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Nutrient and Sensory Quality of Soymilk Produced from Different Improved Varieties of Soybean

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Abstract: The study aimed to determine the most nutritionally and organoleptically suitable improved variety of soybean sample for soymilk production. Soymilk sample were extracted from different varieties of soybean namely; TGX-4482E, TGX-814496E, SAMSOY 1, SAMSOY 2, SAMSOY 3 for sample A, B, C, D and E, respectively. The processed soymilk samples were subjected to nutrient analysis using standard methods. Also sensory evaluation was carried out using another batch of extracted soymilk using 9-point hedonic scale to rate panellist preference for the organoleptic qualities of the soymilk products. The results were subjected to statistical analysis to determine whether significant difference existed between their nutrient compositions and also in the various organoleptic qualities. Results from the proximate analysis of soymilk showed that the crude protein values ranged from 4.52±0.03 to 4.84±0.02 with sample A (TGX4482E) having the highest value of 4.84±0.02 and SAMSOY 1 the least value of 4.52±0.03. TGX 4482E did not differ significantly from the other sample at ($p>0.05$). The moisture content ranged from 89.62±0.11 to 90.46. The % crude fat ranged from 1.98 to 2.17 with the highest recorded for TGX 4482E and the least SAMSOY 2. The Vitamin composition showed that the Vitamin B1 ranged from 0.058±0.00 to 0.074±0.00, vitamin C content ranged from 0.34±0.0 to 0.435±0.02. The mineral composition showed that TGX448-2E has the highest phosphorous of 89.63 mg/100 g and highest zinc content of 0.96 mg/100 g. SAMSOY 3 has the highest Iron content and TGX 81449E has the highest calcium content. Also sensory evaluation result revealed that SAMSOY 2 was mostly preferred. The study has shown that soymilk is a good source of macronutrient however, it also was observed that the sample highly preferred had lower nutritional quality when compared to others used in the study. There is need therefore to fortify the product with micronutrients so that it can conveniently serve as a good alternative to animal proteins.

Key words: Nutrient, sensory quality, soymilk, improved varieties, soybean

INTRODUCTION

Soymilk (also known as soymilk, soy juice and soybean milk or soy drink/beverage) is a beverage made from soybeans. It is defined as an aqueous extract of whole soybeans (dehulled or non-dehulled), closely resembling dairy milk in physical appearance and composition (Patil and Jha, 2008). It is a nutritious beverage rich in high quality protein and contains no cholesterol or lactose. Soymilk is also referred to as a liquid obtained by suspending soybean flour in water, used as fat free substitute for milk. It is inexpensive, highly digestible; it is rich in water soluble protein, carbohydrate and oil nutrient. It is rich in polyunsaturated fatty acids, linoleic acid (Deshpande *et al*., 2008). It is also non-allergic, can easily be produced with low level technology and serve as good nutrient for vegetarian diet.

According to Wang *et al.* (1978) soymilk originated in the orient by a Chinese Philosopher. This has since spread to many parts of the world especially the so-called "third", although, it is still more popular in Asia than any other parts of the world. Soya milk is a popular beverage in Asian countries like China, Japan and Thailand (Kanawjia and Singh, 2002). A patent for Soymilk production was issued in 1910, to Li Yu-ying, a Chinese living in France (Wang *et al*., 1978).

Soymilk has a great potential to supplement the dairy milk and it is nutritionally comparable with the mother's milk and cow's milk. At the standpoint of nutritional quality, soy protein (Soymilk) has many advantages over animal proteins beyond the fact that soymilk are low in saturated fat and cholesterol free, Soymilk and cow milk have approximately the same protein content and

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composition and the amino acid composition show a fairly close correspondence (Smith and Circle, 1972).

The sensory analysis depends on the method used as well as the variety of which different tasting panels will taste and judge. There are several ways of soymilk production and it includes the following: the Traditional Oriental method which is the most common method of soymilk production. Johnson and Singder (1978) described two other methods of processing termed “Illinois” and “Cornel” methods which are aimed at improving the acceptability of soymilk in terms of odour and flavour. Upon heat treatment and some chemical treatments, the undesirable characteristic of soy bean such as antinutritional factors (trypsin inhibitors), flatus factors, beany flavour, disagreeable taste and cooking difficulties are either eliminated or reduced. A temperature above or below the standard processing time of soybean will affect the nutritional quality adversely (Smith and Circle, 1972). Since soymilk does not contain lactose, it is suitable for lactose intolerant patients. It is reported that soymilk may help reduce the risk of heart diseases because it naturally contains isoflavones, plant chemicals that help control low density lipoprotein cholesterol (LDL) (Rolfes *et al*., 2011).

Soybean (*Glycine maxmerill*) belongs to the family *leguminosae*. It is native to China and is one of the oldest world crops (Wang *et al*., 1978). United States is the world’s leading producer of soybean followed by China (Wang *et al*., 1978). There are many varieties of soybean, the shape and size of seeds vary from small round pea to large elongated beans. The colours also vary from yellow, brown and green to black. The seeds are enclosed in a short hairy pod containing 2-3 seeds attached to the plant. Names of the different varieties of soybean include Glycine max, Glycine Ussuriesis (wild), Glycine gracilus (intermediate) and Glycine soja (Iwe, 2003). The above mentioned are the native varieties. Improved varieties used in this study include; Samsoy 1, Samsoy 2, Samsoy 3, TGX4482E and TGX814496. Other varieties have been developed in different parts of the world.

The products derived from soybean comprises; Tofu (curdled soymilk like the cheese), it is also known as soy curd, Tempeh (fermented soybeans), Natto, Miso, Edamame, soyflour, Infant formula, soya meal, soy oil (Shakuntala and Shadaksharaswamy, 2008). Different varieties of soybean are good for different products of soybean. However, the composition and quality of soymilk varies with the variety of soybean used and the method of production (Wang *et al*., 1978). It is expected that different varieties of soybean could affect both the proximate and sensory attributes of products from soybeans basically soymilk. This research provided us with information on the best seed variety of the improved varieties of soybean suitable for soymilk production based on the nutrient and sensory properties. The specific objectives of the study were:

1: To produce soymilk from different improved varieties of soybean
2: To conduct sensory evaluation on the soymilk from different improved varieties of soybean
3: To evaluate the proximate, mineral and vitamin composition from different improved varieties of soybean
4: To determine the Hydrogen Ion Concentration (pH) of the soymilk produced from different improved varieties of soybean

MATERIALS AND METHODS

Sample collection and preparation: Different varieties of soybean (samsoy 1, Samsoy 2, Samsoy 3 and TGX4482E and TGX814496) used for this study were produced from the Department of Crop Science in the Faculty of Agriculture of Federal University of Agriculture, Umudike in Abia State, Nigeria and were separately used to prepare soymilk in batches. The picture of the soybean varieties are seen in (Appendix 1) (Plate 1, 2, 3, 4 and 5). The process used is the Illinois process using the Somimax machine seen (Appendix 1) (Plate 6). Each sample was soaked in 2 liters of tap water for 15 min and placed in a Somimax Tm (Model N0.5 360D USA) soymilk machine using 1.2 liters of tap water. The soymilk of each was poured into sterilized MacConkey bottles (25 ml in duplicate) and then pasteurized at 80°C for 30 min. After that, the processed soymilk in the MacConkey bottles were store for further analysis.

Method: The method used is the Illinois process. Each of the soybean varieties were weighed 75 g using 20 capacity weighing scale. They were sorted, washed and soaked in 2 liters of tap water for 15 min. 1.2 liters of water was poured into the soymimax machine at the level calibrated 1.2 mark. The soybean was put into the sieve and fixed with the soymimax. The soymimax machine was then switched on and allow to heat for 15 min. After 15 min, it was removed and soymilk was extracted. Both sieving and dehulling were taken care of by the soymimax machine (Johnson and Snyder, 1978) (Fig. 1).

Chemical analysis for nutrient composition

Determination of proximate composition: Moisture content was determined by the gravimetric method (James, 1995). The protein content was determined by Kjeldahl method described by James (1995). Fat content of the sample were determined by the continuous solvent extraction method using a soxlet apparatus (Pearson, 1976; James, 1995). Crude Fibre was determined by the Wende method (James, 1995). Total Ash was done using the furnace incineration gravimetric method (AOAC, 1990). The total carbohydrate content

Steps in production of soymilk

Step	
Soybean	→ 75 g was weighed
↓ Sorting	→ To remove bad ones and foreign materials
↓ Washing	→ To remove dirt
↓ Soaking	→ Using 2 liters of water for15 min
↓ Heating/Grinding	→ For 15 min using soymimax machine
↓ Sieving	→ Using 0.04 mini sieve
↓ Packaging	→ Using sterile MacConkey bottles
↓ Pasteurization	→ For 30 min at 80°C

Fig. 1: Flow diagram of soymilk production

was calculated by difference as the Nitrogen free extractive (NFE) Method separately (Pearson, 1976; James, 1995).

Mineral determination: Phosphorus in the sample was determined by the Vanado Molybdate (Yellow) spectrometry described by James (1995). The iron content of the sample was determined using bipyridyl spectrophotometer method described by James (1995). The zinc content and of the sample was determined by Alpha 4 automatic absorption spectrophotometer (AAS) (Onwuka, 2005).

Vitamin determination: The ascorbic acid content of the sample was determined using the method described by Barakat *et al*. (1991). The riboflavin, niacin and thiamin content of the test samples was determined using the method of AOAC (1990).

Hydrogen ion concentration (pH): The pH was measured directly using a pH meter (Jensway model).

Sensory evaluation and statistical analysis: A point hedonic scale was used to evaluate the samples namely TGX4482E, TGX814496, SAMSOY 1, SAMSOY 2 and SAMSOY 3. They were coded as Sample A, B, C and E, respectively. The samples were tested organoleptically for taste, colour, flavour, mouth feel and general acceptability. The test was conducted by 20 members/panellists. The 9-point Hedonic scale was used to know where the degree of likeness or dislike (extremely like and extreme dislike) fall on. The sensory score were then subjected to ANOVA as described by Ihekoronye and Ngoddy (1985).

Illustration of the 9-point hedonic scale:

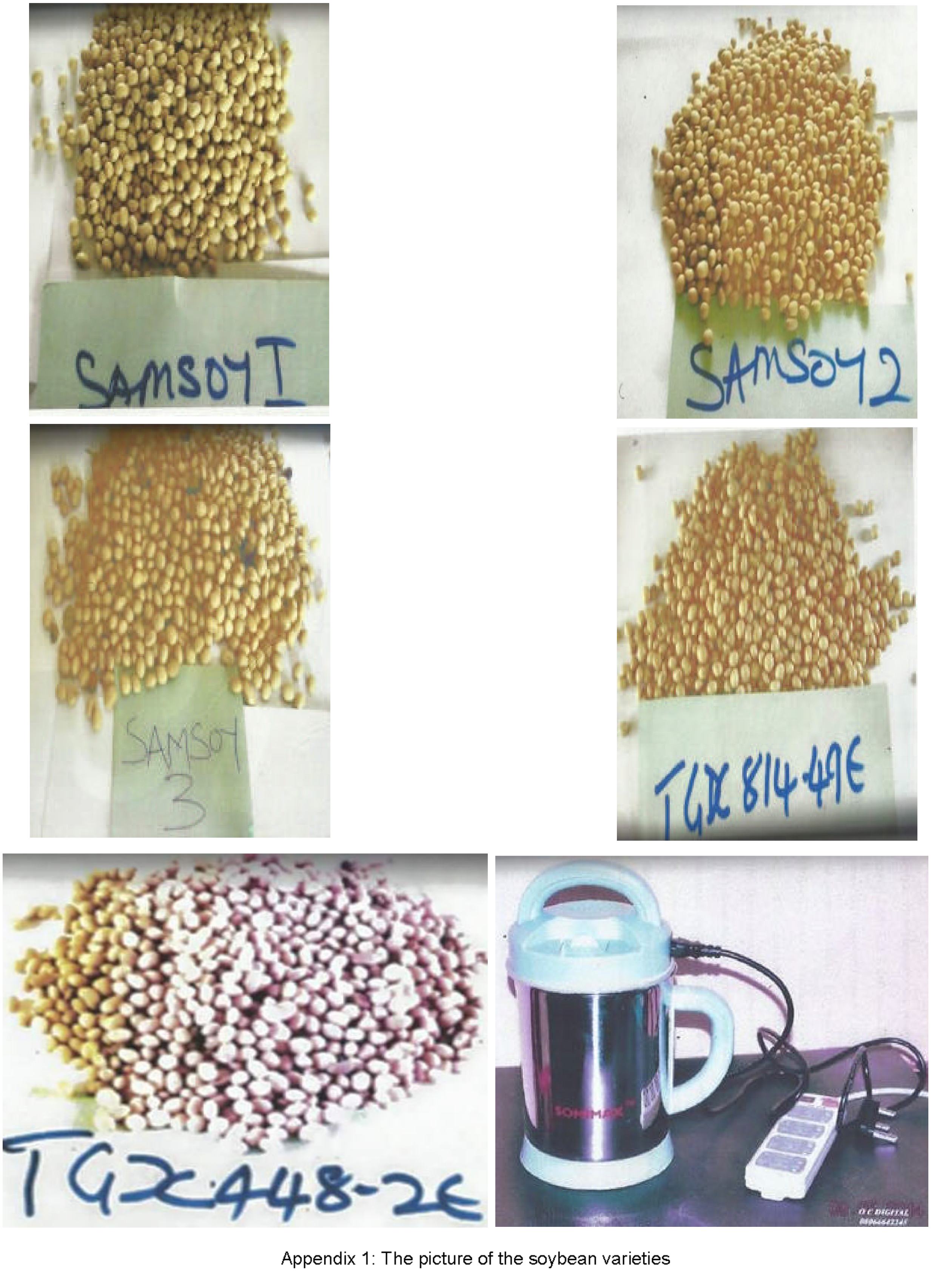
9 - Like extremely
8 - Like very much
7 - Like moderately
6 - Like slightly
5 - Neither like nor dislike
4 - Dislike slightly
3 - Dislike moderately
2 - Dislike much
1 - Dislike extremely

RESULTS AND DISCUSSION

Proximate composition of soymilk: The proximate composition of soymilk from different varieties of soybean is as shown in Table 1.

Table 1 showed that the moisture content of soymilk produced from different varieties of soybean. It was observed that the value ranged from 89.62±0.11 to 90.46±0.06 with Sample B (TGX 814496) having the highest value of 90.46% and Sample C (SAMSOY 1) had the least value of 89.62%. There is no significant difference existing between sample E (TGX 84482E) and sample C (SAMSOY 1) and sample E (SAMSOY 3) at (P0.05) but there was significant difference at ($p>0.05$) existing between sample B (TGX 814496) and Sample C (SAMSOY 1). And also in sample B (TGX 814496) and Sample E (SAMSOY 3). Also Sample C ((SAMSOY 1) is significantly different from sample D (SAMSOY 2) at ($p<0.05$). The variation in their moisture content could be as a result of moisture loss during heating, time of heating and the quantity of water used. The highest value of the moisture content which ranges from 89.62±0.01 to 90.46±0.06 corresponds with that of Enwere (1998) who stated that about 92.75% of soymilk is water. With the moisture content, it will have short storage stability and hence there is need to concentrate or evaporated the milk for longer storage. Also the higher moisture content could be due to partial coagulation of protein leaning to restriction of water expulsion (Udeozor, 2012). This could affect the stability and safety of food with respect to moisture to microbial growth and proliferation hence require cold storage or evaporation/concentration.

The protein composition values ranges from 4.52±0.03 to 4.84±0.02 with sample A (TGX4482E) having the highest value of 4.84±0.02 and Sample C (SAMSOY 1) the least value of 4.52±0.03. Sample A (TGX 4482E) did not differ significantly from the other sample at ($p>0.05$). Although, it has the highest value and the same with sample C (SAMSOY 1). Generally, there is no significant difference in the mean values of the analyzed samples at $p>0.05$. Khatib *et al*. (2002) also reported that the protein content ranges from 4.9 to 5.5% while Iwuoha



Appendix 1: The picture of the soybean varieties

and Umunnakwe (1997) gave results for protein content as 4.1%. Hence, from the results obtained from this work, the crude protein content ranged from 4.5 to 4.84%. The discrepancies among various studies might be partly because of the variety differences and processing conditions (extraction conditions, maturity conditions as well as storage conditions). Besides the higher the protein in the soybean, the higher the protein in the soymilk, higher protein varieties are therefore preferred for soymilk production (Khatib *et al*., 2002). Also the lower protein value may have resulted in smaller droplets size particles and the white colour of soymilk is a substitute to cow milk and provides protein for the body when consumed.

The fat composition ranged from 1.98±0.00 to 2.175±0.02. The highest value is found in TGX 4482E (Sample A) 2.175 while the least value is found in SAMSOY 2 (Sample D), 1.98%. There is no significant difference at ($p>0.05$) between the analyzed samples. These figures obtained were comparable to those obtained by Babajide (1985) who stated that soymilk contain 2.12% fat content. The variation in the values could be attributed to the fact that heat help extraction of oil and hence the amount of heat applied could affect the fat composition.

Values for crude fibre determination ranges from 0.081±0.00 to 0.087±0.00 to 0.087±0.00 with sample A (TGX4482E) having the highest value, 0.087% and sample E (SAMSOY 3) the least value, 0.081%. Notwithstanding, the crude fibre of soymilk is trace as seen from the result. This agrees with the work done by Enwere (1998) that soymilk contains no crude fibre in minute quantity, reason could be as a result of processing, variety differences (structure) of the soybean and the soil profile.

Values obtained for carbohydrate determination ranged from 1.66±0.10 to 2.81±0.14. Sample C (SAMSOY 1) had the highest value of 2.81%, followed by sample E (SAMSOY 3) 2.73%, next is sample A (TGX4482e), 2.25% then sample D (SAMSOY 2), 2.22% and finally, sample B (TGX814496), 1.66%. The result obtained from the analyzed samples for carbohydrate are very close to the value reported by Udeozor (2012) was 2.7%. The difference in the values could be due to the variety of the soybean and the processing conditions.

Vitamin composition of soymilk: The vitamin composition of soymilk from different varieties of soybean is as shown in Table 2.

The values of vitamin B_1 (Thiamin) ranged from 0.058±0.00 to 0.074±0.00. Sample A has the highest value of 0.074 mg/100 g while sample D (SAMSOY 2) had the least value of 0.58 mg/100 g. These values obtained from the result fall within the range reported by US Department of Agriculture (USDA) (2005), 0.060 mg/100 g. There is no significant difference at $p>0.05$ between the samples. From the result obtained, the vitamin B_1 content of soymilk is poor and therefore, needs fortification with vitamin B_1. The variations could be due to processing, heating and storage conditions as it is a water soluble vitamin that can leach out during processing.

The Vitamin B_2 (Riboflavin) values ranged from 0.046±0.00 to 0.050±0.00 with the highest value recorded for sample E (SAMSOY 3) and the least value recorded for sample D (SAMSOY 2). The values obtained which ranged from 0.46 to 0.059 mg/100 g are close to the values reported by USDA (2005) 10.069 mg/100 g. There is no significant difference at ($p>0.05$), between the analyzed samples although values varies from one another.

The Vitamin B_3 (Niacin) values range from 0.062±0.00 to 0.085±0.00 with the highest value recorded for sample B (TGX 814496), 0.085±0.00 and the least value recorded for sample D (AMSOY 2), 0.062±0.00. The values obtained are lower than USDA (2005) values (0.513 mg/100 g). the results shows that the vitamin B_3 content of the analyzed soymilk samples are far below the standard Adult Recommended Daily Allowance which is 15 mg, hence it will take drinking a lot of the soymilk to achieve this which might not be possible to achieve easily. This also indicates that soymilk especially the one used here is poor in micro nutrient such as Vitamin B_3 and need to be fortified with this food nutrient. The variation among the analyzed samples compared to the one reportedly by USDA and could be due to the variety of the soybean used processing and storage. Vitamin B_3 helps to prevent pellagra (FNB, 2001).

The Vitamin C (Ascorbic acid) values rage from 0.34±0.00 to 0.435±0.02 with the highest value recorded for sample B (TGX 814496) and the least value recorded for sample E SAMSOY 3. There is no statistical significant difference between all the samples, however sample B (TGX 814496) have proved to be higher in vitamin tested more than all other samples. The USDA (2005) nutrient data base revealed that the variety of soymilk they analyzed do not contain any vitamin C but these varieties in this study contained vitamin C however, it is small to meet the RDA. Hence, fortification with vitamin C will improve the nutritional value of the product.

Mineral composition of soymilk: The mineral composition of soymilk from different varieties of soybean is as shown in Table 3.

The mean mineral composition of soymilk produced from different varieties of soybean. The calcium values ranged from 41.82±0.04 to 45. 78±0.03 with the highest value recorded for sample B (TGX814496), 45.78±0.03 and the least value recorded for sample D (SAMSOY 2), 41.82±0.04. There is significant difference ($p<0.05$)

between the analyzed samples. Comparing the values obtained from this work and the one reported by USDA (2005), 25 mg/100, it is observed that the values got from the analyzed samples used in this work has more of calcium content than the one used by USDA (2005). The variation among the analyzed samples could be due to variety of the soybean, growing condition and processing methods. Again, the higher calcium content of sample B could be due to processing condition. This agrees with the statement that processing considerably affects calcium. The value obtained from this study is in agreement with the work of Udeozor (2012) who reported that calcium content of unfortified soymilk is 44.5±0.3368.

The magnesium content ranged from 53.76±0.20 to 54.82±0.02 from the results obtained. The highest value recorded for sample C could be due to the processing conditions and variety of the raw material. There was significant difference existing between the analyzed samples at $p<0.05$. The low value obtained could be due to the sieving of the soymilk which results in removal of the hulls. Also, processing methods could affect the magnesium composition hence, the removal of the nutrient rich germ and bran, lower magnesium content substantially. The sample with the highest value will still provide the body with magnesium if consumed adequately. This magnesium has been reported to serve as a co-factor in more than 300 enzymes systems that regulate diverse bronchial reactions in the body, including protein synthesis, muscle and heme function, blood glucose control, blood pressure regulation, structural development of bone, nerve impulse conduction, muscle contraction and normal heart rhythm (Rolfes *et al.*, 2011). However, the result obtained showed that the magnesium content of soymilk from the improved variety of soybean is higher than the range reported by Udeozor (2012) that soymilk (plain) has magnesium content of 51.5±0.3.

The Iron values ranged from 1.08 ± 0.00^{c} to 1.87±0.04 with the highest value recorded for sample E and the least value recorded for sample A. The values obtained is close to the value reported by Enwere (1998) who opined that plain soymilk contain 1.44 mg/100 g. There was significant difference existing between the analyzed samples although slight difference were found between sample A (TGX 4482E), sample B (TGX814496) and sample D (SAMSOY 2). Sample E (SAMSOY 3) is significantly different from sample A (TGX 4482E), Sample B (TGX814496) sample D (SAMSOY 2) but no significant difference was found between sample C (SAMSOY 1) and sample E (SAMSOY 3). The variations could be due to variety of the soybean and processing conditions. The value obtained from the analyzed sample is higher than the one reported by USDA (2005) which is 0.6 mg. The sample with the highest value will be of nutritional important especially to infants and growing children and pregnant mothers. Enough consumption of Iron will help to prevent impaired intellectual development in children, lead poisoning in children and prevent anaemia both in adults and children and help in the metabolism of almost living organisms and humans. It is an essential component of hundreds of proteins and enzymes (Cousin, 2006; Rolfes *et al.*, 2011).

The zinc values ranged from 0.85±0.00 to 0.96±0.00 with the highest value recorded for sample A (TGX 4482E) 0.96mg and the least value of 0.85±0.00 recorded for sample E SAMSOY 3). The values are higher than the value reported by United Soybean Board (USDA, 2005) which is 0.54 mg. Sample A (TGX4482E) is significantly different from sample C (SAMSOY 1), sample D and sample E $p<0.05$. Reason for the differences could be due to variety of soybean used, growing condition and soil profile. The sample with the highest value will help provide zinc. Zinc is said to help in growth and development, immune response, neurobiological function and regulatory role (Cousins, 2006; Rolfes *et al.*, 2011).

The phosphorus content ranged from 84.55±4.16 to 89.63±0.04. The highest value is recorded for sample A (TGX 4482E), 89.63±0.04 while the least value is recorded for sample B (TGX814496). There is no significant difference between the analyzed samples $p<0.05$ although the values differ. Reasons for the variation could be leaching of this mineral during because it cannot be destroyed by heat or inhibition by phytates (Rolfes *et al.*, 2011). Also what could cause the variation in the results could be due to variety, soil profile and quantity of water. Comparing those values 84.55±4.16 to 89.63±0.04 with 52 mg reported by USDA (2005) for phosphorus content for soymilk, the analyzed soymilk sample had higher phosphorus content. This could be due to the improved variety used and soil profile. The sample with the highest value will help provide phosphorus to the body. Phosphorus is reported to serve as a major structural component of bone in the form of a calcium phosphate salt called hydroxyapatite phospholipids and this phosphorus are major structural components of cell membrane. Also phosphorus is reported to help maintain normal acid-base balance (pH) by acting as one of the body's most important buffers as well as prevention of loss of appetite, anaemic condition, muscle weakness, bone pain, rickets (in children), osteomalacia (in adults) (Rolfes *et al.*, 2011). Hence soymilk phosphorus need to be fortified with phosphorus to meet up with the body requirement of phosphorus for cellular and bone formation. With result obtained from the mean composition of soymilk, it indicates that the values is below the findings of Udeozor (2012) who stated that soymilk has a phosphorus content of 114.8±2.

Table 1: Proximate composition of soymilk samples from different improved varieties of soybean

Samples/Nutrient content (%)	A TGX 4482E	B TGX 814496	C SAMSOY 1	D SAMSOY 2	E SAMSOY 3	LSD
Moisture	89.78±0.03^{bc}	90.46±0.006^{a}	86.62±0.11^{c}	90.20±0.001^{ab}	89.67±0.05^{c}	0.54
Ash	0.88±0.00^{a}	0.86±0.00^{a}	0.85±0.00^{a}	0.84±0.00^{a}	0.84±0.01^{a}	-
Crude fibre	0.087±0.00^{a}	0.084±0.00^{a}	0.082±0.00^{a}	0.084±0.00^{a}	0.081±0.00^{a}	-
Fat	2.175±0.02^{a}	2.17±0.01^{a}	2.12±0.00^{a}	1.98±0.00^{a}	2.03±0.00^{a}	-
Protein	4.84±0.00^{a}	4.76±0.06^{a}	4.52±0.003^{a}	4.68±0.00^{a}	4.66±0.005^{c}	-
Carbohydrate	2.25±0.04^{b}	1.66±0.10^{a}	2.81±0.14^{a}	2.22±0.001^{a}	2.73±0.12^{a}	0.26

Means in the same row with the same superscript were not significantly different at p>0.05. The means were separated using least significant difference (LSD)

Table 2: Mean vitamin composition of soymilk samples from different improved varieties of soybean

Samples/Vitamin (mg/100 g)	A TGX 4482E	B TGX 814496	C SAMSOY 1	D SAMSOY 2	E SAMSOY 3	LSD
Vitamin B1 (Thiamin)	0.074±0.00^{bc}	0.072±0.006^{a}	0.069±0.00^{a}	0.058±0.00^{a}	0.062±0.00^{a}	-
Vitamin B2 (Riboflavin)	0.05±0.00^{a}	0.054±0.00^{a}	0.049±0.00^{a}	0.046±0.00^{a}	0.059±0.0^{a}	-
Vitamin B3 (Niacin)	0.084±0.00^{a}	0.085±0.00^{a}	0.0785±0.00^{a}	0.062±0.00^{a}	0.063±0.00^{a}	-
Vitamin C (Ascorbic acid)	0.35±0.05^{a}	0.435±0.02^{a}	0.37±0.01^{a}	0.35±0.00^{a}	0.34±0.00^{a}	-

Means in the same row with the same superscript were not significantly different at p>0.05. The means were separated using least significant difference (LSD)

Table 3: Mineral composition of soymilk samples from different improved varieties of soybean

Samples/Mineral (mg/100 g)	A TGX 4482E	B TGX 814496	C SAMSOY 1	D SAMSOY 2	E SAMSOY 3	LSD
Calcium	43.85±0.01^{c}	45.78±0.03^{a}	45.34±0.03^{b}	41.82±0.01^{c}	42.42±0.05^{d}	0.036
Magnesium	54.66±0.08^{a}	54.78±0.03^{a}	54.82±0.02^{a}	53.76±0.20^{a}	53.82±0.03^{a}	0.28
Iron	1.08±0.00^{c}	1.82±0.00^{bc}	1.85±0.00^{ab}	1.79±0.01^{c}	1.87±0.04^{a}	0.036
Zinc (mg/100 g)	0.96±0.00^{a}	0.95±0.00^{ab}	0.93±0.01^{b}	0.89±0.00^{c}	0.85±0.00^{d}	0.023
Phosphorus (mg/100 g)	89.63±0.04^{a}	84.55±4.16^{a}	88.53±0.11^{a}	87.18±0.03^{a}	86.87±0.04^{a}	-

Means in the same row with the same superscript were not significantly different at p>0.05. The means were separated using least significant difference (LSD)

Table 4: Mean sensory scores of soymilk samples from different improved varieties of soybean

Samples/Parameters	A TGX 4482E	B TGX 814496	C SAMSOY 1	D SAMSOY 2	E SAMSOY 3	LSD
Colour	7.25±1.33^{a}	7.40±1.31^{a}	7.55±1.32^{a}	7.75±1.16^{a}	6.5±1.91^{a}	-
Taste	6.65±1.27^{ab}	5.85±1.31^{b}	6.75±1.89^{ab}	7.8±1.10^{a}	7.4±1.54^{a}	1.27
Flavor/Aroma	6.8±1.51^{a}	6.30±1.56^{a}	6.74±1.41^{a}	7.4±1.10^{a}	6.4±1.54^{a}	-
Mouth feel/Texture	6.75±1.16^{a}	6.45±1.39^{a}	6.95±1.79^{a}	7.25±1.37^{a}	6.8±1.98^{a}	-
General acceptability	7.2±1.11^{b}	7.35±2.35^{ab}	7.45±1.15^{ab}	7.75±1.37^{a}	7.05±1.54^{b}	0.47

Means in the same row with the same superscript are not significantly different at p>0.05. The means were separated using least significant difference (LSD)

Table 5: pH value of soymilk samples from different improved varieties of soybean

Samples/Parameters	A TGX 4482E	B Tax 814496	C SAMSOY 1	D SAMSOY 2	E SAMSOY 3	LSD
pH	6.24±0.01^{a}	6.28±0.03^{a}	6.18±0.00^{a}	6.24±0.02^{a}	6.20±0.00^{a}	-

Means in the same row with the same superscript were not significantly different at p>0.05. The means were separated using least significant difference (LSD) Fisher's test

Sensory evaluation: The organoleptic mean score for various soymilk samples are shown in Table 4.

Colour: The sensory scores for colour ranges from 6.5±1.91 to 7.75±1.16. The highest mean score for colour was recorded for SAMSOY 2 (7.75±1.16) and the least mean score for colour was recorded for SAMSOY 3 (6.5±1.91). However, it was observed that the samples did not differ significantly (p>0.05) from one another but with slight difference. Sample D being the highest means score (7.75±1.16) did not differ significantly (p>0.05) from others. Also the sample with the least mean score did show significant difference (p<0.05) from other samples. The reason for the highest mean score in terms of colour SAMSOY 2 (Sample D) could be as a result of milk colour due to clear helium associated with this variety. Previous work shows that the colour of soymilk is greatly influenced by the colour of soybeans (Wang *et al*., 1983; Jain, 1985). The good quality colour could be also as a result of intrinsic factors like carotenoid and polyphenol contents in high amounts (Wang *et al.*, 1983). Hence the factors affecting the colour of sample D could be as a result of the maturation and storage of the bean variety and type of growing soil (Tunde-Akintude and Souley, 2009). Also the colour could be affected by protein aggregates, droplets size concentration and lipid content.

Taste: The mean sensory score for taste from different varieties of soymilk samples produced from different varieties of soymilk varied. The highest mean score for taste was recorded for sample D (7.8±1.10) and the least mean score was recorded for Sample B (5.85±1.31) here the mean sensory score ranged from 5.85±1.31 to 7.8±1.10. The statistical evaluation shows that sample D (SAMSOY 2) differ ($p<0.05$) significantly from sample B. It also shows that there was a slight difference ($p<0.05$) from sample A and sample C while sample E did differ ($p>0.05$) significantly from sample D. Hence, the reason for the highest mean score for sample D in terms of taste could be as a result of the variety of the soybean, genetic make-up, growing conditions, processing conditions as well as quality and maturation of the soybean.

Flavour/aroma: The mean sensory score in terms of flavour/Aroma ranges from 6.30±1.56 to 7.4±1.10. The highest mean score recorded for sample D (7.41±1.10) while the least mean score was recorded for sample B (6.30±1.56) in terms of flavour/Aroma. These result from the statistical evaluation shows that Sample D being the highest mean score is not significantly different from others at ($p>0.05$). Also sample B which has the least mean score showed no significant difference at ($p>0.05$) for other samples. Hence the reason for the highest score could be as a result of the soybean variety, climatic conditions, growing location, quality (storage condition affects Quality) and heating that could result to maillard reaction and enzymatic activities, whereas, the least mean score in sample B (TGX814496) could be as a result of much presence of aldehydes and ketones especially the xenals and heptals that causes off flavour in soy milk.

Mouth feel/texture: The mean sensory score in terms of mouth feel/ texture ranges from 6.45±1.39 to 7.25±1.37. SAMSOY 2 (Sample D) has the highest mean score of 7.25 mean score of 6.45±1.39. There is no significant difference observed between the Samples at ($p>0.05$). Although sample D (SAMSOY 2) was the highest and sample B (TGX814496) has the least mean score. The reason for the highest score could be as a result of processing methods and conditions, quality of the soybean which will eventually affect the quality of the soymilk, maturation and variety of the soybean and distribution of fat evenly in the soymilk.

General acceptability: The mean sensory score in terms of general acceptability ranges from 7.05±1.54 to 7.75±1.37. The highest general acceptability was observed in sample D (7.75±1.37) while the least was found in sample E (7.05±1.54). Sample D differ significantly ($p<0.05$) from other samples except in sample B and C where there is a slight difference ($p<0.05$). Also Sample E being the least in the sensory showed a slight difference ($p<0.05$) from sample B and C but did not show significant difference ($p>0.05$) from sample A. Also Sample D showed significant difference ($p<0.05$) from sample A (TGX4482E) and Sample E (SAMSOY 3) while there was slight difference observed in sample B and C. The highest mean score in terms of general acceptability obtained in decreasing order of magnitude includes; Sample D (7.75±1.37) > Sample C 7.45±1.15 Sample B 7.35±2.35 Sample A 7.2±1.11> Sample E 7.05±1.54. Hence, from the above statistical scoring, Sample D was preferred in terms of general acceptability and that could be due to the all other factors affecting the colour, taste, mouth feel, flavour/aroma of the soymilk, depending on the soybean variety which is influenced by the quality, storage conditions, maturation, climatic conditions, processing methods and conditions.

Hydrogen ion concentration (pH): The mean pH of soymilk from different varieties of soymilk is shown in Table 5.

The pH values of soymilk ranged from $6.18±0.03^a$ to $6.28±0.03^a$. Sample B (TGX814496) had the highest pH value of 6.28±0.03 and sample C (SAMSOY 1) had the least pH value of 6.18±0.06. These results were in agreement with the findings of Udeozor (2002) who reported that plain soymilk has pH of 6.34. Also the mean pH value for the sample A (TGX4482E), sample B (TGX814496), sample C (SAMSOY 1), sample D (SAMSOY 2) and sample E (SAMSOY 3) showed no significant difference $p>0.05$. Although the variation in the values could be due to the concentration in ash content of the soymilk.

Conclusion: The increase in protein demand in developing countries led to efforts in finding an alternative source of protein especially from plant origin which will be cheaper than the animal protein and still provide protein close to the animal protein. This was found among the leguminous crops especially soybean and was used to produce soymilk which is highly recommended for developing countries such as Nigeria because of the availability of soybean in commercial quantity. Soymilk is nutritious except for its low micronutrient content as have seen from this research work. The research carried out showed that SAMSOY 2 was highly preferred in terms of sensory evaluation but of poor nutritional value especially in the micronutrient composition (Vitamins and minerals) compared to TGX

4482E, TGX 814496, SAMSOY 1 and SAMSOY 3. On the basis of protein, fat, crude fibre and ash content, TGX 4482E exhibited more desired quality than other varieties. According to Khatib *et al.* (2002), higher protein varieties are recommended for soymilk production. However, for general acceptability in the market, it is necessary to consider both the nutritional quality and sensory quality. Since objective evaluation must not compromise subjective evaluation.

Despite the findings from this research work it is important to research more on the best variety that will produce better result in terms of both sensory and nutritional quality evaluation which enhances general acceptability. Therefore, SAMSOY 2 is recommended for soymilk production in terms of sensory evaluation but need to be enriched with other essential nutrients and micronutrients lacking in it as this will enhance its acceptability based on its nutritional quality. Since soymilk has both nutritional benefits and health benefits, it is therefore recommended for both adult and children as alternative milk to cow milk.

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