, 1956, **26**, 219—223).—The fungus, *Gymnosporangium juniperi-virginianæ*, produces indolylacetic acid as a metabolic product from tryptophan, tryptamine and indolylacetaldehyde being intermediate products. A. G. POLLARD.

A temperature-independent riboflavin-requiring mutant of *Neurospora crassa*. L. Garnjobst and E. L. Tatum (*Amer. J. Bot.*, 1956, **43**, 149—157).—Three new genes contained in a multiple mutant strain of *Neurospora crassa*, Y.30539a, requiring inositol and riboflavin for growth, are described. They were not present in the inositolless strain, Y.8743-13(19-5)a, from which Y.30539a was derived asexually. E. G. BRICKELL.

Susceptibility of plants to hydrofluoric acid and sulphur dioxide gases. P. W. Zimmerman and A. E. Hitchcock (*Contr. Boyce Thompson Inst.*, 1956, **18**, 263—279).—Some species of plants were susceptible to HF but resistant to SO_2; in others the susceptibility was reversed. A few were equally susceptible to both gases. All species of plants stored F, the rate of absorption varied with species and different parts of the plant absorbed different amounts, these results being of use in diagnosing symptoms on vegetation in industrial areas. (12 references.) R. H. HURST.

Crops and Cropping

Recent developments in potato research in the United States. O. Smith (*Amer. Potato J.*, 1956, **33**, 60—66).—A review. A. H. CORNFIELD.

Response of Irish potatoes to different amounts and ratios of nitrogen, phosphorus and potassium when grown in continuous culture. T. E. Odland and J. E. Sheehan (*Amer. Potato J.*, 1956, **33**, 22—27).—Yields of two varieties of potatoes over 10 years on a silt loam varied considerably from year to year but on an average were only slightly greater where 2500 lb. than where 1250 lb. of 6-12-12 (N–P_2O_5–K_2O) fertiliser was applied per acre per annum. Yields were similar with P_2O_5 ranging from 90 to 225 lb. per acre and with K_2O ranging from 135 to 270 lb. per acre, but increased somewhat with N applications from 60 to 120 lb. per acre. Sp. gr. and keeping quality of tubers were very similar with all treatments. When potatoes are grown in continuous culture the N–P_2O_5–K_2O ratio may be changed gradually from 1-2-2 to 1-1-1. A. H. CORNFIELD.

Application of mineral fertilisers to grasslands. A. Pavlov (*Anal. Inst. Cerc. agron. Român*, 1952—3, [1955], **22**, 287—297).—Trials were carried out with NH_4NO_3, superphosphate, and K salts on old grassland on an alluvial clay soil which had a dominant growth of *Festuca pseudovina*. Increases in hay yields of up to 65% could be obtained. Superphosphate, by itself, gave no increase in yield but favoured the growth of *Lotus corniculatus*. (French summary). J. S. C.

Chemicals as mould inhibitors in hay. R. B. Hopkins and D. E. Wiant (*Mich. agric. Exp. Sta. Quart. Bull.*, 1956, **38**, 431—449).—Methods for the application of fungicides to hay, and changes in the moisture content of hay during storage are examined; no satisfactory fungicide for this purpose has been found. (23 references.) P. S. ARUP.

Yield and composition of lucerne as modified by free lime in the soil. W. H. Longstaff, jun. (*Dissert. Abstr.*, 1956, **16**, 425).—The several effects of free $CaCO_3$ in the soil and the effect of various Mg and K saturation levels of the colloidal clay in the soil on the growth and chemical composition of lucerne plants are determined. The various interactions of free lime and Mg, of free lime and K, and of Mg and K are also considered. O. M. WHITTON.

Response of leguminous crops to borax fertilisation. D. A. Russel (*Dissert. Abstr.*, 1956, **16**, 426—427).—Field trials with B fertiliser on leguminous crops included determinations of hay yields, seed yields, and leaf-to-stem weight ratios. Soil test values for water-sol. B, chemical composition of plant samples (for B, Ca, Cu, Fe, K, Mg, Mn, N, Na, P and Si), nutrient ratios, and yields of nutrients were determined. Ashing techniques and chemical procedures for determining B in plant material were studied. Results are given and discussed. O. M. WHITTON.

Effects of potassium nutrition and fruit load on the peach as indicated by foliar analysis. J. Popenoe (*Dissert. Abstr.*, 1956, **16**,

5—6).—Application of KCl to the soil increased the foliar content of Ca and Mg for four years, but had no significant effect on N and P. Blossom removal reduced foliar levels of N, Ca and Mg, and increased those of P and K. Thinning had a similar but smaller effect. Removal from a single limb lowered foliar Ca in that limb but did not affect the level of the other nutrient elements. The effects of crop load and K fertilisation should be taken into consideration when leaf analysis data are used to determine the nutritional status of peach trees. G. HELMS.

Influence of various levels of calcium, potassium and magnesium in the soil on the absorption and yield response to potassium and magnesium by seventeen vegetable crops. S. L. Windham (*Dissert. Abstr.*, 1956, **16,** 427).—Seventeen specified vegetable crops were grown under all combinations of three pH levels (6·5, 6·0 and 5·5), three potassium levels (220, 120 and 12 lb. applied to the acre), and two magnesium levels (50 and 0 lb. applied to the acre). Marketable yield and total plant growth were recorded and samples of each crop chemically analysed. Both differential cation absorption by crops and characteristics of individual ions influence composition and yield response to both K and Mg. O. M. WHITTON.

Leaf-feeding of determinate tomato plants. I. Influences of environment. R. J. Hilton and D. A. Shaw (*Canad. J. agric. Sci.*, 1956, **36,** 27—35).—In greenhouse trials on tomato foliage, the addition of 0·5M-sucrose to a 0·5M-urea spray greatly reduced leaf injury due to the urea, but delayed the absorption of urea. The combined spray increased the development of the plant tops, increased contents of starch in the stems and sol. C in the fruit, but delayed ripening, and reduced the yields of fruit. Effects on the C : N ratio in the fruits were much less pronounced when urea was used alone, either in leaf- or root-feeding. In the absence of sucrose, optimum conditions for urea absorption by the leaves, with a min. of leaf injury, are low temp., high light intensity, and low R.H. P. S. ARUP.

Influence of soil and air temperatures on cropping of glasshouse tomatoes. A. Calvert (*J. hort. Sci.*, 1956, **31,** 69—75).—Variations in soil temp. above 57°F. have little effect but reduction in air temp. produced marked decreases in early yield, although there was no clear effect on the total crop. E. G. BRICKELL.

Nutritional factors affecting production and composition of soya-beans. M. Drake (*Dissert. Abstr.*, 1956, **16,** 3).—Green manuring by ploughing in heavily fertilised rye crop offered no advantage over similar broadcasting of the fertiliser without green manuring. Ploughing the fertiliser into the permanently moist soil layer thus making it available in dry months substantially increased crop yields. Liming plus ploughing in of fertiliser also increased yields. P increased the oil and protein yield and K at a rate insufficient completely to eliminate K-deficiency increased the oil yield with a diminution in protein level. N applied before planting did not improve seed yield ; it reduced nodulation. The effects of S and Mg were small. The soil under treatment was Crosby silt loam, Indiana. G. HELMS.

Growth stimulation of forest-tree seedlings by the activity of free-living mycorrhizal mycelia. I. Levisohn (*Forestry*, 1956, **29,** 53—59).—Experimental evidence suggests that mycorrhizal fungi operating in soil can stimulate the growth of tree seedlings prior to actual mycorrhizal infection, and also that ectotrophic mycelia can stimulate endotrophic tree species although no infection occurs at any stage. Some ectotrophic mycelia, e.g., *Boletus scaber* and *Rhizopogon luteolus*, probably attack soil org. matter, thus rendering nutrients available to the tree seedlings. A. G. POLLARD.

Composition of tree leaves. J. D. Ovington (*Forestry*, 1956, **29,** 22—28).—Data for the Na, K, Ca, Mg, Fe, Mn, Si, P, ash, C and N contents of leaves of a no. of tree species from three different sites are recorded. Leaf composition is largely a charactertistic of species, the influence of site being small. Distinctive differences between leaf analyses of hard and soft woods are indicated ; these are reflected in differences in the surface org. layer and in profile development in the soil. A. G. POLLARD.

Fertiliser studies with tobacco plants using radiophosphorus-labelled superphosphate. V. H. L. Pearse and L. H. Stein (*J. S. Afr. chem. Inst.*, 1955, **8,** 59—67).—Superphosphate labelled with ^{32}P was applied to a phosphate-deficient soil by three methods : (1) mixture with top 2 in. of soil, (2) mixture with top 8 in. of soil, (3) as a band at 6 in. depth to one side of the planting stations. The effects on growth and phosphate uptake of Orinoco-type tobacco plants were observed. In the first 6—8 weeks, method (1) gave a better supply of phosphate to the plants than (2) or (3) but, subsequently, little difference between results from the three methods was observed. Fixation of applied phosphate did not appear to be appreciably higher in late-ploughed than in early-ploughed virgin soil. J. S. C.

Soil factors affecting the growth of carnations. J. M. Rawson (*Dissert Abstr.*, 1956, **16,** 6).—The depth of soil in a constant water-level bench affects shoot growth and morphological development. Adequate soil aëration is essential and causes increased growth and development of lateral buds. Growth substance formed in the apical tip which inhibits lateral growth may become inactivated by soil O_2 or may be reduced to such a level that it becomes stimulative. G. HELMS.

Analysis of forage harvester design. F. Z. Blevins and H. J. Hansen (*Agric. Engng*, 1956, **37,** 21—26, 29).—The power requirements of various components of the field-type forage harvester are reported, and suggestions for increasing efficiency are discussed. A. H. CORNFIELD.

Effect of potato digger design on tuber injury. R. B. Hopkins (*Agric. Engng*, 1956, **37,** 109—111).—In the operation of a level-bed digger nearly all the major injuries, 50% of the minor injuries, and 33% of the feathering occurred as the tubers were lifted from the ground by the shovel. Improvements in design are indicated. A. H. CORNFIELD.

Maize picker featuring a new principle. C. B. Richey, J. F. O'Donnell, J. T. Ashton and R. J. Groves (*Agric. Engng*, 1956, **37,** 93—97).—A one-row maize picker, incorporating a new principle, whereby the stalk is bent sideways and passes through the snapping rolls at about a 45° angle, is described. A. H. CORNFIELD.

Use of polyethylene greenhouse for rooting softwood cuttings. F. B. Widmoyer and D. P. Watson (*Mich. agric. Exp. Sta., Quart. Bull.*, 1956, **38,** 350—352).—The cuttings root normally in the polyethylene greenhouse, provided that the danger of a killing frost has passed, and that mist is used for the maintenance of a high R.H. and the reduction of temp. fluctuations. P. S. ARUP.

Laboratory determination of germinating power of sugar-beet seeds. Gh. Anghel and M. Raianu (*Anal. Inst. Cerc. agron. Romîn*, 1952—3, [1955], **22,** 493—500).—The effects of various factors, particularly temp., soil humidity and the amount of prior moistening of the seeds, on the germination of sugar-beet seeds were studied and a method of determining the germinating power of seeds in the most favourable standard conditions was devised. The conditions defined for this method are : temp. 20°, soil humidity 60—70% of max. water capacity. In these conditions, germinative energy is determined after five days and germinating power after 10 days. Preliminary moistening of seeds prior to germination is not advisable except in cases of necessity. (From French summary.) J. S. C.

Pest Control

Modern pesticides. F. R. Preuss (*Dtsch. ApothZtg*, 1956, **96,** 110—112, 135—137).—The insecticidal properties of DDT, DFDT, DDD, DFDD, methoxychlor, Gammexane, chlordane, aldrin, dieldrin, and toxaphene are briefly reviewed. Recently developed esters of phosphoric acid, e.g., tetraethyl pyrophosphoric ester and hexaethyl tetraphosphate, Diazinon, E605, malathion, etc. are described and their possible mode of action is suggested. G. R. WHALLEY.

Antifungal factors in cultivated plants. A. I. Virtanen, P. K. Hietala, E. Valle and V. Salakivi (*Acta chem. fenn.*, 1956, **29,** 108).—Samples of cereals, meadow grasses, or winter turnip rape were pounded in a mortar, extracted with boiling water and the solution shaken with ether ; the water and the ether extracts were each evaporated to dryness and the effect of these residues was tested on *Sclerotinia trifoliorum* and *Fusarium nivale* in agar cultures, e.g., amount of fresh plant material (g. per ml. of substrate) required for complete inhibition of growth : oats ~1·8 ; barley <1·3 ; wheat (Varma) ~1·6 or (Vakka) ~1·0 ; winter turnip rape ~1·8 ; timothy ~2 ; meadow fescue ~7 ; maize ~7. The active principle in winter turnip rape is probably mustard oil. E. M. J.

Insect pests of vegetables in the Sudan. D. G. Pollard (*Minist. Agric. Sudan Governm.*, 1955, *Bull.* No. 16, 76 pp.).—A summary of the pests and their control and of the appropriate legislation is presented. E. M. J.

Effects of large-area pest control on forest fauna. II. Cockroach control by helicopter. H. H. Cramer (*Z. PflKrankh.*, 1956, **63,** 129—138).—Aeroplane spraying of beech woods with BHC caused heavy damage to forest soil fauna (chiefly collembola and mites) which, however, was substantially regenerated 19 days later. No mortality was observed among predatory beetles feeding on poisoned cockroaches. In open areas surface vegetation completely protected the soil fauna from injury. A. G. POLLARD.

Increasing the absorption of streptomycin by leaves and flowers with glycerol. R. A. Gray (*Phytopathology*, 1956, **46,** 105—111).—The addition of 1% glycerol to a spray containing streptomycin (500

p.p.m.) caused a five-fold increase in the absorption of the antibiotic by bean leaves after 6 hr. : in 96 hr. the increase was nearly 24-fold. Tomato, pepper and tobacco plants shared similar benefit as did also quince flowers. Glycerol was superior in action to sorbitol, diethylene glycol and other polyhydroxy alcohols.
E. G. BRICKELL.

Colorimetric determination of chloranil in fungicide preparations. Delwin P. Johnson (*J. Ass. off. agric. Chem.*, 1955, **38**, 946—949).—The chloranil, dissolved in benzene, is converted into chloranilic acid by treatment under controlled conditions with NaOH followed by acetic acid. The transmittance of the aq. phase is determined spectrophotometrically at 545 mμ., and the percentage read on a standard curve, which shows close adherence to Beer's law. DDT, BHC, toxaphene, chlordane, and S remain dissolved in the benzene and do not interfere. A. A. ELDRIDGE.

Determination of dinitro*ortho*cresol in insecticides. S. Petraşcu and E. Grou (*Anal. Inst. Cerc. agron. Român*, 1952—3, [1955], **22**, 509—517).—The respective drawbacks of the Knecht–Hibbert ($TiCl_3$ titration) and Fischer (colorimetric reaction with KCN) methods are discussed. A new method is proposed in which the dinitro-*o*-cresol is converted (Zn + 50% H_2SO_4) into diaminocresol which is then oxidised to aminoquinoneimine by a Mayer reaction (with $K_2Cr_2O_7$), and extinction measured with a spectrophotometer or photoelectric colorimeter. Within certain (undefined) concn. limits the colour developed follows the Lambert–Beer law. The accuracy of the method is between 1 and 5% (mean 4%), i.e., that it is comparable with that of the two older methods considered. The coloration produced remains constant for 24 hr. (From French summary.) J. S. C.

Comparison of suspensibility test methods for water-dispersible insecticide powders. E. L. Gooden and S. J. Ringel (*J. agric. Food Chem.*, 1956, **4**, 244—248).—Various criteria that have been used for judging the suspensibility of slow-settling powders are compared. Five methods involving observation of the settling rate were tested, a common effect being to ensure that under rigorous conditions not much of the material in a given powder shall have settling velocities $>\sim$1 cm. per min. The recognition of this as the sp. objective is suggested as a focal point for co-ordination of further development in test methods. E. M. J.

Recent developments in the use and application of dual-purpose seed-dressings. D. Price Jones (*J. Sci. Food Agric.*, 1956, **7**, Suppl. Issue, s62—s65).—Aldrin and dieldrin seed-dressings are in general appreciably less efficient than is γ-BHC for the control of wireworm, wheat bulb fly (in late winter drillings), flea beetle and carrot fly, but they may have greater residual action against wheat bulb fly or spring wireworm attack when applied to early autumn drillings. On wheat and barley they are less phototoxic than is γ-BHC but the reverse is probably true on oats. A dressing of 1 oz. per bushel of seed is now adopted. E. M. J.

Antagonistic activity of micro-organisms in control of barley smuts. S. H. F. Chinn and R. C. Russell (*Canad. J. agric. Sci.*, 1956, **36**, 1—7).—Control of *Ustilago hordei* can be obtained by soaking the infected seeds in a broth culture of *Pseudomonas viscosa* or of a filamentous yeast during 50 hr. at room temp., but not in a culture of *Bacillus subtilis* or in water. Control of *U. nuda* is similarly obtained with the use of the *P. viscosa* culture, or by soaking in water for 60 hr. Soaking times can be somewhat reduced at higher temp. (25—30°). P. S. ARUP.

Effect of antibiotics on infection of wheat by *Xanthomonas translucens*. W. A. F. Hagborg (*Canad. J. Microbiol.*, 1956, **2**, 80—86).—Wheat seedlings which had absorbed streptomycin or chloramphenicol from a culture medium showed increased resistance to infection by *X. translucens*. Actidione, griseofulvin and neomycin, similarly applied, had no influence on infection. All antibiotics restricted the growth of the seedlings. A. G. POLLARD.

Control of the *Helminthosporium* blight diseases on sweet maize in S. Florida. R. S. Cox (*Phytopathology*, 1956, **46**, 112—115).—Various commercial fungicides were tested of which formulations of maneb (manganous ethylenebisdithiocarbamate) were outstanding. Ziram, Vancide Z-65 (65% of Zn dimethyldithiocarbamate and a Zn derivative of 2-mercaptobenzthiazole) and C & C 7443 (a complex S compound) were also effective. E. G. BRICKELL.

Foliage fungicides for potatoes in Iowa. W. J. Hooker (*Amer. Potato J.*, 1956, **33**, 47—52).—In years when late blight was severe yields of potatoes were greater and extent of defoliation was less where zineb and maneb than where Bordeaux mixture was used.
A. H. CORNFIELD.

Susceptibility of potato varieties to infestation by the eel-worms, *Ditylenchus destructor* and *D. dipsaci*. J. B. Goodey (*Ann. appl. Biol.*, 1956, **44**, 16—24).—In pot tests over two years with 10—24 varieties of potato, all were about equally susceptible to attack by *D. destructor*. In field tests King Edward was significantly less susceptible than were most of the other varieties. Only a small proportion of the inoculated plants in the field showed leaf malformation, the extent of which was in any case slight. All plants of some varieties were completely free of leaf symptoms. A race of *D. destructor* from mushroom spawn had almost no effect on potatoes. Various races of *D. dipsaci* reproduced in the shoot tissue of potatoes, sometimes causing damage, whilst one population produced lesions on tubers. A. H. CORNFIELD.

Control of *Fusarium* dry rot of potatoes by seed treatment. G. W. Ayers and D. B. Robinson (*Amer. Potato J.*, 1956, **33**, 1—5).—Incidence of *Fusarium* dry rot in stored potatoes was reduced where the seed pieces from which the potatoes were grown had been treated with Semesan Bel prior to planting. A. H. CORNFIELD.

Breeding varieties of potato resistant to *Verticillium* wilt in Maine. R. V. Akeley, F. J. Stevenson, D. Folsom and R. Bonde (*Amer. Potato J.*, 1956, **32**, 15—21).—There were significant differences in reaction to the wilt fungus between progenies of crosses and between selfed lines, indicating that resistance is heritable. Some varieties were highly resistant to infection and some produced satisfactory yields despite heavy infection. Differences in extent of infection of different varieties as well as in yields varied with location.
A. H. CORNFIELD.

Control of potato blackleg with antibiotic. D. B. Robinson and R. R. Hurst (*Amer. Potato J.*, 1956, **33**, 56—59).—An instant dip of cut seed pieces in streptomycin (100 p.p.m.) prior to planting almost eliminated incidence of blackleg, due to *Erwinia atroseptica*, and improved plant vigour. The treatment was no more effective than was an instant dip in Semesan Bel. Spraying six-week-old potato plants with streptomycin (100 p.p.m., 80 gal. per acre) reduced somewhat the extent of infection due to blackleg. A. H. CORNFIELD.

Economy in the control of potato blight, *Phytophthora infestans*, (Mont) de Bary. H. I. Kingston (*J. Sci. Food Agric.*, 1956, **7**, Suppl. Issue, s16—s19).—Addition of phenylmercury chloride (1%) to a Cu oxychloride dispersible powder (50% Cu) permitted a 40% economy in Cu used with the same degree of blight control. E. M. J.

Effect of some soil factors on efficiency of fungicides in controlling *Rhizoctonia solani*. M. Rushdi and W. F. Jeffers (*Phytopathology*, 1956, **46**, 88—90).—Activity of Dithane D-10 (Na_2 ethylenebisdithiocarbamate), Puratized Agricultural Spray [7·5% tris-(2-hydroxyethyl)(phenylmercuri)ammonium lactate] and Vancide 51 (Na dimethyldithiocarbamate and 2-mercaptobenzthiazole) increased as soil acidity decreased whereas the opposite was true for actidione. Soil texture and org. matter content were also significant factors. E. G. BRICKELL.

Pathogenicity of tyrosinase-deficient mutants of *Streptomyces scabies*. K. F. Gregory and E. B. Vaisey (*Canad. J. Microbiol.*, 1956, **2**, 65—71).—Tyrosinase-deficient mutants were unable to cause a positive " brown ring " test in skim milk. They were, however, sufficiently virulent to cause scab in potatoes. A. G. POLLARD.

Evidence that potato virus Y is carried near the tip of the stylets of the aphid vector, *Myzus persicæ*. (Sulz.). R. H. E. Bradley and R. Y. Ganong (*Canad. J. Microbiol.*, 1955, **1**, 775—782).—Aphids carrying the virus were rendered non-infective by exposing the tips of their stylets to u.v. radiation (2537 A.). Only the exposed stylet was affected in this way but u.v. radiation generally lowered the capacity of the aphid to acquire the virus during a short feeding period immediately following irradiation. A. G. POLLARD.

Some effects of formaldehyde on potato virus Y *in vitro* ; ability of aphids to transmit the virus when their stylets are treated with formaldehyde. R. H. E. Bradley and R. Y. Ganong (*Canad. J. Microbiol.*, 1955, **1**, 783—793).—The virus, made non-effective by incubation with formaldehyde, reacted with the appropriate antiserum and caused the production of antibodies in rabbits as readily as did the normal infective virus. Treatment of stylets of infective aphids with formaldehyde (0·03% for 30 sec. or 0·25% for 5 sec.) rendered them non-infective but did not prevent the insects from acquiring and transmitting the virus subsequently.
A. G. POLLARD.

Soil populations of beet eelworm (*Heterodera schachtii*, Schm.) in relation to cropping. II. Microplot and field plot results. F. G. W. Jones (*Ann. appl. Biol.*, 1956, **44**, 25—56).—In microplots growth of cruciferae caused greater increases in beet eelworm populations than did Chenopodiaceæ when the initial population was low and greater decreases when it was high. Non-hosts and inefficient hosts caused reductions of the same order as host plants in the same families. When sugar beet was grown at varying initial populations of eelworm, the final population tended to rise to a max. which varied with soil and season. There was a linear relationship between log.

of initial eelworm population and yields of both tops and roots. Eelworm attack reduced the size of the sugar beet plant but had little effect on the % of sugar in the root. A. H. CORNFIELD.

Soil aëration and the emergence of larvæ from cysts of the beet eelworm, *Heterodera schachtii*, Schm. H. R. Wallace (*Ann. appl. Biol.*, 1956, **44**, 57—66).—Increasing the clay content of a sand–clay mixture drastically reduced the rate of emergence of larvæ from cysts buried in the mixture. Rate of emergence decreased with depth at which the cysts were buried. Rate of emergence increased with water tension to a max. and then decreased with further increasing water tension. Water tension at which max. emergence occurred varied with different soil types. Extent of larval emergence differed between soil types and these differences were not related to porosity or pH. Larval emergence decreased with increasing O_2 consumption of the soils. A. H. CORNFIELD.

Control of fungus diseases of fruit, other than apple scab. R. W. Marsh (*J. Sci. Food Agric.*, 1956, **7**, Suppl. Issue, s120—s123).—The importance of the biology of the fungus in consideration of the use of fungicides is stressed. The control of the following is discussed: apple mildew, apple canker, storage rot, blackcurrant leaf spot and *Botrytis*. E. M. J.

Recent advances in scab control. E. Hainsworth (*J. Sci. Food Agric.*, 1956, **7**, Suppl. Issue, s117—s119).—The life cycles of apple scab fungus (*Venturia inaequalis*) and of pear scab (*V. pyrina*) are outlined. From tests made in Britain since 1946 the following facts have emerged: winter washes have been discontinued in favour of spring spraying; captan is intensely active against *Venturia*, but not against apple mildew; dithiocarbamates (ziram, zineb, maneb, ferbam) have given excellent results in scab control compared with lime–S; org. Hg fungicides eradicate *Venturia* up to five days after infection has occurred. The best of other fungicides do not prevent infection if applied >48 hr. after an ascospore discharge. The interpretation and application of these findings to commercial practice are discussed. E. M. J.

Non-ionic surfactants in concentrate mixtures for control of apple scab. J. E. Swales and K. Williams (*Canad. J. agric. Sci.*, 1956, **36**, 36—40).—The addition of two surfactants (Triton B-1956 or Colloidal Spray Modifier) to fungicidal sprays gives a more effective distribution of the fungicide, but also increases injury to the leaves and fruits. A compromise can probably be reached by reducing the amount of fungicide. P. S. ARUP.

Rotting of apples by *Glœosporium perennans*, Zeller & Childs. K. L. Edney (*Ann. appl. Biol.*, 1956, **44**, 113—128).—Some factors affecting the incidence of *Glœosporium* rot of apples are described. There were varietal differences in susceptibility to rotting and susceptibility also varied from orchard to orchard with the same variety of apple. Resistance of apples to infection with *Glœosporium* decreased with length of storage. In commercially-stored samples rotting commenced at widely different dates. The apple loses its resistance to attack by the fungus on being picked. Lenticels which were impermeable to gaseous exchange were resistant to penetration by the fungus. Rate of rotting of infected apples increased with temp. from 0° to 20°. No rotting occurred at 25°. A. H. CORNFIELD.

Influence of nitrite on the development of *Phytophthora* root rot of avocado. G. A. Zentmyer and F. T. Bingham (*Phytopathology*, 1956, **46**, 121—124).—In water-culture tests in the glasshouse, development of *Phytophthora* root rot of avocado seedlings was prevented by the presence of NO_2' (2 p.p.m.) at pH 4·5, but at pH 6·5 40 p.p.m. was required. No evidence was obtained that NO_3' predisposes avocado roots to infection by *P. cinnamomi*. E. G. BRICKELL.

Rotting of cabbage roots. V. Bontea (*Anal. Inst. Cerc. agron. Român*, 1952—3, [1955], **22**, 379—427).—The attack on cabbage by *Phoma lingam* and measures taken in Roumania to counteract it are described. Seeds can be disinfected by immersion in water at 50° for 20—25 min., washing with cold water and drying, or, alternatively, by steeping in 0·1% aq. $HgCl_2$ for ½ hr. Beds can be disinfected with a 1% solution of 40% formalin two weeks before sowing. (From French summary.) (35 references.) J. S. C.

Infestation of winter lettuce by aphids and its control. M. J. Smieton and N. Montgomery (*Ann. appl. Biol.*, 1956, **44**, 67—79).—Extent of infestation of winter lettuce by aphids varied considerably from year to year. Where attacks were early and persistent hearting was reduced, whilst attacks in early spring spoilt fully-hearted lettuce. More effective control of aphids on transplants was obtained with $C_6H_6Cl_6$ than with nicotine. A. H. CORNFIELD.

Purification and properties of tobacco ringspot virus. R. L. Steere (*Phytopathology*, 1956, **46**, 60—69).—Purified *Annulus tabaci*, Holmes (RSV) showed as uniform polyhedral particles of average diam. 26 mμ, containing two components of sedimentation const. 116 S and 89 S. The virus was found to contain 34·4% of nucleic acid. E. G. BRICKELL.

Plant virus local lesions in relation to osmotic pressure. J. D. Panzer (*Dissert. Abstr.*, 1956, **16**, 439).—The effect of osmotic pressure on the no. of tobacco mosaic virus lesions in Pinto bean plants was studied using solutions of sucrose, glucose, fructose, maltose, $CaCl_2$ and K_2SO_4. In general the no. of lesions decreased as the osmotic pressure increased, but there was an increase when plants were placed in K_2SO_4 solutions of 0·6, 1·3 or 2 atm. O. M. WHITTON.

Influence of seed treatment and planting rate on the emergence and yield of soya-beans. K. L. Athow and R. M. Caldwell (*Phytopathology*, 1956, **46**, 91—95).—Seed treatment, with Arasan or Spergon, appears to be of value only when seed of poor quality is used or seeding is at a very low rate. E. G. BRICKELL.

New techniques for the control of pests on hops. G. A. Emery (*J. Sci. Food Agric.*, 1956, **7**, Suppl. Issue, s110—s116).—The life histories of two major pests of hops, the hop-damson aphid (*Phorodon humuli*) and red spider (*Tetranychus telarius*) are discussed. Aphids are efficiently controlled by schradan, if there is no early migration (late May—early June). Schradan is best applied about 10—14th June onwards, when there is adequate leaf surface to absorb the spray. If there is an early migration TEPP can be used. Schradan gives a less effective, but adequate control of red spider, except where infestation is very severe. Demeton or its methyl analogue gives good control of red spider, but is less efficient than is schradan for the control of aphids. Experiments with dimefox and demeton applied to the soil demonstrated the value of independence of weather conditions. E. M. J.

Field tests with fungicides to control damping-off of Scots pine. O. Vaartaja and J. Wilner (*Canad. J. agric. Sci.*, 1956, **36**, 14—18).—Soil treatment with formaldehyde or acids, or combined soil and seed treatment with Kolodust (S + Dichlone) gave inconsistent results, but seed pelleting (using methyl cellulose) with Dithane Z-76 (zineb), Orthocide 75 (captan), or Tersan (thiram) gave good control. Combined seed and soil treatment with Tersan gave good initial results, but caused high seedling mortality later on. P. S. ARUP.

Soil factors affecting *Verticillium* wilt of antirrhinum. I. Isaac (*Ann. appl. Biol.*, 1956, **44**, 105—112).—The incidence of antirrhinum wilt caused by *Verticillium dahliæ* and *V. nigrescens* in plants growing in John Innes-type compost decreased with increasing level of K_2SO_4 or $(NH_4)_2SO_4$. Incidence of wilt caused by three other species of *Verticillium* was unaffected by varying levels of these fertilisers. Wilt symptoms caused by *V. nubilum* and *V. tricorpus* occurred only where hoof and horn meal was applied or where the soil was kept fairly wet. Incidence of wilt due to all five species increased with soil moisture content. Variations in the level of applied $CaCO_3$ or superphosphate had no effect on the incidence of the disease. A. H. CORNFIELD.

Control of weeds by herbicides and the effect of the latter on crop yields. C. Zahariadi (*Anal. Inst. Cerc. agron. Român*, 1952—3, [1955], **22**, 331—378).—A series of herbicides, vehicles and activators and various techniques of application were compared in respect of their efficacy in the control of, notably, *Lepidium draba* L., *Convolvulus arvensis* L., *Polygonum convolvulus* L., and *Vicia striata* M.B. A dosage of 1—2 kg. of 2 : 4-D per hectare was found necessary. The best modes of dispersion were: 0·1% 2 : 4-D with emulsifiable mineral oil (1%), or with 0·25—0·5% Penetrol. The use of growth stimulators and contact herbicides, and their effects on crop yields, are also discussed. (From French summary.) (60 references.) J. S. C.

How herbicides act on weeds. N. S. Hanson (*Sugar, N.Y.*, 1956, **51**, No. 4, 46, 48).—A few of the concepts of herbicidal action concerning pre- and post-emergence control, absorption through leaves and roots and translocation, covering 2 : 4-D, substituted ureas, Na trichloroacetate and Dalapon, phenolic compounds and oils are briefly discussed. Death of the treated plants may be caused by imbalance of nutrients or other compounds in the protoplasm, coagulation of protein, or tissue breakdown. E. M. J.

Toxicity to honey-bees of herbicide and solutions of mineral fertilisers applied to foliage. N. I. Ostrovskii (*Pokl. vsesojuz. Akad. seljsk. Nauk*, 1955, **20**, 32—34).—As contact poisons 1% 2 : 4-D and MCPA were not injurious to bees but if used as stomach poisons even in 0·3% concn. both caused >90% mortality. Corresponding data for solutions of fertiliser salts included: 1·5% superphosphate 0, 96; 2% $(NH_4)_2SO_4$ 7, 22; 0·6% KCl 3, 10; 0·1% B 0, 50% respectively as contact and stomach application. HORT. ABSTR. (A. G. P.).

Use of experimental herbicide, Natrin 8 OS, in tomatoes. R. J. Zedler (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955,

127—130).—In general, 2—4 lb. of Natrin (Na 2 : 4 : 5-trichlorophenoxyethyl sulphate) per acre satisfactorily controlled the weeds. Applications made after the transplants have become established are less likely to injure the crop than are those made at the time of transplanting. A. G. POLLARD.

Chemical weed control in field maize. J. Vengris (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 271—274).—The butoxyethanol ester of 2 : 4-D and the alkanolamine salts of dinitro-*o*-*sec*.-butylphenol (probable optimal dosage, >1 and >3 lb. per acre, respectively) gave effective weed control, post-emergence being superior to pre-emergence applications. A. G. POLLARD.

Control of weeds in maize by pre-emergence, emergence and post-emergence treatments. C. Veatch (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 265—270).—In general, weeding by cultivation produced somewhat better results than did the use of the chemicals tested. 2 : 4-D and Premerge (alkanolamine salt of dinitro-*o*-*sec*.-butylphenol) were notably effective, post-emergence applications being inferior to emergence and pre-emergence treatments. A. G. POLLARD.

Weed control in field maize following planting and emergence applications of herbicides. E. R. Marshall (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 257—264).—Of 32 herbicides examined effective weed control was obtained with the amine formulation of dinitro-*o*-*sec*.-butylphenol (Sinox PE), 2 : 3 : 6-trichlorobenzoic acid (the best among growth-regulating substances), 3-(*p*-chlorophenyl)-1 : 1-dimethylurea, phenyldimethyl urea, 2 : 4-D (butoxyethanol ester) in descending order of efficiency. Applications during the emergence of the maize were more effective than those made at sowing. A. G. POLLARD.

Pre-emergence weeding of sweet maize. W. H. Lachman (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 111—113).—Na pentachlorophenate was particularly effective as a pre-emergence spray. Among hormone-type materials trichlorobenzoic acid was notably successful. A. G. POLLARD.

Pre- and post-emergence weed control in sweet maize. S. K. Ries and B. H. Grigsby (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 105—109).—Comparison is made of 3-(*p*-chlorophenyl)-, 3-(3 : 4-dichlorophenyl)-1 : 1-dimethylurea and dinitro-*o*-*sec*.-butylphenol prep. for this purpose. The last-named at the rate of 4 lb. per acre at the 3—4-leaf stage give the best results. Maturation of the crop was somewhat delayed. A. G. POLLARD.

Chemicals applied pre- and post-emergence for controlling weeds in potatoes. R. J. Aldrich and J. C. Campbell (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 239—243).—As a pre-emergence spray dinitro-*o*-*sec*.-butylphenol (amine formulation, 4·5 lb. per acre) controlled weeds and increased tuber yields as effectively as did hand weeding. CMU [3-(*p*-chlorophenyl)-1 : 1-dimethylurea] exerted control over a longer period but, in amounts >1 lb. per acre, lowered yields. For late-germinating weeds CMU and 2 : 4-dichlorophenoxyethyl benzoate (Sesin) applied after the final ridging gave promising results. A. G. POLLARD.

Pre-emergence herbicides and cultivation for weed control in potatoes. R. L. Sawyer and S. L. Dallyn (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 227—229).—Prep. of 3-(*p*-chlorophenyl)-1 : 1-dimethylurea (Karmex) effectively controlled weeds but lowered the yield and the sp. gr. of the tubers. Premerge (an alkanolamine salt of dinitro-*o*-*sec*.-butylphenol) was more generally satisfactory. Of nine herbicides tested none increased the yield of potatoes. A. G. POLLARD.

Comparison of granular and spray applications of herbicides on vegetable crops. L. L. Danielson (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 89—95).—In field trials, largely with CIPC, Dalapon (2 : 2-dichloropropionic acid) and CMU [3-(*p*-chlorophenyl)-1 : 1-dimethylurea], granular formulations were as effective as pre-emergence sprays carrying the same amount of herbicide per acre. Inert carriers tested (clays, vermiculite, tobacco pulp of similar particle size) were approx. equally effective. Rolling or raking the soil after applications of granular herbicides did not influence their effects. A. G. POLLARD.

Use of Dalapon and Natrin on certain transplanted vegetable crops. L. L. Danielson and M. H. Schumacher (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 97—103).—Used as a pre-emergence spray at the rate of >4 lb. per acre Dalapon (2 : 2-dichloropropionic acid) controlled annual grasses. Maize and snap beans tolerated 6 lb. of the herbicide per acre but tomatoes, sweet potatoes and peppers were much more sensitive. Natrin (2 : 4 : 5-trichlorophenoxyethyl sulphate) was harmful to young tomato transplants but older plants were more tolerant. A. G. POLLARD.

Weed control in sweet Spanish onions. S. L. Dallyn, R. L. Sawyer, T. H. Haliburton and R. D. Seif (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 161—168).—The most effective pre-emergence sprays for this purpose were CMU [3-(*p*-chlorophenyl)-1 : 1-dimethylurea] (0·3—0·6 lb.), and CIPC [*iso*propyl *N*-(3-chlorophenyl)carbamate] (3—6 lb. per acre). For post-emergence application CIPC is probably the less harmful prep. A. G. POLLARD.

Trials of herbicides on muck-grown onions in New York State. M. J. Papai, W. Baran and E. R. Marshall (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 151—155).—*iso*Propyl *N*-(3-chlorophenyl)carbamate was a safe and effective herbicide for this purpose. 2-Chloropropyl *N*-(3-chlorophenyl)carbamate gave promising results. A. G. POLLARD.

Chemical weed control in onion, squash and tomato. W. Ferguson and J. J. Jasmin (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 169—175).—*iso*Propyl *N*-(3-chlorophenyl)carbamate (CIPC) markedly reduced the weed population in onion beds when used at the rate of 4 lb. per acre. Application of 8 lb. per acre caused some injury to the crop and delayed its growth. On pumpkin and squash *N*-1-naphthylphthalamic acid (Alanap-1) (8 lb. per acre) gave reasonable weed control. On tomato soils 2 : 4-dichlorophenoxyethyl benzoate (Sesin) was more satisfactory than 2 : 4 : 5-trichlorophenoxyethyl sulphate (Natrin.) A. G. POLLARD.

Weed control in set onions with pre- and post-emergence applications of herbicides. C. J. Noll and M. L. Odland (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 157—159).—On the basis of % weed control, crop yield and cost KCNO (16 lb.) and Chloro-IPC (4 lb. per acre) were the most satisfactory materials tested. Pre-emergence applications of Chloro-IPC, followed by post-emergence treatment with KCNO gave better control than did KCNO alone. A. G. POLLARD.

Control of quackgrass and annual weeds in Michigan asparagus plantings. J. H. Davidson and S. K. Ries (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 131—136).—Dalapon (Na 2 : 2-dichloropropionate) at the rate of 7—15 lb. per acre controlled quackgrass (*Agropyron repens*). Combination of this herbicide with CMU [3-(*p*-chlorophenyl)-1 : 1-dimethylurea] or Silvex [2-(2 : 4 : 5-trichlorophenoxy) propionic acid propylene glycol butyl ether ester] gave more prolonged control of quackgrass and of broad-leaved weeds. A. G. POLLARD.

Effect of Karmex-W on the flavour of canned and frozen asparagus. J. H. Ellison, R. J. Aldrich and W. A. Maclinn (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 137—139).—The herbicide [3-(*p*-chlorophenyl)-1 : 1-dimethylurea] caused a difference in flavour in frozen but not in canned asparagus. A. G. POLLARD.

Herbicides for tomatoes. R. D. Sweet, G. Crabtree and C. Benedict (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 141—149).—In comparative trials Natrin (2 : 4 : 5-trichlorophenoxyethyl sulphate) was notably successful. Several derivatives and also Karmex [3-(*p*-chlorophenyl)-1 : 1-dimethylurea] gave promising results. The response of tomato to Natrin was influenced more by physiological condition than by age. Plants capable of rapid root production tolerated the treatment better than more hardened plants. A. G. POLLARD.

Post-setting and lay-by applications of herbicides to canning tomatoes. H. A. Sweet and E. R. Marshall (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 115—119).—Promising results were obtained with the Na salts of 2-methyl-4-chlorophenoxyethyl sulphate and of 2 : 4 : 5-trichlorophenoxyethyl sulphate. A. G. POLLARD.

Responses of tomatoes to Natrin and derivatives as affected by time of application and by irrigation. R. M. Menges and R. J. Aldrich (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 121—126).—2 : 4 : 5-Trichlorophenoxyethyl sulphate (Natrin) and the triethanolamine salt of 2 : 4 : 5-trichlorophenoxyethanol (5·0 lb. per acre in each case) effectively controlled broad-leaved and grass weeds. Early application induced epinastic and formative defects in the crop. The amount of irrigation water applied did not affect the herbicidal action. In general, the quality of the fruit was not affected. A. G. POLLARD.

Beet weed control. C. J. Noll and M. L. Odland (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 223—225).—Endothal (Na_2 3 : 6-*endo*-oxohexahydrophthalate) gave best control when applied (24 lb. per acre) as a pre-emergence spray when the soil was sufficiently moist to promote germination of weed seeds; on dry soil it did not affect weed germination. A. G. POLLARD.

Effect of environment and rate of application on bean pre-emergence weed control with CIPC. G. Loeffler (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 177—181).—Injury to bean plants caused

by CIPC [*iso*propyl *N*-(3-chlorophenyl)carbamate] (4 lb. per acre) was greater when applications were made at the higher temp. of midday than when in morning or evening. The vapour of the herbicide probably penetrates the seedlings before actual emergence.
A. G. POLLARD.

Weed control in Lima beans with various herbicides. C. J. Noll and M. L. Odland (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 183—185).—The most satisfactory control was obtained by use of Premerge (alkanolamine salt of dinitro-*o-sec.*-butylphenol) as a pre-emergence spray and Na pentachlorophenate applied two days after sowing. A. G. POLLARD.

Autumn applications of CIPC on three strawberry varieties for control of chickweed. R. F. Carlson (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 221—222).—Applications (1·5—3·4 lb. per acre) of *iso*propyl *N*-(3-chlorophenyl)carbamate (CIPC) completely controlled common chickweed, but not mouse-ear chickweed, and gave 80% control of sorrel. Strawberry plants were not damaged by autumn treatment. A. G. POLLARD.

Effect of CIPC on field sorrel in strawberry plantings. R. F. Carlson (*Mich. agric. Exp. Sta., Quart. Bull.*, 1956, **38**, 365—367).—Spraying of strawberry fields in Oct. with CIPC (*iso*propyl *N*-3-chlorophenylcarbamate) at 2 lb. in 50 gal. of water per acre reduces the no. of sorrel plants counted in the following May by 65—75%. Injury to the strawberry plants is negligible. P. S. ARUP.

Grass control in red raspberries. R. F. Carlson (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 217—220).—Annual autumn applications of *iso*propyl *N*-(3-chlorophenylcarbamate) (CIPC) at the rate of 8 lb. in 100 gal. per acre) or of 2 : 2-dichloropropionic acid (Dalapon) 5—10 lb. per acre) effectively controlled grass without injury to the crop. A. G. POLLARD.

CMU as herbicide in vineyards. R. F. Carlson (*Mich. agric. Exp. Sta., Quart. Bull.*, 1956, **38**, 409—412).—Single sprayings in spring with CMU 3-(*p*-chlorophenyl)-1 : 1-dimethylurea give satisfactory weed control at 3 lb. per acre, and excellent control at 6 or 9 lb. (in 50 gal. of water). At the higher rates, temporary vine-leaf yellowing may occur on very light soil and high ground. P. S. ARUP.

Pre-emergence weeding of squash. W. H. Lachman (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 193—194).—Of materials examined the alkanolamine salt of dinitro-*o-sec.*-butylphenol was a more effective herbicide and was less injurious to squash plants than were some naphthylphthalamic acid prep.
A. G. POLLARD.

Response of squashes to Alanap-1 (*N*-1-naphthylphthalamic acid). R. D. Sweet, G. Crabtree and C. Benedict (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 195—199).—In trials with a no. of varieties of squash pre-emergence applications were more efficacious and less harmful to the crop than were post-emergence treatments. A. G. POLLARD.

Aquatic weed control in New Jersey: progress report. R. K. Huckins (*Proc. 9th annu. Mtg Northeast Weed Control Conf.*, 1955, 519—534).—The general problem is reviewed together with investigational techniques. Tests with a no. of herbicides are recorded. Cat-tail was successfully controlled by a Na chlorate–metaborate prep. A. G. POLLARD.

Effect of herbicides on a number of aquatic plants. H. H. Rigg (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 535—544).—The breakdown of tissue of aquatic plants following herbicidal treatment is due partly to the chemical used and partly to the growth of algæ. Penetration of herbicides through the cell wall is followed by plasmolysis and chlorosis. Inorg. substances are translocated in aquatic plants through the xylem ; 2 : 4-D is translocated only in dicotyledons. A. G. POLLARD.

Effect of ATA on woody plants. W. W. Meyers, W. W. Allen and R. H. Beatty (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 445—450).—Details of the action of this herbicide (aminotriazole) on a no. of woody species are recorded.
A. G. POLLARD.

Effect of volume, concentration and point of application of 2 : 4 : 5-T in the basal treatment of bear oak. D. P. Worley, W. C. Bramble and W. R. Byrnes (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 439—444).—Prep. of 2 : 4 : 5-T were more effective when applied to the root collar of *Quercus ilicifolia* in the dormant period than when in the active season. High-vol.–low-concn. sprays were superior to low-vol.–high-concn. formulations.
A. G. POLLARD.

Chemical desiccation of lucerne for hay. E. K. Shaw and G. E. Ahlgren (*Proc. 9th annu. Mtg Northeast. Weed Control Conf.*, 1955, 279—287).—The crop was sprayed, in the field, with the desiccant and subsequently cut at intervals. 2-Ethylhexanoic acid and its NH_4 and lauryl salts were the most effective substances tested for this purpose. 15—20% of the moisture in the green crop was lost within 3 hr. of applying the substances at the rate of 50 lb. per acre.
A. G. POLLARD.

Chemical defoliation of dry beans. R. Cheng-Wei Fang (*Dissert. Abstr.*, 1956, **16**, 6).—Field and greenhouse experiments on the relative efficacies of 12 defoliants for hastening the maturing of dry beans are described. Endothal (disodium-3 : 6-*endo*-oxohexahydrophthalate) and Shed-A-Leaf (Na chlorate plus Na perborate) were the most promising, with Tumbleleaf, De-Fol-Ate, Ortho C-1 and Aero-Cyanate occasionally as good. Gallonage and pressure as separate factors had little effect on the degree of defoliation, but as conjoint factors, low gallonage and high pressure caused more desiccation than did high gallonage and low pressure. After spraying, the more mature plants showed the greater defoliation. Increased defoliation was favoured by darkness, low soil moisture level, relatively high temp., and small droplet size. The effect of defoliation on yield was not consistent. Other aspects covered include translocation of the effect of defoliant from stem or petiole to abscission zone ; reduction of auxin activity by defoliant ; and cell division in the abscission zone in treated and untreated leaves.
G. HELMS.

Animal Husbandry

An *in vitro* study of the type of fermentation exhibited by rumen micro-organisms on high-nitrogen substrates. J. H. Ware (*Dissert. Abstr.*, 1956, **16**, 20).—Strained rumen fluid was incubated with cellulose plus graded levels of urea, zein or cotton-seed meal for 24 hr. at 38° in a dialysing artificial rumen. Subsequent to fermentation, residual cellulose and volatile fatty acids in the dialysis medium were determined. Cellulolytic activity increased with all N sources up to 20% protein level and thereafter decreased sharply with urea and cottonseed meal and less sharply with zein. As the N content increased, samples containing urea produced acetic and butyric acid primarily, and those containing cottonseed meal produced acetic acid. High N levels inhibit cellulolytic activity ; zein and the meal stimulate production of ketogenic acetates and butyrates, and urea, the production of glycogenic propionates.
G. HELMS.

Microbiological utilisation of cellulose and wood. I. Laboratory fermentations of cellulose by rumen organisms. D. W. Stranks (*Canad. J. Microbiol.*, 1956, **2**, 56—62).—Butyric, propionic, acetic and traces of formic acids were produced in the fermentation of cellulose by rumen organisms. In a peptone-containing mash (4·1% cellulose), controlled at pH 6·5, and with products removed continuously by a dialysis-ion exchange system, 84% of the cellulose was fermented. A. G. POLLARD.

Development of digestive enzyme system of pig during its pre-weaning stage. [A] Pancreatic amylase and lipase. W. D. Kitts, C. B. Bailey and A. J. Wood. **[B] Intestinal lactase, sucrase and maltase.** C. B. Bailey, W. D. Kitts and A. J. Wood (*Canad. J. agric. Sci.*, 1956, **36**, 45—50, 51—58).—[A] Amylolytic activity in aq. pancreas extracts in relation to gland or body wt. is relatively low at birth, and increases markedly with age, especially after three weeks. Initial and subsequent lipolytic activity levels in the extracts are of a relatively high order.

[B] Lactase activity per kg. of body wt. in aq. extracts of the small intestine is comapartively high during the first two weeks of life, after which it declines rapidly. Sucrose and maltase activities increase from negligible initial levels to a max. after 25 days. The significance of these findings for diet formulation is pointed out. (23 references.) P. S. ARUP.

Grass silage preservation with sodium metabisulphite. J. W. Bratzler, R. L. Cowan and R. W. Swift (*J. Anim. Sci.*, 1956, **15**, 163—176).—Addition of the sulphite (8 lb. per ton of green matter) to grass or grass–legume mixture for silage reduced the loss of dry matter during fermentation and improved the palatability of the product ; preliminary wilting of the material was unnecessary.
A. G. POLLARD.

Effects of the addition of molasses on the composition and digestibility of field silages. P. McDonald and D. Purves (*J. Sci. Food Agric.*, 1956, **7**, 189—196).—A medium-protein grass–clover mixture, and molassed and unmolassed silages derived from it, were compared in respect of chemical composition and digestibility. In addition to the usual determinations (org. matter, crude protein, ether extract, etc.), sol. sugars and fructosan values were determined. Digestibility was assessed from the results of feeding trials with half-bred wethers. The possible effects of the reduction of solid carbohydrate resulting from fermentation during ensilage, on the nutritional value of the silage product, are discussed. Little difference in quality and feeding value between molassed and ordinary silage at a crude protein level of 12—13% dry matter was

observed and both silages compared favourably with the original grass. (18 references.) J. S. C.

Amino-acid and vitamin composition of feather meal. B. R. Gregory, O. H. M. Wilder and P. C. Ostby (*Poultry Sci.*, 1956, **35**, 234—235).—The content of 16 amino-acids and four vitamins in a feather meal is recorded. A. H. CORNFIELD.

Lack of toxicity of biuret to animals. W. T. Berry, jun., J. K. Riggs and H. O. Kunkel (*J. Anim. Sci.*, 1956, **15**, 225—233).—Biuret produced no toxic symptoms in rats, poultry, lambs or steers. It tended to increase the consumption of water and to depress the appetite. The latter effect was counteracted by addition of cotton-seed meal protein or an increased proportion of urea to the ration. The small amount of biuret in commercial samples of the urea used in stock-feeds is relatively unimportant. A. G. POLLARD.

Effect of antibiotic on the rate of passage of feed marker through the digestive tract of the chick. H. G. Jukes, D. C. Hill and H. D. Branion (*Poultry Sci.*, 1956, **35**, 232—234).—Addition of procaine penicillin *G* (10 p.p.m.) to the diet of chickens (17—26 days of age) for 3—20 days resulted in a decrease (significant in some cases) in the time required for the passage of the feed marker (carmine or Cr_2O_3) through the bird. The effect of the antibiotic disappeared soon after the treatment was discontinued. A. H. CORNFIELD.

Separation of aureomycin, chlortetracycline and oxytetracycline in feeds by paper chromatography. A. V. Stiffey and William L. Williams (*J. Ass. off. agric. Chem.*, 1955, **38**, 870—874).—Aureomycin (chlortetracycline) and oxytetracycline present in low concn. in feeds are extracted with acidified aq. acetone and chromatographed on buffered paper sheets which are then developed by the descending technique with *n*-butanol saturated with water. The presence and position of the antibiotic are then determined by placing the sheet on a nutrient medium seeded with *Bacillus cereus* and incubating. Chlortetracycline and oxytetracycline are distinguishable by the zones of inhibition, and the feed can be assayed if the ratio of their concn. is known. A. A. ELDRIDGE.

Photometric determination of total phosphorus in feeding stuffs and fertilisers. George F. Rickey and A. W. Avens (*J. Ass. off. agric. Chem.*, 1955, **38**, 898—903).—Digestion with HNO_3–$HClO_4$ is recommended, 0·25—1 g. (depending on the guaranteed % of P) being used. A suitable aliquot of the final solution is treated with vanado-molybdate reagent, and the % transmittance at 400 mμ. is determined with a spectrophotometer or photoelectric colorimeter. The method is rapid and sufficiently accurate for routine analysis. A. A. ELDRIDGE.

Fertilisation and embryonic mortality rates for bulls with histories of either low or high fertility in artificial breeding. H. J. Bearden (*Dissert. Abstr.*, 1956, **16**, 2).—Data on fertilisation rates and embryo mortality show that all the eggs of normal heifers are capable of fertilisation and that the bull is the contributory factor in fertilisation failures. High fertility bulls present only one problem, viz., embryonic mortality, whereas low fertility bulls present two problems: (*a*) low fertility with low embryonic mortality and (*b*) high fertility and high embryonic mortality. In relation to embryonic mortality, research should be directed to the first few days of gestation and to the rôle of hormone imbalances. G. HELMS.

Forage quality and protein feeding of dairy cows. C. R. Hoglund, E. J. Benne, L. V. Nelson and C. F. Huffman (*Mich. agric. Exp. Sta., Quart. Bull.*, 1956, **38**, 413—430).—Chemical analysis is a better criterion of quality and protein content than is visual judging. Factors affecting forage quality (kind of forage, date of harvesting, and harvesting and storage methods) are examined with examples drawn from practice, especially in connexion with lucerne–brome grass crops. The value of judicious liming and fertilising of these crops and the deterioration in quality of the forage with the age of the stand are demonstrated. P. S. ARUP.

Hot weather shelters for dairy cows. G. L. Nelson, E. R. Berousek and G. W. A. Mahoney (*Agric. Engng*, 1956, **37**, 98—102, 107).—Temp., R.H. and moisture vaporisation within different types of shelters using various cooling methods are described. A. H. CORNFIELD.

Washing and sanitising the cow's udder. A. V. Moore (*J. Milk Food Technol.*, 1955, **18**, 314—316).—Bacterial counts of freshly drawn milk were found to be lower when plenty of plain water was used to rinse the udder as compared with merely wiping with a NaClO-soaked cloth. The most satisfactory procedure is a thorough water rinse, followed by wiping with a cloth soaked with aq. NaClO (200 p.p.m.). This is more effective than the use of quaternary ammonium compound solutions. J. S. C.

Utilisation of low-quality pasture. M. C. Franklin, P. K. Briggs and G. L. McClymont (*J. Aust. Inst. agric. Sci.*, 1955, **21**, 216—228).—Tabular data are presented and discussed. Sheep may be fed on low quality roughage at relatively low cost provided supplements such as cereal chaff, linseed meal, lucerne chaff are maintained. The addition of urea and sulphate to wheat rations (normally not a satisfactory supplement) was beneficial. (14 references.) E. G. BRICKELL.

Effect of chlortetracycline on the digestion of ration components, retention of nitrogen and volume of urine excreted by sheep, with observations on rectal temperatures. A. D. Tillman and R. MacVicar (*J. Anim. Sci.*, 1956, **15**, 211—217).—Chlortetracycline fed to sheep at the rate of 11·8 mg. per 100 lb. live-wt. had no effect on the digestibility of the feed. At a higher level (15·4 mg.) the antibiotic caused a diminution in digestibility of the dry matter, crude protein, crude fibre, N-free extract and energy but did not affect N-retention. A. G. POLLARD.

Effects of chlortetracycline, stilbœstrol and chlortetracycline–stilbœstrol supplements on fattening lambs. P. S. Jordan, R. M. Jordan and H. G. Croom (*J. Anim. Sci.*, 1956, **15**, 188—192).—Neither rate of growth, feed consumption nor feed efficiency was significantly affected by feeding chlortetracycline (21·6 mg.) or stilbœstrol (2 mg. per head daily) or a mixture of the two. A. G. POLLARD.

Retention of injected testosterone in the meat of adult ewes. E. F. Johnson, F. Hudson, R. Bogart and J. Kaufmes (*J. Anim. Sci.*, 1956, **15**, 185—187).—Feeding tests with young cockerels provided evidence that testosterone fed to ewes up to within four days of slaughter was not retained in the carcass meat. A. G. POLLARD.

Comparison of refined cane sugar, invert cane molasses and unrefined cane sugar in starter rations for early-weaned pigs. F. Diaz, V. C. Speer, G. C. Ashton, C. H. Liu and D. V. Catron (*J. Anim. Sci.*, 1956, **15**, 315—319).—The rate of growth of pigs weaned at nine days (5—8 lb.) increased and the feed efficiency improved with increase in the proportion of refined or unrefined cane sugar but not with that of invert cane molasses in the ration. A. G. POLLARD.

Interaction of temperature and thiouracil feeding on carcass characteristics and feeding characteristics of pigs. E. F. Johnston, N. R. Ellis and C. F. Winchester (*J. Anim. Sci.*, 1956, **15**, 271—279).—Pigs were given rations containing 0·15% of uracil and were maintained at "cool" (45—65°F.) or at "hot" (75—90°F.) temp. In those subjected to the treatment when weighing >150 lb. and at temp. ~50°F. the thickness of the back fat diminished, the % of protein in hams increased, the rate of growth was higher and the feed efficiency greater in comparison with those in untreated controls. In a high-temp. environment (~90°F.) the effects of uracil were much smaller, the growth rate being unaffected. Treatment of younger pigs (70 lb.) resulted in lower feed efficiency, especially at the high temp., smaller rates of gain at the low temp. though no change at the high temp., increased lean : fat ratio and increased water content of hams compared with the older pigs. Liver and thyroid sizes were increased in all cases. A. G. POLLARD.

Influence of tryptophan, methionine and lysine supplementation of a maize–soya-bean oil-meal diet on the nitrogen balance of growing swine. R. J. Meade (*J. Anim. Sci.*, 1956, **15**, 288—296).—The efficiency of a pig ration (total crude protein, 15·9%), comprising ground yellow maize 80, soya-bean oil-meal 15·7% with minerals and vitamins was not increased by supplementary feeding of tryptophan, methionine or lysine. The min. requirements of the three amino-acids to ensure adequate N retention were 0·132, 0·27 and 0·69% respectively. For animals weighing >40 kg., 15·9% of protein in the ration probably exceeded the requirement. A. G. POLLARD.

Influence of protein content of the diet and of chlortetracycline and/or vitamin B_{12} supplementation on the performance of growing-fattening pigs. R. J. Meade (*J. Anim. Sci.*, 1956, **15**, 297—306).—Protein levels of pig rations were reduced by approx. 2% at average wt. of 75 lb. and again at 125 lb. Differences in range of protein levels, 18–16–14, 16–14–12 and 14–12–10 in the rations, otherwise complete in non-protein factors, did not affect the final average wt. per pig. A satisfactory protein level combination for growing weanling pigs (38 lb.) was 14·15–12·17–10·18 provided the ration contained tryptophan, methionine, and lysine at levels 0·13, 0·25 and 0·65% respectively. No protein-sparing effects resulted from inclusion of chlortetracycline or vitamin B_{12} in the ration. A. G. POLLARD.

Comparative value of antibiotics and arsonic acids for growing pigs. L. E. Hanson, E. G. Hill and E. F. Ferrin (*J. anim. Sci.*, 1956, **15**, 280—287).—Pigs receiving arsanilic acid (60 g.), 3-nitro-4-hydroxyphenylarsonic acid (37 g.), chlortetracycline (10 g.) + arsanilic acid (60 g.) or penicillin (10 g.) + arsanilic acid (60 g. per ton of feed) showed some, though not significant, increases in wt. gains. Retention of As by animals given arsonic acids was influenced by the amounts fed but there were no symptoms of toxicity. A. G. POLLARD.

Supplemental riboflavin and a feed flavour in creep-feed rations for pigs. I. R. Sibbald and J. P. Bowland (*Canad. J. agric. Sci.*, 1956, **36**, 19—26).—Supplemental riboflavin and/or a proprietary aniseed flavouring to a small-grain and sucrose ration did not improve the performance of suckling pigs. A significant seasonal variation was found in creep-feed consumption and weaning wt. Approx. 22% of the latter variation was statistically associated with the former. P. S. ARUP.

Methionine and cystine requirements of chicks determined by calculation. R. J. Evans, S. L. Bandemer and D. H. Bauer (*Poultry Sci.*, 1956, **35**, 174—178).—The "available" methionine and cystine contents of some poultry feeding-stuffs were determined by *in vitro* digestion with trypsin and erepsin and by microbiological assay with *Leuconostoc mesenteroides*. The requirement of chicks for available methionine and cystine as determined by other reported studies were re-calculated using the values obtained here. Available methionine + cystine requirement ranged from 0·22 to 0·46% with 0·15—0·42% as methionine. These values agreed fairly well with those obtained by tissue analysis and amino-acid balance studies. A. H. CORNFIELD.

Unidentified mineral required by the chick. H. Menge, R. J. Lillie, J. R. Sizemore and C. A. Denton (*Poultry Sci.*, 1956, **35**, 244—245).—Addition of 4% of feather meal or an amount of feather meal ash (700°) ≡ 4% feather meal to the diet of chicks fed a practical-type maize-soya-bean meal ration considered to be adequate in all known nutrients resulted in significantly better wt. gains to four weeks of age. The ashed and unashed meals produced almost identical effects. A. H. CORNFIELD.

Effect of dietary cobalt on growing chicks and rats. M. J. Burns and W. D. Salmon (*J. agric. Food Chem.*, 1956, **4**, 257—259).—The effect of dietary Co on the growth of chicks and weanling rats fed diets with and without adequate choline and vitamin B_{12} was tested. Addition of Co to a chick diet containing 5% of fat significantly increased growth; with a 20% fat diet, addition of Co depressed growth. This effect of fat content of the diet probably results from its action on the microbial synthesis of vitamin B_{12}. Addition of Co to a rat diet failed to produce a growth response when folacin was omitted; but when folacin was present Co increased growth. The vitamin B_{12} content of the liver was increased when Co (12 mg. per kg.) was added to a vitamin B_{12}-deficient ration that contained 0·1% of choline chloride. Growth was not improved by the addition of Co to diets that contained adequate amounts of choline, methionine or vitamin B_{12}. Dietary Co is nutritionally important for non-ruminants fed diets inadequate in choline and vitamin B_{12}. E. M. J.

Rôle of antibiotics in modifying the energy, vitamin and protein requirements of chicks. R. H. Thayer (*Dissert. Abstr.*, 1956, **16**, 424).—Penicillin increases the efficiency with which proteins, vitamins and energy are utilised by the growing chick, increases the % of dietary N absorbed, reduces the % of absorbed dietary N excreted as urinary N, and increases the rate of enzyme activity per g. of intestinal wt. O. M. WHITTON.

Low-protein diets for turkeys raised under practical conditions. H. Fisher, J. Dowling, jun., and K. H. Maddy (*Poultry Sci.*, 1956, **35**, 239—241).—A 20% protein diet to which 0·05% of MHA (OH analogue of methionine; Ca DL-2-hydroxy-4-methylthiobutyrate) and 0·1% lysine hydrochloride had been added supported better growth of turkeys than did a 28%-protein diet without these supplements. Addition of the supplements to a 28%-protein diet had no effect on its growth-promoting ability. Supplementation of the low-protein diet beyond six weeks of age was of no added benefit up to 26 weeks of age. A. H. CORNFIELD.

Effects of varying protein and fat levels in a finishing ration for turkey broilers. H. Yacowitz, R. D. Carter, J. Wyne and M. G. McCartney (*Poultry Sci.*, 1956, **35**, 227—229).—Varying protein levels, 20—26%, in the diet from 9—16 weeks of age had no effect on wt. of birds at 16 weeks. Addition of 3—6% of fat to the diet slightly increased the rate of gain in wt. of males but had no effect on the growth of females. Market quality was similar with all rations. Feed efficiency increased with the fat content of the diet but was unaffected by the protein level. A. H. CORNFIELD.

Protein and lysine requirements of turkeys at various ages. F. H. Kratzer, P. N. Davis and B. J. Marshall (*Poultry Sci.*, 1956, **35**, 197—202).—The protein requirement for optimum growth of turkeys was 20% in the diet at eight weeks, 15% at 16 weeks, and 13·5% at 20 weeks of age. The lysine requirement (corrected to ideal protein level) was 0·92% at four weeks, 0·82% at eight weeks, and 0·50% at 20 weeks of age. Pigmentation failures occurred in turkeys on low lysine levels from 4—8 weeks of age. A. H. CORNFIELD.

Cooling and freezing pan-ready turkeys. W. E. Matson, M. C. Ahrens, J. V. Spencer and W. J. Stadelman (*Agric. Engng*, 1956, **37**, 33—35).—Of the four methods used for cooling birds the ice-water method was the most rapid and also gave the highest appearance score. Varying freezing rates (obtained by varying the temp. of the cold air blast) affected the appearance of birds with relatively little fat covering; birds frozen without pre-cooling had better appearance scores as the freezing rate increased. In general birds frozen by being placed directly in the freezer were less tender than those which were pre-cooled prior to freezing. A. H. CORNFIELD.

Growth-promoting ability of fluid egg yolk. J. H. Hopper, H. M. Scott and B. C. Johnson (*Poultry Sci.*, 1956, **35**, 195—197).—Addition of 5—10% of fluid egg yolk (obtained from eggs of normal hens) to a purified diet stimulated the growth of chicks to 28 days of age. Growth stimulation was not as great when egg yolk was added to the diet of chicks receiving a practical maize-soya-bean meal diet. Comparison of the growth-stimulating effect of egg yolk with that of liver powder, dried whey and fish solubles indicated that egg yolk is lacking primarily in the whey factor. The growth-promoting ability of egg yolk is probably due to its content of fish factor. A. H. CORNFIELD.

Influence of age of New Hampshire female breeders upon hatchability of eggs. A. E. Tomhave (*Poultry Sci.*, 1956, **35**, 236—237).—The % hatchability of either fertile or total eggs set from breeders in production for 329 days was lower than that with eggs from the same birds in production from 110 to 225 days. In general, hatchability of eggs produced by March-hatched breeders was comparable to that of June- and Oct.-hatched birds at a similar period of production. A. H. CORNFIELD.

Effects of coating the shells of washed eggs, that formerly were dirty, with antibiotics upon subsequent spoilage. W. A. Miller (*Poultry Sci.*, 1956, **35**, 241—243).—Dipping washed eggs in solutions of various antibiotics (streptomycin, penicillin, aureomycin, Terramycin, bacitracin, polymixin B), followed by drying, prior to storage at 2·2—7·2° for 12 months had no effect on % spoilage or no. of spoilage organisms arising during storage. A. H. CORNFIELD.

Effect of sulphamethazine feeding on the thyroids, combs and testes of Single Comb White Leghorn cockerels. A. van Tienhoven, H. C. Thomas and L. J. Dreesen (*Poultry Sci.*, 1956, **35**, 179—191).—Addition of 0·1—0·2% of sulphamethazine to the feed from one day to 16 weeks of age resulted in precocious spermatogenesis, larger combs and increased thyroid wt. and increased uptake of ^{131}I by the thyroids. The treatments had no consistent effect on gonadotrophic potency. A. H. CORNFIELD.

Virus of avian myeloblastic leucosis. J. W. Beard (*Poultry Sci.*, 1956, **35**, 203—223).—Isolation and purification, physical and chemical properties, stability, host response to, and antigenic constitution of the virus are described. A. H. CORNFIELD.

Paratyphoid infection in turkey poults due to *Salmonella reading*. M. Mitrovic (*Poultry Sci.*, 1956, **35**, 171—174).—Characteristics of the disease, which resulted in a mortality of 66% in the flock, are described. This is the first known published report of paratyphoid infection in turkey poults due to *S. reading*. A. H. CORNFIELD.

Response of the suckling hamster to two strains of the chronic respiratory disease of fowl. R. L. Reagan, F. S. Yancey and A. L. Brueckner (*Poultry Sci.*, 1956, **35**, 243—244).—Syrian suckling hamsters were not susceptible to the two strains of chronic respiratory disease virus by intranasal exposure. A. H. CORNFIELD.

Bursa of Fabricius and antibody production. B. Glick, T. S. Chang and R. G. Jaap (*Poultry Sci.*, 1956, **35**, 224—225).—Whereas the bulk of the normal birds developed antibodies to *Salmonella typhimurium* injections, few of the bursectomised birds developed antibodies. A. H. CORNFIELD.

[Preparation of] fungicides and insecticides. Badische Anilin- & Soda-Fabrik A.-G. (B.P. 737,277, 4.12.52. Ger., 6.12.51).—Compounds $(S{\cdot}CS{\cdot}NR)_2$, $RN{\cdot}CS_2H$ (**I**) and salts of **I**, are claimed as fungicides and insecticides (R is *cyclo*tetramethylene). F. R. BASFORD.

Pesticidal compositions containing chloronitrophenothiazine-9-oxides. Farbwerke Hoechst A.-G. (B.P. 737,781, 2.7.51. Ger., 1.7.50).—A chloronitrophenothiazine-9-oxide containing 2—4 negative groups, e.g., a mixture of monochlorodinitro- (25) and dichloromononitro-phenothiazine-9-oxide (75%) is compounded with a non-solvent liquid diluent or inert solid carrier, to provide pesticidal compositions. F. R. BASFORD.

[Preparation of] chlorophenyl-cyanoacrylic acids and derivatives. Ethyl Corp. (B.P. 737,753, 30.4.53. U.S., 6.5.52).—Compounds $C_6H_{5-n}Cl_n{\cdot}CH{:}C(CN){\cdot}CO{\cdot}XR$, useful as plant-growth regulants, are obtained by interaction of $C_6H_{5-n}Cl_n{\cdot}CHO$ with $CN{\cdot}CH_2{\cdot}CO{\cdot}XR$ in

aq. medium at high temp. (*n* is 2—5; X is O and R is H, ester-forming group, or salt-forming group or element; or X is NH, *N*-alkyl, or *N*-aralkyl and R is H or an org. radical; or X is N and R is the residue of a heterocyclic ring). Thus, an aq. solution of Na_2CO_3 is added to an aq. solution of chloroacetic acid at 25°, then after 30 min. at 35°, an aq. solution of NaCN is charged in two equal portions while keeping at 50°. The mixture is cooled to 25°, diluted with water (to 220), then treated with NaOH (3·85) in water (220), and heated to 40°. 2 : 4-Dichlorobenzaldehyde is now added during 20 min. with stirring, and after 4 hr. at 20° the pptd. solid is separated, and washed with C_6H_6 (400) to give *Na α-cyano-β-(2 : 4-dichlorophenyl)acrylate* (127·2 pt.).

F. R. BASFORD.

2.—FOODS

Rapid estimation of dialdehyde content of periodate oxystarch through quantitative alkali consumption. B. T. Hofreiter, B. H. Alexander and I. A. Wolff (*Analyt. Chem.*, 1955, **27**, 1930—1931).—The method is based on the quant. consumption of alkali by the dialdehyde content of periodate-oxidised starches. Close agreement was obtained with other methods and the average standard deviation for completely oxidised samples was 1·88%. G. P. COOK.

Predefecation of sugar cane juices. V. E. Baikow (*Sugar, N.Y.*, 1956, **51**, No. 4, 39—40).—The addition of the correct amounts of lime and the timing, in treatment of raw cane juice, the maintenance of a uniform pH, the formation of less scale in the evaporators, and of heavier and more granular mud from the clarifiers, the importance of the quality of the lime [95% of $Ca(OH)_2$, ≯1% of MgO, and free from Fe, Al oxides and sand] and the possible need of addition of H_3PO_4 to the cane juice are discussed. E. M. J.

Degradation products of caramelised sucrose. H. Lukesch (*Naturwiss.*, 1956, **43**, 108—109).—Sucrose was heated at 150° over a naked flame, and the subsequently solidified melt was pulverised and extracted in a Soxhlet apparatus with a solvent in which sucrose was scarcely sol., e.g., benzene, chloroform. The solutions were analysed by paper chromatography and the components were detected by different spraying reagents and identified. The compounds found were: glucose, fructose, glyceraldehyde, dihydroxyacetone, pyruvic acid, hydroxymethylfurfural and methylglyoxal (?). SUG. IND. ABSTR. (E. M. J.).

Tests to determine the sensitivity of sugar beet cossettes to scalding. G. Helms (*Zucker.* 1956, **9**, 104—107).—A sample of beets (8—10 taken from the elevator, cut longitudinally into 1—2 mm. slices) in a strainer, is dipped into a bath of diffusion juice and condensate of pH 6·5—6·8, ~9·5° Brix and ~8·3° pol, maintained at a temp. between 60 and 70° ± 1°, for 3 to 3·5 min., removed and drained, tested for slipperiness, tenacity and brittleness, and examined microscopically. By repeating the tests at 2—3° intervals up or down, the temp. at which slipperiness begins is established: above that point diffusion is hindered. The scalding point is little affected with variation of pH between 5·9 and 8·2, but alkalinities of 8·5—9·0 are harmful. Beets on storage, or exposure to frost, or from drier, higher areas were more sensitive to temp.

SUG. IND. ABSTR. (E. M. J.).

Fondant graining. A micro-grain for low-grade massecuite seeding. A. F. J. Appleboom, jun. (*Int. Sugar J.*, 1956, **58**, 99—101).—A filtered solution of 500 g. of white sugar of about 60° Brix is boiled until the temp. reaches 116°, 140 g. of filtered invert syrup of 84° Brix are added and the mixture is boiled until 116° is reached again, quickly cooled to 75°, transferred to a basin and agitated thoroughly until the fondant has fully developed. The advantage of this new seed is the improved grain regularity and clarity of the sugar produced. The slurry can be stored in an air-tight jar for several weeks, and the seed can also be used in an alcohol slurry (2 ml. per g. of seed). SUG. IND. ABSTR. (E. M. J.).

Volatile carboxylic acids in molasses and their inhibitory effect on fermentation. G. H. Dierssen, K. Hotlegaard, B. Jensen and K. Rosen (*Int. Sug. J.*, 1956, **58**, 686).—The presence of formic, acetic, propionic, *n*-butyric and *n*-valeric acids in beet molasses was demonstrated by a paper-chromatographic technique (cf. Isherwood and Hanes, *Biochem. J.*, 1953, **55**, 824) and also by a distillation method with a small amount of conc. H_3PO_4. The inhibiting effect of *n*-butyric acid on fermentation was studied. It was found that some strains of yeast resisted this inhibition. J. S. C.

Analysis of glucose syrups. L. Robinson-Görnhardt (*Stärke*, 1955, **7**, 305—310).—A comparison was made between three different methods available for the estimation of saccharides contained in glucose syrups produced by acid hydrolysis of starch. (1) Method of Bleyer-Sichert, which determines glucose only, using a modified Fehling's solution. Maltose and dextrins can be calculated by difference from total reducing value. (2) Quant. paper chromatographic analysis of constituent sugars. (3) Selective fermentation with micro-organisms. Results show that methods (1) and (2) give good agreement for glucose values, but not so good for maltose and dextrin values. Analysis of dextrins after microbiological fermentation of glucose and maltose gives values comparable with method (2) for maltotriose and higher dextrins. The average degree of polymerisation of the dextrin fraction is computed and used to characterise this fraction according to its degree of conversion. Results of paper chromatography show that the difference between various syrups is due not only to a variation of the average degree of polymerisation, but also to the actual content of dextrins.

E. DUX.

Microscopical identification of microgram quantities of L-arabinose and L-fucose. Direct synthesis of crystalline 2 : 4-dinitrophenylhydrazones and 1 : 1-diphenylhydrazone derivatives by solvent diffusion technique. G. E. Secor and M. L. White (*Analyt. Chem.*, 1955, **27**, 1998—1999).—The method is an extension of that by White *et al.* (*Analyt. Chem.*, 1955, **27**, 1016), in which μg. amounts of some pure and chromatographically separated pentoses and hexoses were identified by direct synthesis and microscopical examination of their 2 : 4-dinitrophenylhydrazones. Improvement enables L-arabinose to be determined by this means. A similar test is also described for determining L-arabinose and L-fucose as their crystalline 1 : 1-diphenylhydrazones; as little as 1—10 μg. of the pure or 5—15 μg. of the chromatographically separated pentose is sufficient for the test. G. P. COOK.

Kinetics of mutarotation of aldoses in the presence of metallic ions W. B. Neely (*Dissert. Abstr.*, 1956, **16**, 19).—Mutarotation of aldoses in salt solutions was investigated, catalysis by Li, Be, Mg, Cu^{++} and Fe^{+++} ions was observed, and catalytic constants were determined in each case. Addition of these ions to acetate buffers caused a reduction in rate constant at lower concentrations and an increase at higher concentrations. On the basis that the acetates of these ions are incompletely dissociated, the Li acetate system was treated mathematically. Better values for rate constants were obtained by assuming a termolecular reaction as compared with a bimolecular process; and on the basis of a termolecular process a mechanism is presented in which the rate-determining step appears to be a concerted attack by the metal ion and the nucleophilic reagent.

G. HELMS.

Organic acids in peaches. J. J. David, B. S. Luh and G. L. Marsh (*Food Res.*, 1956, **21**, 184—194).—Changes in major org. acids during the development of Halford and Peak clingstone and Fay Elberta freestone peaches determined by silicic acid column chromatography are discussed. Results are correlated with the maturity of the peach as measured by the pressure test. Citric, malic and quinic acids were the chief acids present, others being acetic, aspartic and mucic or galacturonic. The total titratable acidity and the concentrations of malic and citric acids increased to a max. during fruit growth and decreased during maturation. The ratio of malic to citric acid of clingstones at canning maturity and pressure of 8 lb. was >6·0 while that of freestone peaches at pressure test of 2 to 3 lb. was 2·0. A method for the separation of quinic acid by alcohol extraction, fractionation on Dowex-1 anion-exchange resin column and crystallisation is described. (25 references.) E. M. J.

Cellulose from cranberry pulp. E. Bennett (*Food Res.*, 1956, **21**, 207—208).—The possibility of incomplete removal of cutinous substances from plant material, enhancing the yields of cellulose and lignin to levels higher than those which actually exist is discussed. E. M. J.

Conserving the orange odour principle in concentrated and dehydrated preparations. Anon. (*Riechstoffe u. Aromen*, 1956, **6**, 45—46).—Descriptions are given of the latest American processes devised for producing highly conc. and dehydrated orange juice preparations with preservation of the original highly volatile orange flavour principle (**I**). A "High Ester" process for producing highly conc. orange juice is described, in which ~95% of the original **I** and the fruit sugar are preserved. The orange juice is frozen to give a higher ester fraction and an ice phase. Apart from the special plant for effecting the freezing and partition from the frozen phase, the plant is similar to that used for ordinary orange juice concentration. The process gives a production 20% higher than the usual concentration processes. Heat evaporation processes are discussed and a high-vacuum process for production of dehydrated and cryst. orange (or grapefruit) juice product ("instant citrus juice") is described. In the latter, ~95% of the original vitamins is retained in the product. The cultivation and use in citrus products of Acerola (a cherry-like fruit of Puerto Rico, rich in vitamin C) is also considered. H. L. WHITEHEAD.

Vitamin, mineral and proximate composition of frozen fruits, juices and vegetables. M. Burger, L. W. Hein, L. J. Teply, P. H. Derse and C. H. Krieger (*J. agric. Food Chem.*, 1956, **4**, 418—425).—Quant. data are presented on eight vitamins, six minerals, and proximate composition, determined on composites of 796 sets of samples representing 1953 and 1954 production seasons for 14 frozen fruits, seven frozen juices and 30 frozen vegetables in the U.S. and Hawaii. Packages were taken from >150 freezing plants in all areas, at statistically predetermined intervals to cover variables in weather, varieties, harvesting, processing, packaging and grades. Substantial amounts of ascorbic acid were found in all citrus juices, and in most fruits and vegetable products. The report provides a useful addition to the literature on the nutritional composition of frozen foods. (21 references.) E. M. J.

Procedure for sampling and grading raw green asparagus. A. Kramer, A. Kornetsky, N. Elehwany, G. Steinmetz and E. L. Morin (*Food Technol.*, 1956, **10**, 212—214).—The problem of how much asparagus out of how many boxes will provide the most efficient sample is discussed statistically. Recommended procedures for grading green asparagus are given. E. M. J.

Influence of moisture content on keeping quality of dry beans. H. J. Morris and E. R. Wood (*Food Technol.*, 1956, **10**, 225—229).—Beans having moisture content of >13% deteriorate in flavour and texture significantly in six months at 77°F.; in 12 months they become unpalatable, an increase in lipin acid value to 20 indicates low organoleptic quality. Beans having moisture content below 10% maintained their quality for two years at 77°F. almost as well as control samples stored at −10°F. E. M. J.

Some effects of reducing, during storage, the water content of dehydrated strip potato. J. F. Hearne and D. Tapsfield (*J. Sci. Food Agric.*, 1956, **7**, 210—220).—The inter-relation of moisture content, SO_2 and atm. composition in the storage of dehydrated potatoes was studied in detail. Free SO_2 concn. and the incidence of deterioration due to browning were shown to be related. The maintenance of an adequate free SO_2 concn., particularly at high temp., depends mainly on a low moisture content. A critical moisture content governs the reaction of " binding " SO_2. Packing in an inert atm. (N_2) reduces the rate of loss of SO_2 at high and medium moisture content, except at high temp. The use of in-package desiccants (e.g., CaO) keeps the moisture content low (2—3%) and prevents loss of free SO_2. (10 references.) J. S. C.

Viscometric test for determining the capacity for clarification of apple cider musts. P. Jacquin and J. Tavernier (*Industr. agric. aliment.*, 1956, **73**, 161—169).—The viscosity of cider must is measured in a 25-ml. Ostwald viscometer. The must is then treated with " Pectinol M ", an enzymic powder containing pectin-glycosidase and pectin-methylesterase, and viscosity again determined after the pectins have been broken down. The ratio of the two viscosities is shown, by a series of tabulated results and in a graph, to be a measure of the capacity of the must for clarification. J. S. C.

Stabilisation of wines by metallic-ion-exchangers. II. J. Ribéreau-Gayon, E. Peynaud, E. Portal, J. Bonastre and P. Sudraud (*Industr. agric. aliment.*, 1956, **73**, 171—177).—(cf. J.S.F.A. Abstr., 1956, ii, 65) The treatment of wines by anion-exchange resins is discussed and tables are given showing detailed analyses of white and red wines comparing the original composition of the untreated wine with that of wine treated by cation-exchangers, by anion-exchangers, and by both types of treatment. A further table shows variations of composition for each hourly period of treatment. The whole question of ion-exchange treatment of wines is discussed fully in relation to French legislative requirements. (23 references.) J. S. C.

Improved preliminary treatment for the routine estimation of lead in wines and related products. N. Greenblau and J. P. van der Westhuyzen (*J. Sci. Food Agric.*, 1956, **7**, 186—189).—The sample of wine, or other food product, is oxidised with I_2O_5 and conc. HNO_3, evaporated to dryness, and calcined at 480°. Pb in the residue is determined colorimetrically after extraction with dithizone in $CHCl_3$. J. S. C.

Small-scale malting as link between science and practice. H. Lüers (*Brauer u. Mälzer*, 1956, **9**, 6—10).—A review. P. S. Arup.

Small-scale malting procedure. K. Schuster (*Brauer u. Mälzer*, 1956, **9**, 10—12).—A review covering the three main systems in use, and the information afforded as to the brewing value of barley. P. S. Arup.

Kinetic study of the fermentation of sugars [in wort]. J. Montreuil, M. Petit, R. Scribau and P. Boulanger (*Brasserie*, 1956, **11**, 85—89).—Fermented worts were dialysed and the two fractions purified by passage through ion-exchange resins, and then chromatographed on filter paper. Worts contain sugars which cannot be fermented, such as glucosans of the *iso*maltose series and two unidentified glucosans. The failure of enzymes to attack these sugars is linked to their particular structures and, in particular, to glucoside linkages of the 1—6 type. The fermentability of glucosans is related to their mol. wt. It is concluded that the problem of utilisation of glucosans depends on securing the max. breakdown of starch and of high mol. wt. glucosans during brewing. (17 references.) J. S. C.

Brewery bacteriology. I. J. L. Shimwell. **II. Scientific notes.** Anon. (*Brew. J., Lond.*, 1956, **92**, 129—131, 162—163).—I. The bacteriology of brewing is reviewed, covering the changes in bacterial populations caused by " adaptation " of the organisms to their environment, or by spontaneous " mutations " in a very small no. of the individual bacteria according to whether the environment was favourable or unfavourable, the complementary mechanisms, mutation and selection, and accelerated evolution where antibiotics are killing off " normal " pathogenic bacteria and replacing them by mutants resistant to the antibiotics.

II. The trend towards microbiology in brewing research is outlined briefly and the following are discussed: the nutritional requirements of *Flavobacterium proteus*, Strandskov and Buchanan (cf. J.S.F.A. Abstr., 1956, i, 277), the effect of antibiotics on brewery bacteria, G. J. Haas (cf. *ibid.*, i, 277), the effect of light on the colour of wort, J. E. Buckingham and L. R. Bishop (*ibid.*, ii, 30). E. M. J.

[A] **Influence of maltose and maltotriose contents in finished beer and the yeast development in storage tests.** [B] **Secondary carbohydrates not utilisable by yeast in beer.** A. Stockli (*Schweiz. Brauerei Rdsch.*, 1956, **67**, 51–56, 62–65).—[A] To test the effect on yeast of residual maltose in finished beer, 0·2 to 0·8% of maltose was added to samples, incubated for 14 days at room temp. and the vol. of yeast measured. A positive and almost linear relation between maltose content of the beer and the yeast growth was found. Samples of bottled beers of known carbohydrate content, from four different breweries were inoculated with the same yeast and stored at room temp. for four weeks. There was good positive correlation between the quantity of carbohydrate used, the maltose content of the beers and the quantity of yeast produced. Good biological stability in finished beer depends on three factors: the contents of yeast and air and biologically utilisable substances.

[B] Continuing the above analytical study, chromatographic tests are described and illustrated. Two substances X_1, X_2 difficult to separate from maltose were found, and a third, X_3, was associated with maltotriose. These are discussed; X_2 was considered to be *iso*maltose, X_3 *iso*maltotriose and X_1 was not identified. E. M. J.

Performance characteristics of various bulk milk tanks. J. Simon and Robert Hill (*J. Milk Food Technol.*, 1955, **18**, 306—313). —A study was made of the cooling characteristics of various farm bulk milk tanks operated in both cold and warm ambient temp. conditions. Power consumptions required for cooling were compared and the data reported applied to develop criteria for the choice of a cooling plant. J. S. C.

Flavoured milk and flavoured milk " tablets." D. Sheppard, H. Burton, S. D. Carrinci and G. D. Lewis (*J. Soc. Dairy Technol.*, 1956, **9**, 36—43).—A series of organoleptic tests with flavoured milks is reported in detail. It is concluded that only 30% of adults and 58% of children favour flavoured milks and that plain milk is generally preferred by the majority. (21 references.) J. S. C.

Effect of freezing on the standard plate count of milk. C. K. Johns and I. Berzius (*J. Milk Food Technol.*, 1955, **18**, 297—299).—Milk and cream samples were both slowly and rapidly frozen, and analysed after 24 and 48 hr. storage periods by the standard plate count method. It was found that the bacterial count was reduced very little and it is concluded that freezing of milk for purposes of shipment is unlikely to cause any appreciable change in bacterial content. J. S. C.

Browning of heated milk. I. El-Dessouki Rifaat (*Dissert. Abstr.*, 1955, **15**, 2510).—Isolation of the brown colour from heated milk was attempted using methanol and water as solvents. The characteristics of the fractions obtained (including the dialysable and non-dialysable fractions from the water extract) are detailed. O. M. Whitton.

Nutritive value of instant non-fat dry milk. A. Z. Hodson (*Food Technol.*, 1956, **10**, 221—224).—On a reconstituted basis the thiamine, riboflavin, niacin, pantothenic acid and vitamin B_6 contents of two brands of instant non-fat dry milk are essentially equal to those of fresh milk samples. The ascorbic acid content which is low may be decreased by conversion to instant powder; the protein quality of an instant non-fat dry milk (rat-growth measurement) is equal to that of pasteurised milk. (21 references.) E. M. J.

Detergent test for the milk fat content of dairy products. I. Milk, cream and ice cream. O. S. Sager, P. Sanders, G. H. Norman and M. B. Middleton (*J. Ass. off. agric. Chem.*, 1955, **38**, 931—940).—The detergent procedure for determining butter fat in milk and cream (Sager and Sanders, *Milk Ind. Found. Conv. Proc., Lab. Sec.*, 1952, **4**, 29) is modified by addition of $NaHCO_3$ to the detergent–tetraphosphate reagent and in the heating and shaking procedure. The fat column is clear, the upper meniscus is distinct, and the curved bottom meniscus can be flattened by the use of silicone-treated bottles. Results then agree closely with those obtained by the Babcock test; for cream (but not milk or ice cream) the Röse–Gottlieb test gave results 0·25% lower. A. A. ELDRIDGE.

Chemical sterilisation. L. F. L. Clegg (*J. Soc. Dairy Technol.*, 1956, **9**, 30—37).—The development of procedures for sterilisation of milking machines, using NaClO, quaternary ammonium compounds, etc., is reviewed. A process of cleaning surfaces coming into contact with milk by complete immersion in aq. NaOH between milkings is described and the various procedures are discussed in relation to present legislative requirements. (18 references.) J. S. C.

Biochemistry of cheese ripening. XV. The retention of serine and threonine in process of ripening. J. Schormüller, M. Glathe and H. Huth (*Z. LebensmittUntersuch.*, 1956, **103**, 14—32).—Studies were made on the balance of N, of serine and of threonine at various stages in the ripening process of Harz cheese using, as well as normal, greater than, and less than normal amounts of ripening salt on the sour milk curds. Without ripening salt loss in the cheese mass of serine and threonine was 15—17% after seven days, mounting to 20% after 28 days; with the normal amount there was a loss of serine of ~7% after seven days, but no appreciable decrease of threonine. The fast ripening process is not recommended owing to the loss of ~7% of threonine. Against the considerable losses of amino-acids, "free" serine and threonine were found in only extremely small quantities. Incubation tests with washed cheese suspensions and addition of pyridoxal phosphate, pantothenic acid, folic acid and biotin indicated that added oxyamino-acids were decomposed in great measure, all known co-factors raising the activity of the decomposition enzyme. α-Aminobutyric acid and α-alanine were detected by chromatographic methods as decomposition products of threonine and serine. The results are discussed. (~112 references.) E. M. J.

Biochemistry of cheese ripening. XVI. Phosphatase systems in sour milk cheese and their development during ripening. J. Schormüller and E. Lahmann (*Z. LebensmittUntersuch.*, 1956, **103**, 211—238).—During the ripening of the cheese, two phosphatases, ostensibly of microbial origin, develop first in the rind and later in the interior of the cheese. One of these ("alkaline phosphatase") shows max. activity at pH 9·95—10·2, and the other ("acid phosphatase") at pH 5·2—5·7. The former is normally produced in greater quantity than the latter, the relative proportions and absolute amounts being influenced by ripening conditions. The former is more heat-resistant than the latter, and both are more resistant than milk-phosphatase; both are almost totally destroyed on heating during 5 sec. at 85°. Differences in behaviour on dialysis are also noted. The "alkaline" phosphatase is strongly inhibited by CN' or $Be^{\cdot\cdot}$, appreciably inhibited by $Mn^{\cdot\cdot}$, $Zn^{\cdot\cdot}$, $Ca^{\cdot\cdot}$, cysteine or citrate, but not appreciably so by F'. The "acid" phosphatase is specifically inhibited by F', but not (or only slightly so) by the other above-mentioned ions; it is stimulated by the presence of $Co^{\cdot\cdot}$, $Ni^{\cdot\cdot}$ or $Mn^{\cdot\cdot}$. Phosphates in concn. 10^{-2}M inhibit both enzymes. A pyrophosphatase showing max. activity at pH 6·3 is mentioned. The above and other characteristics and modes of occurrence of the two phosphatases are discussed in great detail. (160 references.) P. S. ARUP.

Freeze-dried meat. II. The mechanism of oxidative deterioration of freeze-dried beef. A. L. Tappel (*Food Res.*, 1956, **21**, 195—206).—During storage at 38°, freeze-dried beef reacts chemically with relatively large amounts of O_2. The oxidation of ether-sol. lipins accounts for ~10% of the total oxidative reaction, oxidation of non-ether-sol. conjugated lipins for ~50% of the total O_2 absorption. The most deteriorative oxidative reaction appears to involve the oxidation of the protein fraction and this can account for 50—100% of the total O_2 absorbed. During freeze-drying of beef oxymyoglobin is deoxygenated to myoglobin; during storage and subsequent rehydration, the myoglobin is oxidised to metmyoglobin, resulting in the development of brown colour. The main oxidative deterioration may be prevented by storing in inert atm. or at high vac., but this does not prevent the oxidation of myoglobin. (18 references.) E. M. J.

Effect of moist and dry heat cooking on vitamin retention in meat from beef animals of different levels of fleshing. S. Cover and W. H. Smith, jun. (*Food Res.*, 1956, **21**, 209—216.)—Evaporation from the surface of meat during cooking by dry heat methods or washing of the surface by condensing steam during cooking by moist heat methods may be important factors in the retention of thiamine and niacin: internal temp. of meat may also influence thiamine retention: meat from animals from pasture or feedlot gave similar results. (11 references.) E. M. J.

Nitrogen content of lean pork. C. R. Marshall (*Analyst*, 1955, **80**, 776—778).—Low results were obtained when the meat contents of pork sausages of known composition were calculated from the results of analysis. The method used was that of Stubbs *et al.* (*Analyst*, 1919, **44**, 125) with use of the corrected factor 100/3·6 of Jackson *et al.* (Brit. Abstr., B, 1932, 959) to convert meat nitrogen into defatted meat. Sampling error is excluded as a possible explanation and in order to account for the deficiency, the distribution of N in a headless side of home-killed pork was examined. The average contents of the defatted meats were lower than those obtained by Jackson *et al.* (*loc. cit.*) and accounted for the discrepancies originally observed. Changes in methods of feeding during recent years may possibly account for the differences between the factors found and those of Jackson *et al.* Breed also may have a contributory effect. A. O. JONES.

Concomitant use of radiation with other processing methods for meat. H. W. Schultz, R. F. Cain, H. C. Nordan and B. H. Morgan (*Food Technol.*, 1956, **10**, 233—238).—The combined effect of the use of conventional procedures and of ionising radiations of $< 2 \times 10^6$ rep. in the sterilisation of food is discussed. Dosages from 124,200 to 993,600 rep gave a linear relationship between irradiation dosage and intensity of radiation flavour of ground beef. A dosage of only 124,200 rep may produce a flavour different from that of non-irradiated ground beef. Radiation flavour is one to which persons may become accustomed over a period of time. E. M. J.

Development of spectrophotometric method for estimation of pigmented compounds of meat. H. Broumand (*Dissert. Abstr.*, 1955, **15**, 2396).—The pigments are extracted from finely chopped meat with water at 45°F. and the pH of the extract adjusted to 5·9—6·1 with NaH_2PO_4 buffer solution. The solution is examined at appropriate wavelengths for oxy- and met-myoglobin. The changes that the colour of meat undergoes in contact with air are discussed with reference to the contents of the two pigments and to micro-organisms and biological oxidising agents present. H. S. R.

Some applications of paper chromatography to the examination of meat extract. T. Wood (*J. Sci. Food Agric.*, 1956, **7**, 196—200).—A sample of meat extract, from which the proteins had been removed by dialysis, was electrolytically desalted and chromatograms run on 10-in. sq. sheets of Whatman No. 4 filter paper. A list of the substances identified and their approx. proportion present in the extract are given. The method enables most of the known components of meat extract to be identified leaving about 20—30% to be accounted for. (13 references.) J. S. C.

Technology of bacon-curing. E. H. Callow (*J. Sci. Food Agric.*, 1956, **7**, 173—179).—The breeding, feeding and growth of the live pig, the conditions of slaughter, the processes of curing and the underlying theoretical considerations, are reviewed. (37 references.) J. S. C.

Chemical composition and nutritional value of bacon. L. C. Baker (*J. Sci. Food Agric.*, 1956, **7**, 179—186).—The variations in composition of fresh and cured pork, the distribution of B-group vitamins in pig muscles and the effects of curing, smoking and cooking on them, the biological and nutritive values of pig flesh proteins, and the effect of frying on the chemical composition and nutritive value of bacon are reviewed. (14 references.) J. S. C.

Fish handling and hold construction in Canadian North Atlantic trawlers. W. A. MacCullum (*Fish. Res. Bd, Canada*, 1955, Bull. 103, 61 pp.).—Handling the catch (cod, haddock and flat fish, etc.) aboard trawlers on longer fishing trips than those formerly made, and problems arising in connexion with the preservation of the fish at sea are dealt with. The following are covered: spoilage and its control aboard ship; ice and refrigeration requirements in trawler fish holds; development of metal-surfaced, wholly refrigerated fish holds; good practice in fish hold construction, outfitting and refrigeration, and fish room costs. E. M. J.

Effects of aureomycin-containing sea water and ice on the storage life of round herring. T. Tomiyama, S. Kuroki, D. Maeda, S. Hamada and A. Honda (*Food Technol.*, 1956, **10**, 215—218).—Storage life of round herring was prolonged by treatment either with (*a*) storage in sea water containing ice and aureomycin (10 p.p.m.) on the boat, (*b*) storage in an aureomycin-containing ice (5 p.p.m.) after landing; in combination storage life was prolonged ~90% and 40% more than that of the control, at 15—20°c., and at −1 to 2°c., respectively. E. M. J.

Post-mortem changes in the lenses of fish eyes. II. Effects of freezing, and their usefulness in determining the past history of the fish. R. M. Love (*J. Sci. Food Agric.*, 1956, **7**, 220—226).—The development of turbidity in the eye lens of ice-stored fish was further investigated (cf. J.S.F.A. Abstr., 1955, i, 264). It is shown that the fish must be cooled to −4·8° (or lower) for the effect to occur. It is masked by storage in ice for >16 days and by salting one day or more before freezing. The effect is attributed to the formation of minute ice crystals which on thawing remain as small pockets of fluid in proportion to the period of freezing. J. S. C.

Effect of different fats and oils and their modification on changes during frying. M. Bennion and F. Hanning (*Food Technol.*, 1956, **10**, 229—232).—The influence of added monoglycerides on the frying fat of potatoes lowered the smoke point. A continuous process lard, as compared to a steam-rendered lard, maintained a higher smoke point and lower free fatty acid content with the frying of potatoes or fritters. The addition of antioxidant resulted in lower peroxide values. In a comparison of changes in various types of fats produced by frying of fritters, the trends of increased acidity and lowered smoke point and peroxide values were similar in all fats tested under small scale conditions. (16 references.) E. M. J.

Spectrophotometric study of olive oils using ultra-violet radiation. A. Uzzan (*Oléagineux*, 1956, **11**, 27—33).—Examination of a large no. of olive oil samples defined the limits of K_{270} and K_{232} and $R(K_{270}/K_{232})$ as functions of acidity, degree of oxidation and in relation to geographical origin (K = coeff. of sp. absorption, the numerical subscript defining wavelength in mμ). The data are used to discuss u.v. spectrophotometry as a method of grading olive oils for quality and for studying the " ageing " process. J. S. C.

Component acids of glycerides of *Erythrina indica* seed fat. S. P. Pathak and L. M. Dey (*J. Sci. Food Agric.*, 1956, **7**, 200—203).—Neutral seed fat of *E. indica* was crystallised from acetone and ether and the composition of the glyceride fractions studied by the ester-fractionation method. The component acids were found to be: palmitic (8·2%), stearic (8·0%), arachidic (4·3%), behenic (13·3%), hexadecenoic (3·1%), oleic (45·6%), linoleic (7·1%), eicosenoic (9·8%) and lignoceric (0·6%). The component glycerides were: 10·1% of mono-unsaturated-disaturated, 79·4% of di-unsaturated-monosaturated, and 10·5% tri-unsaturated glycerides. J. S. C.

Chromatography of proteins. I. Cellulose ion-exchange adsorbents. Elbert A. Peterson and H. A. Sober. **II. Fractionation of serum protein on anion-exchange cellulose.** H. A. Sober, F. J. Gutter, M. M. Wyckoff and Elbert A. Peterson (*J. Amer. chem. Soc.*, 1956, **78**, 751—755, 756—763).—I. Cellulose derivatives containing carboxymethyl-, diethylaminoethyl-, and phosphate-groups have been used to effect chromatographic separation of enzymes and proteins. Another adsorbent, containing basic groups derived from triethanolamine bound to cellulose through reaction with epichlorohydrin, was found to be exceptionally useful in chromatography of nucleic acids. Details of methods of preparation, protein adsorption capacities, physical characteristics and stability of these materials are given. (29 references.)

II. Separation of proteins from horse serum in a column of adsorbent derived from cellulose and containing diethylaminoethyl-groups is described. Gradients of pH and salt concn. were used for elution. Most of the protein components emerged in the order of decreasing iso-electric point in the decreasing pH, increasing salt gradient, suggesting an ion-exchange effect. Fractions were examined by u.v. spectrophotometry and electrophoresis. (43 references.) J. S. C.

Separation of creatine and creatinine by paper chromatography and the quantitative estimation of total creatinine in foods. L. Acker, W. Diemair, D. Pfeil and G. Schiffner (*Z. anal. Chem.*, 1955, **148**, 10—14).—Creatine and creatinine are separated by paper chromatography, using as developing solvent a 4 : 1 : 5-butanol–acetic acid–water mixture, to whose organic layer 20% of methanol is added. On a Whatman no. 1 paper at 27°, R_F values of 0·42 and 0·55 are given, respectively. The chromatogram is dried at 100° and the zones are revealed by spraying first with 2N-NaOH and then with 1·2% aq. picric acid. For the quant. estimation of total creatinine, the creatine is first converted into creatinine by evaporating with HCl for 2 hr. After chromatographing, the zone is located with the help of a control chromatogram, and cut out. The creatinine is dissolved out with the NaOH and picric acid reagents and the extinction of the solution is measured against that of a blank. Details are given for the estimation of total creatinine in meat extracts and in meat broth pastes and cubes. J. H. Waton.

Coenzyme A. F. Pasquinelli (*Sperimentale*, 1956, **5**, 66—125.)—A review is presented covering the structure, biosynthesis, and distribution of coenzyme A, the oxidation of pyruvate, and the formation of acetyl-coenzyme-A. The effect of the acetyl-coenzyme-A on the oxidation of pyruvate in animal tissues, and of the effect on lipoic acids is described in particular detail. The oxidation of acetaldehyde and formation of acetyl phosphate is discussed together with *trans*acetylase, and with the reaction between adenosine triphosphate and acetate (the acetate " activation " reaction). The oxidation of α-ketoglutarate and the formation of succinyl coenzyme A is considered. The metabolic behaviour of coenzyme A is described in relation to the synthesis of citric acid from oxalacetate and either acetate or acetoacetate. In the metabolism of fatty acids the behaviour of coenzyme A in the " activation " of fatty acids and their oxidation with extracts of either *Clostridium kluyveri* or animal tissues and in synthesis is considered. In this last connexion, the fatty acid cycle is discussed. The part of coenzyme A in the synthesis of acetoacetic acid is detailed. A discussion of the action of coenzyme A in various forms of *in vivo* metabolism, including pantothenate deficiency and diabetic ketosis is presented. (401 references.) C. A. Finch.

The determination of 3 : 5-dinitro-*o*-cresol in the presence of β-carotene in biological tissues. M. L. Fenwick and V. H. Parker (*Analyst*, 1955, **80**, 774—776).—The Na salt of 3 : 5-dinitro-*o*-cresol (**I**) is bright yellow and the free acid almost colourless in methyl ethyl ketone. The optical density of β-carotene at 430 mμ, however, is the same in acid and alkaline solution. Two procedures based upon this fact are described. The first is devised for application to cows' blood, and the second to determine **I** on locusts. Both methods are applicable to other similar problems. A. O. Jones.

Rapid estimation of vitamin A using a surface-active agent. E. T. Gade and J. D. Kadlec (*J. agric. Food Chem.*, 1956, **4**, 426—427).—The procedure, based on the solubilisation of lipin material by a surface active-agent and extraction of the vitamin A with a mixed solvent, may be used for determining vitamin A in powdered formulas for infants and with slight modifications, for determining vitamin A in the liver of chickens. Animal feed supplement samples containing *NN'*-diphenyl-*p*-phenylenediamine and fortified with vitamin A are given a preliminary washing with ether; the ether is removed and the samples are extracted as above. (10 references.) E. M. J.

Determination of vitamin B_1 by the thiochrome method. Y. de Hemptinne and A. Wilmes (*Fermentatio*, 1956, No. 1, 3—63).—Several methods for vitamin B_1 determination based on the thiochrome reaction are compared. A British method, proposed by the Aneurin Panel of the Vitamin Sub-committee of the Society of Public Analysts (*Analyst*, 1951, **76**, 127) was found to give very reliable results and is described in detail with a number of minor modifications which are suggested for estimations in cereal products. (61 references.) J. S. C.

Determination of vitamin C in vegetable tissues. G. Enăchescu (*Anal. Inst. Cerc. agron. Român*, 1952—3, [1955], **22**, 463—491).—A number of methods of assay of vitamin C in vegetable tissues, whether as ascorbic acid or as total vitamin C (ascorbic + dehydroascorbic acids) were studied and compared. For the extraction of the vitamin, a mixture of 8% aq. acetic and 0·5% aq. citric acids was used instead of HPO_3. Hot and cold extractions gave practically the same results, except with hard, dry tissues, for which hot extraction was preferable. In order to remove colloidal impurities which interfere with filtration and clarification of extracts, it is considered advisable to add 25—50% ethanol. In the indophenol (Tillmans) method, the presence of ethanol causes an error of at least 2—12%. To establish (visually) the titration end-point in the indophenol method, it is recommended that a standard, having the same composition as the sample under titration but previously oxidised with iodine and mercuric acetate, be employed. This generally enables 93—100% of the vitamin C, experimentally added, to be determined. In the method of determination with methylene blue, the ratio of methylene blue used to vitamin C content decreases as the latter value increases. This decrease of the ratio is small: to obtain satisfactory results, the aliquot titrated should not contain >0·04 mg. of vitamin C. Visual determination of the end-point with the aid of a standard is again recommended. The iodimetric method, using KIO_3, was also studied. The conclusions drawn are (1) that the indophenol method is sufficiently accurate, is the most simple method and has the widest sphere of application, (2) the methylene blue (Martini and Bonsignore) method gives results 3—10% lower than the indophenol method, and (3) the iodimetric method gives results 20—40% higher.

In the assay of total vitamin C by the Emmerie and Eckelen method, it was shown that, with the exception of pure vitamin C and certain vegetable extracts, the elimination of H_2S is not complete even after 8—10 hours of bubbling through CO_2 but that the errors due to traces of H_2S are unimportant. The adjustment of the pH value to 5, prior to the treatment with mercuric acetate, is better effected with a solution of Na_2CO_3 than with solid $CaCO_3$,

thus avoiding an additional filtration. This method, under the conditions established, enables a value equal to 95—105% of the vitamin C added to be obtained. The determinations carried out indicate that fresh fruit and vegetables contain little dehydroascorbic acid with certain exceptions which contain it in the proportion of 20—60% of total vitamin C. (28 references.)
(From French summary) J. S. C.

New titrimetric method for the determination of ascorbic acid. M. Z. Barakat, S. K. Shehab and M. M. El-Sadr (*Analyst*, 1955, **80**, 828—833).—The method described depends upon the rapid quant. reduction of the orange-coloured sodium 1 : 2-naphthaquinone-4-sulphonate to the colourless corresponding quinol. A metaphosphoric acid–acetic acid solution is added to the prepared sample solution which is then diluted so that 100 ml. contain 0·5—2·0 mg. of ascorbic acid. A known vol. of the standard solution of the reagent (1 millimol. per 100 ml.) is then titrated with the sample solution. Each mol. of the reagent ≡ 1 mol. of ascorbic acid. Examples are given of the application of the method to pharmaceutical products and to citrus juices and the results are compared with those obtained by the 2 : 6-dichlorophenolindophenol method. The main advantages of the new method are the stability of the reagent solution and the absence of interference by Fe salts and some other compounds affecting the older method. Interference occurs, however, with alkali sulphites, sulphides and thiosulphates and with thiourea. The experimental error is within ±2%.
A. O. JONES.

γ-Ray-induced oxidation of ascorbic acid and ferrous ion. N. F. Barr and C. G. King (*J. Amer. chem. Soc.*, 1956, **78**, 303—305).—Oxidation of aq. ascorbic acid solutions by ^{60}CO γ-rays is studied and interpreted in terms of the mechanism of oxidation of Fe^{2+} under similar conditions. The ratio of the rates of radiation-induced oxidation of Fe^{2+} in the presence and absence of O_2 is 1·89 ± 0·04. The ratio of the rate of oxidation of Fe^{2+} to the consumption of O_2 is 4·5 ± 0·1. The results for both substances are interpreted in terms of radical mechanisms. M. DAVIS.

Antioxidant properties of spices in foods. J. R. Chipault, G. R. Mizuno and W. O. Lundberg (*Food Technol.*, 1956, **10**, 209—211).—Data are given on the antioxygenic activity of 18 spices expressed in terms of an antioxidant index (ratio of the stability of the samples containing the spice to the stability of a control without spice) in ground pork at − 5 and − 15°, in mayonnaise and a French dressing. Allspice, cloves, sage, oregano, rosemary and thyme increased the stability of all the fat substances tested ; oregano was most effective in mayonnaise and French dressing. E. M. J.

Essential oil of *Backhousia myrtifolia* Hooker et Harvey. III. Single-tree studies on physiological forms from Queensland. R. O. Hellyer, H. H. G. McKern and J. L. Willis (*J. roy. Soc. N.S.W.*, 1955, **89**, 30—36).—Examination of the essential oils from 18 individual trees of *B. myrtifolia* shows the existence of four types characterised by a phenol ether as principal constituent, i.e., elemicin, *iso*elemicin, methyleugenol, and methyl*iso*eugenol. In oils of the latter type, *iso*elemicin is a minor constituent. Variations in physical constants of the *iso*elemicin fractions are attributed to *cis-trans* isomerism. The 1 : 3 : 5-trinitrobenzene derivative of *iso*elemicin (m.p. 89—90°) is described. J. S. C.

Time errors in the paired comparison taste preference test. J. W. Mitchell (*Food Technol.*, 1956, **10**, 218—220).—Data revealed a significant positive time error, i.e., a greater frequency of choice of the first sample (whiskey). A conditioner sample eliminated the time-error. E. M. J.

Discernment of primary tastes in the presence of different food textures. A. O. Mackey and K. Valassi (*Food Technol.*, 1956, **10**, 238—240).—The levels at which primary taste substances (NaCl, sucrose, tartaric acid and caffeine) could be detected, were determined in water solutions and in two foods. Threshold values were lower for taste substances in aq. solution than for the same substances added to foods. E. M. J.

Preservation of foods. VIII. Preservation by refrigeration. P. Noordzij (*Conserva*, 1956, **4**, 337—346 ; cf. *ibid*,, 305).—A review covering ventilation of stores, refrigerating plant, refrigerated transport, measuring instruments, and qualifications of personnel.
P. S. ARUP.

Heat resistance. VII. Effect of phosphate on the apparent heat resistance of spores of *Bacillus stearothermophilus*. O. B. Williams and A. D. Hennessee (*Food Res.*, 1956, **21**, 112—116).—There was an apparent increase in resistance of spores of *B. stearothermophilus* heated in disodium phosphate buffer, with decreasing molal concentrations of phosphate over the range M/15 to M/120. There seems to be an inhibitory effect of the phosphate added by the buffer to the recovery medium in concentrations >M/120, and a stimulation of germination and growth by the M/120 buffer as compared with distilled water and greater phosphate concentrations. E. M. J.

Antiseptics in the food industries. R. G. Eeckhaut (*Fermentatio*, 1955, No. 6, 265—278).—The physical and chemical factors—e.g., temp., pressure, pH, rH, O_2, vitamins—which control the growth of micro-organisms in food are reviewed and the mechanism of action of various common antiseptics defined, e.g., the action of salicylic acid in inhibiting the synthesis by organisms of pantothenic acid. The objections to the use of preservatives in foods are discussed at length and it is concluded that the control of processes by other means, e.g., pasteurisation, refrigeration, filtration, etc. is a more satisfactory method of ensuring food preservation. J. S. C.

Permissibility of boric acid as food preservative. J. F. Reith and H. van Genderen (*Conserva*, 1956, **4**, 326—330).—From a review of data for possible max. daily intake and for toxic effects, it is concluded that the use of boric acid as a food preservative cannot be justified. (26 references.) P. S. ARUP.

Drying by atomisation in the food industries. II. R. Deveaux (*Industr. agric. aliment.*, 1956, **73**, 179—183).—The advantages and disadvantages of spray-drying are discussed and the types of plant used in the process are classified and compared. J. S. C.

Spectrophotometric determination of diphenyl in treated fruit wrappers and a note on sampling of striped sheet materials. K. E. Almin (*Svensk Papp. Tidn.*, 1956, **59**, 44—50).—U.v. and i.r. spectrophotometric methods have been adapted for the determination of diphenyl in fruit wrappers and their accuracy and suitability are compared. The u.v. method is more accurate but a correction must be made for the absorbency of the paper sizing so that a sample of the untreated paper is required. A sampling procedure is derived for wrappers to which diphenyl has been applied in equidistant bands. K. WENDTNER.

Method of rendering anti-adhesive the surface of a bread- or cake-baking pan. John Norman Read (B.P. 738,371, 31.3.50).—The inside surface of a baking pan is coated with a solution of an epoxy resin with a hardening agent and heated to form a hard, flexible and anti-adhesive film. J. S. C.

Extraction of sugar-beet sections. G. Bredt, E. G. von Langen and O. von Loesse (B.P. 738,025, 7.1.53. Ger., 7.1. and 22.3.52).—Juice is continuously drawn from the lower part of the diffusion tower and used for mixing with beet sections to be extracted. This mixture is pumped back to the diffusion tower, a part of it, equal to the amount of fresh water to be added, being diverted and used for preheating fresh beet sections before being treated for sugar production. This liquor has considerably higher concn. than that drawn directly from the tower, so that its treatment is more economical.
K. RIDGWAY.

Process for obtaining sugar. Badische Anilin- u. Soda-Fabrik A.-G. (Inventor : W. Schmidt) (Ger. P. 932,480, 21.1.51).—Beet cossettes, comminuted sugar cane, or raw sugar are extracted at 10—60° by an org. solvent, preferably methanol, but acetone or chloroform may be used, in which NH_3 (2 mol. per mol. of sugar) has been dissolved, the extraction being carried out under pressure (up to 5 atm.). The solution is led to a vessel where the pressure is released, NH_3 is volatilised and sugar is precipitated in crystalline form. The sugar is removed by centrifugation, the solvent is distilled leaving a residue of non-sugars and small amount of sugar. The solvent and the recovered NH_3 can be re-used.
SUG. IND. ABSTR. (E. M. J.).

Making of infusions and dispensing of beverages [e.g., tea and coffee]. James Stott & Co. (Engineers), Ltd. (Inventor : Arthur Young) (B.P. 738,796, 5.6.53). K. RIDGWAY.

Coffee preparations. M. Ruben (B.P. 738,818, 23.4.52).—Coffee is compounded with a mixture of sugar (or sugar material) (e.g., cane sugar, mannite, lævulose, saccharin or sorbitol) and (animal or vegetable) albumin, to overcome the harmful effect of caffeine on people suffering from heart trouble. A suitable composition comprises cane or beet sugar (92·5), methyl cellulose glycollate (7), and egg or soya-bean albumin (7 wt.-%). When this is added to a coffee infusion, the added protein combines with the caffeine present.
F. R. BASFORD.

Production of milk tablets. Aplin & Barrett, Ltd. (Inventor : H. B. Hawley) (B.P. 738,755, 23.7.52).—Roller-dried skim or separated milk powder (optionally incorporating vitamin A blended with sugar) is coated with an aq. emulsion of hydrogenated fat or fatty oil, then compressed to form a milk tablet containing 0·1—0·5 wt.-% of fatty material. F. R. BASFORD.

Method and apparatus for making ice cream confections. Eskimo Pie Corp. (Inventor : C. K. Nelson) (B.P. 738,185, 9.2.53).—Partially frozen mix portions of confection are deposited at spaced intervals

on a flat band carrier maintained at $\gtrless -30°$F. within a freezing chamber and are frozen to the required extent by passage through the chamber, after which they are discharged. J. S. C.

Manufacture of cheese. Italcolloid S.p.A. (B.P. 738,151, 18.1.51. It., 18.1.50).—In the manufacture of processed cheese from "semi-green" or "green" cheese, alkali metal-, alkaline-earth metal-, and/or org-. acid salt of tripolyphosphoric acid (P_2O_5 82·55%) is used as flux in 0·8—1·2% concn., optionally in conjunction with alkali metal pyrophosphate or metaphosphate. F. R. BASFORD.

Preservation and storage of biological material. Arthur D. Little, Inc. (Inventor: H. O. McMahon) (B.P. 738,556, 5.12.53).—The material is subjected to high atm. pressure (~2000 atm.), cooled to a point below normal freezing point ($\lessgtr -20°$), the formation of ice being prevented by the pressure. The operation may be carried out in a flexible water-tight envelope in a suitable pressure-tight container, completely filling the free space with water, and tightly closing and cooling the container. For use, the material is heated (to 70°) before the pressure is released to avoid ice formation. J. S. C.

Pasteurisation or sterilisation of liquids contained in drums. Samuel J. Young (B.P. 738,274, 27.5.52).—Liquids in metal drums and similar containers are sterilised by heating in a chamber, rotating them on their axes before they leave the chamber and spraying with hot water or steam before discharge. J. S. C.

Bottling and preserving of liquids. J. N. Wiser (B.P. 738,015, 18.11.52. Belg., 23.11.51).—A bottle closure is made double, an inner disc being included under the closure proper. The closure and the disc each have a hole, but these holes are not in register. An assembly carrying a small tube passes through the closure hole, and separates the disc and the closure. The small air pocket above the liquid can then be exhausted, and replaced by, e.g., CO_2. On withdrawing the tube, the disc and closure spring together, aided by the pressure of the CO_2, to give a tight seal. The preserving qualities of the bottle contents are improved by the withdrawal of the air. K. RIDGWAY.

3.—SANITATION

Air-tight storage of grain: its effects on insect pests. II. ***Calandra oryzæ* (small strain).** S. W. Bailey (*Aust. J. agric. Res.*, 1956, **7**, 7—19).—The effects of O_2 depletion and CO_2 accumulation, previously studied on *C. granaria* (cf. J.S.F.A. Abstr., 1955, i, 387—388) have now been studied on *C. oryzæ* L., with broadly similar results. Complete mortality occurred with O_2 reduced to ~7%. With O_2 maintained a little above a lethal min., and CO_2 varied, mortality occurred at concn. below those found to cause death when O_2 was normal, e.g., as little as 13·2% CO_2 caused complete mortality. These results apply to the adult insect. Young immature stages were the most susceptible to changing O_2 and CO_2 concn. The main cause of death was O_2 depletion: accumulation of CO_2 played only a minor rôle. (10 references.) J. S. C.

Identification of insect fragments: relationship to the etiology of the contamination. O'Dean L. Kurtz and Kenton L. Harris (*J. Ass. off. agric. Chem.*, 1955, **38**, 1010—1015).—Information on the source of contamination afforded by the microscopical examination of insect fragments is discussed, and photographs of diagnostic characteristics of beetle and moth fragments are reproduced. A. A. ELDRIDGE.

Human exposure to aërosol application of malathion and chlorthion. D. Culver, P. Caplan and G. S. Batchelor (*Arch. industr. Hlth*, 1956, **13**, 37—50).—Studies of human exposure to aerosol application of malathion and chlorthion are described. Atmospheric concn. of insecticide in the aërosol clouds decreases with increased distance from the source, but levels of exposure beyond 17 yd. from the source are relatively constant. None of the men exposed during the study exhibited changes ascribable to choline-esterase inhibition or parasympathetic overstimulation. Study of the measurements on the man with the highest exposure show that he would have acquired gradually during a period of one month <45 mg. per kg. deposited on his skin and <11 mg. per kg. inspired through his nostrils. These are 100 to 200 times less than acute LD_{50} for animals. The conclusion is reached that malathion and chlorthion can be used safely in aërosol form against adult mosquitoes in populated areas. I. JONES.

Air-sterilisation by fibrous media. A. E. Humphrey (*Dissert. Abstr.*, 1956, **16**, 509).—The design of a filter from fibrous media for air sterilisation is discussed. It utilises the irreversible impaction and adsorption of the micro-organisms on the fibre surfaces. The efficiencies of fibrous glass filters (0·12 in. thick) in removing *Bacillus subtilis* spores from air streams were compared at various air velocities. The results are discussed. O. M. WHITTON.

4.—APPARATUS AND UNCLASSIFIED

Determination of plant acids by ion-exchange chromatography. I. Percuprimetric determination of tartaric acid in presence of oxalic acid. N. Velikonja (*Arhiv Kem.*, 1955, **27**, 161—166).—Tartaric acid is separated from sugars, etc., by ion-exchange chromatography and the portion containing the tartrate and oxalate ions is oxidised with 0·01N-K cupric-3-periodate, of which the excess is determined by back-titration with standard arsenite, a blank titration being also run. J. S. C.

Theory of chromatography. Formulæ for diffusion into spheres and their application to chromatography. E. Glueckauf (*Trans. Faraday Soc.*, 1955, **51**, 1540—1551).—Four equations are presented relating the rate of the mean internal concentration change dq/dt as a function of the mean internal concentration q and the surface concentration q. The application of these to conditions occurring in chromatographic columns is fully discussed and conclusions are drawn. J.A.C. ABSTR.

Theory of chromatography based on the theory of counter-current distribution. M. Verzele and F. Alderweireldt (*Bull. Soc. chim. belg.*, 1955, **64**, 579—592).—The height of an equiv. theoretical plate of a chromatographic column (HETP) is shown to be equiv. to that of a single unit in a counter-current distribution series. If the chromatographic partition coeff. and the no. of HETP of a column are known, it is possible to calculate in advance the chromatogram. The success of the method is illustrated with some data for the separation of the humulone complex on silica gel buffered at pH 9·0 with *iso*-octane as the eluant. J.A.C. ABSTR.

Values [of pH] of the Clark and Lubs buffer solutions at 25°c. V. E. Bower and R. G. Bates (*J. Res. nat. Bur. Stand.*, 1955, **55**, 197—200).—The pH values, over a range of 1—10, and Van Slyke buffer values, of the Clark and Lubs series of buffer solutions, at intervals of 0·1 pH, were accurately determined ($\pm$0·02 pH) and are tabulated for various compositions. (11 references.) J.A.C. ABSTR. (J. S. C.).

Determination of lead in organic material. J. C. Gage (*Analyst*, 1955, **80**, 789—796).—In the method described organic matter is destroyed first in a current of air at low temp. and then, after addition of $Mg(NO_3)_2$, at 500° in a current of HNO_3 vapour. A simple and convenient electrically heated apparatus is described. The solution of the ash in HCl is treated with Na diethyldithiocarbamate and the Pb diethyldithiocarbamate is extracted with a mixture of pentanol and toluene, and then converted into Pb dithizonate. This is extracted with CCl_4 and the optical density of the extract determined at 515 mμ. The concn. of Pb. is ascertained from a calibration graph. The method as described is specific for Pb and precision and recovery are good. A. O. JONES.

Handling of bottles. Co-operative Wholesale Society, Ltd. (Inventors: Harold J. Porter, J. Glover, G. K. Medlock and W. Jepson) (B.P. 733,150, 22.8.51 and 31.10.52).—A device for handling a group of bottles (e.g., milk-bottles), crated or about to be crated, picks up each bottle by a suction nozzle, which is adapted to receive the neck and to make air-tight contact with the shoulder. The application of the device to unloading a 20-bottle crate is illustrated. J.A.C. ABSTR. (J. S. C.).

Heat pumps and refrigerators. Radiation, Ltd. (Inventor: Alec R. Bennett) (B.P. 733,104, 7.1.53).—The heat pump or refrigerator, for space warming or cooling, consists of (*a*) a hollow rotor inside which a working fluid (air or other suitable gas) circulates between the centre and periphery, (*b*) an axial duct through the centre of the rotor for conveying a fluid stream (air, water, etc.) to serve as a low-grade heat source, and (*c*) a means for promoting circulation of working fluid within the rotor. Rotation causes the fluid to be alternately compressed and expanded, making thermal contact with the heat source on expansion, and losing heat to the medium to be heated when compressed. J.A.C. ABSTR. (J. S. C.)

Heat exchangers. C. A. Parsons & Co., Ltd. (Inventor: W. Hryniszak) (N.P. 732,977, 19.6.52).—A heat exchanger used as an air preheater in a gas turbine comprises a number of elements, each equipped with a filter for the gas to be cooled, a valve for cutting off, and the pumping of a cleaning fluid (e.g., air) through the ducts of each element to remove dust when it is shut off. J.A.C. ABSTR., (J.S.C.)

Antifoaming centrifugal methods and apparatus. Merco Centrifugal Co. (B.P. 732,703, 6.2.53. U.S., 15.2.52).—When foaming occurs the efficiency of centrifugal separation of two substances is greatly reduced. The foaming is prevented by displacing all the air from the apparatus by steam, which is condensable in the aqueous liquid being centrifuged. A nozzle type centrifuge with vertical rotor is described in which this may be achieved. J. A. C. ABSTR.

SOCIETY OF CHEMICAL INDUSTRY

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