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PROXIMATE ANALYSIS OF SOME UNDER-UTILIZED GHANAIAN VEGETABLES

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Abstract

The study determined the nutrient composition of eight vegetables in order to assess their value as food. Analyses covered the seven proximate factors - moisture, protein, fat, ash, crude fibre, total carbohydrate and energy in fresh vegetables. Moisture was determined by the air-oven drying method, ash by furnace dry ashing, crude fibre by an AOAC (1980) method, carbohydrate by calculation, crude protein by the Kjeldahl procedure and crude fat by Soxhlet extraction method. Energy contents were calculated. On wet basis, all have low protein content in the range of 0.4-4.5 per cent and ash in the range of 0.3-1.5 per cent confirming the literature expectations for vegetables. Fat in breadnut (3.83%) exceeded the 1 per cent expectation for vegetables making it a high energy source. The low calorie of fresh Alefi (13.7 kcal/100 g) and mature green pawpaw (27.9 kcal/100 g) may help with weight control. Dried Alefi (21.6% protein) and Eyoyio (15.7% protein) are potential sources of high protein supplements.

Introduction

The word "vegetable" has been defined in more than one way. Duckworth (1966) reports its definition as "plant parts which are usually eaten with meat, fish or other savory dish". The Webster's dictionary defines it as "an edible part of a plant that is used for human food and is usually eaten cooked or raw as the main part of a meal rather than as a dessert." Although there are many well-known vegetables in Ghana, e.g. Kontomire (cocoyam leaves), okra, garden eggs, tomatoes, onions etc. there are others which are less known or less utilized. The drought and food shortage in Ghana in 1983 did much to introduce some previously obscure vegetables and foods into popular usage. The geen leaf vegetable "Bokoboko" (*Talinum triangulare*) and the unripe pawpaw fruit are examples.

The objective of this study, therefore, has been to concentrate on the nutrient composition of less utilized and un-analyzed vegetables. For lack of appropriate instrumentation, the scope of nutrients analyzed has been narrow. The paper focuses upon the proximate factors of the vegetables studied.

Experimental

Sample collection and precautions

Care was taken to obtain the fresh samples from multiple locations in order to even out the effects of different environments and soil types on nutrients. Alefi leaves (*Amaranthus incurvatus*) and sweet potato leaves (*Ipomea batatas*) were each obtained from two different geographic localities. Eyoyio leaves (*Corchorus tridens*), Kwaansusuaa (*Solanum nigrum*), breadnut fruit (*Artocarpus altilis*), unripe papaw (*Carica papaya)* and Madras thorn fruit (*Pithecelobium dulce*) were each collected from three different geographic localities. The young cocoa fruit-cherelles (*Theobroma cacao*) were collected from four different localities. In all cases, differences between collection points varied from 4 - 90 km.

On the field, freshly-collected samples were put into polyethylene bags and stored on ice in an ice-chest for transportation to the laboratory. Sam-

ples of fresh edible portions were used for moisture determination at 105 °C in an air-oven, drying to constant weight. Edible portions of the remaining fresh vegetables were dried to a constant weight at 90 °C (to retain volatile constituents for analysis). For each sample, all dried sub-samples were pooled together and ground into a composite powder. These were packaged in air-tight polyethylene bags and stored in a freezer in preparation for analyses. Glassware were carefully washed, rinsed in distilled and de-ionized water and dried before use.

Chemical analysis of nutrients

Three replicates of each composite sample were analyzed. For moisture determination, 2 g samples were dried to a constant weight overnight at 105 °C in an air-oven according to the method described by Osborne & Voogt (1978). Crude protein was determined on 2 g samples, with the macro-Kjeldahl procedure outlined by Pearson (1976). The factor of 5.3 for converting nitrogen to proteins for vegetables was used (Bernice & Merril, 1975).

Crude fat was determined on 2 g samples with the Soxhlet extraction procedure as described by Osborne & Voogt (1978). Crude fibre was analyzed on 2 g fat-free samples saved after crude fat determination with the Soxhlet procedure. Details followed the AOAC procedure (AOAC, 1990). Ash determination was also made on 2 g samples in porcelain dishes in a muffle furnace at 600 °C overnight (Osborne & Voogt, 1978). Total carbohydrate (including crude fibre) was calculated as the difference between 100 and the sum of the moisture, protein, fat and ash contents (Eyeson & Ankrah, 1975). The Energy contents of the vegetables were calculated from the energy-yielding nutrients (i.e. protein, fat and carbohydrate). For the calculation of energy content, the conversion factors recommended for use in vegetables are protein = 2.44 kcal/g; fat = 8.37 kcal/g; carbohydrates = 3.57 kcal/g. For breadnut and pawpaw, however, conversion factors are protein = 3.36, fat = 9.37 and carbohydrate = 3.60 kcal/g (Osborne & Voogt, 1978).

Results

The results obtained in the experiment are presented in Table 1.

Discussion

Eyoyio (Corchorus tridens)

On wet weight basis, Eyoyio is the richest source of ash (1.5%) or minerals among the vegetables. Ash ranged from 0.3 to 1.5 per cent among the vegetables. The ash content of most fresh vegetables are in the range of 0.1 - 4.4 per cent (Pearson, 1976). These vegetables are hence poor sources of ash. Ash values are considered useful criteria for identifying different foods (Pearson, 1976). Eyoyio has the alternative names of "Poor man's meat" and "West African sorrel". It is considered one of the most valuable local vegetables of the hot arid regions of the tropics (FAO, 1988) and is eaten young and tender. Leaves and young shoots are usually cooked with other vegetables like tomatoes and groundnut paste in oil. It yields a popular mucilaginous dish and is suitable for stews. The plant may also be used as forage for cattle.

Alefi (Amaranthus incurvatus)

Alefi is the richest source of protein (21.6%) on dry-weight basis but fourth on wet weight basis among the vegetables (Table 1). Food-labelling regulations consider any food a good source of protein when, at least, 12 per cent of its calorie is provided by protein (Pearson, 1976). Protein accounts for almost 38, 13.5 and 13.3 per cent of the calorie contents of dry Alefi, Eyoyio and Madras fruit, respectively, making them good protein sources. If an evaluation of the quality of these proteins (animals studies or protein scores) shows them to be of high quality, their dry powders could be useful protein supplements for soups, gravies, stews and other foods. As fresh vegetables, protein concentrations among the vegetables ranged from 0.4 to 4.5 per cent. These are in agreement with the literature reports of 0.1 - 8.0 per cent protein for fresh vegetables (Hart & Fisher, 1971). As

TABLE 1

Proximate compositions (g/100 g) of fresh edible portions

Common names	*Eyoyio*	*Alefi*	*Kwaansusuaa*	*Young cocoa fruit*	*Breadnut fruit*	*Unripe pawpaw*	*Ripe pawpaw*	*Sweet potato leaves*	*Madras thorn fruit*
Botanical names	Corchorus tridens	Amaranthus incurvatus	Solanum nigrum	Theobroma cacao	Artocarpus altilis	Carica papaya	Carica papaya	Ipomea batatas	Pithecelobium dulce
No. of sources	3	2	3	4	3	3	3	2	3
Moisture	82.8±0.0[b]	90.3±0.6	80.4±1.3	85.0±0.4	60.5±0.3	91.6±0.2	87.9±0.3	83.7±0.2	79.6±0.5
Energy	48.7	13.7	47.5	45.4	148.8	27.9	40.2	47.0	61.5
(kcal/100 g)	(283.1)[c]	(141.2)	(242.3)	(302.7)	(376.7)	(332.1)	(332.2)	(288.3)	(301.5)
Total	12.9	2.3	16.5	11.6	31.3	7.6	10.9	13.5	15.8
Carbohydrate	(75.0)	(23.7)	(84.2)	(77.3)	(79.2)	(90.5)	(90.1)	(82.8)	(77.4)
Protein	2.7±0.9	2.1±0.9	1.1±0.1	1.6±0.1	4.5±0.1	0.4±0.1	0.5±0.0	1.3±0.1	3.3±0.5
	(15.7±5.2)	(21.6±9.3)	5.6±0.5)	10.7±0.7)	(11.4±0.2)	(4.8±1.2)	(4.1±0.0)	(8.0±0.6)	(16.2±2.4)
Fat	0.16	0.04	1.23	0.64	3.83	0.08	0.10	0.12	0.07
	(0.93)	(0.41)	(6.28)	(4.27)	(9.7)	(0.95)	(0.82)	(0.74)	(0.34)
Crude Fibre	1.4±0.2	1.0±0.2	6.8±0.6	1.5±0.1	0.9±0.2	0.2±0.1	0.2±0.1	0.6±0.2	0.1±0.1
	(8.1±1.2)	(10.3±2.1)	(34.7±3.1)	(10.0±0.7)	(2.3±0.5)	(2.4±1.2)	(1.7±0.8)	(3.7±1.2)	0.5±0.5)
Ash	1.5±0.1	1.4±0.4	0.8±0.1	1.1±0.1	0.7±0.1	0.3±0.0	0.6±0.2	0.3±0.1	1.1±0.4
	(8.7±0.6)	(14.4±4.1)	(4.1±0.5)	(7.3±0.7)	(1.8±0.2)	(3.6±0.0)	(5.0±1.6)	(1.8±0.6)	(5.4±2.0)

a) No. of localities from where samples were collected and pooled.

b) Mean ± SD

c) Concentration on dry-weight basis in brackets

fresh vegetables, the eight reported in the present study are poor sources of proteins. Fat (0.04 %) and carbohydrate (2.3%) concentrations were lowest in Alefi, leading to a low energy content (13.7 kcal/100 g) which makes it an excellent aid to weight-loss. For use as food the leaves of Alefi are picked fresh, washed and used as greens in salads or blanched, steamed, boiled, stir-fried or baked to taste. It had been used as an ingredient of baby foods, stews and pastas (Osborne & Voogt, 1978). The leaves may be finely-chopped and used as a basis for soups, mixed with other vegetables or eaten alone.

Kwaansusuaa (Solanum nigrum)

This berry has the alternative local Ghanaian name "Abedru". It is the richest source of fibre among the foods (Table 1) because of its seedy nature. High-fibre foods usually provide loose stools, reduce stool transit time in the intestines and discourage colon cancer (Wilson, Fisher & Garcia, 1979). *Solanum nigrum* is believed to be of Asiatic origin. The consumption of its fruits is widespread in some parts of West Africa e.g. La Côte d'Ivoire (Osborne & Voogt, 1978). It has gained widespread consumption in Ghana since 1983 and is reputed to be prescribed now and then by physicians to reduce anaemia in pregnant women. The green berries are usually boiled and used in stews or soups (Osborne & Voogt, 1978).

Young cocoa fruits (Cherelle)

The cherelle (approximately 2.2 - 4.4 cm long) cocoa pod is not outstanding in the concentration of any of the proximate factors. These unripe tender cocoa pods are boiled and used as vegetables as a substitute for okra. They contain a mucilage which adds a slippery texture to foods when cooked (Osborne & Voogt, 1978). In parts of Sierra Leone, these young pods are reportedly collected, pounded in a mortar and used for soups to which palm oil, meat or fish and condiments are added and served with rice. It could be considered a special treat for visitors (Pearson, 1976).

Breadnut (Artocarpus altilis)

Breadnut stands out as the richest source of carbohydrate (31.3%), protein (4.5%), fat (3.83%) and energy (148.8 kcal/100 g) on wet-weight basis (Table 1) among the eight vegetables. Though highest in protein among the vegetables when fresh, it is still a poor source of protein. The fat content of fresh vegetables is usually reported to be less than 1 per cent (Hart & Fisher, 1971). The fat concentration of breadnut (3.83%), followed by *Solanum nigrum* (1.23%) is high. Fat ranged from 0.04 to 3.83 per cent among the vegetables, Alefi having the lowest and breadnut the highest. The breadnut is relatively rich in fat, yielding a beautiful light-yellowish oil with the Soxhlet extraction procedure. A light-yellowish powder can be prepared from it when the Soxhlet extract is evaporated dry. This powder contains 9.71 per cent fat. The breadnut, also known as "Jackfruit" and locally called "Dee ball" in Ghana, contains nuts which can be dehulled when mature, cooked or roasted with salt before eating.

Unripe pawpaw (Carica papaya)

Moisture ranged from 60.5 to 91.6 per cent among the vegetables, with breadnut having the lowest (60.5%) and unripe pawpaw having the highest (91.6%) (Table 1). Owing to its bulkiness and low energy content, it could be a useful aid to weight loss when used to increase the bulk of soups and gravies. Foods with moisture levels of 50-95 per cent are referred to as high-moisture foods (Desrosier & Desrosier, 1977). Thus, all the vegetables of this study are high-moisture foods. Micro-organisms thrive well in such foods and cause quick spoilage. High-moisture foods also have a high respiration rate and enzyme activity and deteriorate quickly unless precautions (e.g. blanching) are taken to inactivate enzymes. As food, unripe pawpaw is a tasty substitute for garden eggs in stews and soups. It also contains a compound which makes meats tender.

Ripe pawpaw

In all the proximate factors, except for moisture and fibre, ripe pawpaw had higher nutrient levels

than green pawpaw. Eaten as fruit, ripe pawpaw has striking nutritional advantages over green pawpaw (Table1).

Sweet potato leaves (Ipomea batatas)

These leaves are not particularly outstanding in the concentrations of any of the proximate factors. It is commonly cooked as a vegetable in stews and soups and reported to be quite tasty.

The Madras thorn fruit (Pithecelobium dulce)

The edible part of this fruits is the second highest in energy (61.5 kcal/100 g) and protein (3.3 %) on wet-weight basis. The energy content of these less-popular Ghanaian vegetables range from 13.7 kcal/100 g for Alefi to 148.8 kcal/100 g for breadnut, on wet-weight basis. Their median kilocalorie content is 47.2 kcal/100 g (n=8) compared with the energy content (29.0 kcal/100 g (n=6) of some common vegetables (cabbage, peppers, garden eggs, okra, cocoyam leaves) (Eyeson & Ankrah, 1975). Human consumption of any part of the Madras thorn fruit was something the authors had never heard of or encountered in Ghana until a group of young children were encountered hunting for the fruit, in its ripe-red pod stage. The pod is opened up and some white fluffy pad attached to their seeds eaten raw. The white material was found to taste mildly sugary. This was the edible portion analyzed.

Conclusion

The conclusion from the results of priximate analysis of the eight under utilized Ghanaian vegetables is summarized as:

1. On wet-weight basis, the protein concentrations (0.4-4.5%) in the eight vegetables are in the range 0.1-8.0, expected for vegetables.

2. Their ash content (0.3-1.5%, wet weight) is in the range 0.1-4.4% expected for vegetables.

3. Breadnut with (3.83% fat wet weight) is a comparatively high source of energy and could benefit persons who need to gain weight.

4.On dry-weight basis, Alefi (*Amaranthus incurvatus*) and Eyoyio (*Corchorus tridens*) with 21.6 per cent and 15.7 per cent protein, respectively, are potential sources of high-protein supplement.

5. Owing to their low energy content, Alefi and the mature green pawpaw can help in the loss of body weight while providing bulk in stews and soups.

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References

AOAC (Association of Official Analytical Chemists) (1990) *Official Methods of Analysis.* Washington D.C.

Bernice, K. W. & Merril, A. L. (1975) Handbook of the Nutritional Contents of Foods. United States Department of Agriculture. New York: Dover Publ. Inc.

Desrosier, W. W. & Desrosier, J. N. (1977) The Technology of Food Perservation. Westport, Connecticut: AVI Publ. Com Inc.

Duckworth, R. B. (1966) Fruits and Vegetables. Oxford, London: Pergamon Press.

Eyeson, K. K. & Ankrah, E. K. (1975) Composition of Foods Commonly Used in Ghana. Food Research Institute - Ghana, UNDP/FAO Publication.

FAO (1988) Traditional Food Plants. *Food and Nutrition Paper,* pp. 42-45, Rome.

Hart, L. A. M. & Fisher, H. J. (1971) Modern Food Analysis. New York: Springer-Verlang.

Osborne, D. R. & Voogt, P. (1978) The Analysis o Nutrients in Foods. New York: Academic Press.

Passmore, R. & Eastwood, M. A. (1986) Human Nutrition and Dietetics, 8th edn, pp. 177. New York: Churchill, Livingstone.

Pearson, D. (1976) Chemical Analysis of Foods. New York: Chemical Publishing Company Inc.

Wilson, E., Fisher, K. H. & Garcia, P. A. (1979) Principles of Nutrition, 4th edn, pp. 53-55. New York: John Wiley and Sons.

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