

EFFECT OF ADDED BAMBARA GROUNDNUT FLOUR ON THE QUALITY OF ACHA BASED FURA

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ABSTRACT:

Aims: To improve the nutrient quality of fura, an acha based flour food by adding bamabara groundnut flour.

Study design: Product development approach

Place and Duration of Study: Dept. of Food Science and Tech., Federal Polytechnic, Bauchi and for six months

Methodology: Acha grain (*Digitaria exilis*) and Bambara groundnut (*Vigna subterranean*) were cleaned, dry milled, sieved to produce flour. The Bambara groundnut was substituted into acha grain flour (0-25%), mixed with spices (cloves, salt, ginger, red chilly-pepper, black pepper), conditioned (adding water), molded into balls, steamed (15_mins), boiled (30_min), pound and molded to produce fura. The sample were analyzed for chemical (protein, fat, ash, moisture, carbohydrate), sensory (taste, colour, tecture, odour) and functional (water absorption, bulk density and foam capacity).

Results: The added bambara groundnut increased protein (6.14 – 9.30%), fat (3.01 – 4.80%), crude fibre (1.20 – 4.4%), ash (0.50 – 1.12%), but decreased the carbohydrate (88.20 – 79.21%) content of the fura with increase in quantity (0.25%). The bulk density and foam capacity increased 0.57 – 0.71% and 5.0 – 12.2%, respectively with increase in added bambara groundnut (0 -25%). There is significant increase in the foam capacity, p= 0.05. The average means scored of the taste, texture and general acceptability increased 6.4 -7.55, 7.1 – 7.8, and 6.9 – 7.85 with increase in added Bambara groundnut up to 10% and thereafter decreased significantly, p= 0.05.

Conclusion: The addition of Bambara groundnut increased the protein, fat, fibre and ash content significantly, p = 0.05, however, it was most acceptable at 10%. At this level of acceptance, the protein, fat and fibre content have been improved by 27.5, 37.8 and 31.5% respectively.

Keywords: Bambara groundnut, acha, fura quality

INTRODUCTION

Acha (*Digitaria exilis*) also known as hungry rice is one of the indigenous African cereal which belong to the poaceae (grasses) (Jideani and Akingbala 1993). The plant is about 4.5 cm high with tiny bug ears. ~~It will~~ grows on poor sandy soils which ~~do will~~ not support the growth of some more popular cereals and thrive in area where few cereal would ~~to form~~ (Irvine 1979, NRC 1996).

The kernels of this cereal ~~are is~~ tiny and weighs about 0.5 mg. ~~it~~ is classified as millet but on like other millet it is low in protein???? (Oyenuga, 1968). ~~How~~ever acha protein is unique ~~in that it because of the high concentration of has greater~~ methionine ~~and~~ lysine ~~and content~~, ~~higher~~ than other cereals protein (Kent, 1987).

The major traditional food from the grain are thick (Tuwo) and thin (kunu) steamed product (Burabusko or Couscous) and alcoholic beverages (Jideani and Akingbala, 1993)

Acha is one of the most nutritious of all grain, ~~their~~ seeds ~~are is~~ rich in methionine and ~~cystine~~ amino acids, they are vital to human health and deficient in todays major ~~is~~ cereals, like wheat, rice, maize, sorghum, barley and rye (Jideani and Akingbala, 1993).

Enrichment of cereal based food with other protein source such as legumes has received considerable attention. The use of cereal-legume based food has long been advocated as alternative protein and energy source for infant and young children food products (Mensah on Tomkins 2003). It is evident that when cereals and legumes are judiciously selected and combined, a desirable pattern of essential amino acids of high biological value is obtained (Nnam, 2001). Cereals are deficient in essential amino acids like lysine and tryptophan (Davidson et al., 1980). ~~While~~ Legumes are deficient in sulphur containing amino acids ~~that like is~~ methionine and cystine, but rich in tryptophan and lysine. ~~This is because legumes protein are rich in lysine, an essential limiting amino acid in most cereal~~ (Alobo, 2000, GRAD 2004). Acha ~~contain~~ has a high water absorption capacity that gives it the capacity to be utilized in baked foods. It also contains pentosan (Lasekan and lasekan 1998, Ayo 1998)

Comment [PV1]: Sometimes, authors use the , after the author and sometimes not. What is the appropriate style?

Comment [PV2]: Repeated in the previous paragraph but they said met and lysine and here met and cystine. Which is the correct?

which gives it the ability to form gel in the presence of oxidizing agent at room temperature with high residual protein coupled with high level of sulphur and hydrophobic amino acid residue which makes it useful in baking (Obizoba et al 1994, Okaka 2005). The recent finding of the unique property of acha is relatively lowering the blood glucose level (Ayo et al 2007) and the subsequent reducing of diabetic populace has made the same an attractive research focus in recent time. (Jideani 1999, Ayo et al 2007).

The use of composite flour in making baked products has been studied in great details since 1904 when food and agricultural organizations (FAO) of United States sponsored composite flour programme. Most effort of researchers was centered on composite flour made from sorghum, maize, cassava, cha yam, potatoes etc. The study of composite flour was further triggered by food and agricultural organization FAO (1993). Investigation on the use of cassava in biscuit making has of-recently become the focus of researchers in Nigeria. (Ayo et al -2007).

Bambara nut (Voandzeia subterranean (L) Thouars) is a seed-species of Africa origin used locally as a vegetable. It was first found in West Africa. (<http://wapedia.mobi/en/bambara>). Bambara groundnut is called Gurjiya or Kwaruru in Hausa, Kwam in Geom, part of Plateau State, Okpa in Ibo and Epa-kuta in Yoruba part of Nigeria. (Oyeleke et al 2012). Bambara ground nut seed can be consumed in different forms, either at immature green state or matured. At matured however, the seeds become very hard and therefore require boiling before any specific preparation can be carried out on it. (Oyeleke et al 2012). The plant is leguminous and has numerous nitrogen fixing nodules on the root. Evidence has shown that based on the root nodules, the plant supports land care provision in Africa (National Research council, 2006). The quest for plant with nutritional properties continue to receive attention. Bambara groundnut (Vigna subterranean) which constitutes complete food stuff is reported to contain protein, carbohydrate and lipids and can be consumed at different stages

of maturation (NRC, 2006, Baryh 2001). The plant has a potential to improve malnutrition and boost food availability.

Food fortification has been defined as the addition of one or more essential nutrients to a food whether or not its normally contained in the food for the purpose of preventing or correcting a demonstrated deficiency of one or more nutrient in a population or specific group (FAO/WHO 1994). Diet that lack variety can be deficient in certain nutrient due to the soil of a region, or because of the inherent inadequacy of diet. Addition of micronutrients to staples and condiment can prevent large scale deficiency disease in these cases.

Fura is a semi-solid dumpling cereal meal produced mainly from moist pearl millet (*Pennisetum glaucum*) flour, blended with spices compressed into balls and boiled for 30 minutes while still hot the cooked dough is worked in the mortar with pestle (with addition of hot water) until a smooth slightly elastic cohesive lump (fura) was formed. The work is aimed at adding bambara groundnut flour to improve the quality of acha based flour food fura.

MATERIAL AND METHODS

Acha grains (*Digitaria exilis*), Bambara nut (*Vigna subterranean*), cloves, salt ginger, red chilly pepper, black pepper were purchased from Muda-Lawal market Bauchi.

The Acha grain was sorted and washed with water to remove stones, dust and foreign materials, the grain was sundried, milled using hammer mill and sieved with a sieve of aperture size of 0.300m. The flour was packed in Polythene and stored in a cool dry environment acha flour.

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The Bambara nut seed was sorted, cleaned, toasted, and allowed to cool. The seed was milled with the use of hammer mill into fine flour and sieved through a sieve with aperture 0.300m, packed in a polythene bag and stored in a cool dry environment as Bambara nut flour

Production of Fura:

The bambara groundnut flour was substituted into the acha flour (0, 5, 10, 15, 20, 25) and mixed with weighed spices (ginger, cloves, black pepper and red chilly pepper) as shown in Table 1, mixed thoroughly (manually) and conditioned (adding 100 cm³ water) to improve molding. The conditioned flour was weighed (20 g), molded into balls, steamed (15 mins), boiled (30 min covered with water) and pound (local mortar) until a smooth and slightly elastic consistency was achieved. The smooth and elastic dough is remolded into balls (30g), coated with wheat flour to avoid cracking, cooled and stored in dry atmosphere.

Table 1: Recipe for Formulation

	Sample/Ingredient per gram					
Acha flour	100	95	90	85	80	75
Bambara nut flour	0	5	10	15	20	25
Ginger	1.34	1.34	1.34	1.34	1.34	1.34
Black pepper	0.24	0.24	0.24	0.24	0.24	0.24
Chilly pepper	0.50	0.50	0.50	0.50	0.50	0.50
Cloves	0.67	0.67	0.67	0.67	0.67	0.67

Comment [PV3]: Please write the unities of the different components. Maybe Acha and Bambara are percentages but then, what are the other components?

Sensory quality evaluation

The sensory evaluation of the samples were carried out for consumer acceptance, and preference using twenty (20) untrained judges randomly selected (student and staff of the Dept. of Food Science and Technology, Federal Polytechnic, Bauchi) using a nine (9) point Hedonic Scale (1 and 9, representing extremely dislike and extremely like, respectively). The quality assessed include:- colour, taste, odour, texture and overall acceptance. Coded samples of the same size at the same temperature (35 °C) were served in a coloured

(white) plate of the same size to judges in each panel cupboard under the florescent light. Only one sensory attribute was tested in one sitting (Ihekoronye and Ngoddy 1985). Data collected were subjected to aAnalysis of vVariance and difference between the mean were separated using Duncan multiple test (Larmond, 1997). Unless otherwise mentioned, all the measurements were made in triplicate and the values represent the average of the three measurement.

Chemical properties

The moisture, fat, ash Moisture determination, carbohydrate and protein content was determined (A.O.A.C 2006, Ayo and Agu 2012).

Comment [PV4]: Please, explain a little bit more, as in the other sections

Functional properties

Foaming capacity: Two gram of the sample of fura was blended (using Kenwood blender) with 80 ml distilled water for 5 min and poured into the measuring cylinder. The height of the foam was determined by taking the reading (Clarke and Lee 1986, Gomeaz et al 1997, Narayana 1982)

Water Absorption Capacity: The samples (2.0 g) were weighed into the tubes and 25 ml of water was added, shaken allowed to stand for 1 hr at room temperature (30-32 °C) with occasional shaking. The mixture was centrifuged at 16000 rpm for 25min. Excess water was decanted by inverting the tubes on absorbent paper. Weight of the sample before and after was recorded. The water absorbed was calculated (Lin et., 1974, Ayo and Okoliko 2003, Ooraiiku, 1980)

Comment [PV5]: Before and after what????

Bulk Density: The procedure of Hall and Hedicy (1971) was used. Twenty gram (20g) of the sample was measured into graduated flask, and tapped or dropped on a soft pad-table

30times and the volume noted (Vml). The bulk density is calculated by dividing the Vml by the weight of sample_(20g).

Data Analysis

Data collected were subjected to aAnalysis of variance and difference between the mean were separated using Duncan multiple test (Larmond, 1997). Unless otherwise mentioned, all the measurements were made in triplicate and the values represent the average of the three measurement.

RESULTS AND DISCUSSION

Effect of added bambara groundnut flour on the chemical quality of Acha based Fura

The effect of added bambara groundnut flour on the chemical composition of Acha based fura is detailed in Table 2 below;

Table 2: Chemical Composition of Acha based Fura (%)

Acha	Bambara g/nut	Crude protein	Fat	Crude fiber	Ash	Moisture	Carbohydrate
100	0	6.14c	3.01d	1.20bc	0.50c	0.99b	86.21a
95	5	7.41b	3.50c	1.31b	0.60bc	1.00b	84.53a
90	10	7.83ab	4.25b	1.71b	0.70b	1.05ab	82.54a
85	15	8.90a	4.40ab	2.30b	0.81ab	1.10a	80.33a
80	20	9.11a	4.61a	3.90a	0.93a	1.20a	79.21a
75	25	9.30a	4.80a	4.4a	1.12a	1.22a	

Comment [PV6]: Where this c letter come from?

*Average means scores with the same alphabet in same column are not significantly different $p=0.05$

Moisture: The moisture content increased from 0.99 to 1.22% with increase in the added bambara nut flour (0-25%). The increase in the moisture content is relatively low which could be an advantage in the keeping quality of the product as it will not allow the growth of spoiling microorganisms and biochemical and enzymatic reactions.

Fat: The fat content increases from 3.0 – 4.8% with an- increase in the percentage (0 – 25%) of bambaranut flour. The increase in fat content could be due to the added bambara groundnut-added. The relative increase in fat content could improve the energy level of the consumer as it has been known that one gram of fat or oil will yield about 368kj/gkcal of energy when oxidized in the body (Okaka, 2001). The relatively low level of moisture content of the products could prevent hydrolysis of the fat that could endanger its shelf life.

Crude Protein: The protein content increased from 6.14 – 9.3% with increase in the percentage (0 – 25%) of bambara groundnut flour. The increase in the protein content could be due to the added bambara groundnut which have been confirmed to contained substantial high level of the same and could be an inexpensive source (Oyeleke et al 2012 Akinkugbe, 2009).

Ash Content: The Ash content of the product increased from 0.5 – 1.1% with increased concentration (0 – 25%) in added bambara groundnut flour. The increase in the ash content could be due to the added bambaranut which have been noted to relatively high in the same (Oyeleke et al 2012). High ash content could be an indication in increase in the- principal mineral content which could be of vital importance to the body_(CIRAD, 2004; Baryeh 2001) High Ash content is usually as-a result of mineral and vitamin which apart from the nutritional value are good for eye sight, skin, and bones (Akinkugbe, 2009). Ash is a non organic compound containing mineral content of food and nutritionally it aid in the metabolism of other compound (De humen, 2003).

Crude Fibre: The crude fibre of the product increased from 1.2 – 4.4% as the percentage concentration (5 – 25%) of added bambara groundnut flour increased. The increase in percentage fibre could be due to high fibre content of bambara groundnut (4.9) (Hepper, 1980).

Carbohydrate: The carbohydrate content of the product decrease from 88.2 – 79.2% with increase proportion of bambara groundnut flour (5 – 25%). The decrease in carbohydrate content could be as a result of relatively low carbohydrate content of bambara groundnut. Carbohydrate is macronutrient needed in the largest amount. According to Dietary Reference intake published by USDA, 45 – 65% of calories should come from carbohydrate. Acha has a high carbohydrate content of 75% (Axtell et al., 1996) and the reduced carbohydrate content could be attributed to the reduction in Acha flour proportion (100 – 75%) and increase in bambara groundnut flour (5 – 25%).

Comment [PV7]: In this case, authors do not detect significant differences. Then, it is not true that carbohydrate content decreased. For other compounds, there are significant differences but increasing do not occur from 0 to 25% because usually after 15%, not further changes occur.

Sensory Evaluation of the Fura

The effect of added bambara groundnut flour on the sensory quality of Acha base fura is shown in table 3 below.

Table 3: Sensory Evaluation of Instant Fura

Acha /g	Bambara-g/nut/g	Taste	Odour	Texture	Colour	Overall acceptability
100	0	6.4f	7.7f	7.1f	7.3a	6.9a
95	5	6.95e	7.2e	7.25eh	6.7b	7.0a
90	10	7.55d	7.68d	7.8dh	6.0c	7.85a
85	15	6.6c	6.1c	6.5cg	6.6d	6.05a
80	20	6.15b	6.05b	5.8bg	6.2e	6.0a
75	25	6.0a	6.55a	5.18a	6.1f	5.2a

*Average means scores with the same alphabet in the same column are not significantly different $p=0.05$

Taste: The addition of bambara groundnut flour on the quality of acha based instant fura decreased the mean score for taste from 7.55 – 6.0 as the concentration of bambara groundnut flour increased (5 – 10 – 25%). This increase could be due to increase in concentration of bambara groundnut flour which could have affected the taste.

Texture: The addition of bambara groundnut flour on the quality of acha based instant fura decrease the mean score from 6.7 – 6.1 as the concentration of bambara groundnut flour increases.

Colour: The average mean score of the instant fura colour decreased from 7.2 – 5.55 with increased in the percentage (5 – 25%) of bambaranut flour. The decrease could be due to increased concentration of bambara groundnut flour. The colour of the biscuit shows no significant difference, $p=0.05$, at 100 – 75% concentration of acha and bambara groundnut composite flour.

Odour: The average mean score of the instant Fura odour decreased from 7.8 – 5.18 with increased percentage flour. The sample with the highest mean score for odour is the sample with 5% bambaranut flour. While sample with the least mean score for odour is sample with 25% bambara groundnut flour. The decreased in the sensory evaluation of odour could be as a result of odourous compound which is inherent to bambara groundnut flour.

Comment [PV8]: The letters in the comparison of means are wrong. I already ask for this table in the first review but authors do not give any explanation nor corrected the table.

Comment [PV9]: First increased and then decreased which makes the 10% bambara the best accepted combination

Comment [PV10]: ???? Probably refers to the colour

Comment [PV11]: Probably odour, but this is not true. First increased and then decreased

Comment [PV12]: Texture. Idem

General Acceptability: The average mean score for general acceptability decreases from 7.8 – 6.5 with increased percentage concentration of bambara groundnut flour. The sample with 10% bambara groundnut flour is ranked the best in terms of taste, colour, and texture but the sample with 5% bambara groundnut flour is ranked the best in terms of odour.

Effect of added bambaranut flour on Functional Properties of the Instant Fura

Bulk Density: From the result of the bulk density computed, the addition of bambara groundnut flour and the bulk density of Acha based instant Fura increased the bulk density from 0.57 – 0.74g/ml(Table 4) which could be as a result of increase percentage concentration (0 – 25%) of bambara groundnut flour on the product. The increase in bulk density could be an advantage in packaging of the product as it will occupy less space and could also be advantage in solubility as the particles has less tendency of floating during soaking in liquid prior to consumption.

Foam Capacity: The foam capacity of the product increased from 6.8 – 12.2% as the percentage concentration (0 – 25%) of bambara groundnut flour increase. The increase in the foaming capacity could be due to -high protein content of the added bambara groundnut as noted by Iwe (2001). The high foaming capacity could be advantage in the solubility of the product and also high ability in mixing with other food components.

Water Absorption Capacity: The result of water absorption capacity shows that it decreases from 55 – 42% as the percentage concentration of bambara groundnut flour increase. The relatively decrease in the water absorption capacity could be due to the presence of the husk or outer coat of the bambara groundnut as complete de hulling of the same proved impossible. The presence of the hull which contain principally the cellulose and hemi-cellulose which has poor water absorption capacity.

Table 4: Water Absorption

Acha	Bambara g/nut	Bulk Density g/ml	Water absorption capacity (%)	Foam capacity (%)
100	0	0.57b	57a	5.0d
95	5	0.59b	55a	6.8c
90	10	0.60b	54ab	8.2b
85	15	0.60b	51b	8.9ab

80	20	0.72a	42c	11.0a
75	25	0.71a	42c	12.2a

*Average means scores with the same alphabet in the same column are not significantly different, p=05

CONCLUSION

The addition of defatted bambara groundnut flour to acha based biscuit has greatly improved the quality of the product mostly at the 10% acceptable level as indicated by the panelist. At this level of acceptance the protein, fat and fibre content has been improved by 27.5, 37.8 and 31.5% respectively, making the product highly nutritious particularly for the diabetes who have been proven to consume acha with less difficulty. The pretreatment of the bamabara groundnut prior to usage could improve the water absorption capacity of the product.

AUTHORS' CONTRIBUTIONS

“ ‘Author Ayo.JA ’ designed, supervised, wrote the first draft of the manuscript and approve the final manuscript.
 ‘Authur Andrew E’ managed the analysis, literature searches and statistical analysis of the study.
 ‘Authors Ayo.v.A and Popoola C.A’ managed the literature searches.

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