ANALYSIS OF CEYLON FOODSTUFFS

VII.—FURTHER ANALYSES OF LOCAL FOODSTUFFS WITH PARTICULAR REFERENCE TO THEIR MINERAL COMPOSITION

A. W. R. JOACHIM, Ph.D. (Lond.), Dip. Agric. (Cantab.),
CHEMIST,

S. KANDIAH, Dip. Agric. (Poona),
ASSISTANT IN AGRICULTURAL CHEMISTRY
AND
D. G. PANDITTESEKERE, Dip. Agric. (Poona),
ASSISTANT IN AGRICULTURAL CHEMISTRY

SINCE the publication of the articles on the analysis of Ceylon foodstuffs in *The Tropical Agriculturist* of January, 1938 (1), analyses have been made of locally-grown foods which had not been examined or had only been partially examined before. The results of these analyses are now published, as they may be of value to those who are interested in the practical aspects of nutrition in the Island. The paper has, for the sake of convenience, been divided into two sections. The first deals with the analyses of 18 varieties of grains, roots, yams, tubers, and seeds; the second with the comparative mineral composition of 23 vegetable samples obtained from three important marketing centres. The data are presented in three tables.

In all cases, only the edible portion of the foodstuff was analysed. The methods of analysis adopted were the same as in the earlier investigations, except in regard to the iron determinations for which a Lovibond tintometer was used in making the colour comparisons. Some of the iron results were checked by the thioglycollic acid method. Potassium was estimated in a few samples by the volumetric cobaltinitrite method.

SECTION I.

The foodstuffs examined were the yellow, purple, and white varieties of adlay, dried palmyra root (raw and parboiled), wild breadfruit and *Cycas* seeds (*madu* S.), dioscorea, alocasia and colocasia yams, artichoke (local), country potato (*innala* S.), and young-coconut water. The mineral constituents of gingelly, king yam, and sweet potato were also determined. Table I shows the proximate composition of the foods mentioned and Table II their mineral composition. In the latter table, the mineral analyses of local samples of rice, green gram, and kurakkan, which have already been published in part, are included for comparison. Attention may be drawn to the magnesium data which are presented for the first time. Rice is poorer in this mineral constituent than kurakkan or green gram.

TABLE I

The Composition of Local Foodstuffs.

Name.	Botanical Name.	Sinhalese Name.	Tamil Name.	Moisture Per Cent.	Protein Per Cent.	Carbo-hydrate Per Cent.	Ether Extract Per Cent.	Fibre Per Cent.	Mineral Matter Per Cent.	Calorific Value per 100 Gms.
Grains, Seeds, and Roots—										
Adlay (yellow)	Coix lachryma-jobi	Kirindi	Netpavalam	11·3	10·3	74·3	3·1	0·29	0·70	366·3
„ (purple)	do.	do.	do.	10·2	11·7	73·1	3·8	0·32	0·87	373·4
„ (white)	do.	do.	do.	10·1	12·1	72·7	3·8	0·31	0·99	373·4
Wild breadfruit seed	Artocarpus nobilis	Wal-del, bedi-del	Asinippala	7·8	13·1	42·7	34·2	—	2·2	541·0
Cycas seed	Cycas circinalis	Madu	Madukoddai	11·0	12·3	72·9	1·5	0·43	1.9	354·3
Dried Palmyra root (raw)	Borassus flabellifer	Kottaikilangu	Odiyal	15·6	3·8	75·7	1·0	1·8	2·0	327·0
„ „ (parboiled)	do.	do.	Pulukkodiyal	13·4	4·6	77·2	1·2	1·6	2·1	332·0
Yams, Tubers, &c.—										
Coco	Alocasia indica	Desaiala	Sembu	77·7	1·2	18·8	0·13	0·45	1·6	81·2
Taro, Tannia	Colocasia antiquorum	Gahala or Dehiala	do.	67·2	1·8	29·6	0·12	0·42	0·85	126·1
Country potato	Coleus parviflorus	Innala	—	77·6	1·3	19·7	0·18	0·35	0·87	84·7
—	Dioscorea bulbifera	Udala	Mothakavallie	82·5	0·96	15·3	0·13	0·42	0·63	66·4
Artichoke, Jerusalem	Helianthus tuberosus	—	—	79·7	1·9	16·7	0·03	0·59	1·1	74·7
Young-coconut water	Cocos nucifera	Kurumba	Ilaneer	94·8	0·08	4·2	0·10	—	0·51	17·3
King coconut water	do.	Tambili	Sevilaneer	94·5	0·07	4·3	0·11	—	0·44	17·3

TABLE II

The Mineral Composition of Local Foodstuffs.

Name.	Moisture Per Cent.	Mineral Matter Per Cent.	Calcium Per Cent.	Phosphorous Per Cent.	Iron Mgm. Per Cent.
Yams, Roots, and Tubers—					
King yam (Jaffna)	75·3	0·77	0·01	0·09	1·1
Sweet potato	72·7	0·58	0·03	0·02	0·8
Desaiala (1)	77·8	1·6	0·02	0·10	—
,, (2)	75·2	1·4	0·02	0·11	—
Gahala or Dehiala (1)	67·2	0·85	0·02	0·12	—
,, (2)	70·3	0·98	0·04	0·14	—
Innala	77·6	0·87	0·03	0·05	—
Artichoke	79·7	1·1	0·02	0·08	—
Palmyra root (raw)	15·6	2·0	0·04	0·17	—
,, (boiled)	13·7	2·1	0·03	0·17	—
Udala (aerial tuber)	82·5	0·63	0·01	0·02	—
Grains, Oil Seeds, &c.—					
Gingelly	6·4	6·5	1·39	0·47	19·6
,,	6·0	6·6	1·38	0·50	10·7
Adlay (yellow)	11·3	0·70	0·005	0·30	—
,, (purple)	10·2	0·87	0·006	0·40	—
,, (white)	10·1	0·99	0·006	0·51	—
Average	*10·5*	*0·85*	*0·006*	*0·40*	Magnesium Per cent.
Rice (country)	13·2	0·91	0·02	0·39	0·06
,, (hill)	15·3	0·80	0·02	0·32	0·05
Green gram	9·3	3·7	0·17	0·38	0·19
Kurakkan	12·6	2·7	0·37	0·26	0·17
Wild breadfruit seed	7·8	2·2	0·07	0·29	—
Madu seed	11·0	1·9	0·07	0·18	Potassium Per cent.
Mature-coconut water	94·9	0·51	—	0·013	0·19
Young-coconut water	94·8	0·51	—	0·005	0·24
King coconut water	94·5	0·44	—	0·005	0·21

The following points in the tables call for comment :—

(1) *Adlay* compares favourably with dry grains in protein and fat, but its total mineral content is low. It is also low in fibre and is, in this respect, very similar to rice. Its phosphorus content (0·40 per cent.) is higher than that of kurakkan (0·26 per cent.) and rice (0·35 per cent.). It is, however, extremely deficient in calcium, being even more so than rice. Adlay is thus an unbalanced food so far as the essential minerals are concerned and cannot be used like kurakkan, which is rich in calcium, to supplement the deficiency of rice in this element. The three varieties of the grain are similar in composition, but the white variety appears to be of somewhat higher nutritive value than the other two.

(2) *Palmyra Root.*—Dried palmyra root, whether raw or parboiled, is mainly a carbohydrate food. Its protein, fat and calcium contents are low, but its supply of phosphorus is fair. There is but little analytical difference between the raw and parboiled products.

(3) *Cycas seed* (*Madu* S.) flour is relatively rich in protein but is mainly a carbohydrate food. It has a fairly high phosphorus content, but its calcium content is low. The flour is reported to contain certain toxic constituents which give it narcotic properties. It should not, therefore, be consumed regularly for any length of time, and when used for making food preparations is best mixed with two to three parts by weight of rice flour (6).

(4) *Yams, Tubers, &c.* are all starchy foods. They differ but little in analytical composition, but artichoke is relatively poorer in fat than the other samples examined. Yams are generally poor in calcium ; some of them, *viz.*, the colocasias and the alocasias (*desaiala* and *dehiala* S.) are rich in phosphorus. The iron contents of two samples of yams are low.

(5) *Oil Seeds, &c.*—The mineral analyses of gingelly indicate that it is a very good source of calcium, phosphorus and iron. This is a food crop the cultivation of which should be encouraged in Ceylon, for the reason that, in addition to being well supplied with the essential mineral constituents, it is rich in protein and fat (1). A minor food product of some interest, from the nutritive standpoint, is wild breadfruit (*wal del* S.) seed. Unlike jak, this seed is essentially an oilseed. It contains 34 per cent. of oil and 13 per cent. of protein and is fairly well supplied with phosphorus but is relatively poor in calcium.

Young-Coconut Water.—With a view to making the investigation on the nutritive values of local foods more complete, samples of king coconut (*tambili* S.) and young-coconut (*kurumba* S.) water were examined and compared with that of a mature coconut. Carbohydrates are the main constituents of the water of young coconut. Reducing sugars (3·95 and 3·46 per cent. respectively) amount, on the average, to over 85 per cent. of the total carbohydrates. Cane sugar is present only in small quantities (0·31 and 0·56 per cent.) In the water of mature coconut, the total carbohydrate content is lower (2·5 per cent. in one sample), but the sucrose content is relatively much higher (1·9 per cent.). Apparently, as the coconut matures, reducing sugars are converted into cane sugar. A similar observation has been made by Cochran (3).

SECTION II

In order to determine to what extent, if any, variations in the soil and climatic conditions under which vegetables are grown affect their mineral composition, samples of three leafy vegetables and three non-leafy vegetables were obtained from Colombo, the Jaffna Peninsula, and Kandy for determination of the mineral constituents, calcium, phosphorus, and iron. The Jaffna leafy vegetable samples were obtained from Tellippalai and Chunnakam and are indicated as (I) and (II) respectively in Table III which shows the complete results.

For Table III see page 341.

It will be noted from a study of this table that :

(i) In the case of the leafy vegetables, the Chunnakam samples are appreciably richer in calcium than the rest. The comparatively low calcium content of the Tellippalai samples is difficult to explain, as the soils of Chunnakam and Tellippalai are both derived from Miocene limestone and would be expected to be rich in lime. *Agathi* leaf appears to be richer in calcium than the other leafy vegetables. This was noted in the previous analyses also (4). The percentages of phosphorus in the leafy vegetables do not differ to any appreciable extent. Local leafy vegetables are rich in iron. Variations in their content of this element do not appear to be connected with the place of origin, but the Jaffna amaranth samples (*tampala* S.) are characteristic in being abnormally rich in this constituent. Repeated analytical determinations have confirmed this result. The only explanation that can be offered is that these samples were of a more tender age than those from Colombo and Kandy.

(ii) The non-leafy vegetables from Jaffna appear to be richer than the Colombo and Kandy samples in phosphorus and iron, but not in calcium. These vegetables have, on the whole, considerably lower calcium and iron contents than the leafy vegetables. "Ladies fingers" are richest and tomatoes poorest in calcium.

A comparison of the calcium and phosphorus percentages of local vegetables with those of corresponding Indian samples confirms what has been found previously (4, 5), *viz.*, that local vegetables compare unfavourably with Indian samples in regard to calcium and, to a lesser degree, phosphorus.

SUMMARY

Further analyses of samples of local foodstuffs with particular reference to their mineral composition and the variation of the latter with place of origin of the foodstuff, have shown that (i) yams, in general, are a poor source of calcium, but that the alocasias and colocasias are relatively well supplied with phosphorus ; (ii) gingelly is second only to the leafy vegetables as a

TABLE III

The Mineral Composition of Local Foodstuffs.

Name.	Botanical Name.	Sinhalese Name.	Tamil Name.	Place.	Moisture Per Cent.	Ash Per Cent.	Calcium Per Cent.	Phosphorus Per Cent.	Iron Mgm. Per Cent.
Leefy Vegetables—									
Drumstick	Moringa oleifera	Murunga	Murungai	Jaffna (1)	78·8	2·4	0·37	0·10	8·3
				,, (2)	77·9	3·1	0·64	0·09	9·6
				Average	*78·3*	*2·7*	*0·50*	*0·09*	*8·9*
				Colombo	78·6	2·9	0·35	0·09	10·7
				Kandy	77·1	2·2	0·39	0·08	5·2
				General average	*78·1*	*2·6*	*0·44*	*0·09*	*8·4*
Agathi	Sesbania grandiflora	Kathurumurunga	Agaththi	Jaffna (1)	78·9	2·0	0·38	0·10	5·3
				,, (2)	77·7	3·2	0·93	0·06	7·8
				Average	*78·3*	*2·6*	*0·66*	*0·08*	*6·5*
				Colombo	79·6	2·7	0·59	0·07	7·3
				Kandy	79·0	2·4	0·49	0·07	7·7
				General average	*78·8*	*2·6*	*0·59*	*0·07*	*7·0*
Amaranth (spp.)	Amarantus paniculatus	Tampala	Keerai	Jaffna (1)	89·7	2·9	0·26	0·10	32·6
				,, (2)	88·9	4·2	0·37	0·09	32·8
				Average	*89·3*	*3·6*	*0·34*	*0·09*	*32·7*
				Colombo	85·4	3·3	0·50	0·07	9·3
				Kandy	87·1	2·8	0·25	0·08	9·2
				General average	*87·8*	*3·3*	*0·34*	*0·08*	*20·9*
Other Vegetables—									
Brinjal	Solanum melongena	Battu	Kaththarikkai	Jaffna	92·8	0·70	0·02	0·07	1·1
				Colombo	91·6	0·71	0·01	0·03	0·5
				Kandy	92·3	0·62	0·01	0·035	0·6
Ladies fingers	Hibiscus esculentus	Bandakka	Vendikkai	Jaffna	90·8	0·84	0·07	0·09	1·8
				Colombo	92·9	0·62	0·06	0·045	0·7
				Kandy	89·4	0·86	0·07	0·05	1·3
Drumstick	Moringa oleifera	Murunga	Murungakai	Jaffna	87·1	0·97	0·02	0·11	1·5
				Colombo	86·4	0·76	0·03	0·03	1·1
				Kandy	88·2	0·94	0·02	0·05	0·5
Tomato	Lycopersicum esculentum	Takkali	Thakkali	Jaffna	93·6	0·78	0·01	0·06	1·2
				Kandy	94·6	0·66	0·004	0·02	0·5

rich source of calcium and iron ; its phosphorus content is also very high. Gingelly is a crop which should be extensively cultivated owing to its high nutritive value ; (iii) of the grains, kurakkan is richest in calcium, and adlay and rice in phosphorus. Adlay is extremely deficient in calcium ; (iv) there is some variation in the calcium content of leafy vegetables with place of growth. Soil conditions are apparently the determining factor ; (v) samples of young amaranth spp. (*tampala* S.) from Jaffna are very rich in iron ; (vi) of the minor food products, wild breadfruit seed, which has a composition similar to oilseeds, is a useful supplementary food ; (vii) young coconut water consists largely of reducing sugars. Potassium is its chief mineral constituent ; (viii) compared with Indian samples, Ceylon foodstuffs are generally poorer in calcium and, to a lesser degree, in phosphorus.

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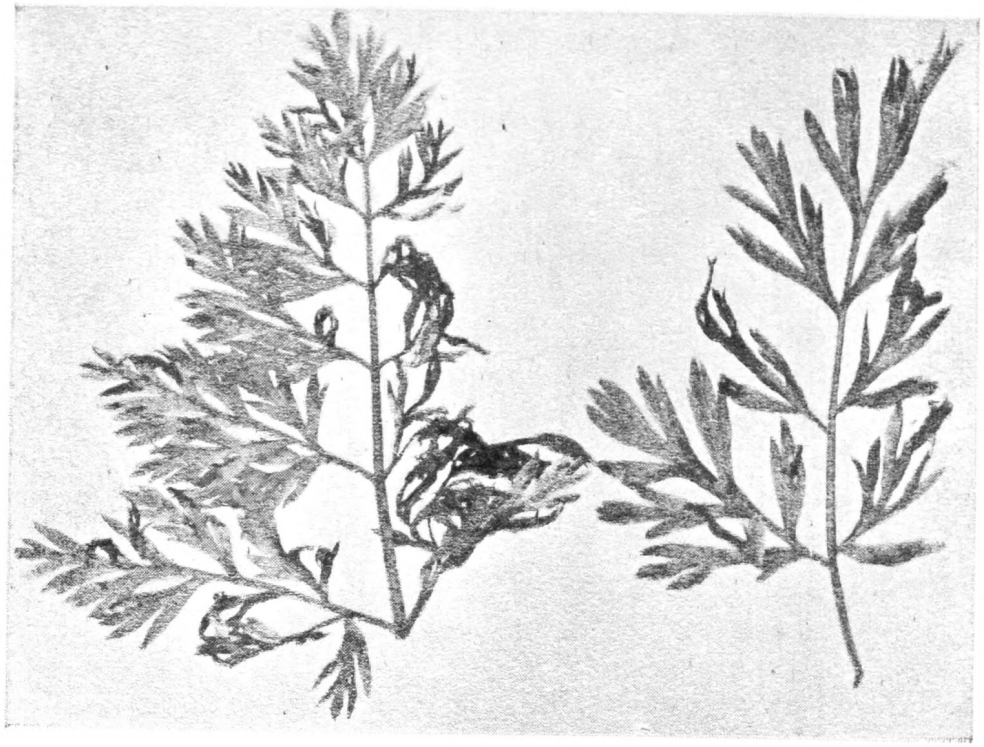

FIG. 1.—LEAFLETS OF CARROT ATTACKED BY *Macrosporium carotae*

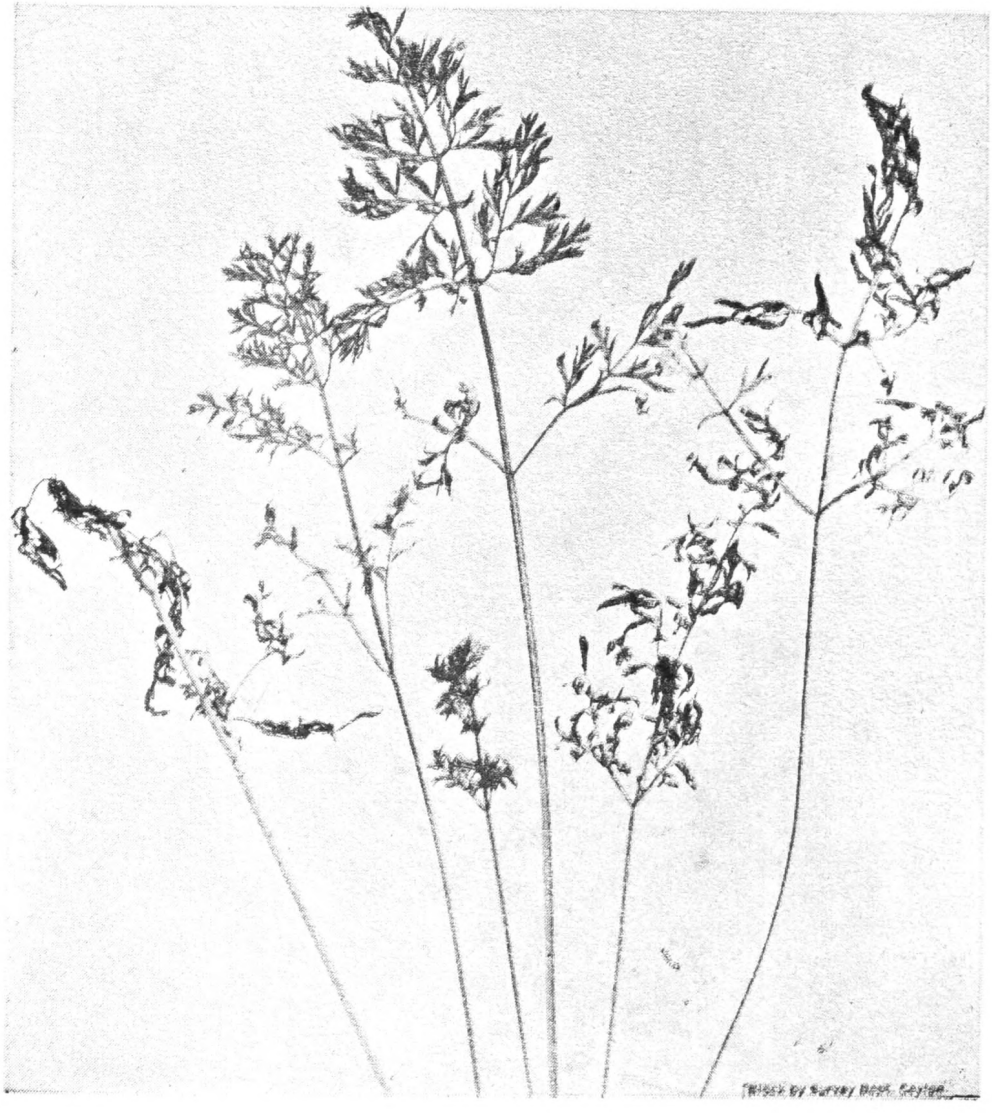

FIG. 2.—LEAVES OF CARROT PLANT ATTACKED BY *Macrosporium Carotae*