



Proximate and Heavy Metal Compositions of Milk from Ewe, Cow, Goat, and Human

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Abstract. Fresh milk samples from ewe, cow, goat, and human of Nigerian stock were analyzed for proximate and heavy metal compositions. The human milk was lowest in crude fat (13.7%) and ash contents (0.61%), but highest in crude protein 4.77%. Goat milk was lowest in moisture (83.3%) and crude protein (3.11%); while cow milk, goat milk, and ewe milk were highest in moisture, crude fat, and ash contents respectively. The levels of Fe (0.21 to 0.51 mg/L), Zn (0.17 to 0.24 mg/L), Cu (0.19 to 0.89 mg/L), and Co (0.01 to 0.06 mg/L) in the samples were acceptable when compared to WHO limits, but higher in their contents of Cr, Mn, and Ni.

Keywords: fresh milk, heavy metals, proximate composition, Nigeria.

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1 Introduction

Milk is a white fluid secreted by the mammary glands of female mammals for the nourishment of their young that consists of minute globules of fat suspended in a solution

of casein, albumin, milk sugar and inorganic salts [9]. In most countries, the principal source of milk is the cow, but other animals such as sheep goats, buffaloes, camel and yak are also raised for milk production, particularly in the tropics. Nevertheless, the dairy cow produces more milk over longer periods than other animals [17].

All milk contains the same kind of constituents but in varying amount. Within a given species, genetic factors (breed), type of feed, nutritional status of the animal, stage of lactation, milking, environmental conditions, and storage (mode of preservation) influence the composition [11, 19, 22]. The major components of milk include water, fats, proteins, carbohydrates, minerals, organic acids, enzymes and vitamins. The quality of milk samples including infant formulas, milk powder, milk from markets, raw (unprocessed) milk, human milk and animal milk from various countries have been extensively studied [7, 8]. And many arguments on the quality of milk have ensued. Some people think pasteurized milk is milk from pasture. It is nothing but half-boiled milk that lacks nourishment. If given to calves, they die; if given to rats, they will fail to reproduce as it is considered as a form of birth control [18].

A cup of hot sheep milk before retiring to bed aids a peaceful night rest. This has been shown to be particularly beneficial for children and elderly people with a bedwetting problem [23]. Rashida [21] recommended a change to sheep and goat milk product to aid the treatment of asthma, eczema and other related problems. Milk is reported to be the antidote to aluminium poisoning from consumption of large amounts of tea and coffee.

Milk can provide a non-immune disease defence and control of microbial infections. Human milk provides protection against infection, sudden infant death syndrome, diabetes, and chronic digestive diseases [2]. Milk allergy is an example of a relatively rare nutrition related problem that can be life threatening but is easily treated with modified diet. Consequently in the United States, the safety of commercially

prepared infant formula is regulated by the Food Development Association on the recommendation of the American Academy of Pediatric Committee on nutrition, which specifies the levels of nutrients to be present in infant formula [2].

Lawrence and Willington [16] reported that the mineral contents in milk have fallen significantly in the past 60 years. Minerals and vitamin contents of goat and sheep milk are mostly higher than in cow milk [10]. Gupta [12] reported that the Zn, Cu, Mg and Ca content of preterm and term milk from Indian mothers were analyzed of different periods of lactation to examine their adequacy as a source of nutrients for preterm infants. Breast milk samples were obtained from 14 mothers who gave birth to preterm infants (mean gestation of 35 weeks) and from 50 mothers who gave birth to full term infants (mean gestation of 39 weeks) after normal pregnancy. The mean levels of Zn, Cu, Mg, and Ca were higher in breast milk of term mothers. The contents of raw milk of cows for 38 macro and trace elements in the Silesian region (Poland) studied by Dobrzanski *et al.* [8] showed that the location of cows had a significant impact on the minerals content of the milk.

Ikem *et al.* [13] analyzed infant formula samples sold in Nigeria, UK and USA for various essential elements (Ca, Co, Cu, Cr, Fe, Mg, Mn, Mo, Na, K and non essential elements (Ag, Al, As, Cd, Hg, Ni, Pb, Sb, Sn, Sr, Ti, Tl, U, and V. They found that soya beans powder infant formulas generally had highest element levels than milk based powder formulas. Some brands also had low nutritional contents when compared with the recommended dietary allowance (RDA) and dietary recommended intakes (DRI) for use in North America. Perveen *et al.* [20] investigated for Na, Cu, Mn and Cr in powdered milk and processed milk samples available in Pakistan, while Jaffer *et al.* [14] reported the levels of 12 metals (Ca, K, Na, Mg, Fe, Mn, Zn, Cd, Cr, Pb, Co and Ni) in 19 different imported brands of unexpired and expired canned dry milk. The following order of decrease in concentration was observed for unexpired and expired milk: Ca >

Na > K > Mg > Fe > Zn > Cr > Pb > Cu > Ni > Cd > Mn.

On a dry basis, the milk of all animals is fairly similar in composition being high in protein, fat and minerals. But on a fresh basis, milk of different farm animals varies considerably in percent water and dry matter content [24]. In this work, the proximate and heavy metals compositions of milk samples from cow, goat, sheep and human are determined and reported.

2 Materials and methods

2.1 Collection of the Milk Samples

Three fresh milk samples each from cow, goat, sheep (ewe), and human were collected in sterile polythene bottles by direct milking to give a total of twelve samples. The samples of cow, goat and ewe milk were collected from Fulani herdsmen in Jos North Local Government Area of Plateau State in Nigeria. The human milk samples were collected from a healthy breast feeding mother in Karu Local Government Area of Nasarawa State in Nigeria.

2.2 Proximate Analysis of the Milk samples

Proximate analysis of the milk samples includes the determinations of percent moisture, crude fat, ash, crude protein ($% N \times 6.38$). For each determination, triplicate analyses were done.

2.3 Determination of Heavy Metals Contents of the Milk Samples

5 ml of each sample was digested with 2 ml of concentrated nitric acid. 1 ml of perchloric acid was added, heated gently on a hot plate, followed by a vigorous heating till dryness. After cooling, the digested sample was quantitatively transferred to a flask and diluted to 1000 ml with distilled water and then filtered. Atomic absorption spectrophotometer (Solar 969) was used for the determination of heavy metals.

3 Results and discussion

Table 1 showed that the percent ash contents in the different milk samples varied from 0.97 (for ewe) to 0.61 (for human), lower than the ash content of 3.80% and 1.90% in infant formula and breast milk reported by Erhinyodavwe *et al.* [5]. The recommended ash content of milk is 1% [3]. The ash value is an empirical measurement of the mineral constituent of foodstuff volatile component which is very essential in nutrition. Cow milk contained the highest percent moisture (89.3%), while goat milk had the lowest moisture content (83.3%). Crude fat was lowest in human milk (13.7%) but highest in Goat milk (36.2%). Crude protein was highest in human milk (4.77%) but lowest in goat milk (3.11%). The human milk sample was lowest in crude fat (13.7%) and ash contents (0.61%), but highest in crude protein (4.77%). Etonihu and Etonihu [6] had earlier reported an average content of 85.23% moisture and 16.55% crude protein in cow milk from Keffi Local Government Area of Nasarawa State. Percent crude protein varied from 3.11% (goat milk) to 4.77% (human milk). Goat milk had the highest crude fat (36.2), while human milk was lowest in crude fat with 13.7%. The results are comparable to those by Khan and Zeb [15] who reported moisture content of 87.6% for cow and 82.1% for human milk; 6.7% crude protein for goat and 5.4% for human; and

Table 1: Mean percent proximate compositions of the milk samples*.

Milk Samples	Moisture	Crude Fat	Crude Protein	Ash
Ewe	87.30 ± 0.01	26.50 ± 0.01	3.49 ± 0.02	0.97 ± 0.03
Cow	89.30 ± 0.02	21.70 ± 0.01	4.12 ± 0.01	0.79 ± 0.01
Goat	83.30 ± 0.02	36.20 ± 0.02	3.11 ± 0.02	0.68 ± 0.01
Human	86.70 ± 0.03	13.70 ± 0.01	4.77 ± 0.02	0.61 ± 0.01
Mean	86.70	24.50	3.87	0.58
SD	2.50	9.41	0.73	0.26
CV%	623	8846	53.15	7.00
¹ Infant Formula	2.41	21.23	14.76	3.80
¹ Breast Milk	21.32	5.04	20.10	1.90

*Mean of triplicate determinations ± standard deviation; ¹Erhinyodavwe *et al.* [5].

crude fat of 29.8% for goat and 14.5% for human milk.

Lawrence and Willington [16] reported that the physicochemical characteristics of milk are related to its composition for a particular animal species. Sheep milk contains higher level of total solids and major nutrients than goat and cow milk. Lipids in milk of sheep and goat have higher physical characteristics than in cow milk and micelle structures in goat and sheep milk differ in average diameter, hydration and mineralization from those of cow milk [4, 25].

Generally, at the biochemical level, the toxic effects caused by excess concentrations of heavy metals include competition for sites with essential metabolites, replacement of essential ions, reaction with–SH groups, damage to cell membranes and reaction with phosphates group [1]. Co content was highest in cow milk (0.06 mg/L) but within the recommended limit for sheep and goat milk. Cu content ranged from

Table 2: Heavy metals content of the milk samples (mg/L)*.

Milk Samples	Cr	Mn	Ni	Fe	Zn	Co	Cu
Ewe (Sheep)	0.60	1.16	1.72	0.26	0.17	0.01	0.89
Cow	0.15	1.15	1.77	0.33	0.20	0.06	0.67
Goat	0.08	0.83	1.60	0.21	0.19	0.01	0.19
Human	0.09	0.75	1.53	0.51	0.24	0.04	0.55
Mean	0.23	0.97	1.66	0.33	0.20	0.03	0.58
SD	0.25	0.21	0.11	0.13	0.11	0.02	0.29
CV%	6.18	4.55	1.21	1.72	1.32	0.06	8.57
WHO HDL (mg/L)	0.05	0.05	0.02	0.30	5.00	0.02	1.00

*Mean of triplicate determination; SD = standard deviation;

HDL = highest desirable limit WHO [26].

0.19 mg/L (for goat milk) to 0.89 mg/L (for sheep milk) and below the WHO highest desirable limit (HDL) of 1.00 mg/L. Cr content ranged from 0.08 mg/L (for goat milk) to 0.60 mg/L (for sheep) higher than the HDL of 0.05 mg/L [26]. Mn was lowest in human milk (0.75 mg/L) but highest in sheep milk (1.16 mg/L) higher than the recommended limit of 0.05 mg/L. Ni ranged from 1.53 mg/L (for human milk) to 1.77 mg/L (for cow milk). The HDL by WHO is 0.02 mg/L for Ni. The Zn content of the milk samples ranged from 0.17 mg/L (for sheep) to 0.24 mg/L (for human) lower than WHO recommendation of 5.00 mg/L. High concentrations of Zn in the tissue of animal could lead to alteration of the stereochemistry of the enzymes and impairment of its catalytic activity. Fe was highest in human milk (0.51 mg/L) but lowest in goat milk (0.21 mg/L). Fe is important in animals because of its presence in hemoglobin for respiratory and blood circulatory processes.

4 Conclusion

The goat milk sample was lowest in percent moisture (83.3%) and crude protein (3.11%); while the cow milk, goat milk, and ewe milk samples were highest in moisture, crude fat, and ash contents respectively. The milk samples were higher in Cr, Mn, and Ni than their WHO recommended limits; while their contents of Fe, Zn, Cu, and Co are acceptable except for cow milk that had a higher Co content. Being good sources of most essential minerals, milk are highly suitable for the fortification of cereal products used as weaning foods for children in most parts of the world including Nigeria. In view of the high nutritional content of milk, and the current global economic melt down, citizens should be encouraged to consume dairy products to keep healthy.

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