Analysis of heavy and trace metals in Buffalo *(Bubalus bubalis)* milk collected from Mumbai dairy farm

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Abstract- *Milk has a nutritional value among human being. It provides strength to bones. The nutrients which are present in milk are very essential for body as it helps in build new cells and also help them to proper functioning. Buffaloes (Bubalus bubalis) are known as the second major milk producers in the world. Buffalo milk contains many minerals, which are very crucial to maintain human health. The aim of present study is to check the quality of buffalo milk by the study of various metals present in milk. The concentration of different metals were found in following order Ca > Mg > Fe > Zn > Cr > Mn. Cadmium (Cd), copper (Cu), lead (Pb), arsenic (As) and mercury (Hg) were found be below the detectable level. Our study suggests that buffalo milk has a great significance and contribution to human health.*

Keywords- buffalo milk, calcium, chromium, iron, magnesium, manganese, metals, zinc

I. INTRODUCTION

Increased number of industrialization and agricultural process are the main source for increase in concentration of metals in air, water and soil (Zodape et. al., 2002). Different heavy and trace elements can accumulate in food chain, therefore there is high probability of their toxic effect on humans and animal health (Birghila et. al., 2008).There is need to keep observation on intake of these metal ions by humans, plants, and animals (Zodape et. al., 2002).

Milk and milk products are widely consumed across India; milk is a good source of minerals and vitamins. The most common minerals are Ca, P, K, Na and Mg, while, Zn, Fe, Cu and Mn are also found in milk (Burrow et. al., 2018).

The utilization of milk and milk products are increased due to their daily requirement in diet, especially in infants, school going children and old persons (Enb et. al., 2009; Qin et. al., 2009). Milk is an ideal source of calcium, potassium and phosphorus (Qin et. al., 2009). Beside this, microelement and heavy metal can be also present in milk (Kabir et. al., 2017).Animals receive heavy metals from soil, water and fodder. Because mammary gland are physiologically very active so, heavy metals can be easily observed in milk (Roy et. al.,, 2009). Microelement such as Cu, Fe, Se and Zn are essential trace element whereas As, Cd, Hg, and Pb don't have any beneficial effect on humans health (Qin et.al., 2009). The presence of lead, cadmium, and mercury has a potential public health concern because young children absorb these metals faster than adults (Roy et. al., 2009). Arsenic has a cumulative poison effect due to its long retention period in the body (Roy et. al., 2009). Singh et. al., (2005) reported high level of arsenic in animal tissue and milk from the areas contain higher arsenic concentration. In the current study, we have studied presence of heavy and trace analysis of metal in buffalo milk form Mumbai region.

II. MATERIALS AND METHOD

In the present study, commercially available fresh milk sample from dairy farm were collected and analysed from different areas of Mumbai, Maharashtra. A total of 11 minerals calcium, cadmium, chromium, copper, iron, magnesium, manganese, lead, zinc, arsenic and mercury were analysed by using Inductively Coupled - Plasma Atomic Emission Spectroscopy (ICP-AES).

Sample Preparation

0.1gm of fresh milk sample was taken from nearby dairy farm and 4 ml of concentrated HNO3 was added to it and heated on hot plate. After boiling 1 ml of HClO4 (perchloric acid) was added and heating continued to destroy the organic matter from the sample. Sample were diluted with distilled water to make the total sample volume to 10 ml. Blank was prepared by adding 4 ml. of concentrated HNO3, 1 ml of HClO4 and 5 ml distilled water to make the total volume to 10ml.

Standard was prepared separately for each selected metals by diluting readymade stock metal solution of 1000 ppm. The stock solution of 1000 ppm was diluted with deionised water to varying concentrations of 0.10, 1.00, 10 and 100 ppm. Intensities of varying concentration of standard metal solutions were analyzed by ICP-AES. Results were expressed in mean ± SD.

III. RESULT AND DISCUSSION

In present study, the concentration of minerals (cadmium, copper, lead, arsenic and mercury) in fresh buffalo milk was found to be below the detectable level. Rest of the recorded concentration of the mineral were calcium 1730.063 ±0.545 ppm, chromium 1.4272 ± 0.021 ppm, Iron 20.3216 ± 0.0224 ppm, magnesium 161.146 ± 0.247 ppm, manganese 0.441 ± 0.013 ppm , and zinc content 11.94 ± 0.015 ppm was recorded.

Table: 1. Composition of minerals (ppm) in buffalo milk.

	Ca	Cr	Fe	Mg	Mn	Zn
1	1731.09	1.494	20.362	161.25	0.467	11.956
2	1730.02	1.425	20.351	160.75	0.465	11.914
3	1728.085	1.398	20.256	160.55	0.453	11.989
4	1730.07	1.45	20.36	161.98	0.399	11.898
5	1731.05	1.369	20.279	161.2	0.425	11.943
mean	1730.063	1.4272	20.3216	161.146	0.4418	11.94
S.E.	0.545128	0.021479	0.02246	0.247115	0.013063	0.015978

Minerals in buffalo milk have specific significance for example they are essential component for human bones and teeth (calcium and phosphorus). Calcium actively participates in coagulation process in the manifestation of rennet for cheese and fermented milk products. Adult human required 75% calcium and 63% phosphorus by half a liter milk/ day.The environmental factors such as type and quantity of feed are also associated with mineral content of milk (Elvingson, 2013).

In present investigation calcium was recorded in highest concentration i.e. 1730.063 ± 0.545 ppm. The higher concentration of calcium may be associated with casein in colloidal phase. According to Fox and McSweeney (1998) 500mg calcium can be exist in one liter of cow milk in colloidal phase. They also reported high concentration of calcium in the beginning and in the end of the lactation period. Coroian et. al., (2009) suggested that high mineral content in buffalo milk increases the buffering power which is associated with slow development of acidity in dairy products therefore increased calcium concentration is correlated with lower coagulation periods. According to Elvingson (2013) calcium concentration is also related to animal growth, because it is essential for the development of offspring.

The presence of chromium may causes impurity in milk. In present study chromium concentration was observed 1.4272 ± 0.021 ppm. Ayaz (2017) suggested that this metal enter in to the animal body by the bio augmentation. According to them the grazing land may contain chromium due to industrial pollution in nearby areas, and from there this metal enters into the animal body.

In present study Iron concentration was found to be higher (20.3216 ± 0.0224 ppm) then lead concentration (below the detectable level) and zinc (11.94 ± 0.015 ppm) in milk. These results are accordance with the findings of Abdulkhaliq et. al., (2012). The studies of many scientist (Garg et. al., 2007; Qin et. al., 2009; Enb et. al., 2009) suggested that iron and zinc can be present in the food of animal, it may be due to the transfer of these metal ion from equipment's or machines which are used in milking process, milk collection and production.

Garg et. al., (2007) showed the presence of Mg in Cattle forages. In our research work magnesium concentration (161.146 ± 0.247 ppm) was observed very low as compared to calcium concentration (1730.063 ± 0.545 ppm). Similar findings were obtained from Nogalska et. al., (2017). They suggested that old age of animal may be responsible for low Mg concentration in milk.

In present research work manganese concentration was observed very low (0.441 ± 0.013 ppm) as compared to zinc concentration. The findings are accordance with the result of Islam et. al., (2014). Windisch (2002) suggested that cation concentration (Mn) is not dependent on intake, because they are involve in regulation of gut absorption and changing metabolic demand.

Zinc is a micronutrient but it is essential factor for biologic and public health (Kumari et. al., 2012). It play an important role in maintaining the histological and cellular integrity of various organs such as prostate, testis, and pituitary pituitary (Kumari et. al., 2012; Joshi et. al., 2014a, 2014b; Kuldeep et. al., 2018). It is also crucial for normal functioning of mammalian erythrocytes (Nair et. al., 2019). Zinc is the second most abundant cation and it is a important constituent of many enzymes and proteins (Petrilli et. al., 2017). It has a important role in over 300 biological process, and also necessary for cellular function, including DNA replication, transcription, protein synthesis, maintenance of cell membranes, cellular transport, endocrine system, immunological system and neuronal systems (Prasad, 1995; Nowak et. al., 2003). Its deficiency leads to decrease in food intake and intermittent diarrhea (Joshi et. al., 2014a). DiGirolamo et. al., (2009) suggested relationship between zinc deficiency and mental health problem. Grønli et. al., (2009) reported that zinc deficiency is commonly visible into psychogeriatric patients. According to Rafalo et. al., (2016) depression, increased anxiety, irritability, and emotional instability may be due to zinc deficiency. Elbaz et. al., (2017) reported that attention deficit hyperactivity disorder (ADHD) is seen in the person who are deficient in zinc, copper and magnesium. Severe zinc deficiency can causes diarrhea, alopecia, and irritability in infants (Dassoni et. al., 2014). Zinc deficiency may lead to delays in cognitive development, abnormal neuropsychologic functioning and motor developments and may interfere with cognitive performance (Black, 1998). It also leads pneumonia, diarrhea, and growth impairment, acrodermatitis enteropathica. In premature infants aquired zinc deficiency is associated, with clinical conditions including celiac disease, cystic fibrosis, and liver disease (Black, 2013). In present investigation observed zinc concentration was 11.94 ± 0.015 ppm. Same concentration range was observed by Birghila et. al.(2008) in cow milk sample. According to Qin et. al., (2009) zinc may be entered into the milk by the tools or machines which are used in milk collection.

IV. CONCLUSION

Buffalo milk which was collected from nearby dairy farms had mineral (Ca, Cr, Fe, Mg, Mn, and Zn) and was free from toxic heavy metals such as cadmium, copper, lead, arsenic and mercury. The quality of milk has satisfactory characters and can be used for consumption. Our study suggests that milk cannot be considered as the primary source of heavy metals. Present research work also recommended that quality control measurements in milk processing/ milk collection should be improved. Further research work also required to assess the essential, deficient and toxic level of these metals in buffalo milk samples from various producers.

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