EFFECT OF SOYMILK SUBSTITUTION ON THE QUALITY PROPERTIES OF MALTED MAIZE BEVERAGE DRINK

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ABSTRACT

The effects of substituting soy milk with a malted yellow corn-based beverage were evaluated. The mixture of soy milk and malted yellow corn was formulated. 100% soy milk, 0% malted yellow corn as sample A, 90% soy milk, 10% malted yellow corn as sample B, 80% soy milk, 20% malted yellow corn as sample C, 70% soy milk, 30% malted yellow corn as sample D, and 60% soy milk, 40% malted yellow corn as sample E. The blends were evaluated for proximal, functional, microbial, and sensory attributes and compared with the control made from 100% soy milk using standard methods. The proximal composition of the blend showed that the moisture content of the blended beverage ranged from (80-85.8) %, protein from (3.80-4.28) %, ash content from (1.15-1.80) %, crude fat from (1.63-2.93) %, and carbohydrate from (2.48-13.01) %. Total titratable acidity ranged from (0.030-0.65). The viscosity of the slurry beverage mixture ranged from 1.75 to 11.00. PH values ranged from 5.0 to 9.66. The microbial load ranged from (3.36x10^4- 5.33x10^6). For total fungi, sample B has the highest fungal count. There is no significant difference (p<0.05) in the number of fungi in all samples. Similarly, significant differences (p<0.05) existed in the sensory scores of flavor/aroma, texture, taste, and overall acceptability, except (p<0.05) for appearance. All samples were generally acceptable in terms of sensory quality. Malted corn-based beverage replaced with soy milk could be used to alleviate hidden hunger, especially in rural communities.

Keywords: Soymilk, substitution, malted maize, beverages, drink, quality

INTRODUCTION

Soybeans are valued for their many qualities. It plays an important role in agriculture, trade and nutrition. It is an excellent source of protein, which is why the seed is the richest in nutritional value of all plant foods consumed in the world. It is used in fresh, fermented or dried form as flour, oil and condiment and for enrichment or fortification. It is rich in protein, calcium, phosphorus, iron and vitamins (**Ahsan et al., 2020, 2021).** Soy is the only vegetable source that contains all the essential amino acids. However, it is a poor source of vitamin C. Soybeans contain certain biologically active substances, called anti-nutritional factors, such as lecithin, trypsin, inhibitor, phytic acid, goitrogen and urea, which are water-soluble and heat-labile and therefore destroyed during processing. The hull is used as animal feed, while the meal can be used to enrich other foods and the residue can be used to make soups. Soy milk is a beverage made from soybeans. A traditional staple of Asian cuisine, it is a stable emulsion of oil, water and protein. Plain soy milk is unsweetened, although some soy milk products are sweetened. Salted soy milk is also consumed in China (**William and Akiko, 2000).**

The proteins are rich in lysine but poor in methionine (**Pamplona-Roger and George, 2007).** Fortification of soy milk with other nutrients found in corn and millet can be used to correct nutrient deficiencies in the products (**Marero et al., 1989).** There was an increase in lysine, tryptophan, and methionine in sprouted corn compared to unsprouted grain, as well as a reduction in viscosity. The consumption of grain-based food products from maize and millet is very common and popular worldwide, especially in developing African countries where they are a major source of their staple foods (**Gernah et al., 2011**). With total world cereal production estimated at 784 million tons in 2007, these crops, particularly maize and millet, are widely grown and produced in significant quantities per year in most developing African countries (**FAOSTAT, 2005**).

Maize grains are rich in carbohydrates and also contain significant amounts of beta-carotene (**Ingbian and Oduyela, 2010**). Due to the unfavorable economic conditions prevailing in most developing countries of the world, especially in Nigeria where over 40% of the population lives below the poverty line (**Nzeagwu and Nwaeijike, 2008**). The incidence of protein-energy malnutrition in different age groups, especially among children, is widespread and increasing daily (**Orji, 1994; Oosthuizen et al., 2006; Agiriga and Iwe, 2008**).

This can be attributed to the fact that the ever-increasing population feeds mainly on their staple food crops (maize, millet, soybean, cassava) which have been reported to be poor sources of protein (**FAO, 1995; Labadarious et al., 2005**). This is not the case for protein sources, especially in terms of amino acid balance, but for carbohydrate-rich sources, especially starch. However, empirical evidence has shown that there is a strong positive relationship between good nutrition and the mental, physical and cognitive development of children in general, as well-nourished children are strong and healthy, have increased intellectual capacity and high school performance with reduced mortality and disease (**Chandhari, 2008**). Malting has proven to be one of the most effective and practical ways to improve the nutritional value of cereals (**Adeyemo et al., 1992; Gernah et al., 2011**).

In addition, there is a growing interest in formulating food products using the combination of composite mixtures of malted cereals and legumes as a means to improve the nutritional quality of products suitable for children (**Agu and Aluya, 2004**). The processing of cereals and legumes (through malting) and the formulation of intermediate products into nutritious mixtures that complement each other, especially in terms of essential amino acids, have been reported by

several authors (**Alabi and Anounye, 2007**). Similarly, the use of legume meal to improve the protein quality of cereal and tuber meal in different food formulations has been studied and reported by various researchers (**Iwe, 2001; Nnam, 2003; Agiriga and Iwe, 2008**).

These studies have focused on the production of fortified breakfast meals, cookies and soft drinks. The consumption of cereal-based drinks across all age groups is very common in Nigeria and some West African countries for its thirst-quenching and satiating properties (**El-Mahmood and Doughari, 2007**). However, the need to formulate and develop a high protein and energy drink for school children cannot be overemphasized as it is hoped that it will help to alleviate the endemic problem of protein energy malnutrition among school children, since most processed and packaged drinks available in Nigeria cannot be classified as high protein and energy products. In addition, efforts in developing countries have been directed towards improving the quality of protein foods by using mixtures of legumes and cereals to form a more nutritionally balanced product in which this work fits.

MATERIALS AND METHODS

Materials

The soybean, yellow maize and millet varieties used in this study were obtained from Wurukum market in Benue State. Other materials used were dried net, plastic bowl, pot, hammer mill, roller mill, sieve, gas stove, granulated sugar and food flavoring obtained from Makurdi modern market and drinking water was obtained from Makurdi University of Agriculture.

Methods

Malting of yellow corn

Using the modified method of (**Osho, 1991**), the grain was cleaned manually to remove stones and dirt. Cereals were washed in 5% (w/v) sodium chloride (NaCl) solution to suppress mold growth and then soaked in portable water at room temperature (30+20C) at a ratio of 1:3 (w/v) grains/water in a plastic container. The water was changed every 3 hours (to prevent fermentation) for a total period of 9 hours, after which the grains were drained and subjected to a 48-hour malting period. After 48 hours of germination, germination was stopped by drying in the cabinet dryer at 450C for 24 hours and then manually uprooted before being dry milled into flour using the Apex hammer mill (Model No: 114S2/FLP) to obtain the corn and millet malt flour. Malt extraction from the malted grains was performed by adding 2.5 liters of water at 42-450C to 1kg of each malt flour with stirring for 20-30 minutes for each malt flour produced in this study. The extract was obtained after decanting the surface water.

Product mixture

The product formulation used in this study is shown in Table 1. The milk obtained from samples B, C, D, and E was mixed with sample A (soy milk) in a bowl. The mixture was sieved, boiled (10-20 minutes) to prepare a paste (which was continuously stirred to avoid lumps) from the milk. Added food flavouring (0.25 g) and table sugar (50 g) were incorporated into the mixtures to improve the organoleptic qualities of the developed beverages which are referred to as soy milk malt in this study. Finally, the mixture was allowed to cool for a few minutes and filled into a bottle.

Table 1 Blends Formulation of Soymilk and Malted Yellow Maize for Beverage Drink

sample	Soymilk	Malted yellow maize	Blend composition
A	100	0	100%:0%
B	90	10	90%:10%
C	80	20	80%:20%
D	70	30	70%:30%
E	60	40	60%:40%

Keys;
A=100% Soy milk:0% malted yellow maize
B=90% Soy milk:10% malted yellow maize
C=80% Soy milk:20% malted yellow maize
D=70% Soy milk:30% malted yellow maize
E=60% Soy milk:40% malted yellow maize

Production of soybean milk

Soybean was produced using the modified method of (**Giesinde *et al*., 2008**) with small modifications. Healthy soybeans obtained from Wurukum market in Makurdi were cleaned to remove stones, dirt and washed. The soybeans were then pressure cooked with 0.1% sodium bicarbonate for 15 minutes, drained, manually depelleted, and then wet milled (1000 g cooked soybeans to 250 ml water) to a paste using a heavy duty blender (Waring blender, model CB15, serial

number 556973). The milk was then extracted from the paste by filtration through a muslin cloth using one-part paste to four parts water. Figure 1 below shows the flow chart for the production of soy milk.

Protein determination

Two grams of yellow malted corn milk and nutsedge were measured into a Kjedhal digestion tube and 15 ml of tetraoxosulfate (IV) acid (conc.H2SO4) was added for rapid dissolution. Kjedhal catalyst was added to accelerate the process which then yields a clear solution. Distilled water (75 ml) was added to the tube after digestion, the mixture was distilled to 50 ml using dilute 40% NaOH solution and then into 25 ml of 40% boric acid. The mixture was titrated with 0.47 M HCl to the first gray color. A blank titer was titrated and the value was recorded (**AOAC, 2012**).

$$\% \, Total \, Nitrogen = \frac{Titre \, value \, \times 14.01 \, \times 0.47}{Weight \, of \, sample \, \times 100}$$

$\% \, Protein = Total \, nitrogen \, \times conversion \, factor$
$Molecular \, weight \, of \, Nitrogen = 14.01$
$Molarity \, of \, HCl = 0.47$
$Conversion \, factor = 6.25xN$

Ash Content

Two gramms (2 g) of beverage blend samples was measured into an empty porcelain ignitable crucible that was ignited, cooled and measured. The sample was ignited over a hot plate in a fume cupboard to char organic matter. The ignitable crucible was placed in the muffle furnace maintained at $600°C$ for 6 hr. After ash, it was then cool in a desiccator and measured (**AOAC, 2012**).

$$Ash = \frac{(Weight \, of \, the \, crucible \, + Ash) - (Weight \, of \, empty \, crucible) \times 100}{Weight \, of \, sample}$$

Crude Fat

The method of the AOAC. (2012) was used. The empty soxhlet die was measured as W1. Five (5) grams of dried sample was then added and measured as (W2). The soxhlet bottom flask was cleaned and measured empty as (W3), then filled with petroleum ether to three quarters of the flask. The Soxhlet extractor was attached with a condenser to adjust the heat sources so that the solvent boiled gently. The thermowell containing the sample solution was then placed in the Soxhlet apparatus and the extraction was performed for 6 hours. At the end, the vial containing the oil was dried in a hot air oven for one hour at 100°C to remove traces of water and solvent. Then it was cooled and weighed as (W4).

$$Percentage \, Fat \, content = \frac{W4 - W3}{W2 - W1} \times 100$$

W_1 = Empty thimble
W_2 = Thimble and sample before extraction
W_3 = Empty round bottom flask
W_4 = Flask and extracted oil

Crude fiber determination

Crude fiber content was analyzed using the **AOAC (2012).** Two (2) grams of beverage sample was measured and placed in a 250 ml beaker. The mixture was boiled for 30 minutes with 100 milliters of H2SO4 at a molar concentration of 0.12 and then filtered. The filtrate was washed with boiled water until no acidic traces were detected. This procedure was performed twice and filtered with hot water and methylated spirits three times. The residue was transferred to a flammable crucible and dried in the oven at 1030C for 1H. The crucible with its contents was cooled in a desiccator and then weighed as (W1). The residue was then introduced into an oven to be ashed at 600C for 1H. The ashed sample was removed from the furnace and placed in a desiccator to cool and measured as (W2).

$$Crude \, Fiber = W1 - W2$$

Where:
W_1 = crucible and residue, W_2 = final ash sample

Carbohydrate content determination

The carbohydrate content of each of the samples was obtained by difference according to (**Ihekoronye and Ngoddy, 1985**). That is, the difference between the total summation of percentage moisture, fat, ash, crude fibre, crude protein from 100g.

$$\%\,Carbohydrate = 100 - (Moisture + Protein + Fat + Ash + Fibre)\%$$

Functional Properties

pH Measurement

A 10% w/v suspension of each sample in distilled water was prepared. The suspension was mixed thoroughly with a stirrer and the pH measured with a digital pH meter.

Viscosity

The apparent viscosity of the slurries was determined using the method described by [7]. The samples were dissolved in 200ml of distilled water on a 5.0% (W/V) basis and allowed to remain at room temperature with constant agitation for one hour. Viscosity was the n measured using a viscometer.

Total Acidity

The total acidity was determined according to AOAC (2012), official method by direct titration of 2g o the puree with 0.1m sodium hydroxide using phenolphthalein as indicator. The total acidity (as % citric acid) was calculated as follows:
Citric acid % = Mole of NaoH x Vol. of (Base) x Mole Mass (acid) x 100 Milliequivalent of acid x volume of sample

Total solid determination (Ts)

Total solid was determined grammatically using the method by (**Chandhari 2008**). A measured weight of each test sample was put in a previously weighted evaporating dish and evaporated to dryness over a steam bath. It was then dried in an oven at 105^0C for an hour. It was cooled in desiccators and then reweighted by difference, and the dry weight of the sample was obtained and expressed as percentage of the sample weight. The formula below used in detecting the total solid and subsequence the moisture content.

$$\%Ts = \frac{W_2 - W_1}{W}$$

Where: w=Weight of sample analysed (mg)
W1=Weight of sample evaporating dish
W2= Weight of dish + dry sample
Subsequently, % moisture content = 100- total solid

Microbiological analysis

Determination of yeasts, moulds and bacteria

Sample preparation by serial dilution: MaConky bottles were sterilized, arranged and labelled 10-1 appropriately. 9.0ml of peptone water was poured into the bottles. 1ml of the samples was taken from the first bottle and transferred to another bottle containing peptone water and labelled. Using another pipette, the contents of the first dilution were taken and transferred to the second bottle and labelled 10-2, this was repeated four times.
Preparation of media for total plate count: 28g of nutrient agar powder was weighed and added to deionized water in a volumetric flask to 1 liter and mixed. The whole was heated gently to boiling and then sterilized in the autoclave at 15psi at 121 degrees centigrade for 15 minutes.
Preparation of media for molds and yeasts: Sabourand dextrose ager was prepared for the determination of molds and yeasts. 62g of Sabourand dextrose ager was suspended in 1 liter of deionized water and soaked for 10 minutes in a volumetric flask, mixed and sterilized by autoclaving for 15 minutes at 121 degrees centigrade, cooled to 47 degrees centigrade.

Determination of total plate count

1 ml of the prepared samples was poured into a dish, 15 ml of solid anger medium was poured into a Petri dish and allowed to form a gel, this was done in duplicate. The plates were incubated at 370C for 24-48 hours. Colonies were counted per plate using a manual magnifying glass as described by (**Adegoke, 2004**).

Determination of moulds and yeasts

1ml of the prepared serial dilution was placed in a Petri dish and 15ml of sabourand dextrose agar was poured in and allowed to gel, then incubated at 370C for 24-48 hours.

Statistical analysis

All data obtained were subjected to one-way analysis of variance (ANOVA), and Turkey's statistical test was used to separate the means. A probability of $P<0.05$ was considered statistically significant (**Ihekoronye and Ngoddy, 1985**).
Results and Discussion

Proximal composition of the malted yellow corn soymilk beverage

The data presented in Table 4 shows the chemical composition of the mixture of soy milk and malted yellow corn in different proportions. The water content ranges from 80.07 to 85.88%; sample B (85.88) has the maximum water content, while sample E (80.07) has a lower water content. The protein content varies from 3.80 to 4.28%, which shows that the mixing ratio used to produce the soy milk malt is better as it increases the protein content of the soy milk. It was also observed that the sample coded as B had the highest protein content, followed by sample C. The ash content of the soymilk blend samples varied from 1.15 to 1.80%. There is no significant difference between the two products because they are in the same range. The fat content ranges from 1.63 to 2.93 in the soy milk sample, indicating that the product is high in fat. The carbohydrate value in the soy milk is significantly different, showing that the soy milk with a value of 2.48 has a lower carbohydrate value than the one that was mixed with malted yellow corn. The value of the samples ranges from 2.48 to 13.01, with sample E having the maximum value. This indicates that mixing with malted corn increases the carbohydrate content of the soy milk.

Table 2 Proximate Composition of Beverage Drink from Soymilk and Malted Yellow maize

Sample	Moisture	Protein	Fat	Ash	Carbohydrate
A	85.00^c	3.80^a	2.93^a	1.30^a	2.48^d
B	85.88^a	4.28^b	2.66^b	1.25^c	5.80^a
C	80.34^d	4.13^c	2.03^f	1.15^f	8.28^b
D	75.00^e	4.04^e	2.15^c	1.79^d	11.48^b
E	80.50^b	3.81^f	1.63^d	1.80^e	13.01^c
LSD	0.005	0.005	0.005	0.005	0.005

Means are values from two determinations. Means with different superscript within the same column are significantly different at(p>0.05)
Keys
A=100%Soy milk:0% malted yellow maize
B=90% Soy milk:10% malted yellow maize
C=80% Soy milk:20% malted yellow maize
D=70% Soy milk:30% malted yellow maize
E=60% Soy milk:40% malted yellow maize

Table 3 Functional property of Beverage drink from soymilk and Malted Yellow Maize

sample	Total solid	TTA	Viscosity	pH
A	15.00^d+_0.01	0.030^e+_0.0001	1.75^e+_0.007	5.00^d+_0.01
B	14.12^c+_0.1	0.049^d+_0.0002	4.75^a+_0.007	4.12^c+_0.01
C	19.66^a+_0.15	0.056^c+_0.0006	7.00^b+_0.006	9.66^c+_0.15
D	15.00^b+_0.1	0.059^a+_0.0001	9.00^e+_0.06	5.00^b+_0.01
E	19.50^e+_0.1	0.065^c+_0.0002	11.00^d+_0.006	9.50^e+_0.01

Means are values from two determinations .Means with different superscript within the same column are significantly different at (p>0.05)
Keys
A=100%Soy milk:0% malted yellow maize
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D=70% Soy milk:30% malted yellow maize
E=60% Soy milk:40% malted yellow maize

Physical Properties of Beverage Drink from Soymilk and Malted Yellow maize

The result shows that soluble solids are higher in control sample and sample A respectively, while samples B, C, D and E have almost the same percentage of soluble solids. The result of titratable acidity (% lactic acid) in the soy milk sample presented in Table 3 revealed that high acidity can be an advantage in that better milk will be produced. High acidity promotes digestibility during the hydrolysis of lactose to lactic acid (**Ohenhen and Ikenemoh, 2007**). Their acidity value varies; the control is 0.03. Sample E has the highest acidity value of 0.065, while sample A has the lowest acidity value of 0.03. This difference is a result of the blend ratio and the variety of corn used, meaning that malting increases the acidity values of the product. Steeping alone gives the product a high acidity value. The recommended standard is 0.6 (**FDA, 1999).**
The viscosity of the blend increases with increasing blend percentage. The control sample had the least viscous flow and the E sample with about 40% malt addition had the highest value. This observation may be from the concentration

of solutes from the leaching of soluble amylose in the beverage. The pH of the soy milk sample and its mixture with malted yellow corn, the data reveal that the samples are slightly acidic (low acid foods) and range from 5.93 to 6.08, which is slightly above the average as indicated by (**Olukoya, 1994**). This acidity is slightly higher than the average acidity reported by (**Olukoya, 1994**), thus reducing microbiological growth.

Microbial Composition of Beverage Drink from Soymilk and Malted Yellow maize

The quality evaluation on the microbial composition is presented in Table 7. Total viable count ranged from $3.34 \times 10^4 \pm 6.1$-$5.33 \times 10^6 \pm 0$ with significant differences ($p \leq 0.05$) among sample C, D and E but there was no significant difference among sample A and B. Total fungi count of the blend ranged from < 30-$3.43 \times 10^6 \pm 0$. There were no significant differences among all the samples.

Table 4 Microbial Loads of soymilk and malted yellow maize Beverage Drink

Sample	Total Viable Count	Total Fungi Count
A	$5.3 \times 10^6 \pm 6.0^c$	$1.1 \times 10^6 \pm 0.0^a$
B	$4.2 \times 10^5 \pm 5.9^b$	$3.4 \times 10^6 \pm 0.0^a$
C	$4.1 \times 10^4 \pm 6.1^b$	$3.0 \times 10^2 \pm 1.4^a$
D	$3.4 \times 10^4 \pm 4.99^b$	<30
E	$3.3 \times 10^4 \pm 6.1^a$	<30

Means are values from two determinations. Means are values from two determinations. Means with different superscript within the same column are significantly different at (p>0.05)
Keys
A=100% Soy milk:0% malted yellow maize
B=90% Soy milk:10% malted yellow maize
C=80% Soy milk:20% malted yellow maize
D=70% Soy milk:30% malted yellow maize
E=60% Soy milk:40% malted yellow maize

Sensory attributed of beverage Drink Blends from Soymilk and Malted Yellow Maize

The sensory attributes of the yellow malted tigernut and corn blend are presented in Table 5. The appearance of the blend ranged from 8.67 to 7.06, with no significant difference between samples. Sample B had the highest score.
The flavor/aroma of the blend ranges from 7.12 to 8.01 with an LSD of 0.05. There are no significant differences between samples A, B and D but there are significant differences ($p<0.05$) in samples E and C. Samples B and C have the highest scores of 8.01 and 8.0 and sample E has the lowest scores of 7.80 in terms of flavor/aroma. The texture of the drink ranges from 5.96 to 7.90 with an LSD of 0.05. Samples A and B have similar values, with significant differences ($p<0.05$) in sample E. Sample C has the highest score of 7.90 and sample E has the lowest score of 5.96 in terms of texture. The taste of the mixture ranged from 8.00 to 5.00 with an LSD of 0.005. There were no significant differences between samples A, B, C and D, but there were significant differences ($p<0.05$) in sample E. Sample A had the highest taste scores of 8.00 and sample E had the lowest taste scores of 5.00. Overall acceptability ranges from 8.30 to 6.09 with an LSD of 0.005. There was no significant difference between the samples. The blend composed of 90% soy milk and 10% malted yellow corn had the highest score of 8.30 and the blend composed of 60% soy milk and 40% malted yellow corn had the lowest score of 6.09 for overall acceptability.

Table 5 Sensory Attribute of Blend of soymilk and malted yellow maize beverage drink

Sample	Appearance	Flavor	Texture	Taste	General Acceptable
A	8.06^c	7.12^d	6.00^b	8.00^f	7.10^a
B	8.67^a	8.10^b	6.22^d	7.15^c	8.30^r
C	7.93^b	8.00^a	7.90^c	6.70^d	7.30^f
D	7.11^c	7.86^f	7.01^b	6.40^b	7.20^c
E	7.06^e	7.80^a	5.96^f	5.00^e	6.09^d
LSD	0.74	0.05	0.05	0.05	0.06

Means are values from two determinations. Means with different superscript within the same column are significantly different at(p>0.05)
Keys
A=100% soy milk:0% malted yellow maize
B=90% soy milk:10% malted yellow maize
C=80% soy milk:20% malted yellow maize
D=70% soy milk:30% malted yellow maize
E=60% Soymilk:40% malted yellow maize

CONCLUSION

The proximal compositions of the soy milk mixture with the malted yellow corn samples changed significantly as the proportion of malted corn increased relative to the control. The use of malted yellow corn and soy milk in different proportions has great potential. The beverage promoted all chemical, physical, and sensory attributes, resulting in increased reducing sugars and decreased bun elasticity. Therefore, it is recommended to check the content of micro and macro nutrients, vitamins, amino acids and fatty acids in this drink, as well as the bioavailability of proteins, digestibility and toxicity level of the drink.

Conflict of interest: There are no conflicts of interest among the authors

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