Food Chemistry **15** (1984) 31–36

Composition of Some Tropical Tuberous Foods

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(Received: 22 February, 1984)

ABSTRACT

Four tropical root tubers were evaluated for their chemical compositions and amino acid patterns. These were winged bean (Psophocarpus tetragonolobus *(L.)DC., yam, sweet potato and cassava* (Manihot utillisima, *Pohl.). Winged bean tubers had protein contents ten times higher than those of cassava and sweet potato and five times higher than yam and contained a high level of carbohydrates. The minerals analysed were about the same in concentration but winged bean tubers had about three times more iron than other root tubers.*

Although cassava roots have the highest content of S-containing amino acids, winged bean roots have the highest values for lysine, tyrosine, tryptophan and threonine. The total content of essential amino acids is much greater in winged bean tubers than in the other tuberous roots.

INTRODUCTION

In tropical countries, many tubers are used mainly for human consumption. These tubers supply the proteins and carbohydrates needed for growth and energy. Among the common tubers consumed in the developing countries are cassava, yams, cocoyams, sweet potatoes and, recently, winged bean tubers. Cassava is the major energy source in countries of the humid tropics but is a poor supplier of nutrients.

Besides being deficient in nutrients and low in proteins, cassava has an antithyroid action in man and livestock, leading to endemic goitre and cretinism (Ermans *et al.*, 1980*a*). The cause has been attributed to the endogenous release of thiocyanate (SCN) from linamarin which is a cyanogenic glucoside present in the tuberous roots of cassava (Bourdoux *et al.*, 1980). Some wild yams contain a toxic factor, dioscorine. Honara & Sohonie (1955) found that the tubers of sweet potatoes contain a trypsin inhibitor.

The winged bean tubers have been used in Burma, Papua New Guinea, Ivory Coast and Ghana and are often eaten cooked. It has been indicated that cooked tubers eaten with cocoa or chocolate produce severe intoxication while raw tubers produce nausea (Claydon, 1978).

This study reports on the nutritive value of winged bean tubers as compared with other common tuberous roots.

MATERIALS AND METHODS

Materials

Tubers of winged bean were grown in a greenhouse, washed and air-dried under a fan at room temperature. Cassava roots were peeled, grated and the water drained off. The grated cassava was dried in the open for a few days. Both samples were separately ground to a fine powder.

Methods

Proximate analysis of the samples was determined in duplicate by standard AOAC (1981) methods. Samples for mineral analysis were prepared according to AOAC (1981) methods and the minerals were assayed using an atomic absorption spectrophotometer (Perkin-Elmer Corp., Atlanta, GA). Phosphorus was determined with the Beckman Model DU spectrophotometer.

The methods used for the determination of amino acids have been previously described by Ekpenyong & Borchers (1982).

RESULTS AND DISCUSSION

Various reports have shown that some varieties of winged bean produce high yields of tuberous roots. These tubers have a pleasant and slightly

TABLE 1
Chemical Composition of Some Tropical Tubers (per 100 g fresh edible weight)

	Winged bean	*Yam**	*Sweet potato**	*Cassava*
Moisture (g)	56·2	71·8	70·7	65·2
Calories	148	108	115	136
Fat (g)	0·7	0·1	0·3	0·1
Crude protein (g)	11·0	2·0	1·2	1·5
Carbohydrate (g)	28·8	25·1	27·1	32·8
Fiber (g)	2·4	0·5	0·8	0·9
Ash (g)	2·0	1·0	0·7	0·5
Minerals (mg/100 g)				
Calcium	30·0	22	36	30
Phosphorus	42·0	39	56	31
Iron	2·6	1·0	0·9	1·0
Zinc	—	1·1	2·0	—
Magnesium				
Manganese		—	387	—

* Source: FAO (1972).

sweet taste, extremely white flesh and a firm texture (Cerny, 1978). Khan & Claydon (1975) and NAS (1975) have reported on the consumption of the tubers in places like Papua New Guinea and Burma and in the Ivory Coast (Ravelli *et al.*, 1978).

A comparison is made in Table 1 of the chemical composition of winged bean tubers and some common tuberous roots. Winged bean tubers have less moisture than other roots but a protein content about ten times higher than those of cassava and sweet potatoes and five times higher than that of yams. In fact, results for winged bean tubers have shown protein values ranging from 15–24·6% (Hooper, 1902; Burkill, 1966; NAS, 1975). This is almost the only known tuber with such a high protein content. The tuberous roots of winged bean are also high in carbohydrates and produce about the same energy as cassava. It seems that, unlike cassava, whose protein deficiency has been implicated as one of the factors responsible for human illness or reduced animal performance in cassava-consuming populations (Tewe & Maner, 1982), winged bean tubers are unique among tropical root crops, for their nutrient richness. The reason for the high protein content of winged bean roots may be the heavy root nodulation and high nodule activity characteristic of the plant (Masefield, 1961). However, Claydon (1978) has reported that African yam bean

TABLE 2
Amino Acid Composition of Winged Bean Tuber Compared with Some Tropical Tubers (mg/gN)

Amino acid	*Winged bean*	*Yam**	*Sweet potato**	*Cassava*
Iso-leucine	304	234	230	183
Leucine	465	404	340	252
Lysine	485	256	214	249
Methionine	130	100	106	162
Cystine	58	72	69	92
Phenylalanine	210	311	241	153
Tyrosine	233	210	146	98
Threonine	254	225	236	171
Tryptophan	109	80	—	69
Valine	472	291	283	211
Arginine	310	477	307	687
Histidine	173	118	84	120
Alanine	348	265	298	200
Aspartic acid	786	691	825	398
Glutamic acid	824	777	541	998
Glycine	236	220	234	180
Proline	360	249	219	169
Serine	375	330	255	210
Total S-amino acids	188	172	175	254
Total essential amino acids	2 720	2 193	1 865	1 640

* Source: FAO (1970).

(*Sphenostylis Stenocarpa* Hockst. Harms.) also has a very high tuber protein content. It could be considered that, because of the high protein content of the root, winged bean tubers may not be classified as a 'starchy' root crop. This is important since yams, cassava and sweet potato are commonly used as food for young children.

Mineral analysis shows that the values for calcium and phosphorus compare well with those of other tropical tubers. The iron content in winged bean tubers is about three times more than in the other tropical tubers considered.

Choo (1975) and Ekpenyong & Borchers (1982) have reported on the amino acid composition of the winged bean tuber. The results, shown in Table 2, compare the amino acid composition of winged bean with those of other tropical tubers. When compared with previously published results there appear to be differences which may reflect not only differences in degree of nodulation and nodule activity but also differences between varieties and environment and cultural practices. The amino acid content of winged bean tubers, although poor when compared with the provisional amino acid scoring pattern of FAO/WHO (1973), is far superior to that of other tubers. The only exceptions are found with cassava roots where the S-containing amino acids are higher (254 mg/gN) than in winged bean tubers (188 mg/gN). Cassava tubers also contain more arginine (687 mg/gN) and glutamic acid (998 mg/gN) than winged bean tubers which have 310 and 824 mg/gN, respectively. In terms of the total essential amino acids, winged bean tubers contain the largest amount (2720 mg/gN) with cassava containing the least (1640 mg/gN). Experience has shown that the range of values for individual amino acids in the winged bean tubers can largely depend on varietal differences. Our unpublished data have shown that for winged bean tubers the range for lysine is 395–588 mg/gN; for aspartic acid, 700–1100 mg/gN and for total S-containing acids, 170–300 mg/gN. In contrast, FAO (1972) has reported for cassava a range of 31–197 mg/gN for methionine and 25–154 mg/gN for cystine.

It appears from the results presented here that winged bean tubers may replace other common tropical tubers as staple foods. In order to make an effective contribution, the production of tubers from winged bean must be intensified. It is estimated that winged bean can produce as much as 1200 kg for staked plants and 790 kg for unstaked plants in Ghana and 600 kg for staked plants in Papua New Guinea (Ravelli *et al.*, 1978). The nutritional superiority of winged bean tuber over other common tropical root crops makes it a unique food crop which could become a valuable substitute for cassava and yam.

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