



# INVESTIGATING THE MINERAL COMPOSITION OF PROCESSED CHEESE, SOY AND NUNU MILKS CONSUMED IN ABUJA AND KEFFI METROPOLISES OF NIGERIA

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## ABSTRACT

Milk and its products are needed for proper body building. Processed cheese, *nunu* and soy milk consumed within Abuja and Keffi metropolises were analyzed for their mineral contents.  $X_1$ ,  $Y_1$ ,  $Z_1$  represents soy milk, *nunu* and cheese from Abuja metropolis while  $X_2$ ,  $Y_2$ ,  $Z_2$  represents sample from Keffi metropolis respectively. Calcium ( $265.53 \pm 0.25$  mg/mL), iron ( $1.19 \pm 0.92$  mg/mL), potassium ( $162.77 \pm 0.02$  mg/mL) were found to be higher in cheese milk ( $Z_1$ ) from Abuja than that ( $225.82 \pm 0.13$  mg/mL,  $1.05 \pm 0.60$  mg/mL and  $130.41 \pm 0.04$  mg/mL) found in Keffi ( $Z_2$ ) examined respectively, though the amount of sodium present ( $151.0 \pm 0.08$  mg/mL) in cheese ( $Z_2$ ) from Keffi is slightly higher than that ( $150.08 \pm 0.01$  mg/mL) from Abuja ( $Z_1$ ). Also, Soya milk from Abuja ( $X_1$ ) had highest amount of zinc ( $0.76 \pm 0.00$  mg/mL) while that of Keffi ( $X_2$ ) was  $0.65 \pm 0.3$  mg/mL, for magnesium and copper, higher values  $18.40 \pm 0.10$  mg/mL and  $0.25 \pm 0.02$  mg/mL were recorded for soy milk ( $X_2$ ) from Keffi while soy milk from Abuja ( $X_1$ ) had  $17.97 \pm 0.20$  mg/mL and  $0.16 \pm 0.01$  mg/mL respectively. Chromium was detected in both cheese samples but not detected in soya and *nunu* milks from both metropolises. It is seen from the investigation that cheese had more minerals followed by soya milk. *Nunu* milk sample had the least quantity of minerals; also all the samples analyzed have minerals present in them. Therefore, they are needed for the proper functioning of the body system

**KEYWORDS:** Analysis, Concentration, Milk, Mineral, Metropolis, Flame Atomic Absorption Spectroscopy.

## INTRODUCTION

Milk products nowadays are considered as good sources of nutrients for human health throughout the world (Steijns, 2001). It is the raw material used in processing and manufacture of other milk products for example butter, kefir, cheese, margarine, soymilk, Wara, whey, skim milk, sour cream, yoghurt, buttermilk, acidophilus milk, ice-cream, *kunu*, fermented cow's milk (*nunu*), mayonnaise and many others (Singh *et al.*, 2014). These milk products may be consumed in original form or they may be mixed with fruits, grains, and nuts to yield delicious beverages, snacks, desserts, breakfast foods, or a light lunch. Obviously, the nutritional value of any food product depends on its composition. Milk products constitute an important group of foods. They include vitamins, minerals, fats, water, enzymes, carbohydrates and proteins, they help in body growth, energy supply, maintenance and repair of body tissues and appetite satisfaction, thus it is used for drinking purpose. They are important in uptake of vitamins (Fox & Cameron, 1989).

Dairy products are considered an excellent source of calcium, phosphorus and magnesium, which are highly bioavailable, these minerals in optimum ratio are present in milk and its products and are required for optimum growth and maintenance of bones (McKinley, 2005; Aneja *et al.*, 2002). Milk is also considered an excellent source of protein, riboflavin (vitamin B2), thiamin (vitamin B1), vitamin B12, folate, niacin and zinc (McKinley, 2005). The Presence of phosphorous in the milk is essential for controlling acid base balance, energy metabolism and also organizes the cell membrane structure. Phosphorous collaborate with milk calcium and works to sustain the hardness of bones and teeth.

The main minerals present in milk are: Sodium, Magnesium, Phosphorus, Chlorine, Potassium, Calcium, copper and Zinc which are good for man's growth and development. Milk like *nunu* when preserved well can be nourishing and refreshing and can be purchased at a low cost. (Nebedum & Obiakor, 2007).

They are also required for body building and control of metabolic processes e.g. nerve impulse transmission

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(Tull, 1996). Since there are different sources of milk samples available, sufficient information regarding their minerals, protein, fat, carbohydrate and fiber content etc. are not well known among the consumers of these products. Therefore, there is the need to evaluate the quality of milks (*nunu* and soya) and milk product (cheese) consumed by the people within Abuja and Keffi Metropolises. This is to enable the people to know their various compositions and to buy products that are healthy and more nutritious.

## MATERIALS AND METHODS

### Materials

The following were used for this analysis: *nunu*, Soya beans, cheese, pH meter and Flame Atomic Absorption Spectrometer.

### Methods

#### Sample Collection

The '*nunu*' (1 L) each was gotten from three (3) Fulani women in Apo Abuja and Akwanlabu in keffi Area of Nasarawa State respectively this was homogenized then paled in a clean container. The cheese (250 g) were purchased from three (3) well-known supermarkets in both metropolises, these were homogenized while the soybeans (500 g) were purchased from village market (Garki) in Abuja and from (Sowokasuwa) market in Keffi, these were kept in a safe place for preparation.

#### Sample Preparation

The homogenized *nunu* and cheese samples from the two different metropolises were labeled correctly and kept in a refrigerator at 4°C under aseptic condition until they were used for analysis.

#### Production of Soya milk.

Soya milk was produced by modified method described by Belew & Belew (2007). Soybeans (500 g) were soaked for 12 hours in a one and half litres of clean warm water. It was later blanched with 3 liters of water (65°C) for about 5 minutes so as to inactivate lipoxigenase and other anti-nutritional factors. The blanched beans were drained, dehulled and ground with 325 ml of portable water in a Q-link auto clean blender (model-365 XG). The resulting slurry was filtered through a small diameter white cloth and the extract (milk) obtained was pasteurized at 80°C for 25 minutes to destroy pathogenic microorganisms and then stored in a sterile container with cap in refrigerator after labeling. This method of preparation was used for both samples from Abuja and Keffi.

#### Mineral Analysis

The samples were ashed and the ash obtained was used for mineral composition determination. The ash was digested on a steamed water-bath with 20 % nitric acid, cooled and diluted with de-ionized water in 25cm<sup>3</sup> volumetric flask, filtered, made-up to mark, transferred into capped plastic bottles, labeled accordingly and kept at room temperature followed by sample analysis for mineral contents (Ca, Mg, Fe, Na, K, Zn, Cu and Cr) using Flame Atomic Absorption Spectroscopy (FAAS) method. The machine was calibrated with buffers at different frequencies and linear graph obtained before using the samples. The data obtained were used to calculate the concentrations of the elements using the formula:

$$\text{Elements (mg/ml)} = \frac{C \times V \times d.f}{W (g)}$$

Where: C is concentration, V is volume of which the sample was made-up to, W is the weight of the sample used, and d.f is dilution factor used.

## RESULTS AND DISCUSSION

Mineral elements are the most important component of foods which play many roles in chemical and biochemical body processes. Table 1 shows the mineral composition of the milk samples, calcium composition for the milk samples X<sub>1</sub>, X<sub>2</sub> (soy milk), Y<sub>1</sub>, Y<sub>2</sub>, (*nunu*) Z<sub>1</sub> and Z<sub>2</sub> (cheese) were (40.22±0.04, 43.85±0.01, 106.01±0.00, 156.0±0.06, 265.53±0.00 and 225.82) mg/mL for Abuja and Keffi respectively. Cheese from Abuja (Z<sub>1</sub>) has the highest value (265.53±0.00 mg/mL). This value for cheese was lower than the value as reported by Nazim *et al.*, (2012) as (1284.30± 4.68 mg/mL). Sample Z<sub>1</sub> was higher than sample Z<sub>2</sub> collected from Keffi. The calcium content of both soy milks in the result of this study is in agreement with the reported work (44.5± 36mg/mL) of (Nwoke Faith *et al.*, 2015 & Udezor, 2012). The calcium content of sample *nunu* was lower than that of sample cheese. The reason for this difference could be due to added coagulants in cheese production. Kato *et al.*, (2002) have showed in their experiments with rats that milk calcium taken with cheese (sample Z) was better absorbed than calcium taken without cheese. The calcium content of sample Y<sub>2</sub> was higher than the corresponding sample Y<sub>1</sub>. This high calcium content in sample Y may be due to forage consumed by cows. The result of this study for sample X calcium content was low but in agreement with the reported work (40 to 44 mg/mL) of Udezor (2015) for unfortified soya milk. This low calcium content in sample X may be the reason why manufacturers fortify soymilk with calcium. Furthermore, animal milk products have high calcium bioavailability than other sources like plants milk, this could be partly because the contents of animal products was highly phosphorylated fragments of caseins, named caseinophosphopeptides (CPPs) (Peres *et al.*, 1999). These CPPs has the ability to form CPPs-metal ion complexes, which would potentially increase calcium bioavailability (Dupas *et al.*, 2009). The health aspect of cheese focuses on the role played by this specific mineral but also the roles played by protein and lipid cannot be ignored. Calcium is required for bone formation in both infants and adults to prevent osteoporosis, for cell membrane permeability, for blood clotting, muscle response and enzyme activation (Cashman, 2002).

The result for Magnesium content of the milk products for this study was 17.97±0.20, 18.40±0.10 mg/mL for sample X<sub>1</sub> and X<sub>2</sub>, 9.12±1.76, 10.20±1.25 mg/mL for sample Y<sub>1</sub> and Y<sub>2</sub> and 4.05± 1.24, 3.05±0.90 mg/mL for samples Z<sub>1</sub> and Z<sub>2</sub> (Table 1). Sample X<sub>2</sub> gave the highest value and this value 18.40± 0.20 mg/mL was within the range of 10 to 19 mg as given by the USSDA, (2005) from Nutrient Database for Standard Reference. However, the value of magnesium obtained for samples Z in this study was lower than the reported value of 9.50 mg/mL by Holland *et al.*, (1995). The reason could be due to loss of this mineral during processing methods which lowers the nutrient germ and bran of the cheese. The Iron content for the milk were 0.5± 0.30, 0.58±0.25 mg/mL for samples X<sub>1</sub> and X<sub>2</sub>, 0.07±0.27, 0.13±0.12 mg/mL for sample Y<sub>1</sub> and Y<sub>2</sub> and 1.19±0.92, 1.05 mg/mL for samples Z<sub>1</sub> and Z<sub>2</sub> (Table 1). Sample Z<sub>1</sub>

has the highest Iron value; this was reflected in the high ash content of this milk sample. The value for sample Y ( $0.07 \pm 0.27$  mg/mL) was the same as that obtained by Amistu *et al.*, (2015). Sample X provides more iron ( $0.5 \pm 0.30$  mg/mL) than sample Y. The result of sample X in this study is close to the value reported by USDA, (2005) which is 0.6mg. Iron is responsible for the transport of oxygen throughout the body; it helps in red blood cell formation. Enough consumption of iron will help prevent impaired intellectual development in children, lead poisoning in children and prevent anemia in both adults and children (Cousin, 2006). It is also an essential component of hundreds of protein and enzymes (Rolfes *et al.*, 2014). Soya milk consumption will help the body to acquire more iron in the body than other products unless they are fortified with iron.

Zinc and Copper which are trace elements are also present in the samples but in minute levels. Zinc values for the milk sample were  $0.76 \pm 0.00$ ,  $0.65 \pm 0.03$  mg/mL for soya milk ( $X_1$  and  $X_2$ ) from Abuja and Keffi respectively, ( $0.08 \pm 0.01$ ,  $0.29 \pm 0.02$  mg/mL for *nunu* (Y) samples and  $0.06 \pm 0.00$ ,  $0.048 \pm 0.00$  mg/mL for cheese (Z) samples from Abuja and keffi respectively. The values for cheese (Z) and *nunu* (Y) were lower than the reported value of  $0.61 \pm 0.35$  mg/mL by Nazim *et al.*, (2012) and  $0.29 \pm 0.00$  mg/mL of Amistu *et al.*, (2018) respectively. The observed differences could be due to difference in the breed of cow used and the milking condition of the cows from the different places. Sample  $X_1$  ( $0.76 \pm 0.00$  mg/mL) was higher than the value reported by USDA nutrient database for standard reference which is 0.23mg. The reason could be due to variety of soya beans used, growing conditions and soil profile of the area in which the soya beans was grown. Zinc value for sample X from both Abuja and Keffi is higher in vegetable protein than animal protein. Zinc functions as an antioxidant, aids in maintaining healthy bone structure (Saltman & Strause, 1993), maintains healthy immune functions, healthy vision and supports normal fetal growth (Simmer *et al.*, 1991).

The level of copper in the milk samples are presented in Table 1 Soymilk gave  $0.16 \pm 0.01$  mg/mL,  $0.25 \pm 0.02$  mg/mL of copper for sample  $X_1$  and  $X_2$ . Samples  $Y_1$  and  $Y_2$  gave  $0.08 \pm 0.00$ ,  $0.12 \pm 0.06$  and samples  $Z_1$  and  $Z_2$  gave values  $0.04 \pm 0.02$ ,  $0.032 \pm 0.04$  respectively. Copper is essential for enzymes that help to synthesize collagen. It is also a critical component of the enzyme superoxide dismutase (SOD) which acts as a catalyst in the formation of hemoglobin (Harris, 2000). The copper value for sample Z and Y from Abuja in this research are  $0.04 \pm 0.02$  mg/mL and  $0.08 \pm 0.00$  mg/mL respectively, it was found to be lower than the value reported by Nazim *et al.*, (2012) for cow milk cheese  $0.25 \pm 0.03$  mg/mL. Sample  $X_2$  from Keffi

$0.25 \pm 0.02$  mg/mL was higher than the other samples and this could be due to good vegetation and soil type in the soya beans cultivation area.

Potassium is one of the intracellular cations and the levels of potassium in this study as presented in Table 1 were  $80.50 \pm 0.02$ ,  $80.95 \pm 0.04$  mg/mL for sample  $X_1$  and  $X_2$  respectively. This value did not show any difference in mineral content of soymilk from Abuja and Keffi. The USDA nutrient database for standard reference (2005) reported value of 141.0mg for soya milk (X samples) and 150.0 mg for cow milk (Y samples) but the result of this study was lower than their report. The result for sample  $Z_1$  from Abuja ( $162.77 \pm 0.02$  mg/mL) was higher than the findings of Wong & Alford (1978), Holland *et al.*, 1995) who reported  $134.1 \pm 0.00$  mg/mL and  $89.0 \pm 0.00$  mg/mL respectively, this value corresponds to the report of this study on sample  $Z_2$  from Keffi. This difference could be due to technology of production. Potassium found in most of the milk products and food we consume; so its deficiency (hypokalemia) is rare and it is very essential for life. The kidney filters excess potassium in the blood so that these concentrations remain stable. Kidney patients who have high potassium levels should check with their nephrologist before eating cheese because if the kidney cannot filter potassium they cannot filter phosphorous according to National institute of Diabetes, digestive and kidney disease.

The concentration of Sodium in the samples as seen on the Table are  $13.12 \pm 0.03$  mg/mL for samples soy milk from both metropolises of the study areas,  $46.21 \pm 0.07$  and  $46.80 \pm 0.26$  mg/mL for samples  $Y_1$  and  $Y_2$ ;  $150.08 \pm 0.01$ ,  $151.0 \pm 0.08$  mg/mL for  $Z_1$  and  $Z_2$  respectively. There was no difference in sodium content of milk samples from both metropolises. The result of sample  $Y_1$  ( $46.21 \pm 0.07$  mg/mL) is higher than the reported work of Wong *et al.*, (1978) but within the reported findings of Dadasah & Gupta (2015). The reason could be difference in breed and stage of lactation. Sodium in soy milk (X) was lower than that seen in *nunu* (Y) and cheese (Z). The high sodium content of sample Z ( $150.08 \pm 0.01$  mg/mL and  $151.0 \pm 0.08$  mg/mL) could be due to salt used in their preparation. Sodium has an adverse effect to hypertensive patients and in raising of blood pressure. A high salt intake increases the mass of left ventricles and thickens the arteries. It increases renal function deterioration and stroke. Hypertensive patients should take caution in taking cheese with high sodium content National Institute of Medicine, (2001).

Chromium metal was not found in soy and *nunu* milks but a little quantity ( $0.10 \pm 0.04$ ,  $0.16 \pm 0.03$ ) mg/mL was found in samples  $Z_1$  and  $Z_2$  respectively and this could be from the processing equipment's used in its making.

Table 1. Concentration of Mineral Elements in the milk Samples (mg/mL).

Samples	Ca	Mg	Fe	Na	Zn	K	Cu	Cr
X <sub>1</sub>	40.02±0.04	17.97±0.20	0.50±0.30	13.12±0.03	0.76±0.00	80.50±0.05	0.16±0.01	ND
Y <sub>1</sub>	106.01±0.00	9.12±1.76	0.07±0.27	46.21±0.07	0.08±0.01	83.03±0.01	0.08±0.00	ND
Z <sub>1</sub>	265.53±0.25	4.05±1.24	1.19±0.92	150.08±0.01	0.06±0.01	162.77±0.02	0.04±0.02	0.16±0.03
X <sub>2</sub>	43.85±0.01	18.40±0.10	0.58±0.25	13.12±0.03	0.65±0.03	80.95±0.04	0.25±0.02	ND
Y <sub>2</sub>	156.0±0.06	10.20±1.25	0.13±0.12	46.80±0.26	0.29±0.02	98.30±0.25	0.12±0.06	ND
Z <sub>2</sub>	225.82±0.13	3.05±0.90	1.05±0.60	151.0±0.08	0.048±0.00	130.41±0.04	0.032±0.00	0.10±0.04

= X<sub>1</sub> Y<sub>1</sub> and Z<sub>1</sub> represents soymilk, *nunu* and cheese from Abuja metropolis while

= X<sub>2</sub> Y<sub>2</sub> and Z<sub>2</sub> represent samples from Keffi metropolis.

= ND means not dictated

Values presented are mean ± standard deviation of triplicates.

## CONCLUSION

The nutritional values for the milk products are comparable; all the products had mineral nutrients but the mineral contents calcium, iron and potassium for cheese samples Z<sub>1</sub> and Z<sub>2</sub> are higher than the other milk samples. This could be attributed to the effects of the activities of men in Abuja Metropolis which affects the soil due to the high population of people. Sample X has high magnesium but calcium content is quite deficient while samples Y contain less Iron value. These findings will help consumers in their choice of products and be aware of the components of their diet, which must be chosen judiciously to provide all the nutrients needed by their body to function. It was also concluded that locations in which these milk samples were obtained affects their compositions

## RECOMMENDATIONS

Government agencies that monitor quality milk products will ensure that soya milk are fortified with calcium during large production; as well as iron in cow's milk. Consumption of vegetable source protein (soya milk) should be encouraged

Further investigation should be carried out to examine their microbial quality. The soya milk could also be developed to soy yoghurt and soy cheese and compare with animal cheese in terms of their nutritional value

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