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Evaluation of mineral in the indigenous and industrially produced soya milk in the Anyigba, Kogi State.

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Abstract *The aim of this research is to assess some mineral elements in both local and commercial produced soya milk. The samples from locally and industrially produced soy milk were digested with nitric acid and determined at appropriate wavelength with atomic absorption spectroscopy. The mean concentrations (mg/kg) of the selected elements are: 180 ± 0.02 (K), 1.50 ± 0.02 (Mg), 0.63 ± 0.01 (Fe), 1.50 ± 0.01 (Zn) and 4.90 ± 0.01 (Mn) but Na was not detectable (ND) in local soy milk. Whereas the mean concentrations (mg/kg) in commercially produced soy milk are 160 ± 0.01 (K), 2.12 ± 0.02 (Fe), and 2.63 ± 0.01 (Mn) but Na, Mg and Zn were ND. The concentrations of these elements were compared with Food and Agriculture Organization as well as World Health Organization nutritional recommendation standards, in order to ascertain their regulatory compliance. The results showed that locally made soy milk was rich in micro-nutrients than the commercially produced ones and also, a good source of Mg and Zn.*

Key Words: *Soya beans, milk, processing methods, mineral elements*

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1.0 Introduction

Chemical composition of any food and food materials can analysis be assayed through analysis of its proximate, elemental, phytochemical, vitamins, antioxidant and toxicant content (Eddy and Ekop, 2005) However, nutritional requirements of the body essentially include proximate, vitamins and mineral compositions. Proximate and vitamin components requirement are easily achieved through the consumption of food but mineral or essential elements requirement are hardly sufficient in most food and food materials (Aletan 2018). Several studies have indicated that during food processing, highest percentage of nutrient loss involves mineral elements indicating that little of such mineral is available for human nutrition (Eddy and Udoh, 2005).

Soybeans is a well know leguminous plant that contain up to 40 and 20 % of protein and fat respectively. Due to its outstanding source of plant protein (which is more preferred than animal protein) , soya beans is commonly used in fortifying several food products (Ladokun & Oni, 2014; Rizzo & Baroni, 2018). According to Liu (1997), soybeans also contain phospholipids, vitamins, and minerals. It also contains biological active minor substances including trypsin inhibitors, phytates, and oligosaccharides and isoflavones (which has powerful ability to prevent human cancers and other diseases) (Bansal and Kaur, 2014). The soya beans have numerous nutritional advantages including prevention of severe diseases like heart problem, osteoporosis and cancer. Also, its low level of cholesterol made it generally acceptable in food diets and prevent high blood pressure (Bansal & Kaur,2014). About 1% reduction in cholesterol level could reduce to 2-3% risk of having coronary heart disease (Anderson, 1995). However, despite all its protein content, it contains compounds such as polyphenols and phytoestrogens having a related structure as endogenous estrogens, raise worries about its safety when used at high dose (Ko, 2014; Kumar et al., 2017). In Asia and Africa continents, soya plant is used for feeding cattle for the production of hybrid (Gerber et al., 2013). Wijewardana et al . (2018) stated the presence of protein, palmitic and linoleic acids, sucrose, raffinose, stachyose, N, P, K, Fe, Mg, Zn, Cu, and B as some of the elements presence in soybean. There are several options that are available for processing soybean milk. However, the most popular method is the local methods which is very common among many Nigerians households. Since mineral nutrition is one of the major nutritional challenges, the present study is aimed at comparing the mineral content of locally and commercially processed soybean milk.

2.0 Materials and Methodology

All the plastic containers, glass wares, muslin cloth are thoroughly washed, rinsed with distilled water and dried at ambient temperature. Reagents used were of analytical grade and included nitric acid, per-chloric acid and others. Atomic absorption spectrophotometer (AAS) model PU9100x, pH meter, fume cupboard, thermometer and thermostatic refrigerator were in good order.

2.1 Sample collection

Soya beans were purchased from Ayingba market in Kogi State. They were collected in a clean leather bag and its identity as Glycine *max* was confirmed by a botanist in the Department of Botany, Kogi State University (KSU). They were stored at room temperature before processing them to soya milk. The commercially available soy beans mild were bout from a commercial store in Ayingba.

2.2 Sample preparation

Small stones and damaged soya beans were removed from the soya bean samples. About 300 g of soya beans were soaked in 2 L of warm water for 6 h in order to remove the outer layer before crushing. After soaking, the samples were removed and washed with distilled water before crushing with a laboratory blender in the presence of 500 ml of water. The slurry obtained was sieved through muslin cloth. The filtrate was heated at 100 °C for 25 minutes before allowing it to cool to room temperature. The synthesized soy bean was preserved in a refrigerator before analysis.

2.3 Digestion of samples for mineral analysis

Concentrations of K, Mg, Fe, Zn and Mn in soybean milk samples were determined using atomic absorption spectrophotometer (AAS) model PU9100x. The steps adopted included sample digestion, preparation of standard solution, preparation of calibration curves and aspiration of the digested sample to the AAS sample injection system. Sample digestion is necessary in order to masked components that are not needed for the elemental analysis. About 50 ml of the soybean samples was digested using 5 ml of trioxonitrate (V) acid. The product was filtered into a 250 ml beaker and made up to 30 ml with distilled water. Maximum wavelength of absorption for the respective elements were obtained and absorbance measurements for the elements were done with reference to these wavelengths. Standard solution of Na, K, Mg, Zn and Mn were prepared and absorbances obtained were used to prepare calibration curves for the elements. The digested sample was in turn aspirated into the atomic absorption spectrophotometer (whose absorbance was pre-set to the wave length of interest). Concentration of each metal ion was deduced through extrapolation from their respective calibration curve (Yahaya *et al*., 2012).

Statistical Analysis

The data were analyzed for analysis of variance (ANOVA), mean, standard deviation and T-test were done using Statistical Programs for Social Sciences (SPSS) application software. Statistical significance was established when $p < 0.05$.

3.0 Results and Discussion

Mean concentrations of sodium, potassium, magnesium, iron, zinc and manganese ions in locally prepared and commercial soybean milk are recorded in Table 1. The results obtained indicated that mean concentration of sodium in both locally processed and commercial soybean milk were below detectable limit. This suggest that if sodium was present in the crude sample, it must have been loss during processing. Eddy & Ekop (2005) have stated that nutrients can be loss during processing. Sodium is an alkali metal. The metal and its salts are soluble in water. This implies that during the processing stages, the elements must have been removed. Etiosa *et al*.(2017) stated that the sodium content of raw soya beans seed is 3.0 mg/100 g. This indicate that a slight leaching of sodium ion during processing can significantly reduced the sodium content of the milk.

Table 1: Mean concentrations of some elements in locally prepared and commercial soybean milk.

Elements (mg/L)	Local soya milk	Industrial soya milk	FAO/WHO (1997) Recommended nutrient intake (mg/day) (Anisu and Anjuman, 2016)
Na	ND	ND	-
K	180 ± 0.02	160 ± 0.01	-
Mg	1.50 ± 0.02	ND	260
Fe	0.63 ± 0.01	2.12 ± 0.02	23
Zn	1.50 ± 0.01	ND	7.0
Mn	4.90 ± 0.01	2.63 ± 0.01	-

**** Mean ± standard deviation of triplicate analysis**, **ND = not detected**

Magnesium ion was undetectable in the commercial samples of the soybean milk but mean concentration of magnesium in the locally produced soybean milk. FAO/WHO recommended daily intake of magnesium is 260 mg/day, which is significantly greater than the mean concentration of magnesium in the produced soybean milk. Therefore, the soybean milk alone cannot meet the daily recommended dosage of magnesium ion. Etiosa *et al*. (2017) reported that magnesium content of crude soybean seed is 258.24 mg/100g. This indicate that excessive concentration of magnesium was lost during the processing. Magnesium is needed for several biochemical reactions in the body, in maintenance of normal nerve and muscle functions, supports a healthy immune system, sustenance of a steady heartbeat, strengthening of bones and in the adjustment of blood glucose level (Vormann, 2016). Mean concentration of iron in locally produced soybean (0.63 ± 0.01 mg/L) was lower than the mean concentration in the commercial samples (2.12 ± 0.02 mg/L). However, recommended daily intake of iron is 23 mg.L which is significantly higher than the measured concentrations. The higher concentration in the commercial soybean milk might have been contribution by fortification process which is normally carried out on commercial food products due to nutrient loss during their processing. Neither the commercial or locally produced soybean milk can meet the iron requirement for the body, therefore, consumers must seek for other source of iron ions if their mineral nutrition must be balanced. Iron is a vital element in human nutrition. It is an essential element in hemoglobin and iron deficiency can lead to anemia (*Lieu et al., 2001)*.

Mean concentration of potassium ion in locally processed and commercial samples of soybean milk were 180 ± 0.02 and 160 ± 0.01 mg/L. The recommended nutrient intake for potassium is 141.0 mg/L. Therefore, daily consumption of locally and commercially produced soybean milk can provide the recommended daily potassium requirement for the body. Nutritional roles of potassium ion have been linked to their electrolytic properties (Stone *et al*., 2016). Potassium aid in regulating fluid balance of the body, muscle contraction and nerve signals. High potassium rich diets have been reported to be useful in regulating blood pressure, water retention capacity of the body and prevent osteoporosis and kidney stone. (He and MacGregor, 2008).

Zn is necessary for proper functioning of enzymes, cell growth and replication as well as deoxyribonucleic acid (DNA) repair (Haug *et al*., 2007; FAO, 2011). Mean concentration of zinc ion in the locally produced milk was 1.50 ± 0.01 mg/L but zinc ion was absent in the commercial soybean milk samples. However, the recorded concentration is below the recommended intake of zinc. According to Etiosa *et al*. (2017) crude soybean seed contain up to 2.7 mg/100g of zinc which indicating that the observed low concentration of zinc can be attributed to leaching during the processing.

Manganese was present in both the locally produced (4.90 ± 0.01 mg/L) and commercial soybean milk samples (2.63 ± 0.01 mg/L). Manganese is needed by the body for protein and amino acid digestion and utilization, in cholesterol and carbohydrate metabolism, normal liver functioning and in utilization of vitamins including choline, thiamine, and vitamins C and E (Keen and Zidenberg-Cheer, 2003)

Comparison of the mean values obtained from the locally and commercial soybean milk through simple T-tes indicated T_{Cal} (0.713053) to be less than $T_{Critical}$ for both one tail (2.131847) and two tail (2.776445). Therefore, there is no significant difference between the mean concentration of mineral elements in locally produced and commercial soybean milk. Also, results obtained from analysis of variance (Table 2) indicated that calculated F-value for the processing method (i.e locally and commercially produced soybean milk) is less than the critical F-value indicating that the two methods do not differ significantly.

Table 2: Analysis of variance for locally and commercially produced soybean milk

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F critical*
Elements	45353.71	4	11338.43	303.5974	3.23E-05	6.388233
Methods	56.54884	1	56.54884	1.51415	0.285921	7.708647
Error	149.3877	4	37.34692			
Total	45559.64	9				

However, when considering the individual elements, there could be a significant difference. A T-test statistic can also be used to test the significant difference between two data set if their means and standard deviations are known. The applicable T-test equation is given by equation 1,

$$T_{Cal} = \sqrt{\frac{\bar{X}_1 - \bar{X}_2}{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_1}}} \quad (1)$$

where $\bar{X}_1$ and $\bar{X}_2$ are the mean of the first and second samples respectively while their corresponding standard deviations are S_1 and S_2 . n_1 and n_2 are the sample size of the first and second data set respectively. The tabulated T value is 2.776 for 4 df. Calculated T values for potassium, iron and manganese are 346.4102, 94.55157 and 15.32409 respectively. Therefore, there the mean concentration of potassium, iron and manganese in locally prepared soybean milk is significantly higher than the concentrations in the commercial product.

4.0 Conclusion

The results and findings of the study reveals that concentrations of potassium, magnesium, zinc and manganese in the locally produced soybean milk is significantly higher than those in the commercial product. However, the commercial has significant higher concentration of iron than the locally produced soybean milk. There is no significant difference between the local and commercial methods of producing soybean milk. Commercially produced and locally produced soybean milk can meet the daily recommended intake of potassium and manganese but may need to be fortified with sodium, magnesium, iron and zinc if their nutritional role must be enhanced.

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Conflict of interest

The authors declare no conflict of interest.

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