International Food Research Journal 25(3): 1031-1035 (June 2018)
Journal homepage: *http://www.ifrj.upm.edu.my*

Nutritive and sensory properties of okra fortified instant *fufu*

[1*]Gbadegesin, A. R., [1]Odunlade, T. V. and [2]Otunola, E. T.

[1]*Department of Food Science and Technology, Obafemi Awolowo University, Ile-Ife, Nigeria*
[2]*Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria*

Article history

Received: 10 February 2017
Received in revised form: 24 March 2017
Accepted: 25 March 2017

Keywords

Fufu
Okra
Fortification
Protein-energy malnutrition

Abstract

This study is aimed at fortifying instant *fufu* with ground dried roasted okra seeds at different proportions (100:0, 95:5, 90:10, 85:15, and 80:20). This was with a view to recommending the best level of fortification with okra seeds through the evaluation of the nutritional composition, some physicochemical and sensory properties of *fufu* samples. The protein, fat and ash contents of the samples ranged from 3.64 to 11.13%, 0.37 to 6.29%, and 1.33 to 1.87%, respectively while carbohydrate and fibre contents of the samples ranged from 65.20 to 76.90% and 10.16 to 11.80%, respectively. Calcium, iron and magnesium contents of the samples were 30.15 to 43.27 mg/100 g, 2.10 to 3.40 mg/100 g and 19.10 to 26.50 mg/100 g, respectively. The pH and water absorption capacity of the samples were 5.42 to 5.55 and 271 to 283% respectively. The fortification of instant *fufu* with okra seed flour resulted in improvement of the nutritive values of the foods. Sensory evaluators recommended an optimal substitution level of 10% of roasted floury okra seeds.

Introduction

Fufu is a cream coloured semi-solid fermented food product that is produced from cassava. It is a common staple in Nigeria and some other parts of West Africa. Its commercial utilisation has been increasing over the years (Opara *et al*., 2013). Upon cooking, the resulting product is also known as *fufu* in South-western Nigeria. Like any other starchy food, it has very low protein of poor biological value. It is a food product that is widely consumed in traditional households which can contribute to protein-energy malnutrition when over relied on. As a result, fortification of the food product becomes necessary to lessen the symptoms of protein-energy malnutrition in those consuming it, most especially in children and some adults as this food remains one of the staple foods consumed in most rural areas of Nigeria.

Okra seeds are excellent source of protein and amino acids. The amino acids contained in okra seeds compared propitiously with those of poultry eggs and soybeans (Aminu-Taiwo et al., 2014). The protein efficiency ratio of okra seed is relatively higher than that of soybean (Martins *et al*., 2006). Okra seeds are also rich in essential fatty acids. In addition to Vitamin B_6, folic acid and fibre, they contain some calcium, iron, manganese and zinc (Savello *et al*., 1980). Its usage had been limited to the preparation of vegetable stew. Because of its far reaching nutritive composition comparable to eggs (Aminu-Taiwo et al., 2014), there is the need for the expanded usage of the seed for fortifying foods such as *fufu* that are largely limited nutritionally which could increase the cultivation of okra. This study, therefore, sought to evaluate the fortifying effects of ground dried roasted okra seed flour on instant *fufu*.

Materials and Methods

Fresh mature cassava tubers and okras were obtained from Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso (07°05´N, 04°50´E), Nigeria. All chemicals used for analyses were of analytical grade and procured from Sigma Aldrich.

Fermentation of cassava into fufu

The production of *fufu* was carried out using the method of Chukwuemeka (2007) with slight modifications. Freshly harvested cassava tubers (25 kg) were peeled and cut into pieces and soaked in water for 5 days. The steeped water was decanted after every 24 h and fresh water was poured on the tubers. After the fifth day, the resulting retted mash, after fermentation, was put in a cheese cloth and squeezed inside water of 15 L to force out the fine retted mash. The fibrous part was removed while the properly

*Corresponding author.
Email: *ronkeadewumi@gmail.com*

retted part was allowed to sediment overnight and then dewatered and dried in a cabinet dryer at 50°C for 48 h. The dried cake, after dehydration, was milled to instant powdery *fufu* using a disc attrition mill (2A Premier mill, Hunt and Co., UK).

Preparation of ground dried okra seeds

The seeds of okra were removed after laterally slicing the already washed freshly harvested matured okra. The seeds were dried in an electric oven set (Gallenkamp hot air oven, OVB 305, UK) at 50°C for 24 h. The dried okra seeds were further roasted in the forced air oven at 160°C for 10 min, ground and sieved.

Preparation of instant fufu *fortified with ground dried okra seeds*

The instant *fufu* and ground dried okra seeds of ratio 100:0, 95:5, 90:10, 85:15 and 80:20% (w/w) were individually mixed using an electric mixer (Model KM300, Kenwood, UK).

Proximate analysis

Proximate analysis was carried out on instant *fufu* and the fortified samples using AOAC (2010) methods 925.10, 920.53, 920.39, 923.03 and 962.09 for moisture, protein, fat, ash and crude fibre contents, respectively. The total carbohydrate content was determined by difference (Mbaeyi-Nwaoha and Obetta, 2016).

Mineral analysis

Minerals (calcium, iron, and magnesium) of the samples were determined using Flame Atomic Absorption Spectrophotometer (Onoja *et al*., 2014).

Physicochemical properties

pH and water absorption capacities of the samples were analysed using the methods described by Adepeju *et al.* (2011) and Sathe and Salunkhe (1981), respectively.

Sensory evaluation

Each of the instant *fufu* samples was poured gradually into boiling water in a cooking pot and stirred until a smooth paste was formed. It was covered for 3 min so as to cook properly. The samples were coded and presented to the evaluators for assessment. The sensory evaluation was conducted using a descriptive-quantitative sensory analysis by a 15 judge semi-trained sensory panel. The sensory properties of taste, texture, appearance, flavor, colour, and acceptability were assessed. The scores were based on a nine-point hedonic scale, where 9 represented like extremely and 1 represented dislike extremely.

Statistical analysis

The software of statistical package for social sciences (SPSS), version 16.0 (SPSS Inc., Chicago, IL, USA), was used to analyze all obtained data. All the data were subjected to one-way analysis of variance while Duncan's multiple range test was used for separation of means at 95% confidence level.

Results and Discussion

Proximate composition

The proximate composition of *fufu* and okra-fortified-*fufu* samples are presented in Table 1. The protein content increased significantly ($p<0.05$) with increase in fortification levels. The unfortified cassava flour recorded the lowest protein content of 3.64% which was lower to 4.23% reported by Adeniran *et al.* (2012) for cassava starch. Meanwhile, the sample with the highest fortification level of 20% had the highest (11.13%) protein content. The fortification of *fufu* with okra seed flour from 5 to 20% increased the protein content by 50 and 206%, respectively. This increase in protein content is an indication that the fortification of instant *fufu* with okra seed flour could contribute in the reduction of protein energy malnutrition which is often associated with the over reliance on the unfortified *fufu*.

The fat content of the highest fortified sample had the highest value of 6.29% while the unfortified sample had the lowest value of 0.37%. This suggests that okra seed flour contributed significantly to the fat content of the samples. The fat content observed for the unfortified instant *fufu* (0.37%) in this study agreed with the 0.35% reported by Hussein *et al.* (2012) for instant *fufu*. The fat content of 20% okra-fortified-*fufu* sample with the highest fat content (6.29%) was not higher than the recommended upper limit of 10% for complementary/composite food (Odunlade, 2016).

The carbohydrate and fibre contents of the samples which ranged between 65.20 to 76.90% and 10.16 to 11.80%, respectively reduced as fortification levels increased. The reduction in carbohydrate contents of the samples with increase in okra seed flour addition is somewhat beneficial because of its effects on protein energy malnutrition. The carbohydrate and fibre contents of the fortifying agent (okra seed) are lower than those of cassava tuber.

The ash content of the sample also increased with increase in fortification level which indicates that the mineral contents of the instant *fufu* samples

Table 1.Proximate composition (%) of *fufu* and okra-fortified-*fufu* samples

Sample	Moisture	Ash	Fat	Protein	Fibre	Carbohydrate
A	5.90 ± 0.02^{a}	1.33 ± 0.02^{e}	0.37 ± 0.01^{e}	3.64 ± 0.02^{e}	11.80 ± 0.01^{a}	76.90 ± 0.00^{a}
B	5.61 ± 0.03^{b}	1.46 ± 0.01^{d}	1.80 ± 0.03^{d}	5.46 ± 0.01^{d}	11.39 ± 0.02^{b}	74.28 ± 0.02^{b}
C	5.38 ± 0.01^{c}	1.61 ± 0.02^{c}	2.59 ± 0.02^{c}	7.48 ± 0.02^{c}	10.80 ± 0.02^{c}	72.14 ± 0.03^{c}
D	5.03 ± 0.02^{d}	1.73 ± 0.02^{b}	4.81 ± 0.01^{b}	9.39 ± 0.02^{b}	10.57 ± 0.01^{d}	68.47 ± 0.01^{d}
E	4.75 ± 0.04^{e}	1.87 ± 0.01^{a}	6.29 ± 0.01^{a}	11.13 ± 0.03^{a}	10.16 ± 0.03^{e}	65.20 ± 0.01^{e}

Means along a column with the same superscript are not significantly different (p>0.05)

A 100% Instant *fufu* and 0% okra seed flour
B 95% *fufu* and 5% okra seed flour
C 90% *fufu* and 10% okra seed flour
D 85% *fufu* and 15% okra seed flour
E 80% *fufu* and 20% okra seed flour

Table 2. Physicochemical properties of *fufu* and okra-fortified-*fufu* samples

Sample	pH	WAC (%)
A	5.42 ± 0.01^{d}	271 ± 0.01^{e}
B	5.45 ± 0.01^{c}	274 ± 0.03^{d}
C	5.50 ± 0.00^{b}	278 ± 0.01^{c}
D	5.51 ± 0.00^{b}	280 ± 0.02^{b}
E	5.55 ± 0.01^{a}	283 ± 0.01^{a}

Means along a column with the same superscript are not significantly different (p>0.05)

A 100% Instant *fufu* and 0% okra seed flour
B 95% *fufu* and 5% okra seed flour
C 90% *fufu* and 10% okra seed flour
D 85% *fufu* and 15% okra seed flour
E 80% *fufu* and 20% okra seed flour

would increase with okra addition. This is because ash content is more of a measure of the minerals in foods (Pomeranz and Meloan, 2004). The moisture of all the samples ranged between 4.75 and 5.90% which were lower than the recommended upper limit of 15% for floury foods (Codex Stan 152-1985). This therefore suggests that all the samples would not deteriorate quickly as a result of its low moisture content (Makinde and Ladipo, 2012) because the samples were sufficiently dried.

Physicochemical properties of fufu *and fortified* fufu *samples*

The results for the physicochemical properties of *fufu* and okra-fortified-*fufu* samples are presented in Table 2. The pH of all the samples ranged between 5.42 and 5.55. The pH of the unfortified instant *fufu* was 5.42 which agreed with the range reported by Achi and Akomas (2006) and Oyedeji *et al*. (2013) for *fufu* samples. The addition of okra did not considerably influence the pH of the *fufu* samples.

The water absorption capacity (WAC) of the samples ranged between 271 and 283%. The unfortified instant *fufu* sample had the least WAC while 20% okra-fortified-*fufu* sample recorded the highest WAC. There was an increase in the water absorption capacity of the samples as fortification increased. Adetuyi and Adelabu (2011) also reported increase in water absorption capacity with the addition of okra seed to plantain flour. Water absorption capacity had been reported to be a function of the nutritive component of foods namely protein and carbohydrate (Odunlade, 2016). The increase in the water absorption capacity of the *fufu* samples upon fortification could be attributed to the increase and decrease in protein and carbohydrate contents, respectively (Chandra and Samsher, 2013).

Mineral composition of fufu *and fortified* fufu *samples*

The results of the mineral composition of *fufu* and fortified *fufu* samples are presented in Table 3. The values for calcium for the samples ranged between 30.15 and 43.27 mg/100 g. The iron and magnesium contents of the samples ranged between 2.10 to 3.40 mg/100 g and 19.10 to 26.50 mg/100 g, respectively. It was largely observed that the evaluated mineral contents significantly (p<0.05) increased with increase in inclusion level of roasted floury okra seeds.

Sensory evaluation of fufu *and okra-fortified-*fufu *samples*

The results of sensory evaluation of *fufu* and okra-fortified-*fufu* samples are presented in Table 4. The 100% instant *fufu* and 5% okra-fortified-*fufu* samples were not largely significantly different from each other in terms of taste, texture, and flavour. They, however, differ significantly in terms of colour, appearance and acceptability. Sample with 20% okra

Table 3. Mineral composition (mg/100 g) of *fufu* and okra-fortified-*fufu* samples

Sample	Calcium	Iron	Magnesium
A	30.15 ± 0.04^{e}	2.10 ± 0.02^{e}	19.10 ± 0.02^{e}
B	35.83 ± 0.02^{d}	2.33 ± 0.02^{d}	21.24 ± 0.02^{d}
C	38.13 ± 0.05^{c}	2.58 ± 0.04^{c}	22.83 ± 0.03^{c}
D	40.50 ± 0.03^{b}	2.94 ± 0.02^{b}	24.19 ± 0.02^{b}
E	43.27 ± 0.02^{a}	3.40 ± 0.05^{a}	26.50 ± 0.04^{a}

Means along a column with the same superscript are not significantly different (p>0.05)
A 100% Instant *fufu* and 0% okra seed flour B 95% *fufu* and 5% okra seed flour
C 90% *fufu* and 10% okra seed flour D 85% *fufu* and 15% okra seed flour
E 80% *fufu* and 20% okra seed flour

Table 4. Sensory evaluation of *fufu* and okra-fortified-*fufu* samples

Sample	Taste	Texture	Flavour	Colour	Appearance	Acceptability
A	7.50^{a}	7.63^{a}	6.88^{a}	8.25^{a}	8.38^{a}	8.50^{a}
B	7.25^{a}	7.12^{ab}	6.63^{a}	6.13^{b}	6.38^{b}	6.88^{b}
C	6.25^{b}	6.25^{b}	5.63^{b}	5.13^{c}	5.63^{c}	6.13^{b}
D	4.75^{c}	4.88^{c}	5.38^{b}	4.25^{cd}	4.15^{d}	5.00^{c}
E	4.50^{c}	4.75^{c}	5.38^{b}	4.13^{d}	3.63^{e}	4.00^{d}

Means along a column with the same superscript are not significantly different (p>0.05)
A 100% Instant *fufu* and 0% okra seed flour B 95% *fufu* and 5% okra seed flour
C 90% *fufu* and 10% okra seed flour D 85% *fufu* and 15% okra seed flour
E 80% *fufu* and 20% okra seed flour

seed flour fortification level was significantly different from other samples. Samples with 15 and 20% okra seed flour fortification levels were not significantly different from each other. The preference in terms of these quality attributes was observed to reduce with increased okra addition. Unfortified instant *fufu* and 5% okra-fortified-*fufu* samples had nearly the same better preferences when compared to other samples. Sample with 10% okra seed flour fortification level was also preferred while samples with 15 and 20% okra seed flour inclusion levels were not largely preferred by the semi-trained sensory evaluators.

Conclusion

This study has indicated that the nutritive composition of *fufu* can be improved by fortifying it with okra seed which could boost the production of okra by farmers and subsequently ameliorating the menace of protein-energy malnutrition. In terms of consumer acceptance, *fufu* with 10% substitution level was the optimal acceptance level because of the seemingly negative impact of the roasted okra seed meal on the colour of *fufu*.

References

Achi, O. K. and Akomas, N. S. 2006. Comparative assessment of fermentation techniques in the processing of fufu, a traditional fermented cassava product. Pakistan Journal of Nutrition 5(3): 224-229.

Adeniran, H. A., Gbadamosi, S. O. and Omobuwajo, T. O. 2012. Microbiological and physico-chemical characteristics of fufu analogue from breadfruit (*Altocarpus altilis* F). International Journal of Food Science and Technology 47: 332–340.

Adepeju, A. B., Gbadamosi, S. O., Adeniran, H. A. and Omobuwajo, T. O. 2011. Functional and pasting characteristics of breadfruit *(Artocarpus altilis)* flours. African Journal of Food Science 5(9): 529-535.

Adetuyi, F. O. and Adelabu, H. A. 2011. Impact of okra *(Abelmoschus esculentus)* seed flour on nutrients, functional properties and zinc bioavailability of plantain flour. Malaysian Journal of Nutrition 17(3): 359-366.

Aminu-Taiwo, B. R., Idowu, A. A., Alamu, O. O., Olaniyi, O. W. and Olufunmi, O. O. 2014. Influence of mulch materials on population of plant parasitic nematode, growth and yield of okra (*Abelmoschus esculentus* L. Moench). IOSR Journal of Agriculture and Veterinary Science 7(4): 12-17.

AOAC. 2010. Official methods of analysis of AOAC International, 18th ed. Gaithersburg, MD: AOAC International.

Chandra, S. and Samsher. 2013. Assessment of functional properties of different flours. African Journal of Agricultural Research 8(38): 4849-4852.

Chukwuemeka, O. C. 2007. Effect of process modification on the physico-chemical and sensory quality of fufu-flour and dough. African Journal of Biotechnology 6(16): 1949-1953.

Codex Stan 152. 1985. Standard for wheat flour. Codex Alimentarius International Food Standards, CXS-152, Rome: Food and Agriculture Organization of the United Nations.

Makinde, F. M. and Ladipo, A. T. 2012. Physicochemical and microbial quality of sorghum-based complementary food enriched with soybean *(Glycine max)* and sesame *(Sesamum indicum)*. Journal of Food Technology 10(2): 46-49.

Martins, F. W., Lettel, T. and Ruth, R. 2006. Protein, oil and gossypol contents of vegetable curd made from okra seed. Journal of Food Sciences 44(5): 1517-1579.

Mbaeyi-Nwaoha, I. E. and Obetta, F. C. 2016. Production and evaluation of nutrient-dense complementary food from millet *(Pennisetum glaucum)*, pigeon pea *(Cajanus cajan)* and seedless breadfruit *(Artocarpus altillis)* leaf powder blends. African Journal of Food Science 10(9): 143-156.

Odunlade, T. V. 2016. Studies on sorghum based ogi fortified with cocoa powder. Ile-Ife, Nigeria: Obafemi Awolowo University, MSc Thesis.

Onoja, U. S., Akubor, P. I., Gernar, D. I., Chinmma, C. E. 2014. Evaluation of complementary food formulated from local staples and fortified with calcium, iron and zinc. Journal of Nutrition and Food Sciences 4: 326.

Opara, C. C., Agueze, C. C. and Abraham, A. 2013. Dehydration and rehydration of fufu. Greener Journal of Science, Engineering and Technology Research 3(2): 068-075

Oyedeji, O., Ogunbanwo, S. T. and Onilude, A. A. 2013. Predominant lactic acid bacteria involved in the traditional fermentation of fufu and ogi, two Nigerian fermented food products. Food and Nutrition Sciences 4: 40-46.

Pomeranz, Y. and Meloan, C. E. 2004. Food Analysis Theory and Practice. New Delhi: CBS Publishers and Distributors.

Sathe, S. K. and Salunkhe, D. K. 1981. Isolation, partial characterization and modification of Great Northern Bean (*Phaseolus vulgaris* L.) starch. Journal of Food Science 46: 617-621.

Savello, P. A., Martin, F. W. and Hill, J. M. 1980. Nutritional composition of okra seed meal. Journal of Agricultural and Food Chemistry 28(6): 1163-1166.