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Toxicity Potential of Heavy Metals Concentration in Cow Milk in Katagum, Local Government Area of Bauchi State

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Abstract: The study Investigated the concentrations of selected heavy metals (Cr,Cu,Pb, Ni, Cd and As) In cow milk from three locations in Katagum Government Area, Bauchi state. The Concentrations of the metals in the cow milk samples were determine using Atomic Absorption Spectrophotometric method. The levels of the heavy metals ranged from: Cr 0.020 mg/dm³ (Yeldewo farm) to 0.103 mgldm³ (Gadau farm), Cu: 0.033 mg/dm³ (Gadau farm) to 0.097 mg/dm³ (Yeldewo farm), Pb: 0.024 mg/dm³ (Buskuri farm) to 0.061 mg/dm³ (Gadau farm), Ni: 0.006 mg/dm³ (Buskuri farm) to 0.077 (Gadau farm) Cd: 0.05 mg/dm³ (Buskuri farm) to 0.038 (Yeldewo farm) and As: 0.058 mg/dm3 (Buskuri farm) 0-470 mg/dm³ (Yeldewo farm) respectively. The experimental values were subjected to one was way analysis of variance and the result showed That there was no statistical significant difference at 95% confidence level. In conclusion the study examined the concentrations of several significant heavy metals (Cr, Cu, Pb, Ni, Cd, and As) within cow milk samples sourced from distinct farms across Katagum Government Area, Bauchi State.

Keywords: Heavy metals, Concentration, farm

1. Introduction

Milk is the first food for mammals taken immediately after birth to ensure proper growth and postnatal development. Milk is considered a complete food containing almost all nutrients like proteins, carbohydrates and minerals (Meshref *et al.*, 2014). Availability of these nutrients in milk is affected by a variety of factors like animal species of nutrition, genetics, lactation stage and environmental factors (Vahčić *et al.*, 2010). Cow milk is the most consumed livestock milk in Ugandan, markets although milk from other species like goats and sheep is also available. Milk contains both lipo soluble and hydrophilic minerals; hydrophilic vitamins like vitamin C and B-complex are dissolved in the water portion. The lipo soluble minerals are found in the fat

portion that is vitamin A, D and E. Milk is rich in minerals that include calcium with the biggest proportion, phosphorous, magnesium, zinc, selenium, iodine, copper, sodium, iron and sodium (Vahčić *et al.*, 2010).

Heavy metals are persistent contaminants in the environment that can cause serious environmental and health hazards. They are released into the environment from natural as well as anthropogenic activities (Abdulkhaliq *et al.*, 2012). Some heavy metals like Mn, Co, Ni, Cu and Zn are essential to maintain proper metabolic activity in living organisms; others such as Pb and Cd are non-essential and have no biological role (Ayar and Akin 2009). At high concentrations, even essential metals also cause toxicity to living organisms. Toxicity of metal is closely related to age, sex, route of exposure, daily intake, solubility, metal oxidation state, percentage retention, duration of exposure, frequency of intake, absorption rate and mechanisms/efficiency of excretion (Vahčić *et al.*, 2010).

With increasing population, industrialization and urbanization, various pollutants are been released into the environment. Some heavy metals have become widely distributed in the environment, in particular, chromium, arsenic, cadmium and lead (Kwon *et al.*, 2017), facilitating their entry in the human food chain (González-Montaña *et al.*, 2012). Heavy metals have negative effects on both livestock health (Rahimi, 2013) and human health (Norouzirad *et al.*, 2018). These metals are potentially toxic, causing hematologic, neurotoxic and nephrotoxic effects even at low concentrations. Human exposure to these heavy metals has a negative effect on specific organs and may lead to metabolic disorders, fatigue, heart failure and cancer (Perween, 2015). This problem is particularly serious for children, whose immune systems are underdeveloped and for whom gastrointestinal absorption is not as efficient as in adults (Su *et al.*, 2020).

The bioaccumulation of heavy metals in the environment made them very dangerous to living organisms. Heavy metals cannot be degraded and are very toxic even at low concentrations. When living organisms are exposed to these metals through food chain, the heavy metals are accumulated and stored at a rate faster than their metabolism and excretion. These heavy metals are taken in by plants and consequently accumulate in their tissues. The accumulation of toxic heavy metals lead to metabolic disorders and serious health problems such as weakness, heart failure, cancer and kidney problem (Licata *et al.*, 2004).

2. Materials and Method

2.1 Materials

Beakers, measuring cylinder, funnel, Whatman filter paper, sample bottle, conical flask and burette

Equipment/Instruments

The instruments used for this research are: analytical weighing balance, fume cupboard, heating mantel and atomic Absorption Spectrophotometer2.

Chemicals

Chemicals of analytical grade purity and distilled water were used throughout the study.

2.2 Description of the Study Area

Azare is a town in Bauchi State, Nigeria. It was founded by Mallam Zaki who received his flag office from Shehu Usman Danfodio in the year 1814. Azare is the headquarter of Katagum division in Bauchi State, Azare town is bounded to the East by Damban LGA and Potiskum, Yobe State and to the South by Misau Local Government, in the West by Jama'are Local Government, and to the North by Itas/Gadau Local Government Area of Bauchi State. Azare is located at coordinates: 110 40'27" N 100 11 28E at an elevation nearly town in the region including Misau, Bulkachuwa, Disina, Faggo, Zadawa and Madara. The vegetation pattern of the emirate can be classified into Sudan and Sahel savannah. Rainy season commences in May and June and terminate in September to October, the temperature is high throughout the emirate with a mean daily of 220c from April to May. The population has grown from 69,035 at the 1991 census to its 2007 estimated value of 110,452. In the last five years, the population has grown by more than 20%. It is also the largest growing town in the state and region.

3. Methods

3.1 Sampling of Analytes

3.1.1 Sampling of Cow Milk

Cow milk were bought from Buskuri, Gadau and Yeldewo areas of Katagum Local Government Area of Bauchi State, Nigeria. Sampling was carried out during the milking process of lactating female cow. The sample was collected in free contaminated bottles. The samples (cow milk) were placed in a refrigerator to prevent the milk from fermenting.

3.1.2 Digestion of Samples

A 50.00 cm^3 cow milk was digested with 10.00 cm^3 of concentrated HNO_3 and 30.00 cm^3 of HCl at 80 ^0C until brown fumes of nitric acid was obtained (APHA, 2017). Heating continued until the content of the sample reduced to one quarter of its original volume. After cooling, distilled water was added and filtered using Whatman filter paper Number 1. The resulting solution was transferred quantitatively into a 100 cm^3 volumetric flask and water was added to mark.

3.1.3 Determination of Metal Contents

Calibration curve was prepared to determine the concentration of the metals in the sample solution. The instrument was calibrated using series of working standards. The working standard solution of each metal was prepared from standard solutions of the respective metals and their absorbance taken using the AAS calibration curve of each metal ion to be analysed was prepared by plotting the absorbance as a function of metals ions concentration.

4. Result and Discussion

4.2 Results

Table 1 shows the concentrations of some heavy metals (mg/dm^3) in cow milk obtained in three different farms of Buskuri, Gadau and Yeldewo respectively.

Table 1: Shows the concentrations of some heavy metals (mg/dm^3) in cow milk from three different farms

	Concentrations (mg/dm^3)											
Sample Location	Cr		Cu		Pb		Ni		Cd		As	
Buskuri	0.039 ± 0.004	±	0.073 ± 0.001	±	0.024 ± 0.001	±	0.016 ± 0.003	±	0.015 ± 0.003	±	0.058 ± 0.003	±
Gadau	0.103 ±0.001	±	0.033 ± 0.004	±	0.027 ± 0.004	±	0.077 ± 0.001	±	0.027 ± 0.004	±	0.158 ± 0.001	±
Yeldewo	0.020 ± 000		0.097 ± 0.001	±	0.061 ± 0.007	±	0.069 ± 0.005	±	0.038 ± 0.003	±	0.470 ± 0.016	±

Values are mean ± standard deviation (n=3)

5. Discussion

Levels of some heavy metals (mg/dm^3) in cow milk from three different farms.

The concentration of Cr in the cow milk samples investigated ranged from 0.020 mg/dm^3 (Yeldewo farm) to 0.103 mg/dm^3 (found in Gadau farm). While the concentration in (Buskuri farm) 0.039 mg/dm^3. The Observed Cr level in cow milk from selected farm are much lower than reported literature values of 0.845 to 0.895 mg/dm^3 (Licata *et al.,* 2004) and 0.468 to 0.828 mg/dm^3 reported by (Su *et al.,* 2020) in Ethopia. The levels of Cr in this presences study are relatively higher than 0.055 to 0.075 mg/dm^3 in Ethopia reported by (Ahmad, 2006). The Concentration of Cr found in cow milk in Bangaladash (0.00 to 0.11 mg/dm^3) compares favorably well with the present observed value of Cr (0.020 to 0.103 mg/dm^3) in cow milk samples in the three different farms investigated. The levels of Cr found in cow milk samples obtained from Yeldewo farm (0.020 mg/dm^3) and Buskuri farm (0.0039 mg/dm^3) are lower than standard value of 0.05 mg/dm^3 (WHO 2012). This is therefore shows that cow milk samples obtained from this two farms are safe for human consumption. However, the level of Cr found in cow milk sample obtained from Gadau farm (0.103 mg/dm^3) is higher than 0.05 mg/dm^3 (WHO, 2012) threshold value. Based on this cow milk in this farm might be toxic to consumers. Cr is fundamental in maintaining metabolism in human body, but at levels higher than threshold limit, it can cause convulsions, ulcer, stomach upset, liver and kidney damage in some cases even death (Qin *et al.,* 2009).

The concentration of Cu in the cow milk samples investigated ranged from 0.033 mg/dm^3 (Gadau farm), 0.073 mg/dm^3 (Buskuri). While the highest concentration in (Buskuri farm) 0.039 mg/dm^3. The values are within permissible limits of heavy metals in the study areas. The concentration of Cu in this study ranged from 0.033 – 0.097 mg/dm^3. The average concentration in the three milk samples was found within the maximum permissible limit of Cu for cow's milk and dairy product taken as 1 mg/dm^3 (WHO 2018). The concentration of Cu obtained in the present study is close to 0.62 – 0.85, 0.04 – 1.778 and 0.17 – 1.79 mg/dm^3 the report made by (Abdulkhaliq *et al.,* 2012) in Palestine, (Mohammed-imam *et al.,* 2017) in Bangladesh and (Belete *et al.,* 2014) in Nigeria respectively. Lower levels 0.087 – 0.122, 0.181– 0.229 and 0.203 – 0.251 mg/dm^3 were reported by (Hassan *et al.,* 2020) in Ethiopia. Excess Cu in the body leads to s Wilson's disease which is characterized by abdominal pain, fluid buildup in the legs or abdomen and problems with speech (Malhat *et al.,* 2012)

In this study the concentration of Pb ranged from 0.024 mg/dm^{3-} (Buskuri farm) to 0.061 mg/dm^3 (Yeldewo farm). The observed Pb level from selected farms are much lower than the reported literature as reported (Belete *et al.,* 2014) in Nigeria and (Malhat *et al.,* 2020) in Egypt respectively, and higher than 0 – 0.93 ppm and 0.0 – 0.87 ppm the study made by (Ahmad, 2006) in Bangladesh and (Abdulkhaliq *et al.,* 2012) in Palestine respectively. The Concentration of Pb found in cow milk samples obtained from Buskuri (0.024 mg/dm^3), Gadau (0.027 mg/dm^3) and (0.061 mg/dm^3) are higher than Pb Standard Value 0.01 mg/dm^3 (WHO 2018). This is therefore show that the cow milk samples obtained from this three farm are no safe for human consumption and may be toxic to consumer. High concentration of Pb in milk may result from consumption of contaminated feeding stuffs and the commonly used underground water in the redistricts. Pb has no beneficial biological function and is known to accumulate in the body. Pb exposure can cause adverse health effects, especially in young children and pregnant women. Pb is a neurotoxin that permanently interrupts normal brain development (Bano *et al.,* 2015).

The concentration of Ni in the cow milk samples investigated ranged from 0.016 mg/dm^3 (Buskuri farm) to 0.077 mg/dm^3 (found in Gadau farm). The Observed Cr level in cow milk from selected farm are much lower than reported literature values of 1.02 mg/dm^3 in Roamina (Brighila *et al.,* 2012). The levels of Ni found in cow milk samples obtained from Yeldewo farm (0.069 mg/dm^3), Buskuri farm (0.016 mg/dm^3) and Gadau farm (0.077 mg/dm^3) are lower than standard value of 0.1 mg/dm^3 (WHO 2012). This is therefore shows that cow milk samples obtained from these farms are safe for human consumption. Ni at levels higher than threshold limit, is poisonous, carcinogenic and can cause gastrointestinal distress (Brighila *et al.,* 2008)

The concentration of Cd in the cow milk samples investigated ranged from 0.015 mg/dm^3 (Buskuri farm) and 0.038 mg/dm^3 (Yeldewo). The observed level Cd level in cow milk from selected farm is said to be in agreement with 0.016-0.04 mg/dm^3 and 0.022-0.057 mg/dm^3 the report made by [2] in Egypt and [3] in Palestine respectively, but it is lower than the 0.200-0.288 ppm reported by [19] in Egypt. The level of Cd found in cow milk samples obtained from Buskuri farm (0.027 mg/dm^3) and Gadau farm (0.027 mg/dm^3) are lower than the Cd standard value of 0.003 mg/dm^3 [13] while that of Yeldewo farm (0.038 mg/dm^3) is higher than standard value and is not safe for human consumption. Cd at lower level than is considered consumption,

but at levels higher than threshold limits can cause liver and kidney damage, bone demineralization, internal hemorrhage and respiratory disorder.

The level of As in milk sample from all the sites ranged from 0.05mg/dm^3 (Buskuri farm) to 0.470 mg/dm^3 (Yeldewo farm). The observed value of As in cow milk sample from selected farms are much lower than the reported literature values 0.041 mg/dm^3 to 0.044 mg/dm^3 (Hassan *et al.*, 2020) in Ethiopia and 0.037 mg/dm^3 (Bano *et al.*, 2015) in Pakistan respectively. The levels of As found in cow milk samples obtained from (Yeldewo farm) 0.470 mg/dm^3, 0.158 mg/dm^3 (Gurin farm) and 0.058 mg/dm^3 (Buskuri farm) are higher than the As standard value of 0.01 mg/dm^3 (WHO 2012) threshold value. Base on this cow milk sample in these farms might be toxic to consumers. As is generally considered consumption if it meets the regulatory standard, but at higher levels than the threshold limit As is associated with mental and emotional disturbances, impaired male fertility, birth defects, and impaired bone development (Bano *et al.*, 2015).

Toxicity of Some Selected Heavy Metals

The toxicity assessment of all the selected heavy metals showed the values below 1.00, except for Yeldewo and Gadau samples, where the toxicity potentials for Arsenic are greater than 1.00 and considered beyond acceptable limits and therefore is said to be toxic. Base on this study cow milk from all the farms will not pose any health threat to consumers.

Statistical Analysis

Single factor analysis variance (one-way analysis of variance) was carried out on each metal taken into consideration the sampling farms or locations of Buskuri, Gadau and Yeldewo. The statistical analysis revealed that all the metals in the three farms have no statistical significant difference at 95 % confidence level. This is because the F computed was less than the F critical and therefore the results were not subjected to post-hoc test(LSD).

6. Conclusion

The study analyzed the concentrations of heavy metals (Cr, Cu, Pb, Ni, Cd and As) in the milk of cows from three different locations in Katagum Local Government Bauchi State. The results showed the that all the milk samples contained detectable levels of these heavy metals, the metals varied across the samples the result demonstrated that most of the heavy metals some are within the permissible Cr Buskuri farm 0.039 mg/dm3, Yeldewo 0.020 mg /dm3 Cr Standard

Value 0.05 mg/dm3 (WHO 2012) and 0.103 mg/dm3 is above the permissible limit set by World Health Organization (WHO) and some other permissible limits.

References

Abdulkhaliq, A., Swaileh, K. M., Husseinand, R. M. and Matani, M. (2012). Levels of Metals (Cd, Pb, Cu and Fe) in Cow Milk, Dairy Products and Hen's Eggs from the West Bank, Palestine. *International Food Research Journal*, **19**(3): 1089-1094.

Ahmad, W.M.S. (2006). Study of Heavy Metal **"Pollution Farm in Relation to Products Performance",** Ph.D. Thesis, Faculty of Veterinary Medicine Zag University, pp. 87-90.

Ayar, A. S. D. and Akin, N. (2009). The Trace Metal Levels in Milk and Dairy Products Consumed in Middle Anatolia-Turkey. *Environmental Monitoring and Assessment*, **152:** 1-12.

Bano, R.C., Swarup, D., Kumar, P., Nandi, D., Naresh, R. and Ali, S.L. (2015). Milk Trace Elements in Lactating Cows Environmentally Exposed to Higher Level of Lead and Cadmium Around Different Industrial Units. Science *Total Environment*, **404**: 36–43.

Belete, T., Hussen, A. and Maheswara, R. (2014). Determination of Concentrations of Selected Heavy Metals in Cow's Milk: Borena Zone Ethopia *Journal of Health Science*, **4**(5):105-112.

Brighila, S., Atukwase, A. and Manirakiza, L. (2008). Assessment of Lead and Cadmium Concentrations in Raw Cow Milk from Farms Near Namanve Industrial Park in Kira Division, Wakiso District, Uganda. *Journal of Applied Science Environmental Management*, **26**(8): 1357-1361.

Duruibe, S., Lucot, E., Gimbert, F., Crini, N. and Badot, P.M. (2017). Trace Metals in Raw Cows' Milk and Assessment of Transfer to Comté Cheese. *Food Chemistry*, **129**(1): 7-12.

González-Montaña, J.R., Senís, E., Gutiérrez, A. and Prieto, F. (2012). Cadmium and Lead in Bovine Milk in the Mining Area of the Caudal River (Spain). *Environmental Monitoring. Assessment*, **184:** 4029–4034.

Hassan, U.F., Hasssan, H.F., Baba H., Madaki, A.A., Hassan, H.F., Ibrahim, I. *et al.* (2020). Evaluation of Toxicity Potentilas of Heavy Metals in Camel Milk from

Selected Farms in Yobe State, Nigeria. *International Journal of Research and Innovation in Applied Science*, **5**(7): 2454-6194.

Kwon, J.C., Nejad, Z.D. and Jung, M.C. (2017). Arsenic and Heavy Metals in Paddy Soil and Polished Rice Contaminated by Mining Activities in Korea. *Catena*, **148:** 92–100.

Licata, P., Trombetta, D., Cristani, M., Giofre, F., Martino, D., Calo, M. and Naccari, F. (2004). Levels of Toxic and Essential Metals in Samples of Bovine Milk from Various Dairy Farms in Calabria, Italy. *Environment International*, **30**(1):1–6.

Malhat, S., Urszula, P., Radosław, K., Artur, M., Katarzyna, Ś. and Magorzata, G. (2012). Determination of the Content of Pb, Cd, Cu, Zn in Dairy Products from Various Regions of Poland. *Chemistry Research Journal*, **23:** 5677-5881.

Meshref, A.M., Moselhy, W.A. and Hassan, N.E. (2014). Heavy Metals and Trace Elements Levels in Milk and Milk Products. *Journal of Food Measurement and Characterization*, **8**(4): 381-388.

Mohammed-imam, A. T., Muhammad, Z. and Zakasri A. (2017). Determination of Some Heavy Metals in the Milk of Cow Grazing. *International Journal of Advance Research in Computer Science and Software Engineering*, **7**(7): 341-346.

Norouzirad, R., González-Montaña, J.R., Martínez-Pastor, F., Hosseini, H., Shahrouzian, A., Khabazkhoob, M., *et al.* (2018). Lead and Cadmium Levels in Raw Bovine Milk and Dietary Risk Assessment in Areas Near Petroleum Extraction Industries. *Science Total Environmental*, **635:** 308–314.

Perween, R. (2015). Factors Involving in Fluctuation of Trace Metals Concentrations in Bovine Milk. *Pakistan Journal of Pharmacological Science*, **28:** 1033–1038.

Qin, L. Q., Wang, X. P., Li, W., Tong, X. and Tong, W. J. (2009). The Minerals and Heavy Metals in Cow Milk from China and Japan. *Journal of Health Science*, **55**(2): 300-305 WHO (2018). Food Safety of Milk and Dairy Product od Dairy Cattle from HeavyMetals World Health organization, **2**: 23-33.

Rahimi, E. (2013). Lead and Cadmium Concentrations in Goat, Cow, Sheep and Buffalo Milks from Different Regions of Iran. *Food Chemistry*, **136**: 389–391.

Su, C., Liu, H., Qu, X., Zhou, X., Gao, Y., Yang, H., Zheng, N., *et al*. (2020). Heavy Metals in Raw Milk and Dietary Exposure Assessment in the Vicinity of Leather-Processing Plants. *Biology Trace Elements Research*, **199:** 3303–3311.

Vahčić, N., Mirjana, H., Marković, K., Banović, M. and Colić, I. B. (2010). Essential Minerals in Milk and their Daily Intake through Milk Consumption. *Mljekarstvo Journal*. **60**(2): 77-85.

WHO (2012). Heavy Metals Levels in Milk and Dairy Produvts and Health Risk Assessment. World Health organization, **2**: 23-33.