LABORATORY

OF THE

INLAND REVENUE DEPARTMENT

OTTAWA, CANADA

BULLETIN No. 126

FOOD PRESERVATIVES

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OTTAWA, September 27, 1906.

W. J. GERALD, Esq.,

Deputy Minister of Inland Revenue.

SIR,—It is now some time since you requested me to consider a communication received from a Joint Committee appointed by the Canadian Manufacturers Association and the Society of Chemical Industry, asking the Department to make regulations specifying under the provisions of the Adulteration Act, the limits within which preservatives might be legally used in food. Subsequently you authorized Mr. A. McGill, Assistant Analyst to the Chief Analyst, to attend a meeting of the British Medical Association in Toronto and read a paper on the same subject.

Before any action is taken by the Department or this branch, I believe it would be advisable to give the manufacturers and the public generally an opportunity of becoming fully acquainted with the subject. I beg, therefore, to submit a report by Mr. McGill on Food Preservatives and to recommend its publication in the Bulletin Series of this branch.

I have the honour to be, sir,

Your obedient servant,

THOMAS MACFARLANE,

Chief Analyst.

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LABORATORY OF THE INLAND REVENUE DEPARTMENT,

OTTAWA, September 8, 1906.

THOS. MACFARLANE, F.R.S.C., &c.,

Chief Analyst, I.R.D.

SIR,—I have the honour to submit for your approval the following report on the general subject of preservatives in food products. A portion of the matter contained in this report has already been published, in June of last year, with your own sanction and that of the then Acting Deputy Minister. A considerable amount of new material has, however, been added, and the whole may be taken to represent, in epitome, the present state of our knowledge on the subject.

A special incentive to the preparation of this report was the meeting of the British Medical Association in Toronto (August 21 to 25). It is apparent that final conclusions regarding the influence of chemical preservatives upon the public health must be reached through the concerted action of the medical profession. If so influential a body of medical men could be induced to take up this subject a working basis for legislation would soon be established. The Secretary of Agriculture for the United States of America has recently (June 30, 1906) been authorized to obtain opinions from experts in the matter of food preservatives, with a view to legislation, and has issued a circular letter in accordance with this authorization.

I believe that the physician is the proper person to give an opinion in this matter, and that medical health officers, in particular, should be expected to pay attention to it. For this purpose, these officials could obtain the co-operation of local physicians, thus furnishing data of first-class value in guiding legislation. The matter is of so great importance as to demand immediate attention and study. But I would utter a word of caution against impetuous and indiscriminating action. The public press has, for some time, taken up the subject of preservatives in food and treated it in a manner quite hysterical. The desire to create a sensation is too much in evidence. This is a question where judicial calmness is needed. I trust that my attempt to present the subject fairly will assist in arriving at sane and honest conclusions.

I have the honour to be, sir,

Your obedient servant,

A. McGILL.

LABORATORY OF THE INLAND REVENUE DEPARTMENT,

OTTAWA, September 8, 1906.

FOOD PRESERVATIVES.

There has been frequent request, by the interested public, for a note on the subject of food preservatives, which was published with Bulletin 83 (November, 1902). I have thought it worth while to augment this note by additions, which bring the subject matter down to date. My sketch makes no claim to being exhaustive, but I have reason to believe that no important researches on the physiological effects of preservatives have escaped my attention.

Manufacturers very reasonably ask that the Department of Government which is charged with the administration of the Food Act, should define as clearly as possible its attitude towards the use of preservatives in food. They claim that, without preservatives, their business as packers of meat and fruit products would be destroyed, or at least seriously handicapped. They believe that the chemical substances employed by them are harmless in the quantities used. They wish to use nothing that makes their products unwholesome ; they desire to do nothing illegal, and they wish to be definitely instructed as to the conditions under which they may use preservatives and have a guarantee of security against being charged with adulteration under the food laws.

It is inconceivable that legislation in the matter of preservatives in foods should be absolutely prohibitive. Common salt, sugar, vinegar, wood smoke and many other antiseptic substances, whose use goes back further than the memory of man, would have to be excepted. It follows that any laws in this regard must be specifically permissive, *i.e.*, must name the substances which are permitted to be used, or must be specifically prohibitive ; whence, by inference, any article not named for prohibition will be regarded as available to the manufacturer until such time as its name is added to the schedule.

Some countries require that the fact of a preservative being used, and its name and amount shall appear on the label. This is good, so far as it goes, but it assumes an amount of knowledge and discrimination on the part of the purchaser which is unreasonable. At the same time I regard it as right and necessary that the presence of a preservative and its name should always be announced on the label, and this for two reasons. First, that the physician may be able to direct the regimen of his patient. Second, that the manufacturer who puts up his goods without a chemical preservative may get due credit.

The manufacturer is naturally desirous to secure cheapness and efficiency in the preservative he uses, and under the term efficiency, I include not only the possession of high antiseptic power, but such qualities as tastelessness, colour, harmlessness to health, &c. The experience of recent years shows that new substances, claiming to possess these characteristics, are being offered from time to time. Is the public to take the risk of testing the harmlessness of such new claimants for favour, or shall we make it illegal to use any new antiseptic until such time as we may feel justified in adding its name to a schedule of substances specifically permitted to be used ?

Manufacturers claim that such action would seriously handicap the search for desirable preservatives. The question is worthy of consideration. I must confess that my own opinion is favourable to the making everything of the nature of a food preservative illegal in use, unless specifically permitted. I am aware that under such conditions, many largely used preservatives, such as borax, boracic acid, benzoates, &c., would have stood a poor chance of demonstrating their efficiency and comparative harmlessness. But we are now in possession of a sufficiently large number of effective

antiseptics to enable us to delay additions to the list until we have had time to make a careful study of the properties of any new substance offered for trial. In other words, we cannot afford to risk a trial which shall involve possible injury to the public health.

I am, for this reason, in favour of *specific permission* in the legalization of preservatives. But this is not enough. The older preservatives, such as salt, vinegar, wood smoke and others, possess decided taste or smell, thus fixing safe limits so far as quantity is concerned, while their comparative inefficiency as antiseptics makes them practically harmless in excess. It is not so with modern antiseptics. These are for the most part devoid of taste and smell ; or if bitter (like sodium benzoate), or pungent (like formaldehyde) are so powerful in their germicidal properties that they are effective in quantities too small to be detected by taste or smell. It is quite easy to understand that either through want of knowledge or want of care, a manufacturer may add a harmful dosage of such a preservative, the consumer being unable to judge in the matter. The very potency of our modern preservatives, by virtue of which they can be employed in small amount, is a reason for carefully limiting the amount.

If the two principles which I have laid down be accepted, it remains to make out a schedule of preservatives which may be used in foods. Perhaps it might suffice to include, under a single heading, the *older preservatives*, although this would be open to some lack of definiteness. We might name, for example, as permissible, without percentage limitation—sugar, salt, vinegar, wood smoke, alcohol.

Saltpeter (nitrate of potash), although among the older preservatives, can scarcely be regarded as sufficiently harmless to permit of its employment without limitation, although its taste is so characteristic as practically to fix a limit. There remain to be considered a long series of substances, the most important being : Boracic acid and borax, sulphurous acid and sulphites, benzoic acid and benzoates, salicylic acid and salicylates, hydrofluoric acid and fluorides, silicofluorides, formaldehyde, saccharin, beta-naphthol (hydronaphthol), asaprol (abrastol), hydrogen peroxide, &c.

To whom shall we look for guidance in the matter of deciding what chemical preservatives, if any, may be safely employed and in what amounts ?

Chemists have done much to investigate the influence of these substances upon artificial digestion, and upon the properties of the food stuffs in which they are used. It must be noted, however, that digestion carried out in glass is not identical with the process as carried out in the living body.

Physiologists have accomplished much in the way of investigating the effect of preservatives upon the life processes of the lower animals. The results obtained by biological methods have doubtless great value, but the differences between man and the lower animals are so great as to make necessary very cautious interpretation.

I am convinced that it is to the physician we must look for the final word upon this question. For this reason I had pleasure in bringing the subject to the notice of the British Medical Association at its Toronto meeting in August last. Civic health officers in particular, have opportunity of forming valuable opinions on the subject, and, I believe that upon a matter of so great importance as this one, it would not be difficult to enlist the active sympathy and cordial assistance of every physician.

The notes which follow give a brief account of work done in this field, and it is hoped that their conciseness may make them the more readily acceptable to busy men. Readers desirous of possessing fuller information may refer to original memoirs as indicated.

Official analysts are not to be understood as having any other bias against new methods of preserving food than the general principle that every new thing must be required to show cause for its existence. So far as preserving foodstuffs in wholesome and palatable condition is concerned, we are ready to welcome every innovation which can be proved harmless to health, and effective in that which it proposes to accomplish. Certain methods of preserving foods have been recognized so long and employed so largely, that the safety of using them scarcely comes into question. Such are refrigeration, hermetical sealing *in vacuo* under proper conditions, the smoking of meat, the use of common salt, of vinegar, sugar, alcohol, and other substances. When a new

thing like borax or formaldehyde, or salicylic acid is offered to the public, we say : Demonstrate unequivocally the harmlessness of this article and we shall be glad to commend its use. We don't question its efficacy as an anti-ferment; that is easily demonstrable. But we know hundreds of chemical substances capable of preventing putrification, which we could not dream of recommending for use in foods. And there is such well recognized analogy between ferment action without the human body, and ferment or digestive action within the body, that we should be culpably derelict in duty if we did not insist upon proof of the harmlessness to health of anything which is recognized and recommended as capable of inhibiting putrifactive ferment action in food.

I find an inclination on the part of manufacturers and users of preservatives to throw the onus of proof of the harmfulness of these articles upon those who, by virtue of their official position, are compelled to question the safety of using them. The tremendous magnitude of the responsibility resting upon a public analyst is such that he is compelled to proceed deliberately and cautiously. In a very literal sense he is responsible for the physical health of the nation. His hesitancy to concede the safety of an innovation should not be interpreted as due to a desire to hamper great industries, or to put a brake on the wheels of progress. To be anything less than cautious and deliberate would be criminal.

The extensive use of chemical preservatives in perishable foods is one of the most noteworthy features of our time. That the use of antiseptics is very general, is proven by the result of our own experience, and by the various reports issued by the governments of civilized countries, which make official investigation of food and drink sold in the open market.

It is well known (see paragraph 75, Report of the British Food Commissioners, and elsewhere) that quantitative methods for the estimation of preservatives and colouring matters in foods, are far from being perfect. Work is being done in this laboratory, and in all national food laboratories, with a view to perfecting methods of research; and there is little doubt that methods commanding universal acceptance and recognition will soon be available. Meantime, our qualitative processes are above suspicion, and the presence of these antiseptics can be ascertained with absolute certainty in most cases. The following note shows that it is not only the peculiar nature of the food stuff, which may present difficulties to the analyst, but that manufacturers of preservatives seek, by making these as complex as possible, to hamper the search for them in food.

In November, 1898, (Analyst, 1898, 309—) A. C. Chapman, F.I.C., called the attention of the British Society of public analysts to the fact that very complex mixtures were sometimes put on the market as food preservatives. He had found one which contained sulphate of alumina, chloride of sodium, nitrate of sodium, sulphurous acid, chloral hydrate, benzoic acid and iodine, the last probably as hydriodic acid.

Dr. Rideal, in discussion, said that he had met with several such complex preservatives, which he asserted to be almost invariably of French origin, and probably intended to baffle analysts through the introduction of a large number of ingredients.

The extent to which chemical preservatives have come into use is illustrated in a forcible way by the report of A. E. Leach, of the State Board of Health, Massachusetts (Analyst, 1901, p. 289). During the summer months of 1898, 1899 and 1900, 5,169 samples of milk were examined for preservatives, and 179 samples, or 3·5 per cent of the whole number were found to contain such. Of this number 142 contained formaldehyde, and 30 contained boracic acid.

In the Report of the Conn. Agri. Expt. Stn., for 1899 (p. 139) after a summary of reasons for condemning the wide-spread use of chemical preservatives in food, occurs the following:—

The Station has secured a considerable number of the advertised preservatives, and these have been qualitatively and as far as possible quantitatively analyzed. Results of analysis are as follows:—

'Freezine'—B. Heller & Co., Chicago—A 5·19 per cent solution of formaldehyde.

'Iceline'—Heller Chemical Co., Chicago—is 1·92 per cent formaldehyde.

'Special M. Preservaline'—A solution of formaldehyde, 1·99 per cent.
'Reg Magnus, Snow Flake Brand'—Contains 78·15 per cent boric acid.
'Reg Magnus, Pearl Brand'—Contains 95·72 per cent boric acid.
'M. Preservaline'—Contains 97·81 per cent boric acid.
'B.B. Preservaline'—Contains 65·42 per cent boric acid.
'Preservaline Butter Powder'—Is merely bi-carbonate of soda.
'Cream Albuminoid'—Contains 50·4 per cent boric acid.
'Preservaline for Cider'—Is salicylic acid only.
'Blue Seal Preservative'—Contains 70·24 per cent salicylic acid.
'Forman's Cider Preservative'—An alcoholic solution of beta-naphthol.
'Preservite'—Contains 96 per cent benzoate of soda.
'Forman's Preservative for Wine'—Contains 36·13 per cent formaldehyde.
'Compressed Preserving Powder for Beer'—Contains 49·01 per cent of salicylic acid.
'Emken's Preserving Cakes'—Contained 22·09 per cent salicylic acid.
'A. Boake Roberts & Co's., K.M.S.'—Tablets containing 84·35 per cent bisulphite.
'K.M.S. Preserving Powders'—Contained 25·47 per cent bisulphite.
'Reg Magnus, Viandine Brand'—Contained 81·77 per cent boric acid.
'Sportsman's Rex'—Same composition as last.
'Ocean Wave Brand'—Contained 88·85 per cent boric acid.
'A' preservaline for sausages—Contained 68 per cent borax.
'Freeze-Em'—Contains 29·19 per cent sulphurous acid.
'Maas and Waldstein's Preserving Salts'—Six samples contained from 29·05 to 33·16 per cent boric acid.

Although sold under various trade names it will be noted that the active component in most of these articles is formaldehyde, boric acid, salicylic acid or sulphurous acid. The following list gives further illustration of an apparent desire to disguise the presence of the truly efficient chemical constituent of the preservative :—

J. Kochs.—(Apoth. Ztg.-1905-886 'Oetkers' salicylic acid for the household is a mixture of nearly equal parts of salicylic acid and sugar.

Hydrin.—Schlegel (Bericht der Untersuchungsanstalt Nürnberg, 1904, 45) shows that a preservative sold under this name consists of benzoic acid, milk sugar, common salt and sodium phosphate.

Kölner Pokelsalz.—According to Schaffer (Bericht des Kantons Chemikers Bern, 1901, 9) consists of 62·89 per cent chloride of sodium, with saltpeter, cane sugar and sodium benzoate.

Zeolith with 60·58 per cent common salt, contains fluoride, phosphate and acetate of sodium, and traces of sulphates, and sand and dust.

A preservative for dry milk consists of bicarbonate of soda and benzoic acid.

Macinato di Sansa, a preservative for cattle feed, consists of ground olive stones. Benzoate of sodium and impure saltpeter, were sold as preservatives for foods in Basel (1904).

Matthes and Müller (Zeit. fur Untersuch. Nahr. and Genussm., 1905-541), discuss a preparation sold as '*Seeths Neues Hacksaltz*,' and highly recommended by the German Butchers' Union. This article consists of sodium benzoate, 20 per cent, sodium phosphate, 75 per cent, and aluminium nitrate, 5 per cent.

Hoffmann R. (Apotheker Ztg., 1904, 78). '*Fruktol*' has been put upon the German market, with a certificate from Dr. Lebbin, attesting it to contain no preservative substances forbidden by law. Directions are given to add from 1 to 1½ per cent to fruit juices. Fruktol is a 12½ to 13 per cent solution of formic acid, with some sulphuric acid and organic matter, apparently sugar.

'*Werderol*' is a very similar preparation.

Hoffmann finds that 5cc. of official formic acid added to one kilog. of raspberry juice is an efficient preservative.

Baier.—(Bericht des Untersuchungs—Amtes der Landwirtschaftskammer fur die Provinz Brandenburg, 1903, 4), *Nadol* is a mixture of benzoic acid and sodium benzoate.

'*Carnit*' is an aluminium acetate solution containing sugar and saltpeter.

Matthes & Müller (Bericht des Nahrungsmittel—Untersuchungsamtes Jena, 1903-4—13). Found preservatives on sale having the following composition :—

Eminent.—Common salt 85, sugar 5, saltpeter 5, spices 5 (chiefly pepper).

Nova.—Commercially pure sodium acetate.

Zeolith.—Sodium fluoride 0·4, sodium phosphate 15, sodium chloride 51, sodium acetate 17, water 16·4 per cent.

Es ist Erreicht.—Saltpeter, common salt and phosphate of soda.

I Conservesalt.—Benzoate of soda, common salt and a little saltpeter.

II Conservesalt.—Sodium benzoate, phosphate, chloride and a trace of saltpeter.

Brilliant Conservesalt.—Sulphate of alumina, benzoate and phosphate of soda.

Spice Salt.—Sodium sulphite 6 per cent, and also saltpeter, common salt, paprika, pepper and carraway.

Cassalin.—Sugar, common salt, sulphate of alumina, sodium phosphate and benzoate.

Schwartz, F.—(Jahresbericht des Chemischen Untersuchungsamtes Hannover, 1902, 14)—Found preservatives of the following composition on the market:—

	Per cent.
No. 1.—Starch	0·62
Common salt	25·79
Boracic acid	30·48
Saltpeter	39·15
Water	3·96

	Grammes per liter.
No. 2.—Aluminium acetate	100
Saltpetre	15
Sugar	15

No. 3.—Consisted of two fluids and a mixture of salts.

	Grammes per liter.
I.—Aluminium acetate	100
Saltpeter	25
Sugar	15

II.—Dilute tincture of benzoin salt mixture. Common salt 2 parts ; cane sugar 1 part.

	Per cent.
No. 4.—Common salt	22·7
Saltpeter	75·7
Sugar	1·3
Water	0·1

Edward Polenske (Abstr. Ch. Centralb., 1904, I., 903) has investigated a number of preservatives placed on the German market since the edict of Feb., 1902. The following list is interesting:—

1. *Hackfleishpulver Victoriaröte* I: red pepper, &c.
2. *Secura:* aluminium acetate, basic salts and sugar.
3. *Viandol:* acetic acid, alumina, sugar, nitre.
4. *Carnecons:* acetate of alumina, sugar, saltpeter.
5. *Barmenitpökel:* nitre, common salt, sugar, gypsum.
6. *Wittenberger Pökelsalz:* spices, common salt and nitre.
7. *Einfaches Konservierungssalz:* benzoic acid, common salt, nitre, sugar.
8. *Cervelatwurstsalz:* spices, common salt, nitre, sugar.
9. *Carniform* A: phosphate of soda, common salt and nitre.
10. *Carniform* B: phosphate of soda, nitre, phosphate of lime.
11. *Carnokonservensalz:* sodium acetate, common salt.
12. *Rubrolindauerwurstsalz :* chloride of ammonium and nitre.

13. *Michels Cassalasalz:* common salt, sodium phosphate, potassium and sodium tartrate, acetate of alumina, sugar and benzoic acid.

14. *Servator*—special milk and butter preservative. Crystallized benzoic acid, boracic acid and common salt.

The most largely used preservatives are probably salicylic acid and boracic acid; but new substances are being added to this list from time to time. Thus sulphurous acid and sulphites, benzoic acid, fluoride of sodium and many other articles of an antiseptic character are quite frequently reported, and according to A. H. Allen (Analyst, 1902, 178)—the use of silico-fluoride of sodium as a preservative is patented in England, and the compound is manufactured to a considerable extent at Warrington.

The reckless manner in which patentees and manufacturers of preservatives advertise and recommend their goods, is a source of danger to the public health, which demands attention.

The following extract is from the report of the Massachusetts State Board of Health, 1899—p. 614:—

'The manufacturer of a largely used preservative, known as 'Freezine' (which is a weak solution of formaldehyde) issues an attractive pamphlet in which he makes the following remarkable claims. "It is not an adulterant.—It immediately evaporates, so that no trace of it can be found, as soon as it has rendered all the bacteria inert. No chemical analysis can prove its presence in the milk quantitatively or otherwise." Its use in milk is also claimed by the manufacturer to be beneficial to the health of infants, many of whom have been saved from sickness and even death, he alleges, by a liberal use of 'Freezine' in the milk.'

Not only do manufacturers acclaim the safety and benefit resulting from use of their products, but they obtain and publish what purports to be expert evidence in substantiation of their statements. Thus, in 1899, the Preservaline Company of Chicago, New York and San Francisco, issued a pamphlet giving an account of physiological tests made by Doctors Frœhling, Kuhn and Mœchel in Kansas City. These tests were held to prove that milk preserved with 'Preservaline' (=solution of formaldehyde) was as nourishing as ordinary milk. Another pamphlet, continuing these tests, was issued in 1901—i.e. one year after the English Parliamentary Committee had recommended 'that the use of the formaldehyde, or preparations thereof, in foods or drinks, be absolutely prohibited'—and, Dr. Frœhling, after describing the non-interference of preservaline, with amylolytic and proteolytic digestion, concludes as follows: 'I must say that in all our experiments, we have never found any detrimental effects on the body from the use of preservaline, as prescribed by the company.'

The same company distributes an undated pamphlet by Dr. Randall, health officer of Augusta, Maine, extolling the beneficial effects derived from the use of preservaline (formaldehyde) in the city milk supplies. The doctor uses the following arguments in an appeal along chemical lines:—'It is made from sugar by peculiar methods of distillation and redistillation....Stopping the development of bacteria by an agent as harmless as sugar, is a step in the direction of pure food,' and further:—'The conclusion which has been reached, after a most careful microsopical examination of milk, and a chemical examination of the preservative used, is that it is not harmful but beneficial to the public health.'

National attention in England was drawn to the matter of preservatives in 1897 by the *Lancet*, which issued a circular letter to certain very eminent physicians for the purpose of securing expert opinion on the whole subject.

This circular proposed the following questions:—

1. Is the presence of small quantities of salicylic, boric or benzoic acids or formaline in food, in sufficient quantities to preserve it, injurious to health?
2. Should the use of antiseptics for this purpose be forbidden by law altogether?
3. Should legislation be brought to bear on the restriction of the amount?
4. Should the law insist that when preservatives are used the fact should be stated on the label?

Sir Henry Thompson wrote that 'he had long held that the addition of antiseptics was undesirable, though unable to produce evidence that any one of them had given rise to deleterious action owing to the impossibility of isolating the precise influence of the drug. He objects strongly to the dietetic use of drugs, and is of opinion that the name and quantity of the antiseptic employed should be on the label, or on a paper setting forth the maker's or vendor's name.'

Dr. Pavy wrote that 'he did not consider our knowledge sufficiently extended to permit of its being taken for granted that no injury is producible, though there is no evidence of injury to health. He points out that it is the vendor, and not the consumer, that is benefited. He considers that, notification of the fact of antiseptics being employed, and their nature and amount would be sufficient, any deviation from the notification should be liable to prosecution. With the public interest thus safeguarded, he thinks that advantage might be taken of the power of antiseptics in preserving articles of food.'

Dr. F. J. Allan points out the possibility of daily accumulation of antiseptics quite sufficient to produce a gradual lowering of the standard of health, and is of opinion that the fact of an antiseptic being added, and its nature, should be required by law to be announced at the time of sale.

Dr. Sims Woodhead draws attention to idiosyncracy and cumulative effect, and dwells upon our ignorance of the action of certain drugs (*e.g.*, formalin) on food stuffs. He points out that by the use of preservatives foods of inferior quality may be doctored. He would make use of antiseptics illegal unless their nature and quantity be made known.

The late Sir B. W. Richardson considered that antiseptics are not only necessary at this moment, but when used in proper form and quantity cause no injury whatever. There ought to be a license given permitting a certain, fixed, and not a dangerous quantity of antiseptic, and it ought to be stated on the label what the antiseptic is and its quantity.

Dr. T. Lauder Brunton writes that 'one must remember that poisons are formed in foods by spontaneous decomposition, which may take place after purchase. The question to be decided comes to be whether antiseptics are likely to be more injurious to health than the natural products of decomposition. His own belief is that preservatives are the less injurious. His answers are: (1) The use of antiseptics should not be forbidden by law. (2) It is doubtful whether legislation should restrict the amount, as the makers will probably use the minimum amount found sufficient. (3) The fact of preservatives being used, and their amount, should be stated on the label.'

Sir W. Roberts says that 'there is no reliable information available, and an inquiry is needed.'

Dr. W. D. Halliburton is not able to give information as to injurious effects from his experience, but quotes F. J. Allen as mentioning cases of ill-health in children due to boric acid.

Dr. J. R. Bradbury thinks that 'it is not necessary to forbid antiseptics, but that the amount should either be restricted, or the fact of their addition stated on the label.'

Dr. Whitelegge cannot speak positively, though it is clear to him that the law should insist upon a plain statement on the label if any preservative be added.

I am tempted to make one remark in connection with the report of Dr. Brunton. The claim that antiseptics should be used in perishable foods because they are less injurious to health than the poisonous products of the spontaneous decomposition of these foods, seems to me quite untenable. The decomposition of food should be a fact of exceptional occurrence, and such food should be rejected altogether; whereas the systematic addition of an antiseptic to food, in order to prevent decomposition, would result in the habitual dietetic use of a powerful drug.

Recognizing the national importance of the problem, a departmental committee was appointed in July, 1899, to report to the British Parliament upon the following subjects:—

1. Whether the use of such materials (preservatives and colouring matters) or any of them, for the preservation and colouring of food, in certain quantities, is injurious to health, and if so, in what proportions does their use become injurious.

2. To what extent, and in what amounts, are they so used at the present time.

The committee consisted of the Right Honourable Sir H. E. Maxwell, Bart., M.P.; Professor T. E. Thorpe, C.B., D.Sc., F.R.S.; Dr. T. H. Bulstrode and Dr. F. W. Tunnicliffe.

The committee reported to parliament in the following year; and as the evidence taken represents the knowledge of the scientific world upon the subject of preservatives, up to the year 1900, it may be well to make some extracts from the reports as presented. This report together with the minutes of evidence and appendix, forms a closely printed volume of 497 folio pages. 'From the evidence brought before the committee it would appear that, at the present time, the only artificial or chemical antiseptic agents other than oils, spirits of wine, vinegar, salt, sugar, &c., employed, or said to be employed, in the preservation of food are:—

Boric or boracic acid and borates; so-called 'boron preservatives.'
Sulphurous acid and sulphites.
Fluorides.
Salicylic acid.
Benzoic acid or benzoates.
Formalin or formaldehyde.

'As regards fluorides, benzoic acid and the benzoates, it may be said at once that, if employed at all, their use must be extremely limited. Mr. Leonard Boseley, analyst to Messrs. Keiller and Son, Limited, stated that he believed that a firm in London were trying to get benzoate of soda taken up as a preservative for jams.

'The boron preservatives are generally sold in the form of a white powder (sometimes, however, coloured with a coal tar dye) under a great variety of fanciful names, which as a rule afford no clue to their real nature. They are used largely for dairy produce, for margarine, ham, bacon, sausages and preserved meat foods generally, and to a much smaller extent in beverages.

'Salicylic acid comes next in the extent to which it is used. It is employed chiefly in beverages and in foods derived from fruit.

'Formalin, which is of comparatively recent introduction consists of a 40 per cent solution of formaldehyde in water. The solution is diluted to various strengths, and sold as a preservative for milk chiefly, and to a less extent for other foods.

'Sulphites are used for very much the same purposes as salicylic acid, especially by brewers. They are also employed by butchers, and to a less extent by game and poultry dealers.

'As the result of an inquiry among a large number of farmers and dairymen, 110 replies were received, and 65 of these admitted the use of preservatives.

'Of 4,251 food samples examined for the committee in the government laboratory, 1,659 samples (=39 per cent) were found to contain preservatives, as follows:—

Boric acid	1,247 samples.
Salicylic acid	320 "
Formalin	50 "
Sulphites	143 "

(71 samples were found to contain two preservatives of different kinds.)—

Of 290 samples of cream		77·9 per cent	contained	preservatives.
" 364	" butter	57·1	"	"
" 210	" bacon	70·5	"	"
" 185	" ham	82·7	"	"
" 226	" sausages	66·4	"	"
" 48 pork pies		70·8	"	"
" 150 samples jam		44·0	"	"
" 78 "	lime and lemon juice	88·5	"	"
" 769 "	temperance drinks	26·1	"	"
" 100 "	imported beers	39·0	"	"

'A comparison of the percentages of preservatised foods in the poorer districts and the wealthier districts of London, respectively, shows that they are practically identical, being 42·9 per cent in the former and 43·4 per cent in the latter.

'Preservatives are extensively used in certain foods imported into the United Kingdom from the colonies and foreign countries, especially in butter from Australia, in ham and bacon from Canada, and in butter and margarine from France, Holland and Belgium.

'Of the temperance beverages received from all parts of the United Kingdom, 83·5 per cent of those sold as temperance 'wines' and cordials, contained preservatives, chiefly salicylic acid, and to a less extent sulphites.

'With regard to the amount of the several preservatives, it appears that the boracic acid in the milks varied from 1·3 to 9·1 grains per pint; in cream from 10 to 57 grains per pint; in sausages, potted meats and brawn, from 15 to 66 grains per pound; in butter from 18 to 65 grains per pound; in bacon from 8·6 to 46 grains per pound. The amount of salicylic acid in jams varied from 1·7 to 8·5 grains per pound; in temperance drinks and cordials from 1·5 to 19 grains per pint; in herb beers and similar beverages from 0·5 to 8·1 grains per pint; and in imported beers from 1·3 to 3·4 grains per pint. Sulphites were found to be contained in lime juice, ginger wine, lemon syrup, raspberry and peppermint cordial in amount (estimated as sulphur dioxide) varying from 0·1 grain to 4·5 grains per pint.

'Mr. Vasey, who has been employed for upwards of ten years to examine foods and beverages on behalf of the *Lancet*, stated that he had found boric acid in meat peptone and beef jelly intended for invalid use, and that practically all the samples of invalid foods which he had occasion to analyze contained chemical preservatives.

'Dr. Vœlcker testified from personal observation, to the casual and haphazard manner in which both farmers and vendors add preservatives to milk.'

The report continued as follows:—

'Convinced as we are of the very general and increasing use of chemical preservatives by traders in the more perishable articles of food, we desire now to focus the evidence which has been placed before the committee, as to whether such preservatives may be expected to be attended with any risk to the public health.

'The evidence given before the committee bearing on this question may be classified as that of:

A. The public analyst.
B. The medical officer of health.
C. The physician and surgeon.
D. The physiologist and pharmacologist.

A.—THE EVIDENCE OF THE PUBLIC ANALYST.

1. Prosecutions have exercised an inhibiting effect upon the use of preservatives.

2. Maximum amounts found must be regarded as exceptional and unnecessary, yet there is no guarantee that such excessive amounts may not continue to be used.

3. With regard to the precision with which limits could be determined, there was some difference of opinion; and as regards formalin, the evidence was unanimous that the estimation of such minute quantities as may be present in foods, is attended with great difficulty.

4. As to colouring matters the general testimony was to the effect that the nature and amounts of the substances in general use at the present time is such that but little danger is likely to accrue to the public health therefrom.

B.—THE EVIDENCE OF THE MEDICAL OFFICER OF HEALTH.

1. The medical officers of health were practically unanimous in their opinion that all preservatives should be prohibited in milk.

2. They saw danger in the unknown administration of drugs in morbid conditions of the body; and pointed out that such drugs are used at times, in amounts far in excess of those sanctioned by the B. P.

3. When more attention is paid by medical men to the use of preservatives, obscure conditions, such as indigestion, malaise, faintness, &c., which at present receive no adequate explanation, may be made clear.

C.—THE EVIDENCE OF THE PHYSICIAN AND SURGEON.

1. Was not very conclusive, and it is evident that the question of food preservatives had not, at the time of inquiry, received special consideration by the medical profession.

2. Dr. Anderson had found that daily doses of 10 to 20 grains of boracic acid is generally followed by dyspepsia 'sufficiently pronounced to make life miserable while it lasts, and at times it causes distinct gastritis, with repeated vomiting.'

Sir Lauder Brunton considered that boracic acid was capable of exercising an injurious effect upon pregnant women.

3. On the other hand, an assistant physician at the London hospital described extended experiments as to the effects of borax and boracic acid upon himself, which resulted in 'no sort of stomach irritation or intestinal irritation or trouble, or anything of that sort at all.'

The consulting surgeon to Westminster hospital had administered borax to hundreds of patients in doses of 10 grains, 3 times a day, and up to 40 grains a day, and never found any evil or unpleasant effects, except in those patients who having kidney disease could not void the drug readily.

4. In so far, however, as expression of opinion went, the profession was almost unanimous in its condemnation of the present unrestricted use of preservatives. The medical profession was clearly impressed with the importance of at least intimating by a system of labelling, the nature, and when practicable, the amount of the preservative used. In the opinion of Sir Lauder Brunton and other witnesses, it is a serious matter that a medical man should prescribe a daily dose of any drug to a patient who may, unknown to himself and the physician, be consuming an indefinite quantity of the same drug in his food. He also pointed out that by the indiscriminate employment of drugs there was a possible danger that the action of certain drugs might be, if not entirely nullified, at least reduced in effect.

5. There was, however, another aspect of the question to which certain witnesses referred. They were of opinion that there are certain conditions of the human economy in which the administration of drugs, such as boracic acid and salicylic acid, are held to be contra-indicated. Among such conditions, specific reference was made to inflammatory states of the digestive tract, and of the reproductive organs.

D.—EVIDENCE OF THE PHYSIOLOGIST AND THE PHARMACOLOGIST.

1. All these witnesses strongly deprecated the unregulated use of preservatives, at least those at present known, and of any colouring matter having a possible deleterious effect upon the human system; and were generally agreed that formic aldehyde was a dangerous substance, even in very dilute solution.

2. An opinion inimical to the use of preservatives was also held by some of these witnesses on the ground that these substances were added to food for the purpose of destroying or preventing the development therein of living organisms, and hence that these same substances when introduced into the highly organized animal, could not behave indifferently to living matter, but must also tend to exert upon it some influence. Especially, they maintained, was this the case since the secretion of the digestive juices was dependent upon the activity of cells not differing sufficiently from micro-organisms to render it probable that substances affecting deleteriously the one would be indifferent to the other.

3. Other objections offered by the physiologists applied especially to one preservative, viz., formalin, and were based upon the fact that this substance actually enters into combination with the proteid constituents of the food, the compound formed being less digestible than the original substance, thereby entailing a nutritive loss to the consumer.

4. Other witnesses testified to the value of chemical preservatives in protecting consumers from the evils of tainted or decomposing food. One witness said that in his opinion the use of preservatives, even in milk, under certain conditions, was in the public interest.

5. Dr. Attfield found, from experiments upon himself, that pharmacopœial doses of boric acid taken with his meals, had no appreciable action upon the digestion of his food. He found also that salicylic acid did not interfere with digestion.

6. Experiments on digestion in glass vessels were concerned with formic aldehyde, borax and boracic acid. Speaking generally, the results of these experiments may be regarded as showing that each of these substances had a retarding effect upon certain digestions; this amounting in the case of strong solutions of formaldehyde, to marked inhibition.

7. Experiments on animals (kittens) gave contradictory results.

8. The evidence was contradictory as to the harmfulness of copper 'greening' in peas and other vegetables.

The general conclusions of the committee are contained in the paragraphs numbered 103 to 135 of the Report to Parliament, and are exceedingly interesting and important.

Upon these conclusions are based the following recommendations:—

RECOMMENDATIONS.

(*a.*) That the use of formaldehyde or formalin, or preparations thereof, in foods or drinks, be absolutely prohibited, and that salicylic acid be not used in a greater proportion than 1 grain per pint in liquid food, and 1 grain per pound in solid food. Its presence in all cases to be declared.

(*b.*) That the use of any preservative or colouring matter whatever in milk offered for sale in the United Kingdom be constituted an offence under the Sale of Food and Drugs Acts.

(*c.*) That the only preservative which it shall be lawful to use in cream be boric acid, or mixtures of boric acid and borax, and in amount not exceeding 0·25 per cent expressed as boric acid. The amount of such preservative to be notified by a label upon the vessel.

(*d.*) That the only preservative permitted to be used in butter and margarine be boric acid or mixtures of boric acid and borax, to be used in proportions not exceeding 0·5 per cent, expressed as boric acid.

(*e.*) That in the case of all dietetic preparations intended for the use of invalids or infants, chemical preservatives of all kinds be prohibited.

(*f.*) That the use of copper salts in the so-called 'greening' of preserved fruits be prohibited.

(*g.*) That means be provided either by the establishment of a separate court of reference or by the imposition of more direct obligation on the local government board to exercise supervision over the use of preservatives and colouring matter in foods, and to prepare schedules of such as may be considered inimical to the public health.

Dr. Tunnicliffe, while agreeing on all other points, took exception to the prohibition of the use of copper in colouring vegetables, holding that in a proportion not exceeding half a grain of metallic copper per pound the presence of copper is quite harmless.

The evidence heard before this committee was concluded May 14, 1900, and it may be safely regarded as a full statement of the case to that date.

In the abstracts which follow I have sought to give an account of work done upon this subject since the date mentioned, and, in a few cases, to do this for important work which was not brought to the notice of the committee.

The antiseptic property of boric acid was noted by Jacquez in 1856, and he employed it in preserving the bodies of rabbits by immersion in a 5 per cent solution. Its use as a food preservative did not become general until about 1880, since which time it has steadily increased.

From 'A Second Treatise on the Effects of Borax and Boracic Acid on the Human System,' by Dr. O. Liebreich (published by T. & A. Churchill, London, in 1902) we learn: (1) The first boron preservative for meat and milk in Germany was the so-called 'Aseptine,' 1870. There are now (1902) a large number of boron preservatives on the German market. (2) Boron preservatives were known in Belgium as early as 1867, and a 'Milk Extract,' containing borax, existed as early as 1861. (3) Hager even asserts that the preservative quality of borax for milk is 'an old and well-known fact.'

The great international discussion which has arisen over the use of boric acid and its salts as preservatives for food seems to have been inaugurated by a treatise written by Dr. Oscar Liebreich, of Berlin University, and first privately printed in 1899. A translation of this paper has been published in England by Messrs. Churchill, under the title, 'Effects of Borax and Boracic Acid.' Dr. Liebreich holds that borax and boracic acid, as used for preserving foodstuffs, and especially meat foods, are practically harmless.

In a later publication ('Second Treatise on the Effects of Borax and Boric Acid on the Human System,' 1902: J. & A. Churchill, London), Dr. Liebreich hints at the conditions under which he was led to make a special study of borax. 'My first investigation into the use of borax and boracic acid as a food preservative was made at the instigation of Professor Virchow. The question arose whether fish caught in deep-sea fishing and preserved with borax and boric acid was injurious to health. I was able without the further proofs being published—since the innocuousness of the substance was already generally known at that time—to give my opinion that the fish might be eaten without hesitation, and this was acted on very freely during eight to fourteen days.'

The opinion seems to have been given off-hand, in Dr. Liebreich's capacity as *Medizinalrat*, and to have been based upon then known physiological properties of borax and boric acid. Dr. Liebreich adds: 'Subsequently representatives of the chemical industry desired me to express an opinion. I undertook to comply with this request, since the question was also of extensive scientific interest, on condition that any unfavourable data which might be contained in my report should be published equally with the favourable results. I may further remark that the chemical industry did not require an expert's opinion with the object of trying, under any circumstances, to maintain the right of refining borax for food preservative purposes, but in order to decide whether the manufacture and sale of boron compounds might be continued without injury to the consumers.'

This very candid and satisfying explanation of the conditions under which Dr. Liebreich took up the study of borax and pursued such study, I have thought right to quote in his own words, because his conclusions form by much the most important element in justification of the world-wide use of boron compounds in food; and, further, because Dr. Liebreich's work is the first important contribution to the scientific study of boron compounds as preservatives, but must not be understood as a final deliverance on the subject. The matter was first brought to Dr. Liebreich's notice professionally; and his professional utterance as to the harmlessness of borax in curing fish, led to his being retained by the 'chemical industry.' For this industry he carried out elaborate and painstaking investigation, which appears to have partaken of combined professional and scientific characters. The professor did not hold a brief for his clients, but insisted that unfavourable data found by him should be published equally with favourable data.

In the second treatise, a pamphlet of 87 pages, Dr. Liebreich first occupies himself with criticising certain statements of Dr. Robinson, made in 'Public Health,' August, 1899, and ascribing to boric acid the illness of five people who had eaten 'blanc-

mange,' made with borated milk. Five out of nine fowls fed with the same 'blanc-mange' died. Dr. Kister (Zeits. für Hygiène u. Infektions-Krankheiten, 1901—229) repeated borax experiments on fowls; and although he concludes that Dr. Robinson was too hasty in ascribing the illness to borax, he adds: 'After the result of the experiments, I cannot but be of the opinion that boric acid, even when not taken in immoderately large doses, may have an injurious effect on healthy adults when continually used. I am justified in this conclusion by the discovery of albumen in the urine of two healthy persons after they had taken boracic acid several times.'

After some criticism of Dr. Kister's work and report, and very full description of work carried out by himself on rabbits, Dr. Liebreich concludes: 'From these experiments on animals may be deduced that borax is entirely innocuous as regards the functions of the kidneys.' He further administered borax to patients, and says: 'The above named investigations offer a further proof that borax and boric acid are substances which cause no injury to health when judiciously used.'

Meantime (February 18, 1902) boric acid and its salts were added to the list of articles forbidden to be used in foods under the German law of June, 1900. In an appendix to the second treatise, Dr. Liebreich criticises the technical argument which was held to justify the proscription of boric acid and its salts. The character of the argument in question may be gathered from the following excerpts, which are taken from the Zeit. fur Untersuch der. Nahr., and Genussmittel, 1902, 678-682 (through 'Analyst,' 1902, 271).

E. Rost 'As the antiseptic action of boric acid is small, comparatively large quantities are necessary to preserve articles of food, and it is quite possible for a person to take as much as 3 grammes daily in his ordinary food. Meats, sausages, milk, butter, margarine, white and yolk of egg, fish, caviare, shellfish, &c., are frequently preserved by the action of boric acid. The author found 3·87 per cent in dry salt meat and 2·8 per cent in shrimps. Boron compounds are stated to have no specific action on the enzymes of the stomach and intestines, except as regards their acid or alkaline properties. Borax retards to a small extent the coagulation of milk by rennet; the addition of borax to milk, especially when the latter is intended for infant's food, is therefore injurious. Large doses were found to cause local irritation and inflammation in dogs, cats and rabbits, and also affected the action of the bowels. In two experiments on men it was found that doses of 1, 2 and 3 grammes of boric acid retarded the assimilation of albuminoids, the nitrogen contents of their urine being determined hourly before and after taking the boric acid. By taking the temperature of various dogs fed on borated meat, it was demonstrated that assimilation of the food was delayed. Experiments on other dogs showed that only large doses caused a loss of corpuscular albuminoids. It may be here mentioned that no essential difference was noticed between the action of boric acid and borax. A striking loss of weight in the animals was noticed. As this was not due to destruction of albumen or loss of water, it must be put down to oxidation of fat. Apparent increase in the digestion of albumen, shown when very large doses of borax were given, was due to the 'salt' action of the borax, similar results being exhibited by large doses of common salt and potassium nitrate. A large consumption of water prevented these effects.

'Assimilation experiments in the presence of boric acid were carried out on four assistants. During a preliminary period of 5 to 17 days the men were brought into a state of 'nitrogen equilibrium' followed by administration of boric acid (3 grammes per diem) for 12 days. Two of the men then, for a time received no boric acid, and afterwards underwent a second treatment. Finally, some days were devoted to studying the after symptoms of the experiments. Two of the men showed a loss of weight due to loss of fat. The final observations also showed less secretion of urine and absorption of food materials. The two other assistants also showed a loss of weight. These two latter were also chosen for Rubner's experiments (see below) in which the amounts of expired carbon dioxide and water were determined. One of them diminished so suddenly in weight after taking 3 grammes of boric acid daily, that the experiment had to be discontinued. The weight of the other also decreased, but increased when the boric acid was discontinued, and fell again when the latter was readministered. It was not

demonstrated by the above experiments that boric acid affected the appetite. No influence upon health and appetite were noticeable. Boric acid was not found by the author to influence the temperature, blood pressure or kidneys. As the elimination of boric acid by the urine takes from 8 to 14 days, its action is probably cumulative. The author comes to the conclusion that the use of boron compounds in food should be forbidden.'

RUBNER.—According to the author, who comes to the conclusion after numerous experiments, boric acid has an important latent action on the digestive process. Not only the digestive organs themselves, but the whole alimentation is affected. The change produced, which may amount to a loss of 22 per cent of energy and 30 per cent of the utilization of nitrogen free food, is a very important fact, and undoubtedly means injury to health, as the amount of fat in the body may be of the greatest importance, and the reduction of the fat must be followed by a rapid fall in albuminoids. Serious results may follow in infant feeding, to invalids, old people or convalescents by borated foods.

R. O. NEUMANN.—The experiments carried out by the writer on himself consisted of a preliminary period of 4 days, during which various observations were taken; then 19 days with daily doses of 3 grammes of borax, followed by 4 days without borax, and concluding with daily doses of 5 grammes of borax for 3 days. During the first period nitrogen equilibrium existed; the secretion of nitrogen decreased during the first borax treatment, also in the intermediate 4 days, but was not further diminished by the larger doses of borax. His weight fell 1,200 grammes in seven days of the borax period. The flow of urine was somewhat increased, and boric acid could be detected for 18 days after the last dose of borax had been taken.

A. HEFFTER made four series of experiments on himself, alternately fasting for 18 to 20 hours, and then feeding on milk and eggs for 48 hours. In two of the series he used food without borax, in the other two he used 1 and 4 grammes borax daily. The boric acid was found to increase the solids and nitrogen in the excreta, probably due to the diminished absorption of albuminoids as a result of the injurious effect of the boric acid on the mucous membrane of the intestines. The conclusion is that boric acid is not without objection when used as a preservative.

G. SONTAG found by experiment that 3-gramme doses of boric acid required 5, 8 and 9 days, respectively, for elimination by the urine, in the cases of three healthy individuals.

E. POLENSKE showed experimentally that fresh and smoked hams, when packed in borax, dry, for periods of three and four weeks, absorbed into the interior of the ham quantities of borax varying from 0·076 to 4·05 per cent.

Dr. LIEBREICH criticises with something of the attitude of special pleading, most of the evidence brought forward by the scientific men above quoted, and, although Dr. Rost says: 'A deceasing effect on the assimilation of albuminous food in the intestine is peculiar to boron compounds, showing itself with even small quantities (0·5 grammes)' Dr. Liebreich concludes: 'Every day of the diet without boric acid, the conditions of absorption in the intestine became worse, in consequence of unsuitable food, and according to these (Dr. Rost's) experiments, boric acid produces a favourable effect on the absorbing capacity of the intestine.' I don't know of a better example of the proverbial disagreement of doctors than this. Again, in contradiction to a statement by Dr. Rosé—that borax caused inflammation of the mucous membrane—Dr. Liebreich asserts: 'Boron preparation are not only comparatively but *absolutely* harmless to the mucous membrane.'

A critical essay on the subject of 'The Preservation and Colouring of Meat Produce,' was published in Berlin, 1901, by Dr. George Lebbin, chemist to the Royal Prussian Ministry of War, and contains an introductory preface by Dr. Liebreich. This essay contains nothing original and may be fairly described as a setting forth of the subject matter in the interest of the trade. That the trade recognizes this fact is shown by the republication of portions of Dr. Lebbin's essay in the form of a fly-leaf, in translation from 'Die Medicinische Woche,' of September 23, 1901. In the course of his paper Dr. Lebbin states, 'Although I consider that the above experi-

ments (Pfeiffer's) have already settled the question in favour of the meat dealers, I have, nevertheless, begun experiments which are being carried out with meat prepared in the usual way and with the normal doses. For this purpose I have secured the co-operation of a medical man as well as of an official meat expert.' I have not, up to this time, obtained any account of the experiments referred to.

A very full account of Dr. Liebreich's work has been written for 'American Medicine,' March 15, 1902, by Drs. Vaughan and Veenboer of the University of Michigan ; these authors refer to other authorities favourable to the use of boron compounds. This paper has been reprinted and widely distributed in the interest of the trade.

H. LEFFMAN (Journ. Franklin Institute, 1899-97. Through 'The Analyst,' 1899, 102.

From the results of a large number of experiments on the artificial digestion of arrowroot starch, the author concludes that 'beta-naphthol is injurious to malt-diastase, but does not seriously affect the starch-converting capacity of taka-diastase or pancreatic extract. Boric acid, borax and boroglyceride, infere but little with either starch or proteid digestion. Salicylic acid interferes with the action of most of the enzymes, especially those that convert starch, but does not seriously affect proteid digestion. Sodium benzoate has no appreciably injurious influence on any of the enzymes. Sodium fluoride interferes but little with the digestion of starch, but sodium silico-fluoride has a considerable influence on pancreatic extract.

In his opinion, if the use of any preservative is to be permitted in food, boric acid and sodium benzoate are the least objectionable since they appear to have less tendency to disturb the digestive functions than the other preservatives commonly employed.

The following medical testimony regarding the use of milk containing preservatives was given in a case brought before the English courts, and is reported from the British Food Journal, 1901, p. 110.

Dr. CHARLES JACKSON, medical officer of health for Fulham, 'had seen cases where children using milk containing boracic acid, exhibited serious digestive disturbances.'

Dr. L. B. DIPLOCK said, 'four years ago he attended a large number of children suffering from marasmus, and on testing the milk with which they were fed, he found in each case that it contained boracic acid. Upon the infants being fed on pure milk direct from the cow, they recovered without the aid of any medicine, yet before he discovered the cause of the symptoms several of the infants died.'

A collection of medical and scientific data favourable to the use of boron preservatives is published by Perkins, Bacon & Co., London. It is undated, and without any signed editorial introduction. It seems reasonable to infer that this pamphlet is issued by persons interested in the use of borax and boracic acid. It includes statements by Dr. Redwood, Dr. Chittenden, de Cyon, Bussy, Gavarret, Wurtz, Dr. Bell and others.

By far the most important contribution to the subject of boron preservatives which has been made since 1902, is Dr. W. H. Wiley's account of actual feeding experiments, carried out under strict scientific supervision at Washington in 1902 and 1903. The detailed account of this investigation is contained in Bull. 84, part 1 of the Bureau of Chemistry. It forms a volume of 477 pages, and bears evidence throughout of the extreme care with which the research was prosecuted. At the time of its inauguration, my friend, Dr. W. D. Bigelow wrote me as follows :—

'The experiment is being undertaken very seriously and on a somewhat extensive scale. In fact, we consider it the most important inquiry we shall have on hand this year. About a dozen men, almost all from the Department of Agriculture, have volunteered, and will be divided into two equal lots, one of which will eat preserved food, while the other will receive only food that is known to be pure. The conditions will be controlled as carefully as possible, and the presence of nitrogen, phosphoric acid, and energy expressed as heat of combustion, will be determined. The preservative used will be determined in the food, as well as in the excrement and urine, and careful observations will be made daily regarding the physical conditions of the men. A 'clinical

sheet' will be kept for each man. The work will be very similar to that recently conducted by the Imperial Health Office at Berlin, but will be more extensive, and will also differ from it in the fact that we shall employ largely young men of scientific training instead of labourers. We are just entering upon this work now. The first table will be started the beginning of next week, and the analytical work will begin early in December.'

The investigation, as reported in June, 1904, dealt solely with boron preservatives. It would be futile to attempt any extended sketch of the methods and progress of the experiment. The following sentences sum up Dr. Wiley's conclusions:—'On the whole, the results show that one-half gram per day is too much for the normal man to receive regularly. On the other hand, it is evident that the normal man can receive one-half gram per day of boric acid, or of borax expressed in terms of boric acid, for a limited period of time, without much danger of impairment of health. * * * 'It appears, therefore, that both boric acid and borax, when continuously administered in small doses for a long period, or when given in large quantities for a short period, create disturbances of appetite, of digestion and of health.'

Critical notices of Dr. Wiley's work will be found in the Chemiker Zeitung, 1905—194 (Bericht über die Wileysche Arbeit, A. Kraus); and 1906, 10 Jan.—(Versuche über den Einflurs von Borsäure und Borax auf den Menschlichen Organismne,—Dr. L. Spiegel).

Leo. Goldsmith (thesis for B. Sc. degree. Abstract of Prof. Mayberry in Jour. Am. Ch. Soc., 1897, p. 889) made several series of experiments on the digestion of blood fibrin in presence of alum, boric acid and formalin. The results are summarized as follows:—'While all the substances tested show some influence on the digestive action of pepsin, only alum exhibits a marked effect.'

Ch. Harrington (Am. Jour. of the Medical Sciences, Sept., 1904—Through Zeit. f. Untersuch der Nahr und Genussmittel—1905.) Seven cats were fed, from 442 to 133 days, with similar food, containing doses of 0·544 to 0·857 gms. borax. One cat died. In all the kidneys were affected, least so in the animal which got least borax. Deterioration of the epithelial lining of the tubuli uriniferi and increase of fat (fatty degeneration) were observed. Some of the tubuli were filled with epithelial cylinders.

Bassenge (Zeit. Exper. Pathol. und Therap. 1905, 113) found that 2 per cent of boracic acid did not hinder the development of pathogenic bacteria in flesh.

Rost, B. (Arch, internat. Pharmacodyn, Therap., 1905, 291), concludes a very exhaustive series of experiments regarding the excretion of boric acid in the words:—'Practically the whole of the injested boric acid is eliminated by the kidneys.'

Liebreich (Therap. Monatsh, 1904-416) finds that a certain amount of boric acid is got rid of through the skin, and quotes Wiley to the same effect.

There is, however, no room to doubt that the statements of Rost, as to elimination of boric acid, are essentially correct. The chief portion, in most cases, nearly the whole of the boric acid is eliminated by the kidneys.

Dr. Von Ramner (Zeits. f. Untersuch. Nahr. & Genussm., 1905, 405) points out the difficulty of carrying out the German law regarding boric acid in meat products, in face of the strong convictions of experts who believe it to be harmless. He also demonstrates the impossibility of carrying out the law in its prohibition of alkaline earth hydroxides and carbonates.

Formaldehyde.

This preservative is specifically condemned by the English Parliamentary Commission of 1900. It is, therefore, scarcely necessary to consider it as a competitor for public approval. The following work done on it may, however, be put on record.

Waldemar Koch (Am. Jour. Physiol., 325). The action of formaldehyde does not depend on active oxygen. Yeast made to grow anærobically is killed by it in 0·05 per cent solutions, but in 0·005 per cent solutions is unaffected. In cases of tryptic digestion, where the presence of formaldehyde has been observed to interfere with digestion, the reason may be discovered in the fact that the formaldehyde acts upon the proteids and renders them indigestible.

A. TRILLAT (Comptes Rendus de Chimie, 1904—720) shows that formalin hinders the digestibility of milk, and that it remains as formaldehyde in milk, so long as the milk remains unaltered.

A new method of using formaldehyde has been patented in France (Pat. 342769) by Budde (Jour. Soc. Chem., Indust., 1904—947). This consists in sterilizing the food with a 0·005 per cent solution of formaldehyde, and then treating with a 0·025 per cent solution of hydrogen peroxide. It is claimed that, in this way, fish, milk and meat can be sterilized without heat, and their characteristic flavours preserved.

A. FÖLSING—Eng. Patent, 13689, 1904 (Jour. Soc. Ch. Indust., 1904—878)—has been granted a patent for the use of tri-oxymethylene as a preservative for meat, fish, butter, jams, &c., used either as a powder or in solution. Oxymethylene in solution would be nothing else than formaldehyde, and in the solid state it is a polymer of formaldehyde, so that this patent must be regarded as merely an attempt to use formaldehyde under a new name.

The same remark may be made regarding a recommendation of G. Marpmann, (Chem. Centralb, 1904, I 687) to the effect that 0·5 per cent to 1·0 per cent of Hexamethylenetetramine is an efficient and harmless preservative for milk. This substance is a derivative of formaldehyde, sometimes used as a drug under the name *formin*.

F. MALLMAN (Zeit. für offentl. ch. 10-165), describes a new preservative sold under the name 'Sterilisol' which consists essentially of formaldehyde and common salt.

KARL ASCHOFF (op. cit, —10-181) shows that a 2 per cent solution of di-thionate of soda is sold under the same name.

The efficiency and convenience of formaldehyde as a preservative are so well recognized that it need not surprise us if it continue to be used, especially for milk and non-alcoholic or weakly alcholic liquors.

The question arises, may the use of formalin as a disinfectant and cleanser be permitted ? I know of milk companies who use formalin in rinsing out the tin cans which are sent out to bring the farm milks. These cans are all thoroughly washed, scrubbed and scalded, but it is claimed that in spite of these precautions, a stale odour remains and taints the fresh milk. To prevent this the cans are sent out with a small quantity of a solution of formalin in them. This, the farmers are instructed to throw out before filling them with new milk. Of course there is a strong temptation, especially in warm weather, to ignore such instructions. It would be of considerable interest to obtain a general expression of opinion among dairymen on this subject.

ERNST LÖWENSTEIN.—Zeit. für Hygg.—48-238, through Chem. Centralb.—1905-893. Formalin solutions, of such strength as are used for milk preservation, cause the milk to be so altered as not to react with rennet. The degree of change is dependent rather on the time during which the formalin acts, than upon its amount. Gaseous formaldehyde acts more energetically in this way than do solutions.

LIEBREICH (Therap. Monatsh., 1904-59) considers the question of using formalin as recommended by V. Behring, for the 8-day preservation of unboiled milk, in proportion of 1·5000. He contends that experiments in which large amounts of formaldehyde are used, prove nothing as regards the healthfulness of formaldehyde, in minute amount as recommended by V. Behring. The former employ the *disinfectant power* of the reagent, while the latter make use of its *restraining* power (Erhaltende Kraft). Dr. Liebreich holds that the prohibition of formalin in meat does not make its use in milk illegal.

CHESTER & BROWN (Bull. 71—Del. Agr. Expt. Ston.) conclude, as the result of extended experiment, that the addition of formaldehyde to milk in amount not exceeding 1 part in 40,000 and the holding of the milk at temperatures between 60° and 70° Fah. will improve its sanitary quality by preventing rapid and objectionable fermentations, and there is no reason to believe that in this proportion any marked injury could result to the person consuming it.

Bassenge (Zeit. Exper. Pathol. und Therap. 1905, 113) found that 2 per cent of dish 320 mgr, of formaldehyde. Sugar gave 700 mgr, per kilog. and in presence of

Thus, 1 kilog. of fire wood, burned in glass gave 27, in copper 1,800, and in ordinary dish 320 mgr. of formaldehyde. Sugar gave 700 mgr. per kilog. and in presence of copper gauze 5,760 mgr. Smoke was shown to have a germicidal effect on various kinds of bacteria. The use of smoke for preserving meats was shown to be dependent on formaldehyde, together with creosote, &c.

Salicylic Acid.

(The following note is taken from Year Book, Department of Agriculture, at Washington, p. 557):—

'In 1874 Kolbe was led, by the readiness with which salicylic acid is converted into carbolic acid, to investigate the antiseptic properties of the former. The perfection of Kolbe's method of manufacturing salicylic acid greatly cheapened the product, and led to vigorous efforts to extend its use. During the first three or four years immediately following the discovery of its antiseptic properties, and before its physiological action was understood, a number of prominent chemists warmly advocated it as a food preservative. It gained in favour at first, and its use increased rapidly till 1880. In that year 110,000 pounds were used in France for the preservation of food.

Since 1880, the mass of evidence resulting from physiological studies with salicylic acid, tends to condemn the addition of this substance to foods under all circumstances. It is possible that the majority of persons in sound health may suffer no evident injury from small amounts of salicylic acid, but its use by aged and infirm persons is attended with great danger. Many European countries prohibit the addition of salicylic acid to foods. At the present time it is chiefly used to preserve fruit and vegetable products.

Speaking of salicylic acid Dr. Wiley says (evidence before Committee of H. of R. in February, 1906): 'There has been a general consensus of opinion throughout the world that salicylic acid is a very harmful substance, and this prejudice is perhaps greater than against any other material employed for preserving purposes. That salicylic acid should be singled out especially for condemnation among preservatives does not seem to be warranted by the data which have just been presented and discussed. That it is a harmful substance seems to be well established by the data taken as a whole. It is, however, a harmful substance of very minute virulence.'

Sulphurous Acid and Sulphites.

A very compendious study of sulphurous acid and its salts as food preservatives has been published by Dr. C. E. Calm, of Chicago, in pamphlet form in 1904. It is made specially valuable by containing a good bibliography of the subject.

After citation of numerous authorities, Dr. Calm sums up the case for this preservative as follows:—

1. Sodium sulphite is prescribed by the United States Dispensatory and medical text books.

2. Sulphurous acid compounds exist naturally in food stuffs, for example, in meats, &c.

3. Sulphurous acid or the sulphites are extensively employed in nearly all articles of food.

4. Sodium sulphite acts as a meat preservative (1) by inhibiting to a certain extent the growth of bacteria, and (2) by maintaining the natural colour of fresh meat.

5. Spectroscopic analysis proves that sodium sulphite causes the formation of oxyhæmoglobin, to which the red colour of sulphite treated meat is due.

6. Sodium sulphite acts as a preservative only when it is added to strictly fresh meat, and has no effect when the meat is even slightly tainted and the hæmoglobin begins to be broken down.

7. The sulphites by their nature prohibit an abuse, since an excessive amount produces an unnatural colour, and renders the meat unpalatable.

8. All experiments made thus far on animals to determine the toxic effects of the sulphites have failed to represent existing conditions, since excessive doses of the sulphites have been given over long periods of time.

9. Seventy-six per cent to 96 per cent of the sulphite used on meat as a preservative becomes oxidized to sulphate before the meat is ready for consumption.

10. No case is on record in which it was proved that sodium sulphite as used in foods was injurious to health.

Without in the least impugning the good faith of Dr. Calm, we cannot shut our eyes to the fact that he holds a brief for the trade, being himself a manufacturer of these preservatives. In illustration of the natural bias involved in such connection, I may quote the deliverance of the English Parliamentary Committee on this subject, italicising the portion of this deliverance which Dr. Calm has quoted (page 30):—

'Concerning the physiological effects of the sulphites, a preservative often used by butchers, poultry dealers and brewers, there has been no evidence laid before this committee. *It appears, however, that when sulphurous acid or its salts are added to organic compounds such as beer or butchers' meat, some is at once oxidized to sulphate, which may be regarded at any rate in the amount present as indifferent; some attaches itself chemically to certain constituents of the food in question and the compound formed is also innocuous;* a third portion remains as sulphurous acid, and it is this portion alone which is of permanent efficacy as an antiseptic. Concerning the effect of this moiety upon the consumer pharmacologists do not seem agreed, and further investigation is required before the sulphites can be regarded as either harmful or harmless.'

It will be noted that Dr. Calm only quotes that part of the finding of the committee which seems to bear out his own contention, and omits the limiting clause, which, for the consumer, contains what is, by far, the most important feature of the committee's declaration.

Another point—which I would fain ascribe to a printer's error—must not be overlooked. Instead of writing, 'some is at once oxidized to sulphate, which, &c,' Dr. Calm writes, 'same is at once oxidized to sulphates, which, &c.' It is apparent that the very slight verbal change puts a quite different meaning on the phrase; a meaning which, however, any careful reader would see to be unwarranted by the context—since the word 'some' after the semi-colon demands its correlative.

I am not aware of any important research work on sulphites since 1901 (the date of the Parliamentary Report) which would warrant us in finding a positive safety in their use as preservatives; and I think that the question of the harmfulness or the harmlessness of their use must remain open for the present.

Lebbin and Kallman (Zeits. offenth. Chem. 1901, 324)—From numerous experiments carried out on animals and on human beings, the authors have come to the conclusion that our present notions as to the toxicity of normal sulphites are wholly erroneous. With acid sulphites, however, the action is quite different, for most of them are as corrosive as free acids.

In Dr. Lebbin's pamphlet, already quoted under Boron Compounds, he takes up the matter of sulphites, specially criticising the experimental work and conclusions of Pfeiffer; and he holds that the very experiments which led Pfeiffer to regard sulphites as dangerous to health, are capable of such interpretation as 'settles the question in favour of the meat dealers.' It is, however, abundantly evident that in this pamphlet Dr. Lebbin is a champion of the trade, and not an investigator.

H. Schmidt (Ch. Centralb, 1904, II, 59), asserts that sulphurous acid in dried fruits exists in combination with aldehyde and ketone bodies, and with glucose. The sulphurous acid disappears gradually on long storage of the fruits, with access of air. On cooking the fruit, the sulphurous acid rapidly disappears and the more completely in proportion to the quantity of water used.

A. Beythien (Zeits. flür Untersuch, Nahr und Gennssm, 8-36) considers the question of use of sulphurous acid as a preservative in wine, hops, beer, flesh, fruit and vegetables. He criticises an opinion of Hofman, and thinks that the use of the acid in dessicated fruits should be challenged.

Sulphurous acid has been reported in dried fruits, chiefly American, by Beythien and Bohrisch (Zeit für Untersuch, der Nah, und Genussmittel, 1902, 401)—Californian apricots contained from 0·216 to 1·158 per cent, (calculated as crystallized sodium sulphite) peaches, 0·992 per cent, pears, 0·2399 per cent—Italian prunes contained 0·264 per cent.

W. KERP (Ch. Centralb, 1904, II, 56) as the result of a critical study of the analyses of 1,071 wines from different countries, reports as follows :—

42·95	per cent	contained	SO_2 per litre	up to 50 mgr.
34·18	"	"	"	51 to 100 "
14·00	"	"	"	101 to 150 "
5·88	"	"	"	151 to 200 "
2·99	"	"	"	over 200 "

The highest quantity found was 466 milligrammes, SO_2 per litre.

CH. HARRINGTON (Boston Med. and Surg. Journal, 1904, 21, 550, through Zeits. f. Untersuch. d. Nahr und Gunnssm, 1905, 300).—Fed five cats for 20 weeks with meat preserved with ·2 per cent of sodium sulphite. All organs were found normal at the end of the period, except the kidneys, which showed very decided deterioration in every case.

W. D. BIGELOW (Year Book, Department of Agriculture, Washington, 1900, p. 556).—'In all wine producing countries, except America, the amount of sulphurous acid employed in treatment of wine is limited by law to one or two parts in 10,000 parts of wine (from 1·5 to 3 grains per quart). In this connection it must be remembered that the sulphurous acid content of the wine is largely combined as aldehyde sulphurous acid. Free and sulphite sulphurous acid are only permitted in European wines, in one-tenth the amount given above. The compound is recognized as distinctly toxic, and a larger proportion than that mentioned is universally recognized as injurious. The sale of beer containing sulphurous acid or sulphide is specially prohibited in almost all civilized countries.

HOLLEY (Jour. Am. Chem. Soc., 1906, 994) finds, as the results of work upon a large number of samples of sausage meats and dried fruits, the following :—

1. The amount of sulphites mixed with meats to preserve them is much larger than is generally supposed.

2. The amount of sulphites recovered in analysis is about one-fourth of that originally present.

3. Cooking sausage meat does not convert the sulphites into sulphates, as claimed.

4. With dried fruits, which have been bleached with sulphurous acid, the amount remaining unoxidized in the fruit is large.

BENZOIC ACID AND BENZOATES.

A. WEITZEL (Analyst, 1902, 271) shows that benzoate of soda, along with other alkaline salts, retards the coagulation of milk by rennet.

H. LEFFMAN (Analyst, 1899, 102) finds that sodium benzoate has no appreciable injurious influence on any of the enzymes.

There appears to have been very little research work done, touching the nature of physiological effects of benzoic acid and its salts in food. These substances are, at the present day, very extensively in use; and that this should be the case, without first establishing their harmlessness to health, is a violation of what should be a fundamental principle.

In his evidence given before a committee of the House of Representatives, in February of this year, Dr. Wiley refers to conclusions reached as the result of a practical feeding test, extending over three or four months, with twelve young men, whose food was treated with benzoic acid. 'The most pronounced symptoms during the preservative period were burning sensations in throat and esophagus, pains in stomach, some dizziness, bad taste, and when the limit of endurance was reached the subject suddenly became nauseated an ill. In all cases but one there was a material loss of weight. And that this bad effect was continued during the after period shows the persistance of the after effect. Only two of the members of the class immediately showed an increase in health after the suspension of the preservative.'

HYDROGEN PEROXIDE.

Probably the newest suggestion for a preservative for milk is that of Jablin Gonnet—(Ann. Chim. Analyt., 1901, 129—through the Journ. Soc. Chem. Indust., 1902,

420) who states that '1 c.c. of a 12 per cent solution of hydrogen peroxide added to one litre of milk, prevented spoiling for two days; 2 c.c. for four days and 6 c.c. for six days, at a temperature of 20° C.=68° F. The hydrogen peroxide cannot be tasted in the milk, and according to a series of physiological experiments, is harmless to the human system.'

A. Renard (Moniteur Scientifique, 1904, 39—Abstract Jour. Soc. Chem. Indust., 1904, 74), recommends this substance as a preservative for milk.

H. Frings, Jr.—(French Pat. 338,333, 1903), obtained a patent for the use of hydrogen peroxide as hindering the development of mycelium and schizomycetes, while not prohibiting the development of saccharomycetes. He also suggests the addition of substances, like peroxides, which are capable of producing hydrogen peroxide when acted on by acids.

A. Schröder, Berlin (Jour. Soc. Chem. Indust., 1904, 1108) obtained a patent in England in 1904, for the addition of peroxides to foods, and subsequent decomposition of the peroxides (of Ca, Mg or Na.) by carbonic acid, under pressure, or by acid phosphates.

Amberg (Jour. Biol. Chem. I, 219) says : 'While there is some doubt as to whether hydrogen peroxide can bring about a complete sterilization of raw milk in every case, and while the amount of this substance needed for the preservation of milk during a given period of time is uncertain, it harmlessness seems to justify its trial as a milk preservative.'

Budde (Milch—Ztg. 32—No. 44) has asserted that the treatment of milk by 35-100,000 ths. of hydrogen peroxide at a temperature not lower than 40° C. destroys bacterial growth.

P. Gordan (Centralb. fr. Bakter u. Parisitenk II, 13—716 through Chem. Centralb. 1905 —551) has examined Budde's work, and finds the development of bacteria very little affected by the treatment recommended. Somewhat larger quantities restrained the development of acidifying bacteria, and three times the quantity stated by Budde destroyed them altogether. 7-10,000 ths. of hydrogen peroxide gave decided taste to the milk, and larger additions gave an itching sensation in the throat. 7-10,000 ths. caused but little reduction of the resting spores, or streptococci; 6 hours at 50° C. with above amount destroys the typhus bacillus, but this temperature will destroy it without peroxide. Budde's experiments are shown to be untrustworthy in other respects.

Among the less known preservatives may be mentioned:—

Saccharin: in regard to which the only work that I have seen is that of—

F. Berlioz (Chem. Zeit. 1900, 416)—The author's experiments confirm the statement of Nencki, that saccharin, at least in small amounts, does not interfere with gastric or pancreatic digestion.

Fluorides:

Otto and Charles W. Hehner (Analyst, 1902, 173) give the results of experiments which show that 'salivary action is prevented by a solution containing 0·04 per cent of sodium fluoride, or its equivalent in ammonium fluoride, and that as little as 0·02 per cent solutions of fluoride greatly interfere with peptic digestion.'

Hydrofluoric Acid: which was patented in France in 1903 (Jour. Soc. Chem. Indust., 1903—756) by Sandmann and Eichelbaum, for preserving fruit juices. ' To 100 litres of the juice add 50 c.c. of a 40 per cent solution of hydrofluoric acid. Before putting the juice on the market the acid may be precipitated by chalk, or neutralized by addition of an alkaline carbonate.'

Chevy (Bull. de Therap. C. IX., 108) finds that hydrofluoric acid in the ratio 1·3000 prevents fermentation in milk, soup and wine.

It may be mentioned that Neuder (Chem. Zeit., 1904, 857) claims priority in the discovery of this substance as a food preservative, and also for the mode of using it, which involves its separation from fluids containing it by precipitation with lime.

G. Heinzelmann (Jour. Soc. Chem. Indust., 1904, 797) calls attention to the fact that since the disallowance of salicylic acid as a preservative for fruit juice in Germany, a solution of hydrofluoric acid has come on the market under the name 'Fruit,'

accompanied by a white powder (chalk) to be added before offering the fruit juice for sale.

The danger, in this case, is quite evident, and the placing of such irritant poison on the market illustrates the recklessness which characterizes the effects of manufacturers under stress of competition.

Carbonic Acid:. J. HERZFELD (German Pat. 147,653) obtained a patent in 1902 for the preserving of solid foods by the use of carbonic acid under pressure. The pores of the material are opened by application of suitable temperature, and the gas is then applied under higher or lower pressure, as may be necessary. (Chem. Centralb, 1904, I., 334.)

Formic Acid: OTTO and TOLMACZ (Zeit. für Nahr. and Genussm, 7-78) describe a new preservative, 'Werderol,' for fruit juice. This is essentially a 10 per cent solution of formic acid.

Beta-Naphthol : is a compound of marked toxic properties. Dose for an adult is 3 to 8 grains. As a food preservative it should not be tolerated.

Zirconium Salts.—Quite the newest and entirely up-to-date preservative, has been patented by *A. Müller Jacobs* in the United States (pat. 775066, 1904). This is the immersion of decomposable food stuffs in a solution of zirconium salts—'these salts possessing radio-active functions.'

U. S. Patents have been granted (April, 1905), to H. Lieber for the impregnation of foods with radio-active emanations from thorium—(J. Soc. ch. Indust., 1905, 557.)

ED. MACKAY CHACE (Jour. Am. Chem. Soc. XXVI, 662) has recently examined some samples of canned sausage of German origin, to which aluminium acetate had been added as a preservative. Two brands were found to contain 60 to 70 and 175 to 200 milligrammes of aluminium respectively per 1 pound tin, the greater part being present in the sausages themselves.

It is claimed that the alumina exists in a condition in which it is insoluble, and hence harmless to the system. Chace carried out experiments to determine the truth of these claims. He found that from 70 to 80 per cent of the alumina was dissolved from these sausages, by action of pepsin, and he holds that this is sufficient to fully condemn the use of the article named as a food preservative.

JEAN FERDINAND (Rev. intern. fabricat., 1903, 159) is of opinion that the study of *Fluoride of sodium* as a butter preservative, is deserving of attention. From 10 to 15 grammes per 100 kilog. of butter suffices, and this small quantity would be certainly made insoluble by reaction of lime salts naturally present in drinking water and other foods.

GENERAL.

The subjoined notes, having a general bearing on the subject of food-preservation, may find a place here.

E. LABORDE (Jour. Pharm. Chim., 1899, 484. Through the Analyst, 1900, 154).

Small quantities of isobutyl alcohol, glycerol and malic acid favoured peptic digestion; also methyl alcohol in very slight degree; ethyl and propyl alcohols, lactic and tartaric acids and mannitol and glucose on the other hand retarded peptic digestion.

With trypsin (pancreatic digestion) methyl and isobutyl alcohols, glycerol and glucose accelerated, while ethyl and propyl alcohols, lactic, malic and tartaric acids and mannitol, retarded the process.

A. WEITZEL, the Analyst, 1902, 271.—Experiments on the coagulation of milk by rennet, in presence of various substances, as follows:—Group (1) Alkaline: Borax, sodium hydroxide, sodium carbonate and sodium bi-carbonate. (2) Salts capable of precipitating lime: Sodium oxalate, sodium fluoride and sodium oleate. (3) Other salts having an alkaline reaction: Sodium sulphite, salicylate, benzoate, propionate, acetate and formate. (4) Neutral salts: Sodium chloride, lithium chloride, sodium nitrate, perchlorate, tartrate, sulphate, ammonium sulphate and magnesium sulphate. (5) Acid salts: Sodium hydrogen tartrate, sodium hydrogen sulphate and sodium per-

sulphate. (6) Acids: Boric, carbon dioxide, oxalic, benzoic, salicylic, protocatechuic and gallic. (7) Formaldehyde, saccharin and cane sugar.

The following results were obtained:—

(1) Borax retarded the coagulation when present in only small quantities (0·01 to 0·04 per cent), and the amounts usually employed (1 gramme per litre of milk) stopped the action of the rennet altogether. All other alkaline salts acted similarly.

(2) Coagulation was checked by those salts which precipitated the lime compounds. When the reaction became alkaline, the influence of alkalinity also showed itself.

(3) The neutral salts generally had a retarding action. Some (sodium and lithium chloride), principally in concentrated solution, more feebly when present in small quantities. Magnesium sulphate, in both concentrated and dilute solution, had considerable influence.

(4) Small quantities of the acids aided the coagulation. After carbon dioxide, boric acid had the most feeble action. The acid salts acted in the same manner as the acids.

(5) The action of formaldehyde was so powerful that it must be considered as a direct poison to the rennet enzyme. Saccharin in small quantity had little influence, but stronger solutions greatly hindered the coagulation. Sugar, up to 20 per cent of the weight of the milk, had no action.

Price, T. M. (Centralb. Bakteriol. 1905, 65). Calves of two weeks old were fed for two nine-day periods with preserved milk, parallel experiments with normal milk being carried out.

Digestion of Protein and Fat as compared with Normal Milk.

Treatment of Milk.	Protein.	Fat.	Remarks.
Normal milk	Normal.	Normal.	
Formaldehyde, 1:10000	0·76	0·96	Per cent excess.
Salicylic acid, 1:1000	5·07	3·71	„ defect.
Boric acid, 1:1000	1·73	0·08	„ „
Borax, 1:675	1·30	0·02	„ „

It will be seen that the formaldehyde treatment did not injuriously affect the digestibility of the milk, while the other treatments did so in marked degree; the salacylic acid being specially harmful. Two calves fed for two months on formaldehyde and boric acid treated milks, continued to increase in weight.

The influence of formaldehyde upon the digestive ferments was studied with the following results:—

Milk was treated with formaldehyde in the proportions given:

Digestive Action.

Enzymes.	Not Affected.	Disturbed.	Stopped.
Rennet	1 : 2500	1 : 1875	1 : 500
Pepsin	1 : 125	1 : 50	1 : 25
Pancreatin	1 : 2000	.....	1 : 1500
Steapsin (fat digesting ferments)	.....	1 : 50	1 : 35
Ptyalin	1 : 1500	.....	1 : 1250
Amylopsin	.....	1 : 1000	1 : 500

Bouillon cultures of bacillus acidi lactici, B. Subtilis, B. Coli were killed by formaldehyde in six hours by a ratio of 1: 1560, and in 72 hours by a ratio 1: 1870.

The smallest amounts of the following preservatives found effective in preserving milk for 48 hours, were:—

Borax	1 to 675
Boracic acid	1 to 1,000
Salicylic acid	1 to 1,000
Formaldehyde	1 to 20,000

A. Chabrin (Comptes Rendus d' l'Acadamie des Sci., 139-160) shows that sterilized food is less digestible than natural food, and may give rise to irritation of the intestinal mucous membrane, with all its consequences.

It will, I think, be conceded by any one who reads the subject carefully, that the balance of evidence is decidedly against the use of any preservative in food. At the same time it must be granted that there are degrees of danger to health among the chemical substances which find favour as preservatives among manufacturers, and it may be that, in certain cases, less harm may result from the preservative than would result from deterioration of the food-stuff, were this kept for a length of time without an antiseptic. In order to decide the question as to whether, in certain cases, such as long voyages, travelling in out-of-the-way regions, supplying stores to soldiers on the march, mining camps, &c., as well as in the distribution of food-stuffs to the great centres of population, far removed from the places where such foods are produced, it might not be preferable to employ chemical preservatives rather than consume food which had suffered natural decomposition, or pay the high prices necessitated by quick transit, or such costly methods as cold storage, hermetical sealing, &c., it is evident that experiment must determine the extent of the injury to health which results from the use of food preserved from decomposition by antiseptic chemicals.

The most complete investigations of the kind named, which are so far on record, are those conducted by the Imperial Health Office at Berlin, and those conducted by the Bureau of Chemistry at Washington. The general conclusions reached in both cases go to show that danger attends the use of all preservatives, and that unless great care is employed in regulating the quantity, very serious harm must result. Most countries have enacted stringent laws regarding the matter.

The following concise summary of Food Laws, as regards preservatives, is taken from a bulletin issued by the United States Department of Agriculture, through the *Jour. Soc. Chem. Industry*, 1901, p. 774:—

'Prohibition of the use of chemical preservatives and aniline dye stuffs as colouring agents for liquors is almost universal, while the employment of all foreign colouring matter is often prohibited. The use of chemical preservatives and foreign colouring matter with beer is usually prohibited. The sale of foods containing saccharin, sucrol, and similar preparations is prohibited in Belgium, France, Germany, Italy and Roumania. The importation of saccharin, except for medicinal use and under prescribed conditions, is prohibited by Belgium and Greece. All countries permit the dyeing of confections and similar articles which are themselves colourless, but are customarily coloured artificially. Belgium permits mustard to be coloured artificially when properly labelled. Salicylic acid and boric acid have been used so much more commonly than other preservatives, that legislation is usually directed against them, whilst local bodies often extend the prohibition to benzoic acid and other substances as they come into use.

'The sale of foods containing preservatives is prohibited in Austria, France, Hungary and Roumania, and that of beverages containing preservatives in Belgium, Germany and Switzerland. The addition of salicylic acid to food is prohibited in France. Holland does not permit the sale of beer containing salicylic acid, and Spain forbids its addition to wine. Italy permits the addition of 0·2 per cent of boric acid to butter, but forbids the use of other preservatives.'

Canada is behind other countries in this regard, and with the single exception of salicylic acid in potable liquors, which is specifically forbidden, leaves the onus of proving the harmfulness of any preservative used in food upon the complainant. There can be little doubt, however, that our courts would find a verdict in accordance with the recommendations of the English Parliamentary Committee of 1901. It is desirable that action should be taken to give these very conservative recommendations a legal status.

It has been suggested that the scheduling of certain preservatives as alone permissible would put a stop to the investigatory and experimental work now carried on by the manufacturers who, it is asserted, are continuously seeking for new substances suitable to their needs. There does not seem to me to be much force in this contention. If we assume that no manufacturer would wish to employ a new preservative until he had made sure of its harmless character; then the evidence which serves to satisfy himself of this fact could easily be adduced before a government committee; and if it proved to be convincing, such new preservative could easily be added to the list. The literature of formaldehyde is in evidence to show that, in this particular case, certain manufacturers were satisfied with data which entirely failed to satisfy disinterested experts.

Finally, I have several times been asked, 'Is it possible for an honest and conscientious manufacturer to use a preservative, in view of the conflicting evidence which investigators have put on record?' In reply I would say, that I can easily conceive the natural bias of a manufacturer in favour of preservatives to lead him to accept the conclusions of men like Dr. Liebreich and Dr. Lebbin and others, as sufficient justification for the careful and judicious employment of boron compounds, sulphites and benzoates; while the concessions of the English Parliamentary Committee in regard to the first two named may seem to give him full warranty for their use. The attitude of the consumer towards the matter is quite different, as I have already pointed out. His preference should undoubtedly be for fresh food, or for food preserved by methods which have stood the test of time, and have proved their harmlessness.

Important opinions upon the subject of legislation regarding preservatives, are as follows :—

M. Favolle (Bull. Scien. Pharmacolog, 1904, 172 ; abst. Zeit. für Nahr, and Genussm., 1905, 374).

After referring to the demonstrations of the consulting committee of hygiene, as proving interference with assimilation and reduction of activity of the digestive ferments, due to preservatives in foods, says : 'A partial prohibition is insufficient. Only a general law which shall make the addition of such preservatives a punishable offence can be effective.'

Eccles, R. G. (Amer. Jour. Pharm., 1904, 506) contends that the opposition to the use of preservatives is based on theoretical considerations. He asserts that statistics prove that countries in which the use of preservatives is forbidden, show a higher percentage of deaths due to diseases of the digestive tract than those in which no laws against preservatives exist.

In his recently issued work on Food Preservatives (New York : Van Nostrand & Co.), a very lucidly written book of 202 pages; Dr. Eccles shows an extensive acquaintance with the literature of his subject.

Chapters III., IV. and V. contain many references of value. Dr. Eccles is, however, a special pleader; and the judicial attitude towards his subject is conspicuously lacking. Such sentences as the following bear out this contention.

'Food commissioners and food chemists, for some reason, do not interfere with sugar manufacturers and candy men as they do with catsup bottlers and fruit juice bottlers.'—(p. 37.) 'Surely no one can seriously contend that the almost weekly recurrence of cases of severe ptomaine poisoning is at all comparable with the imaginary ills that preservatives are supposed, by some people, to produce.'—(p. 23.) It is regrettable that Dr. Eccles should have allowed himself to depart from clear and plain statement, because he has much of real value to say; and an unbiassed narrative of experience and fact is always valuable and welcome.

Many of his statements clearly indicate his standing as a special pleader. Such are the following : 'There is absolutely nothing inherently injurious in substances the dose of which is kept below the limit of minimum medicinal effect.' —(p. 197.) 'By permitting free competition in the use of preservatives, newer and better ones are sure to be sought for and discovered.'—(p. 34.) Apart from the fact that it is out of the question that a long-suffering public should permit 'free competi-

tion in the use of preservatives,' it is open to question whether a ready acceptance of preservatives by the public would not tend to make further research unnecessary. By prohibiting the use of any preservative not proved to be physiologically harmless, will not the search for such a preservative be stimulated?

H. LEFFMANN (Amer. Jour. Pharm., 1904, 503) acknowledges that a certain degree of injury to health results from the use of most modern preservatives. But he contends that this is not the proper way to look at the question. No preserved food is as good as a fresh food; and even boiling renders albumen less digestible. Dessication, smoking, pickling, have still more marked effect in hindering the digestibility of food. It is therefore an arbitrary and unreasonable conclusion to condemn the newer preservatives while allowing the old. What evidence shows that common salt is harmless in food? What proof have we that benzoate of soda is more objectionable than the residues from wood smoke?

Dr. Wiley stands out clearly for the prohibition of all chemical preservatives in food; he makes a distinction between condimental preservatives and chemical preservatives; but I fear that it may sometimes be difficult to mark the dividing line. He recognizes that exceptional cases may occur, when the employment of a preservative may be the lesser of the evils, *e.g.*, prolonged voyages, or exploration, sieges, &c. Dr. Wiley's attitude is altogether admirable, as the expression of a high principle of ethics; but it may be questioned whether we may absolutely ignore the economics of a matter of this kind. The cost of a food stuff to the consumer is often a reason for his choice of the second best, and there is no doubt that the cost of placing many kinds of food on the market is greatly lowered by the use of preservatives. The wealthy will always be able to commend fresh food stuffs; or to pay the higher prices required to meet the cost of packing in the best methods known to art. But the poorer classes of the community may be compelled to do altogether without certain desirable foods or use these as preserved by one or other of the so-called chemical preservatives. At the same time when we consider that the excretion of most of these substances falls chiefly upon the kidneys, and recognize the fact that kidney disease of one kind or another is a main cause of the loss of vitality in middle life, and indeed figures very largely in mortality records, we cannot but feel that the legislation of potent germicides in food products is a matter of the most serious kind.

It may be well to notice the fact that traces of chemical substances, identical with some of the preservatives above named, occur naturally in certain fruits. Thus, benzoic acid is a constituent of several kinds of fruit, and in particular of the cranberry.

L. PORTES AND A. DESNOULIÈRES (Ann. Chim. Anal. Appl. 401) have found out by the examination of fresh strawberries, that salicylic acid, probably as the methyl ester, is a normal constituent of this fruit. The amount in the fresh berries is about 1 mgr. per kilog. (i.e., about 1 part per million or 0·0001 per cent.)'

E. O. V. LIPPMAN (Chem. Zeit. 1902–465) found a deposit in a vacuum pan, which had been used for concentrating lemon juice. On analysis this gave about 0·5 per cent of boric acid. Various commercial samples of lemon juice were then examined, as well as lemons and oranges, and in nearly every instance strong boric acid reactions were obtained. In the lemons, boric acid was detected both in the juice and in the rind.

Advocates of preservatives have sought to make an argument in their favour of the above mentioned fact. But aside from the extreme minuteness of the quantity naturally occurring in these fruits, the fact that it occurs naturally, and has hence always been a part of the food stuff in question, puts it out of the category of ordinary commercial preservatives.

Some samples of common salt are found to contain traces of borax, and the following note is interesting :—

FARNSTEINER and others (Bericht über die Nährungsmittel Koutrolle in Hamburg, 1903-4, 36) find that common salt is free from any such amounts of borates as would interfere with the detection of these when used as food preservatives. But certain Italian samples of salt contain notable amounts of borax."

A. McGILL.