©*Journal of Applied Biosciences, (2008). Vol.1 (2): 40 - 45.*
ISSN 1997 – 5902: www.biosciences.elewa.org

Production and quality evaluation of Soy-corn milk

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Abstract

Objectives: This study focused on improving and diversifying the food and nutrition situation of low income families in the developing world by initiating the production of soy-corn milk and evaluating its quality and potential for acceptance.

Methodology and Results: Soy-corn milk was produced from 75% soybean and 25% maize. Milk samples were analyzed for protein, moisture, ash, fiber and fat contents, microbiological assays and sensory attributes. The protein, fat, ash and total solid contents of soy-corn milk were 4, 4.14 1.23 and 12.2%, respectively while those of soymilk were 3.15, 3.42, 1.17 and 11.23%, respectively. Fortification of soymilk with corn did not produce any significant changes in the microbial count and profiles of soy-corn milk. However, adding maize to soybean for the production of soy-corn milk significantly ($P<0.05$) improved its taste, aroma, consistency and overall acceptability when compared with soymilk.

Application of findings: Addition of maize to soybean for the production of soy-corn milk added value to the product through increased nutrient content and sensorial attributes. Being cheaper and readily available, increased adoption of soy-corn milk would increase milk availability to low-income families in the developing world

Keywords: Maize, milk, soybean, soymilk, soy-corn milk

Citation: Kolapo AL and Oladimeji GR, 2008. Production and quality evaluation of Soy-corn milk. *Journal of Applied Biosciences* 1 (2): 40 – 45.

Introduction

The diets of people in many developing countries comprise mainly starchy roots, cereals and few legumes. Unfortunately, animal sources of proteins, which are used to complement the starchy diets are expensive and out of reach for low-income families (Obatolu *et al*., 2007). In recent years, different edible varieties of legumes have been identified that have high nutritional value, and therefore could help to address a number of diet related problems globally. Soybean (*Glycine max*) is recognized as one of the crops with huge potential the world over. This plant has been exploited for the manufacture of food products such as Soybean fortified gari and tapioca, and cereal-based traditional weaning food (Sanni & Sobamiwa, 1994; Osundahunsi & Awor, 2003; Kolapo & Sanni, 2005). In addition to these soybean foods, soymilk has been identified as one of the promising product.

Soymilk is made by soaking soybeans in water before grinding and straining. The milk is a white or creamy emulsion, which resembles cow milk (conventional milk) in both appearance and consistency (Ahmed, 1984; Soya.be, 2006). The increasing popularity of soymilk as a beverage worldwide (Dashiell *et al*., 1990) is credited to health benefits, e.g. low cholesterol and lactose, its ability to reduce bone loss and menopausal symptoms, prevention and reduction of heart diseases and certain cancers (Soya.be, 2006).

Although soymilk is a potential substitute for cow milk, and could be used for solving malnutrition problems in developing countries, its utilization is hampered by a number of factors, including several biological and storage factors (Wei *et al*., 1985). However, acceptability of soybean products has been enhanced by modification of processing methods (Osundahunsi *et al*., 2007). Some of the modified soymilk extraction methods include application of heat, soaking of soybean in ethanol or alkali and acid grinding. Iwe & Agu (1993) reported on the use of natural flavourants to improve soymilk acceptability. Owing to soymilk's immense health benefits, research targeted at improving its acceptability should be undertaken. Maize in its different processed forms is an important food for large numbers of people in the developing world. In Nigeria and other countries in Africa, maize grain is fermented to give Ogi (Oke, 1976). Maize protein is deficient in lysine and tryptophan, but has fair amounts of sulphur-containing amino acids (Bello-Perez *et al*., 2003). Improvement of the qualities of tortilla (maize product) through soybean fortification has been reported (Obatolu *et al*., 2007). Fortification of soybean product with maize has the potential of creating a valuable food product.

The objective of this study was to initiate the production of soy-corn milk and evaluate its quality and potential for acceptance, aiming to improve nutrition and diversify the food resources of low-income families especially in developing countries.

Materials and Methods

Dried seeds of maize (*Zea mays* L.) and soybean (*Glycine max*) used in this study were collected from International Institute of Tropical agriculture (IITA), Ibadan and Institute of Agricultural Research and Training (IAR&T), Ibadan respectively. The sugar and salt were purchased from a local market in Ibadan, Nigeria.

Processing of Soymilk and Soy-corn milk: Soy milk was produced using the method of Mital *et al*. as reported by Lee *et al*. (1990). Soy-corn milk was produced from 75% soybean and 25% maize following the scheme shown in Figure 1.

Proximate analysis: The analysis of samples for protein (NX6.25), moisture, ash, fiber and fat contents as well as total solid in the milk samples were carried out in triplicates using AOAC methods (AOAC, 1990). Carbohydrate content was calculated by difference (100-[moisture + crude protein + fat + ash]). Energy values were obtained using the Atwater formula, whereby fat, protein and carbohydrate supplied 9, 4 and 3.75 Kcal/g respectively (Manzi *et al*. 2001).

Microbiological examination: Total viable counts of microorganisms in the soymilk and soy-corn milk were done by pour plate technique, whereby 0.1ml of the appropriate dilution was plated out on nutrient agar plates. The plates were incubated at 35°C for 48h and colony forming units per milliliter sample (cfu/ml) was estimated. For fungal counts, the above procedure was repeated using potato dextrose agar and incubation was done at 28°C for 3-5 days.

The organisms that were isolated from the milk samples were grouped on the basis of their colony morphology. Cultures were then purified by repeated streaking of cells from a single colony on fresh media. Characterization of the bacterial isolates was done and definitions given according to Sneath *et al*. (1986). The purified fungal cultures were primarily identified using cultural and morphological features and by comparison with reference cultures from the Plant Pathology laboratory of the Institute of Agricultural Research and Training, Ibadan, Nigeria.

Sensory evaluation: Sensory evaluation of the soy products was done by a 20-member sensory panel who were regular consumers of soymilk. The panel members were requested to evaluate the milk samples in terms of taste, colour, aroma, consistency and overall acceptability on a 5 point hedonic scale ranging from 1= Poor to 5=Excellent.

Statistical analysis: Data obtained were expressed as the mean ± standard deviation (SD). The means were separated using Duncan Multiple Range Test.

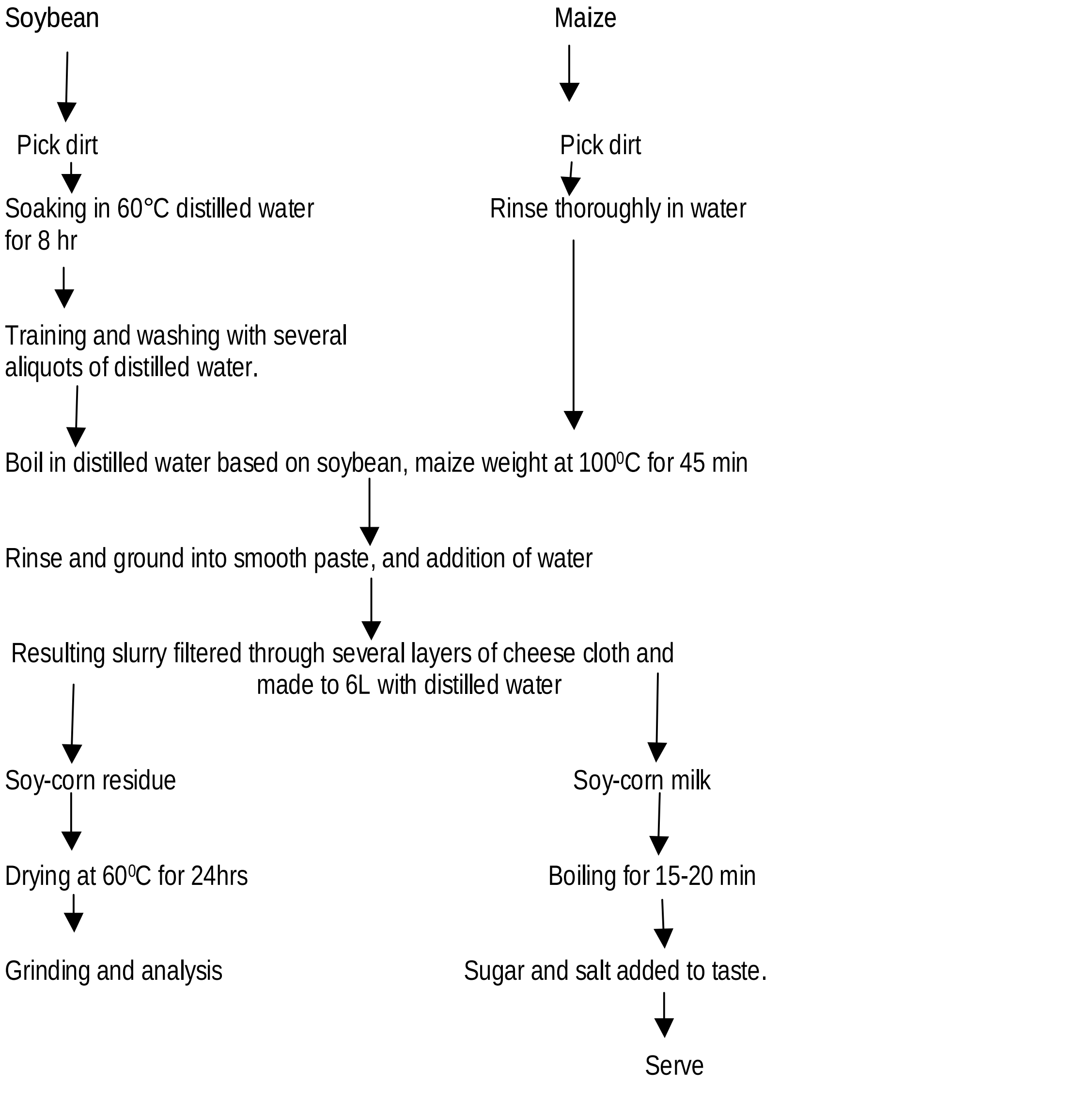

Figure 1: A scheme of the steps followed in production of Soy-corn milk.

Results

The protein, fat and ash content of soymilk, soy-corn milk and their respective residues were significantly lower ($P<0.05$) than those of soybean and maize grains (Table 1). However, the moisture content of soymilk and soy-corn milk increased tremendously after processing while those of soy milk residue and soy-corn milk residue were significantly lower ($P<0.05$) than the observed values for soybean and maize grain. The protein, fat, ash and total solids content of soy-corn milk were improved following fortification while the moisture content and carbohydrate decreased.

The gross energy values of the soy milk residues and soy-corn milk residues were not significantly different from raw soybean but were significantly higher than that obtained for maize grain. However, processing of soybean and maize resulted into enormous reduction of energy values of soymilk and soy-corn milk. The crude fiber content of soy-corn milk residue was the highest while soymilk had no fiber.

Table 1: Proximate compositions and energy values of soybean, maize, soymilk and soy-corn milk and their residues.

Parameter (%)	Soybean	Maize	Soy-corn milk residue	Soy milk residue	Soy milk	Soy-corn milk
Moisture	9.11±0.40 [b]	8.22±0.18[b]	2.14±0.11[c]	1.46±0.33 [c]	88.77±0.17[a]	87.79±0.03[a]
Protein	39.6±0.26 [a]	9.17±0.02 [b]	2.05±0.11[d]	3.08±0.16 [c]	3.15±0.38 [c]	4.00±0.09 [c]
Fat	17.07±0.10[a]	3.74±0.06 [c]	13.96±0.05 [b]	13.13±0.32[b]	3.42±0.06 [c]	4.14±0.04 [c]
Ash	5.13±0.15 [a]	1.60±0.01 [d]	3.09±0.08 [b]	2.41±0.03 [c]	1.17±0.17 [d]	1.23±0.10 [d]
Crude fiber	5.28±0.11 [a]	1.70±0.02 [c]	5.96±0.04 [a]	4.88±0.07 [b]	0	0
Total solids	90.89±0.18[b]	91.78±0.18[b]	97.86±0.11 [a]	98.27±0.06[a]	11.2±0.04 [c]	12.20±0.02[c]
Carbohydrate	29.1±0.01 [b]	77.27±0.15[a]	78.76±0.03 [a]	79.65±0.11[a]	3.49±0.16 [c]	2.83±0.21 [c]
Gross energy	421.22 [a]	360.10 [b]	429.19 [a]	429.18 [a]	56.92 [c]	63.87 [c]

Values are Mean ± S.D; n=3. Means followed by different superscripts within row are significantly different ($P<0.05$).

Table 2: Microbiological qualities of Soy milk and Soy-corn milk

	Total bacterial count (cfu/ml)	Total fungal count (cfu/ml)	Bacterial Isolates	Fungal Isolates
Soy milk	$3.8X10^4$	$2.5X10^4$	*Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeuroginosa, Streptococcus spp*	*Rhizopus spp, Aspergillus niger*
Soy-corn milk	$3.0X10^4$	$2.2X10^4$	*Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeuroginosa, Streptococcus spp*	*Rhizopus spp, Aspergillus niger*

Fortification of soy milk with corn did not produce any significant changes in both the microbial count (total bacterial and fungal count) and the profiles of microorganisms associated with the two milk products (Table 2). Microorganisms isolated included common saprophytes, e.g. *Bacillus subtilis, Staphylococcus aureus, Streptococcus spp, Pseudomonas aeuroginosa, Rhizopus spp and Aspergillus niger*.

Result of sensory attributes' evaluation (Figure 2) showed that the addition of maize to soybean for the production of soy-corn milk significantly improved the taste, aroma, and consistency as well as acceptability but the colour was not affected.

Discussion

The significant reduction of protein and fat contents nutrients after processing would be expected, as similar changes have been reported previously (Obatolu *et al*., 2007). The reduction in protein content could be due to swelling of protein bodies, which resulted in shape loss or physical destruction during processing (Gomez *et al*., 1989).

The observed increase in protein, fat and ash content of soy-corn milk compared with soy milk is likely due to the contribution realized from the maize added to soybean for the production of soy-corn milk, as noted previously by Osundahunsi *et al*. (2007). The extra value obtained in the developed soy-corn milk is also qualitative since combining two different plant protein sources most often results into a better amino acid balance (Bello-Perez *et al*., 2003; Obatolu *et al*., 2007).

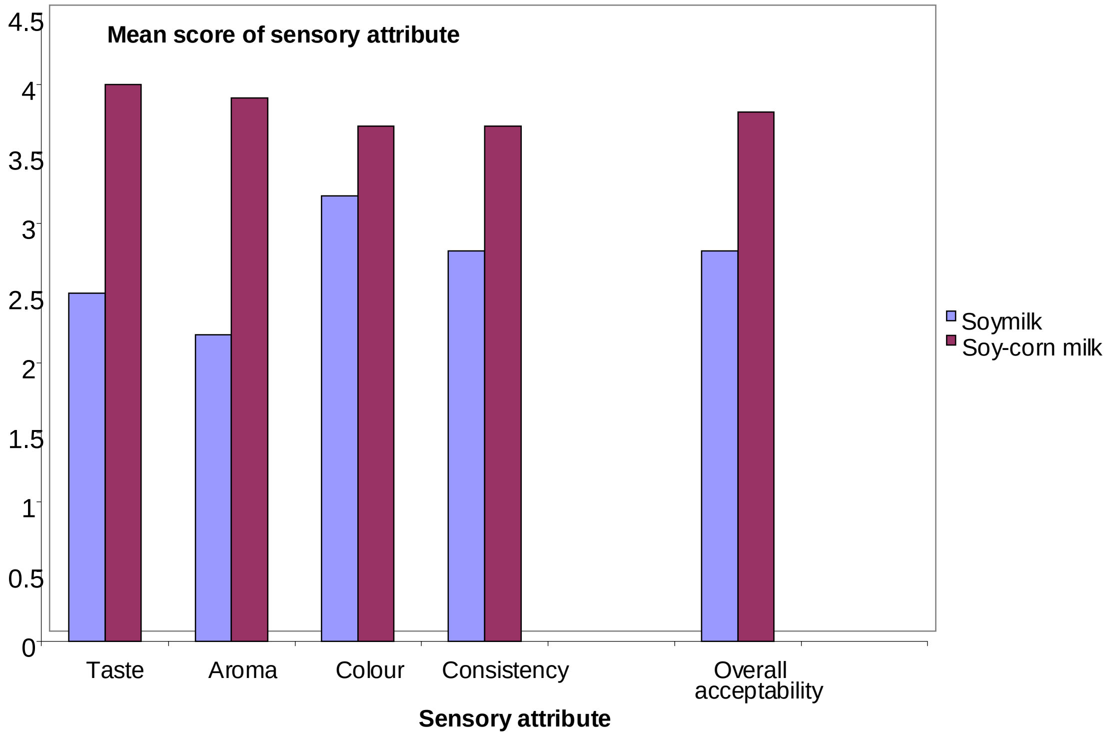

Figure 2: Result of sensory evaluation of Soy-corn milk and Soymilk

Considering the nutrient status of both soy-corn milk residues and soy milk residues, it appears that these by-products could be used as, or incorporated into livestock feed. These products have great potential as sources of energy, fat and fiber. In addition, they are suitable due to their minimal ash and protein contents.

The absence of crude fiber in both soy-corn milk and soymilk, also reported by Ene-Obong (2001) appears to portray these products as poor sources of energy. However they have great potential use to meet daily protein, fat and minerals requirements.

This study further shows that fortifying soymilk with maize did not alter the microbiological qualities of the resultant 'new' product. The microorganism profiles of both milk products were as well as the microbial loads were not significantly different (P>0.05). The organisms isolated from the products were similar to the ones reported for soybean daddawa and de-fatted residues of some Nigerian oil seeds (Kolapo & Sanni, 2006; Kolapo *et al*., 2007; Oladimeji & Kolapo, 2008), and they pose no known threat to public health.

The addition of maize to soymilk improved the overall acceptability of the resulting soy-corn milk. The improvement in the consistency of soy-corn milk is most likely due to the increase in the amount of total solids, compared to soymilk. Further to this, the improved aroma and taste of soy-corn milk further enhances its acceptability.

The different types of food groups that are traditionally included in meals include milk group, meat group, vegetable and fruit group, and bread and cereal group. Unfortunately, items in the milk group hardly feature among the major items of food in developing countries (Ene-Obong, 2001), especially in the diets of low-income families. The results of this study have demonstrated the acceptability and potential of soymilk to address these deficiencies. Soymilk is cheaper and could be more readily available, with adoption being high as shown in the case of soy-corn milk.

Acknowledgement: We express our sincere appreciation to The Polytechnic, Ibadan, for a conducive working atmosphere. IART and IITA are also acknowledged for providing soybean and maize respectively.

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