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Influence of natural fermentation, malt addition and soya-fortification on the sensory and physico-chemical characteristics of Ibyer-Sorghum gruel

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ABSTRACT

The influence of natural fermentation, malt addition and soya fortification on the sensory and physico-chemical characteristics of 'Ibyer', a sorghum gruel was studied. Eight gruel samples were produced and subjected to sensory evaluation after which the most acceptable five were reproduced for further quality' evaluation. The pH and titratable acidity (TA) ranged from 4.88 to 6.16 and 0.31% to 0.14% respectively for the gruel from fermented meal with added malt (FGM) and that produced from non-fermented sorghum meal (NFG). Fermentation with malt addition considerably lowered the pH and increased the TA 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.

Key Words: Sensory evaluation, malt addition, soya fortification and physico-chemical parameters.

INTRODUCTION

Ibyer, is an indigenous non-alcoholic gruel made from cereals (maize, sorghum and millet) consumed by the Tiv people in the Middle Belt of Nigeria, particularly in Benue State. It is prepared by cooking reconstituted cereal flour or wet milled paste in water. There are two types of Ibyer; the sweet type (unfermented) called Ibyer-i-nyohon and the sour type (fermented) called Ibyer-i-angen[1].

According to [2], sorghum protein is reported to be low in lysine, methionine, and tryptophan (lysine being the most limiting with a chemical score of 37) and needs to be supplemented. [3] explains that legume proteins {like soya protein) are good sources of lysine but some are low in sulphur containing amino acids (methionine, cysteine and cysteine). [4,5,6] note that because of this well known deficiency of lysine in particular and the fact that cereals are consumed in relatively large amounts by the world population, it is necessary to supplement its protein to improve the quality of those deficient to specific amino acids. Hence, nutritionally balanced local foods can be produced using cereals-legumes formulations, where they will complement each other with respect to the limiting amino acids.

African traditional cereal gruels consumed by adults and children alike, usually have low energy and nutrient density. Such bulk high fibre diet with low energy content will not provide the sufficient nutrients needed to sustain growth. Consequently, [7,8] explain that denser gruels are likely to provide children (and adults alike) with a higher daily intake of energy and proteins. Several technologies have been developed to increase the nutrient and energy density by reducing the bulk while ensuring their viscosity remains acceptable. These include the use of industrial enzymes such as amylases (or amylase-rich food), as well as natural processes of fermentation, germination sprouting [9,10].

Cereals and legumes (sorghum 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 cereal-legumes formulation and applying such technologies.

This work therefore sets out to produce sorghum gruel-Ibyer using various technologies and study the influence of fermentation, malt addition and soya fortification on its sensory and physico-chemical characteristics.

MATERIALS AND METHODS

Sorghum (*Sorghum bicolor*) and soyabeans (*Glycine maxima*) were purchased at the Wurukum market in Makurdi, Benue State.

Soya flour production
Soyabean flour was produced according to the methods described by [6,11].

Sorghum Malt Production
Sorghum malt was produced according to the method described by [9].

Production of meal formulations
Sorghum grains were cleaned /sorted manually, dehulled and split into two portions. One portion was dry-milled and sieved (500 microns) to obtain sorghum meal while malt 5% (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 soy flour in the ratio 70 30 (i.e. 70 parts sorghum meal to 30 parts soy-flour), and the other without soy-flour.

Sorghum gruels of various formulations were made using the traditional processing method as a basis.

Production of fermented and non - fermented gruel samples.
Fermented gruels
100g portions each of the respective formulated meals (FG, FSG, FGM, and FSGM) were mixed with water in the ratio 1:1½ (w/v) and allowed to ferment overnight (12 hours) at room temperature. The fermented paste was then mixed with the predetermined quantity of cooking water (400ml water per 100g portion), and poured into a cooking pot. This was cooked for 10-15 minutes with continuous stirring to prevent sticking and lump formation, after which it was poured into a clean plastic container and labeled appropriately.

Non-fermented gruels
The formulated meals (100g portion each) of NFG, NFSG, NFGM and NFSGM were also mixed with water in the ratio 1:1½ (w/v) prior to addition of cooking water (400mls) and subsequent cooking with continuous stirring for 10-15 minutes. The cooked non-fermented gruel was then poured into a clean plastic container and labelled appropriately.

QUALITY EVALUATION
Sensory Evaluation
Eight coded gruel samples were presented to fifteen semi-trained panelists comprising staff and students of the College of Food Technology, University of Agriculture, Makurdi. The samples were evaluated for taste, colour, flavour/aroma, texture and overall acceptability on a nine – point hedonic scale [4]. Results were analyzed using the ANOVA and Turkey's test was used for mean separation [12]. The five most acceptable gruel samples were then reproduced for further evaluation.

Physico-chemical evaluation
The viscosity was determined using Brookfield Viscometer [13[, pH and titratable acidity using method of [10]. The total solids (TS), total soluble solids (TSS), and bulk density (BD) as described by [14].

RESULTS AND DISCUSSION

TABLE 1: MEAN SCORES FOR SENSORY EVALUATION OF GRUEL SAMPLES

Gruel Sample	Taste	Colour	Sample means Flovour Aroma	Texture	Overall Acceptability
NFG	5.3^a	5.3^b	5.9^a	4.9^a	5.5^a
FG	5.4^a	5.3^b	6.3^a	5.3^a	5.7^a
NFSG	4.9^b	4.9^b	5.7^a	5.4^a	4.9^a
FSG	4.0^b	5.5^b	5.5^a	5.9^a	5.1^a
NFGM	4.5^b	4.8^b	5.5^a	5.5^a	4.4^a
FGM	6.6^a	7.7^a	6.3^a	5.9^a	6.8^a
NFSGM	5.4^a	5.7^b	6.3^a	5.7^a	5.2^a
FSGM	4.2^b	5.5^b	5.2^a	4.9^a	5.4^a

Means not following by the same superscript in the same column are significantly 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

DISCUSSION

Sensory evaluation

The results of sensory evaluation are shown in Table 1 above. There is a significant difference at 5% level among the gruels in terms of taste and colour. The results show 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 is no significant difference in the flavour/aroma, texture and overall acceptability of the gruel samples at 5% level. Thus the samples were similar in flavour/aroma, texture and overall acceptability ($P < 0.05$).

TABLE 2: RESULTS OF PHYSICO-CHEMICAL EVALUATION

Gruel Sample	pH	Titratable acidity (as % lactic acid)	Viscosity (cps)	Total Solid (%)	Total Soluble Solid (%)	Bulk density (g/cm^3)
FG	5.69^a	0.15^c	244^b	17.2^c	7.8^c	1.17^c
FSG	5.61^{ab}	0.24^b	250^a	17.8^c	7.9^c	1.16^d
FGM	4.88^b	0.31^a	243^b	19.4^b	10.5^a	1.25^b
NFG	6.16^a	0.14^c	243^b	16.4^d	8.2^{bc}	1.09^e
NFSGM	6.13^a	0.22^b	242^b	20.6^a	8.6^b	1.28^a

Means 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.

Physico-chemical evaluation

The results of physico-chemical analysis of the gruel samples are as shown in Table 2 above. These include the pH, titratable acidity, viscosity, total solids, total soluble solids and bulk density.

There is a significant difference ($P \leq 0.05$) in the pH of the gruel samples, which ranged from 4.88 to 6.16. The pH of samples FG, NFG, NFSGM and FSG are not significantly different from one another i.e they are similar. However, sample FGM is significantly different (more acidic) from others except FSG. The fermented gruel samples had lower pH values than the unfermented ones. Consequently, the acid content (titratable acidity) was also lower in the unfermented samples. This is due possibly to the production of organic acids from fermentable sugars during the fermentation. Such trend has also been reported by [10] where pH of fermented maize-cowpea weaning blends ranged between 4.4 - 5.3 and the unfermented 6.6 – 6.8. Also, unfermented sorghum flour has been reported to have pH of 6.5 (titratable acidity 0.30) while fermented ones ranged from 3.6 – 4.6 (titratable acidity 0.86 – 1.13). [1] also reported pH values of 3.8, 3.9, 4.4, and 4.4 for sunfermented, room-fermented, room-fermented and boiled as well as sun fermented and boiled gruels *(Ibyer)*.

There is a significant difference in the titratable acidity of the gruel samples ($P < 0.05$). Sample FGM has a significantly higher acidity than the other samples. Samples FSG and NFSGM are not significantly different and are therefore of similar level of acidity while, samples NFG and FG are also of similar (lower) titratable acidity. Sample FGM was found to have the lowest pH (4.88) and highest titratable acidity (0.31). This can be attributed to the cumulative effect of malt addition and fermentation and would help improve keeping quality of gruel by controlling microbial activity. It has been reported that fermented foods with low pH have some antimicrobial activities [15].

There is a significant difference in the viscosity of the gruels (P 0.05). Sample FSG which is the most viscous is significantly different from all others in terms of viscosity. However, other samples are similar since they are not significantly different from one another. Those with added malt (i.e FGM and NFSGM) had lower values (243 and 242), meaning that they are slightly less viscous than the other samples. [16] also reported that apparent reduction in viscosity was better with gruels prepared with ARF treatment (i.e added malt) than with gruels from unfermented flours. The soya- fortified fermented gruel (FSG) had the highest viscosity (250 cps) most likely due to the added bulk contributed by the soya-flour. [15] however, reports lower viscosity in porridge cooked from fermented cassava flour than the product from unfermented flour. This is due 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 [15]. They add that effective increases in energy density are associated with reduction in viscosity.

There is a significant difference in the total solids content of the gruels at 5% level with sample NFSGM having the highest TS followed by FGM, which are both significantly different from each other and from all other samples. However, samples FG and FSG are similar and are better than sample NFG. The gruels are significantly different ($P \leq 0.05$) in terms of TSS content. Sample FGM has the highest (10.5%) and is significantly different from the other samples, while samples NFG and NFSGM are not significantly different from each other. NFG is also similar to samples FG and FSG which both have similar TSS content and are therefore not significantly different at 5% level.

The total solids and total soluble solids content also has the same trend as the gruel viscosities. Samples FGM and NFSGM were found to have total solids and total soluble solids contents of 19.40 and 10.5; and 20.6 and 8.6 respectively exceeding 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 are all significantly different from one another ($P \leq 0.05$). The best being sample NFSGM, followed by FGM, FG, FSG and NFG respectively. The bulk density ranged from 1.09 g/cm3 for the non-fermented gruel sample (NFG) to 1.28 g/cm3 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.

CONCLUSION

Based on the results obtained above, it can be deduced that:

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.

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