Effects Of Some Processing Techniques On The Functional Properties Of Raw And Differently Processed African Yam Bean Seeds Flours *(Sphenostylis Stenocarpa)*

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Abstract

The experiment was conducted to asses the functional properties of raw and differently processed African yam bean seeds. Processing methods adopted were boiling, roasting and autoclaving. Processing methods had no significant effect on some of the parameters assayed. The functional properties of African yam bean seeds revealed that processing had no significant effect on fat (oil) absorption capacity (FAC), emulsion capacity, emulsion stability, foaming capacity, least gelation concentration and foaming stability of raw and differently processed African yam bean seeds, while bulk density and water absorption capacity (WAC) were significantly affected by processing techniques. The variation observed in the water absorption capacity was influenced by processing procedures. Higher WAC was recorded in the moist heated treatment (boiled and autoclaved). However, a better bulk density was obtained from boiled African yam bean seeds.

Introduction

In the current search for cheap sources of protein-rich foods, efforts have been focused on home-grown crops, under-exploited and neglected legume species whose seeds contain relatively high amount of protein and which are rarely consumed by man and can be used to improve the diets of man and his animals. From this background, an alternative source is such legume like African yam bean (AYB) (*Sphenostylis stenocarpa*).

The Coconut

The African yam bean (*Sphenostylis stenocarpa*) grows wild in many of our tropical areas, especially in the South Eastern and South Western parts of Nigeria, (Abbey and Ayuh, 1991). In Nigeria, it is a climbing legume, widely cultivated in Southern part of the country for its nutritious seeds, as well as edible tubers. Although, there has been declined in cultivation in Nigeria especially in Southern Nigeria, we have three major varieties: namely; black, white and brown. The ripe pods vary between 120 and 300mm in length and contain from 10-30 seeds, with crude protein levels varying from 21 to 26% (Evans and Boulter, 1974). African yam bean represents a less expensive source of dietary protein than soya bean among Nigerians of low economic status and very little is known about its nutritional potentials (Apata and Ologhobo, 1990) and when compared to available information with other types of beans. Several methods such as cooking (Ogbonna, Soraki and Achinewhu, 2001), germinations, dehulling (Marquardt and Campbell, 1986), roasting (Aletor and Ojo, 1989), extrusion (Alonso Aquirre and Marzo, 2000), Lactic acid fermentation (Azeke, 2005) and autoclaving (Ologhobo and Fetuga, 1983) can significantly detoxify and improve the functional properties of African yam bean seeds. Secondly, African yam bean seeds coats are very hard resulting in long cooking time and high energy requirement.

Food processing of much food has aided easy digestion of foods. It also leads to improvement of taste and flavour. Taste and flavour plays a key role in the acceptability of any food. Generally, processing is aimed at enhancing colour, brightness, consistency, viscosity etc. The processes of aeration, gel formation and crystallization are aimed at improving the texture and appearance of product.

Functional properties (water and oil absorption capacities, emulsification, nitrogen solubility, whippability, foam stability, slurry viscosity and gelation) of legumes are determined to know the potential food uses of their flours.

The properties of water and fat binding capacity, emulsification and viscosity are associated with the functionality of soybean protein products in ground meat formulations, doughnuts, pancakes, baked foods and soups (Wolf and Cowan, 1971). Okezie and Kosikowski (1998) are of the opinion that functional properties of legume flours are necessary because they determine their acceptability and application as ingredients in food systems. Fasuyi (2006) described water absorption capacity (WAC) as a critical property of protein in viscous foods like soups, gravies, dough and baked products (Adeyeye, Oshodi and Ipinmoroti, 1994).

Also whippability and foam stability could be utilized by the meat canning industry Garrant and Sosulski (1976) and foam stability is an important index in the suitability of a whipping agent in food system Fasuyi (2005).

Fat (oil) absorption capacity(FAC) is a critical assessment of flavour retention, while fat emulsion capacity (FEC) and emulsion stability are important attributes of additives for the stabilization of fat emulsion in the production of such foods as sausages, soups and cakes (Kinsella, (1976), bulk density Protein gel formation provides the matrix for holding water, flavours, sugar and ingredients hence it is an important consideration in food product development (Fayusi and Aletor, 2005; Fayusi, 2006).

Many food processing techniques have been highlighted as possible means of reducing or totally eliminating the anti-nutrient levels that can be tolerated by animals particularly in monogastric nutrition (Fayusi and Aletor, 2005) and man. Whatever methods adopted should ensure that African yam bean seeds are detoxified to a considerable extent that reasonable quantity of the seeds can be incorporated into diets of man and his animals.

Materials and Methods

Sample Collection and Preparation

Some African yam bean seeds were purchased from the central market at Ekpoma in Edo State, Nigeria. The bad seeds, stones and other non-AYB substances were removed. The seeds were then divided into four (4) parts of 2kg each. Three (3) of the parts were respectively processed as follows; roasting, boiling and autoclaving. The fourth part was left raw

Processing of African Yam Bean Seeds

The processing methods adopted included roasting, boiling and autoclaving as indicated above.

(i) Roasting: 2 kg of samples of African yam bean seeds were placed in a pot and mixed with clean fine sand. The pot was heated by naked fire from firewood. Frequent steering or turning was carried out at intervals to prevent burning of the seeds coat and to ensure uniform distribution of heat. They were heated for thirty (30) minutes before the sand was separated from the seed. Separation was done with the use of a sieve and then allowed to cool.

ii) Boiling: 2kg of African yam bean seeds were pre-soaked to facilitate bean hydration before boiling. The bean samples were boiled at 100-120^{0}c for 90 minutes, using aluminum pot. The boiling water was not changed. They were considered boiled when they became soft when pressed between fingers. The residual boiling water was drained off and the sample oven-dried over night at 75^{0}c and later sun-dried.

(iii) Autoclaving: 2kg of AYB seeds were autoclaved at 120^{0}c and 1.05kg / cm^3 for thirty (30) minutes.

All the processed samples and the raw sample were finally milled using a laboratory hammer mill to pass through 0.5mm mesh and stored in an air tight container pending analysis.

Analytical Procedure
The following functional properties of all the samples were determined:-
Bulk density, Water absorption capacity (WAC), Fat absorption capacity (FAC), Fat emulsion capacity (FEC), Emulsion stability (ES), Foaming capacity (FC), Foaming stability (FS), Least gelation concentration (LGC) and Protein solubility (PS)

- Bulk density: this was determined by employing the method of Moreyra and Peleg (1981).

-Determination of Water and Oil Absorption Capacity
The water and oil absorption capacity of the samples were determined as described by Beuchat (1977).

-Determination of Emulsion Activity and Stability
The emulsion activity and stability was determined by the method of Beuchat (1977).

- Determination of Foaming Capacity and Stability
The method of Coffman and Garcia (1977) was employed in the study of foaming capacity and stability.

- Determination of Least Gelation Concentration
The modified procedure of Coffman and Garcia (1977) was used to determine gelation property.
Note: In case of different salts concentrations used, the suspensions were prepared in 5ml of different salts solutions.

- Protein Solubility
200mg of the sample was dissolved in 5ml of distilled water, pH adjusted to the desired value with 0.1N HC l/NaOH, it was centrifuged, and the protein content of supernatant was determined using Biuret method. Analysis was performed in triplicate and the mean reported.

Results and Discussions

The functional properties of AYB revealed that processing had no significant($P>.05$) effect on fat (oil) absorption capacity (FAC), emulsion capacity, emulsion stability, foaming capacity, least gelation concentration and foaming stability of raw and processed AYB seeds, while bulk density and water absorption capacity (WAC) were significantly ($P<.05$) affected by processing techniques. The water absorption capacity (WAC) in the raw and differently processed AYB ranged from the raw 120.00±0.00% to 200.00±0.00% in the boiled AYB sample as shown in table 1. The values recorded for roasted, boiled and autoclaved AYB seeds were not significantly ($P>.05$) different from each other. The boiled African yam bean recorded the highest value of (200.0 ±0.00%), followed by autoclaved (193.33± 6.67%), roasted AYB (166.67±33.33%) and the raw AYB (120.00±0.00%) the least. The variation observed in the water absorption capacity was due to processing procedure effects.

Table 1: Functional Properties Of Raw And Differently Processed African Yam Bean Seeds

PARAMETERS	ROASTED AYB (SE±)	BOILED AYB (SE±)	AUTOCLAVED AYB (SE±)	RAW AYB (SE±)
% Water absorption capacity	166.67±33.33[ab]	200.00±0.00[a]	193.33±6.67[a]	120.00.±0.00[b]
% Oil absorption capacity	147 ±22.88	146.19±11.38	130.48±28.47	180.37± 6.03
% foaming capacity	7.33±1.87	7.33±1.74	6.67±0.88	6.67±1.76
%foaming stability	2.33± 0.33	2.00±0.00	2.33± 0.33	2.00±0.00
%oil emulsion capacity	8.84±2.29	7.53±1.97	9.86±2.23	11.54±2.13
%Oil emulsion stability	49.67±2.60	56.33±2.96	51.67±11.02	60.67±2.60
%(w/v) least gelation concentration.	6.67±1.74	4.67±0.67	7.33±0.67	6.00±1.16
(g/cm^3)Bulk density	14.33± 6.16[ab]	25.04± 1.18[a]	21.72± 3.73[a]	7.53± 4.02[c]

a-c: Means in the same row with varying superscripts differ significantly ($p<0.05$).
SE±: Standard error of means.

The WAC values recorded in this study are comparable to the previous report by Adeyeye *et al* (1994) except for the raw AYB seeds. It is averagely higher than that reported for soya bean (Lin, Humbert and Sosulski, 1994) cow pea (130%) and pigeon pea (130%) (FAO/WHO/UNU, 1985). WAC of this work is lower than breadnut flour (250%) reported by Oshodi, Inpimoroti and Fagbemi (1999), winged bean flour (228%) reported by sathe, Desphande and Salunke (1982) and Igene (2002) respectively. WAC is a critical property of proteins in viscous foods like soups, gravies, dough and baked products (Adeyeye, Oshodi and Ipinmoroti, 1994). The incorporation of processed African yam bean in food/feed formulation most especially into low-protein traditional foods such as maize, rice, and yam or in soups to boost their nutritive values is therefore suggested.

Oil absorption values of roasted, boiled and autoclaved AYB were not significantly ($P<.05$) improved by processing procedures. The highest oil absorption was recorded for roasted AYB among the processed seeds. The oil absorption capacity ranged from 180.37±6.03% to 130.48±28.47%. The oil absorption capacity was higher or comparable to the values reported for most legumes and nuts e.g. pigeon pea 89.7% (Oshodi, Ipimoroti and Fagbemi, 1989) and soya flour 156% (Fagbemi, Oshodi and Arise, 1994). Fat absorption capacities are a critical assessment of the flavour retention. The mean values obtained for foaming capacity and foaming stability revealed a comparable effect or improvement in processed AYB. The foaming capacity and the foaming stability values were both affected by processing procedures. The highest foaming capacities were recorded in roasted AYB and boiled AYB (7.33± 1.87% and 7.33±1.74%), followed by autoclaved AYB (6.67 ± 0.88%) and raw AYB (6.67± 1.76%). The foaming stability ranged from 2.00±0.00% in both raw AYB and boiled AYB flour to 2.33±0.33% in both roasted AYB and autoclaved AYB flour respectively. Foaming stability is an important ingredient in determining the suitability of a whipping agent in food systems. Generally, the oil emulsion capacity and oil emulsion stability were higher in the raw AYB seeds. The oil emulsion capacity and the oil emulsion stability were lower in the processed African yam bean seeds. Fat emulsion capacity and emulsion stability are important in the determination of the stabilization of fat emulsion in the production of such foods as sausages, soups and cakes (Kinsella, 1976). Adeyeye added that the ability of proteins to aid the formation and stabilization of emulsions is important in many applications including mayonnaise, milks, comminuted meats and salad dressings.

Boiled AYB recorded the lowest least gelation. The mean values ranged from 7.33±0.67(w/v) in autoclaved to boiled (4.67±0.67(w/v).The values recorded was comparable with the values reported by Adeyeye *et. al.* (1994). The least gelation concentration values were lower than those of pigeon pea (12%) and lupin flour 14% (Sathe, Desphande and Salunke, 1982). Fayusi and Aletor (2005) reported values of 9.0 - 12.5%respectively for cassava leaf meals and cassava protein concentrate. Other reports were fluted pumpkin 36% (Fagbemi and Oshodi, 1991) and Talinum triangulare leaf meal 8.0% (Fayusi, 2006). Protein gel formation provides the nature for holding water, flavours, sugar and ingredients hence it is an important consideration in food product development (Fayusi, 2006). AYB can also be used as additives to other materials for gel formation in food products. There were significant improvements in the bulk density as influenced by the processing procedures. The values ranged from 7.53± 4.02 to 25.04 ± 1.18(g/cm^3). However, a better bulk density was obtained from boiled AYB seeds.

Conclusion

The functional properties of African yam bean seeds revealed that processing had no significant(P>0.05) effect on fat (oil) absorption capacity (FAC), emulsion capacity, emulsion stability, foaming capacity, least gelation concentration and foaming stability of raw and processed AYB seeds, while bulk density and water absorption capacity (WAC) were significantly (P<0.05) affected by processing techniques. The incorporation of processed African yam bean in food/feed formulations most especially into low-protein traditional foods such as maize, rice, and yam or in soups to boost their nutritive values is therefore suggested. Since, water absorption capacity is a critical property of proteins in viscous foods like soups, gravies, dough and baked products.

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