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COMPARATIVE METHODS FOR DETERMINATION OF MIINERAL CONTENT IN HUMAN BREAST MILK

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ABSTRACT

The mineral content in human breast milk from five different lactating mothers was determined using a flame atomic absorption spectrophotometer (FAAS) for macro-elements (Ca & Mg) and inductively coupled plasma emission spectrophotometer (ICP-ES) for heavy metals (Fe, Mn, Zn & Cu) analysis. The fresh human milk sample was digested using chloroform, trichloroacetic acid and wet digestion procedures. The concentration of the essential elements for the wet digestion varied in the sequence Ca > Mg > Fe >Mn > Zn > Cu. The concentration of the elements compared favourably with WHO standard for human nutrition except for calcium and zinc. The concentration of toxic metal, Pb was lower than the tolerance level defined by the world regulation of 1992.

Keywords: comparative study, mineral content, breast milk, Jos north, Plateau

INTRODUCTION

Milk is a key contributor to improving nutrition and food security in developing countries. Improvements in livestock, dairy technology and milk quality may offer the most promising in reducing poverty and malnutrition in the world. Human breast milk is the milk produced by the breast (or mammary glands) of a human female for her infant off spring. Milk is the primary sources of nutrition for newborns before they are able to eat and digest other foods [1].

Human milk is a complete and variable fluid of increasing interest to human biologist who study nutrition and health [2]. It contains the vitamins and nutrients a newborn requires. Human milk also contains a balance of nutrients that closely matches infant requirement for brain development, growth and a healthy immune system [2, 4]. Human milk also contains immunologic agents and other compounds that acts against viruses, bacteria and parasites (increase immunological protection). Since an infant's immune system is not fully developed until the age of two, human milk provides distinct advantage over formula [5]. The most common reason mothers probably choose to breast feed is the knowledge that human milk is the superior in infant food. It contains live cells like those in blood. Some compounds of human milk also enhances the effect of other, so the ingredients of human milk work together for the benefit of the child [6]. Human milk is recommended as the exclusive nutrient source for feeding of an infant for the first six months of life and should be continued with the addition of solid foods after six months of age [7 - 9]. The aim of this research work was to compare the three extractive methods for the determination of the minerals content in human breast milk and to compare the result obtained with the WHO standards for food and nutrition.

MATERIALS AND METHOD

Sampling and Sample Treatment

Samples of raw human milk were collected from five lactating mothers in different areas of Jos North Local Government Areas of Plateau State. The lactating mothers were in the middle period of lactation i.e. from 2-6 months after delivery. The milk samples were collected closely from the mother's teat into a carefully washed plastic bottle to avoid contamination. The samples were then immediately refrigerated to prevent coagulation before analysis [10].

Chloroform Digestion

A 30 ml of fresh human milk sample was transferred into a 25 ml volumetric flask, 5 ml of chloroform and 70 ml of de-ionized water was added to the mixture to make up to 150ml solution. The mixture was then transferred into a separation funnel and shook for 15min to ensure proper mixing of the solution. The mixture was allowed to stand overnight for proper separation of aqueous and organic layer. After separation, the organic layer was discarded while the aqueous layer was collected for analysis [13].

Trichloroacetic Acid (TCA) Digestion

A 50 ml fresh human milk sample was transferred into a 250 ml volumetric flask. Exactly 50 ml of TCA and 50 ml of de-ionized water was added to make up to 150 ml solution. The mixture was transferred into a separating funnel and shaken for 15 minutes and allowed to stand overnight for proper separation. The aqueous layer was collected. Three drops concentrated acid was added and heated for 15 minutes and the coagulant were filtered. A colourless solution was obtained and then heated in a fume cupboard until all the fumes were given off, and the solution was taken for analysis [10].

Wet Digestion

A 30 ml of fresh human milk sample was transferred into a volumetric flask. Exactly 30 ml of de-ionized water and 5 ml of aqua regia mixture (6 ml HNO_3 and 2 ml HCl) was added and the mixture heated for 20 ml in a fume cupboard, and a solution of milk coagulant was obtained. The mixture was then filtered and further heated for 5 minutes with no further coagulation occurring indicating that no residue was left. The coagulants was filtered. The filtrate was made up to 50 ml with de-ionized water and heating continued until all fume disappeared [13].

Mineral Content Determination

The mineral content of human milk was determined using Flame Atomic Absorption Spectrophotometer (FAAS) and inductively coupled plasma emission spectrophotometer (ICP-ES) after proper sample digestion.

RESULT AND DISCUSSION

Table 1: Chloroform digestion (mg/l) in human milk

Sample	Metal concentration mg/l						
	Ca	**Mg**	**Cu**	**Mn**	**Zn**	**Fe**	**Pb**
A	100.20	13.65	0.04	0.21	0.78	1.27	0.02
B	106.40	13.87	0.02	0.38	0.13	1.56	0.05
C	162.10	11.62	0.07	0.35	0.50	4.25	0.04
D	103.90	13.19	0.04	0.50	0.20	2.50	0.04
E	131.82	11.85	0.06	0.44	0.33	2.83	0.02

Table 2: Trichloroacetic acid extraction (mg/l) in human milk

Sample	Metal concentration (mg/l)						
	Ca	**Mg**	**Cu**	**Mn**	**Zn**	**Fe**	**Pb**
A	197.90	12.09	0.06	1.33	0.44	1.29	0.03
B	181.80	11.44	0.01	0.39	0.04	2.37	0.04
C	183.10	11.13	0.12	0.41	0.27	3.90	0.02
D	160.20	13.98	0.04	0.11	0.09	1.10	0.05
E	192.40	12.09	0.12	0.53	0.38	2.82	0.03

Table 3: Wet digestion (mg/l) in human milk

Sample	Meta Concentration (mg/l) in Human Milk						
	Ca	**Mg**	**Cu**	**Mn**	**Zn**	**Fe**	**Pb**
A	321.70	11.14	0.06	0.38	0.43	2.56	0.05
B	204.20	12.20	0.07	0.37	0.34	2.78	0.02
C	222.70	11.51	0.06	0.36	0.20	4.65	0.07
D	231.40	10.02	0.09	0.65	0.26	3.90	0.09
E	305.60	11.92	0.08	0.43	0.54	3.60	0.02

TABLE 4: Result of chloroform digestion, trichloroacetic acid digestion and wet digestion in comparison With the WHO standards (1992) (mg/l).

Element	Chloroform Digestion	TCA Digestion	Wet Digestion	WHO Permissible Limit
Calcium	120.90±29.20	183.10±14.60	257.10±45.00	150.0
Magnesium	12.82±1.02	12.15±1.10	11.48±0.65	100.0
Copper	0.37±0.02	0.07±0.03	0.07±0.02	1.000
Manganese	0.37±0.11	0.55±0.25	0.42±0.14	1.000
Zinc	0.27±0.15	0.25±0.13	0.42±0.22	0.100
Iron	2.48±0.18	2.30±0.11	3.50±0.20	3.000
Lead	0.03±0.01	0.05±0.02	0.01±0.00	0.045

The concentration of the essential minerals in raw human milk from five different lactating mothers in this research work were in the sequence Ca > Mg > Mn > Zn > Cu (Table 4.0). Research has shown that metal concentration in human milk can vary due to the factors influencing its secretion from the mammary gland and also in addition to environmental and traffic pollution [12]. The toxic metal, lead was lower than the tolerance level defined by the world regulations. Breast milk can however be a pathway of material secretion of Lead. Lead impacts more severely on new born at the time of rapid development of central nervous system. Mother gets exposed to Lead through automobile emission in the urban areas [15]

As stated earlier, it can be seen that calcium and magnesium are among the major elements present in human milk. There is more calcium in the body than any other mineral elements. Plants absorb calcium from the soil and when human eat plants, calcium passes into the food chain. Calcium can also be obtained from food and water. When potash is added to food, it increases calcium concentration [16]. The result shows the concentration of calcium for the three extractive procedures as 120.9mg/l (chloroform digestion), 183.1mg/l (TCA digestive) and 257.lmg/l (wet digestion) respectively. Calcium is vital in bone and teeth development. Generally, milk is said to be the major source of calcium. Recommended intake in infant is about 800-1000 mg/day [13].

Magnesium is an essential element whose dietary deficiency may result in neuro muscular cardiac and renal damage. The mean concentration in human milk for the three extraction procedure were 12.82 mg/l (chloroform digestion), 12.15mg/l (TCA digestion) and 11.48 mg/l (wet digestion). Recommended nutrient intake for human milk fed infant is 26 mg day. The main source of Mg is from food obtained from plants and water [14].

The micro nutrients are those elements that are required in minute quantity. They include: copper, manganese, zinc and Iron. Their average concentrations from the three extraction procedures fall within the WHO permissible limits. The concentration of copper is lower than all other trace elements due to the fact that the concentration decreases as lactation period progress. lron is important in myoglobin and haemoglobin and also for the development of red blood cells. The low concentration of Zn indicates that breast milk was found to contain lower concentration of Zinc than formulas. However, breast fed newborn often showed a more suitable and balanced Zinc status than the non-breast fed one. Human milk being an excellent source of mineral elements referred to as 'Ash contents' as essential micro elements are involved in several functions, proper development of tissue and organs of humans [6].

Lead is a toxic metal. It is a cumulative poison. Its presence in milk is detrimental to health. The mean concentration of lead for the three extraction procedures are 0.03 mg/l (chloroform digestion), 0.05mg/l (TCA digestion) and 0.01 mg/l (wet digestion) respectively. The high level of lead in breast milk above the WHO standard could be used to contaminations during sampling and sample analysis in addition to environmental and traffic pollution. The presence of lead in breast milk comes from lead stored in the mother's bone. During pregnancy and lactation, a woman body extracts calcium for her infants bone development. Calcium extraction from the bone is greater during lactation and as a result, lead stored in the mother's bones also enters the blood and breast during pregnancy and lactation, posing an exposure risk to the foetus [15].

CONCLUSION

The research work carried out on the breast of five lactating mothers from different areas in Jos metropolis showed the concentration of the essential element in the order Ca > Mg > Fe > Mn > Zn > Cu. The result agreed favorably with the WHO standards for food and nutrition except for calcium and zinc. The mean concentration of the toxic metal, lead falls within the tolerance level defined by the world regulation limit. When the result of the three extraction procedures chloroform digestion and wet digestion were compared. It was observed that wet digestion procedure gave a more acceptable result when compared with the WHO standard and other result obtained from other countries.

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