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Research Article

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Assessment of Heavy Metals in Fresh Cow Milk Grazed around Gwallagan-Mayaki of Bauchi

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Abstract

This research assessed the health risk of heavy metals in fresh cow milk of cows grazed around Gwallagan-Mayaki in Bauchi. The results when compared with standard safe limits of Food and Agricultural Organisation and World Health Organizations of United Nations (FAO/WHO) revealed that the concentration of heavy metals in fresh cow milk Zn=1.088, Mn=0.087, Cd=0.011, Cu=ND, Cr=0.228, Pb=0.046 mg/dm^3 for dry season and Zn=1.642, Mn=0.192, Cd=0.007, Cu=0.229, Cr=0.253, Pb=0.143 mg/dm^3 for raining season and were within the safe limits of FAO/WHO. The data obtained were analysed to assess the exposure of human through health risk index, an index more than 1 is considered as not safe for consumption. The health risk index calculated were less than 1 for all the heavy metals determined, hence this research concluded that the fresh cow milk from Gwallagan-Mayaki may pose no risk to human health.

Keywords: Heavy Metals, Fresh Cow Milk, Gwallagan-Mayaki

Introduction

Heavy metals are hazardous elements to human health. Although adverse health effects of heavy metals due to continuous exposure to heavy metals have been known for long time and is found to be increasing in some areas due to improper dumping of waste [2]. Toxic metals sometimes imitate the action of essential elements in the body, interfering with the metabolic process to cause illness. Heavy metals have been given considerable concern worldwide due to their toxicity and accumulative behaviour. Heavy metals such as vanadium, manganese, iron, cobalt, copper, zinc, selenium, strontium and molybdenum are essential, in small quantities, for human health [1]. Others such as lead, cadmium, nickel, cobalt, copper, zinc and chromium are toxic at high concentration [2]. The concern on intake of heavy metals is due to the increase in non-biodegradable environmental pollutants from dumping of waste around any plant or animal that are consumed either direct or indirect. The metals taken in by these plants and animals consequently accumulate in their tissue. Heavy metals are natural components of the earth's crust. They cannot be degraded or destroyed, to a small extent they enter our bodies via food, drinking water and air [3]. Due to non-biodegradable and persistent nature, heavy metals are accumulated in vital organs in the human body such as the kidneys, bones and livers and are associated with numerous serious health disorder [4]. The contamination of food by heavy metals have become a serious problem these days. This is because heavy metals are accumulating in the vital organs in human body which lead to a serious health problem. Ingestion of contaminated vegetables and milk is one of the ways in which heavy metals enter human body, hence there is need to investigate the heavy metal concentration in fresh cow milk, as milk is one of the food diet for human beings. Thus, the concentration of heavy metals in cow milk was investigated and also the health risk of these heavy metals was assessed in this research.

Methodology

Study Site and Collection of Fresh Cow Milk Samples

The fresh cow milk samples were collected from Gwallagan-Mayaki in Bauchi, Bauchi State for three months [5]. About three different cows were selected for this research, and 250ml of milk was collected from each cow in 500ml polypropylene bottles (pre-acids washed), and stored in a refrigerator before digestion in a glass container. This sample collection was carried out during two seasons; during rainy season for three months and during dry season for three months. The samples were then harmonized.

Digestion of Fresh Cow Milk Samples

Milk samples were prepared for analysis through digestion; 10ml of each sample was digested with an acid mixture (HNO_3, HCl and $HClO_4$ in 4:2:1 ratio) at 80^0C [5]. The solution was cooled, filtered and the filtrate diluted with distilled water to 200ml, 100ml and 50ml polypropylene bottles to make three different concentrations. This solution was taken for analysis.

Heavy Metal Analysis

Concentration of manganese, copper, cadmium, lead, zinc and chromium in the filtrate of digested samples were estimated using atomic absorption spectrophotometer. The instrument was calibrated using manually prepared standard solution of respective heavy metals and the blank. Precision and accuracy were assured through repeated analysis; the samples were analyzed in triplicate. Blank and drift standard were run after three determinations to calibrate the instrument for heavy metal analysis. Mean and standard deviation of the triplicate analysis were determined to assess the reliability of data [5].

Data Analysis

Metal Pollution Index (MPI)

To examine overall heavy metal concentrations of all the metals in the samples analysed, metal pollution index (MPI) was calculated. This was done by calculating the geometrical mean of concentrations of all the metals in the samples [5].

Health Risk Index (HRI)

To determine the health risk analysis, the daily intake milk was determined by conducting a survey on the people with average body weight of 55-60kg; these people were asked for their daily intake of fresh cow milk from the experimental area in each month of sampling [5]. Using method adopted from Anita *et al.*, [5] the average daily intake of milk in Gwallagan-Mayaki was found to be 0.58 dm^3/person /day. The health risk index was calculated at ratio of estimated exposure of test item and oral reference dose [5]. The oral reference dose was 0.30 for Zinc 0.001 for Cadmium, 0.04 for Copper 0.004 for Pb and 1.5 for Chromium, 0.033 (mk/kg/day) for Mn [6]. The estimated exposure was obtained by dividing daily intake of heavy metals by their safe limits. An index more than 1 is considered as not safe for human health [6].

HRI = Daily intake metal/Reference dose

Where Daily intake metal (DIM)= $\frac{C_{metal} \times D_{foodintake} \times C_{factor}}{B_{averageweight}}$

C_{metal} = represent the heavy metal concentration in plant (mg/kg)

$D_{foodintake}$ = represent daily intake of vegetables

$B_{averageweight}$ = represent average body weight
C_{factor} is used to convert fresh vegetable weight into dry weight and is given as 0.085

Result and Discussion

Table 1: Concentration of Heavy Metals (mg/dm^3) in Milk Samples

		concentrations				
Samples	**Zn**	**Mn**	**Cd**	**Cu**	**Cr**	**Pb**
D_1Milk	1.843±0.000000	0.919±0.000007	0.002±0.000007	0.418±0.00007	0.285±0.00000	0.198±0.0
D_2Milk	1.365±0.000014	0.171±0.000000	0.008±0.000000	0.199±0.00000	0.179±0.00000	0.077±0.0
D_3Milk	1.718±0.000000	0.214±0.000000	0.011±0.000000	0.069±0.0	0.296±0.00000	0.155±0.0
R_1Milk	0.966±0.000007	0.087±0.000014	0.024±0.000007	ND	0.294±0.000007	0.069±0.0
R_2Milk	0.775±0.000000	0.087±0.000000	0,001±0.000007	ND	0.203±0.000014	0.019±0.0
R_3Milk	1.523±0.000000	0.087±0.000000	0.009±0.000000	ND	0.187±0.000000	0.049±0.0

Values are mean ± standard deviation (n = 3)

Key: D Milk = milk samples of dry season, R Milk = milk samples of rainy season and ND = Not detected

Table 1 above shows the concentrations of heavy metal in fresh cow milk collected at Gwallagan-Mayaki area during the dry season and rainy season. From the table, the milk sample of dry season shows the presence of all the heavy metals (Zn, Mn, Cd, Cr, Pb & Cu) analysed, with zinc having the highest concentrations. The milk samples of Rainy season show present of of Zn, Mn, Cd, Cr and Pb while Copper is not detected. Also zinc have highest concentrations in the rainy season samples.

Table 2: Comparison of Concentration of Heavy Metals (mg/dm^3) in Fresh Cow Milk

Heavy Metals	**D Milk (This research)**	**R Milk (This research)**	**Semaghuil *et al.*, (2008)**	**Ogabiela *et al.*, (2011)**	
				Kano	**Zaria**
Zn	1.088	1.642	0.980	3.239	5.521
Mn	0.087	0.192	0.080	0.179	0.219
Cd	0.011	0.007	0.004	0.163	0.099
Cu	0.000	0.229	0.170	0.252	0.214
Cr	0.228	0.253	0.040	1.757	1.568
Pb	0.046	0.143	0.120	0.550	0.710

The Table 2 above shows the overall mean concentration of heavy metal in fresh cow milk from dry season and rainy season and comparison of those heavy metal concentrations with Samaghuil *et al.*, [7] and Ogabiela *et al*., [8]. The concentration of heavy metals in present study are higher than concentration of heavy metals of Semaghuil *et al*., [7] but lower than the concentrations of Ogabiela *et al*., [8] (both in Kano and Zaria).

Chart 1: Metal Pollution Index

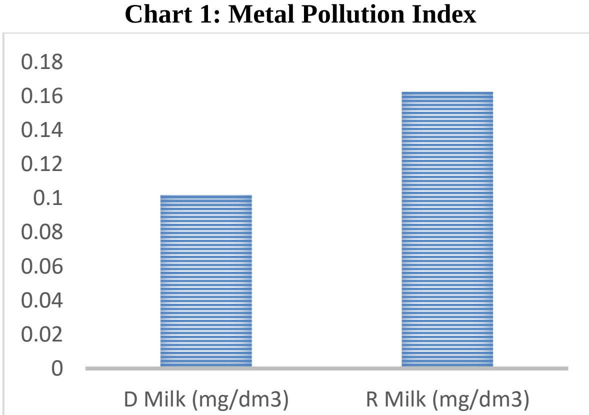
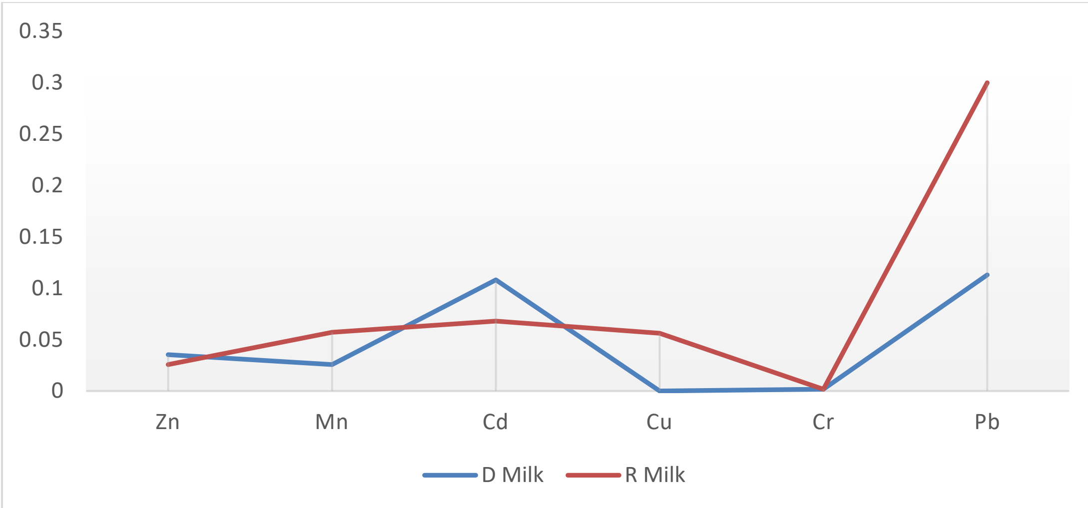


Chart 1 above shows metal pollution index (MPI) which is the geometrical mean of heavy metal concentrations in milk samples. The MPI of dry season milk sample is lower than the MPI of the rainy season milk sample therefore, the milk of dry season will be at lower risk to human health. MPI is a reliable method for monitoring metal pollution of waste water irrigated sites.

Chart 2: Health Risk Index



The chart 2 above shows health risk index of this research in fresh milk samples. The analysis revealed that metal index for all the samples were less than. It is also revealed that Pb has the highest contamination because it has highest index value 0.113 for the dry season and 0.3 for rainy season. Cr has least contamination because it has least index value of 0.00160 and 0.00165 in milk samples of dry season and rainy season respectively.

Conclusion

The concentrations of all the heavy metals analyzed in the fresh cow milk samples are within the safe limits of FAO/WHO (2011). Furthermore, the metal pollution index was very low compare to some other research. Beside-that, the health risk index calculated are less than 1, thus fresh cow milk collected from Gwallagan-Mayaki may be safe for consumption.

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