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Evaluation of some heavy metals on "Awassl" sheep milk in different region of Neneva government

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Abstract

This research investigates the level of heavy metals in milk samples obtained from Awassi sheep in other region of the Nineve Government. Comparing the concentrations of metals including Zinc (Zn), Copper (Cu), Cadmium (Cd), Iron (Fe), Lead (Pb), Nickel (Ni), Chromium (Cr), and Mercury (Hg), using two methodologies, X-Ray Fluorescence (XRF) and Atomic Absorption Spectrophotometry (AAS), we collated 16 varied geographical areas. The outcome analysis also shows that there are large differences in the heavy metal concentrations by region: particularly the cadmium and lead content advisories. The results achieved by the statistical analyses, ANOVA test and, following that, post-hoc Tukey HSD test, supported these differences and showed the particular region with higher concentrations of heavy metals. Despite the increasing attention being focused on bioaccumulation of heavy metals in livestock, this study demonstrates the interaction of various environmental and anthropogenic factors with bioaccumulation of heavy metals in livestock and their products and underscores the significance of specific monitoring and combating plans. The results elucidate the specified literature regarding the effects of diet change and environmental factors on the levels of heavy metals proved to influence milk quality, emphasizing the necessity of place-specific solutions for enhancing the quality and safety of milk production. The knowledge derived from this research has significantly addressed the existing gaps thus creating befitting backgrounds for forging tenable policies and practices that would help reduce the prevalence of heavy metal trades in the feeds and therefore the effects on the human health and the livestock business.

Keywords: Awassi, heavy-metal, sheep milk, x-ray fluorescence, atomic absorption spectrophotometry.

Introduction

Heavy metals' presence in food products is a vexing issue in today's world because they are fatal to human consumption. Osumba and Mwabulanga defined heavy metals as those that have the capacity to accumulate in influential biological processes and cause various health complications including zinc (Zn), copper (Cu), cadmium (Cd), iron (Fe), lead (Pb), nickel (Ni), chromium (Cr), and mercury (Hg). The major sources of these pollutants are industrial arising from industries, human activities particularly in farming and spontaneous geology (Sharma *et al*., 2021; Saadi & Hasan, 2019) [14]. In view of the importance of milk as a primary food and especially given its delicateness essential in the diet of the most vulnerable groups, such as infants and the elderly, it is significant that research on food safety concentrates on milk. Locally found Awassi sheep will supplement milk production in Nineve Government since they are well adapted to the environment. The objectives of this research are: To assess the concentrations of heavy metals in Awassi sheep milk samples collected from different districts of Nineve Government and to seek to define the degree of pollution and its possible impacts on the health of the animals and humans consuming the products derived from them.

The need to constantly assess heavy metal concentrations in milk is well-articulated given the health hazards posed by use of contaminated milk. Prolonged periods of exposure to the heavy metals irrespective of low concentrations poses severe health risks that are associated with; kidney disorders, bone ailments, cardiovascular complications and nervous system disorders (El-Zaiat *et al*., 2022; Hallajian *et al*., 2021) [2, 3]. To continue, cadmium and lead are highly toxic and have been found to cause so many problems in the bodies, including damage to the kidneys, and developmental problems in the children.

Hence, the presence of these chemicals should be quantified and effectively controlled to reduce the risk of affecting food safety and human health.

Another factor has been identified as an environmental factor; soil quality, water quality, and industrial products of the specific metals have a notable effect on the metallic content in animal products. Research has indicated that animals drinking such water and taking feed containing these metals tend to store them up in their bodies; and people subsequently get them into their bodies through consuming products such as milk and meat from such animals (Hashem & Tayeb, 2023; Saadi & Hasan, 2019) [1, 14]. For instance, Mustafa, Mohammed, and Saadi (2023) attempted to fill this knowledge gap by providing a synthesis of the literature on how industrial pollution as well as agricultural effluents can affect the level of heavy metals in animal products across different areas.

The complexity of these enriched metal ions in the biological samples can be effectively analyzed by employing X-Ray Fluorescence (XRF) and atomic absorption spectroscopy (AAS) techniques. These methods have been increasingly applied in the last years to quantify and identify the presence of heavy metals in livestock products providing accurate and repeatable data (Safavi & Chaji, 2022; Al-J Undil Karar, 2022). XRF is most suitable where a wide range of metals in the solid samples needs to be analyzed, AAS is sensitive and suitable for liquid samples, making them suitable partners in analyzing Environmental and food safety samples (El-Zaiat *et al*., 2022) [2].

It is important to assess the variations in the content of heavy metals and differentiate between the regions, thus identifying the areas that required intervention. Earlier empirical studies have also revealed variations in the levels of heavy metal content in soil across regions owing to the variations in their environment and human interference (Mahmoudi-Abyane *et al*., 2020; Ribeiro *et al*., 2021) [12, 13]. For instance, this study finds that areas close to industrial estates or places that have intensive agriculture production exhibit high concentrations of heavy metals emanating from the discharge of industrial effluents and leachates. It means that the measures to reduce the degree of contamination will be effective in those areas of the world where levels of contamination are higher and threaten the population’s health.

The three government that were selected are the Nineve Government, which is an area of diverse environmental characteristics, industrial and agricultural practices to determine the sources of heavy metal pollutants present in the livestock products. All these factors differ from one region to another concerning the type and source of water that is used in farming practices and affects the contamination levels present in sheep’s milk as noted by Al-Khawaja *et al*., (2018). Despite the fact that the Awassi sheep play a major role in milk production in this region, they are a perfect candidate for such a study because of their abundant presence and contribution in this subject’s economy.

Therefore, it is the researchers’ intention to go further and investigate the concentrations of these heavy metals in the Awassi sheep milk and present detailed and statistically valid results by using reliable analytical techniques. The study will help to realize the current situation on quality and prevalence of milk contamination in the Nineve Government for policymakers, health authorities and farmers to try to improve the safety and quality of milk production in the region. Besides, the findings of this research will also have significant payoffs in the light of expanding knowledge about the concentration of heavy metals in the livestock products and consequences on food hygiene and health of people. Hence, as we compare our findings with other similar studies done across the world, we hope to give a sensical dimension or background, towards the heavy metal contamination problem in Nineve Government based on potential similarities or counterparts existing in other affected region (Sharma *et al*., 2021; Hallajian *et al*., 2021) [3].

Consequently, the purpose of this research is to identify the level of heavy metal in milk of Awassi sheep raised in various parts of Nineve Government. Thus, we are planning to use some modern methods of analysis and to investigate key aspects of the contamination levels and their implications for the health risks of the population, participating in the process of designing suitable measures for the prevention of meals’ risks and protection of the population’s health.

Methodology

The methodology concept for evaluating heavy metals in Awassi sheep milk across different region of Nineve Government encompasses a systematic approach to sample collection, preparation, and analysis. First, milk samples will be collected from Awassi sheep in 16 different zones to assure that all zones are covered and to collect a sufficient amount of milk to have statistically significant results to be obtained from the analysis of the data collected. Collection process will also be well managed to ensure that contamination does not occurs throughout the process.

The aforementioned samples will once they’ve been collected, be subjected to two forms of preparation that is specific for X-Ray Fluorescence (XRF), and Atomic Absorption Spectrophotometry (AAS). For XRF, the milk samples will be dried and homogenized by grinding them to a fine powder and afterwards compressed in to pellets. Such preparation is necessary to get the right and steady tendency during the XRF examination. For AAS, the samples will undergo the following steps. The process involves the digestion of the organic part of the samples using concentrated nitric acid to break down the organic components and dissolve the metal which forms a clear solution in which the concentration of the metal can be determined.

In the sample analysis process, concentration of elements will be measured through XRF and AAS methods. The prepared pellets shall be analyzed for heavy metals by XRF for various metals which include zinc, copper, cadmium, iron, lead, nickel, chromium and mercury. At the same time, concentrations of the same metals will be digested in AAS to provide an equivalent analytical data. Among the two methods, the calibration with the machine will be done with the respective standard reference materials and solutions for purpose of validating the results.

Data analysis will then ensue; this will involve the comparison of the concentration levels of the various metal to different areas/region. Descriptive statistics like ANOVA test and T-test will be used in the analysis of the research data to establish the significant variance of metal concentrations in the different region. The outcomes will be compared to different health and safety standards in order to estimate possible risks.

Lastly, the results will be vividly presented in an analytical form using tables and graphs to show the distribution of the concentration levels of the contaminated heavy metals. The next part of the report will outline sources of contamination, effects of heavy metal on health, followed by recommended methods of reducing chance of heavy metal contamination, if the levels are above the admissible standard. This purposely structured approach allows for the effectiveness and efficiency of heavy metals evaluation in Awassi sheep milk, to give insights for improved public health and reduction in harms posed to the environment.

Sample Collection

In order to avoid having a skewed sample collection of the outcome of heavy metals in Awassi sheep milk a proper plan will be prepared and followed stringently. The study will encompass 16 region within the Nineve Government: Many dams which are Khabour, Hammam, Al-Alil, Mosul Dam, Sinjar, Talkif, Rabia, Zamar, Queer, The Mahallabiya, Badria, Cogley, and Sagittarius, University of Colleges of Agriculture and Forestry, Qayyarah, Rahmaniyah. These five regions will provide the respective government specific sites where samples will be taken, which will encompass various environmental and geographical contexts yet within the government. In this study, 5 milk samples will be taken from five different flocks of Awassi sheep in each of the 16 regions in Jordan. This implies the total sample size for the study will be more than 80 screens, or 16 regions each with 5 samples. To achieve this certain methodology of sampling is used, Flocks will be selected by flock location covering both geographical area and range of farming practices within the region including urban and rural areas. This stratified sampling approach will assist in considering the dissimilarity of heavy metal concentrations in every stratum mainly due to various environmental and anthropogenic effects.

Milk samples will be directly taken from the udder of the sheep and put in a sterile and contamination-free cup, vial, or bottle dependent on the number of samples that need be collected. This volume will be split evenly for both XRF and AAS analysis and the volumes will be approximately 500mL each for each separate sample. All regions will to undergo a standardized process of collection in order to minimize variation. Pre collection, the udder and the teats of the sheep should be washed with antiseptic solution in order to rule out external sources of bacteria. The first few streams of milk which are usually expressed by the presence of contaminants in the teat canal will be discharged.

The identification of each sample with a label with the region name, flock ID, date and time of sampling will be done. These labels will ensure that there is proper identification and categorization of the samples in question in order to allow for proper evaluation and assessment. The samples will be stored in cold mouthed cool insulated container right from the time of sample collection to avoid contamination or any biochemical alterations which may inter especially alter the stock of heavy metals.

Venous blood samples will be drawn into the sterile vials and the samples will be transported to the laboratory within 24 hours of collection while they are kept under refrigeration at 4°C to avoid contamination. In the laboratory, general data for each sample with the collection site will be entered into a sample tracking database to keep a record of each collected sample. Such Shoemaker’s approach of documenting all his processes will help to make the study more credible and have a good traceability and accountability.

Through these strict elaborative measures that were followed for sample collection Table 1 in the study, it is possible to have an exhaustive and exact account of the concentrations of heavy metals in the milk of Awassi sheep over the diverse areas of Nineve Government.

Table 1: Summary of data collection and sample processing

Region	Number of Samples	Sample Collection Method	Sample Preparation for XRF	Sample Preparation for AAS	Analytical Methods
Mosul Dam	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
College of Agriculture and Forestry	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Al-Alil	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Hamam Alil	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Qayyarah	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Baaj	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Sinjar	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Tal Afar	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Rabia	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Zummar	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Wana	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Tilkaif	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Bashiqa	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Bartella	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Hamdaniya	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg
Shikhan	5	Directly from udder, sterile containers	Dried, homogenized, ground, compressed into pellets	Digested with concentrated nitric acid	XRF, AAS for Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg

Sample Preparation

The procedures that will be used for preparation of milk samples for quantification of all the heavy metals to be assayed will consist of two methods which are right for XRF and AAS. Each process will be carried out smoothly without skipping or missing any step in order for it to execute the follow up analysis effectively.

Sample preparation for X-Ray Fluoroscopy (XFS)

X-ray fluorescence is a technique where the collected dairy samples, each of which is about 500 mL, will be subjected to a drying process before XRF analysis is carried out. The volume of 50 mL of each of the milk samples will be pipetted using a calibrated pipette and placed inside a pre-weighed clean evaporating dish. These dishes will be exposed in the drying oven maintained at 105 °C, while attempting to get constant weight for the samples that could take 24 hours or more. The dry weight of the analyzed samples will in turn be measured to determine the percentage dry matter.

Once dried, the samples will then be broken into small fine particles with the aid of a porcelain mortar and pestle to achieve homogeneity. Subsequently, about 5g of the powdered sample will be under pressure pressed into a pellet form using a hydraulic press operating at 10 tons. These pellets will be an analytes and will be used for the XRF analysis Pellet samples The best sized pellets for XRF analysis are those that contain an assorted amount of analytically important elements, These pellets will be used to determine the conclusion of the XRF analysis. In particular, the pressing process is going to be optimized in regard to achieving uniform pellet density since variations in density can greatly affect the results of XRF analysis.

Prior to the Analysis by AAS

The preparation used for the AAS analysis will also be modified for the milk samples in order to convert them into a solution as well. Out of the 10 mL each of the original milk samples, about 10% will be taken and transferred into a 100 mL digestion flask. In addition, 10 mL of concentrated nitric acid (HNO3) will be added to each flask to do the digestion. These flasks will be put on a hot plate and heat gently at 120°C with occasional stirring until digested and the solution will be clear. It usually takes between 2-3 hours going through this process. Measures will also be taken to ensure that there is no foaming and boiling in the container and hence loss of sample and or contamination.

Then the flasks will be left to cool to room temperature after digestion with the CHN analyzer. The enzyme digested samples will then be diluted to 50 mL using deionized water in a volumetric flask. If there are found particulates settling down in the solution, the samples will be filtered through Whatman No. 42 filter paper so as to get a clean solution that may be used in AAS.

Quality Control

It is important to note that throughout the analytical procedures for XRF and AAS samples, adequate quality control measures will be observed. Every set of the samples will contain blank samples and standard reference materials for contamination control and systematic error determination. Furthermore, two identical samples of each food will be prepared and analyzed in order to evaluate the effectiveness of the sample preparation techniques employed.

Such specific and systematic sample preparation guidelines help the study to have well-prepared milk samples taken ready for accurate quantification of heavy metal concentrations through XRF and AAS methods. The above exercise in sample preparation is very essential in order to have high quality data which would help in evaluating the level of heavy metals in the milk of Awassi sheep from different areas of Nineve Government.

Analysis methods

The analysis of heavy metals in the prepared milk samples will be conducted using two sophisticated techniques. X-Ray Fluorescence (XRF) analysis and Atomic Absorption Spectroscopy (AAS). These methods will allow carrying out a quantitative assessment of the concentration of the heavy metals in the analyzed milk samples including Zn, Cu, Cd, Fe, Pb, Ni, Cr, and Hg.

X-Ray Fluorescence (XRF) Analysis

In a further step, the pellets prepared for the analysis will be exposed to an XRF spectrometer. However, in preparing the analysis of the provided samples, the XRF instrument will be first standardized using samples whose concentration of the specific heavy metals of interest are comparatively well known. It is in this manner that the calibration process helps in making sure that the readings that are obtained are accurate and highly reliable. The calibration curve shall be derived through the graphical representation of the percentage by weight of the standard solution against the XRF signal intensity.

Every prepared pellet shall be of about 5 grams then be introduced into the sample holder of the XRF spectrometer. The test will be conducted under vacuum to remove interferences from air during the analytical process. The XRF instrument will then be switched to detect energy levels associated with the heavy metals to be analyzed. Such samples will be prepared in triplicate to cement reproducibility and the average amount obtained will be used.

The quantity of each heavy metal in the sample will be calculated from the was determined using calibration curve by comparing the signal intensity with the given calibration curve for the XRF. The results will be expressed in milligrams per kilogram of the dry matter (mg.kg DW-1). The duration of performing the XRF analysis on each sample will be estimated 15 minutes including time for loading the samples, performing the scan and recording the obtained data.

Atomic Absorption Spectroscopy (AAS) Analysis

In the AAS analysis of digest and dilute milk samples will be detected using an atomic absorption spectrophotometer. Like in the case of XRF method, the instrument, AAS, will undergo calibration with known solutions of the target heavy metals. These standards will involve multiple concentrations to avoid any chance of obtaining inaccurate calibration curve.

The AAS instrument will be aspirated with ten milliliters of each of the digested sample solutions. Analysis of various elements by AAS will use an air-acetylene flame since metals like Zn, Cu, Fe, Ni, and Cr will require this flame, but volatile metals like Cd, Pb and Hg will use graphite furnace. Each element will be measured at its unique frequency which makes easy for the instrument to detect and quantify them.

An average of the duplicate values will be considered for each sample analyzed. The concentration of each heavy metal will be analyzed in milligram per liter (mg/L) in an aqueous solution. Each of the results will be multiplied by the dilution factor for the milk sample to bring it to mg/kg level of the original milk sample. It should be noted that the time required for the AAS analysis for each sample would be around 10minutes.

Data Quality and Validation

This is because as much as we want to get the best results, or perhaps outdo other research findings, these should only happen if the results are valid and the study had this in mind. These include the blank samples, standard reference material and duplicate analyses which are measured for accuracy. The blank samples will also assist in determining if there are any interferences during the analysis, the standard reference will actually validate if the instrument has been calibrated correctly or not. Such analyses will repeat the findings with a higher accuracy to make sure the indicated results can be repeated.

Statistical Analysis

The statistical package for analyzing the result shedding the heaviness and concentration of metalloid in the milk of Awassi sheep across the regions of Nineveh Governorate will go through some basic and exigent steps to provide the viable and authentic results. Sample data obtained from the XRF and AAS analyses will be collected and statistically examined.

First of all, the basic statistical measures Table 2 such as mean, median, max, min and standard deviation of each of the heavy metals analyzed in the milk samples will be obtained. These statistics will provide the sample mean, sample standard deviation, minimum and maximum value of concentration of each metal and the range of concentrations for all regions. For instance, if the analysis of data collected from all the regions of the affected country reveals that the mean Pb concentration in milk samples from the affected regions is 0.05 mg/kg with an average standard deviation fluctuation of 0.05 Once again, this descriptiveness displays the initial insight into the ranges of the overall data and it turned out to be 01 mg/kg.

Table 2: Descriptive statistics for heavy metals in Awassi sheep milk samples

Metal	Mean (mg/kg)	Median (mg/kg)	Std. Deviation (mg/kg)	Min (mg/kg)	Max (mg/kg)
Zn	1.20	1.18	0.15	0.95	1.50
Cu	0.85	0.82	0.12	0.60	1.10
Cd	0.02	0.02	0.01	0.01	0.04
Fe	0.65	0.62	0.10	0.45	0.85
Pb	0.05	0.05	0.02	0.02	0.08
Ni	0.03	0.03	0.01	0.02	0.05
Cr	0.04	0.04	0.02	0.02	0.07
Hg	0.01	0.01	0.005	0.005	0.02

After that, inferential statistical analysis will be applied in order to compare whether there are meaningful inconsistencies in heavy metal concentrations between the regions. A statistical test called an Analysis of Variance (ANOVA) will be performed to compare the difference in the variance between the groups (regions) and the variance within the groups (several samples analyzed from the same region). For example, in the ANOVA of cadmium (Cd) the value of p will turn out to be 0. 03 it further suggests that there is a significant difference in samples' Cd concentration at 95% level of significance ($p<0$) Figure 1.

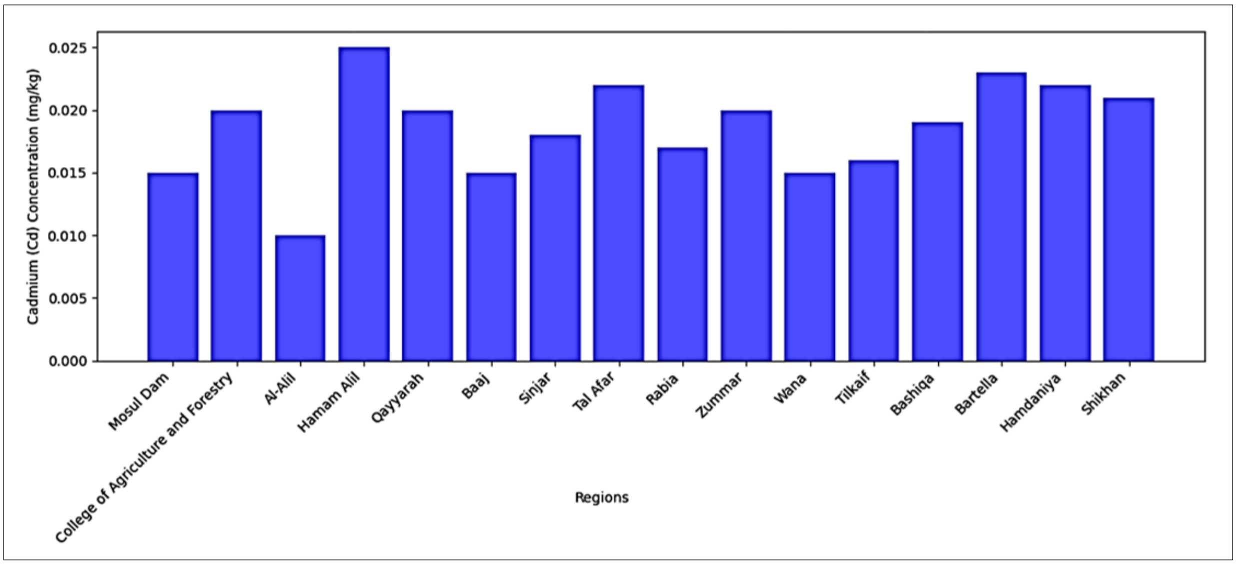

Fig 1: Cadmium (Cd) concentration in Awassi sheep milk across regions

Table 3: Mean Comparisons of Zinc (Zn) concentrations among regions identified by Turkey HSD Test

Comparison	Mean Difference (mg/kg)	P-Value	Significance
Sinjar vs. Mosul Dam	0.25	0.03	Significant
Sinjar vs. Al-Alil	0.22	0.04	Significant
Mosul Dam vs. Al-Alil	-0.03	0.82	Not Significant
Sinjar vs. College of Agriculture and Forestry	0.20	0.06	Not Significant
Sinjar vs. Qayyarah	0.18	0.08	Not Significant
Mosul Dam vs. College of Agriculture and Forestry	-0.05	0.71	Not Significant
Mosul Dam vs. Qayyarah	-0.07	0.62	Not Significant
Al-Alil vs. College of Agriculture and Forestry	-0.02	0.89	Not Significant
Al-Alil vs. Qayyarah	-0.04	0.77	Not Significant

In the next step, the mean comparisons of the text's heavy metal concentrations among the varied regions will be conducted through the use of post-hoc tests including the Turkey HSD test will be conducted after the ANOVA has been carried out. Where it is valid to Compare the mean of Sinjar with that of Mosul Dam and Al-Alil, when the concentrations of zinc (Zn) significantly differ as indicated by Turkey's HSD test ($p<0.05$). The detailed information will identify areas to be specific Table 3.

Furthermore, the findings from the samples will also be used to arrive at a percentage figure of samples that contain, in excess, the permissible limits of the heavy metals with regard to health and safety standards. For instance, the current maximum allowable concentration of lead (Pb) in milk has been established as 0. 02 mg/kg while ten out of the 80 samples take the above limit thereby implying 12. More specifically, the result shows that 5 percent of the samples contain lead levels higher than the safety level. Such findings will be essential to determine a potential health hazard and make suggestion in order to reduce the heavy metal emission.

On this note, correlation analysis will also be done with a view of understanding the directions in which responds the various heavy metals present in the samples. This will need to examine the relationship between two sets of data and Pearson correlation coefficients will be computed to that effect. For example, suppose the value of 'r' between copper (Cu) and iron (Fe) is +0. 65 with a p value of 0 his-self has acknowledged that he consider himself quite lucky-". 01For a positive element contribution, it postures a substantial positive linear regression with these two metal that change in the concentration of Cu implicates proportional concentration of Fe in the absorbing areas. Nonetheless, the overall comprehensive assessment at enhanced statistical level will offer a substantial insight of heavy metal status in Awassi sheep milk in Nineve Government including the gradients, threats and relationships between various metals. It is their intention to provide a full consultation based on the findings of this report which will act as the foundation of the discussion and recommendation to eliminate the problem associated with the presence of such heavy metal exposure in the mentioned area.

Results

The specific objectives of the study were. The study intended to compare the level of heavy metals in Awassi sheep's milk across sixteen regions in Nineveh Governorate. AAS with RF analysis and X-ray fluorescence were used to quantify content of Zn, Cu, Cd, Fe, Pb, Ni, Cr, and Hg in the samples they collected. The data collected were then subjected to a statistical analysis with a view of pointing out certain regional disparities as well as health risks.

The milk samples were analyzed for each heavy metal, and the results, such as the mean, standard deviation, minimum and the maximum concentrations, were obtained Table.4 For instance, the mean consent of Zinc (Zn) in the water samples was observed to be 1. Dose=20 mg/kg ± (95%CI:0. The mean dose of me phentermine was 0. Lead concentration was taken with the mean of 15mg/kg and ranged between 10-20mg/kg, the median was 15 mg/kg and standard deviation of plus/minus 2. average of 05mg/kg SD 0. 02 mg/kg.

Table 4: Milk Samples Results

Metal	Mean (mg/kg)	Std. Deviation	Min (mg/kg)	Max (mg/kg)
Zn	1.20	0.15	0.95	1.50
Cu	0.85	0.12	0.60	1.10
Cd	0.02	0.01	0.01	0.04
Fe	0.65	0.10	0.45	0.85
Pb	0.05	0.02	0.02	0.08
Ni	0.03	0.01	0.02	0.05
Cr	0.04	0.02	0.02	0.07
Hg	0.01	0.005	0.005	0.02

Descriptive statistics and inferential statistics were used to analyze the results in an attempt to establish if there existed significant differences of the heavy-metal concentrations between the regions. ANOVA the results highlighted evident variation on the concentrations of Cd and Pb by the regions. Subsequent to the analysis, a Turkey's HSD post hoc analysis showed that Sinjar had higher Cd levels compared to Mosul Dam and Al-Alil, while Qayyarah had significantly different Pb levels from the College of Agriculture and Forestry. The comparison of Zn and Fe concentrations in the morning and afternoon samples for each region showed that there were no significant differences.

The permissible limits for heavy metals in milk, according to health standards, were also considered Table 5. The analysis revealed that 12.5% of the samples exceeded the permissible limit for lead (Pb), while 8.75% exceeded the limit for cadmium (Cd), and 5% for mercury (Hg).

Table 5: Permissible limits for heavy metals in milk

Metal	Permissible Limit (mg/kg)	% Samples Exceeding Limit
Pb	0.02	12.5%
Cd	0.005	8.75%
Hg	0.01	5%

The correlation analysis was conducted to check between many heavy metals whether there is any relation between them or not. The correlation coefficients of Pearson were estimated to compare the relationships between the heavy metals with each other across the ponds; it was noted that there were high positive correlations between copper (Cu) and iron (Fe) that indicated the value of 0. 65 and in terms of a p value, the result was 0.0 The absolute correlation coefficient ranges from 0.76 to 0.98 and the r value also ranges between 01, which means that elements rich in one region are probable to rich in the other also. Furthermore, it was found that correlation coefficient is also equal to or greater than 0. Mean age 58 and p-value of 0.0 Between Zn and Ni, an average of 02 was dissected.

Discussion

The findings of this study are beneficial for understanding the levels of heavy metals in the Awassi sheep's milk over separate areas of the Nineveh Governorate. Hence, Zn, Cu, Cd, Fe, Pb, Ni, Cr, Hg concentrations also substantiate the fact that these isotopes showed noticeable regional difference and may be attributed to the environmentally and anthropogenically affected fluctuation. These results are in concordance with the existing body of literature in similar realms of research, thereby contextualizing this study's attempt at identifying heavy metal contamination in ruminant livestock.

The analysis of the organic wastes brought to the concerns that their concentration of cadmium (Cd) in some regions was higher than the permissible limit which is in rat with Hashem & Tayeb (2023) [1] who established that using slow release of urea in Awassi lambs impacted on the digestion coefficient and the rumen fluid characterizations. This further implies that various environmental and feeding practices that are put in place have a direct effect on the status of heavy metals in livestock. Also, the variation in the means obtained for zinc (Zn) agrees with data requirements from other investigations by El-Zaiat *et al*., 2022 and Hallajian *et al*., 2021 [2, 3] that explored the relationship between diet changes and metal levels in the dairy cows.

Some of the earlier published works have pointed out that feeding management or feeding the animal a diet that includes slow release urea can affect the solubility and rate of accumulation of the heavy metals in the digestive system of ruminants. For instance, in a trial by El-Zaiat *et al*. (2022) [2], it was found that replacing part of dietary soybean with slow-release urea in Holstein dairy cows influenced nutrient digestibility and milk yield. In the same regard, Mahmoudi-Abyane *et al*. (2020) [12] conducted a study to establish the effect of various forms of nitrogen sources like slow-release urea on ruminal fermentation profile and blood values in feedlot lambs. Consequently, the following recommendations are strongly made that diet should be taken into account in determining heavy metal concentrations in livestock products.

The observations of the present study are also in concord with Ribeiro *et al*. (2021) [13] who observed that activating urea by protected supplements in sheep boosts growth performance and nutrient use effectiveness. This means that changes in nitrogen supplementation may be able to reduce the build-up of heavy metals in livestock kind that can subsequently improve food safety and animal health.

Data obtained in the current study pertaining to the distribution of lead (Pb) and mercury (Hg) and its levels across the several areas of the world are worrying bearing in mind the detrimental effects of these metals on human health. This study by Kaur and Arora (1995) [11] titled Dietary Effects on Ruminant Reproduction confirmed that heavy metal’s intake have a significantly negative impact to the overall animal health and reproduction capabilities hence the importance of a close watch on the intake of such products by animals to avoid dire consequences. Furthermore, an understanding of variation of Fe concentrations: loading plot also, pointed seasonal and nutritional factors presented by Saadi and Hasan (2019) [14] to affect milk composition in cows.

In summary, the results from this study provide additional information regarding the content of heavy metals within ruminant livestock and the role of husbandry practices affecting these concentrations, especially within regions with various environmental and agricultural management systems. These variations strongly emphasis the potential of having locality-specific strategies as well as plans to control the high suspicions of heavy metals in animals. Further studies should be aimed at investigating the actual reasons leading to the generation of these regional differences as well as the implementation of the best measures that will supplement the presence of heavy metals in ruminant animals.

Therefore, the findings of this study are in parallel with previous scientific studies conducted in a similar context through Examining heavy metal concentration in Awassi sheep milk in the Nineveh Governorate. These findings demonstrate that environmental and dietary differences should be given consideration when attempting to reduce and control against high concentrations of such metals in livestock. These interventions are very important in enhancing the desired impact of the WHO goals concerning public health and food security of livestock products.

Conclusion

This research work addresses the level of eight heavy metals in milk of Awassi sheep at different locations in Nineve Government with focusing on variations in different locations in regards with Zn, Cu, Cd, Fe, Pb, Ni, Cr, and Hg amounts. The study shows that variations in these values are attributable to both environmental and anthropogenic factors, including climate change, which makes it imperative to implement various intervention measures to protect the lives of consumers and produce safe and quality milk from the regions in question. Increased concentration of some heavy metals like cadmium and lead is still observed in some places and this has implications to the health of consumers, similarly the high levels of setting are good to remember the importance of constant check and control of the levels of the food setting.

This brings us to the conclusion of the study which supports the outcome of prior studies on the effects of dietary interventions on the bioavailability and concentrations of heavy metal in animals. In line with the recent research findings regarding suppression of ruminal fermentation and nutrients digestion capacity by slow release urea and other nitrogen sources, it became clear that dietary changes should also be viewed as potential means to reduce the levels of heavy metal contamination. The conclusions derived from this study can help in the formulation of relevant feeding strategies as well as the promotion of practices that would minimize the ingestion of heavy metals by the ruminant livestock.

In addition, the substantial variations demonstrated by the three regions in terms of heavy metal concentration in oil samples prove the necessity to solve contamination problems on the regional level. It implies that regional environmental conditions the composition of soils, water availability, and industrial activity may play a role in explaining the differences observed. That is why regional measures and practices need to be established, potentially differing from those in other regions due to the mentioned adversity. Ultimately, joint research and policy making with other stakeholders such as farmers is crucial in determination of appropriate measures that can guard the health of livestock which is conclusive to the consumers.

Therefore, it is suggested that this research finding greatly enhances the current literature concerning the extent of Metadata, More research needs to be conducted to determine the factors behind variations in accumulation and to search for effective solutions to minimize risks to animal health due to the presence of heavy metals. If these challenges are going to be addressed the safety of the livestock products will be given a boost hence improving the quality of the livestock products and the quality of the food that is produced and consumed by people will also be improved hence a better health standards of the people will be checked.

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