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The legislation which brought Public Analysts into being over a century ago was designed to prevent the adulteration of food. Much of this adulteration was fraudulent and often dangerous and the public needed protection against unscrupulous vendors. With the passing years and the unceasing efforts of Public Analysts this form of gross adulteration has almost entirely disappeared to be replaced by more insidious problems.

Today the Public Analyst is concerned on the one hand with matters of composition and presentation which are deliberate, and stem largely from commercial considerations, and on the other hand with the detection of unsuitable additives and trace contaminants. Among possible contaminants must now be included pesticide residues.

Public concern has been aroused by such books as "Silent Spring", but much of the outcry has been uninformed. Any suggestion that something is wrong is "news", whereas if it is proved that nothing is wrong, this is not "news". Before we are in a position to form a balanced judgment between the undoubted benefits of chemicals for crop protection and the possible hazards to health, we need to know a great deal more about the amounts of pesticide residues likely to be ingested, their fate in the body and their possible effect on health, particularly of young people who may accumulate them, or their breakdown products, in the body over many years.

Public Analysts had their first experience of these residues just before World War II when imported apples were found to contain substantial quantities of arsenical residues due to the apples having been sprayed with lead arsenate. The avalanche of new insecticidal substances which followed World War II obviously increased enormously the possibility of contamination with such residues. Although the substances used in this country are carefully regulated by the Government Voluntary Scheme, nevertheless Public Analysts have always realised the possibility of contamination of edible crops due to misuse or unforeseen circumstances. The large number of possible substances involved has always been a source of concern to Public Analysts and it was for this reason that they explored the possibility of using a general biological sorting test which would at least protect the public against excessive contamination.

Some five years ago such a general biological sorting test was introduced into Public Analysts' laboratories and a large number of foodstuffs of varying kinds are examined by this test. It is pleasing to report that no really serious case of contamination has been revealed as the result of this work. It should be emphasised that the biological sorting test, while being an excellent safeguard against serious contamination, does not rule out the possibility of some pesticide residuals remaining in foodstuffs. Indeed, with the development of new techniques, capable of much higher sensitivity, traces of pesticide residues were in fact found to be present in a number of the more common foodstuffs. For instance, it was found that in some 130 samples of different foodstuffs as many as 43 per cent. contained traces of D.D.T., which clearly pointed to the origin of the small amounts of D.D.T. now found to be stored in the fatty tissues of many human beings. The finding of these small residuals clearly showed the desirability of an all-embracing scheme which would give a measure of the extent to which our common foodstuffs contain such residues. This survey was initially suggested by the Local Authorities Associations and the Association of Public Analysts was invited to work out the final details. Each Local Authority taking part in the survey will submit a predetermined number of samples of crops, meat and dairy products or other foods, which will be examined in our laboratories for pesticide residues, even if present in the most minute traces. The results of this survey will be correlated and analysed.

It is fortunate that new instruments and techniques are being evolved which are capable of matching the new problems. Until the recent advent of gas/liquid chromatography and thin-layer chromatography it would have been difficult to detect and measure pesticide residues at a level of less than one part per million in foods, but many Public Analysts' laboratories are now equipped with the necessary apparatus, expensive though it is, and others are in process of being so equipped. Few people realise the revolution which has taken place in the extent of instrumentation in these laboratories during the last decade.

Another toxic hazard which attracted public attention during the year was the presence of lead in pencil-type crayons and toys. Hundreds of lead determinations were done on these articles, and relatively large amounts of lead were found in some imported goods. The ingestion over a long period by small children of small amounts of lead, which may be contributed to by sucking the paint off crayons and so on, is now thought to carry with it a risk of mental retardation in addition to the more usual results of lead poisoning found in the adult. The sale of many of these potentially dangerous goods was prevented.

These facts serve to highlight specific dangers, but much of the Public Analyst's work is concerned with the routine task of Consumer Protection.

The word 'consumer' must be interpreted here in the widest sense. It is not merely related to the food he consumes in health or the drugs in sickness, but to the very air he breathes and the water he drinks. Protection covers his pocket as well as his physical well-being, by eliminating extravagant and false advertisements.

We welcome, in this context, the work of the Food Standards Committee on food labelling, and we have submitted an extensive memorandum setting forth our views on this aspect and also on the subject of false or misleading claims made on labels and in advertisements. We hope that the report of the Food Standards Committee on the latter will be published in the next few months.

In the field of food standards we have been particularly active during 1965 in submitting memoranda to the Ministry of Agriculture, Fisheries and Food on proposed Regulations. If the quality of a particular kind of food is controlled by a Statutory Order, the task of the Public Analyst in protecting the public against sub-standard products of that kind is greatly eased. In the absence of any standard, whether statutory or agreed with the trade in the form of a Code of Practice, it is necessary for the Public Analyst to express his opinion on what constitutes a fair and reasonable minimum standard for the article in question. If a prosecution results, this standard, based though it is on the expert knowledge and experience of the Public Analyst, may well be attacked by the defence. This may succeed in raising sufficient doubt in the minds of magistrates to lead to dismissal of the case, as magistrates are under an obligation to decide, on the evidence before them, what constitutes a reasonable standard. It is not surprising that standards may vary from one magistrates' bench to another. Not only is this kind of thing obviated by legal standards; it also protects the responsible manufacturer against unfair competition from less scrupulous firms.

The delay that occurs between the decision that a legal or agreed standard is desirable and the promulgation of the appropriate statutory order is often very considerable. An example of this may be cited in the case of sausages. The Foods Standards Committee issued a Report in 1956 which advocated a statutory standard for the meat content of sausages. Nine years later, in 1965, draft proposals for Regulations were issued by the Ministry of Agriculture, Fisheries and Food. We still await the implementation of these proposals.

During the year under review we have submitted our views on proposed Regulations relating to sausages and other meat products (already mentioned), canned meat, meat pies, colouring matters in food, antioxidants, mineral oil in food, flavourings, fish and meat pastes, salad cream, butter, margarine, coffee mixtures, ice cream and coffee extract. This unprecedented spate of proposed standards promises to fill many gaps in our food legislation if the proposals come to fruition.

Parallel with, and supplementary to, this action at Ministry level, negotiations are being conducted under the ægis of the Local Authorities Joint

Advisory Committee on Food Standards to produce voluntary Codes of Practice relating to the composition and labelling of food. These usually relate to foods which are not considered to be of sufficient importance to warrant legislation. During 1965 the negotiations, in which Public Analysts necessarily played the major part, concerned the labelling of cakes and biscuits, the composition of fancy loaves, the manufacture, composition and description of cider and perry, the composition of canned milk puddings, canned fruit and vegetables, canned beans in tomato sauce and tomato purée. Although such Codes of Practice have no legal force, but are merely agreements made with English manufacturers, it has been found in practice that imported products fall into line voluntarily.

It is sometimes alleged that Regulations and Codes of Practice governing the composition of foods will restrict the consumer's choice by imposing a dull uniformity. This allegation was, in fact, made publicly by the Chairman of the Sausage Section of the Meat Traders Federation, but this is entirely untrue. All we wish to see imposed by law are minimum requirements of composition. Thus we would expect pork sausages to contain not less than 65 per cent. meat, a standard already observed by all reputable manufacturers. This minimum standard allows plenty of latitude with regard to the quality of the meat and flavouring and "know-how" which are responsible for the flavour and succulence of the products of the best manufacturers. It does not preclude the sale of a sausage with a higher meat content, but it protects the customer from a nutritionally inferior product containing a large amount of cereal filling and little meat. We wish only to have a legally defined level of quality below which the product must not sink; above that legal minimum, the sky is the limit as far as we are concerned.

The drafting of Codes of Practice so as to allow variety while at the same time maintaining a minimum standard, is sometimes fraught with considerable difficulty. This may be illustrated by the example of canned fruit salad. The customer is entitled to expect that a product so described will not contain merely two or three of the cheaper fruits, but a reasonable variety and a reasonable proportion of each kind of fruit. This has been agreed by English canners, but South African and Australian canners are not accustomed to include the same, or perhaps as many, varieties of fruit. This may not necessarily mean that their products are inferior, and some modification may have to be made in future drafts of this Code of Practice to allow for these differences.

Such difficulties may cause discussions to be protracted and account, at least in part, for lapse of time between the initiation of discussions and the publication of the agreed Code.

It has been said that the Food and Drugs Act works well for foods but is ineffective for the control of drugs. It is true that for many years the number of drugs submitted under the Act was small and consisted largely of the household remedies sold in small grocers and general stores. This criticism was not without substance but it was due to a number of factors. These included administrative difficulties experienced by Sampling Officers in obtaining drugs normally available only "on prescription".

During the last two years there has been much re-thinking on this aspect of drug control. During the course of manufacture of the more potent drugs, toxic substances produced by side-reactions may be introduced. It may no longer be adequate to ensure that a drug is 99 per cent. pure if the 1 per cent. of impurity is toxic. This presents a new challenge to the analyst and we are happy to have established close relations with the Pharmaceutical Society in our efforts to solve these new problems.

The administrative difficulties have been removed by a clear direction from the Ministry of Health confirming the powers of sampling officers to purchase restricted drugs.

The protection of the public in the fields outlined above demands the co-operation of a number of other people and organisations besides Public Analysts, and in particular the sampling and enforcement officers of the Local Authorities, and we value the good relations which we enjoy with these individuals and their professional organisations.

For the future we are, however, seriously concerned lest the service we render should fail through lack of new entrants. The demand for scientists is such that new graduates are confronted with a wide field in which to work. Many of these are less demanding and more lucrative. The gateway is wider as no post-graduate qualification is essential. The number of candidates coming forward for the Diploma in the Chemistry (including Microscopy) of Food, Drugs and Water of the Royal Institute of Chemistry (the essential qualification for Public Analysts) is a steadily diminishing trickle, and the number who succeed in gaining the qualification is less than that required to offset wastage due to retirement and death. Unless positive steps are taken to attract more candidates of the required calibre, the scope of service will inevitably fall.

A Joint Committee has been set up between the Royal Institute of Chemistry and this Association to investigate these problems, but without generous co-operation of the Local Authorities, it is unlikely that the present trend can be reversed.

Apart from duties imposed by the Food and Drugs Act, which provides the statutory basis for their existence, all Public Analysts' laboratories perform other functions. These include work undertaken under other Acts of Parliament such as the Fertilisers and Feeding Stuffs Act, the Merchandise Marks Act, the Petroleum Regulations and so on. The new Consumer Protection Bill, if it becomes law, may involve further work. There is a general tendency towards more scientific surveillance in all fields in which it can be of value. For this reason Public Analysts are tending more and more to act as general scientific advisors to Local Authorities. This involves a wide field of activities embracing the discharge of trade wastes into sewers, the emission of noxious fumes from industrial processes, corrosion problems, the checking of supplies against specifications and a variety of other matters which involve many departments of the Local Authority.

Many Public Analysts' laboratories also undertake a considerable volume of toxicological work for Coroners, in cases of suicidal or accidental poisoning, as well as investigating cases of suspected poisoning in animals in co-operation with veterinary surgeons.

In addition most laboratories are prepared to advise industrial firms on problems such as effluent disposal, where this is in the public interest, or on other matters where such advice does not conflict with their statutory duties.

From time to time suggestions have been made that the responsibility for the scientific work we do should be taken out of the hands of Local Authorities and organised on a national basis. This step, it is argued, would remedy the lack of co-ordination between different Local Authorities and provide a more uniform pattern of administration, more even distribution of sampling and more logical enforcement. In many respects the arguments put forward apply to the whole spectrum of local government in this country, of which the Public Analyst's service is a microcosm. The structure of Local Government is at present under review. Whatever pattern emerges, and whatever form of control, local, regional or national, is eventually decided upon, we can be confident that our laboratories are ready to serve the public as they have done for more than a century.

Fermentation Losses in Bun Loaves and Chollas

by R. A. KNIGHT

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The problems involved in assessing sugar additions to bun loaf and cholla recipes are discussed and the results of experiments designed to indicate fermentation losses in these products are given. The probable losses of sugar under commercial conditions are calculated, and the relation between the final reducing sugar content of bun loaves and chollas and the proportion of sugar added to the recipes is indicated.

Under the Weights and Measures Act, 1963, bread of net weight greater than 10 ounces can only be sold if it is of a net weight of 14 ounces or a multiple of 14 ounces. In the same Act, "flour confectionery" is defined as including bun loaves, fruit loaves, malt loaves and fruited malt loaves. Of these four products only bun loaves are not readily identified by inspection. Since bun loaves are not defined in any legislation it is important for enforcement purposes to be able to distinguish between "bread" and "bun loaves".

A somewhat similar situation exists with "chollas" which are often prepared from a dough containing fairly high levels of enriching ingredients such as fat, sugar and egg. It has been contended by the trade that "chollas" are "bun loaves" and in recent years two prosecutions have been taken involving "chollas" alleged to be deficient in weight in contravention of the Bread Order, 1953, which at the relevant times was the appropriate legislation.

At Stepney in 1961 the "chollas" in question were made from a dough containing 5 per cent. each of sugar, eggs and fat. In support of the contention that the products were "bun loaves" it was stated that "chollas" were not subject to price control during the war or taken into account in bread subsidy payments. The magistrate found that the "chollas" were not bread and were not, therefore, subject to the Bread Order, 1953. The second case was held at Salford in 1963 and involved loaves made from a recipe containing a total of 11·8% of oil, sugar and egg, based on flour weight. The stipendiary magistrate found that 10 per cent. of enriching ingredients added to the flour was the necessary criterion and that the loaves were "bun loaves".

In order to clarify the position a Baking Industry Committee in consultation with the Association of Public Analysts has drafted a Code of Practice which defines a "bun loaf" as follows:—

"A *Bun Loaf* is a loaf containing in the recipe per 100 parts by weight of flour, not less than 10 parts by weight in all of liquid whole egg (or its equivalent of dried egg), added fat and sugar, including not less than 5 parts by weight of the first two. *Chollas* possessing the same degree of enrichment should be regarded as bun loaves."

Since "fruit loaves" are, together with bun loaves, malt loaves and fruited malt loaves, included in the definition of "flour confectionery" given in the Weights and Measures Act, the addition of fruit to a "bun loaf" will not bring it outside the category of "flour confectionery" as defined in the Act.

The draft Code has been criticised on the grounds that it does not provide a standard based on the finished product, thus making it difficult for an analyst to assess whether the required quantity of enriching agents has been added. Public Analysts would prefer a standard applied to the article as sold. From the baker's point of view it would obviously be desirable to have a standard which is based on the recipe since the composition of the final product will depend on variable factors such as fermentation, baking and cooling losses.

The chief difficulty from the analyst's standpoint is the loss of sugars during fermentation of the dough. This loss will mainly depend on the yeast content of the recipe and on the time and temperature of fermentation. These factors vary widely from bakery to bakery and for this reason it is not possible to suggest a single figure representing the loss of fermentable sugars in all cases. However, it is possible to assess the loss of sugar likely to occur under "average" conditions by carrying out gassing tests on doughs made from suitable recipes. To this end, gassing tests have been carried out on doughs made from the published recipes given in Table I.

TABLE I

RECIPES OF BUN LOAVES AND CHOLLAS

	Bun loaves[1]		Chollas[2]	
	Parts by weight	Parts per 100 parts of flour	Parts by weight	Parts per 100 parts of flour
Flour	28·0		28·0	
Salt	0·3		0·5	
Yeast	1·24		0·75	
Egg	0·75	2·7	2·0	7·2
Sugar	3·0	10·7	1·0	3·6
Fat	3·0	10·7	0·75	2·7
Milk powder	0·75		—	
Water	15·1		13·0	
Total	52·14	24·1	46·00	13·5

The volumes of gas evolved during fermentation of these doughs at 80°F (27°C) are given in Table II. These volumes have been corrected to a temperature of 20°C and a pressure of 760 mm, the measurements being made on 52·1 g and 46·0 g of the bun and cholla doughs, respectively.

TABLE II

GAS PRODUCTION IN BUN AND CHOLLA DOUGHS

Fermentation time (hours)	Carbon dioxide evolved (ml) at 20°C and 760 mm	
	Bun dough	Cholla dough
1	50	45
2	156	125
3	275	208
4	395	283
5	500	340

The fundamental equation of yeast fermentation is:

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

and the theoretical yield of carbon dioxide is 249 ml/g of glucose (262 ml/g of sucrose) at N.T.P. Under practical conditions the yield of gas is less than that expected from the above equation, the efficiency under "average" conditions being about 75 per cent.[3] Temperature has a great effect on the speed of fermentation, the temperature coefficient corresponding to a 10°C increase in temperature being 2·8 at 20°C and 1·9 at 30°C.[3] Yeast quantity also has a profound effect on gas production, which increases as the proportion of yeast increases, although not necessarily in direct proportion.[4]

The approximate amount of sugar (as sucrose) fermented by the yeast in the doughs examined are given in Table III.

TABLE III

SUGAR FERMENTED IN BUN AND CHOLLA DOUGHS

Fermentation time (hours)	Sugar fermented (percentage of flour weight) Bun loaf dough	Cholla dough
1	0·86	0·77
2	2·66	2·14
3	4·68	3·54
4	6·72	4·82
5	8·50	5·79

Thus, under "average" bulk fermentation conditions and assuming total fermentation times of 3 hours and 4 hours for the bun dough and cholla dough, respectively, about 4·7–4·8 per cent. of sucrose (based on flour weight) would be lost in both cases. If a short-time system is employed, about 2–2·5 per cent. sugar is likely to be lost, whereas considerably more sugar would be fermented in the case of prolonged fermentation.

It will be seen from Table III that the amount of sugar fermented in the cholla dough in 5 hours is much greater than the amount of sugar added. This is because two additional sources of fermentable sugar are available to the yeast. These are the fermentable carbohydrates naturally present in the flour and those resulting from amylase attack on the damaged starch. The quantity of fermentable material from these two sources varies from flour to flour, the natural "sugar" content being about 1–2 per cent. The amount of maltose derived from diastatic action on the starch varies more widely but is likely to be in the range 2–4 per cent., based on flour weight. In addition, some maltose (about 1–2 per cent. on a flour basis) is produced by diastatic activity during baking.

Sucrose is inverted very rapidly in doughs and the invert sugar produced tends to be fermented in preference to maltose[5]. Furthermore, dextrose exerts a "sparing" effect on the fermentation of fructose. Thus the nature and quantity of residual sugars in bun loaves and chollas will depend on a number of factors, including the yeast level, the conditions of fermentation, the flour used and the proportion of added sugar. Under these circumstances, it is not possible from an analysis of the final product to assess with accuracy the proportion of sugar added to a recipe unless information on the relevant factors is available. However, by assuming "average" conditions of fermentation and by making allowance for the probable contribution of the flour, the added sugar may be roughly estimated from the reducing sugar content of the product.

The approximate contributions of the flour in terms of reducing sugars will be the sum of the following (expressed on a flour basis):—

(*a*) 1·5 per cent. of "sugars" natural to the flour,

(*b*) 3 per cent. of maltose resulting from amylase activity in the dough,

(*c*) 1·5 per cent. of maltose liberated by amylase action during baking.

If the reducing sugars in the product are determined by titration, using Fehling's solution, the maltose derived from sources (*b*) and (*c*) can be expressed as its equivalent in invert sugar by multiplying by 0·67. The approximate total contribution of the flour then becomes $1{\cdot}5 + (0{\cdot}67 \times 4{\cdot}5)$ per cent., or 4·5 per cent., expressed as invert sugar.

On the basis of a fermentation loss equivalent to 4·8 per cent. of sucrose, made up of the 1·5 per cent. of readily fermentable "sugars" natural to the flour and of added sucrose, the residual sugar content of a product to which has been added X per cent. sucrose, based on flour weight, will be about $[1{\cdot}05\ (X - 4{\cdot}8) + 4{\cdot}5]$ per cent., or $(1{\cdot}05X - 0{\cdot}5)$ per cent., expressed as invert sugar and also based on flour weight.

Using this estimate of residual sugar and knowing the starch content of the product, it is possible to assess the probable addition of sugar to the recipe. Table IV has been constructed on the basis that flour contains 70 per cent. of starch and that this proportion is reduced to 65 per cent. as a result of diastatic action during fermentation and baking. Because of the many variable factors affecting the sugar content of a fermented baked product, the residual sugar contents given in Table IV can only be regarded as rough estimates since they have been calculated on the assumption that "average" conditions prevail. Nevertheless, they can be used as a guide to the analyst who has little or no information on the conditions under which the product he is examining has been made.

TABLE IV

PROBABLE RESIDUAL SUGAR CONTENTS OF BUN LOAVES AND CHOLLAS MADE FROM RECIPES CONTAINING VARYING PROPORTIONS OF ADDED SUGAR

Added sucrose in recipe (per cent by weight of flour) . .	1	2	3	4	5
Residual sugar* in product (per cent. by weight of starch)	0·9	2·5	4·1	5·7	7·3

* Determined by Fehling's method and expressed as invert sugar.

In order to assess the value of Table IV laboratory tests were carried out on bun loaves and chollas made by using the recipes given in Table I. The processing conditions employed are given in Table V.

TABLE V

PROCESSING CONDITIONS USED IN MAKING BUN AND CHOLLA DOUGHS

Processing conditions	Bun dough	Cholla dough
Initial dough temperature (°F)	81	81
Dough temperature on entering prover (°F) ..	83	83
Bulk fermentation time (min.)	136	194
Proof time (min.)	29	50
Prover temperature (°F)	110	110
Baking temperature (°F)	400	400
Baking time (min.)	35	30
Dough scaling wt. (oz.)	16	15
Baked wt. (oz.)	14	13

Reducing sugars (calculated as invert sugar) were determined in the doughs just before baking and reducing sugars and starch contents in the bun loaves and chollas. The results obtained are given in Table VI which also includes the fermentation losses in the doughs and the estimated sugar contents of the recipes.

TABLE VI

COMPARATIVE SUGAR CONTENT FIGURES FOR BUN LOAF AND CHOLLA, BEFORE AND AFTER BAKING

	Bun dough	Bun loaf	Cholla dough	Cholla
Reducing sugars (as invert sugars), per cent. ..	5·1	6·9	1·6	2·8
Starch (per cent.) (—by difference)	—	43·3	—	47·7
Reducing sugars (per cent. of starch)	—	15·9	—	5·9
Fermentation loss* (per cent. of flour wt.) ..	5·9	—	4·3	—
Fermentation loss,* estimated from Table 3 (per cent. of flour wt.)	4·4	—	5·1	—
Calculated sugar addition (per cent. of flour wt.)	—	9·3	—	4·1
Actual sugar addition (per cent. of flour wt.) ..	—	10·7	—	3·6

*At 80°F and expressed as invert sugar.

The fermentation losses given in Table VI have been calculated on the assumption that the flour contributes 1·5 per cent. of sugars and that 3 per cent. of maltose is liberated as a result of amylase attack on the starch. It will be seen that the calculated fermentation losses are in reasonable agreement with those predicted from the results of the gassing tests described earlier, the differences between the calculated and predicted losses being 1·5 per cent. and 0·8 per cent. for the bun and cholla doughs, respectively. The estimates of the added sugar in the recipes were also in reasonable agreement with the actual additions and differed from these by 1·4 per cent. and 0·5 per cent. These results suggest that the proposed method of estimating the proportion of sugar added to bun loaf and cholla recipes is not likely to lead to appreciable errors if conventional processing methods are employed in the bakery.

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The Potassium, Phosphorus and Nitrogen Contents of Whole Citrus Fruits and Juices

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The potassium, phosphorus and nitrogen contents of samples of entire oranges, lemons and grapefruit, and of the corresponding juices, are given. Attention is drawn to the abnormally low potassium content of Israeli Shamouti oranges, and the consequent need for determining also the phosphorus and/or nitrogen content to assess the potable fruit content of comminuted fruit drinks.

The most widely used criteria for the determination of the potable fruit index of soft drinks of the comminuted whole-fruit type are the potassium and phosphorus contents and, to a lesser extent, the nitrogen content. Apart from those in a recent paper[1], few data have been published on the composition of entire citrus fruits as distinct from juices (the data for which are adequate), and some that have been published, e.g. those of McCance and Widdowson[2], do not indicate either the number or spread of the analyses on which the data are based. It was therefore considered that a note on the figures accumulated in these laboratories over a number of years for the composition of oranges, lemons and grapefruit would prove helpful to those engaged in the examination of comminuted drinks.

From time to time the opinion has been expressed that the potassium content of Israeli oranges is lower than that of oranges from other sources, but no results have been published to substantiate this. In 1964, therefore, with the assistance of Messrs. Medijuice Ltd. of Tel-Aviv, samples of Jaffa (Shamouti) oranges were taken from a number of orange groves in Israel, brought to London for analysis and the results compared with those for oranges from other sources.

Methods

Six oranges, six lemons, and three grapefruit were halved. To prepare the "entire fruit" sample, one half of each fruit was cut into small pieces and reduced to a fine purée in a laboratory macerator, with the addition of an equal weight of water.

The "juice" sample was expressed manually from the remaining halves on a glass reamer and strained through muslin to remove pips and coarse particles of albedo.

Potassium was determined by means of an EEL flame photometer without ashing, using an aliquot of an aqueous extract prepared with the aid of a MSE-Mullard ultrasonic disintegrator.

Phosphorus was determined after dry ashing in the presence of calcium acetate by the molybdenum blue method using hydroquinone-sulphite as reducing agent[3].

Nitrogen was determined by the Kjeldahl method.

The results are given as K, P and N per cent. by weight respectively.

Results

The results of the analyses of oranges from sources other than Israel are given in Table I.

TABLE I

THE POTASSIUM, PHOSPHORUS AND NITROGEN CONTENT OF ORANGES

Source		Entire fruit Potassium content	Entire fruit Phosphorus content	Entire fruit Nitrogen content	Fruit juice Potassium content	Fruit juice Phosphorus content	Fruit juice Nitrogen content
Spain	No. of Samples	86	86	18	42	42	18
	Average *per cent.*	0·162	0·018	0·170	0·151	0·014	0·102
	Maximum *per cent.*	0·250	0·021	0·202	0·200	0·019	0·174
	Minimum *per cent.*	0·100	0·013	0·130	0·089	0·012	0·069
South Africa	No. of Samples	72	72	36	72	72	36
	Average *per cent.*	0·166	0·018	0·181	0·160	0·014	0·103
	Maximum *per cent.*	0·216	0·023	0·238	0·219	0·021	0·149
	Minimum *per cent.*	0·099	0·014	0·131	0·104	0·0083	0·070
All sources (excluding Shamouti)	No. of Samples	221	221	61	152	152	60
	Average *per cent.*	0·166	0·018	0·181	0·160	0·014	0·103
	Maximum *per cent.*	0·278	0·028	0·246	0·284	0·021	0·180
	Minimum *per cent.*	0·099	0·013	0·120	0·089	0·0071	0·060

There is no evidence of any wide or significant differences between the K, P and N contents of oranges from Spain, South Africa and other sources (which include the U.S., Brazil, and various Mediterranean countries other than Israel).

The results for Shamouti oranges are given in Table II.

TABLE II

THE PHOSPHORUS AND POTASSIUM CONTENTS OF ISRAELI (SHAMOUTI) ORANGES

Orange grove	Entire fruit Potassium content *per cent.*	Entire fruit Phosphorus content *per cent.*	Fruit juice Potassium content *per cent.*	Fruit juice Phosphorus content *per cent.*
1	0·121	0·021	0·142	0·018
2	0·126	0·020	0·152	0·017
3	0·128	0·021	0·147	0·018
4	0·110	0·019	0·128	0·017
5	0·118	0·020	0·131	0·016
6	0·133	0·022	0·153	0·018
7	0·126	0·020	0·146	0·017
8	0·104	0·017	0·133	0·015
9	0·092	0·017	0·110	0·014
10	0·141	0·018	0·154	0·015
11	0·132	0·021	0·148	0·018
12	0·159	0·022	0·178	0·019
13	0·120	0·015	0·137	0·015
14	0·116	0·021	0·136	0·018
15	0·123	0·017	0·138	0·014
Average	0·123	0·020	0·142	0·017
Maximum	0·159	0·022	0·178	0·019
Minimum	0·092	0·017	0·110	0·014

The results show that the potassium content of this variety of orange is indeed subnormal, particularly in the entire fruit. On the other hand, the phosphorus content is normal, and the indications are that the nitrogen content is also normal, the average obtained for 5 samples being 0·185 per cent. N (0·171 to 0·203 per cent.).

An additional feature of these results is that the potassium content of the entire fruit is less than that of the corresponding juice; in other varieties the entire fruit normally, but not invariably, has the higher content.

Figures made available by the courtesy of Mrs. Samish of the Rehovot Agricultural Research Station showed that over a number of years potassium contents of similar order to those given in Table II had been recorded, and therefore the low values obtained by us were not due to seasonal variations. We found that the potassium content of Valencia-type oranges grown in Israel in the same areas as the Shamouti oranges is normal and in accord with the figures given in Table I. It would therefore appear that the low potassium content of Shamouti oranges is a varietal rather than an environmental characteristic.

The results for lemons and grapefruit are given in Tables III and IV.

TABLE III

THE POTASSIUM, PHOSPHORUS AND NITROGEN CONTENTS OF LEMONS

			Entire fruit			Fruit juice		
Source			Potassium content	Phosphorus content	Nitrogen content	Potassium content	Phosphorus content	Nitrogen content
Mediterranean	No. of Samples		15	15	8	15	15	8
	Average	per cent.	0·197	0·022	0·203	0·148	0·011	0·067
	Maximum	per cent.	0·230	0·033	0·244	0·189	0·014	0·084
	Minimum	per cent.	0·130	0·013	0·127	0·115	0·0061	0·042
South African	No. of Samples		9	9	8	9	9	7
	Average	per cent.	0·204	0·020	0·134	0·137	0·0096	0·045
	Maximum	per cent.	0·250	0·023	0·167	0·166	0·014	0·061
	Minimum	per cent.	0·157	0·018	0·108	0·108	0·0079	0·035
Unknown	No. of Samples		49	49	41	49	49	41
	Average	per cent.	0·192	0·020	0·163	0·147	0·010	0·059
	Maximum	per cent.	0·306	0·032	0·305	0·193	0·014	0·084
	Minimum	per cent.	0·129	0·0092	0·097	0·108	0·0052	0·035
All Samples	No. of Samples		73	73	57	73	73	56
	Average	per cent.	0·195	0·021	0·165	0·146	0·010	0·058
	Maximum	per cent.	0·306	0·033	0·305	0·193	0·014	0·084
	Minimum	per cent.	0·129	0·0092	0·097	0·108	0·0052	0·035

TABLE IV

THE POTASSIUM, PHOSPHORUS AND NITROGEN CONTENTS OF GRAPEFRUIT

			Entire fruit			Fruit juice		
Source			Potassium content	Phosphorus content	Nitrogen content	Potassium content	Phosphorus content	Nitrogen content
Mediterranean	No. of Samples		20	20	20	20	20	20
	Average	per cent.	0·146	0·016	0·157	0·119	0·0096	0·067
	Maximum	per cent.	0·195	0·021	0·203	0·151	0·021	0·094
	Minimum	per cent.	0·108	0·012	0·124	0·094	0·0070	0·050
West Indian and South American	No. of Samples		15	15	15	15	15	15
	Average	per cent.	0·171	0·017	0·124	0·124	0·011	0·052
	Maximum	per cent.	0·235	0·021	0·146	0·162	0·019	0·072
	Minimum	per cent.	0·150	0·011	0·100	0·080	0·0079	0·032
South African	No. of Samples		5	5	5	5	5	5
	Average	per cent.	0·183	0·015	0·161	0·145	0·011	0·067
	Maximum	per cent.	0·203	0·019	0·200	0·168	0·016	0·087
	Minimum	per cent.	0·160	0·011	0·128	0·128	0·0078	0·056
All Samples	No. of Samples		40	40	40	40	40	40
	Average	per cent.	0·160	0·016	0·145	0·124	0·010	0·061
	Maximum	per cent.	0·235	0·021	0·203	0·168	0·019	0·094
	Minimum	per cent.	0·108	0·011	0·100	0·080	0·0070	0·032

The Coefficients of Variation (*viz.* the standard deviation expressed as a percentage of the mean), for the data on entire fruit are given in Table V.

TABLE V

COEFFICIENTS OF VARIATION FOR ENTIRE FRUIT

		Potassium *per cent.*	Phosphorus *per cent.*	Nitrogen *per cent.*
Oranges	Spanish	18·9	9·1	11·6
	South African	14·2	10·5	14·0
	All sources except Israeli Shamouti	19·3	15·0	15·0
	Israeli Shamouti	15·7	7·2	—
Lemons	Mediterranean	14·6	26·1	—
	South African	15·4	—	—
	Unknown	20·5	25·3	29·6
	All sources	18·9	23·6	27·4
Grapefruit	Mediterranean	16·0	15·1	13·5
	West Indian	14·3	16·9	10·7
	All sources	18·4	14·5	16·5

These data support the conclusion of Hulme, Morries and Stainsby[1], that the phosphorus content of an orange product is probably the most satisfactory measure of the potable fruit content. In the case of lemons, the potassium content has the smallest variation, and in that of grapefruit the potassium, phosphorus and nitrogen have similar variabilities.

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