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FUNCTIONAL AND ANTINUTRIENTS PROPERTIES OF UNDEHULLED ENRICHED BEANS FLOUR

[1] Dania, M. I., [2] Oladebeye, A. A., [3]Adejumo, P. O. and [4]Olukoya, F.O.
[1-4]Food Technology Department, Auchi Polytechnic, Auchi, Edo State, Nigeria.
P.M.B. [1,3] corresponding author:

ABSTRACT

This study was carried out to evaluate the functional and antinutrients properties of flour blends from undehulled beans, crayfish, dried fish and dried onions. Samples were sorted and milled to produce four and response surface method (RSM, design expert 7.0.0) was used to generate the proportion of flour samples in the formulations with 100% beans flour and four selected flour blends. Functional and antinutrients properties were determined according to standard procedures. Data generated were subjected to analysis of variance (ANOVA) and the means separated by least significant difference and Duncan tests. The results were significantly different (P<0.05) among the samples. The results obtained for functional properties of the flour blends varied from 0.02%-0.80% for least gelation concentration. This is an indication of high protein content of the flour blends. The highest value of phytate was depicted in sample E with 10.91mg/g and lowest in Sample B with 6.59mg/g. It was evidence that the flour blends had good functional properties and permissive of antinutrients factors lower enough not to cause any deleterious effect.

Keywords: Processing, formulation, functional and antinutrients properties

INTRODUCTION

Cowpea (*Vigna unguiculata*) is a leguminous plant of the family *Fabaceae*. It originated in Africa and is widely distributed in tropical and temperate climates and differs in shape, size and colour of seed coat (Ashogbon and Akintayo, 2013). Nigeria is said to be the largest producer of cowpea (IITA, 2013).The main centres of cultivation of cowpea in Nigeria are Kano, Katsina, Bauchi, Bornu, Sokoto and Niger States in the North; Ibadan, Owo and Benin in the West (Arawande and Borokini, 2010). It is a good source of many health-promoting components, such as dietary protein (18-35%), lysine, soluble and insoluble dietary fibre, Phenolic compounds, minerals, and many other functional compounds, including B group vitamins (Liyanage *et al*., 2014). Cowpea seeds contain 20-25% protein, 1.5-4% crude fiber, 1-2% fat, 3-4% ash and 55-68% carbohydrate in addition to vitamins and beneficial phytochemicals (Lasekan *et al*., 1987; Frank- Peterside *et al*., 2002). Cowpea (*Vigna unguiculata*) according to Adipala (2002) is a very important legume crop in tropical regions of Africa , South and Central America. Cowpea plays a critical role in the lives of millions of people in Africa and other parts of the developing world (Singh *et al*., 2002); it is the foremost grain legume in Nigeria and other West African countries. Demand for cowpea in Nigeria outstripped its production due to rising population and awareness of its nutritive value, therefore Nigeria is also one of the importers of cowpea in the world. It is a good source of plant protein and fibre to Nigerians of the low income groups especially the poor rural communities (Haruna and Usman, 2013). Cowpea is consumed in different processed forms chiefly as boiled beans, eaten as moi-moi (Cowpea puddy), akara (fried cowpea paste), etc. or cooked together with a cereal grain usually rice, fresh maize or with a root or tuber such as yam, cocoyam, potatoes etc(Mamiro *et al*., 2011). Nwosu (2011) reported that it is a well cherished food popularly consumed in Nigerian homes where it is taken with pap, eaten lone or combined with rice.

Cowpea is a good source of protein in the tropics with the seed containing appreciable amounts of lysine and tryptophan but is deficient in methionine and cystiene when compared to animal protein, where it is a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops. It is also a valuable and dependable commodity that produces income for farmers and traders.

Increasing population, urbanization and changing food habits in recent years has led to an increased demand for convenient foods in many developing countries. It contains anti-nutritive factors such as trypsin inhibitors, tannin, phytates, lecitins, and saponin (Vadivel and Jonadhanan, 2001).

The overall aim of this work was to evaluate the functional and antinutrients properties of undehulled enriched bean flour.

MATERIALS AND METHODS

Source of materials: Cowpea (*Vigna uniguiculata*), crayfish, dried fish and dried onions were purchased from Uchi market, Auchi, Etsako West Local Government, Edo State.

Preparation of flour samples: After the preliminary cleaning and sorting out dirt and stones from beans and crayfish, the bones of the dried fish were removed. The samples were milled separately using Philips laboratory blender (HR2811 model, Hong Kong).

Formulation of beans based enriched flour blends: The combination of beans flour, crayfish, dried fish and dried onions in the blended flour samples were determined using response surface methodology (RSM) design expert 7.0.0. with reference to protein (20%), fibre (10%), carbohydrate (55-65%) required for normal dietary intake (Franz *et al*., 1994). The samples were BA (100% beans flour), BB (50% beans flour, 15% crayfish, 25% dried fish and 10% dried onions), BC (50% beans flour, 17% crayfish, 27% dried fish and 5% dried onions), BD (51% beans flour, 20% crayfish, 23% dried fish and 5.3% dried onions), BE (50% beans flour, 15% crayfish, 28.5% dried fish and 6.4% dried onions).

Determination of antinutrients properties. The following antinutrients properties were determined phytate, oxalate, tannin, saponin and phenols.

The phytate and oxalate concentrations of the flours were determined using method described by Oladele *et al*. (2009). Tannin content was determined by the method described by Mugabo *et al*. (2017). Saponin quantitative determination was carried out using the method reported by Ejikeme *et al*. (2014) and Obadoni and Ochuko (2002). Phenol content was carried out using the method reported by Singleton *et al.* (1999).

Determination of functional properties. The following functional properties were determined water absorption capacity, oil absorption capacity, foaming capacity, foaming stability, emulsion, least gelation concentration and bulk density.

The bulk density (loose and packed) of enriched bean flour blend flours was determined by the procedure of Narayana and Narasinga (1984). A specified quantity of the flour sample was transferred into an already weighed measuring cylinder (W_1). For the packed bulk density determination, the flour sample was gently tapped to eliminate spaces between the flour and the level was noted to be the volume of the sample and then weighed (W_2). No tapping was made in the case of loosed bulk density and the level was also noted to be the volume of the sample and then weighed. The study was conducted in triplicate.

$$Bulk\ Density = \frac{\mathrm{W_2 - W_1}}{\mathrm{Vol.\ of\ sample}}$$

Water and oil absorption capacities were determined using the procedures described by Sofi *et al.* (2013).

1g of the flour sample was weighed into a 15 ml centrifuge tube and suspended in 10 ml of water/oil. It was shaken on a platform tube rocker for 1 minute at room temperature. The sample was allowed to stand for 30min and centrifuged at 1200 x g for 30 min. The volume of free water was read directly from the centrifuge tube.

$$\mathrm{WAC\ /OAC(\%)} = \frac{\mathrm{Amount\ of\ water/oil\ added - Free\ water/oil\ \times 100}}{\mathrm{Weight\ of\ sample}}$$

Determination of foaming properties

The foam capacity and stability were studied by the method of Coffman and Garcia (1977). Known weights of the enriched bean flour blends sample were dispersed in 100 mL distilled water. The resulting solution was homogenized for 5 min at high speed. The volume of foam separated was noted. The total volume remaining at interval of 0.00, 0.30, 1, 2, 3, 4 up to 24 h was noted for the study of foaming stability.

$$\%\ Foaming\ capacity = \frac{\mathrm{Vol.\ after\ homogenization - Vol.\ before\ homogenization\ \times 100}}{\mathrm{Vol.\ before\ homogenization}}$$

$$\mathrm{\%\ Foam\ Stability} = \frac{\mathrm{Foam\ volume\ after\ time\ (t) \times 100}}{\mathrm{initial\ Foam\ Volume}}$$

Determination of the gelation concentration

The least gelation concentration was determined by the method of Sathe *et al.* (1981). Test tubes containing suspensions of 2, 4, 6, 8 up to 20% (w/v) flour in 5 ml distilled were heated for 1 h in boiling water, followed by cooling in ice and further cooling for 2 h at 4^{o}C. The least gelation concentration was the one at which the sample did not fall down or slip when the test tube was inverted.

Determination of emulsion

Emulsions were formed inside a 600 ml beaker using a continuous stirring apparatus. The apparatus consisted of a regulated/stabilized 6 V power supply, a burrette, a stirrer, a beaker with emulsion and a digital milliameter. The stirrer was made up of stainless steel rod holding a Perspex bridge was fixed to a 6 V D.C motor spindle by means of a plastic adaptor. The motor itself was driven by a regulated and stabilized 6 V D.C power. The milliameter monitored the current drop by the stirrer motor to maintain a constant speed. The greater the viscosity of the emulsion, the greater will be the current drawn. The protein sample (0.25, 0.5, 0.75, 1.00 and 1.25 g) was dissolved in 25 ml of distilled water making 1, 2, 3, 4 and 5% slurries (w/v), respectively (Adebowale *et al*., 2005).

Statistical analysis: Data obtained were analyzed using SPSS version 23.

RESULTS AND DISCUSSION

The results of functional properties of the flour blends showed that there was significant (P<0.05) difference in the water absorption capacity (WAC) and oil absorption capacity (OAC) of the flour blends. The ability of the blends to absorb water increased from 17.00%-22.00% and 12.00%-21.00% for oil absorption capacity. These values are higher than the values obtained by Oshodi *et al*., 1997 for African yam beans. Water and oil retention are index of the ability of proteins to influence the texture

and mouth feel characteristics of foods and food products like comminuted meats, extenders or analogues and baked dough (Cheftel *et al*., 1985; Okezie and Bello, 1988). Bulk density (BD) is used to evaluate flour heaviness, handling requirements and the type of packaging materials suitable for storage and transportation of food materials (Oppong *et al*., 2015). The bulk density varied from 0.66%- 0.83%. The values of the bulk density of the enriched bean flour blends in this study are within the range of bulk density of *Mucuna* species (0.42-0.88%) reported by Adebowale *et al*., 2005. Foaming capacity (FC) is used to determine the ability of the flour to foam which is dependent on the presence of the flexible protein molecules that decreases the surface tension of water (Asif-Ul-Alam *et al*., 2014). Foaming capacity values ranged from 14.00%- 30.00%. The values of foaming capacity in this study are within the range of values (9.60- 17.7%) obtained by Adebowale *et al*., 2005. The foaming capacity recorded in this study is within the ranged recorded for pumpkin seed flour (13.2%) by Oshodi and Fagbemi (1992), but lower than the values for cowpea flour (40%) reported by Abbey and Ibeh (1988). It was reported that foamability is related to the rate of decrease of the
surface tension of the air/water interface caused by absorption of protein molecules (Sathe *et al*., 1982). Good foamability is linked to flexible protein molecules, which reduces surface tension.
Low foamability on the other hand can be related to highly order globular proteins, which resists surface denaturation. The proteineous food are said to have good foaming capacity if they are able to absorb rapidly at air water interface during bubbling, undergo rapid conformational change and rearrangement at the interface, and form a cohesive viscoelastic film via intermolecular interactions. Rapid absorption at air-water interface and conformational change are essential for better foamability whereas rearrangement at the interface is important for the stability of the foam (Sathe *et al*., 1982). Least gelation capacity (LGC) measures the minimum amount of flour needed to form gel in a measured volume of water. Least gelation capacity varied from 0.02%-0.80%, it was observed that the values are low which indicated high protein content. Foaming stability (FS) values ranged from 6.00%-20.00% and emulsion (E) values ranged from 55.56%-84.66% (Table 1) below.

Table 1: Functional properties of enriched bean flour blends

PARAMETERS	SAMPLES				
(%)	A	B	C	D	E
WAC	$18.00^{a}\pm0.33$	$20.00^{bc}\pm0.80$	$17.00^{a}\pm0.33$	$19.50^{b}\pm0.80$	$22.00^{c}\pm0.80$
OAC	$12.00^{a}\pm1.00$	$18.00^{b}\pm0.26$	$17.00^{b}\pm0.26$	$17.00^{b}\pm0.26$	$21.00^{c}\pm0.26$
BD	$0.83^{d}\pm1.00$	$0.69^{b}\pm1.00$	$0.71^{c}\pm1.00$	$0.67^{a}\pm0.24$	$0.66^{a}\pm0.24$
FC	$30.00^{e}\pm1.00$	$14.00^{a}\pm1.00$	$16.00^{b}\pm1.00$	$20.00^{c}\pm1.00$	$24.00^{d}\pm1.00$
LGC	$0.02^{c}\pm1.00$	$0.10^{b}\pm0.35$	$0.80^{b}\pm0.35$	$0.20^{a}\pm0.35$	$0.80^{b}\pm0.35$
FS	$20.00^{e}\pm1.00$	$6.00^{a}\pm1.00$	$10.00^{b}\pm1.00$	$14.00^{d}\pm1.00$	$12.00^{c}\pm1.00$
E	$82.22^{b}\pm0.09$	$84.44^{c}\pm0.61$	$84.66^{c}\pm0.61$	$82.99^{b}\pm0.09$	$55.56^{a}\pm1.00$

Values are mean of triplicates ± standard deviation. Values within the row with different superscript are significantly (P<0.05) different.

Table 2 below showed the antinutrients composition of the flour blends. The least tannin content 0.46mg/g was observed in sample A and the highest in sample E (0.98mg/g). Sample E had the lowest saponin content (5.85mg/g) while sample C had the highest (10.88mg/g). Saponins are known to possess both beneficiary (cholesterol lowering) and deleterious (cytotoxic permeabilization of the intestine and paralysis of the sensory properties (Price *et al*., 1987). The lowest phenol was in sample A (5.81mg/g) and highest in sample E 12.63mg/g. The lowest oxalate was observed in sample A (3.32mg/g) and highest in sample D (5.70mg/g). Sample E (10.91mg/g) had the highest phytate while sample B

(6.59mg/g) had the least. Robbins. (2003) reported that phytic acid forms complexes with metal ions that are key components of crops that causes zinc deficiency. The values obtained in this study for phytate, tannin and oxalate are lower than the values reported by Makinde and Abolarin, 2020. However, the levels of phytate and saponin in this study are within the acceptable values allowed as such they cannot have deleterious effect when consumed.

Table 2: Antinutrients properties of enriched bean flour blends

SAMPLES	Tannins	Saponins	Phenols	Oxalates	Phytates
A	$0.46^{a}\pm1.00$	$9.81^{b}\pm0.23$	$5.81^{a}\pm1.00$	$3.32^{a}\pm1.00$	$9.88^{b}\pm0.29$
B	$0.83^{c}\pm0.07$	$9.74^{b}\pm0.23$	$10.69^{d}\pm1.00$	$5.34^{d}\pm1.00$	$6.59^{a}\pm1.00$
C	$0.64^{b}\pm1.00$	$10.88^{d}\pm1.00$	$8.07^{b}\pm1.00$	$5.13^{b}\pm1.00$	$10.71^{c}\pm1.00$
D	$0.80^{c}\pm0.74$	$10.33^{c}\pm1.00$	$10.34^{c}\pm1.00$	$5.70^{e}\pm1.00$	$9.89^{b}\pm0.29$
E	$0.98^{e}\pm1.00$	$5.85^{a}\pm1.00$	$12.63^{e}\pm1.00$	$5.23^{c}\pm1.00$	$10.91^{d}\pm1.00$

Values are mean of triplicates ± standard deviation. Values within the columns with different superscript are significantly ($P<0.05$) different.

Conclusion

Formulation of enriched undehulled beans based flour blends in adequate proportion had good functional properties such as water and oil absorption capacity, foaming capacity, foaming stability, bulk density, emulsion and least gelation concentration. The bulk density showed that the samples can easily be packaged. The levels of the antinutrients factors are tolerable as such cannot be deleterious to human' s health.

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