Food Chemistry **22** (1986) 305–314

Effect of Roasting on the Chemical Composition of the Seeds of *Treculia africana*

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(Received 3 January 1986; revised version received 14 April 1986;
accepted 21 April 1986)

ABSTRACT

Roasting of the raw unprocessed seeds of T. africana *did not bring about any significant difference ($P > 0{\cdot}05$) in ether extract, crude protein, dietary fibre, ash or carbohydrate contents of the raw and roasted seeds. However, moisture content ($P < 0{\cdot}01$) showed a significant decrease (16·1%).*

Mineral analysis showed increases of potassium (39·2%) and calcium (28·2%). Significant differences ($P < 0{\cdot}01$) were observed for vitamins B_1, B_2 and C contents with 30·6%, 25·6% and 34·7% destruction, respectively. Amino acid analysis showed losses for lysine (12·1%), isoleucine (13·0%) and leucine (12·7%). The effect of these changes on the nutritive value of the seeds of T. africana *is discussed.*

INTRODUCTION

Heat is known to improve the availability of some nutrients, inactive enzymes that speed up nutrient damage and destroy undesirable micro-organisms and food contaminants as well as favourably change the physical attributes of food such as colour, texture and flavour.

During processing, cooking and preserving of food, the application of dry heat (roasting) has mixed effects on its nutritive value. Rajalakshmi *et al.* (1964) reported the liberation of niacin from niacytin in maize, pears and rice during roasting while Bender (1966) showed that baking of maize into chappaties increased the free nicotinic acid. However, loss of nutrients

Food Chemistry 0308-8146/86/$03·50

is one of the undesirable changes which occur in food processing (Bender, 1966; Cain, 1967; Lachance *et al.*, 1973; Ayatse *et al.*, 1983; Bassir & Lawal, 1985).

Abundant information is available on the effect of cooking on the nutritive value of foods in Nigeria using the wet heat method of cooking (Akinrele & Bassir, 1967; Abaelu, 1973; Okoh & Eka, 1978; Oshinubi & Eka, 1981; Umoh & Bassir, 1981; Bassir & Lawal, 1985; Lawal & Bassir, 1986) but very little information can be obtained for the effect of dry heat methods of cooking on the nutritive value of foods (Ayatse *et al.*, 1983). There are no reports yet on the effect of roasting on the nutritive value of the seeds of *T. africana*. Thus, this investigation was carried out to evaluate, by chemical analyses, the effect of roasting on the nutritive value of the seeds of *T. africana*.

EXPERIMENTAL

The fruits of *Treculia africana* were obtained from Ishara-Remo, Ogun State, Nigeria. Large fresh fruits were allowed to macerate by placing them in water in large containers. After five days, the seeds, which were embedded in the spongy pulp of the fruits, were extracted. They were properly washed with water and are referred to as the raw unprocessed seeds.

1200 g of the raw seeds were divided into two parts; one of the portions was roasted and milled whilst the other was milled raw.

The seeds of *T. africana* (100 g) were roasted in the laboratory in an aluminium frying pan using a 100 W electric stove as source of heat. Preliminary roasting trials were carried out and the roasting time and temperature standardized. In the roasting process the pan was placed on the stove and allowed to warm to a temperature of between 35°C and 45°C. Next, 100 g of the raw seeds were added and heating continued with stirring until a temperature of between 100°C and 120°C was reached. Heating was then stopped and the grains were stirred until the temperature dropped to between 60°C and 70°C. With this treatment the seed was roasted to the desired consistency. The time required to roast each 100 g sample ranged from 10–13 min. The experiment was repeated four times. The roasting conditions were designed to emulate, as far as possible, the method of roasting practised in the Western part of Nigeria. 100 g dry weight of the raw and roasted seed samples were ground separately into fine powder in a grinding mill. Each sample was ground to produce a very fine powder, to pass through a 30 mesh sieve (AOAC, 1975). The samples were stored in airtight cellophane bags in a deep freezer at −20°C until required for chemical analysis.

Analysis of samples

The methods of sample treatment and analysis were the standard methods recommended by the Association of Official Analytical Chemists (AOAC, 1975), and by Joslyn (1970).

The ash was determined by incineration of known weights of the seed samples in a muffle furnace at 550°C until ash was obtained. The lipid composition was determined by exhaustively extracting a known weight of sample with petroleum ether (boiling point, 40–60°C) using a Soxhlet apparatus. Protein (N × 6·25) was determined by the micro-Kjeldahl method. The carbohydrate content was obtained by the difference method; that is, by subtracting the total crude protein, crude lipid, total ash and dietary fibre from 100.

The elemental composition was also determined using the methods of the AOAC (1975). Sodium and potassium were determined by flame photometric method. Calcium was precipitated as calcium oxalate and subsequently determined by titration against permanganate; both phosphorus and iron were determined colorimetrically, the former by the quinol/sodium sulphite method (Yuen & Pollard, 1955) and the latter by the dipyridyl method. Copper, manganese, magnesium and zinc were determined by atomic absorption spectrophotometry (AOAC, 1975). Quantitative estimations of the amino acids were carried out according to a procedure based on the report of Spackmann *et al.* (1956) using a Beckman automatic amino acid analyzer. Tryptophan was, however, estimated chemically (Miller, 1967) using *p*-dimethyl amino benzaldehyde (DMAB) and $NaNO_2$ solution. The vitamins were determined using the methods of the Association of Vitamin Chemists (AOVC, 1966). Carotene was determined colorimetrically at 455 nm. Thiamine was estimated fluorimetrically, using a Locarte fluorimeter. Vitamin C value (ascorbic acid) was determined by the *N*-bromosuccinimide method described by Evered (1960).

The provitamin A was determined using a modification of the method described by Ogunlesi & Lee (1979). Vitamin A analysis involved the separation of individual carotenoids and the further isolation of the major provitamin A carotenoids into their stereoisomers (0·6 μg of all-*trans* β-carotene is equivalent to 1 IU of vitamin A (Food and Nutrition Board, 1974)). All the analyses were carried out in quadruplicate on four separate batches of samples.

RESULTS

The results are shown in Tables 1–4. The results of the proximate composition of the raw and roasted seeds are shown in Table 1.

TABLE 1
Proximate Composition of Raw and Roasted Seeds of *Treculia africana* (g/100 g dry weight[a] of Sample)

Sample	*Moisture*	*Ash*	*Crude fat*	*Crude protein*	*Dietary fibre*	*'Available carbohydrate'*
Raw seeds	40·0 ± 1·12	6·70 ± 0·09	10·6 ± 0·24	14·4 ± 0·24	4·80 ± 0·10	63·5 ± 2·61
Roasted seeds	23·9 ± 1·10	6·55 ± 0·14	11·3 ± 0·18	14·2 ± 0·23	4·63 ± 0·10	63·3 ± 2·61
Per cent loss (−) or gain (+) on roasting	−40·3	−2·2	+6·6	−1·25	−3·5	−0·3

[a] Mean of four determinations ± standard deviation.

TABLE 2
Elemental Composition of Raw and Roasted Seeds of *T. africana* (mg/100 g dry matter)[a]

Sample	*Potassium*	*Sodium*	*Calcium*	*Magnesium*	*Zinc*	*Copper*	*Iron*	*Phosphorus*
Raw seeds	283 ± 5·9	261 ± 3·9	15 ± 4·35	90 ± 3·3	0·89	0·11	0·86	139 ± 3·55
Roasted seeds	393 ± 4·8	261 ± 3·9	19·0 ± 4·25	91·5 ± 3·3	0·89	0·11	0·83	145 ± 3·45
Per cent loss (−) or gain (+) on roasting	+39·2	0	+28·8	+1·7	0	0·0	−3·5	+4·3

[a] Mean of four determinations ± standard deviation.

TABLE 3
Vitamin Contents of Raw and Roasted Seeds of *T. africana*
(Quantities per 100 g dry sample)[a]

Sample	*Thiamine (μg)*	*Riboflavin (μg)*	*Ascorbic acid (mg)*	*β-Carotene (IU)*	*Vitamin A value (IU)*	*Niacin (mg)*	*Pyridoxal (mg)*
Raw seeds	151·6 ± 0·51	234·7 ± 0·80	13·5 ± 1·05	1768 ± 25·9	5972 ± 27·9	0·37 ± 0·00	0·4 ± 0·00
Roasted seeds	105·2 ± 0·55	174·6 ± 0·80	8·1 ± 1·03	1335 ± 5·90	4569 ± 24·8	0·40 ± 0·00	0·35 ± 0·00
Per cent loss (−) or gain (+) on roasting	−30·6	−25·6	−40·0	−24·5	−23·5	+8·1	−12·5

[a] Mean of four determinations ± standard deviation.

TABLE 4
Amino Acid Composition of Raw and Roasted Seeds of *T. africana* (g amino acid/16 g N)[a]

Amino acid	*Raw seeds*	*Roasted seeds*	*Per cent loss (−) or gain (+) on roasting*
Lysine	8·24	7·24	−12·1
Histidine	7·97	7·07	−11·3
Arginine	7·35	8·17	+11·2
Aspartic acid	10·9	10·0	−8·4
Threonine	5·78	5·11	−11·6
Serine	6·37	5·57	−12·5
Glutamic acid	14·8	13·9	−6·2
Proline	7·74	8·75	+13·0
Glycine	6·87	6·10	−11·2
Methionine	2·49	2·89	+16·0
Alanine	13·8	13·1	−5·1
Cystine	3·10	2·73	−12·2
Valine	8·94	7·90	−11·6
Isoleucine	9·20	8·00	−13·0
Leucine	10·2	8·90	−12·7
Tyrosine	4·84	3·91	−19·2
Phenylalanine	5·89	5·20	−11·7
Tryptophan	1·20	1·03	−14·2
Total	134·8	124·6	−7·4

[a] Mean of three determinations.

No significant changes in ash, crude fat, crude protein, dietary fibre and carbohydrate contents ($P > 0{\cdot}05$) of the raw seeds of *T. africana* with roasting were observed.

The mineral element compositions are shown in Table 2.

Sodium, magnesium, zinc, copper, iron and phosphorus were not much affected by roasting but potassium and calcium were drastically increased by 39·2% and 28·8%, respectively. Table 3 shows the vitamin content of both raw and roasted seeds of *T. africana*.

Significant reductions in the levels of thiamine (30·6%), riboflavin (25·6%), ascorbic acid (40·0%) and β-Carotene (24·5%) with roasting were observed.

Table 4 shows the amino acid composition of the raw and roasted seeds of *T. africana*.

Most of the amino acids were reduced during roasting but increases of 13% for proline, and 16% for methionine, were also observed (Table 4).

Of the essential amino acids, lysine, tryptophan, histidine and phenylalanine were found to be significantly reduced.

DISCUSSION

The draft report of FAO/UNICEF (1962) showed that the varieties of traditional cooking methods used in Nigeria contribute immensely to the malnutrition problems in the country. Thus, there may be an urgent need to look into these traditional cooking methods, with a view to improving them so that their adverse effects on nutritive values of the food may be considerably minimized.

In many parts of Nigeria, the raw seeds of *Treculia africana* have been used extensively as food when they are roasted. However, our results showed significant reductions in the levels of nutrients in the seeds as a result of roasting.

The seeds of *T. africana* are a good source of good quality protein although they are deficient in cystine and tryptophan. It may be necessary to supplement meals of roasted seeds of *T. africana* with other richer sources of nutrients such as crayfish, periwinkle and snails (Umoh & Bassir, 1977; Umoh *et al.*, 1980). The amino acid profile of a protein alone may not be the most ideal measure of its nutritional quality. In chemical assessment, the amino acid index is a fair estimation of protein quality. In this study, amino acid losses due to roasting of the seeds have been revealed.

Most of the amino acids exhibited considerable decreases on roasting (Table 4), but methionine, proline and arginine increased. The decrease in 'non-paraffinic' amino acids on roasting could be due to thermal destruction. However, very little losses were recorded in the unreactive paraffin side chain amino acids such as leucine, isoleucine and valine. Isoleucine could have been lost through the thermal conversion to alloiso-leucine (Bjarnason & Carpenter, 1970).

The fairly high level of potassium in the roasted seeds (Table 2) may be important with respect to acid–base balance. Calcium and magnesium have been reported to play a role in the seed firmness (Kertesz, 1951; Eaves & Leefe, 1962). These elements increased significantly during roasting of the seeds, while the other elements were not significantly affected.

The loss of thiamine, ascorbic acid and riboflavin on heating was expected (Table 3) because these vitamins are thermolabile (Oke, 1967; Fafunso & Bassir, 1976; Imbamba, 1977; Ajayi *et al.*, 1980). The results also confirmed that riboflavin is less heat-labile than thiamine. Compared with some popular fruits considered to be good sources of provitamin A, the value 5708 IU/100 g dry matter of the roasted seeds is higher than banana (800–1167 IU/100 g) and papaya (1200–1650 IU/100 g) (ITAL, 1980). However, all these values are not exactly comparable due to differences in the methods used for the estimation and there could have been overestimation or underestimation of the actual provitamin A activity.

From the results (Table 3), a loss of 23·5% in the level of vitamin A value was shown during the roasting of the seeds of *T. africana.*

The nutritional implication of the severe loss of nutrients during roasting of the seeds of *T. africana* is that consumers will need to eat a wide range of foodstuffs that are rich in vitamins together with the roasted seeds to avoid avitaminosis. It may be necessary for consumers to increase the quantities of the roasted seeds eaten daily.

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