# Analysis of Selected Heavy Metals in Fresh Cow milk, drinking water, grass and soil of dairy farms in Saki East local Government area of Oyo State, Nigeria

Sansi, J.A.A. [1]; Sansi, O.O. [2] and Ojezele, O.J. [1]

[1] Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan. Oyo State.
[2] Centre for Sustainable Industrial and Integrated Development, Ibadan, Oyo State.

**ABSTRACT**

Urbanization and industrialization have increased in recent times and these have caused increase in the inorganic contaminants present in the air, food items, water and soil. Soundness of agricultural processes is a matter of concern and safety of the food produced for both animal and human consumption. Twenty-nine fresh milk samples, composite soil, grass and drinking water samples were collected from three dairy farms in Saki East Local Government area of Oyo state, Nigeria. These were analyzed for the concentration of selected heavy metals (copper, cadmium and lead) using Atomic Absorption Spectrometry. The mean concentrations of copper in milk, drinking water, soil and grass were 1.33 mg/L, 0.03 mg/L, 0.11 mg/Kg and 0.16 mg/Kg respectively. The mean concentrations of cadmium in milk, drinking water, soil and grass were 0.12mg/L, 0.13mg/L, 0.11mg/Kg, and 0.10mg/Kg respectively. The mean concentrations of lead in milk, drinking water, soil and grass were 0.77 mg/L, 0.85 mg/L, 0.5 mg/Kg and 0.20 mg/Kg respectively. Mean concentrations of cadmium in water, lead in milk and lead in water were above the permissible standard limits and therefore were not fit for human or animal consumption. Advocacy for organic dairy is highly recommended as one of the standards required for certification is proper analysis of the soil and drinking water sources for heavy metal contaminants. The result of such analyses would guide the prospective farmers in the choice of farm sites and paddocks. Routine analysis for heavy metal concentration in fresh milk, drinking water, grass/feed and soil of dairy farms is strongly recommended.

Key words: fresh cow milk, soil, drinking water, grass, organic

Corresponding author: rsansi17@gmail.com

## INTRODUCTION

Increased urbanization and industrialization have caused an upsurge in the input of inorganic contaminants in air, water and soil. Drinking contaminated water or eating food grown on contaminated soil may pose serious health risks to both humans and animals (Bushra *et al.*, 2014). Consumers are therefore taking into account qualitative aspects that include health and safety as well as societal benefits which include environmental impact and animal welfare ethics (Kaditi and Swinnen, 2007).

Heavy metals are defined as metallic elements that have a relatively high density compared to water (Fergusson,1990) and could cause both environmental and health hazards when they persist in the environment (Tassew Belete *et al.*, 2014). Lead as a soil contaminant is a widespread issue; It accumulates with age in bones aorta, and kidney, liver and spleen**.** It can enter the human body through uptake of food (65%), water (20%) and air (15%) (Nazir *et al.,*2015). Natural and human related activities are responsible for the release of heavy metals into the environment (Abdul Khaliq *et al.,*2012). Milk and its products are main constituents of the daily food consumed by infants, school age children and the aged (Enb *et al.,*2009). It is an excellent source of calcium, magnesium, zinc, vitamin D, vitamin A and vitamin B-12. Atomic Absorption Spectrometry (AAS) is an analytical technique that measures the concentration of elements. It is sensitive and detects the wavelength of light specially absorbed by an element. In the practice of good agricultural system, especially organic agriculture, certain standards are required.

Scientific assessment of soil quality is essential to monitor the sustainability of agricultural systems (Franzluebbers and Haney,2006). Soil quality is the capability of soil to produce safe and nutritious crops in a sustained manner over time and to enhance human and animal health without impairing the natural resource base or harming the environment (Parr *et* a*l*.,1992). According to the IFOAM (2005), accumulation of heavy metals should be reduced and the appropriate remedial measures should be put in place where necessary. It is required that the analysis of the relevant products and possible sources of pollution (soil, water, air, inputs) is undertaken to determine the level of contamination. Appropriate responses, such as detection of contamination sources, consideration of background contamination and other relevant factors are required. This study was done to determine the presence of selected toxic heavy metals namely, cadmium, lead and copper in fresh cow milk, grass, soil and drinking water of cattle in three farm settlements of Saki East Local Government area of Oyo state.

## MATERIALS AND METHODS

*Sample collection*

The samples were collected from three different farms in Ogboro, one of the five major communities in Saki East Local Government area of Oyo State, Nigeria. Saki East is located on latitude 8.704675 and longitude 3.589439. The area was selected based on the fact that one of the main occupation of the inhabitants is cattle rearing, production and sale of fresh milk and local cheese. The area also has a history of blacksmiths, goldsmiths and clay pot molder. A total of twenty- nine cows of different indigenous breeds were used for the collection of milk sample from three farms A, B and C at which 10, 11 and 8 samples were collected respectively. The samples were collected by convenience method as some farmers refused to cooperate and others did not have milking cows at the time the sample collection was done. They were either dry or too young.

Each sample of milk was collected into polyethylene bottles of 100ml which had been previously soaked in 20% $HNO_3$ for 24 hours and rinsed with de-ionized water. These were sealed, labeled and stored in the refrigerator at about 5ºC or less. Composite grass and soil samples were taken from the cattle grazing area. Water samples were also taken from the river and wells which were the drinking water sources.

*Sample analysis*

The milk samples were prepared by wet digestion method and analyzed by Atomic Absorption Spectrometry as described by AOAC (2000), Qin *et al*.(2009) and Bushra Iftikhar *et al*., (2014). Exactly 2 grammes of each grass sample was washed three times with distilled water to remove adhering particles. This was oven dried at100ºC to remove the moisture. It was ground with mortar and pestle. The dried sample was placed in a muffle furnace at 550ºC for 4hrs till the sample was converted to ash. It was put in a desiccator to cool and to prevent moisture after which 5ml of already prepared 10% Nitric acid and perchloric acid with a tablet of selenium catalyst added to it. The tube was placed inside a digestion block, and slowly digested and filtered. Mixture was filtered, poured into 50ml volumetric flask and topped up with distilled water. It was taken to the laboratory for heavy metal analysis using atomic absorption spectrometry. The soil sample was digested using 2grammes of the sample as was done with the grass. It was then taken to the laboratory for atomic absorption spectrometry. The water sample was put in a beaker, 5ml of nitric and perchloric acid was added and put on a heating mantle to boil for an hour until it gave clear solution. It was poured into a 50ml volumetric flask topped up. With distilled water and taken to the laboratory for heavy metal analysis using the AAS.

## RESULTS

The average mean concentration of each element, copper (Cu), lead (Pb) and cadmium (Cd) was determined and compared with the permissible standard in literature for milk, soil, grass and water.

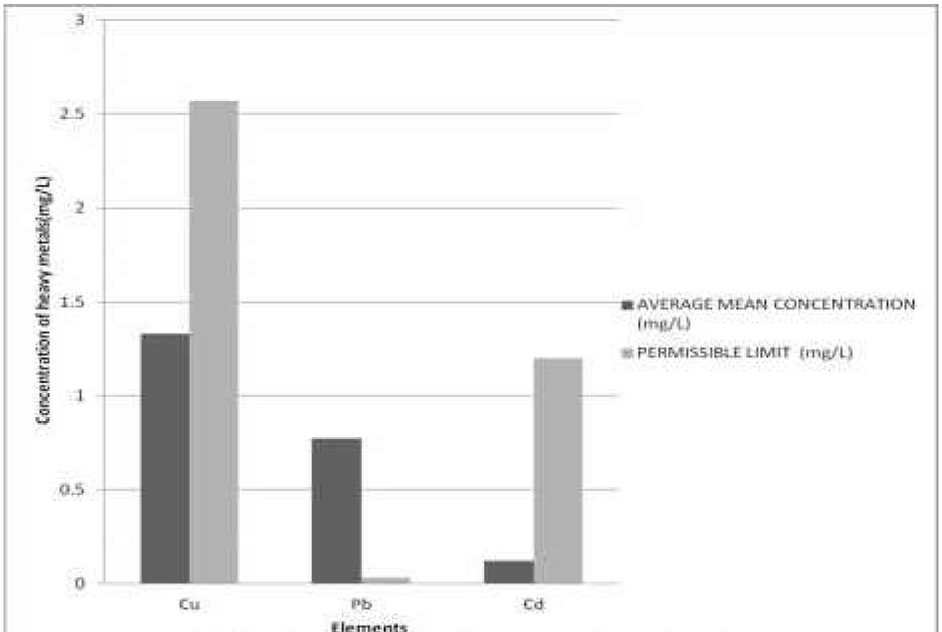


Fig1:- Result of analysis of heavy metals concentratrion in milk samples

**Copper (Cu)**: The permissible limit of copper for cow milk is 2.57mg/L as recommended by WHO (2003). The average concentration of Cu from all collected milk samples from the three farms (Farm A, Farm B and Farm C) in Saki east was 1.33mg/L (Fig. 1) and was below the permissible limit.

**Cadmium (Cd)**: The permissible limit of Cadmium in cow milk, as recommended by WHO (2003), is 1.20mg/L. The result of the average concentration of Cadmium (Cd) from the collected fresh cow milk samples from the three farms all at Saki east was 0.12mg/L which was below the permissible limit (Fig. 1)

**Lead (Pb):** The permissible limit in cow milk sample recommended was 0.03mg/L. (WHO, 2003). All the collected milk samples from the three farms (Farm A, Farm B and Farm C) in Saki east had average concentration value of 0.77mg/L. The value was above the permissible limit (Fig.1).

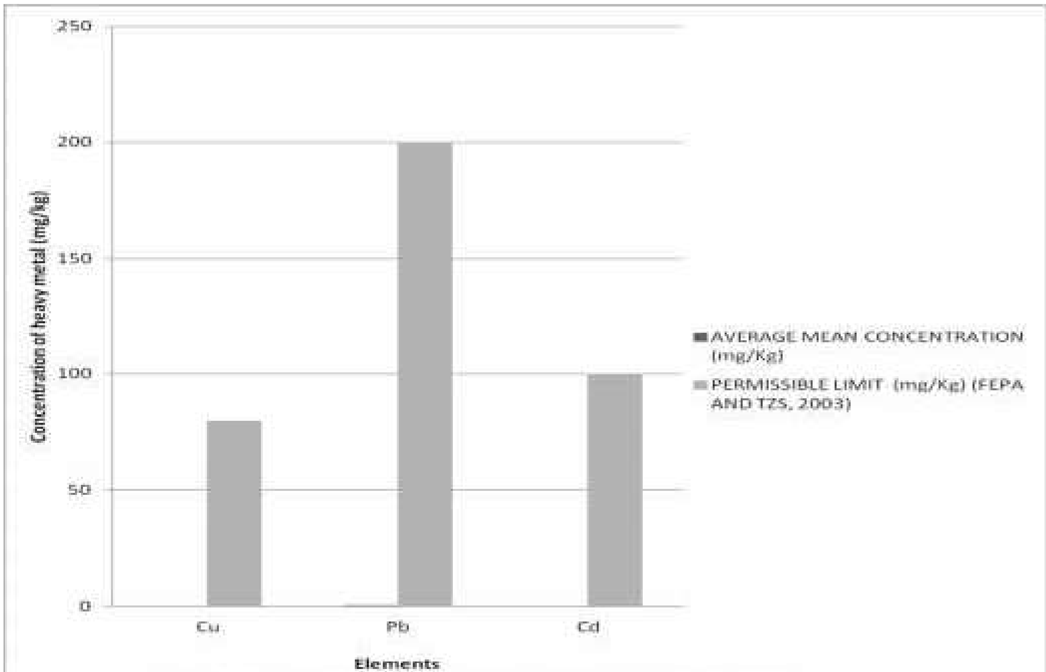


**Fig2:- Result of analysis of heavy metals concentratrion in soil samples**

The average Concentration of copper in all the soil samples From Farm A, Farm B and Farm C was 0.11mg/Kg (Fig. 2) which was below EPA (2002)/TZS (2003) guidelines for heavy metals in soil (70-80mg/kg). The average concentrations of cadmium in the soil samples collected from Farm A, Farm B and Farm C was 0.11mg/kg which did not exceed the (TZS, 2003) maximum limit of 200mg/kg for soil. Concentration of lead in all the soil samples: Average concentration of lead in soil samples from Farm A, Farm B and Farm C was recorded to be 0.5mg/kg (Fig. 2) which was below EPA (2002) guidelines for heavy metals in soil (1.6mg/kg).

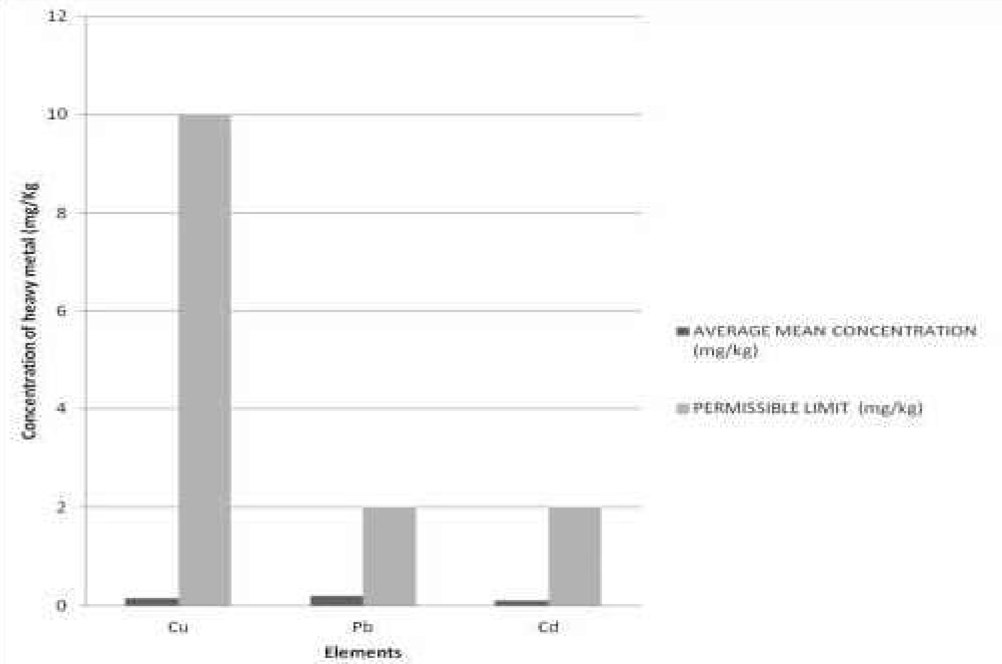


**Fig3:- Result of analysis of heavy metals concentratrion in grass samples**

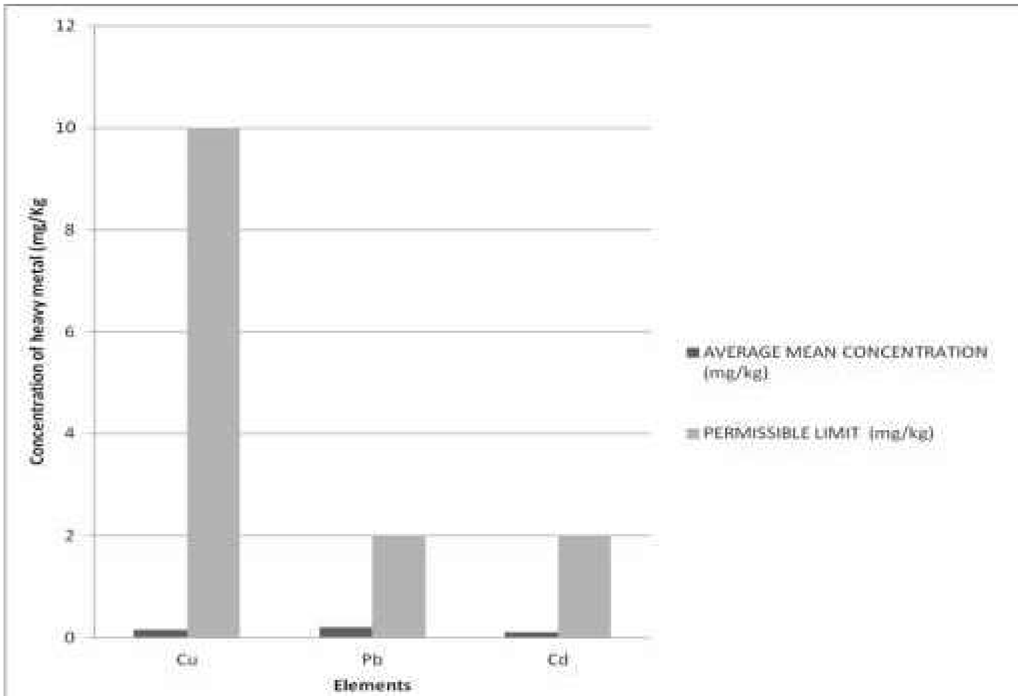


**Fig3:- Result of analysis of heavy metals concentratrion in grass samples**

The permissible limit of copper for plants is 10mg/kg recommended by WHO (1996), Hassan *et al.,*(2012). In all the collected grass samples from Farm A, Farm B, and Farm C the average concentration of the copper was 0.16mg/kg (Fig. 3) the concentration of copper was recorded below the permissible limit. The permissible limit of Cadmium in plants, recommended by WHO (1996) is 2.00mg/kg. In the grass samples from farm A, Farm B and farm C the Average concentration of cadmium was recorded to be 0.10mg/Kg limit which was far below the permissible limit (Fig. 3). The permissible limit in plants as recommended by WHO (1996) was 2.0mg/kg. The average concentration of Lead (Pb) in the grass samples collected from Farm A, Farm B and Farm C was 0.20mg/kg (Fig. 3). Therefore, the concentration of lead was recorded below the permissible limit of WHO (1996).

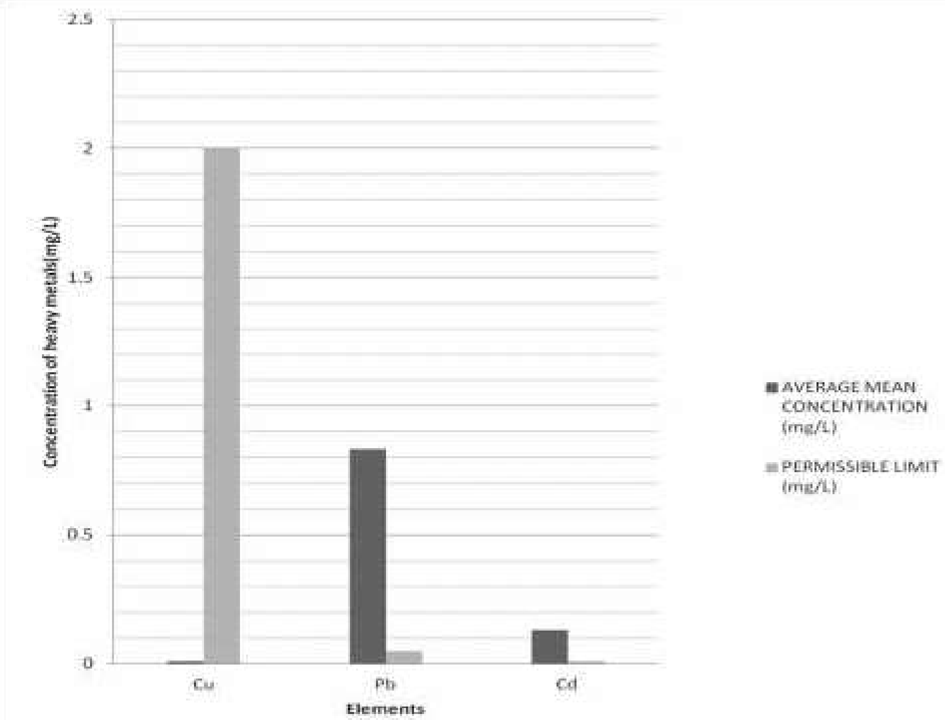


**Fig4:- Result of analysis of heavy metals concentratrion in water sample (river)**

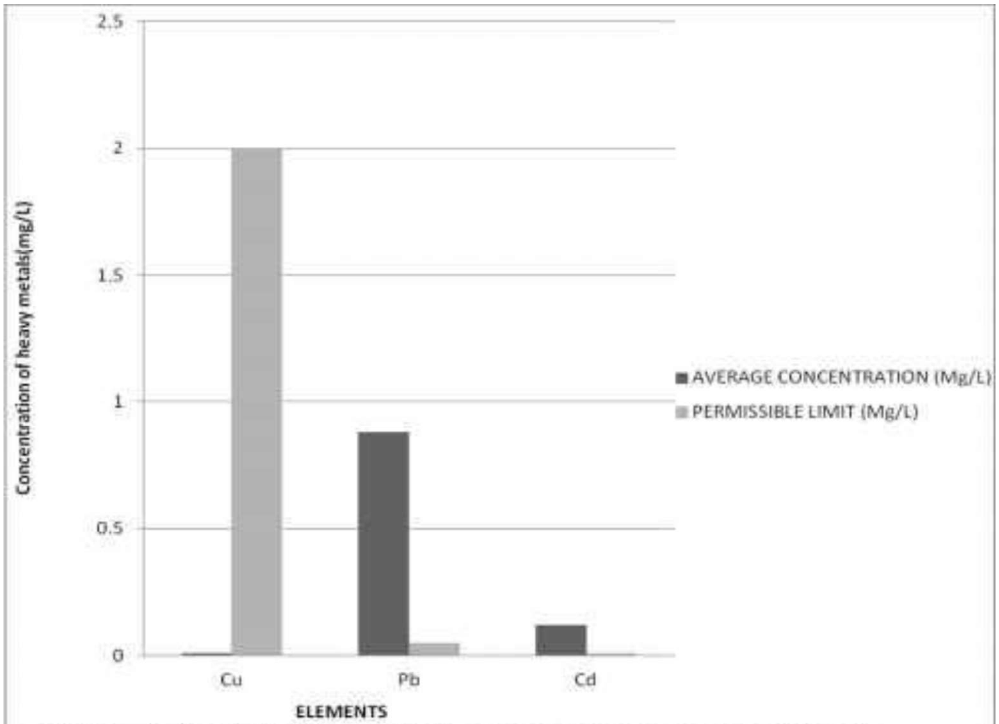


**Fig5:- Result of analysis of heavy metals concentratrion in water samples (well)**

The maximum permissible limit for Copper in water was 2mg/L as recommended by WHO (1996), in water samples from Farm A, Farm B and Farm C the average concentration of copper in water was 0.03 mg/L (Fig. 5). Concentration of copper was recorded below the permissible limit. The maximum permissible limit for cadmium in water was 0.05 mg/L (Hassan *et al*., 2012). The average concentration of cadmium in water samples from Farm A, Farm B and Farm C was 0.13mg/L ( Fig. 4 ) which was recorded above the permissible limit of 0.05mg/L (Hassan *et al*., 2012). Standards permissible limit of lead in water was 0.05mg/L and the average concentration in water samples collected from Farm A, Farm B and Farm C was 0.85mg/L (Fig. 6) the concentration of lead was above the permissible limit.

## DISCUSSION

High values of lead and cadmium in this result agrees with Malhat *et al.*(2012) that global population was exposed to lead from air and from major sources including paint, pesticides, smoking, automobile emission, batteries, mining, burning of coal, chemical industries e.t.c. The result of this work shows that rural areas like Ogboro community are not exempted from this challenge. This is a great contrast to the report of Tassew Belete *et al*. (2014) carried out in Ethiopia where lead and cadmium were reported to be absent. The concentration of lead in the drinking water was high and this might be one of the causes of high lead concentration in milk. The selected metal (Pb ) concentration in milk was found to be higher than the permissible level even though the concentration in grass they fed on was acceptable. A similar report was given by Bushra Iftikhar *et al*. (2014) in Pakistan. This is probably because of bio-accumulation. Miranda *et* a*l.,* in 2005 similarly stated that the food chain is an important source of Cd and Pb accumulation, especially for plants grown on polluted soils, also that significant amounts of Cd and Pb can be transferred from contaminated soil to plants and grass, causing accumulation over time, of these potentially toxic metals in grazing ruminants, particularly in cattle. Accumulation of Cd and Pb in ruminants causes toxic effects in cattle, but also in humans consuming meat and milk contaminated with toxic metals (Vromman *et al.,* 2008; Cai *et al.,* 2009). Metal residues in milk are of particular concern because milk is largely consumed by infants and children (Tripathi *et al.*, 1999). Cd and Pb are amongst the elements that have caused the most concern in terms of adverse effects on human health. The results of this work agree with Jen, *et al*. (1994) that concentration of Cd and Pb in cow milk should be monitored to ensure the consumers' health .

## CONCLUSION

The concentrations of lead (Pb) contaminant in milk and water samples and cadmium in water samples were above the permissible limits. It could be concluded that the milk samples from the study area were not fit and wholesome for human consumption, as they were not free from hazardous heavy metal contaminants. Further investigation should be carried out on the causes of high lead (Pb) in milk samples and high lead (Pb) and cadmium (Cd) in water samples in (Ogboro community) Saki East local Government of Oyo State. The history of metal workers such as blacksmiths and goldsmiths, some of who may still be present could have contaminated the land and water over the years.

In order to minimize the hazardous effects of these pollutants and protect human health, it is hereby recommended that strict and routine monitoring of milk supply should be undertaken by regulatory bodies. Farmers should be warned not to graze their animals in the areas where there is possibility of heavy metal contamination e.g. where mining, metal smelting, battery charging or similar activities are done. Further research should be carried out on samples from areas where there are activities like smelting, welding, painting etc. Rural areas should not be assumed to be ‘organic by default’ but all necessary analyses should be done, especially soil and water analysis to ensure that they are suitable for organic and even conventional farming.

## REFERENCES

Abdulkaliq, A., Swaileh, K.M., Hussein, R..M., and Matani, M. (2012). Levels of metals (Cadmium, Iron, Lead, Copper) in cow’s milk, dairy products and hen’s egg from the West bank, Palestine., *International Food Resources J*., 19(3), 1089-1094.

AOAC. 2000. AOAC Official Methods of Analysis of the Association of Official Analytical Chemists. 15th edition, Washington DC, Association of Official Analytical Chemists:90

Bushra Iftikhar, Saatea Arif, Samina Siddiqui and Riaz Khattak (2014). Assessment of Toxic Metals in Dairy Milk and Animal Feed in Peshawar, Pakistan *British Biotechnology Journal* 4(8): 883-893, 2014

Cai Q, Long ML, Zhu M, Zhou QZ, Zhang L, Liu J. (2009): Food chain transfer of cadmium and lead to cattle in a lead–zinc smelter in Guizhou, China. *Environmental Pollution*.2009;157(11):3078–3082. doi: 10.1016/*j.envpol*.2009.05.048.

Enb, A., Abou Donia, M.A., Abd-Rabou, N., Abou-Arab, A., .A. K.,and El-Senaity, M.H., 2009, Chemical composition of raw milk and heavy metals behaviour during processing of milk products*, Global Veterinaria.,* 3(3); 268-275.

EPA 2002. Environmental protection agency safe drinking water facts sheets, Islamabad, Pakistan.

Fergusson, D.M. ET AL 1988. A longitudinal study of dentine lead levels, intelligence, school performance and behaviour. Part I Dentine lead levels and exposure to environmental risk factors. *Journal of child psychology and psychiatry*, 29: 781–792 (1988).

Franzluebbers, A.J., and Haney, R.L. 2006. Assessing soil quality in organic agriculture. USDA Agricultural Research Service, October, 2006

Hassan Zaigham, Anwar Zubar, Khattak Usman Khalid.2012. Civic pollution and its effects on water quality of River Toi District, Kohat

IFOAM 2005. Norms for organic production and processing.

Jen SL, Lee SJ, Lin SY.1994. Determination of cadmium and lead in raw milk by graphite furnace atomic absorption spectrophotometer. *Journal of Dairy Science*. 1994; 77(4) :945–949. doi: 10.3168/jds.S0022-0302(94)77030-2.

Kaditi E.A and Swinnen JFM 2007. Consumer demands and rural supply chains: Environmental impacts of food consumption and production. Paper presented at the Land use policy group, (LUPG) and Bundesambt fur Naturschutz (BfN) Conference "Future Policies for Rural Europe for 2013 and beyond- Delivering Sustainable Rural Land Management in a Changing Europe" September 20-21 Brussels, Belgium.36pp

Malhat F, Hagag M, Saber A, Fayz AE. 2012. Contamination of cow milk by heavy metal in Egypt. *Bulletin of Environmental Contamination and Toxicology*. 2012;88(4):611–613. doi: 10. 1007/s00128-012-0550-

Miranda M, López Alonso M, Castillo C, Hernández J, Benedito JL. 2005 Effects of moderate pollution on toxic and trace metal levels in calves from a polluted area of northern Spain. *Environment International*. 2005;31(4):543–548.doi10.1016/*j.envint.*

Nazir, R., Khan, M., Masab, M., Shaheen, Z. 2015. Accumulation of heavy metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plant and analysis of physico-chemical parameters of soil and water collected from Tanda Dam, Kohat. *Journal of Pharmaceutical Sciences & Research* vol.7 (3) 2015 89-97

Parr, J.F, Papendick, R.I, Hornick, S.B., Meyer, R.F.1992: Soil quality attributes and relationship to alternative and sustainable agriculture. *American Journal of Alternative Agriculture* 7, 5-11

Qin, L.Q., Wang, X. P., L. W. and Tong, W. J. 2009. The mineral and heavy metals in cow's milk from China and Japan. *Health Sciences.* 2009; 55(2): 300-305.

Tanzania Standards for Receiving Water, Effluents and soils (TZS 789:2003). Tanzania Bureau of Standards.

Tassew Belete, Ahmed Hussen, Vegi Maheswara Rao, 2014. Determination of Concentrations of Selected Heavy Metals in Cow's Milk: Borena Zone, Ethiopia, *Journal of Health Science*, Vol. 4 No. 5, 2014, pp. 105-112. doi: 10.5923/*j.health*.20140405.01.

Tripathi, R. M., Raghunath, R., Sastry, V. N., Krishnamoorthy, T. M., 1999, Daily intake of heavy metals by infants through milk and milk products., *Sci Total Environ*., 227, 9. 229-235.

WHO/FAO Report., 1996. Trace element in Human nutrition and health (1996).

WHO. 2003. Safety evaluation of certain food additives and contaminants. WHO Food Additive Series 52. Joint FAO/WHO Expert Committee on Food Additives. World Health Organization.

Vromman V, Saegerman C, Pussemier L, Huyghebaert A, De Temmerman L, Pizzolon JC. 2008. Cadmium in the food chain near non-ferrous metal production sites. Food Additives and Contaminants: Part A.;25(3):293–301. doi:10.1080/02652030701509998