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Proximate Composition, Microbial Quality and Consumer Acceptability of Gruel from Fermented Maize and Soybean

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ABSTRACT

Gruel is an acid-fermented cereal food product mostly made from maize and wrapped in banana leaves. This study was aimed at producing an enriched gruel from maize by incorporating soybean. Maize and soybeans pastes were mixed in ratios of 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 to produce maize-soy gruel. Proximate, sensory and microbial analyses were carried out on the samples using standard methods. The proximate result shows that moisture content decreased from 35.22% in 100:0 to 25.97% in 50:50 maize-soy gruels. Protein content increased from 6.56% in 100:0 to 14.84% and 16.75% in 60:40 and 50:50 maize-soy ratio respectively. The carbohydrate content decreased from 55.01% in 100:0 to 47.92% in 60:40 maize-soy ratios while the ash content, fat content and crude fiber content increased from 100:0 maize to 50:50 maize and soybeans with values of 1.21% to 3.77%, 1.25% to 4.88% and 0.74% to 2.71% respectively. The maize-soy of 100:0 and 80:20 were highly acceptable by the sensory evaluators whereas addition of soybeans up to levels above 20% affected the colour of the samples. The microbial load of the samples stored at room temperature increased with increasing soybeans composition with values ranging between 3.0 x 105 to 26.0 x 105 cfu/g for bacterial count and 4.0 x 105 to 24.0 x 105 cfu/g for mould count. This work has shown that maize-soy gruel will make a balanced meal that is affordable and acceptable to the consumers..

Keywords: acceptability; gruel; maize; proximate; soybeans

INTRODUCTION

Gruel is a white thin or cream coloured traditionally prepared fermented food product made majorly from cereals especially maize which can be consumed as a whole or using stew or other food products (Abdulrahaman and Kolawole, 2006). It is commonly consumed in West Africa mostly in Nigeria. The organisms responsible for its fermentation are lactic acid bacteria, *Lactobacillus plantarum*; the aerobic bacteria, Corynebacterium and Aerobacter, the yeasts Candida mycodema and *Saccharomyces cerevisiae*. (Odunfa and Oyewole, 1998). It is a good source of carbohydrate which is mostly packaged in banana leaves (Musa spp) but majority use the leaf Thaumatocococcus daniella normally used to wrap moinmoin (depending on your locality) to obtain a characteristic doomed shape. It has recently been wrapped in polythene bags.

In Nigeria, maize is known and called by different vernacular names 'masara' (Hausa); 'agbado' (Yoruba); 'oka' (Ibo); 'apaapa' (Ibira); 'oka' (Bini and Isha); 'ibokpot' (Efik) and 'igumapa' (Yala). Reports showed that maize contains 80% carbohydrate, 10 % protein (although deficient in lysine and tryptophan, but has fair amounts of sulphur-containing amino acids), 3.5% fiber (soluble and insoluble) and 2% mineral. Iron and Vitamin B are also present in maize. Maize is high in both soluble and insoluble fiber. Maize protein is deficient in lysine and tryptophan, but has fair amounts of sulphur-containing amino acids (IITA 2001).

Maize is most popularly consumed as fermented gruel 'ogi' (Aminigo and Akingbala, 2004) but which has low nutritional value as they are not adequate sources of micro and macro nutrients (Fasasi *et al*., 2006). Substantial nutrient losses occur during the various steps of ogi processing. The situation is even made worse by the method of its processing which involves wet milling, wet sieving and several washings which deplete it of even the little nutrients contained and therefore incapable of supporting growth and good health of the people (Otunola *et al*., 2007). Much of the protein in cereal grains is located in the testa and germ which are usually sifted off during processing (Aminigo and Akingbala, 2004).

Soybean (US) or soya bean (UK) (*Glycine max*) assumed to be a source of complete protein, is a species of legume native to Southeast Asia, widely grown for its edible bean which has numerous uses such as a substitute for expensive meat and meat products. (Adelakun *et al*., 2013). In addition to its high food value, it is one of the least expensive sources of protein when compared to eggs, milk, beef and cowpea. They contain proteins which provide all the essential amino acids in the amounts needed for human health. Most of the essential amino acid present in soybean is available in an amount that is close to those required by animals and humans (Adelakun *et al*., 2013).

Efforts have been made to modify the processing of foods with a view of enhancing their nutritive value, shelf life and possible therapeutic qualities. Such effort include s but not limited to fortification of foods with legumes in enrichment processes (Osundahunsi and Aworh, 2003). Soybeans has been used to fortify foods such as kunun zaki (Ayo and Gaffa, 2002); tapioca flour (Samuel *et al*., 2006); tortilla (maize product) (Obatolu *et al*., 2007); Hausa koko (Owusu-Kwarteng *et al*., 2010); tapioca meal (Balogun *et al*., 2012) and gari (Ogunlakin *et al*., 2015; Karim *et al*, 2015).

The production of gruel from maize and soybeans is a way of increasing the utilization of soybeans at the household level and providing a complete meal for consumers. Therefore, this work is designed to produce gruel from different maize-soy ratios and determine the proximate and microbiological compositions as well as assessing the consumer acceptability of the samples.

MATERIALS AND METHODS

Materials

The white maize (*Zea mays*), soybeans (*Glycine max*) and banana leaves (for packaging) were purchased from a local market in Ilorin, Kwara State, Nigeria.

Methods

The maize-soy gruel was prepared in the Home Economics and Food Science kitchen of the Department of Home Economics and Food Science, University of Ilorin in a hygienic manner according to the method of Omemu, (2011). The maize was soaked for 72h in clean water at room temperature (27 ± 2^0C) to initiate fermentation. The steep water was decanted while the fermented maize grains were washed with clean water and then wet-milled using a fabricated attrition mill (Sanzid Nig Ltd) to obtain a white coloured maize paste. The maize paste was then mixed with water and wet-sieved using muslin cloth to remove the shaft or bran. The sievate was left to settle beneath the mixture for another 48h during which fermentation proceeds in the process known as souring. The soybeans were sorted by handpicking to remove unwanted materials such as stones, threads, pebbles, broken beans, spoilt beans etc. while the soy-paste was prepared according to the method of Nwosu *et al.* (2014) with slight modifications. The sorted beans were boiled for 45min to reduce the antinutrional factors in them and to facilitate easy dehulling. The soybeans were then dehulled and wet milled to obtain soybeans paste.

The maize-soy gruel was thereafter prepared according to the method of Adesokan *et al.* (2011) with slight modification. The maize and soy pastes were mixed together at different proportions (100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 respectively). The mixture was poured in boiled water, stirred to obtain a custard-like semi-solid product. Water was then added at the sides of the gruel and left for 10min to mix properly with the water. After stirring, the gruel obtained was packaged in banana leaves and left to cool in order to obtain the doomed shape.

Proximate Analysis

Proximate analysis (crude protein, crude fat, ash, moisture, crude fiber) was determined as described by AOAC (2000) methods while carbohydrate content was obtained by difference.

Microbial Analysis

Agar Preparation

Nutrient agar (NA) and Potato Dextrose Agar (PDA) were prepared according to manufacturer's instruction. 28g of NA and 40g of PDA were weighed into separate beakers and each dissolved in 1L of distilled water, the mixture was thoroughly mixed and sterilized using the autoclave at 121°C for 15 min.

Microbial Examination of Samples

One gram of the gruel sample was added to 10ml of sterile water in sterile test tube and was shaken properly. 1 ml from the first test tube was transferred to 9 ml of sterile water and shaken properly to achieve solution of 10^{-1} dilution. 1 ml from the 10^{-1} solution was then transferred to 9 ml sterile water in another sterile test tube to achieve 10^{-2} and the procedure was repeated until 10^{-5} solution for both bacterial and fungal analysis. The microbial examination was performed according to method described by Barnett *et al.,* (2000) with slight modification. The pour plate technique was used. 1 ml each from 10^{-3} and 10^{-5} were dispensed into sterile petri dishes using sterile pipettes. Cooled, molten sterile NA and PDA were poured separately to cover the mixture in the petri dishes and swirled. The petri dishes were left for some minutes to solidify. After solidifying, the plates for bacterial examination were inverted and incubated at temperature of 36^0C for 24 h while those for fungi were incubated at ambient temperature (27 ± 2^0C) for 72 h. The colonies were counted after incubation using the colony counter.

Sensory Evaluation

Sensory evaluation of maize-soy gruel was carried out by a fifteen-man panel comprising people who are familiar with the product. The parameters evaluated were colour, aroma, taste, texture and overall acceptability using a 7-point hedonic scale. The rating of samples ranged from 1(like extremely) to 7(dislike extremely).

Statistical Analysis

Proximate composition data were obtained in triplicates and expressed as mean ± standard deviation. All data obtained were analyzed using one way Analysis of Variance (ANOVA) and the means separated using Duncan Multiple Range Test.

RESULTS AND DISCUSSION

The result of the proximate analysis carried out on the gruel samples are reported in Table 1. The moisture content in maize-soy gruel are as follows; 35.22%, 33.69% , 31.10%, 29.85% , 27.96% and 25.97% for

100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 maize-soybean respectively. Soybean has been reported to have a high water absorption capacity (Ribotta *et al.,* 2005; Samuel *et al.*, 2006). However, the values of the moisture content obtained in the present study are higher than 8.8-8.9% reported by past study (Ijarotimi and Famurewa, 2006) for soy-maize flour.

Soybeans addition undoubtedly increases protein content of any food product of its inclusion. For 6.56% protein content was recorded for 100%:0 while 90:10, 80:20, 70:30, 60:40 and 50:50 maize-soybean had 8.72, 10.83, 12.78, 14.84 and 16.75% respectively. A similar increase of values ranging from 10.85 to 20.48% has been reported for soy–maize snacks (Lasekan and Akintola, 2002), soy fortified kunun zaki (Ayo and Gaffa, 2002; Ijarotimi and Famurewa, 2006) and soy-fortified custard (Okoye and Mazi, 2011). This is a desirable attribute especially for a developing country like Nigeria where other sources of protein are relatively expensive.

There was increase in fat content on addition of soybeans in the gruel samples 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 maize-soybean having 1.25, 2.29, 3.58, 3.95, 4.32 and 4.88% respectively. The present result is in correlation with fat content (0.97 to 4.52%) reported for tapioca-soybean fortified flour (Samuel *et al.*, 2006). The ash content of maize-soy gruel ($p < 0.05$) significantly increased from 1.21% in 100:0 to 3.77% in 50:50 maize-soybean samples. This is due to the fact that soybeans are rich in minerals. Okoye and Mazi, (2011) reported similar findings in the production of soy fortified custard with values ranging from 3.45 to 6.02%. However the crude fiber content varies considerably with increasing soybean inclusions. This ranges from 0.74% in 100:0, 1.18% in 90:10, 1.50% in 80:20, 1.79% in 70:30, 2.15% in 60:40 and 2.71% in 50:50 maize-soybean. This same variation has been previously observed in past research work (Ijarotimi and Famurewa, (2006).

Meanwhile the carbohydrate content of the 100:0, 90:10, 80:20, 70:30, 60:40 and 50:50 maize-soybean are 55.01, 52.26, 50.86, 48.87, 47.92 and 46.51% respectively. This is showing a decreasing trend in the gruel sample as proportion of soybean flour increases. The present result is lower than those (64.73 - 73.86%) by previous works consistent with previous works (Lasekan *et al.,* 2004; Samuel *et al.*, 2006; Okoye and Mazi, 2011).

The sensory evaluation result of the gruel samples are presented in Table 2. The result showed no significant difference in the colour between samples M and MSA and samples MSB and MSC whereas significant difference was observed between samples MSB and MSD as well as samples MSD and MSE. Samples MSD and MSE were the least preferred in terms of colour with a mean value of 3.06 and 3.33 respectively while samples MSB and M were most preferred with mean values of 1.73 and 2.00 respectively. Similar low sensory scores for colour of soy-fortified kunun zaki and soy-warankashi have been reported (Aworh *et al.*, 1987; Ayo and Gaffa, 2002).

Table 1: Proximate composition (%) of maize-soybean gruel.

Sample	Moisture	Crude protein	Crude fibre	Ash	Crude fat	Carbohydrate
M	35.22 ± 0.01^{a}	6.56 ± 0.01^{f}	0.74 ± 0.01^{f}	1.21 ± 0.01^{e}	1.25 ± 0.0^{f}	55.01 ± 0.04^{f}
MSA	33.69 ± 0.01^{b}	8.72 ± 0.01^{b}	1.18 ± 0.01^{e}	1.86 ± 0.01^{d}	2.29 ± 0.01^{e}	52.26 ± 0.01^{e}
MSB	31.10 ± 0.01^{c}	10.83 ± 0.01^{d}	1.50 ± 0.01^{d}	2.13 ± 0.01^{c}	3.58 ± 0.02^{d}	50.86 ± 0.02^{d}
MSC	29.85 ± 0.02^{d}	12.78 ± 0.02^{c}	1.79 ± 0.02^{c}	2.44 ± 0.01^{b}	3.95 ± 0.01^{c}	48.87 ± 0.04^{c}
MSD	27.96 ± 0.02^{e}	14.84 ± 0.02^{b}	2.15 ± 0.03^{b}	2.95 ± 0.01^{a}	4.32 ± 0.02^{b}	47.92 ± 0.04^{b}
MSE	25.97 ± 0.01^{f}	16.75 ± 0.01^{a}	2.71 ± 0.01^{a}	3.77 ± 0.01^{a}	4.88 ± 0.01^{a}	46.51 ± 0.04^{a}

Values represent means of triplicate determinations. Means within a column with different superscripts are significantly different at $P < 0.05$. where M- 100% maize; MSA- 90% maize and 10% soybeans; MSB- 80% maize and 20% soybeans; MSC- 70% maize and 30% soybeans; MSD- 60% maize and 40% soybeans; MSE- 50% maize and %50% soybeans

Table 2: Sensory evaluation of maize-soybean gruel.

Sample	Colour	Taste	Aroma	Texture	Overall acceptability
M	2.00^{bc}	1.93^{c}	2.67^{b}	2.07^{b}	2.13^{b}
MSA	2.13^{bc}	2.40^{c}	2.87^{ab}	2.53^{ab}	2.47^{b}
MSB	1.73^{c}	1.87^{bc}	2.27^{b}	2.00^{b}	2.13^{b}
MSC	2.60^{abc}	2.20^{bc}	2.27^{b}	2.27^{b}	2.27^{b}
MSD	3.06^{b}	3.31^{ab}	2.94^{ab}	3.87^{a}	3.12^{ab}
MSE	3.33^{a}	4.00^{a}	4.00^{a}	3.38^{b}	3.93^{a}

Values represent means of triplicate determinations. Means within a column with different superscripts are significantly different at $P < 0.05$. where M- 100% maize; MSA- 90% maize and 10% soybeans; MSB- 80% maize and 20% soybeans; MSC- 70% maize and 30% soybeans; MSD- 60% maize and 40% soybeans; MSE- 50% maize and %50% soybeans

Table 3: Total viable count of mesophilic bacteria on sample (cfu/g x 10^5).

Sample	Storage period (days)			
	1	2	3	4
M	3	9	21	31
MSA	7	12	25	36
MSB	10	17	32	44
MSC	15	23	38	52
MSD	19	28	46	58
MSE	26	35	52	66

where M- 100% maize; MSA- 90% maize and 10% soybeans; MSB- 80% maize and 20% soybeans; MSC- 70% maize and 30% soybeans; MSD- 60% maize and 40% soybeans; MSE- 50% maize and %50% soybeans.

Table 4: Total mould count on sample (cfu/g x 10^5)

Sample	Storage period (days)			
	1	2	3	4
M	4	9	19	25
MSA	6	12	28	41
MSB	9	19	35	52
MSC	11	25	46	55
MSD	16	33	57	64
MSE	24	47	65	74

where M- 100% maize; MSA- 90% maize and 10% soybeans; MSB- 80% maize and 20% soybeans; MSC- 70% maize and 30% soybeans; MSD- 60% maize and 40% soybeans; MSE- 50% maize and %50% soybeans.

This low preference could be as a result of the off-colour effects of soybeans on the final food products. The result showed no significant difference between the taste of samples M and MSA, samples MSB and MSC and between samples MSD and MSE. Samples M and MSB were mostly preferred in terms of taste with mean values 1.93 and 1.87 respectively while sample MSE was the least preferred with mean value of 3.31. This may be as a result of the increase in soybeans incorporated to the gruel samples. Past study (Ijarotimi and Famurewa, 2006) has also noted the same observation. Samples MSB and MSC were mostly preferred while sample MSE was the least preferred in terms of aroma with mean values of 2.27, 2.27 and 2.94 respectively. This could be due to carry-over of the beany aroma which could be attributed to the presence of soybean fats as that possess the flavoring compounds (Owusu-Kwarteng *et al*., 2010). The texture of sample MSB is the most preferred while the least preferred sample is sample MSE with mean values of 2.00 and 3.38 respectively. The overall acceptability of the products shows that sample MSB was mostly preferred while sample MSE was least preferred of all the samples as also observed in the report past study (Ijarotimi and Famurewa, 2006).

Tables 3 and 4 shows the total viable counts of mesophilic bacteria and mould counts for the samples during storage at room temperature. There was increase in the number of microorganisms as the storage days increased. Increase in growth rate of these microorganisms may be attributed to nutrient availability for the microorganisms, which are enormous in the gruel samples due to its composition. For instance soybean has been as a rich medium containing proteins, vitamins and importantly fermentable sugars such as sucrose and the oligosaccharides raffinose and stachytose that could aid microbial growth (Adesokan *et al*., 2011).

CONCLUSION

Consumption of maize-soy gruel should be encouraged as it is of good nutritional value and a complete meal. The sample with 80% maize and 20%soybeans was the most preferred according to the sensory evaluation (final consumer perception), therefore, maize-soy gruels of acceptable quality may be prepared with up to 20% soybean paste

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