academicJournals

Vol. 7(12), pp. 446-450, December 2013
DOI: 10.5897/AJFS09.224
ISSN 1996-0794 ©2013 Academic Journals
http://www.academicjournals.org/AJFS

African Journal of Food Science

Full Length Research Paper

Proximate composition, nutritive and sensory properties of fermented maize, and full fat soy flour blends for "agidi" production

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Accepted 30 October, 2013

Composite flours containing 100:0, 85:15, 80:20 and 70:30 fermented maize and full fat soy flours, respectively were prepared. The effect of the soy flour supplementation on the proximate composition and nutritive values of the blends were evaluated. "Agidi", a maize based fermented food product produced from the blends were subjected to sensory evaluation. The result shows higher protein contents (16:55, 20.63 and 20.77%) than the fermented maize used as control (8.92%). There were corresponding increases in the fat, ash and energy contents of the blends. The weight gains of the rats fed the diets containing 20 and 30% soy flour (2.25 and 2.30 g) and then protein efficiency ratio (PER) (2.00, 2.10) were not significantly different from those of casein (2.35 and 2.50 g, respectively) (P>0.05). No statistical differences were found for colour, consistency, flavour and overall acceptability among the "agidi" products (P>0.05). The blends containing 20 and 30% full fat soy flour were found to have the best potential for "agidi" production.

Key words: Proximate composition, composite flour, agidi, fermented food, sensory evaluation, nutritional evaluation.

INTRODUCTION

"Agidi" is a thick gel produced from fermented maize paste or flour. It is a popular food product in Nigeria and some West African countries (Otunola et al., 2006; Otunola et al., 2007; Osungbaro et al., 2009). Agidi produced from fermented maize flour is inherently deficient in nutrients, especially lysine and some nutrients are leached out because of the poor processing techniques involved in its traditional production (Adeyemi and Beckly, 1986; Adeniyi and Porter, 1978; Adeyemi et al., 1987). Such deficiencies may result in protein malnutrition among consumers of "agidi" particularly the young children who are fed with the product as weaning food (Onyeka and Dibia, 2002; Plahar et al., 2003). Earlier attempts at improving the physico-chemical, sensory and nutrient qualities of "agidi" included, process modification, cereal variety selection and protein supplementation (Akpapunam et al., 1997; Tsatsu, 2009; Ohenhen, 2002; Adeniy and Porter, 1978; Aminigo and Akingbala, 2004). Incorporation of oil seed such as soybean to fermented maize floor is supposed to provide a nutritionally improved food because of the expected increase in protein quality and high energy value of the blends. However, very little has been reported about the nutritive value of "agidi" especially those supplemented with legumes or oil seed. One major limitation of plant food blends that is obvious and already noticed is the poor digestibility associated with low solubility of plant proteins (Michelfelder, 2009; Messina and Messina, 2010). These factors such as the physico-chemical, sensory properties and nutritive value of soy supplemented

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agidi need to be investigated so that the full potentials of the blend can be established for product development (Ohenhen and Ikenemoh, 2007., Osundahunsi *et al.*, 2003., Osungbaro,1990a., Osungbaro,1990b., Osungbaro, 1998). The study reported here therefore determined the effect of full fat soy flour supplementation on the proximate composition and protein nutritive value of maize/soy flour blends for "agidi" production. The sensory properties of the "agidi" produced from the maize : soy blends were also determined.

MATERIALS AND METHODS

The maize (*Zea mays* L.) and the soybean (*Glycine max* L.) used for the study were obtained from a local farm in Makurdi, Benue State, Nigeria.

Preparation of fermented maize flour

The fermented maize flour was prepared by the wet milling process with slight modification (Adeyemi and Beckly, 1986; Adeniyi and Porter, 1978; Osungbaro, 1990a; Osungbaro, 1990b; Osungbaro, 1998). The maize grains were sorted and cleaned to remove broken grains and foreign objects. The grains were boiled in water (1:2w/v) at 100 ± 2°C for 2 min. The boiled grains were wet milled in a commercial maize mill and filtered through cheese cloth with excess water. The slurry obtained was left to sediment and ferment for 3 days at room temperature (27 ± 2°C). The water was decanted and the paste obtained was dried in the sun at 40 - 50°C (3 days). The dried paste was milled into flour in a maize mill (model corona - 2N, England) and stored in a refrigerator at 4°C after sieving (150 µm).

Preparation of soy flour

The soy flour was prepared according to the method reported by Amadou et al. (2009) and Iwe (2003). The flour was stored in a refrigerator (4°C) until used.

Blend formulation

Three different blends were formulated based on fermented maize and full fat soybean flours in the ratios of 100:0, 85:15, 80:20 and 70:30, respectively. The formulation was designed to obtain the most acceptable product or products which have the highest protein content (Akpapunam et al., 1997).

Proximate analysis

The proximate analysis (protein, fat, ash, moisture and crude fibre) of the fermented maize flour and the blends was determined by the official methods of AOAC (2012). Carbohydrate was determined by difference (100 - the sum of the content of protein, fat, ash and moisture). Energy was calculated using Artwater factor (fat x 9 + carbohydrate x 4 + protein x 4 kcal/100 g).

Biological evaluation of protein quality

Protein nutritional quality of the blends was assayed *in vivo* by means of the protein efficiency ratio (PER) according to the AOAC (2012) official method. Twenty five young albino rats (21 days old) weighing 45 - 55 g were randomly assigned to five experimental diets in groups of 5 rats each. The rats were housed in individual metabolic cages placed on cardboard to allow collection of faeces.

Ten grams of each experimental basal diet (Table 1) and water were fed to the rats *ad libitum*. Casein served as the control diet. The total food intake of the rats was determined by recording the food left after daily intake. Daily weight gain was determined by weighing the rate individually. Protein consumption was calculated from the food intake.

Carmine red (0.1 g) was added to the diet to serve as marker. The coloured faeces of the rats that appeared on day 10 was collected to mark the beginning of collection. The collection was from day 10 to day 26. All collected faeces were stored in small screw bottles and stored in a refrigerator (4°C) until used. At the end of the collection period, the bulk faeces for each rat were dried, weighed and milled into fine powder. The nitrogen content of the faeces was determined by the standard kjeldahl method (AOAC, 2012) to determine the nitrogen digestibility (N.D).

Preparation of "agidi"

Nigerian agidi or eko is Nigeria's Jello sort of. It is made with corn flour. The process is very similar to the process of making ogi but with a slight difference.

'Agidi" was produced from the fermented maize flour (control) and each of the three blends (85:15, 80:20 and 70:30) according to the method described by Akpapunam et al. (1997). Agidi samples were coded with letters A (100:0), B (85:15), C (80:20) and D (70:30) corresponding to the control and the blends, respectively.

Sensory evaluation of "agidi"

Colour, consistency, flavour and general acceptability of the agidi samples were evaluated by a 22-member panel, using a 5 point Hedonic scale with 1 representing the least score and 5 the highest (Akpapunam et al., 1997).

Statistical analysis

Analysis of variance (ANOVA) was performed on all data collected to determined differences, while the least significant test was used to detect significant differences among the means (Steel and Torrie, 1990).

RESULTS AND DISCUSSION

The proximate composition of maize/soy flour blends is presented in Table 2. The content of protein, fat, fibre and ash increased with the increase in the soy flour in the blends. Conversely, the carbohydrate content of the blends decreased considerably from 84.30% in the 100% maize flour to 67.11% in the blend containing 30% soy flour. The protein content of the 100% maize flour blend was 8.92% as compared to 16.55, 20.63 and 20.77% for the blends containing 15, 20 and 30% soy flours, respectively. The trend was the same for fat, fibre and ash contents of the blends. This is a reflection of the superior nutritional properties of soybean flour over maize flour and it demonstrated their mutual supplementation effect. The protein values compared favourably with

Table 1. Composition of experimental diet (g/100 g diet) (10% been total gram mass of maize and soy flours as the protein containing materials in the formulation).

Component of experimental diets (g/100 g)	Sample code (A - E)				
	A	B	C	D	E
Maize flour protein	10	8.5	8.0	7.0	0
Soy flour protein	0	1.5	2.0	3.0	0
Casein (milk protein)	0	0	0	0	10
Corn starch	70	70	70	70	70
Non-nutritive fibre	1	1	1	1	1
Sugar (sucrose)	5	5	5	5	5
Groundnut oil	8	8	8	8	8
Vitalyte (salt/vitamins)	6	6	6	6	6
Total mass (g)	100	100	100	100	100

A = 0% Casein + 100% maize + 0% soy flour; B = 0% casein + 85% maize + 15% soy flour; C = 0% casein + 80% maize + 20% soy flour; D = 0% casein + 70% maize + 30% soy flour; E = 100% casein + 0% maize + 0% soy flour (control).

Table 2. Proximate composition of maize/soy flour blends (% dry weight).

Sample	Crude protein	Fat	Fibre	Ash	Carbohydrate (by difference)	Energy (Kcal/100 g)
A (100:0)	8.92	4.85	1.92	0.99	84.31	416.6
B (85:15)	16.55	6.89	2.29	1.13	73.14	420.8
C (80:20)	20.63	7.71	2.41	1.21	68.04	424.1
D (70:30)	20.77	7.99	2.74	1.39	67.11	423.4

A (100:0) = 100% maize + 0% soy flours; B (85:15) = 85% maize + 15% soy flours; C (80:20) = 80% maize + 20% soy flours; D (70:30) = 70% maize + 30% soy flours.

those reported by (Edema et al., 2005; Olaoye et al., 2006; Adeyemi and Beckly, 1986; Adeyemi et al., 1987; Osungbaro et al., 2009).

The high caloric value of the blends is note worthy (416.57 to 424.07 Kcal/100 g). It is an indication that agidi produced from the blends would be a good source of energy. The results of the nutritive value of the control ration and the maize/soy flour blends are shown in Table 3. The high food intake of rats fed diet A (7.8 g) could suggest that the protein was of poor quality as such, and the rats consumed more to compensate for the poor quality- a commonly observed phenomena. The rats fed diet A had negative weight gain (-0.44 g) even though they consumed more food. This is a further indication that the protein was of poor quality (Alabi et al., 2001; Chai et al., 2011; Osungbaro et al., 2009; Evans et al., 2007; Adeyemi et al., 1987). The rats fed diet B had the second highest food intake and also the second lowest weight gain.

The same reason adduced for diet A is applicable here. However, diet B appears to have more desirable pattern of essential amino acid (EAA) that supported growth than that of diet A. On the other hand, the control rats which consumed less (2.85 g) gained more weight (2.35 g). This indicates its protein superiority over the other diets.

Table 3. Nutritive value of maize/soy flour blends.

Sample code	MDFI (g)	MDWG (g)	PER	NU	ND
A(100:0)	7.80^{d}	-0.44^{c}	0.35^{c}	-60.52^{d}	98.3^{a}
B(85:15)	4.70^{c}	1.70^{b}	1.50^{b}	48.24^{c}	95.50^{ab}
C(80:20)	3.60^{b}	2.25^{ab}	2.00^{ab}	63.73^{b}	94.9^{b}
D(70:30)	3.50^{ab}	2.30^{a}	2.10^{ab}	65.18^{a}	93.7^{c}
E(Control)	2.85^{a}	2.35^{a}	2.50^{a}	66.69^{a}	98.5^{a}

Means in vertical columns with same letters are significantly different (P>0.05); MDF (g), Mean daily food intake (g); MDWG (g), Mean daily weight gain (g); PER, Protein efficiency ratio; NU, Nitrogen utilization; ND, Nitrogen digestibility; A, Maize flour protein (100%); B, Maize flour (85%) + soy flour (15%) protein; C, Maize flour (80%) + Soy flour (20%) protein; D, Maize flour (20%) + Soy flour (30%) protein; E, Casein (Milk protein) 100% (Control).

The food intake and weight gain of rats fed diets C and D were very close suggesting that their protein quality was readily the same. The lower PER (0.35) of rats fed diet A was not a surprise. The rats had negative body weight and feed efficiency, which affected the PER. The higher PER for casein group showed that the diet contained

Table 4. Sensory properties of maize/soy agidi products.

Agidi/codes	Colour	Consistency	Flavour	Overall acceptability
A(100:0)	3.46[a]	3.75[a]	3.43[a]	3.56[a]
B(85:15)	3.45[a]	3.61[a]	3.40[a]	3.50[a]
C(80:20)	3.35[a]	3.35[a]	3.35[a]	3.47[a]
D(70:30)	3.30[a]	3.50[a]	3.30[a]	3.32[a]

Means in vertical columns with same letters are not significantly different (P>.0.05). A, Agidi from (100% maize) + (0% soy) flours; B, agidi from (85% maize) + (15% soy) flours; C, Agidi from (80% maize) + (20% soy) flours; D, agidi from (70% maize) + (30% soy) flours.

desirable pattern of EAA, which the animals used to synthesize new protein (Alabi et al., 2001; Chai et al., 2011; Osungbaro et al., 2009). The PER of rats fed diet D is close to that of E which tends to suggest that its protein was as good as that of the control (casein). The negative nitrogen utilization (NU) for diet A is expected because of its poorer protein quality. The lower but positive NU (48.24) for diet B showed that 15% soy flour supplementation was not as good as others (20 or 30%). The closer NU for diets C and D to that of E indicates that nitrogen from soy flour and mixtures could be utilized as that of casein.

The high digestibility for the diets (93.7 - 98.5%) showed that their proteins were digestible; however, the utilization was low. The result of the study has shown that addition of 20 to 30% full fat soy flour to fermented maize flour could produce a nutritionally adequate food product ‘agidi’. Similar findings with legume and oil seeds have been reported by other workers (Alabi et al., 2001). The sensory evaluation results of the “agidi” samples are presented in Table 4. No statistical differences were found for colour, consistency, flavour and overall acceptability among the products. There were, however, slight decreases in these quality attributes with increase in soy flour supplementation. Panel members did not detect any beany flavour in the products, which indicates that the processing of the soybean seeds was able to remove the typical beany flavours associated with soy products (Ampofo, 2009).

Conclusion

The nutritive value of maize/soy flour blends for “agidi” production is dependent on the level of soy flour supplementation. Chemical, biological and sensory evaluation of the flour blends and the agidi showed an increased nutritive value and a comparative sensory acceptability with respect to the control (all maize “agidi”). The blends containing 20 and 30% full fat soy flour were found to have the best potential for agidi production.

REFERENCES

Adeniyi AO, Porter NN (1978). Properties of ogi powders made from normal fortified and opaque-2 corn. J. Food Sci. 43:1571
Adeyemi IA, Beckly O (1986). Effect of Period of maize fermentation and souring on chemical properties and amylograph pasting viscosity of ogi. J. Cereal Sci. 4:353-360.
Adeyemi IA, Ogunsanmi AT, Fakorede MAB (1987). Effect of corn varieties on ogi quality. J. Food Sci. 52:322-324.
Akpapunam MA, Badifu GIO, Etokudo EP (1997). Production and quality characteristics of Nigerian Agidi supplemented with soy flour. J. Food Sci.Technol. 34:143-145.
Alabi MO, Anuonye JC, Ndaeji CF, Idowu AA (2001). Comparison of the growth and development of selected children in soybean and non soybean producing and utilization of villages in Niger State, Nigeria. Poly. Math. J. 2:8-12.
Amadou I, Yong-Hui S, Sun J (2009). Fermented Soybean Products. Some Methods, Antioxidants Compound Extraction and their Scavenging Activity. Asian J. Biochem. 4(3):68-76.
Aminigo ER, Akingbala JO (2004). Nutritive Composition Of Ogi Fortified with Okra Seed Meal. J. Appl. Sci. Environ. Mgt. 8(2):23-28.
Ampofo V (2009). Production and sensory analysis of soybean and wheat flour composite cake, HND Dissertation, Cape Coast Polytechnic, Cape Coast, Ghana. 1:5-7.
Chai C, Ju HK, Kim SC (2011). Determination of bioactive compounds in fermented soybean products using GC/MS and further investigation of correlation of their bioactivities. J. Chromatogr. B Analyt Technol. Biomed. Life Sci. 880(1):42-49.
Edema MO, Sanni LO, Sanni AI (2005). Evaluation of Maize-soybean flour blends for sour maize bread production in Nigeria. Afr. J. Biotechnol. 4:911-917.
Evans EM, Racette SB, Van Pelt RE (2007). Effects of soy protein isolate and moderate exercise on bone turnover and bone mineral density in postmenopausal women. Menopause. 14(3 Pt 1): 481-488. doi: 10.1097/01.gme.0000243570.78570.f7.
Iwe MO (2003).The science and Technology of soybeans, Rojoint Communication Services Ltd. Enugu, Nigeria. pp. 20-25.
Messina M, Messina V (2010). The Role of Soy in Vegetarian Diets. Nutrients, 2(8):855-888.
Michelfelder A (2009). A complete source of soy protein. Am. Fam. Physician 79(1):43-47.
Ohenhen RE (2002). Enrichment of ogi, a corn meal product. Ph.D Thesis. University of Benin, Benin City, Nigeria. p. 235.
Ohenhen RE, Ikenemoh MJ (2007). Shelf Stability and Enzyme Activity Studies of Ogi: A corn Meal Fermented Product. J. Am. Sci. 3(1):38-42.
Olaoye OA, Onilude AA, Idowu OA (2006). Quality characteristics of bread produced from composite flours of wheat, plantain and soybeans. Afri. J. Biotechnol. 11:1102-1106.
Onyeka U, Dibia I (2002). Malted weaning food made from maize, soybean, groundnut and cookingbanana. J. Sci. Food Agric. 82:513-516.
Osundahunsi OF, Fagbemi TN, Kesseiman E, Shimoni E (2003). Comparison of the Physical Properties and Pasting Characteristics of Flour and Starch from red and white Sweet Potato Cultivars. J. Agric. Food Chem. 51:2232-2236.
Osungbaro TO (1990a). Effect of differences in varieties and dry milling of maize on the textural characteristics of Ogi (fermented maizeporridge) and agidi (fermented maize meal) J. Sci. Food Agric.

52:1-12.
Osungbaro TO (1990b). Effect of period on Amylose Content and Textural Characteristic of ogi (A fermented maize starch porridge) and agidi (fermented maize starch gel). J. Trop. Res. 14(1):102-109.
Osungbaro TO (1998). Effect of Particle Sizes of Wetmilled Maize Grains on the Rheological Characteristics of Ogi, (Fermented Maize Starch Gel). J. Trop. For. Resources. 14(1):102-109.
Osungbaro TO, Esuoso YA, Esuoso KO (2009). Physical and nutritive properties of fermented cereal foods. African Journal of Food Science. 3(2):023-027. Available online http://www.academicjournals.org/ajfs
Otunola ET, Ogunsola O, Abioye V F (2006). Effect of Tempeh on some properties of 'Agidi', a West African Fermented Maize Gel. Int. J. Food Agric. Res. 3(1):119-128.
Otunola ET, Sunny-Roberts EO, Solademi EO (2007). Influence of Addition of Okra Flour on the Properties of 'Ogi', a Nigerian Fermented Maize Food. Paper presented at the Conference on International Agricultural Research for Development, University of Gottingen. pp. 9-11.
Plahar WA, Okezie BO, Gyato CK (2003). Development of a high protein weaning food by extrusion cooking using peanuts, maize andsoybeans. Plant Foods Human Nutr. 58:1-12.
Tsatsu Tsikata C (2009). Utilization of soybeans in the production of bread, HND Dissertation, Cape Coast Polytechnic, Cape Coast, Ghana. 1:4-28.