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The Iodine Content of Foodstuffs in Relation to the Occurrence of Endemic Goitre in the Langkloof Valley.

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THE literature relating to the problem of iodine metabolism with and without regard to deficiency diseases has been reviewed so comprehensively in recent years that a general discussion will not be attempted in this paper. Only work having a direct bearing will be considered. Von Fellenberg (1926), McClendon (1927), Scharrer (1928), and Orr and Leitch (1929) have all given full accounts of the existing literature, while Hercus and co-workers (1925, 1927, 1931) published valuable information regarding the problem of endemic goitre in New Zealand.

In Switzerland Von Fellenberg found an inverse relationship between the iodine content of foodstuffs and the incidence of goitre, and this has been confirmed by McClendon in America, and Hercus and co-workers in New Zealand. Orr and co-workers, however, were unable to trace any definite correlation between the level of iodine in drinking-water and foods and the incidence of goitre in the British Isles, but judging by the rôle of iodine in the treatment and prevention of the disease they surmise that deficiency of iodine may have a causal relationship to overgrowth of the thyroid. Scheffer (1932), on the other hand, believes that while deficiency of iodine may be a contributing factor for the development of goitre, there are other and perhaps more important constitutional factors.

OUTLINE OF THE INVESTIGATION.

Following a report in 1929 by the medical officer of health for the Union, "Endemic Goitre in the Komgha Valley, Uniondale District" the Senior Chemist in charge of the Government Chemical Laboratories, Pretoria, obtained samples of water, vegetation and foodstuffs from this area for analysis. Unfortunately this program could not be carried out and nothing further was done until the present investigation was started.

In his report the medical officer mentions the high incidence of goitre in some of the valleys on either side of Langkloof, especially in the neighbourhood of Joubertina. The inhabitants of some of these valleys were medically examined and the following figures taken from the report represent the positive goitres encountered:—

Hoeree Valley	79%
Children at Kleinrivier school	93%
Children at Krakeel school	69%

At Joubertina Secondary School no obvious goitres were encountered except in the case of those pupils whose homes are in the valleys where goitre occurs.

It was decided to visit these valleys personally to collect samples of food in order to safeguard against iodine contamination in transit. The tour was undertaken in September, 1932, so that samples of leafy vegetables and grass could be obtained in an immature stage.

Two of the goiterous valleys—Hoeree and Kleinrivier—were visited. They run more or less parallel to each other and at right angles to Langkloof. They lie between longitude east 24° and 24° 15′ and latitude south 33° 40′ and 33° 50′. The Langkloof Valley lies along the course of the Kouga River between the Kouga and Langkloof Mountains near the south coast of the Cape Province, and stretches from George District through Uniondale District to Humansdorp District for approximately 100 miles. Both the Hoeree and Kleinrivier streams originate in the Kouga Mountains and are tributaries of the Kouga River. The geological formation is Table Mountain sandstone. Entrance to the valleys is along the river beds and in times of flood these roads are impassable and communication with the outside world is cut off.

The valleys are very narrow, the sides precipitous and about 1,500 feet high. Furthermore, they extend north-south so that some of the dwelling-houses only have a few hours sunshine daily. The inhabitants are extremely poor and are dependant on the produce grown locally for their food, except meat, which is obtained from the Joubertina butchery when the necessary funds are available. Meat, however, is considered a delicacy and is available only about once or twice a month. On the whole very little green vegetables are eaten.

The daily diet is made up as follows:—

Breakfast.—Black coffee usually without sugar with dry bread and wheat meal or mealie meal porridge, very often without the addition of milk or sugar.

Dinner.—Bean or potato soup, samp or potatoes depending on the variety of soup, dry bread and coffee. The soup is usually prepared without the addition of meat or meat extract.

Supper.—The food left over from the previous meal is consumed in the evening.

This menu clearly demonstrates tbat a very large precentage of the diet consists of starchy food and the main sources of proteins are beans, wheat, meat and eggs, the latter two only eaten occasionally. Very little, if any, leafy vegetables are eaten and the children prefer bread and dripping to greens. Oranges and mandarines are grown to some extent and these are relished while the season lasts. It is interesting to note that this diet corresponds closely with that described by Bodnár and Straub (1930) for the inhabitants of Bodahegyközség in Hungary, where the incidence of goitre amongst children at school is 82 per cent.

Samples of water, food, pasture and soil were collected from the two valleys and transported to Onderstepoort where the samples of food and pasture were dried in the shade and prepared for analysis.

During May this year Mr. Du Toit, the Extension Officer at Humansdorp kindly collected some more samples of foodstuffs from Hoeree and Kleinrivier and also from Twee River, a non-goiterous valley in the neighbourhood of the other two valleys. These samples represent the crop for the 1932-1933 season. For comparative purposes samples of foodstuffs were obtained from different parts of South Africa where endemic goitre is unknown. The food was produced in the areas stipulated and should not be looked upon as market samples.

The results are given in Tables I to V, together wither with some figures taken from the literature. They are summarized in Table VI.

TABLE I.

Iodine Content of Eggs.

Origin of Sample.	Nature of Area.	Iodine expressed as γ per 100 gm. fresh weight.
Joubertina { Hoeree	G.	5·2, 4·8, 4·6.
Joubertina { Kleinrivier	G.	4·1, 4·1.
Joubertina { Tweerivier	NG.	10·5, 9·7.
Graaff-Reinet	NG.	31, 31·5, 51.
Montagu	NG.	10·2, 5·3, 12·7.
Louis Trichardt	NG.	8·6, 11·0, 13·0, 18·2.
Pretoria, Onderstepoort	NG.	5·9, 7·1.
Pretoria	NG.	3·9, 5·5, 6·0, 7·0, 8·0.
Pretoria, Pyramid	NG.	6·1, 7·2, 7·5.
	From Literature.	*Investigator.*
Switzerland	NG.	21·5 v. Fellenberg (1923 & 1924).
Switzerland	G.	8·0, 14·7 v. Fellenberg (1923 and 1924).
Europe	Market samples.	1·2, 2·2, 2·7 v. Fellenberg (1923 and 1924).
New Zealand	NG, Average of 18.	13·7 Hercus and Roberts (1927).
New Zealand	G. Average of 20.	5·6 Hercus and Roberts (1927).
Scotland	N.G. Average of 41.	10·2 Orr (1930).
Scotland	G. Average of 15.	8·6 Orr (1930).
England	Low incidence Average of 56	6·9 Orr (1930).
England	High incidence Average of 52	8·5 Orr (1930).

G. represents Goitre area and N.G. areas where endemic goitre is unknown.

TABLE II.

Iodine Content of Potatoes.

Origin of Sample.	Nature of Area.	Water Content %	Iodine expressed as γ per 100 gm.	
			Fresh Weight.	Dry Weight.
Joubertina — Hoeree (1929)....	NG	—	—	113, 111.
Joubertina — Hoeree (1929)....	G	—	—	104, 107, 113, 113.
Joubertina — Hoeree (1932)....	G	79	3·3, 4·2	15·7, 20·0.
Joubertina — Hoeree (1933)....	G.	77·7	28·3	127·0.
Joubertina — Kleinrivier (1929)	G.	—	—	79, 82·5, 85.
Joubertina — Kleinrivier (1932)	G.	75	4·9, 5·8	19·6, 23·2.
Joubertina — Kleinrivier (1933)	G.	78·9	34·3	163·0.
Joubertina — Twee River (1933)	NG.	78·2	27·8	127·3.
Graaff Reinet	,,	77	17·3	75·2.
Montagu	,,	73·8	8·7	33·2.
Pietersburg	,,	78	21·6	98·2.
Machadodorp	,,	75·3	5·5	22·3.
Pretoria — Pretoria North...	,,	80·5	2·9	14·9
Pretoria — Silverton.....	,,	78·2	3·0, 3·1	13·8, 14·2.
Pretoria — Daspoort No. 1..	,,	80·4	20·5, 16·4	105, 84.
Pretoria — Eerste Fabrieke..	,,	78·5	19·6	91·2.
Pretoria — Pyramid.....	,,	79·6	15	73·5.
Pretoria — Eloffsdal.....	,,	78·4	24·5	113.
Pretoria — Daspoort No. 2..	,,	77·8	2·9	13·1.
Pretoria District.....	,,	77·0	21·5	93·5.
	From Literature.			*Investigator.*
Hungary.....	G.	—	8·35	Scheffer (1932).
Hungary.....	NG.	—	1·5	Bodnár and Straub (1930).
Hungary.....	G.	—	0·5	Bodnár and Straub (1930).
Austria.....	Market sample, Vienna	—	1·0–1·8	Mayhofer, etc. (1932).
New Zealand.....	Market sample	—	1·0, 2·2	Hercus and Roberts (1927).
Germany.....	Market sample	80·9	5·0	Scharrer and Schwaibold (1928).
Scotland.....	NG.	Average of 5 samples	9·6	Orr.
England.....	Low incidence	Average of 10 samples	10·0	Orr.
England.....	High incidence	Average of 7 samples	10·3	Orr.

TABLE III.

Iodine Content of Wheat.

Origin of Wheat.	Nature of Area.	Water Content %	Iodine expressed as γ per 100 gm.	
			Fresh Weight.	Dry Weight.
Jou-bertina { Hoeree (1929)....	G.	—	—	10·1, 10·5, 11·0.
Jou-bertina { Hoeree (1932)....	G.	11·7	8·5, 9·2, 9·6	9·6, 10·4, 10·9.
Jou-bertina { Hoeree (1933)....	G.	11·9	4·3	4·9.
Jou-bertina { Kleinrivier (1932)	G.	10·7	15, 15	16·8, 16·8.
Jou-bertina { Kleinrivier (1933)	G.	12·0	3·8	4·2.
Jou-bertina { Tweerivier (1933)	NG.	12·4	3·8	4·3.
Graaff Reinet.....	NG.	9·5	3·3	3·6
Montagu.....	NG.	10·9	5·0	5·6
Lydenburg.....	NG.	10·6	10·2	11·4
Ceres.....	NG.	10·3	3·9	4·3
Ficksburg.....	NG.	9·8	1·8	2·0
Pietersburg.....	NG.	11·3	2·4	2·7
Pretoria.....	NG.	8·4	3·1	3·4
	From Literature.			*Investigator.*
U.S.A.....	Market sample	—	4·8, 6·4	v. Fellenberg (1924 2.)
Canada.....	,,	—	0·3, 2·6, 5·6	v. Fellenberg (1923)
South America.....	,,	—	0·2, 2·8	,, ,,
Australia.....	,,	—	1·9, 4·4	,, ,,
Roumania.....	,,	—	0·2, 2·8	,, ,,
Switzerland.....	,,	—	2·6, 2·7, 4·0	,, ,,
Wheat Flour Germany.....	NG.	—	14·2, 9·5	Bleyer (1926).
Wheat Flour Germany.....	NG.	—	9·3	Bleyer (1926).
Wheat Flour Hungary.....	G.	—	12·0	Scheffer (1932).

TABLE IV.

Iodine Content of Mealies.

Origin of sample.	Nature of Area.	Water Content. %	Iodine expressed as γ per 100 gm. on.	
			Fresh Weight.	Dry Weight.
Jou-bertina { Kleinrivier (1932)	G.	10·3	5·2, 5·2, 5·4	5·8, 5·8, 6·0
Jou-bertina { Kleinrivier (1933)	G.	10·1	3·8	4·2
Jou-bertina { Hoeree (1933)....	G.	11·1	4·7	5·3
Jou-bertina { Tweerivier (1933).	NG.	12·0	3·8	4·3
Graaff Reinet.....	NG.	11·3	4·0	4·5
Montagu.....	NG.	10·5	3·2	3·6
Pretoria District.....	NG.	10 8	11 3	12·7
Pretoria District.....	NG.	8·7	2·4	2·6
Pretoria District.....	NG.	8·0	1·8	2·0
Heilbron.....	NG.	8·5	3·9	4·3
Pretoria.....	Market sample	8·1	3·8	4·1
Pretoria.....	,,	10·1	2·4	2·7
Pretoria.....	,,	9·0	1·9	2·1
Pretoria.....	,,	10·5	3·3	3·7
	From Literature.			*Investigator.*
Italy.....	Market sample	—	1·2	v. Fellenberg (1924. 2).
Germany.....	,,	12·9	9·0	Scharrer and Schwaibold (1928).

TABLE V.

Iodine Content of Dry Beans.

Origin of Sample.	Nature of Area.	Water Content %	Iodine expressed as γ per 100 gm.	
			Fresh Weight.	Dry Weight.
Joubertina: Hoeree (1932)....	G.	11·3	5·0, 5·3, 5·7	5·6, 6·0, 6·4
Joubertina: Hoeree (1933)....	G.	11·8	4·6	5·2
Joubertina: Kleinrivier (1932)	G.	11·8	3·4, 4·0, 4·4	3·9, 4·5, 5·0
Joubertina: Kleinrivier (1933)	G.	11·1	3·2	3·6
Joubertina: Tweerivier (1933)	NG.	10·9	4·7	5·3
Graaff Reinet.....	,,	9·3	7·5	8·3
Montagu.....	,,	11·2	6·7	7·5
Ceres.....	,,	9·7	7·1	7·9
Western Cape Province.....	,,	9·5	6·7	7·4
Hylands Natal.....	,,	8·5	5·8	6·3
Pretoria.....	,,	9·5	6·1	6·7
Nylstroom.....	,,	8·5	1·95	2·1
"Soya beans" Hylands Natal	,,	5·9	3·6	3·8
	From Literature.			*Investigator.*
Hungary.....	G.	—	26·4	Scheffer (1932).
U.S.A.....	G.	—	2·9	McClendon & Hath (1924).
Hungary.....	NG.	—	0·8	Bodnár & Straub (1930).
Switzerland.....	G.	—	2·5	v. Fellenberg (1926).
Austria.....	Market	—	3·9	Mayrhofer, etc. (1932).
Germany.....	Market	19·5	9·0	Scharrer & Schwaibold (1928).
"Soya beans," Germany....	Market	11·2	17·0	Scharrer & Schwaibold (1928).

TABLE VI.—Summary of Results.

Iodine expressed as γ per 100 gm. fresh weight of eggs and per 100 gm. dry weight of other foodstuffs.

Foodstuff.	Goitre free areas.		Goitre areas.	
	Range.	Average.	Range.	Average.
Eggs.....	3·9–51·0	13·2	4·1–5·2	4·5
Potatoes.....	13·1–127·5	66·4	15·7–162	90·3
Wheat.....	2·0–11·4	4·7	4·2–16·8	9·3
Mealies.....	2·0–12·7	4·9	4·2–6·0	5·2
Dry Beans.....	2·1–8·3	6·2	3·6–6·4	5·0

One of the main essentials in a study of the relationship between the iodine content of foodstuffs and the incidence of goitre is the existence of isolated endemic goitre areas where the inhabitants are dependent on the produce grown locally. These conditions usually only prevail in the case of small islands and valleys not easily accessible. Small inhabited islands, however, are usually free from goitre and the modern methods of transport leave few valleys inaccessible. Consequently a large amount of the food consumed in goitre areas can be procured from somewhere else and, although locally grown samples are collected, they may not represent the food of the inhabitants.

Geographically the Hoeree and Kleinrivier Valleys are practically inaccessible, and as the inhabitants are very poor, they are forced to rely on the produce grown locally for their existence. The high incidence of goitre prevailing in these valleys naturally makes them ideal goitre areas from which to collect samples of food for iodine analysis. Consequently, it was anticipated that, if goitre is due primarily to deficiency of iodine, it would be possible to trace some relationship between the iodine content of food and the occurrence of goitre.

Tables I to V show that no such relation exists. The only foodstuffs of which the iodine content is lower for the goitre areas than that for the other areas are eggs and dry beans, but this difference is more than compensated for by the high iodine content of potatoes and wheat, which form the staple diet of the inhabitants. In normal areas also, such wide variations are encountered in the iodine content of potatoes, eggs, and beans, that the occurrence of goitre cannot be ascribed primarily to the lower iodine content of eggs and beans obtained from the valleys.

The iodine content of plants is dependent on various factors, e.g. the amount and state of the iodine present in the soil, climatic conditions and perhaps the variety of a particular type of plant. It is not known to what extent these different factors contribute to the fixation of iodine by the plant. Possibly the iodine content is also governed by the stage of growth in a manner similar to that obtained in the case of grass which is described in the following paper. Some work has already been done in this connection, but the results do not warrant any definite conclusion at this stage.

It is interesting to note that, although very wide variations are met with in the case of potatoes and wheat, the iodine present in dry beans and mealies remains fairly constant. Only one sample of mealies was found to be high in iodine and this sample was collected before maturity was reached.

SUMMARY.

Iodine was determined in foodstuffs from different parts of South Africa including those from endemic goitre areas in the Uniondale district, and such widely differing results were obtained that no fixed relationship could be established between the iodine content of foodstuffs and the incidence of goitre.

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