Assessment of Mineral Composition of Milk from Selected Animals in Abakaliki Nigeria

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Abstract: This study aimed to assess the mineral composition of milk from selected ruminants reared within Abakaliki Local Government Areas of Ebonyi. Milk provides a good source of micro and macro nutrients and serves as a balanced diet for newborns of different animals. The concentrations of Cu, Fe, Zn, Co, Na, K and Ca, Mn and Mg were determined by atomic absorption spectrometry, while the concentration of P was estimated using the colorimetric method. Results showed that the mineral composition of milk from ranched and unranched West African Sheep and Red Sokoto Goat showed no significant difference (p>0.05) in their concentrations (mg/100g) of Zn, Mn, Na, K, Cu, Ca, Fe and Mg, while the ranced White Fulani cow milk showed higher concentrations of Zn, Mn, Cu, Fe and Mg. However, the concentrations of phosphorus in the unranched West African Sheep and Red Sokoto Goat were significantly higher (p<0.05) compared to the ranced. On the other hand, the pig milk showed higher concentrations of Na, Fe and K than the White Fulani cow milk. This study therefore, confirmed that the methods of rearing the studied animals have no significant difference in their mineral compositions and that pig milk can be a good alternative.

Key words: Milk · Mineral Composition · West African Sheep · Red Sokoto Goat · White Fulani Cow · Pig · Ranched · Unranched

INTRODUCTION

Milk is a whitish food generally produced by the mammary secretory cells of females in a process called lactation with very high nutritional value due to the balance of the nutrient components, it is one of the defining characteristics of mammals [1]. It is considered as nearly complete human food as well as the first and sole food for the newly born mammalian offspring [2]. The diet of adult carnivorous, herbivorous, or omnivorous mammals notwithstanding, all start life as lactivores. Milk provides the nutrients for metabolism, growth and development of animals [3].

Milk is an excellent source of macro- and micro nutrients and therefore can play an important role in helping individuals to meet their nutritional requirements [4]. Dairy animals are a key factor in household food security for small-scale livestock holders, who supply the vast majority of milk in developing countries [5].

Cow, goat and sheep milks account for about 87% of the global milk production [6]. However, minor dairy animal species are nutritionally and economically important in several countries [7]. Nutritional value of milk is closely related with its composition [8] compositions of goat, cow and human milks are different, varying with diet, breed, individuals, parity, season, feeding, management, environmental conditions, locality, stage of lactation and health status of the udder [9, 10]. Minerals play an important role in the structural organization of casein micelles, the main minerals present in milk includes: Na, Mg, P, Cl, K, Ca, Fe, Cu, Zn and I [11].

During lactation, there are significant changes in the amount and composition of milk [12]. Also, the mineral content may vary because of its handling by humans [13]. The composition of a species’ milk provides insight into its evolution, ecology, patterns of growth and development and many other aspects of life history [14]. The variability in milk composition, among individual
animals of the same breed, is attributed to an extensive and complex genetic polymorphism of the animal milk caseins [15, 16].

Due to rapidly increasing human population, the demand for milk and milk products is on the rise in the tropical developing countries. The increased demand can be met by increasing ruminant livestock population as suggested by [17]. Goat milk offers a wide variety of health benefits such as better digestibility because of its small sized globules, uniform protein, fat distribution and less lactose [18]. Unlike cow milk, which is slightly acidic, goat milk is alkaline in nature, which is very useful for people with acidity problems [19] less αs1 casein than cow’s milk and is, therefore, less allergenic [20].

Milk and dairy products contribute a lot to the recommended dietary intakes for some minerals, thus, knowledge of the minerals concentrations in milk samples and dairy products is of particular interest [21]. The breeding of dairy animals dates back to nearly 8000 years and so has opened up opportunities to improve eating habits, especially for infant feeding, as it is a raw material in the dairy industry. Milk must be specific to human consumption i.e. come from well-nourished healthy lactating animals. Quantitatively, cow milk is the raw material most widely produced and processed worldwide [22]. However, the milk of other mammals such as goats, sheep and pig could also be given attention to reduce the pressure on cow.

In Nigeria, cattle (Cow) provide more than 90% of the total animal milk output while goats and sheep provide less than 10% and are kept for production of meat, hides and skin [23]. The white Fulani popularly called ‘Bunaji’ is the most numerous and wide spread of all the Nigerian cattle breeds accounting for about 37% of the national cattle population [24].

This present study investigated the mineral composition of cow, sheep, goat and pig reared in Abakaliki Local Government Area of Ebonyi State, Southeastern Nigeria.

**MATERIALS AND METHODS**

**Sample Collection:** The milk samples used in this study were gotten from ranched and unranched (Goat, sheep, cow and pig) from Abakaliki Local Government Area of Ebonyi State Nigeria into sterilized bottles and the milk samples were preserved in a refrigerator prior to laboratory analysis. The samples were replicated in four places.

**Determination of Mineral Compositions of Milk:**

The concentrations of Copper (Cu), iron (Fe), zinc (Zn), Cobalt (Co), of Sodium (Na), Potassium (K) and Calcium (Ca), Manganese (Mn) and magnesium (Mg) were determined by atomic absorption spectrometry following the method previously reported by [25] while the concentration of Phosphorous (P) was estimated colorimetrically in the ash according to [26].

**RESULTS**

**Mineral Composition of Milk from Ranched and Unranched Sheep:** Figure 1 shows that the concentrations (mg/100mg) of Zn, Mn and Na varied in an insignificant manner, those of K, Cu, Ca, Fe and Mg were the same while a significant difference was observed in the concentrations of Phosphorus between the milk of ranched and unranched West African Sheep.

**Mineral Composition of Milk from Ranched and Unranched Red Sokoto Goat:** The concentrations (mg/100g) of mineral composition of ranched and unranched Red Sokoto Goat milk (Figure 2) shows that Zn, Mn, Na, K, Ca and Mg were different though their differences were insignificant, Phosphorus concentrations significantly varied in the two groups where as Fe and Cu concentrations remained the same.

**Mineral Composition of Milk from Ranched and Unranched White Fulani Cow:** The concentrations (mg/100g) of calcium were the same in the milk of both ranched and unranched White Fulani Cow. All the other mineral constituents including Zn, Mn, P, Na, K, Cu, Fe and Mg were slightly different in the ranched and unranched group.

**Mineral Composition of Pig Milk:** Figure 4 shows that manganese is the highest mineral in abundance in the milk of pig followed by Zinc, Calcium and Phosphorus in that order. The concentrations of Sodium and Potassium were the same while Magnesium was the least in abundance.

**DISCUSSION**

Milk is a biological fluid and food with vital importance for humans, mammals and especially newborns [27]. Milk and dairy products are important sources for meeting the daily requirement of essential elements [28]. Milk nearly contains all of the essential...
Fig. 1: Mineral composition of ranched and unranched West African sheep milk.

Fig. 2: Mineral Composition of Ranched and Unranched Red Sokoto Goat.

Fig. 3: Mineral Composition of Ranched and Unranched White Fulani Cow Milk.

Fig. 4: Mineral Composition of Pig milk.
nutrients as well as all the essential elements that will provide newborn growth [29]. However, the quantities of essential elements in the milk vary according to the race of the animal, the dietary pattern, the lactation period and the geographical region in which it is grown [30].

Milk is an important source of mineral substances, especially calcium, phosphorus, sodium, potassium, chloride, iodine, magnesium and small amounts of iron. Of these mineral constituents, calcium and phosphorus constitute a larger fraction in milk which is needed for bone growth and the proper development of newborns [31]. Milk and its products constitute a rich source of the mineral components that satisfy, to a great extent, men’s demand for calcium, phosphorus, potassium, magnesium and sodium [32]. The suitability of animal milk for the dairy industry, especially in cheese and yogurt production, depends on its elemental composition [33].

The mineral composition of milk of ranched and unranched West African Sheep (Figure 1), Red Sokoto Goat (Figure 2), White Fulani Cow (Figure 3) examined in this study showed no significant difference (p≥0.05) in the concentrations (mg/100g) of Zinc (Zn), Manganese (Mn), Sodium (Na), Potassium (K), Copper (Cu), Calcium (Ca), Iron (Fe) and Magnesium (Mg) which suggests that the above two methods of rearing these animals within Abakaliki Local Government Area of Ebonyi State have comparable effect on the selected mineral constituents. It also implies that the milk of both ranched and unranched West African Sheep, Red Sokoto Goat and White Fulani Cow can be relied on for the supply of these minerals to humans. However, the concentrations of phosphorus in the unranched West African Sheep and Red Sokoto Goat were significantly higher (p<0.05) compared to the ranched which could have resulted from disparity in the genetic make-up of the animals and inadequate supply of food rich in phosphorus to the ranched animals. It was also observed that the concentrations of calcium, magnesium and phosphorus were higher in red sokoto goat compared to the white Fulani cow which corroborates the findings of Park et al. [34] and Power et al. [35] who reported independently that Goat milk contains higher amount of Ca, Mg and P than cow and human milk.

Minerals represent a small fraction of milk and they are distributed in the soluble and the colloidal phase depending on the molecular form Rodrm Hgue et al. [36]. Calcium is mainly present in the colloidal phase (Bond to casein micelles and phosphoserine), Phosphorus and Magnesium are also partially bond to the casein micelles but in a lower proportion [37, 38]. Milk and dairy products provide 50% to 70% of daily Ca intake in human diet, which is crucial for bone and teeth health, along with P and Mg [39, 40].

Moreover, Ca, P and Mg play an important role for cheese manufacturing due to their influence on micelles properties (Structure and stability) which affect milk coagulation and curd rheology [41, 42]. Indeed, Ca, P and Mg are negatively associated with rennet coagulation time and curd firming time and positively associated with curd firmness and titratable acidity [43, 44]. The composition of magnesium in the milk of the ranched White Fulani cow were higher than those of the unranched Zinc is very important for growth, sexual development, the healing of wounds as well as normal functioning of the immune system and other physiological processes. The composition of zinc in the milk of the ranched White Fulani cow milk was higher than those of the unranched. Zinc is a component of the hormone insulin. It assists in the functioning of several other hormones that are important for reproduction and synthesis of DNA, RNA and proteins [45].

There was no difference in the composition of calcium in the milks of both the ranched and unranched White Fulani cow milk. Calcium is very important to human being. It is needed for tissue and bone development and adequate calcium intake is important for maintenance of bone health and may reduce risk of osteoporosis. Calcium can be obtained from foods naturally rich in calcium such as milk and dairy foods [43]. Iron as an essential trace element participates as catalyst in several metabolic reactions. As a component of hemoglobin, myoglobin, cytochrome and other proteins, iron plays an important role in the transport, storage and utilization of oxygen. It is also a co-factor of many enzymes [27].

Copper is an essential element that plays a critical role in oxidation-reduction reactions in mammalian metabolism [38]. Copper is also essential for the hemoglobin synthesis, absorption of iron and glucose metabolism [4]. It plays important for the absorption of iron and as cofactor of enzymes in glucose metabolism and synthesis of hemoglobin, connective tissues and phospholipids [18]. Copper deficiency in the human body is very rare, occurring only in cases of long-term starvation. Milk and dairy products are a poor source of copper [26]. However, it was observed in this research that the ranched White Fulani cow milk had higher concentrations of copper than the unranched counterparts.
The concentration of Manganese was higher in the ranched White Fulani cow milk compared to the unranched. Manganese is a specific enzyme co-factor involved in the synthesis of mucopolysaccharides and a non-specific co-factor for many other enzymes. There are several known manganese metalo enzymes like arginase, glutamine synthetase, phosphoenolpyruvatede carboxilase and manganese superoxidizedismutase [39]. Manganese can be found in significant quantities in all foodstuffs. Its deficiency has not been recorded as a cause of disturbance or disease. Cow milk is a poor source of manganese. Its contribution to the total manganese intake in western countries is low (1 to 3 %). Of the total dietary intake of manganese only 3 to 5 % are successfully absorbed. The remaining quantities are eliminated from the body through faeces [16].

This study has confirmed that the methods of rearing the studied animals gave no statistical difference in their mineral compositions.

REFERENCES


