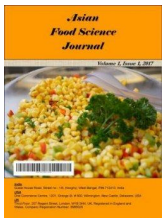

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Effect of Fermentation on Antinutritional Factors and Functional Properties of Fermented Bambara Nut Flour

O. I. Ola[1*] and S. O. Opaleye[1]

[1]Department of Food Technology, Gateway (ICT) Polytechnic, Saapade, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author OIO designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Author SOO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Bambara nut (*Vigna subterrenean*) is a cheap source of leguminous protein that can be a good substitute for relatively expensive animal protein to reduce malnutrition. Despite its potentials, it remains underutilized owing in part to long cooking time, presence of antinutritional factors and drudgery in dehulling. In this regard, this study determined effects of fermentation on antinutritional and functional properties of bambara nut flour.

Bambara nut was procured from local market in Abeokuta while pure culture of *Rhizopus oligosporous* was obtained at the Department of Food Science and Engineering, Ladoke Akintola University of Technology. Bambara nut was fermented for 12, 24, 36, 48, 60 and 72h at 32ºC and dried in oven (55ºC/24 h). The antinutritional (tannin, oxalate, phytate, and trypsin inhibitor) and functional properties (water-absorption-capacity, solubility and swelling power) of the composite flour were determined. The data obtained were subjected to descriptive and inferential statistics and significance established at *P*=.05.

Respective range of values for tannin, oxalate, phytate and trypsin inhibitor were 0.08 - 0.32, 0.72 - 1.49, 0.15 - 3.64 and 0.42 - 3.25 mg/g, respectively. Water absorption capacity, solubility and

**Corresponding author: Email: olarexy@gmail.com;*

swelling power ranged from 8.67 - 11.04, 52.59 - 53.07, 9.20 - 10.16 and 9.14 9.16%, respectively. The fermentation process reduced the antinutritional factors and increased the protein content.

Keywords: Fermentation; bambara nut; antinutritional properties; functional properties.

1. INTRODUCTION

Legumes are generally known as important cheap source of protein to poor resource people in Nigeria. In recent time, traditional foods have been enriched using soybeans as the source of protein towards alleviating the associated low protein problems. Another approach to solve the problem of low intake of protein is to develop high proteinous food from other crop sources. Agricultural research traditionally has focused on staple foods while little attention has been given to underutilized and neglected crops, particularly by scientist in developed countries. One of such underutilized crop is bambara nut. Bambara nut is an indigenous African crop that has been cultivated in Africa for centuries, it is mostly found in central Nigeria Eastwards to Southern Sudan and throughout tropical Africa [1]. In Nigeria, Bambara nut is cultivated in some part of Enugu, Anambra and Ebonyi States [2]. It is a highly nutritious which accordingly plays a crucial role in human diets [3]. One of the main attributes of bambara nut is its tolerance to drought and its ability to yield considerably in poor soils. Ouedraogo et al. [4] described bambara nut seeds as a complete balanced diet, making it a good supplement to cereal - based diets.

Fermented food products have contributed to the socio-economic role and improve the protein requirements of the indigenous consumers in African countries and the developing world [5]. During fermentation, microflora may produce proteolytic enzymes which may be responsible for the increase in protein digestability and also, eliminate phytic acid which contribute to the improvement of protein digestability of fermented products.

The objective of this research is to study the antinutritional and functional properties of flour from fermented bamabara nut. This study could provide some basic information which would help determine an application for bambara nut in food industries.

2. MATERIALS AND METHODS

Bambara nuts (*Vigna subterrenean*), used for this study was obtained from a local market in Abeokuta. The species of Rhizopus used was obtained from the Department of Food Science and Engineering, Ladoke Akintola University, Ogbomoso.

2.1 Sample Preparation

2.1.1 Subculturing of fungal cultures

The subculture of *R. oligosporus* was prepared by the procedure described by Olanipekun et al. [6]. Five hundered millilitres of PDA was prepared by using 18 g of potato dextrose agar and 500 ml of distilled water, it was homogenized and sterilized. After cooling, 15 ml of PDA was dispensed into each McCartney bottle placed in a slant form. The *R. oligosporous* were subcultured singly into each McCartney bottle containing PDA and incubated at 32ºC for 4 days. One (1 ml) of each spores suspension were thereafter taken and transferred into a heamocytometer for spores enumeration. An appropriate volume of 2 ml of these spore suspension from *R. oligosporous* was used to inoculate the bambara nut within 0-72 h fermentation period.

2.1.2 Preparation of fermented bambara nut flour

Bambara nut was fermented using the method described by Olanipekun et al. [6]. Bambara nut (5 kg) was cleaned and washed with tap water. It was steeped in water for 24 h and dehulled. The steeped beans were boiled in the steeped water for 15 mins, drained and spread out to dry a little at room temperature. One hundered grammes of dehulled bambara nut were poured into the perforated polythene bag and an appropriate volume of 2 ml of this spore suspension of *R. oligosporous* was carefully added and thoroughly mixed. The perforated polythene bags were tightly sealed. They were incubated at 32ºC for periods of time ranging between 0 and 72 h (0, 12, 24, 36, 48, 60 and 72 h). The unfermented bambara nut (0 h fermentation) served as the control sample. At regular intervals of 12 h, samples were taken out for appropriate analysis. At the end of each fermentation period, samples were blanched for 20 mins and then sliced into smaller units. The sliced samples were drained and dried in an oven at 55ºC for 24 h, cooled,

milled and then sieved with 180 µm sieves to fine particles. The flour was packed in a polythene bags, sealed and kept in a deep freezer until required for analyses [7].

2.2 Analyses

2.2.1 Antinutritional determination

Phytic acid and trypsin inhibitors were determined by AOAC, [8]. While the Tannic and oxalic acids were determined using the procedure of Medoua [9].

2.2.2 Physicochemical analysis of fermented bambara nut flour

The swelling power and solubility were determined by the method described by Charles and Guy [10] while water absorption capacity (WAC) was carried out as described by Owuamanam et al. [11]. A Rapid Visco Analyser (RVA) was used to study the pasting characteristics of the flour samples.

2.3 Statistical Analysis

The data obtained from study and sensory evaluation were subjected to descriptive and inferential statistics and significance established at *P*=.05.

3. RESULTS AND DISCUSSION

3.1 Effect of Fermentation on Level of Antinutritional Factor of Bambara Nut Flour

The results obtained for the parameters investigated on the antinutritional properties of bambara nut are as presented in Table 1. There is a decreasing trend in tannin content within 0-72 h fermentation period ranging from 0.32±1.00 to 0.08±1.00 mg/g. Fermenting bambara nut at 0 h however gave the highest value (0.32±1.00) while the least values (0.08±1.00) were obtained at 72 h fermentation period. Reduction in tannin due to fermentation might have been caused by the activity of polyphenol oxidase or fermented microflora on tannins [12]. The observed decrease in tannin with increase in fermentation time agrees with the report of Onweluzo and Nwabgwu [13]. The tannin content of fermented bambara nut flour decreases from 0.33 to 0.02 mg/100 g within the period of fermentation which was lower in value compared to 0.16 mg/100 g reported by Abiodun and Adepeju, [12] on dehulled bambara nut flour.

There is a decreasing trend in oxalate content within 0-72 h fermentation period ranging from 1.49 ± 1.00 to 0.72 ± 1.00 mg/g. Fermenting bambara nut at 0 h however gave the highest value while the least value was obtained at 72 h. There was no significant difference in samples (E and F) at *P*= .05. The observed decreasing trend agrees with the findings of Abiodun and Adepeju [12], Oke and Bolarinwa [14] for cocoyam flour and dehulled bambara nut flour, respectively. The values obtained for the phytate content showed a decreasing trend from 3.64±1.00 to 0.15±1.00. Significant differences were observed within 0-72 h of fermentation period at *P*=.05. Fermenting bambara nut at 0 h however gave the highest value while the least value was obtained at 72 h fermentation period. Processing, especially fermentation, has been reported to reduce phytic acid content of cereals, legumes and tubers as a result of the activity of the endogenous phytases from both raw ingredient and inherent microorganisms which hydrolyse phytic acid in many fermented food product preparation inisitol and orthophosphate [15]. Therefore, fermenting bambara nut has higher potential to enhance its nutritional value without any adverse effect and toxicity on human health.

3.2 Physicochemical Analysis of Fermented Bambara Nut Flour

The results of physicochemical analysis of the fermented bambara nut flour are shown in Table 2. The result of swelling power ranged from 143.24 ± 1.00 - 149.28 ± 1.00. There was significant difference at *P*=.05 in the swelling index property of the samples except for samples C and F, as well as samples B and E. Samples A, the unfermented sample had the highest value of 149.28 ± 1.00. The significant increase in the values may be due to the water binding properties of the legume protein [16]. The value is lower than that of native and ginger modified starches with values of 8.9 and 12.9, respectively as reported by Daramola and Osanyinlusi [17].

The water absorption capacity of the flour ranged from 165.0 ± 1.00 - 210.0 ± 1.00 within 0 72 h fermentation. The results for the water absorption capacity showed a significant difference (*P*=.05) in the samples with WAC decreasing as the fermentation period increases. Water absorption capacity describes flour water association ability under limited water supply. Both swelling index

Table 1. Antinutritional properties of fermented bambara nut flour

Sample	Tannin(mg/100g)	Oxalate(mg/100g)	Phytate(mg/100g)	Trypsin inhibitor (mg/100g)
A	0.32±1.00^{f}	1.49±1.00^{f}	3.64±1.00^{g}	3.25±1.00^{g}
B	0.23±1.00^{e}	0.96±1.00^{e}	2.84±1.00^{f}	1.90±1.00^{f}
C	0.21±0.46^{d}	0.83±1.00^{d}	1.37±1.00^{e}	0.76±1.00^{e}
D	0.21±0.46^{d}	0.81±1.00^{c}	1.24±1.00^{d}	0.70±1.00^{d}
E	0.19±1.00^{c}	0.74±0.42^{b}	1.20±1.00^{c}	0.64±1.00^{c}
F	0.14±1.00^{b}	0.74±0.42^{b}	0.18±1.00^{b}	0.56±1.00^{b}
G	0.08±1.00^{a}	0.72±1.00^{a}	0.15±1.00^{a}	0.42±1.00^{a}

All values are means of triplicate determinations ± standard deviation (SD). All values with different superscripts in the same column are significantly different at P=0.05

Key: Sample A = Unfermented bambara nut; Sample B = 12 h fermented bambara nut; Sample C = 24 h fermented bambara nut; Sample D = 36 h fermented bambara nut; Sample E = 48 h fermented bambara nut; Sample F = 60 h fermented bambara nut; Sample G = 72 h fermented bambara nut

Table 2. Physicochemical analysis of fermented bambara nut flour

Sample	WAC (%)	SOL (%)	SP (%)
A	210 ± 1.00^{e}	1.92 ± 1.00^{a}	149.28 ± 1.00^{e}
B	200 ± 1.00^{c}	2.01 ± 1.00^{e}	145.58 ± 0.35^{b}
C	190 ± 1.00^{d}	1.63 ± 1.00^{f}	144.47 ± 1.00^{a}
D	180 ± 1.00^{a}	0.50 ± 1.00^{b}	144.14 ± 1.00^{d}
E	170 ± 0.40^{b}	0.21 ± 1.00^{a}	145.57 ± 0.35^{b}
F	170. ± 0.40^{b}	1.42 ± 1.00^{c}	140.47 ± 1.00^{a}
G	165.0 ± 1.00^{f}	1.54 ± 1.00^{d}	143.24 ± 1.00^{c}

All values are means of triplicate determinations ± standard deviation (SD). All values with different superscripts in the same column are significantly different at P=.05

Key: Sample A = Unfermented bambara nut; Sample B = 12 h fermented bambara nut; Sample C = 24 h fermented bambara nut; Sample D = 36 h Fermented bambara nut; Sample E = 48 h fermented bambara nut; Sample F = 60 h fermented bambara nut; Sample G = 72 h fermented bambara nut; WAC = Water absorption capacity; SOL = Solubility; SP = Swelling power

and WAC ultimately determine the sample consistency that is solid, semi-solid or liquid. It is an index to determine the industrial utilization of the fermented product as an ingredient. The values obtained for solubility of the seed flour samples ranged from 1.54 ± 1.00 - 1.92 ± 1.00% with sample F having the lowest and sample A having the highest. Solubility reflects the extent of intermolecular cross bonding with the granule [18]. This result suggests that bambara nut flour may find application in the production of some baked products.

4. CONCLUSION

The use of *Rhizopous Oligosporous* in the fermentation process showed reduction in antinutritional factors. The lowest values for all the investigated antinutrients were observed at 72 h of fermentation period. The functional properties (water absorption, solubility and swelling power) of bambara nut makes the seeds an ideal raw material for successful utilization in various food products and different beverages.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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