"Comparative Evaluation of Heavy Metals Levels in Feeds, Milk and Urine of Camels at Giade Local Government Area, Bauchi State, Nigeria"

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DOI: https://doi.org/10.51584/IJRIAS.2024.906001

Received: 27 April 2024; Revised: 23 May 2024; Accepted: 27 May 2024; Published: 27 June 2024

ABSTRACT

The aim of this study was carried out comparative evaluation of the levels of heavy metals in feed, milk and urine of camels at Giade Local government area of Bauchi State, Nigeria. A total of 15 samples were collected during hand milking process of lactating female camel in a corral with bulk of camel feed from five different farms: Faguji farm, Goburawa farm, Isawa farm, Jahuri farm amd Uzum farm .The consumption of camel milk and urine is increasing due to its dietry and medicinal benefits.Concentration of nine heavy metals (As, Cd, Cu, Fe, Hg, Mn, Ni, Pb and Zn) were determined using Atomic Absorption Spectrophotometer. The measured concentration of heavy metals were used to compute human health risk. The mean concentration of heavy metals in camel milk between the two extreme values spread (mg/dm^3) from: As 0.004 (Faguji) to 0.092 (Goburawa), Cd 0.022 (Isawa) to 0.045 (Uzum), Cu 0.019 (Uzum) to 0.117 (Jahuri), Fe 0.0278 (Isawa) to 0.0533 (Jahuri), Hg 0.002 (Uzum) to 0.140 (Jahuri) Mn 0.004 (Isawa), to 0.027(Uzum), Ni 0.004 (Jahuri), to 0.020 (Goburawa), Pb 0.007 (Goburawa) to 0.023 (Isawa) and Zn 0.015 (Isawa) to 0.108 (Goburawa). The result of the analysis revealed that from all the farms. As, Cu, Fe, Hg, Mn,Ni, Pb and Zn were within the desirable limit recommended by WHO (2007, 2012, 2017 and 2018) Whilst Hg (Jahuri farm) are above the desirable limit recommended by WHO (2012 and 2018). For camel urine spread (mg/dm^3) from: As 0.003 (Goburawa) to 0.055 (Uzum), Cd 0.002 (Jahuri,) to 0.008 (Faguji), Cu 0.002 (Jahuri) to 0.004 (Isawa), Fe 0.006 (Jahuri) to 0014 (Goburawa), Hg 0.002 (Isawa) to 0.008 (Uzum), Mn 0.003 (Isawa) to 0.040 (Uzum), Ni 0.001 (Faguji) to 0.005 (Jahuri), Pb 0.002 (Uzum) to 0.004 (Jahuri) and Zn 0.008 (Uzum) to 0.076 (Isawa). The result of the analysis revealed that all the element evaluated from urine in all farm were within desirable limit recommended by WHO (2014 and 2018). For camel feed Spread (mg/kg) from: As 0.019 (Uzum) to 0.220 (Isawa), Cd, 0.054 (Jahuri) to 0.0200 (Uzum), Cu 0.515 (Jahuri) to 1.500 (Uzum), Fe 1.011 (Uzum) to 1.190 (Isawa), Hg 0.040 (Goburawa) to 0.081 (Isawa), Mn, 0.170 (Jahuri) to 1.030 (Isawa), Ni, 0.020 (Jahuri) to 0.060 (Goburawa), Pb, 0.023 (Faguji) to 0.080 (Isawa) and Zn 0.170 (Jahuri) to 3.66 (Isawa). The result of the analysis revealed that feed from all Farm, As, Cu, Fe, Hg, Mn, Pb Ni and Zn were within the desirable limit recommended by WHO (2007and 2012) except Cd in all farm were above the permissible limit recommended by WHO (1999, 2010 and 2012).The experimental values were subjected to one way analysis of variance and the result showed that there was no statistical significant difference at 95 % confidence level therefore it is recommended that camel milk, urine and feed sources should be closely monitored to reduced heavy metals concentrations levels.

Keywords: Camel milk, Urine, Feed, Heavy metals, WHO

INTRODUCTION

Milk is the first food that introduce to humans which serves as source of essential nutrients required for biological function and growth during infancy [1]. Commercial infant formulae are designed to mimic the composition of human milk [2]. Milk and dairy products are essential ingredients in a human diet. Milk is referred to as a complete food because it contains essential nutrients, such as essential fatty acids, proteins, vitamins, minerals, lactose acids and in balanced proportion [3]. However, milk and dairy products can also contain hazards, chemicals and contaminants, which constitute a technological risk factor for dairy products, for the related commercial image and above all, for the health of the consumer [3].

Camel milk is an important source of lactation in arid location because it includes numerous nutrition that are beneficial to human health and can provide a considerable portion of person's daily nutritional needs [4]. Apart from the nutritional value of camel milk, this type of milk has potential medicinal properties over long term. Camel milk was used for long medicinal purposes such as metabolic and auto-immune diseases and scientific data has shown that it can contribute to the treatment of diabetic melitus [5]. The physical and chemical properties of camel milk are dependent on the quantity of forage and the amount of water consumed daily [6].

A large amount of metals absorbed by plants and animals eventually make their way into food chain. The scientific community is deeply concerned about ever-increasing pollution of the environment, particularly the intake of hazardous metals by humans, plants and animals [7]. Heavy metals can cause pollution and damaged due to their bioaccumulation, toxic effect and continuity in different varieties of food chain [8]. Heavy metals are particularly problematic as they do not chemically break down in the environment, contaminant heavy metals they are directly generated by pollution therefore these environmentally unfriendly contaminants have direct lethal effects [9]. Animal milk contain some important elements like K, Na, Cl, Mg and some trace elements that include Cu, Zn, Fe, Pb, Cr, Cd and Ni. Breast feeding animals when exposed to high concentration of heavy metals its accumulate in the milk can cause serious health problems when they are consumed [10].

Heavy metal toxicity in humans and animals is the outcome of long term and low-level contamination in our environment, including the air we breathe, the water we drink, the food we eat and so on [11]. Heavy metals are metal elements with high toxicity such as Pb, Hg, Cu, Cd, Zn, As, Cr, Fe and their density greater than 6 g/m^3[12]. Heavy metals pollution has spread widely throughout the late nineteenth and early twentieth centuries due to increase in industrial activity [13]. Heavy metals can cause serious health problems, so accurately determining their residue is critical. Heavy metals in the body can cause nervous system disorders, renal failure and genetic mutations [14].

Camel milk and urine have been reported to be beneficial in the treatment of some various diseases. [15]. Camel urine contains numerous phytochemical constituents that have antibacterial, antifungal, antiviral and anticancer properties [16]. Camel urine is used to treat diabetic neuropathy in Asian countries [17].

Feed is any substance of plant or animal-origin consumed by the animal to provide nutritional support for the body [20]. The term feed used in Animal nutrition, while food is used in human nutrition. Human being and other animal required food and feed to carryout essential function which include growth and development. [21] live tock production occupie approximately 30.00 % of global land with fast depletion of natural resource ever increasing population pressure and rising living standard. It vital to diversify the present day animal agriculture to meet the increasing for animal product [22]. The availability of animal feed and effective feeding are the foundation of successful livestock production. The use of a balanced ratio

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VI June 2024

and proper feed formulation improves animal productivity, product quality and animal welfare. In order to reduce livestock-related pollution of the environment, it is also necessary to feed a diet that is compatible with the physiological status of the animals [23]. The study aimed at carrying out comparative evaluation of heavy metals concentrations in feed, milk and urine of camels at Giade Local Government, Bauchi State, Nigeria.

METHODS

Sampling of Analytes

Sampling of camel milk

Camel milk was collected from Isawa, Uzum, Jahuri, Goburawa and Faguji at Giade Local Government Area of Bauchi State, Nigeria. Sampling was carried out during the hand milking process of lactating female camel in a corral. The samples were collected in free contaminated and labelled polyethylene bottles. The samples were kept in a refrigerator at 5 ^{0}C to prevent the milk from fermenting.

Sampling of camel urine

Camel urine was collected from healthy and lactating domesticated camels. The camel urine was obtained during feeding with the help of experienced camel attendants. Approximately 500.00 – 1000.00 cm^3 of urine was collected. Urine was collected directly into stainless steel containers and transferred to a free contaminated polyethylene bottles. Urine samples were carried to the laboratory, stored in a refrigerator at 5 ^{0}C till further use and labelled appropriately prior laboratory analyses.

Sampling of camel feed

Bulk camel feed was collected from Isawa, Uzum, Jahuri, Goburawa and Faguji at Giade Local Government, Bauchi State. The feed was homogenised to form a composite sample, air-dried, ground using a wooden mortar and pestle, sieved through a 2 mm mesh in order obtained the finest possible powder for analysis. The sieved feed was stored in plastic bottles and labelled appropriately prior to laboratory analyses.

Digestion of Samples

Digestion of camel milk and urine

Camel milk and Urine (50.00 cm^3) was digested with 3:1:1 of concentrated Hydrochloric acid, Nitric acid and Hydrogen peroxide at 80 ^{0}C for 2.00 hours until the total volume reduced to one quarter of the original volume [24]. After cooling, distilled water was added and filtered using Whatman filter paper Number 1. The content was transferred quantitatively into a 100 cm^3 volumetric flask and water was added into a 100 cm^3 mark.

Digestion of camel feed

Camel feed (1.00 g) was weighed in a 250 cm^3 beaker and 10.00 cm^3 of HNO_3, HCl and H_2O_2 were added in a volume ratio of 1:3:1 and heated at 80 ^{0}C in a fume cupboard until the solution becomes transparent [24]. The digest was allowed to cool, filtered using Whatman filter paper Number 1 into a 100 cm^3 volumetric flask and deionised water was added to mark.

Determination of heavy metals

Concentrations of the metal ions present in the sample were separately determined by reading their absorbance using AAS (AAS Wincon 320N Model). Three replicate determinations were carried out on

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VI June 2024

each sample. The metal was determined by absorption/concentration mode and the instrumental readout was recorded for each heavy metal solution manually. The same analytical procedure was employed for the determination of heavy metals in digest, blank solution and for the spiked samples to ensure quality control.

RESULTS AND DISCUSSION

Results

Table 1: Concentrations of Some Heavy Metals (mg/dm^3) in Camel Milk

	Concentrations of Heavy Metals				
Heavy Metals	**Faguji**	**Goburawa**	**Isawa**	**Jahuri**	**Uzum**
As	0.004 ± 0.001	0.092 ± 0.001	0.006 ± 0.001	0.065 ± 0.009	0.067 ± 0.001
Cd	0.031 ± 0.004	0.030 ± 0.001	0.022 ± 0.002	0.044 ± 0.001	0.045 ± 0.00
Cu	0.056 ± 0.001	0.082 ± 0.003	0.121 ± 0.002	0.117 ± 0.001	0.019 ± 0.002
Fe	0.377 ± 0.004	0.211 ± 0.001	0.278 ± 0.010	0.533 ± 0.002	0.286 ± 0.001
Hg	0.003 ± 0.000	0.004 ± 0.001	0.005 ± 0.001	0.140 ± 0.001	0.002 ± 0.001
Mn	0.005 ± 0.001	0.013 ± 0.003	0.004 ± 0.001	0.005 ± 0.001	0.027 ± 0.001
Ni	0.014 ± 0.000	0.020 ± 0.001	0.014 ± 0.001	0.004 ± 0.002	0.008 ± 0.001
Pb	0.011 ± 0.000	0.007 ± 0.001	0.023 ± 0.007	0.011 ± 0.002	0.009 ± 0.002
Zn	0.070 ± 0.001	0.108 ± 0.002	0.015 ± 0.001	0.039 ± 0.002	0.105 ± 0.001

Values are mean ± standard deviation (n=3).

Table 2: Concentrations of Some Heavy Metals (mg/dm^3) in Camel Urine

Heavy Metals	**Faguji**	**Goburawa**	**Isawa**	**Jahuri**	**Uzum**
As	0.016 ± 0.002	0.003 ± 0.000	0.013 ± 0.001	0.004 ± 0.001	0.055 ± 0.001
Cd	0.008 ± 0.001	0.007 ± 0.001	0.005 ± 0.001	0.002 ± 0.000	0.005 ± 0.00
Cu	0.003 ± 0.001	0.003 ± 0.003	0.004 ± 0.002	0.002 ± 0.001	0.004 ± 0.000
Fe	0.007 ± 0.001	0.014 ± 0.001	0.012 ± 0.010	0.006 ± 0.001	0.009 ± 0.001
Hg	0.005 ± 0.001	0.003 ± 0.001	0.002 ± 0.001	0.007 ± 0.001	0.008 ± 0.001
Mn	0.004 ± 0.001	0.013 ± 0.001	0.003 ± 0.000	0.003 ± 0.001	0.040 ± 0.001
Ni	0.001 ± 0.000	0.004 ± 0.000	0.003 ± 0.001	0.005 ± 0.001	0.002 ± 0.000
Pb	0.003 ± 0.001	0.004 ± 0.001	0.003 ± 0.001	0.004 ± 0.001	0.002 ± 0.001
Zn	0.012 ± 0.002	0.009 ± 0.001	0.076± 0.002	0.006 ± 0.001	0.008 ± 0.001

Values are mean ± standard deviation (n=3).

Table 3: Concentrations of Some Heavy Metals (mg/kg) in Camel Feed

Heavy Metals	**Isawa**	**Uzum**	**Jahuri**	**Goburawa**	**Faguji**
As	0.220 ± 0.010	0.019 ± 0.001	0.090 ± 0.001	0.053 ± 0.001	0.042 ± 0.007
Cd	0.144± 0.009	0.200 ± 0.010	0.054 ± 0.010	0.180 ± 0.007	0.190 ± 0.020

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VI June 2024

Cu	1.213 ± 0.002	1.500 ± 0.002	0.515 ± 0.001	0.615 ± 0.003	0.810 ± 0.010
Fe	1.190 ± 0.020	1.011 ± 0.001	1.040 ± 0.005	1.175 ± 0.007	1.114 ± 0.005
Hg	0.081 ± 0.010	0.060 ± 0.001	0.080 ± 0.001	0.040 ± 0.010	0.052 ± 0.010
Mn	1.030 ± 0.010	0.800 ± 0.010	0.170 ± 0.010	0.931 ± 0.009	0.741 ± 0.006
Ni	0.030 ± 0.001	0.031 ± 0.000	0.020 ± 0.000	0.060 ± 0.010	0.040 ± 0.010
Pb	0.080 ± 0.001	0.050 ± 0.002	0.030 ± 0.002	0.060 ± 0.001	0.023 ± 0.001
Zn	3.66 ± 0.007	0.570 ± 0.007	0.170 ± 0.003	0.720 ± 0.038	0.850 ± 0.020

Values are mean ± standard deviation (n=3).

Discussion

Concentrations of Heavy Metals (mg/dm^3) in Milk

Table 1 shows the concentrations of selected heavy metals (mg/dm^3) in camel milk from five different farms of Faguji, Goburawa, Isawa, Jahuri, and Uzum respectively. The observed levels of arsenic in camel milk studied spread from 0.004 mg/dm^3 (Faguji farm) to 0.092 mg/dm^3 found at Goburawa farm. Other observed values are found between the two extreme values. The observed values of arsenic in this present study are much lower than reported literature values of 0.141 to 0.144 mg/dm^3 found in Ethopia [25] The experimental values are still much lower than reported literature value of 0.137 mg/dm^3 found in Pakistan [26]. The observed values are comparatively lower than 0.01 mg/dm^3 standard arsenic value with the exception of 0.065, 0.067 and 0.092 mg/dm^3 found at Jahuri, Uzum and Goburawa farms respectively. Arsenic is considered toxic in higher levels than threshold limit is associated with mental and emotional disturbances, impaired male fertility, birth defects and impaired bone development [27].

The levels of cadmium determined in camel milk from five different farms ranged from 0.022 mg/dm^3 (Isawa farm) to 0.045 mg/dm^3 (Uzum farm) with the results of other farms falling in between the lowest and highest experimental levels. The observed cadmium level in camel milk from the studied farms is said to be in agreement with 0.04-0.06 mg/dm^3 and 0.022-0.057 mg/dm^3 reported in Egypt and Palestine [28,29] respectively, but lower than 0.200-0.288 mg/dm^3 reported in Egypt [30]. The levels of cadmium in the present study are higher than the permissible limit of 0.02 mg/dm^3 [31] and is therefore not safe for human consumption. Cadmium exposure at higher concentration can cause renal dysfunction, bone degeneration, liver and blood damage [32] cadmium is a toxic metal which is carcinogenic [33].

The levels of copper ranged from 0.019 mg/dm^3 (Uzum sample) to 0.121 mg/dm^3 (Isawa sample). Other values fell between the lowest and highest observed values. The average concentration in the milk samples was found to be within the 1.00 mg/dm^3 maximum permissible limit of copper for milk and dairy product [34]. The observed concentrations of copper are lower than 0.162-0.185 mg/ dm^3 reported in Palestine [29], 0.141-1.178 mg/dm^3 found in Bangladesh [35] and 0.170-1.179 mg/dm^3 evaluated in Nigeria [36] respectively. The variation might be as a result of differences in geographical locations. Camel milk from the study areas as far as the observed levels of copper are concerned are safe for human consumption [37].

The concentrations of iron determined in camel milk as shown in Table 1 ranged between 0.211 mg/dm^3 (Goburawa farm) to 0.533 mg/dm^3 (Jahuri farm). Other observed values are found between the two extreme values. The concentration of 0.533 mg/dm^3 of iron found in camel milk sample of Jahuri was the highest. This could be due to the feed and water the animals feed and drink. All the observed values are higher than reported literature value of 0.08 mg/dm^3 of iron determined in camel milk [38]. The levels of iron investigated in this study are lower than the permissible limit of 4.00 mg/dm^3 [31]. This therefore means that camel milk from all the farms are safe for human consumption except in Jahuri farm. Long term exposure of iron can cause hemosiderosis (a condition characterized by large deposits of iron storage protein hemosiderin in the liver and even some tissues).

In this study, the concentration of lead from five different farms as depicted in Table 1 ranged from 0.007 mg/dm^3 (Goburawa farm) to 0.023 mg/dm^3 (Isawa farm). The levels of lead in other farms were found between the spread observed values. The observed lead level from selected farms are much lower than reported lead literature value of 0.01-0.53 mg/dm^3 in Nigeria [39] and 0.02-0.43 mg/dm^3 in another study made in Egypt [30] and higher than 0 – 0.93 mg/dm^3 and 0.0 – 0.87 mg/dm^3 the study made by Ahmad *et al.*, 2016 in Bangladesh and [29] in Palestine respectively. The Concentration of lead found in camel milk samples obtained from Isawa (0.023 mg/dm^3) and Jahuri (0.011 mg/dm^3) are higher than the lead standard value of 0.01 mg/dm^3 [34]. This therefore shows that camel milk samples obtained from these locations are not safe for human consumption and may be toxic to the consumers. High concentration of lead in milk may be due consumption of contaminated feeding stuffs and possibly the underground water used in the districts. Lead has no beneficial biological function and is known to accumulate in the body [40].

The observed levels of mercury in camel milk from five different farms as depicted in Table 1 spread from 0.002 mg/dm^3 (Uzum farm) to 0.140 mg/dm^3 (Jahuri farm). The observed level of mercury in camel milk from selected farms is in agreement with 0.120 mg/dm^3 and 0.157 mg/dm^3 reported in Yobe [41] and Palestine [29] respectively, but it is lower than 0.191 to 0.211 mg/dm^3 reported in Kano [42]. The level of mercury found in camel milk samples obtained from Goburawa (0.004 mg/dm^3) and Isawa (0.005 mg/dm^3) are lower than mercury standard value of 0.100 mg/dm^3 [43], while that of Jahuri sample (0.140 mg/dm^3) is higher than the standard value and is therefore not safe for human consumption [40].

The level of manganese in camel milk as presented in Table 1 ranged from 0.004 mg/dm^3 (Isawa farm) to 0.027 mg/dm^3 (Uzum farm). The concentrations of manganese in other farms fell between the two extreme observed values. The observed values are much lower than reported literature manganese value of 0.234 mg/dm^3 found in camel milk from Kano [42] and also lower than 0.142 mg/dm^3 in camel milk sample from Borno [44]. All the observed manganese levels in camel milk studied are lower than the recommended level of 1.00 mg/dm^3 [45] and is therefore safe for human consumption.

The concentrations of nickel in camel milk investigated ranged from 0.004 (Jahuri farm) to 0.020 mg/dm^3 (Goburawa farm). Other values fell between the two extreme values. The observed nickel level in camel milk from selected areas are much lower than reported literature values of 1.02 mg/dm^3 in Uganda [46] and 0.945 mg/dm^3 in camel milk from Yobe [41]. The levels of nickel found in camel milk obtained from Uzum (0.008 mg/dm^3), Goburawa (0.020 mg/dm^3) and Faguji (0.014 mg/dm^3) are lower than standard value of 0.10 mg/dm^3 [43]. This therefore shows that camel milk obtained from these farms are not toxic for human consumption. Nickel at levels higher than threshold limit is poisonous, carcinogenic and can cause gastrointestinal distress [46].

The concentration of zinc in camel milk from studied ranged from 0.015 (Isawa farm) to 0.108 mg/dm^3 (Goburawa farm). Other observed values were found between the two extreme values. The observed values are lower than reported literature zinc levels of 2.45 mg/dm^3 determined in milk [47] and also lower than 1.24 mg/dm^3 in camel milk [48]. All the observed values are lower than 6.00 mg/dm^3 permissible limit [31]. This therefore shows that camel milk obtained from these farms are safe for human consumption. Zinc is an essential metal needed for optimum growth and development however, at higher concentration, its considered to be toxic {49].

Concentrations of Heavy Metals (mg/dm^3) in the Urine of Camel Studied

Table 2 shows the concentrations of heavy metals (mg/dm^3) in camel urine from five different farms. The experimental levels of arsenic in camel urine from all the locations ranged from 0.003 mg/dm^3 (Goburawa farm) to 0.055 mg/dm^3 (Uzum farm). The experimental value of arsenic in camel urine from selected farms are much lower than reported literature values of 0.113 mg/dm^3 to 0.150 mg/dm^3 in Egypt [50] and 0.248

mg/dm^3 in Nigeria [51] respectively. The levels of arsenic found in camel urine obtained from Uzum farm (0.055 mg/dm^3), Faguji farm (0.016 mg/dm^3) and Isawa farm (0.013 mg/dm^3) are higher than the arsenic standard value of 0.01 mg/dm^3 [31]. Based on this, camel urine, in these farms might be toxic to consumers. Lower level of arsenic exposure can cause nausea and vomiting, reduced production of erycthrocytes and leukocytes, abnormal heart, while long-term exposure can lead to the formation of skin lesions, internal cancer, pulmonary disease, peripheral vascular disease,hypertension and cardiovascular disease [27].

The observed values of cadmium determined in camel urine as shown in Table 2 ranged from 0.002 mg/dm^3 (Jahuri) to 0.008 mg/dm^3 (Faguji). Other observed cadmium levels were found between the lowest and highest cadmium levels. The experimental cadmium levels are lower than 0.09-0.100 mg/dm^3 found in Mexico [52]. The levels of cadmium in the present study are less than the permissible limit of 0.02 mg/dm^3 [31] and is safe for human consumption. Cadmium exposure can cause renal dysfunction, bone degeneration, liver and blood damage [32] and it is a toxic carcinogenic metal [33].

The levels of copper in camel urine from five different farms ranged from 0.002 mg/dm^3 (Jahuri farm) to 0.004 mg/dm^3 (Isawa and Uzum farms) with other values ranging between the extreme experimental values. The concentrations in the urine are much lower than maximum permissible limit of cupper and dairy product of 1.00 mg/dm^3 [34]. The concentrations of copper obtained in the present study are lower than 0.016 – 0.018 and 0.011 – 0.178 mg/dm^3 found in Korea [53] and in Nigeria [48] respectively. Excess copper in the body can lead to Wilson's disease which is characterized by abdominal pain, fluid buildup in the legs or abdominal problem [37].

The experimental values of iron determined in camel urine were found to be between 0.006 mg/dm^3 (Jahuri farm) to 0.014 mg/dm^3 (Goburawa farm). The levels of iron investigated are lower than reported literature values of 0.331 to 0.423 mg/dm^3 [54] and also below the permissible limit of 4.00 mg/dm^3 [31]. Long term exposure of iron can cause hemosiderosis a condition characterized by large deposits of iron storage protein hemosiderin in the liver and even some tissues.

The experimental levels of lead as shown in Table 2 ranged from 0.002 mg/dm^3 (Uzum farm) to 0.004 mg/dm^3 (Jahuri farm). The levels of lead in other sampling locations were found to be between the least and highest values. The observed lead level from selected locations are much lower than reported literature values of 0.093 mg/dm^3 [51]. The concentration of lead found in camel urine are lower than lead permissible limit of 0.01 mg/dm^3 [34]. This therefore shows that camel urine obtained from these locations are safe for human consumption and may not be toxic to consumers.

The concentrations of manganese in camel urine as presented in Table 2 ranged from 0.003 mg/dm^3 (Jahuri and Isawa farm) to 0.040 mg/dm^3 (Uzum farm) with other values ranging between the two extreme observed values. The observed values are much lower than reported literature manganese levels (0.112 mg/dm^3) observed in camel urine sample from Egypt [55] and also lower than 0.154 mg/dm^3 in camel urine sample from Borno [54]. All the experimental manganese levels in camel urine samples from different locations are lower than the recommended level of 1.00 mg/dm^3 [31] and are therefore safe for human consumption and medicinal purpose. Manganese plays an important role in a number of physiological processes as constituents of multiple enzymes and an activator of other enzymes [56].

The observed concentrations of mercury in camel urine as presented in Table 2 spread from 0.002 mg/dm^3 (Isawa farm) to 0.008 mg/dm^3 (Uzum farm). The experimental values of mercury in camel urine studied compares relatively well with 0.004 mg/dm^3 and 0.005 mg/dm^3 found in Borno, Nigeria [54]. The levels of mercury found in camel urine in all the sampling locations are lower than mercury standard value of 0.100 mg/dm^3 [34] and hence fit for human consumption. Mercury at lower level can be considered relatively safe for consumption, but at higher level than threshold limit can cause neurological and behavioral disorders [57].

The observed concentration of nickel in the camel urine samples spread from 0.001 (Faguji farm) to 0.005 mg/dm^3 (Jahuri farm). Other observed values were found between the least and highest values. The observed Nickel level in camel urine samples from selected areas are much lower than reported literature value of 0.200 mg/dm^3 found in Borno [54]. The levels of nickel found in camel urine samples obtained from all the sampling locations are much lower than standard value of 0.10 mg/dm^3 [43]. This therefore shows that camel urine obtained from these locations are safe for human consumption. Nickel at levels higher than the threshold limit is poisonous, carcinogenic and can cause gastrointestinal distress [58].

The level of zinc in camel urine as presented in Table 2 ranged from 0.006 mg/dm^3 (Jahuri farm) to 0.076 mg/dm^3 determined at Isawa farm. The observed values are lower than reported literature zinc level 0.140 mg/dm^3 found in camel urine [52] and also lower than 0.147 mg/dm^3 in camel urine sample [59]. All the observed values are lower than 6.00 mg/dm^3 permissible limit [31]. This therefore shows that camel urine obtained from these locations are safe for human consumption. Zinc is the least toxic among all heavy metals and is an essential element in the human diet as it is required to maintain the proper functioning of the immune system and normal brain activity. Excess of zinc intake can increase the risk of hypertension [60].

Levels of Heavy Metals in The Feed of Camel

Table 3 shows the concentrations of some heavy metals (mg/kg) in camel feed from five different farms. The levels of arsenic determined in camel feed ranged from 0.09 mg/kg (Jahuri farm) to 0.220 mg/kg (Isawa farm). Other observed values were found between the lowest and highest values. The experimental value of arsenic in camel feed from selected farms are lower than reported literature values of 0.263 to 0.275 mg/kg [42]. The levels of arsenic found in camel feed obtained from all farms are lower than arsenic standard value of 1.100 mg/kg [34]. Based on this, camel feed from these farms might not be toxic to consumers. Arsenic is generally considered safe. for consumption if it meets the regulatory standard, but at higher levels than threshold limit, it is associated with mental and emotional disturbances, impaired male fertility, birth defects and impaired bone development [27].

The cadmium level as depicted in Table 3 ranged from 0.054 mg/kg (Jahuri) to 0.200 mg/kg (Uzum), while other values fell between the lowest and highest experimental cadmium levels. The experimental cadmium level in camel feed from selected areas are not in agreement with 0.014-0.132 mg/kg [61]. The levels of cadmium in the present study are higher than the permissible limit of 0.02 mg/kg [34]. and hence not safe for consumption [32,33].

The levels of copper in camel feed ranged from 0.515 mg/kg (Jahuri farm) to 1.500 mg/kg (Uzum farm). Other observed values from Isawa, Goburawa and Faguji were found between the experimental extreme values. The concentration of copper studied in the feed was found to be less than the maximum permissible limit of copper in dairy product of 10 mg/kg [34]. The concentrations of copper found in the present study are lower than 1.613– 2.181 and 0.511 – 1.178 mg/kg [62], [42]. Excess copper in the body can lead to Wilson's disease which is characterized by abdominal pain, fluid buildup in the legs or abdomen and problems with speech [37].

The levels of iron determined in camel feed spread from 1.011 mg/kg (Uzum farm) to 1.190 mg/kg (Isawa farm). The levels of iron investigated in this study are higher than reported literature values of 0.881 to 0.913 mg/kg [62], but below the permissible limit of 150 mg/kg [34]. Long term exposure of iron can cause hemosiderosis, a condition characterized by large deposits of iron storage protein hemosiderin in the liver and even some tissues [62].

The experimental levels of lead as presented in Table 3 ranged from 0.023 mg/kg (Faguji farm) to 0.080 mg/kg (Isawa farm), while other values fell between the two extreme values. The observed lead level from selected locations are much lower than reported literature values of 0.193 mg/kg [62]. The concentrations of lead found in camel feed are higher than lead threshold limit of 0.02 mg/kg [31]. This shows that camel feed obtained from these locations are not safe for consumption and may be toxic to consumers. Lead is a highly toxic metal whose widespread use has caused extensive environmental contamination. Lead is poisoning. Higher levels of lead may produce permanent brain damage and kidney function [40].

The levels of manganese in camel feed as shown in Table 3 ranged from 0.170 mg/kg (Jahuri farm) to 1.030 mg/kg (Isawa farm) with other values ranging between the two extreme observed values. The observed values are higher than reported literature value of manganese 0.187 mg/kg [63] and also higher than 0.554 mg/kg [62]. All the experimental manganese levels in camel feed from different farms are lower than 5.00 mg/kg recommended level of manganese [31] and is safe for camel consumption [56].

The observed concentrations of mercury in camel feed as depicted in Table 3 spread from 0.040 mg/kg (Goburawa farm) to 0.081 mg/kg (Isawa farm). Other values fell between the two extreme values. The observed values of mercury in camel feed from selected farms are not in agreement with 0.059 mg/kg and 0.153 mg/kg [64]. The level of mercury found in camel feed obtained from Uzum (0.060 mg/kg) and Faguji (0.052 mg/kg) are higher than mercury standard value of 0.002 mg/kg [31]. The observed values are higher than threshold limit and is therefore not safe for camel consumption [57].

The experimental concentrations of nickel in camel feed investigated from five different farms as presented in Table 3 spread from 0.020 (Jahuri) to 0.060 mg/kg (Goburawa). Other observed values were found between the two spread values. The experimental nickel level in camel feeds from selected areas are much lower than reported literature values of 0.110 mg/kg in Nigeria [65]. The levels of nickel found in the samples obtained from Isawa (0.030 mg/kg), Faguji (0.040 mg/kg) and Uzum (0.031 mg/kg) are lower than standard value of 10 mg/kg [31]. This therefore shows that camel feed obtained from these farms are safe for human consumption and invariably human being. Nickel at levels higher than threshold limit might be poisonous, carcinogenic and can cause gastrointestinal distress [58].

The observed concentrations of zinc in camel feed ranged from 0.170 (Jahuri farm) to 3.66 mg/kg (Isawa farm), while other values are between the two extreme observed values. Sample from Isawa had the highest concentration of zinc (3.66 mg/kg) in all the studied farms. The observed values are lower than reported literature zinc levels of 1.40 mg/kg to 4.65 mg/kg observed in camel feeds [66] and also higher than (1.547 mg/kg) in camel feed sample [67]. All observed values are higher than 0.6 mg/kg permissible limits (WHO, 2007). This is therefore show that camel feed samples obtained from these farms are not safe for their consumption. Zinc is the least toxic among all heavy metals and is an essential metal needed for optimum growth and development however, at higher concentration, is considered to be toxic. [60].

Statistical Analysis

Single factor analysis of variance (one-way analysis of variance) was carried out on each metal taken into consideration the sampling locations of Faguji, Goburawa, Isawa,Jahuri and Uzum of Giade Local Government Area of Bauchi State. The statistical analysis revealed that all the metals in the five different locations 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).

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ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VI June 2024

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