knowledge of this fact is growing. True, we have not got to the stage in this country where food and drugs law has as high a priority in the legislature as it undoubtedly has in North America. But those of us who have worked in this field have reason to be thankful for the change of heart that has come about in the last few years, and in the increased interest of both trade and public. It was in order to further this interest that I accepted the Chairman's invitation to speak here this morning, and I only hope I have made a few more converts to a worthy cause.

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Problems in the Administration of the Laws Relating to the Food of Men and Animals

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The laws relating to the sale of food for man and for animals differ in certain important respects. With human food, the consumer is the main party to be protected, but with animal food, both the farmer and his livestock must have their interests protected. The Food and Drugs Act, 1938, together with the various Statutory Instruments, protect the human consumer mainly by the application of Section 3, which makes it an offence to sell to the prejudice of the purchaser anything that is not of the substance, nature and quality demanded. This Act differs from the Act of 1928 in empowering the appropriate Minister to make suitable standards which are from time to time embodied in Statutory Instruments. This newer legislation is dealt with by Adams (1951) and will not be amplified here. To a smaller extent the Merchandise Marks Act, 1926, is a protection, particularly in transactions within the food trade.

Fertilisers and Feeding Stuffs Act, 1926

The Fertilisers and Feeding Stuffs Act of 1926 differs from the above acts in being far more specific. The sale of animal feeding-stuffs must, for example, generally be accompanied by a Statutory Statement, the particulars required varying with the type of article, and being enumerated in five Schedules incorporated in the Act. In addition to the Statutory Statement, the vendor may make a voluntary statement relating to certain ingredients not scheduled in the Act, e.g. he may declare that dried grass contains over 100 mg. carotene/1000 g. This voluntary statement is binding under the Act and may also make the vendor liable to action under the Merchandise Marks Act. Regulations embodied in the Act specify limits of error that are allowed to cover small differences due to imperfect mixing and differences in analyses, for although the Regulations include methods of analysis, some variation is inevitable, due to slight differences in technique. Methods and scales for sampling are also included in these Regulations.

The two forms of legislation are similar in that they require that sampling shall be done by duly appointed inspectors, and in a particular manner. Also that the analysis

of human food shall be carried out by the Public Analyst and the analysis of animal food by the Official Agricultural Analyst. In the former instance, prosecutions are undertaken by the local Food and Drugs authority without consent of any Ministry. There are exceptions, e.g. in cases taken under Section 6, which is temporarily replaced by Regulation 1 of the Defence (Sale of Food) Regulations, or where the Enforcement Branch of the Ministry of Food institutes proceedings.

With animal feeding-stuffs, however, the permission of the Ministry of Agriculture must be given before proceedings can be undertaken. This permission is not given until the third portion of the sample has been examined and reported on to the Ministry by the Government Chemist. One of the remaining two portions is sent to the Official Agricultural Analyst for analysis and the other is given to the vendor, who may have it analysed by an independent authority if he wishes. The Government Chemist is not called upon to examine the third portion of the sample of human food unless in cases of dispute the court decides that this is necessary. The Government Chemist in both instances has legal obligations under the Acts, but whereas he acts as an independent referee reporting directly to the court on human food, his report on animal food goes to the Ministry of Agriculture before proceedings can be undertaken, and is only rarely produced in court. Proceedings under the Food and Drugs Act are normally of a criminal nature, but under the Fertilisers and Feeding Stuffs Act may be civil, criminal, or both, depending on the nature of the offence. Some of the details and workings of the latter Act may be conveniently discussed at this stage.

First Schedule of the Act

There are five schedules to the Act. The First Schedule enumerates feeding-stuffs to which all the provisions of the Act apply, and includes items such as meals made from one type of grain; cakes and meals from oilseed; copra; compound cakes and meals; meat-and-bone meal; wheat offals. Particulars that must be included in the statutory statement vary from article to article and may include oil, protein, phosphoric acid, sugar and fibre. With meals such as barley, oat, locust, pea or wheat, these details need not be supplied, but 'implied definitions' are given in the Third Schedule. As a rule the examination of First Schedule articles presents few problems since the methods of analysis are laid down in the Regulations in Part V of the Act. These methods will be revised by a subcommittee which will review the general working of the Act. It may be of interest here to state some of the analytical problems:

Moisture determination. No declaration of moisture is necessary, but in borderline cases it is essential to know that samples agree among themselves and with the bulk. The method laid down by the Regulations merely prescribes oven drying at 100°. Without going into details it is only fair to state that no single method is likely to satisfy all requirements. From many years' study of moisture determination in human and animal foods in the Government Laboratory, we have concluded that this is one of the least satisfactory of all analytical determinations. The methods include hot-air drying, freeze-drying, vacuum-oven techniques, methods which rely on distillation in presence of a solvent immiscible with water, such as toluene, under which the moisture collects and can be measured, relative humidity measurements,

desiccant methods at normal or reduced pressure and normal or elevated temperature and the Karl Fischer method.

Even the normal oven method has been modified in many ways; the latest method described by Fryd & Kiff (1951), in use for the determination of moisture in tobacco, utilizes a forced draught of preheated air. This has also been suggested by Meihuizen (1929) for dairy products and should find ready application to foodstuffs in general, where it is essential to obtain uniform results.

Protein determination. The Regulations prescribe the Kjeldahl method and the materials to be used, the catalysts being either copper or mercury. Though similar results may be obtained with either catalyst, it is our experience that mercury allows greater latitude of time of heating and gives somewhat higher results than copper. Much work has been done in recent years on the use of these, and alternative catalysts such as selenium, with pure amino-acids with the nitrogen in various forms of combination, and the results compared with those given by the Dumas method (see Alcock, 1946; Chibnall, Rees & Williams, 1943; Miller & Houghton, 1945; Reith & Wansink, 1947; Willits, Coe & Ogg, 1949). The general conclusion is that mercury gives the most reliable results and gives greater tolerance in heating.

Oil or fat determination. The Regulations prescribe extraction with petroleum spirit. This, though satisfactory for many human and animal foods, is not satisfactory for certain baked products such as biscuit meal, or with some feeding-stuffs containing molasses. We find that in such instances considerably higher results are obtained by previous hydrolysis by acid. The simple extraction method also fails to differentiate between a reasonably pure glyceride and one containing a high percentage of unsaponifiable matter such as would be expected from a meat-and-bone meal made from parts of the sperm-whale carcass. The possible harmful effect of this high unsaponifiable matter in some animals should be provided for.

Fibre determination. The method prescribed by the Regulations has been in use for many years, but slight differences in technique may influence the results in a disconcerting way. Some years ago a number of laboratories undertook a collaborative study of the method, using a sample prepared by J. F. Tocher, who afterwards carried out a statistical study. The results (Tocher, private communication) showed very clearly that the following results are inevitable where empirical methods, even though carefully specified, can lead to slight modifications in techniques. Duplicates by one worker in the same laboratory show the most consistent results. A somewhat wider spread of results is given by a number of workers in the same laboratory. Workers in different laboratories will get a much wider spread of results than either of the above.

Other schedules

The Second Schedule enumerates articles to which only some of the provisions of the Act apply, and includes clover meal, dried yeast, dried brewery and distillery grains, feeding dried blood and malt culms.

The Third Schedule enumerates ingredients, the presence of which must be declared, and includes husks, chaff, glumes, shudes whether ground or not, treated or untreated and whether used as separate ingredients or in mixtures.

The Fourth Schedule gives implied definitions for many feeding-stuffs; thus 'white fish meal' is defined as 'a product (containing not more than 6 % of oil and not more than 4 % of salt) obtained by drying and grinding or otherwise treating waste of white fish, and to which no other matter has been added'.

Harmful substances in foods

The scheduling of harmful substances both in human and animal foods is perhaps one of the most pressing of modern problems. Our own legislation differs markedly in some respects from that of some other countries, notably the U.S.A., e.g. whereas in this country the use of only five colouring matters is prohibited in human food, the American laws allow only certain scheduled colours to be used. The prevalent use of emulsifying agents, antioxidants and anti-staling agents is causing here wide concern, and although the findings of the Zuckerman Committee have not been made public, it can be stated that the legislature in both this country and the U.S.A. is now well aware of the immense biological and chemical problems confronting the Ministries of Agriculture, Health and Food.

The above Schedules were framed to enable the farmer to plan balanced rations for his livestock according to their different requirements.

Problem of determination of carbohydrate

It will have been noticed that throughout the Schedules no mention is made of carbohydrates, the farmer, unless he has had some scientific training, being left in ignorance of this factor. He cannot calculate carbohydrate from the Statutory Statement, as moisture and ash need not be declared, and fibre declared on only a few items. The calculation of 'available carbohydrate' is no less a problem in assessing the calorie value of human food, and much further work needs to be done on the human and animal organism before chemical methods can be devised that will accurately follow biological equivalents. Until recent years there was little information regarding the availability of the carbohydrates of products like ground oat husks, but the work initiated by Woodman & Evans (1938) has given us much valuable information. It should be remembered that such products are being sold as 'unrationed' feeding-stuffs to-day. Chemical analyses reported recently by Taylor (1948) showed that 'carbohydrate by difference' amounts in ground oat husks to 40–55 %. If such articles occur in a scheduled feeding-stuff their presence must be declared, as the farmer would otherwise calculate his starch equivalent quite incorrectly. We have of course precisely the same problem in compiling tables of the chemical composition of human foods. Whereas the well-known tables of McCance & Widdowson (1946) are based on the determination of 'available carbohydrate' in terms of glucose, those issued by the Nutrition Committee of the Food and Agriculture Organization of the United Nations (Chatfield, 1949) use carbohydrate calculated by difference. In many instances it does not seem possible to state which is the better, until chemical methods can be devised that will reproduce biological equivalents, and for this we need to repeat Woodman & Evans's (1938) work on man, and further to investigate direct chemical methods of

determining carbohydrates as suggested by Bransby, Daubney & King (1948). The problem reaches its most acute form in foodstuffs used by some primitive peoples, e.g. in a specimen of baobab flour which we recently examined, the carbohydrate by difference was 76 %, whereas the glucose calculated from the copper-reducing power after hydrolysis was 33 %. The exceptionally high pectin content accounted for much of the difference.

In this short review it has only been possible to refer to a few of the problems in the administration, including the framing of laws relating to foods, but it must be obvious that much remains to be done not only by the legislature but also by the Scientific Advisory Services to the Legislature before men and animals are adequately protected.

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The Toxicological Aspects of Food Adulteration

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Definition of toxicity

For the present purposes the definition of adulteration will be extended to include substances added to food for a specific purpose as well as those used as substitutes for proper nutrients. It will include also materials that find their way into food as a result of modern agricultural practices.

A substance is usually considered to be toxic if it produces some direct unfavourable effect on a normal metabolic process. In some instances the disturbance has been quite clearly defined and the nature of the 'biochemical lesion' so produced can be identified (Gavrilescu & Peters, 1931). In others injury to a vital organ results directly or indirectly from the action of a poison. Finally, a substance may be considered toxic because it is carcinogenic.

In considering the possible toxic effects of chemicals in food, their more indirect effects must not be neglected. They may act by altering the natural materials of the