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The influence of natural fermentation, malt addition and soya-fortification on the sensory and physico-chemical characteristics of gyok-millet gruel

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Abstract *The search for food is a major concern in developing Countries like Nigeria. The influence of natural fermentation, malt addition and soya fortification on the sensory and physicochemical characteristics of 'Gyok', a millet gruel was studied by producing eight (8) gruel samples. The samples were–subjected to sensory evaluation and the best acceptable five samples were used for physicochemical analysis. The pH and titratable acidity (TA) ranged from 4.88 to 6.16 and 0.31% to 0.14% respectively for the fermented gruel. Fermented gruels with added malt and (FGM) and for the unfermented millet meal (NFG). Fermentation with malt addition considerably lowered the pH and increased the titratable acidity of the products. Fermentation coupled with malt addition also resulted in products of reduced viscosity, higher total solids, total soluble solids, bulk density and energy values. Based on the results obtained, it was observed that fermentation with malt and soya-fortification resulted in higher acidity, and lower pH values of gruels with correspondingly lower microbial count.*

Key Words: *Fermentation. Gyok Millet gruel, malt addition, and sensory evaluation*

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1.0 Introduction

Gyok, is a native non-alcoholic gruel made from millet for consumption mostly by the Gwong (Kagoma) people in the southern part of Kaduna in Kaduna state- Nigeria. It is prepared by removing the outer part of the millet, followed by grinding, cooking and reconstitution of the cereal flour or wet milled paste in water. According to Kure (2013), millet protein is low in lysine, methionine, and tryptophan. The chemical score lysine in millet is 37 and is the most limited in millet. Consequently, if the nutritional roles of lysine must be manifested through the consumption of gyok, then it should be fortified for enhance quality. According to Wolf (1988), legume proteins are good sources of lysine but the concentrations of sulphur containing amino acids (such as methionine and cysteine) are low. Generally, most cereals are not good source of lysine indicating that they may be need to enrich them with lysine and other essential amino acids (Ihekoronye, and Ngoddy, 1985, Bressani, 1988, Enwere, 1988).

Commonly consumed cereals in Southern Kaduna have low energy and low nutrient density and cannot presents the nutritional requirements of balanced diets (Fox and Cameron, 1989, Donnen *et al*.,1996). In view of this challenge, several technologies have been developed to increase the nutrient and energy density by reducing the bulk and ensuring that their viscosity remains acceptable. These technologies include the use of enzymes such as amylases or amylase-rich food, natural fermentation and germination sprouting (John and Gopaldas 1988; Akpapunam and Sefa, 1995).

Cereals and legumes (millet and soyabeans in particular) are widely available, widely consumed and relatively cheap. Hence, nutritionally balanced local foods of high nutrient and energy density can be produced using suitable technology on cereal/legumes formulation. The present study is aimed at producing millet gruel-gyok using various food processing technologies and to investigate the effect of fermentation and fortifications with malt and soya bean on the sensory attributes of the products.

2.0 Materials and Methods

2.1 Sample preparation

Millet and soyabeans were purchased from a local market in Kafanchan, Kaduna State-Nigeria. Soyabeans flour was produced according to the methods described by Enwere (1998) and Onuorah and Akinjide (2004) while millet and malt were produced according to the method described by John and Gopaldas (1988).

2.2 Production of meal formulations Millet grains were cleaned /sorted manually, dehulled and splited into two portions. One portion was dry-milled and sieved through a Mash (having 850 microns size) to obtain millet meal while malt 4% (w/w) was added to the other portion prior to milling. Each of the two portions were further divided into two portions, one with added soya flour in the ratio 65: 35 (i.e. 65 parts Millet meal to 35 parts soya-flour), and the other without soya-flour(Kure, 2013). Millet gruels of different formulations were made using the traditional local processing method as a basis.

2.3 *Production of fermented and non - fermented gruel samples*

In order to produce fermented gruels, 100g portions each of the respective formulated meals (FG, FSG, FGM, and FSGM) were mixed with water in the ratio of 1:2 (w/v) and allowed to ferment for 12 hours at room temperature. The fermented paste samples were mixed with ~~the~~ predetermined quantity of cooking water (500ml water per 100g portion), and transferred in to a cooking pot that was used in cooking the sample for 20 minutes with continuous stirring. When the temperature of the cooked sampled assume room temperature, they were preserved in labelled plastic containers (Kure, 2013).

In order to obtained non fermented gruels, the formulated meals (100g portion each) of NFG, NFSG, NFGM and NFSGM were also mixed with water in the ratio of 1:2 (w/v), 500 ml of distilled water was added and the mixture was cooked for 20 minutes and stored in labelled plastic containers when the mixture assumed the room temperature.

2.4 Quality evaluation

2.4.1 Sensory evaluation. Eight coded gruel samples were presented to fifteen semi-trained panellists which were staff and students of the Department of Chemistry, Kaduna State University, Kaduna. The samples were evaluated for taste, colour, flavour/aroma, texture and overall acceptability on a nine – point hedonic scale at Department of Applied Chemistry, Federal University, Dutsin-Ma in Katsina State. Results were analyzed using the ANOVA while Turkey's test was used for mean separation (Harnett, 1982). Five gruel samples that were most acceptable were then reproduced for further evaluation.

2.4.2 Physicochemical analysis

The viscosity was determined using Brookfield Viscometer (Onwuka, 2005), while the pH and titratable acidity were determined using the method reported by Kure (2013). The total solids (TS), total soluble solids (TSS), and bulk density (BD) were analysed according to the method described by Kirk and Sawyer (1991).

3.0 Results and Discussion

3.1 Sensory evaluation

Results obtained from sensory evaluation test are presented in Table 1.

Table 1: Mean scores for sensory evaluation of gruel samples

Gruel samples	Taste	Colour	Flavour/aroma	Texture	Overall acceptability
NFG	5.2^a	5.2^b	5.8^a	4.9^a	5.4^a
FG	5.3^a	5.2^b	6.3^a	5.4^a	5.6^a
NFSG	4.8^b	4.9^b	5.6^a	5.3^a	4.8^a
FSG	4.0^b	5.4^b	5.5^a	5.8^a	5.2^a
NFGM	4.5^b	4.8^b	5.6^a	5.5^a	4.4^a
FGM	6.6^a	7.6^a	6.2^a	5.9^a	6.8^a
NFSGM	5.3^a	5.6^b	6.3^a	5.6^a	5.2^a
FSGM	4.1^b	5.5^b	5.2^a	4.8^a	5.6^a

**** Means not following by the same superscript in the same column are significantly different different ($P \leq 0.05$)**

NFG: Non-fermental gruel, FG: Fermented gruel, NFSG: Non-fermented soya-fortified gruel, FSG: Fermented soya-fortified gruel, NFGM: Non-fermented gruel with added malt, FGM: Fermented gruel with added malt, NFSGM: Non-fermented soya-fortified gruel with added malt, FSGM: Fermented soya-fortified gruel with added malt

The results of sensory evaluation ~~are~~ shown in Table 1 indicate a significant difference at 5% level of confidence among the gruels with reference to taste and colour. The results indicates that samples NFG, FG, FGM and NFSGM are not significantly different from one another in taste. They are similar and taste better. However, they are significantly different ($P \leq 0.05$) from samples NFSG, FSG, NFGM and FSGM in terms of colour. Sample FGM is significantly different from all other gruel samples ($P \leq 0.05$). It had the most acceptable colour. There was no observed significant difference in the flavour/aroma, texture and overall acceptability of the gruel samples at 5% level. This indicates that the panellists judged the samples to be similar in flavour/aroma, texture and overall acceptability ($P < 0.05$)

3.2 Physicochemical properties

Table 2 presents results for physicochemical properties of the analysed food materials. The analysed parameters included percentage lactic acid, viscosity, total solid, total soluble solid and bulk density.

Table 2: Physico-chemical evaluation of the Gruels

Gruel samples	pH	Titratable acidity (%lactic acid)	Viscosity	Total solid	Total soluble solid	Bulk density
FG	5.70^{a}	0.15^{c}	244^{b}	17.2^{c}	7.8^{c}	1.18^{c}
FSG	5.61^{ab}	0.24^{b}	251^{a}	17.8^{c}	7.8^{c}	1.17^{d}
FGM	4.88^{b}	0.30^{a}	244^{b}	19.4^{b}	10.4^{a}	1.24^{b}
NFG	6.15^{a}	0.15^{c}	243^{b}	16.3^{d}	8.4^{bc}	1.10^{a}
NFSGM	6.14^{a}	0.22^{b}	242^{b}	20.5^{a}	8.9^{b}	1.28^{a}

**** Means or average not followed by the same superscript in the same column are significantly different ($P \leq 0.05$), FG: Fermented gruel, FSG: Fermented soya-fortified gruel, FGM: Fermented gruel with added malt, NFG: Non-fermented gruel, NFSGM: Non-fermented soya-fortified gruel with added malt.**

From physicochemical data recorded in Table 2, there was a significant difference ($P \leq 0.05$) in the pH of the different gruel samples (which ranged from 4.88 to 6.15). The pH of samples FG, NFG, NFSGM and FSG are not significantly different but they are statistically similar and are in agreement with the results obtained by Kure (2013). However, sample FGM is significantly different (more acidic) from other samples (except FSG) with respect to pH. The fermented gruel samples had lower pH values than the unfermented ones. This also explain why the acid content (titratable acidity) was also lower in the unfermented samples. The observed pH can be attributed to the production of organic acids from fermentable sugars during the fermentation process. Such trend has also been reported by Akpapunam and Sefa (1995) for the fermented maize-cowpea weaning blends. They observed that the pH of the unfermented product to range from 4.4 - 5.3, while that of the unfermented product was observed to range from 6.6 – 6.8. They also reported that unfermented flour has a pH of 6.5 (titratable acidity 0.30) while that of the fermented product ranged from 3.6 – 4.6 (titratable acidity 0.86 – 1.13). Kure (2013) also reported pH values of 3.8, 3.9, 4.4, and 4.4 for sun fermented, room-fermented and boiled as well as sun fermented and boiled gruels (Ibyer) samples respectively.

A significant difference in ~~the~~ titratable acidity of the different gruel samples ($P < 0.05$) was also observed. Sample FGM had higher acidity than the other samples. The titratable acidity of samples FSG and NFSGM did not differ significantly from each other. NFG and FG are also of similar (lower) titratable acidity. Sample FGM had the lowest pH (4.88) and highest titratable acidity (0.30). This can be attributed to the cumulative effect of malt addition and fermentation, According to Mesah *et* al. (1991), fermented foods with low pH have some inherent antimicrobial activity. Therefore, the observed properties may help in extending the shelf life of the gruel through the control of microbial activity.

There was a significant difference in the measured viscosities of the different gruels samples ($P \leq 0.05$). Sample FSG which is the most viscous and displayed significant differences with other samples with reference to viscosity.However, there was no significant difference among the other samples. Samples that were fortified with (i.e, samples FGM and NFSGM) had lower viscosity (243 and 242) indicating that the added malt altered the flow properties of the product. Kure (2013) also observed apparent reduction in viscosity in gruels prepared with ARF treatment, when malt was added. The soya- fortified fermented gruel (FSG) had the highest viscosity (251 cps) which may be due to increase bulk index contributed by the soya-flour (Mensah *et al.*, 1991). However, they also recorded lower viscosity in porridge cooked from fermented cassava flour compared to the product from unfermented flour. They attributed the differences to activities of the amylase-producing micro-organisms that break down starch into simpler sugars releasing bound water and thus reducing viscosity. Such simpler sugars do not have the matrix configuration for amylase activity (Mensah *et al.*, 1991, Kure, 2013). They add that effective increases in energy density are associated with reduction in viscosity.

There was a significant difference in the total solids content of the different gruels at 5% level with ~~sample~~ NFSGM having the highest TS followed by FGM, which also differ significantly from each other and from all other samples. However, samples FG and FSG displayed no significant difference from each other and were better than sample NFG. The gruels were significantly different ($P \leq 0.05$) from each other in terms of TSS content. FGM has the highest (10.5%) TSS and differed significantly from the other samples, while samples NFG and NFSG showed no significantly different from each other. The TSS of NFG was statistically similar to those of samples FG and FSG. The total solids and total soluble solids content followed the same trend observed for-the gruel viscosities. Samples FGM and NFSGM were found to have total solids and total soluble solids contents of 18.40 and 10.4; and 20.5 and 8.9 respectively, which exceeded those of FG, FSG and NFG (Table 2). Sample NFSGM has the highest % total solids, perhaps because it is unfermented and has additional solids contributed by the addition of soya flour and malt. In terms of bulk density, the gruels did not differ significantly from each other ($P \leq 0.05$). The samples that had the best bulk density was NFSGM, followed by FGM, FG, FSG and NFG respectively. The bulk density ranged from 1.09 g/cm^3 for the non-fermented gruel sample (NFG) to 1.28 g/cm^3 for non-fermented soya-fortified gruel with added malt (NFSGM), following a similar trend as the total solids with samples with added ARF (malt) having slightly higher values than the others.

4.0 Conclusion

From the results and findings of this study, the following conclusions were drawn,

i. Fermentation with malt addition and soya-fortification resulted in higher acidity, and lower pH values of gruels with correspondingly lower microbial count. This would translate into better shelf stability and safety of gruels.

ii. . Fermentation with malt addition resulted into product of reduced viscosity, higher total solids, total soluble solids, bulk density and energy value. Thus enabling the production of high nutrient and energy density gruels possible of being utilized as weaning foods.

iii. Fermentation with soya-fortification resulted in increased viscosity.

5.0 References

Akpapunam, M. A. and Sefa-Dedeh, S. (1995). Traditional lactic acid fermentation, malt addition, and quality development in maize-cowpea weaning blends. *Food and Nutrition Bulletin*, 16, 1, pp. 75 – 80

Bressani, R., (1985): *Protein complementation of foods. In: Nutritional Evaluation of Food Processing*. Karmas, E. and Harris, R.S. (Eds). ed. New York: Avi Pub.Co.Inc. (1988), pp. 119—152

Donnen, P., Dramaix, M., Brasseur, D., Mihanda, R. B., Fazili, S. & Treche S. (1996). High-energy-density gruels in the treatment of hospitalized children suffering from mainly protein malnutrition in Zaire. *Food and Nutrition Bulletin, 17, 2,* pp. 145-150.

Enwere, N. J. (1998). *Foods of Plant Origin*. Afro-Orbis Pub. Ltd, Enugu, Nigeria.

FAO, (1995). *Sorghum and millets in human nutrition*. FAO Corporate Document Repository.

Fox, B.. A. and Cameron, A. G. (1989): *Food Science, nutrition and health*. 5th ed. Great Britain, Edward Arnold pub. Pp 199-203.

Harnett, D. L. (1982). *Statistical methods*. 3rd ed. London: Addison -Wesley Pub. Co. Pp 655-664.

Ihekoronye, A. I. and Ngoddy, P. O. (1985). *Integrated food science and technology for the tropics*. London: Macmillan Pub. Ltd. Pp 236 - 283.

John, C. and Gopaldas, T. (1988). Reduction in the dietary bulk of soya-fortified bulgur Wheat gruels with wheat-based amylase-rich food. *Food and Nutrition Bulletin*, 10, 4, pp. 500-53.

Kirk, R. S. and Sawyer, R. (1991). *Pearson's composition and analysis of foods*. 9th ed. U.K: Longman Group Ltd., Pp 188-223.

Kure, O. A., and Wyasu, G. (2013). Influence of natural fermentation, malt addition and soya-fortification on the sensory and physico-chemical characteristics of Ibyer-Sorghum gruel. *Advances in Applied Science Research*, 4, 1, pp. 345-349

Mensah, P, Drasan, B. S, Hanson, T. J. & Tomkins, A. M., (1991). Fermented Cereal Gruels: Towards a Solution of the Weanling's Dilemma.*Food and Nutriton Bulletin,* 13, 1, pp. 50- 57.

Omotola, S. O. (1998): *Quality evaluation of Ibyer-I-Angen*. B.Sc. Thesis. Department of Food Science and Technology, University of Agriculture, Makurdi.

Onuorah, C.E. and Akinjide, F.A., (2004). Comparative evaluation of four formulated weaning foods and a commercial product. *Nigerian Food Journal*, 22, pp. 48- 53.

Onwuka, G. I. (2005). *Food Analysis and Instrumentation: Theory and Practice* Surulere: Naphthali Prints, pp. 96- 204.

Wolf, J. W. (1988). *Effects of agricultural practices, handling, processing and storage on Legumes and Oilseeds. In: Nutritional Evaluation of Food Processing*. Karmas, E. and Harris, R.S. (eds.). 3rd ed. New York: AVI Pub. Co. Inc.

Uvere, P.O., Ngoddy, P.O. and Nnanyelugo, D.O., (2002). Effect of Amylase-Rich Flour (Arf) Treatment on the Viscosity of Fermented Complementary Foods
Food and Nutrition Bulletin, 23, 2, pp. 70-81.