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Studies of the Thermal Effect on Parkia Seeds

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ABSTRACT

Fruits from one Parkia filicoideae *Welch plant provided the raw seeds investigated. Portions of the seeds were processed by boiling in water; others were roasted in an oven at 100°C, 120°C and 150°C to obtain beans that were further processed to obtain their oils and seed cakes. The physico-chemical analytical data obtained for the various oils and seed cakes suggest that processing of the seed at 120°C is most suitable to obtain parkia beans of the highest quality. Results obtained from both* in vivo *and* in vitro *digestibility studies confirm that seeds processed at 120°C dry-heat produced the best quality beans.*

INTRODUCTION

Parkia, the African locust bean, belongs to the group of families called leguminoseae, subfamily mimosaceae. A plant of the species *filicoideae* is selected for this study. The seed is very nutritive and compares favourably with other common legumes such as soybean, cowpea and groundnut. Previous dry matter analyses of parkia cake have included: protein 36% (Oyenuga, 1968; Basir & Ogunbunmi, 1980; Balogun & Odutuga, 1982), lipid 10–15% (Oyenuga, 1968; Girgis & Turner, 1972; Ibiyemi, 1987), flavour (Harborne, 1967) and mineral salts (Oyenuga, 1968; Oke & Umoh, 1978). Despite the high nutritive value of the seed, its utility in food as a protein source for humans and livestock is restricted to condiments in soup making. Furthermore, even though the seed is known (Fetuga *et al.*, 1974) to

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be relatively rich in sulphur-containing amino acids, methionine (5%) and cysteine (11%), various feed experiments suggest that the raw seed does not perform as credibly as soybean and groundnut cake, as a protein source. Ibiyemi (1987), in recent studies, has found that organic solvent extraction of the seed does not necessarily improve the quality of the seed as a protein source in poultry feedmeal. Eka (1980), however, reported that processing of the seed in hot water to obtain the bean, followed by fermentation, does not alter appreciably the nutritive qualities of the seed.

Dry-heat roasting improves the quality of protein food; it generates free sugars, amino acids, peptides and other products derivable from these which are known to serve as flavour precursors. It also improves the nutritional qualities of proteins by improving their amino acid contents, protein efficiency ratios, the bioavailability of the amino acids and, consequently, the digestibility of the protein.

To date, all available reports on studies of the treatment of parkia seed are limited to boiling in water (Eka, 1980), the dry-heat effect on the inactivation of trypsin inhibitor, and studies that reveal that aqueous rather than organic solvent extraction considerably reduces anti-nutrients in the seed (Ibiyemi & Balogun, in press).

This paper reports that dry-heat treatment of the seed at 120°C produces parkia bean of an improved quality. Furthermore, dry-heat treatment is neater and less time-consuming than hot water-processing.

MATERIALS AND METHODS

Portions of the seeds, 0·5 kg in weight, obtained from one plant in the University of Ilorin campus, were processed by heating at 100°C, 120°C and 150°C for 1 h in an oven; then the seed was decoated to obtain the beans. Another batch was heated in water maintained at about 90°C for several hours to facilitate decoating; the beans obtained were then dried at 60°C. Each of the five batches of beans and 0·5 kg of decoated raw seeds was ground and the powder obtained was extracted with petroleum ether, 60–80°C, for 6 h, in a Soxhlet extractor. The method of analysis of the oils and defatted cakes followed the procedures outlined by AOAC (1975). Amino acid analysis followed Bidlingmeyer *et al.* (1984) by reverse-phase high-performance-liquid chromatography, using PICO-TAC equipped with an auto injector. Two-gram portions of each of the five samples (in duplicate) were extracted for their globulin and albumin, using the procedures described by Murray (1979). Each sample was vigorously agitated with 40 ml of 5% K_2SO_4 solution, and centrifuged at 2500*g* for 20 min. The supernatant obtained was kept and the extraction repeated. The

TABLE 1
In vivo Digestibility

Ration	*Protein retention (%)*	*Fat retention (%)*	*Feed intake per bird (g/day)*	*Mean body wt gained per bird (g/day)*
I	70·8	78·6	36·8	17·4
II	71·6	75.2	36·3	17·5
III	72·7	75·6	35·4	17·4
IV	67·6	75·3	34·4	16·4

I = Control, 20% protein from soybean only.
II = 5% protein from parkia seed and 15% from soybean.
III = 10% protein from each of soybean and parkia seed.
IV = 20% protein from parkia seed only.

combined supernatant for each sample was then analysed for the salt-soluble protein by standard Kjeldahl analytical methods (AOAC).

Four chick feedmeals (rations I–IV) prepared by using parkia seed roasted at 120°C and soybean roasted at 120°C, in the proportions 1:3, 1:1, 1:0 and 0:1, respectively, as protein sources, were fed into 7-day old broiler chicks for 28 days, adopting the total collection method for nutrient retention study to determine *in vivo* digestibility of the rations (Table 1).

In vitro digestibility was determined using the procedure described by Furuya *et al.* (1979), using 2% pepsin. The *in vitro* crude protein digestibility was calculated on the basis of original crude protein content using the expression:

$$\% \text{ protein digestibility} = (1 - R/S) \times 100$$

where R is the percentage of the crude protein of the oven dry sample residue and S is the percentage crude protein of the original meal.

RESULTS AND DISCUSSION

The results in Table 2 suggest that, for the treatment of parkia seed to yield bean with high quality lipids, dry-heat is better than boiling. However, it is noted that dry-heat treatment at 100°C, which gives the highest oil yield, also gives oil of low saponification value, acid value and iodine value; furthermore, this temperature treatment does not enhance decoating of the seed. The oil obtained from the seed treated at 150°C recorded the highest acid value followed by the oil obtained from seed boiled in water, while untreated seed has the lowest value. This result suggests that high temperature (150°C) and prolonged heating (boiling) promote hydrolysis of

TABLE 2
Data on the Oils

Sample	*I* % w/w oil	*II* Sap. value	*III* Acid value	*IV* Iodine value	*V* Ref. ind.	*VI* Unsap. value	*VII* % Hydro-carbon
Untreated	7·34	314	6·17	35·6	1·475	3·6	45·1
Boiled	10·71	266	22·4	44·5	1·480	3·9	47·2
Roasted at 80°C	14·66	269	11·2	38·1	1·476	4·1	45·9
Roasted at 100°C	16·43	230	12·3	35·6	1·475	4·9	44·6
Roasted at 120°C	14·06	266	15·7	40·6	1·471	8·9	55·6
Roasted at 150°C	10·25	137	23·6	50·8	1·480	18·7	61·6

the triglyceride and consequently rancidity which will affect the overall quality of the bean, particularly on storage.

The iodine values for the oils (Column III, Table 2) are generally low; the values increase correspondingly with increase in the working temperature except for 100°C and wet-heating. The iodine value is lowest for oil in seed treated at 100°C suggesting maximum autoxidation and hydroperoxidation at this temperature, whereas at a higher temperature there would be an increase in decomposition of the hydroperoxides resulting in the high iodine value of the lipid.

Cocoa butter obtained from roasted cocoa beans has a strong flavour reminiscent of cocoa and has been shown by Santodonato *et al.* (1983) to contain more unsaturated cyclic heteroatomic compounds than butter obtained from unroasted cocoa beans. Our results on iodine values for the various oils seem to follow the recent study by Carlm *et al.* (1986) on changes in the fatty acid composition of triglycerides of partially hydrogenated soybean oil over the frying period; the amount of linoleic acid increased with frying time. Heat-treatment of oil at temperatures greater than 100°C is known to result in autoxidation producing volatile carbonyl compounds (Wu & Nawar, 1986). Smoked, fried, grilled and roasted meat and vegetable oils, margarines and fat are also known to contain polycyclic hydrocarbons not known, or present to a lesser extent, in the untreated foods (Gunstore, 1984; Frankel, 1984). It is no surprise, therefore, to find that product obtained after roasting at 150°C had the highest hydrocarbon content and the untreated seed and that treated at 80°C had the lowest values.

The refractive indices for our oils agree with the findings of Mehlenbacher (1960) relating refractive index of oil with unsaturation.

TABLE 3
Data on Defatted Cakes

Sample	*Protein* (% *w/w*)	*Ash* (%)	In vitro *digestibility* (%)	*Salt-soluble Protein* (%)
Untreated	36·1	3·50	40·6	6·85
Boiled	37·2	2·71	69·30	8·90
Roasted at 80°C	35·7	3·43	—	—
Roasted at 100°C	36·0	3·44	67·8	8·10
Roasted at 120°C	35·8	3·15	71·9	8·87
Roasted at 150°C	31·4	3·21	59·4	8·30

Results on protein analysis, presented in Table 3, at first glance seem to rate the bean obtained by the traditional method, which involves boiling in water for several hours, as the best quality product. But a close and careful analysis of the entire data, with particular focus on digestibility and salt-soluble protein, two parameters that are much more important than the other two factors, rate the bean obtained by roasting at 120°C as better than all others. Trypsin-inhibitor in soybean (Kakade *et al.*, 1973) and groundnut cake (Basha & Young, 1985) is known to be destroyed when heated to 120°C, to obtain maximum nutritional values for the various materials. So it may be right to conclude that dry-heat treatment of parkia seed at 120°C leads to total or near total destruction of trypsin-inhibitor coupled with effective decomposition of other antinutrients. The latter is particularly the case since chemical changes, in seeds roasted at temperatures that enhance flavour formation, are associated with complex, numerous, graduated and variable chemical reactions (Wu & Nawar, 1986).

Amino acid analyses of the various beans for the selected essential amino acids (Table 4) provide additional good evidence in support of our claim that 120°C dry-heat treatment of parkia seed seems to be optimum for processing the seed for best quality bean. The essential amino acid content of the raw seed is found to be generally higher than the corresponding amino acids of

TABLE 4
Some Selected Essential Amino Acids

Amino acid	*Raw seed*	*Seed at 120°C*	*Seed at 150°C*
Lys	3·34	1·12	0·93
Phe	2·06	2·37	1·16
Leu	4·83	5·38	1·44
Ile	3·55	2·94	1·55
Val	2·12	3·08	1·44

the seed heated at 150°C. Bressani *et al.* (1981) have reported that the thermal processing of legumes affects protein quality by rendering essential amino acids, and especially lysine, unavailable. This provides an explanation for the observed variation in the values for lysine in our various samples, and particularly why the raw sample shows the highest value.

All the physico-chemical properties so far available from the studies have led us to conclude that 120°C dry-heat roasting of parkia seed is an ideal working temperature for processing the seed for the bean. It is anticipated that if it is adopted it will enhance modern technology for processing the seeds and improve its utility.

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