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Effect of Parboiling on the Composition and Physicochemical Properties of *Treculia africana* Seed Flours

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Abstract: *Treculia africana* seeds are used in a variety of foods like porridges, pastries and weaning food formulations. These food applications require processed seed flour. In processing, parboiling is employed for easy dehusking of the seeds for improved appeal of the products. This study was carried out on four groups of parboiled and native *T. africana* seed flours to investigate the effect of parboiling on the composition and physicochemical properties of the flours. Results indicate that parboiling had significant effect on the composition and properties of *T. africana* seed flours though the effect varied from one tree source to another. Higher yields of flour were obtained with parboiled (61.26-87.65%) compared with native (52.84-74.02%). The proximate composition, inorganic minerals, tannins and phytates levels of the flours of the parboiled were significantly lower than those of the flours of unparboiled. Flours of the parboiled seeds exhibited lower water absorption capacity and lower freeze-thaw stability than the flours of the unparboiled seeds. The RVA paste viscosity of 14% flour slurry showed that parboiling increased the pasting temperature, reduced the viscosity peak and stabilized the resultant paste to breakdown by shearing forces.

Key words: African breadfruit, *Treculia africana*, parboiling, composition, physicochemical properties

Introduction

African breadfruit (*Treculia africana* Decne) is a tropical forest tree and belongs to the plant family Moraceae. The tree bears big heavily-seeded oval fruit heads of mass 2.5-13.62 kg and attains 45cm in diameter. The seeds are brownish and are 8.44mm or less in length and buried in spongy pulp. The fruits are usually wild-harvested and current efforts are geared toward growing them in orchards. The fruits normally are left to rot and the seeds collected, washed with water and used in many food preparations. Foods prepared from *T. africana* seeds are highly prized and it is a common article of trade in local markets and a source of calorie for over 60 million people in Southern Nigeria and Central African Republic. *T. africana* seeds are rich in protein, oil, carbohydrate and minerals (Nwokolo, 1987), Ejiofor *et al.* (1988) and research has been geared to expand its use in processed foods (Akubor, 1997), Fasasi and Fasasi (2004), Giami and Amasisi (2003). In processing African breadfruit seeds into snack and flour, parboiling is employed to improve the aesthetic appeal of the products. In this study we report the effect of parboiling on the composition and physicochemical properties of *T. africana* seed flours and on its possible versatile food application.

Materials and Methods

Seed processing and flour preparation: *T. africana* fruits were collected from trees grown at different locations within the campus environment of the University of Ibadan, Ibadan, Nigeria. The fruits were properly labeled and kept to rot. The seeds were collected, washed with water and air dried. The seeds were manually screened of poorly developed grains, weighed and divided into two portions, for processing. A portion of the seeds was parboiled for 15 minutes. The parboiled seeds were collected, dehusked and sun dried. The second portion of the seeds (native seeds) was sun dried and dehusked. The separate samples were stored in clean polythene bags.

The native and parboiled seeds were manually and separately dry-milled to flour using a domestic milling machine (CORONA®, LANDERS and CIA, S.A.). These were sieved with a Muslin cloth (75 µm mess). The flours were moisture-stabilized by keeping in a thermostated oven at 70°C for 2 hours. The moisture-stabilized flours were transferred into desiccators to cool and later stored in sealed containers.

Chemical analysis: Moisture and ash contents of the flours were determined by AOAC (1990) methods. The crude fibre and crude fat contents were determined by the methods of Maynard (1970). Crude protein was calculated based on Total Kjeldahl Nitrogen (TKN) determined by the HACH method (1990). Total carbohydrate was calculated based on the percentage difference of the other parameters. The energy content was calculated based on the Artwater Calorie Conversion Factor (Pearson, 1970). Free sugar and starch contents were determined by the phenol-sulphuric acid method (Dubois *et al.*, 1956). The pH of the flours was determined according to the method of Camargo *et al.* (1988). The inorganic minerals: sodium (Na), potassium (K), zinc (Zn), calcium (Ca) and iron (Fe)

Table 1: The effect of parboiling on flour yields of *T. africana* seeds

Sample	Weight of seeds (g)	Weight of dehusked seeds (g)	Weight of milled seeds (g)	Weight of flour[+] (g)	Flour yield[*] (%)
TAS 1	1363.84	1209.11	933.08	493.02	52.84
PTAS 1	251.40	225.78	214.68	131.51	61.26
TAS 2	270.48	238.58	210.91	136.55	64.74
PTAS 2	170.26	152.30	142.68	104.44	73.20
TAS 3	558.62	473.26	448.93	261.29	58.20
PTAS 3	274.77	238.35	228.86	200.60	87.65
TAS 4	275.60	247.80	232.56	172.15	74.02
PTAS 4	81.01	66.36	56.77	43.01	75.76

[+]Flour that passed through 75 µm sieve, *Based on the weight of milled seeds

Table 2: The effect of parboiling on the proximate composition of *T. africana* seed flours

Sample	TASF1	PTASF1	TASF2	PTASF2	TASF3	PTASF3	TASF4	PTASF4
Moisture (%)	9.59±0.04	9.52±0.05	10.08±0.04	9.61±0.04	9.50±0.02	9.95±0.54	9.90±0.01	10.07±0.02
Ash (%)	1.01±0.01	0.92±0.004	0.99±0.002	0.90±0.001	1.10±0.08	0.93±0.006	1.03±0.01	0.96±0.003
Crude fibre (%)	0.89±0.002	0.70±0.005	0.85±0.001	0.82±0.0001	0.91±0.0004	0.79±0.005	0.89±0.0003	0.88±0.05
Crude fat[a] (%)	10.60±0.03	9.89±0.02	11.33±0.04	9.99±0.05	11.44±0.03	10.20±0.03	11.59±0.03	10.14±0.03
Crude protein[b] (%)	16.75±0.01	15.31±0.04	17.00±0.03	15.20±0.03	16.61±0.04	15.17±0.04	16.68±0.04	15.26±0.04
Total carbohydrate(%)	61.16±0.02	63.66±0.02	59.75±0.02	63.47±0.02	60.9±0.03	62.96±0.09	59.91±0.01	62.61±0.03
Free Sugar (%)	3.51±0.04	3.05±0.02	3.60±0.03	3.15±0.03	4.05±0.04	2.90±0.02	3.81±0.04	3.50±0.03
Starch (%)	55.67±0.08	57.91±0.05	54.21±0.01	58.95±0.01	54.41±0.04	58.96±0.02	53.91±0.04	57.32±0.01
Energy (kcal/g)	4.090	4.049	4.090	4.130	4.043	4.107	4.031	4.189
pH	6.60±0.007	6.67±0.001	6.68±0.002	6.48±0.001	6.78±0.001	6.68±0.003	5.66±0.001	6.11±0.001

All values are means of triplicates±standard deviation, [a]Hexane extract, [b]Crude protein = (6.25xN), Total carbohydrate = (100- (ash+crude protein+crude fat+crude fibre))

Table 3: The effect of parboiling on the mineral composition (mg/100g) of *T. africana* seed flours

Sample	Na	K	Zn	Ca	Fe
TASF1	6.66	344.5	7.83	30.6	1.02
PTASF1	7.86	263.3	8.55	12.2	0.638
TASF2	6.58	338.5	7.72	28.7	0.988
PTASF2	7.76	253.4	8.06	12.5	0.613
TASF3	5.83	352.7	7.68	31.02	0.986
PTASF3	6.88	256.5	8.12	11.88	0.596
TASF4	5.73	330.2	7.48	30.7	0.963
PTASF4	6.76	248.6	8.06	11.78	0.622

Table 4: The effect of parboiling on the tannins and phytate composition of *T. africana* seed flours

Sample	Phytate (mg/100g)	Tannin (mg/100g)
TASF1	1.73±0.04	0.12±0.007
PTASF1	1.52±0.02	0.11±0.007
TASF2	1.66±0.04	0.13±0.007
PTASF2	1.54±0.010	0.09±0.058
TASF3	1.59±0.03	0.11±0.007
PTASF3	1.40.±0.02	0.10±0.007
TASF4	1.70±0.02	0.12±0.007
PTASF4	1.47±0.02	0.10±0.007

All values are means of triplicates±standard deviation

were determined by the method of Novozamsky *et al.* (1983). The tannin content of the flours was determined by the Acidified-Vanillin method (Burns, 1971) with modification. Approximately 1.0g flour was taken in a 125-ml flask and 50 mL methanol added to extract the tannin. Flasks were stoppered and swirled to mix properly and allowed to settle. 1 mL each of the supernatant was carefully pippetted into two tubes and quickly, 5 mL of vanillin-HCl reagent was added to each of the two tubes. The absorbance was read at 500 nm after 20 minutes. Tannin level in the flours was calculated using a catechin standard curve. Phytate content was determined according to the method of Wheeler and Ferrel (1971).

Physicochemical studies: The water absorption capacity of the flours was studied according to the method of Solsulski (Solsulski, 1962). The least gelation concentration was determined by heating 2-20% (w/v) suspensions of flours in distilled water in boiling test-tubes for 1 hour in a boiling water bath and cooling rapidly under running cold water. The test tubes were further cooled for 2 hours at 4°C in a refrigerator. The test tubes were inverted to see if content would slip or fall off. The least gelation concentration was determined as the lowest concentration (% suspension) at which the flour paste in the inverted tubes did not slip or fall off. The Freeze-thaw stability and the paste clarity were studied according to the method of Singhai and Kulkarni (1990). The paste viscosity was determined in the Rapid Visco-Analyser (Newport Scientific Pty Ltd, Switzerland) at 14% aqueous flour slurry.

Results and Discussion

Flour yield and composition: From Table 1, the parboiled yielded more flour (61.26-87.65%) than the native (52.84-74.02%). This result indicates parboiling enhanced the processing of T. africana seeds into flour. The composition of the flours of the native and parboiled seeds of *T. africana* is presented in Table 2. Flours prepared from the parboiled seeds (PTASF) were lower in ash (0.90-0.96%), crude fibre (0.70-0.88%), crude fat

Table 5: The effect of parboiling on the physicochemical properties of *T. africana* seed flours

Sample	Water absorption capacity (g H_2O/g flour)[a]	Least gelation concentration (% flour, w/v)	Freeze-thaw stability (% H_2O exuded)[b]	Paste clarity (% transmittance)
TASF1	16.15±0.20	8	20.7±0.1	0.82
PTASF1	13.33±0.05	8	25.5±0.7	0.84
TASF2	16.86±0.30	8	9.7±0.1	1.05
PTASF2	16.65±0.40	8	46.8±0.8	0.79
TASF3	13.79±0.01	8	3.2±0.1	1.22
PTASF3	12.18±0.10	8	49.5±0.7	0.66
TASF4	16.76±0.40	8	23.1±0.1	1.04
PTASF4	14.39±0.40	7	32.7±0.5	1.37

[a,b]Values are means of triplicates±standard deviation

Table 6: The RVA pasting properties of native and parboiled *T. africana* seed flours

Sample	Pasting temp (°C)	Peak viscosity (RVU)	Peak time (min)	Through (RVU)	Final viscosity (RVU)	Break down (RVU)	Set back (RVU)
TASF1	64.00	132.08	4.30	58.83	82.50	73.25	23.67
PTASF1	64.50	39.75	5.15	34.83	47.00	4.92	12.17
TASF2	64.45	138.00	4.17	58.75	84.58	79.25	25.83
PTASF2	65.35	80.67	4.95	59.50	78.75	21.17	19.25
TASF3	64.05	212.00	4.01	90.75	113.08	121.25	42.33
PTASF3	63.80	36.33	5.54	33.00	51.17	3.33	18.17
TASF4	64.90	96.00	4.01	50.67	71.75	45.33	21.08
PTASF4	64.00	28.42	8.83	25.75	34.08	2.00	8.33

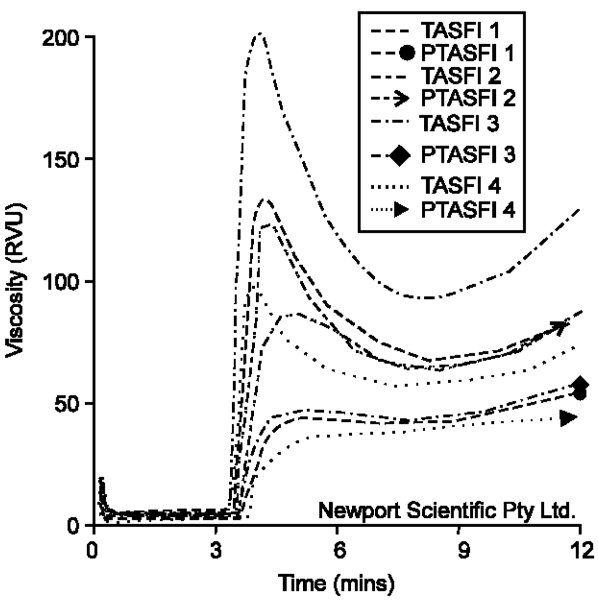

Fig. 1: The RVA Pasting curves of native and parboiled *T. africana* seed flours; TAS: *T. africana* seeds, TAS1-4: Samples of *T.africana* seeds from trees at different locations, PTAS: Parboiled *T. africana* seeds, TASF: Flour of native *T. africana* seeds, PTASF: Flour of parboiled *T. africana* seeds

(9.89-10.20%), crude protein (15.17-15.31%) and free sugar (2.90-3.50%) but higher in total carbohydrate (62.61-63.66%) and starch contents (57.32-58.96%) than flours prepared from native seeds of *T. africana* (TASF): ash (0.99-1.10%), crude fibre (0.85-0.91%), crude fat (10.60-11.59%), crude protein (16.61-17.00%), free sugar (3.51-4.05%), total carbohydrate (59.75-61.16%) and starch contents (53.91-55.67%). TASF3 was the highest in ash (1.10%), crude fibre (0.91%) and free sugar (4.05%). TASF4 was highest in crude fat (11.59%) while TASF2 was highest in crude protein (17.00%). The composition varied from one tree source to another. The composition results are in agreement with those reported in the literature (Akubor, 1997), Fasasi and Fasasi (2004), however the total carbohydrate values obtained are lower than 69.06% reported by Ejiofor *et al.* (1988). The flours of the parboiled seeds were slightly lower in calorific value than those of the native seeds.

The mineral composition (mg/100g) of the flours is presented in Table 3. In all the flours, the most abundant metal is potassium (K), followed by calcium (Ca) and then zinc (Zn) while iron (Fe) is the least abundant. However, Fasasi and Fasasi (2004) have reported zinc as the most abundant metal in *T. africana* seed flour in another work. Parboiling resulted in enrichment in the levels of Na and Zn and decrement in levels of K, Ca and Fe. From Table 4, the tannins and phytates content of the parboiled seed flours were lower than those of the native seed flours.

Physicochemical properties: Table 5 shows some physicochemical properties of flours of the native and parboiled *T. africana* seeds. Both the native and parboiled seed flours exhibited low water absorption capacities. This is attributable to the high lipid content of the flours which reduced water imbibitions (Nwokocha and Ogunmola, 2005). Flours of the parboiled seeds have lower water absorption capacities than those of the native seeds, indicating parboiling resulted in tight granule structures.

The least gelation concentration of the flours was 8% (w/v) in all cases except PTASF4 where it was 7% (w/v). Pastes of flours of the parboiled seeds exuded more water than the pastes of flours of the native seeds when subjected to freeze-thaw cycles, suggesting higher freeze-thaw stability of the native seed flour pastes. The paste clarity of the flours of both native and parboiled seeds was generally low and did not show any trend with parboiling.

The RVA pasting properties and pasting curves of the flours of the native and parboiled seeds are presented in Table 6 and Fig. 1 respectively. Flours of the parboiled seeds exhibited higher pasting temperature than the flours of native seeds, also the time to attain viscosity peak was higher in the parboiled. Similarly, flours of the parboiled seeds were characterized by lower peak viscosity, higher stability to shearing forces and reduced retrogradation. For example the flour of native seeds, TASF3, exhibited a high peak viscosity (212 RVU), considerable viscosity breakdown (121.25 RVU) and a high setback (42.33 RVU). However the flour of the parboiled counterpart PTASF3, exhibited a lower peak viscosity (36.33 RVU), a lower viscosity breakdown (3.33 RVU) and a lower setback (18.17 RVU). Hence parboiling resulted in tightening intra-granular structure, reduced swelling and stabilized the resulting paste against breakdown by shearing forces.

Conclusion: Parboiling employed in improving the aesthetic appeal of the *T. africana* foods affected the composition and physicochemical properties of the flours. Remarkably, parboiling improved flour yields, decreased the levels of tannins and phytates and stabilized the paste viscosity of the flours.

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