Effect of fermentation time and mix ratio on some nutritional qualities of the dry mixture of maize and sorghum powder (*Ogi*)

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Summary

The effect of two process conditions (fermentation time (B) and mix ratio (A)) on the dry mixture of maize (M) and sorghum (S) powder (*ogi*) was investigated. Five mix ratios (1 (M50:S50), 2 (M60:S40), 3 (M70:S30), 4 (M80:S20), 5 (M90:S10)), and five fermentation times (6, 12, 18, 24 and 30 h) were considered. The drying was done at 50 °C in a convective fabricated cabinet dryer. It took about 2 hours for the drying to be completed. After drying, all samples were analysed for the output parameters (carbohydrate, crude fibre crude protein, fat content, vitamin C and magnesium content). The results showed that the interaction of all the levels of the two process conditions did not change the mean values of the carbohydrate, crude protein and magnesium contents of the dried fermented product (*ogi* powder). Various combinations of all the levels of the two process conditions did not cause the value of the carbohydrate, crude fibre, crude protein, fat, vitamin C and magnesium content to be higher than 83.5%, 0.6%, 3.2%, 1.2%, 3.0%, and 3.85 mg/100g respectively.

Keywords: ogi, mix ratio, fermentation time, drying, nutritional qualities

Introduction

Ogi is usually a wet-milled, fermented food product, derived from cereals like maize, sorghum, millet or mixtures of different cereals. The wet product can also be processed to the powder form. Sometimes, other products like ginger, garlic, soybeans and others can be added to it at the processing stage for the purpose of improving its nutritional qualities. Actually, *ogi* is a semi-finished food product, but it can be transformed to the finished food by cooking its slurry in hot water. The finished food after cooking is called pap in English language, and local names in Nigeria are '*Eko'*, '*Agidi'*, '*Akamu'*, and '*Koko'*. Afolayan (2010) reported that its local names in Nigeria could be attributed to some factors like the tribes' names or to the style of its preparation or serving. After preparation to the finished food, it becomes a viscous product, and its final viscosity is attributed to the amount of water added during preparation (Ashworth and Draper, 1992). The food is considered a staple food in Africa, and it is used as a weaning food for infants and as the breast milk production enhancer for lactating mothers. It is also used as a breakfast food for children and a convenient food for people recovering from sickness because it digests faster (Nago, 1985 and Onyekwere et al., 1989); this could be due to the effect of fermentation that usually causes breakdown of food to some level, thereby increasing the rate of digestion of the food in the human body.

Preliminary laboratory investigations conducted by the authors of this work revealed that *ogi* contains carbohydrate, crude fibre, crude protein, vitamin C, fat, magnesium, potassium and so on. Meanwhile, Saldana and Brown (1984), and Ranhotra (1985) reported the nutritional compositions of some raw materials (maize and sorghum) for making *ogi*. These reports showed that the two raw materials considered had highest percentages (about 73%) of the carbohydrate content. Thus, *ogi* and pap are highly rich in carbohydrate contents.

Aminigo and Akingbala (2004), and Laguna (1951) emphasized steeping, milling, sieving and fermentation as some of the steps for processing cereals to *ogi*. Bolaji et al. (2015) reviewed various works on the production of *ogi* in Nigeria. Fields et al. (1982), Osungbaro (1990), Hounhouigan et al. (1993) stated that the physical and biochemical qualities of *ogi* could be influenced by the following factors: type of cereal grains, fermentation or souring periods, and the method of milling.

Drying is a simultaneous heat and mass transfer process that ensures the reduction of the products'

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moisture to a pre-determined level. It is one of the most practical and feasible methods of ensuring all year round availability of the perishable food products because it leads to the shelf life extension. Also, it is a means of minimizing the cost of transportation, packaging and storage due to the reduction in the weight and volume of the products after drying (Olaniyan et al., 2015). Other important information on the different aspects of drying like a theory of drying, methods of drying, classification of dryers, types of dryers, factors affecting drying process and so on, are reported in Odewole and Olaniyan (2015).

In the processing of cereals to ogi powder, some of the factors that can affect the nutritional quality of the dried product are the temperature of drying, fermentation time and mix ratios of the raw materials. However, there is no known work on the investigation of mix ratios of cereals (maize and sorghum) together with fermentation times in order to ascertain the level of the available nutrients after processing to powder. Also, the interaction of raw materials may have some effects on the nutrient level of the final processed product. Therefore, the aim of this research was to investigate the effect of two process conditions (fermentation time (B), and mix ratio (A)) on the nutritional qualities of the dry mixture of maize (M) and sorghum (S) powder. The research on the combination of fermentation time and mix ratio of raw materials provided, to some extent, preliminary information on the development of appropriate food formula for the dried mixture of ogi made from maize and sorghum.

Materials and methods

Experimental design

Design Expert 8.0.3 version Computer Software was used to design the experiment. Response Surface Methodology (RSM) under Central Composite Design was chosen. Five levels of fermentation time (6, 12, 18, 24 and 30 h), and five levels of mix ratios of maize (M) and sorghum (S) (1-M50:S50, 2-M60:S40, 3-M70:S30, 4-M80:S20 and 5-M90:S10) were substituted into the experiment design interface of the software. The results revealed combinations of the different levels of fermentation time and mix ratios that were used for the pre-drying operations. Note: M50:S50 means 50% of maize and 50% of sorghum with respect to the uniform mass of the sample (200 g) used for fermentation.

Experimental procedure

Clean maize and sorghum grains used were procured from a market in Ilorin, Nigeria. The nutritional composition of the unprocessed (raw materials) maize (*zea mays*) used for this study was 8.44, 4.65, 1.14, 1.35, and 75.9% for protein, fat, ash, crude fibre and carbohydrate respectively; while that of the unprocessed sorghum (*sorghum bicolor*) used was 11.31, 3.47, 1.25, 1.58 and 76.23 for protein, fat, ash, crude fibre and carbohydrate respectively. After steeping the maize and sorghum grains in cold water for three days, they were separately milled with a burr mill (Alpak, D100L, Nigeria). The experimental quantity of the milled product per run of the experiment for fermentation was 200 g. The mix ratios with the reference to the 200 g of experimental samples were measured with an electronic weighing balance (OHAUS CL Series, Model CL 201, China), were placed in containers, and fermented for all the required days of fermentation sequentially. This enabled the longest fermentation time (30 h) to end at the same time with the shortest fermentation time (6 h). After fermentation, products were dewatered with a muslin cloth and 50 g of each of the dewatered fermented products was placed on a foil paper, arranged on the drying trays and dried at 50 °C. The nutritional composition of the wet fermented mixture of the milled maize (*zea mays*) and sorghum (*sorghum bicolor*) was 75.85%, 0.47%, 3.01%, 1.01%, 2.57%, and 3.77 mg/100g for carbohydrate, crude fibre, crude protein, fat content, vitamin C, and magnesium respectively. The temperature of the convective fabricated dryer was maintained with the aid of a temperature regulator connected to it. The speed of the fan connected to the dryer was 3.02 m/s. The drying lasted for approximately 2 h, the average moisture content of all dried sample was not less than about 13% (db). All the dried products were immediately arranged in the desiccator and were later analysed for nutritional qualities. The experiment was performed at the Food Quality and Packaging Laboratory of the Department of Food and Bioprocess Engineering, Faculty of Engineering and Technology, University of Ilorin, Ilorin, Nigeria. The average room temperature was around 30 °C and relative humidity of about 63% throughout the period of the experiment.

Output parameters

The following nutritional qualities of the dried fermented powdered products (carbohydrate, crude fibre, crude protein, fat content, vitamin C and magnesium content) were determined using the AOAC (2002) standard.

Data analysis

All the data obtained from the determination of the nutritional qualities were introduced back into the experimental table generated with the Design Expert computer software package. The data were analysed following the stipulated procedures of the software for RSM in order to get the 3-dimensional (3-D) plots that showed the relationship between fermentation times and mix ratios of each of the nutritional quality considered.

Results and discussion

Effect of fermentation time (B) (hours) and mix ratio (A) (%) on the carbohydrate content (%) of the dry mixture of maize and sorghum powder (Ogi)

The effect of A and B on the carbohydrate is shown in Fig. 1. As shown in Fig. 1, the 3-dimesional plot has a flat surface of 180 degrees. It can be explained with the interaction of the fermentation time and the mix ratios, which caused the mean value of the carbohydrate to be maintained. The implication of this is that the levels of the two factors cannot be considered as something that would lead to an increase or a decrease in the mean value of the carbohydrate content of the dried fermented product (*ogi* powder). The possible reason for this observation could be the inability of the available number of microbes to break down the carbohydrate to sugar between 6 h – 30 h, which is the range of time used for the fermentation process. That is, it may require other combinations of mix ratios and longer than 30 h of fermentation for the available microbes to increase to a number that would cause the interaction of factors and the noticeable effect on the mean value of the carbohydrate content. The value of the carbohydrate obtained after drying was about 82%. This result is higher about 77.1% than the result obtained by drying ogi made from sorghum, millet and maize at 60 °C by Esther et al. (2013).

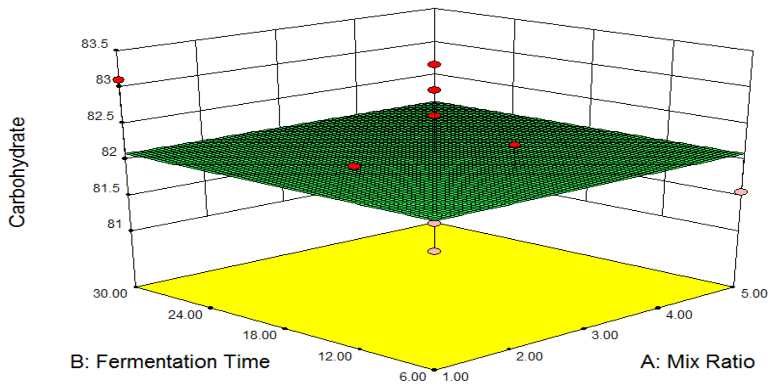

Fig. 1. Effect of A (hours) and B (%) on the carbohydrate content (%) of the product

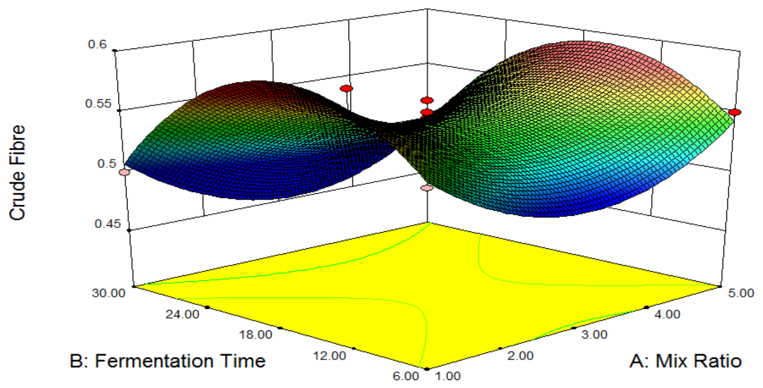

Fig. 2. Effect of A (hours) and B (%) on the crude fibre (%) of the product

Effect of fermentation time (B) (hours) and mix ratio (A) (%) on the crude fibre (%) of the dry mixture of maize and sorghum powder (Ogi)

Fig. 2 presents a saddle shape; as mix ratio increased from 1 (M50:S50) to 3 (M70:S30), the crude fibre first decreased, and then increased again from this point to 5 (M90:S10). Also, as fermentation time increased from 6 h to 18 h, the crude firbre first increased, then decreased to the final time of fermentation (30 h). This implies that the best fermentation time to get the maximum fibre content is 18 h, and the best mix ratio of maize to sorghum is 90:10. However, the level of obtained increment was not more than 0.55%, and decrement was not less than 0.45% for the change in A and B respectively. Esther et al. (2013) obtained about 3.5% at a drying temperature of 60 °C. The value of the crude fibre obtained by Adelekan and Oyewole (2010) was 217% for the dried *ogi* supplemented with soya beans.

Effect of fermentation time (B) (hours) and mix ratio (A) (%) on the crude protein (%) of the dry mixture of maize and sorghum powder (Ogi)

The effect of A and B on the crude protein is shown in Fig. 3. As shown in Fig. 3, the 3-dimesional plot has a flat surface of 180 degrees. The interpretation of this is that the interaction of the fermentation time and the mix ratios caused the mean value (3.05%) of the crude protein to be maintained. The implication of this is that the levels of the two factors may not be considered as something that would lead to an increase or a decrease in the mean value of the crude protein of the dried fermented product (*ogi* powder). Also, the fermentation time and mix ratios may not be factors that can cause a drastic effect on the crude protein of the *ogi* powder. Adelekan and Oyewole (2010) obtained values in the range of 270-284% for *ogi* that was supplemented with soybeans at 60 °C drying temperature in an oven.

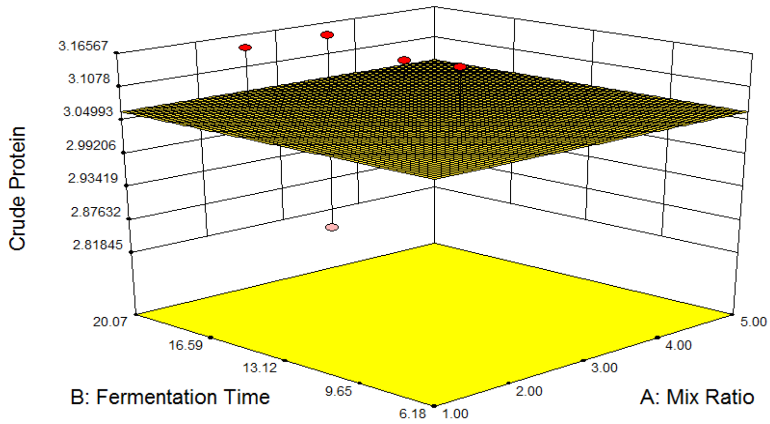

Fig. 3. Effect of A (hours) and B (%) on the crude protein (%) of the product

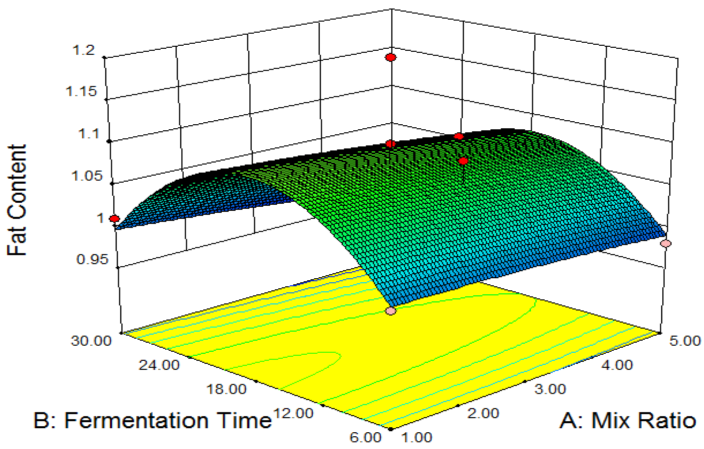

Fig. 4. Effect of A (hours) and B (%) on the fat content (%) of the product

Effect of fermentation time (B) (hours) and mix ratio (A) (%) on the crude fat content (%) of the dry mixture of maize and sorghum powder (Ogi)

The effect of A and B on the fat content of the product is shown in Fig. 4. The figure looks like a horizontal half hollow pipe facing the downward direction. Increase in the mix ratio caused the fat content to be maintained between 1.02% and 1.08%. Also, as fermentation time increased from 6 h to 18 h, the fat content first increased to a peak value of slightly above 1.05%, and then decreased again from this point to 30 h of the fermentation time. This implies that in order to obtain a maximum fat content, 18 h is the appropriate fermentation time. However, the increment was not beyond 1.1%, and decrement not less than 1%. This result is contrary to about 3.1% of what Esther et al. (2013) obtained at 60 °C of drying. However, Adelekan and Oyewole (2010) obtained about 130% for ogi that was supplemented with soybeans at 60 °C drying temperature in an oven.

Effect of fermentation time (B) (hours) and mix ratio (A) (%) on vitamin C (%) of the dry mixture of maize and sorghum powder (Ogi)

Fig. 5 illustrates the effect of A and B on the vitamin C content of the product. The figure has an elevated jet-like shape.. Increase in the fermentation time and mix ratio caused the reduction in the value of vitamin C to approximately 2.70% along x and z axes of the plot. This decrement may be a result of the dissolved vitamin C being fed upon by the some unidentified microbes during fermentation. The combined effect of the two process conditions (A and B) led to a value above 2.8%, but not up 2.9% (the apex of the shape).

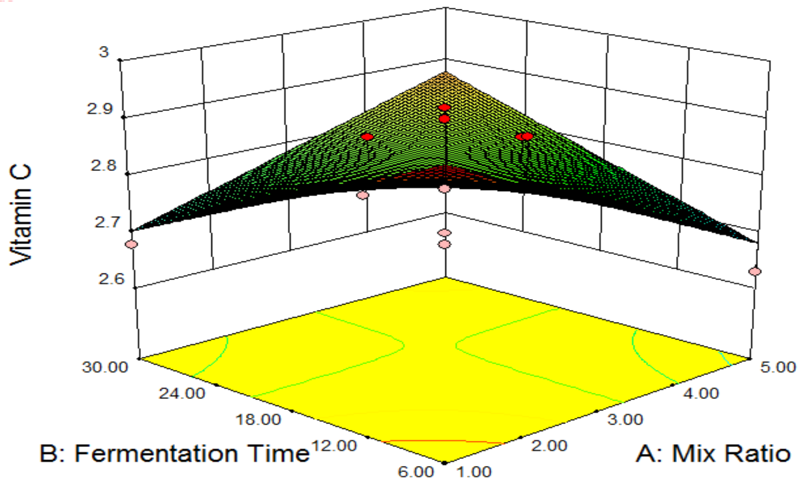

Fig. 5. Effect of A (hours) and B (%) on the vitamin C (%) of the product

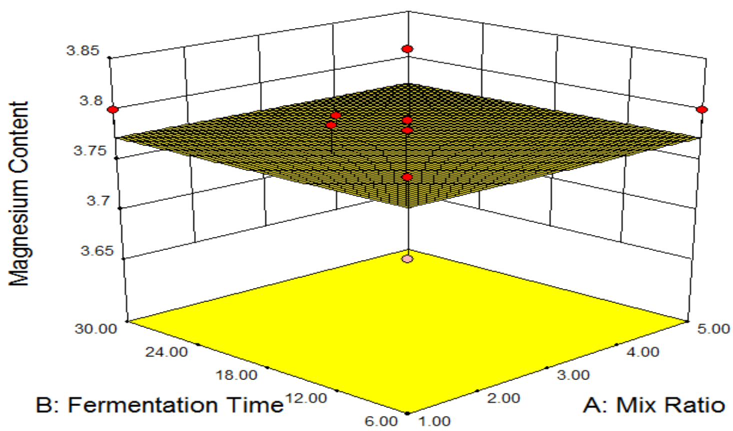

Fig. 6. Effect of A (hours) and B (%) on the magnesium content (%) of the product

Effect of fermentation time (B) (hours) and mix ratio (A) (%) on the magnesium content (%) of the dry mixture of maize and sorghum powder (Ogi)

The effect of A and B on the magnesium content of the product is shown in Fig. 6. The plot in this figure is similar to that of Fig. 1, and Fig. 3 for the carbohydrate and crude protein respectively. Hence the same explanations are applicable. However, the value of the magnesium content obtained for various combinations of the fermentation time and mix ratio after drying was about 3.85%

Conclusions

The levels of the two process conditions (mix ratios and fermentation time) caused the mean values of the carbohydrate, crude protein and magnesium content of the dried fermented products (*ogi* powder) to be maintained. However, various combinations of the process conditions did not cause the value of carbohydrate, crude fibre, crude protein, fat, ash, vitamin C, magnesium and moisture content to be more than 83.5%, 0.6%, 3.2%, 1.2%; 3.0% and 3.85 mg/100 g, respectively. The acceptability probe of the dried fermented product in comparison with the pap prepared from fresh *ogi* should be done. Also, long-term storage of the dried powder in different packaging materials and storage chambers should be given consideration in future.

References

Adelekan, A. O., Oyewole, A. B. (2010): Production of Ogi from Germinated Sorghum supplemented with Soybeans. *AJB.* 9 (42), 7114-7121.

Afolayan, M. O. (2010): An Investigation into Sorghum Based Ogi (Ogi-Baba) Storage Characteristics. *Adv. J. Food Sci. Technol*. 2 (1), 72-78.

Aminigo, E. R. Akingbala, J. O. (2004): Nutritive Composition of Ogi Fortified with Okra Seed Meal. *J. Appl. Sci. Environ. Mgt.* 8 (2), 23-28.

AOAC (2002): Official Methods of Analysis. Association of Official Analytical Chemists, Washington D.C., USA.

Ashworth, A., Draper, A. (1992): The Potential of Traditional Technologies for Increasing the Energy Density of Weaning Foods: a Critical Review of Existing Knowledge with Particular Reference to Malting and Fermentation. WHO/CDD/EDP/92.4, Geneva: WHO. 1-50.

Bolaji, O. T., Adepoju, P. A., Olalusi, A. P. (2015): Economic Implication of Industrialization of a Popular Weaning Food "Ogi" Production in Nigeria: A Review. *AJFS.* 9 (10), 495-503. https://doi.org/10.5897/AJFS2014.1196

Esther, L., Charles, A. O., Adeoye, O. S., Toyin, O. A. (2013): Effects of Drying Methods on Selected Properties of Ogi (Gruel) Prepared from Sorghum (*Sorghum vulgare*), Millet (*Pennisetum glaucum*) and Maize (*Zea mays*). *J. Food Process Technol.* 4 (7), 1000248. https://doi.org/10.4172/2157-7110.1000248

Fields, M. L., Hamad, A. M., Smith, D. R. (1981): Natural Lactic Acid Fermentation of Corn Meal. *J. Food Sci.*18, 900-902.

Hounhouigan, D. J., Nout, M. J., Nago, R., Houben, C. M., Rombouts, F. M. (1993): Changes in Physico-Chemical Properties of Maize during Natural Fermentation of Mawe. *J. Cereal Sci.* 17, 291-300.

Lagunna, J., Carpenter, J. N. (1951): Raw versus Processed Corn in Niacin Deficient Diets. *J. Nutr*. 18 (30), 21-28.

Nago, M. C., Hounhuigan, J. D., Akissoe, N., Zanou, E., Mestres, C. (1998): Characterization of Beninese Traditional Ogi, a Fermented Sorghum Slurry: Physicochemical and Microbiological Aspects. *Int. J. Food Sci. Technol*. 13 (1), 307-315.

Odewole, M. M., Olaniyan, A. M. (2015): Empirical Modelling of Drying Rates and Qualities of Red Bell Pepper. Lambert Academic Publishing, Germany.

Olaniyan, A. M., Sunmonu, M. O., Odewole, M. M., Ige, O. O. (2015): Process conditions governing the drying rate and quality of tomato powder obtained from foam-mat dried tomato paste. *UFJ*. 4 (3), 423-430.

Onyekwere, O. O., Akinrele, I.A., Koleoso, O. A. (1989): Industrialization of Ogi Fermentation. *Industrialization of Indigenous Fermented Foods*. 1, 329-362.

Osungbaro, T. O. (1990): Effect of Differences in Varieties and Dry Milling of Maize on the Textural Characteristics of Ogi (Fermented Maize Porridge) and Agidi (Fermented Maize Meal). *J. Sci. Food Agric.* 10 (84-90), 1-12.

Ranhotra, G.S. (1985): Nutritional Profile of Corn and Flour Tortillas. *Cereal Foods World*. 7, 703-704.

Saldana, G., Brown, H. E. (1984): Nutritional Composition of Corn and Flour Tortillas. *J. Food Sci.* 1 (1), 1202-1203. https://doi.org/10.1111/j.1365-2621.1984.tb10430.x

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