

Lead Exposure Pathways in Poultry Production: Investigating Lead (Pb) Exposure in Chickens and Its Human Health Implications

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ABSTRACT

This research delves into the intricate interplay between agricultural practices, livestock feed compositions, and their implications for both poultry health and human nutrition. The study extensively investigates the nutritional content of various chicken feeds and the edible parts of chickens, while also analyzing the elemental composition of chicken blood and human serum across different farms and sites. The starter feed demonstrates a unique nutritional profile compared to the grower and layer feeds. A comprehensive analysis of edible chicken parts, including heart, wings, and liver, uncovers notable differences in nutrient composition, implying potential dietary implications. The examination of metal concentrations in chicken blood and human serum brings to light intriguing variations

based on different age groups, indicating the potential influence of age-related factors on metal accumulation. The research explored the variability of metal content across different farms, offering valuable insights into the potential impacts on human health. In particular, the study investigated the significance of the role farms played in the presence of these heavy metals. The findings suggest that Pb concentrations were observed in varying levels across chicken feeds and edible parts, no statistically significant differences were noted due to the farms. Comparing the results to existing studies, it is evident that this research provides valuable contributions to the field, shedding light on the potential health implications of metal content in poultry products. Overall, this study emphasizes the importance of monitoring heavy metal concentrations in chicken products and the need for stringent quality control measures to ensure food safety and human well-being.

Keywords: Poultry farming, Chicken, Human health, Heavy metal Toxicity, Environmental impact.

INTRODUCTION

Poultry can be defined as domesticated birds, including chickens, raised for the production of meat or used for the flesh of these birds as food. Native breeds of chicken that are raised and bred within a single nation are known as local or domesticated breeds. They are raised by individuals who live in cities and towns, but they are most frequently found in rural and semi-urban areas. Around 87.4% of the world's 127.3 million ton of poultry produced in 2018 were chickens, and between 2008 and 2018, the number of chickens slaughtered rose by 28.4%. (Chem, 2022)

Most poultry farming is done for meat. Pakistan has an estimated 150,000 chicken farms. The farms generate 570 million ton of beef annually. It has been established that one of the main risks to human health is heavy metal toxicity. Constant human consumption of tainted poultry products could pose serious public health risks. With a 1.3% GDP contribution, poultry is an important sector of Pakistani agriculture. Commercial feed containing a high protein content is used to improve the production of white meat. Finding cheaper less traditional feed sources that aren't utilized in the human food chain is urgently needed (Akter, 2020)

Chickens and other agricultural poultry eat poultry feed. Domesticated bird meat, which accounts for around 30% of all meat, consumed worldwide which is reportedly the second most popular meat. The majority of modern poultry feeds are grains and protein-

and mineral-supplemented grains. In addition to the required vitamins and dietary elements, healthy poultry needs an adequate supply of protein. The most important of these elements for these animals is chicken feed, which accounts for between 60 and 80 percent of the economic cost input in the commercial poultry industry (Arif et al., 2019)

Understanding the main factors influencing the sustainability of this supply chain is crucial for improving sustainability in the meat production process (Benavides et al., 2020)

Lead is the 24th most common element on the planet, and makes up 3% of the crust. Increased exposure, however, may result in human toxicity. Due to decreased calcium excretion in urine, exposure to lead may alter the physicochemical properties of the human body. Lead exposure also causes a reduction in nitrogen retention. Some creatures require nickel as a trace element, and studies have shown that plants and microbes benefit from low concentration (Zavyalov et al., 2022)

The food chain of poultry birds may be affected by environmental contamination in breeding. This is primary method of ingesting heavy metals (Pappuswamy et al., 2021). For starter, grower, and layer feed at different stages of growth, a consistent supply of energy, protein, minerals, and vitamins is necessary for poultry to grow and stay healthy. The basic chicken nutrition highlights the crucial functions that various nutrients have in the development and production of chicken. Starters are heavy in protein, however grower and layer feed may be lower in protein and need less protein (Ofori et al., 2019)

Around 41 kg of meat was consumed per person worldwide in 2015 when the world's population was roughly 7.2 billion. 52 kg of meat will likely be consumed per person by 2030. Understanding the main factors influencing the sustainability of this supply chain is crucial for improving sustainability in the meat production process (Benavides et al., 2020)

Wheat (*Triticum aestivum* L.) is a member of Poaceae family. Wheat, which contains starch and protein, is a significant source of energy. Although this element is required in small amounts for both plants and animals, at higher dosages it is harmful and damaging (Saadony et al., 2021). During the kharif season, maize produces more than 80% of all production, with the remaining 20% coming from irrigated areas throughout the summer and Rabi seasons (Younas et al., 2020)

Pearl millet (*Pennisetum glaucum*) is commonly known by Bajra and one of the major coarse grain crop. Pearl millet grains have a very high nutritional value; it was determined that

they contain up to 8.5% nutritional value of some selected feeds and about 1582 KJ of energy (Sharma & Kumar, 2020)

Heavy metals are hazardous nature is primarily due to their capacity to ingest living systems before moving up the food chain. Given that chickens are fed a wide variety of feed supplies, environmental pollutants are frequently concentrated in their tissues, making it possible to estimate whether exposure was chronic or acute. A few studies have examined the accumulation of metals in chickens due to their use of contaminated foods in order to determine the potential risk to humans from eating poultry (Huma et al., 2019)

Aim

- To identify the heavy metal contamination and proximate composition in chicken feeds and edible chicken parts, as well as to evaluate the transmission of heavy metals to humans from these sources.
- Detection of heavy Metal contamination in chicken feeds and edible parts.
- Assessment of heavy metal transfer from chicken feeds to chicken edible parts.

Objectives

- To Assess heavy metal contamination in commonly consumed processed Grain-based foods
- To Investigate Heavy Metal Bioaccumulation in chicken edible parts
- To Examine the relationship between heavy metal levels in processed foods and chicken edible parts

Research Hypothesis

H0=There was no significant effect of metals in chicken feeds and chicken edible parts including chicken blood and human serum

H1=There was a significant effect of metals in chicken feeds and chicken edible parts including chicken blood and human serum.

MATERIALS AND METHODS

Area of Research

Sargodha is located in Pakistan's Punjab province. Sargodha, Punjab has latitude of 32.082 and a longitude of 72.669. The Sargodha district covers 5,864 square kilometers. Sargodha District is 187 kilometers (116 miles) northwest of Lahore. It is a commercial agricultural center of trade with a variety of industries. Sargodha is the third largest

division in the Punjab province (**Fig. 1**)

Topography and Climate

Sargodha has mostly fertile, flat plains, with only a few small hills along the Sargodha-Faisalabad Road. Winter weather in Sargodha seems to be cool, short, dry, and often clear, although summers are warm, clear and humid. The city has a summer climate that is extremely hot and a winter climate that is moderately cold.

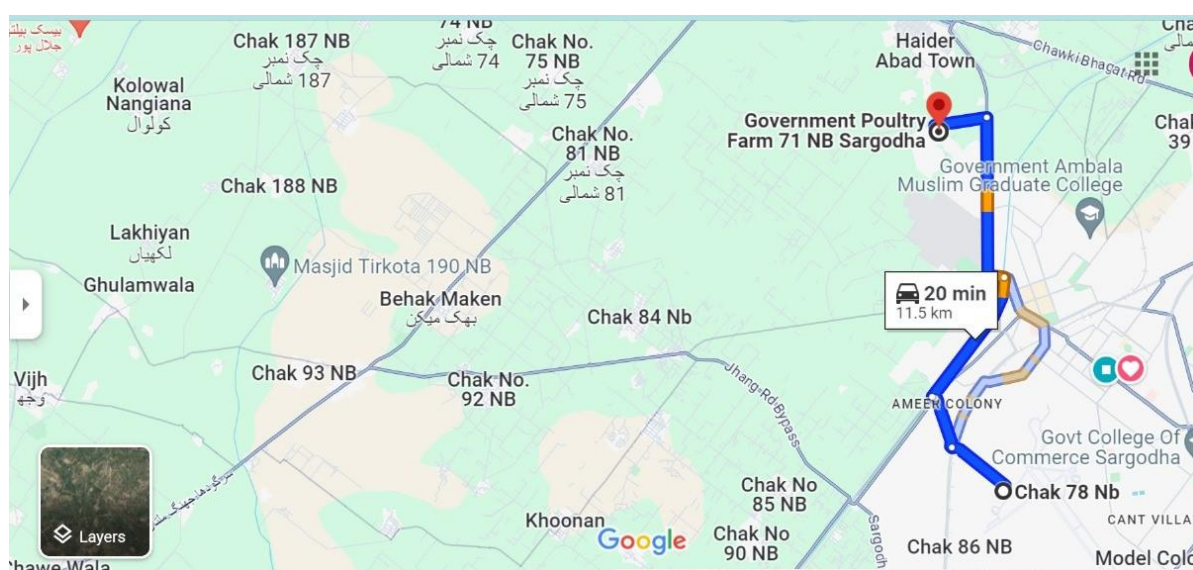


Fig. 1: Map of Study Area

Samples Collection

Different types of chicken feed samples were collected from feed farms of Sargodha. Feed samples were collected and appropriately labeled as starter feed, grower feed, layer feed, scratch feed and pearl millet. While different types of chicken edible parts were also collected from poultry farms, district Sargodha and labeled as heart, wings, drumsticks, liver and gizzard.

Samples Preparation

To achieve a homogeneous particle size, the feed materials were crushed in a blender and sieved through 1.0 mm size mesh. To create a composite sample, feed rations of the same type from various bags were homogenized. For all the feed brands, this was done. For chemical analysis, oven-dried samples were pulverized in a mill using a 1.0 mm sieve. For additional chemical analysis, the ground samples were stored in airtight zip-top bags in three replicates of approximately 250g each.

Standard Preparation

For metal analysis of Chicken feed, chicken edible parts, chicken blood and Human serum samples atomic absorption spectrophotometer was used. In order to set particular curves standard solutions were prepared.

Analysis of Pb

The metal analysis of samples was done by using atomic absorption spectrophotometer. Following metal was analyzed like Pb

Flame atomic absorption spectrophotometer (model) is particularly reliable tools to employ for analysing environmental samples for the presence of metals and metalloids. The method is based on the idea that ground state metals absorb light of a particular wavelength. Metal ions in a solution are changed to their atomic state by burning. When the appropriate wave length of light is provided, the amount of light that is absorbed can be calculated using a standard curve.

In the atomic absorption principal, the wavelength of Pb is 283.3, while the slit width is 0.2 and lamp current is 3.0. While the permissible limits of Lead in chicken feeds is 0.05 (Korish & Attia, 2020) in chicken edible parts is 1.23 (Chiroma et al., 2014) while in chicken blood (Talib Jawad et al., 2021) is 0.10 and in human serum the permissible limit is 0.02 (Korish & Attia, 2020)

Statistical analysis of Data

The data from Atomic Absorption Spectrophotometer on chicken feed grains and chicken edible parts were statistically analyzed. For statistical analysis, SPSS 23 software was used. Through the use of ANOVA software, the mean concentration of metals throughout all the samples was examined.

Estimated Daily Intake

In mg/kg body weight/day, EDI is expressed. The average metal content of each sample was computed, and the corresponding consumption rate was multiplied by that result to determine EDI. The following Eq. was used to calculate the daily intake rate.

$$EDI = \frac{MC \times IR}{BW} * CF \quad (1)$$

Where IR (kg/day/person) is the ingestion rate of the sample, which is assumed to be 17.33 g/day for chicken, and MC is the metal content in the meat (Chowdhury et al., 2023) and 285g of humans respectively (Bilsborough & Mann, 2006). Chickens have been

determined to have an adult body weight of 1.7 kg (Bett et al., 2011) and for humans is 60kg (Chowdhury et al., 2023). The Conversion factor for chicken feed and chicken edible parts is 6.25 for chicken blood is 8.34 (Garcia et al., 2016) and for human serum is 10 (Nair & Jacob, 2016) The metal concentration of Lead is 1.8501.

Hazard Quotient

The ratio of a substance's potential exposure and the concentration at which no unfavorable effects are anticipated is known as the hazard quotient (Amarh et al., 2023). The oral reference dose of Lead is 0.004 (Shaheen et al., 2016)

$$HQ = \frac{\text{Estimated daily intake (EDI)}}{\text{Oralreferencedose(RfD)}} \quad (2)$$

Target Hazard Quotient (THQ)

THQ is a measure of the non-carcinogenic risk level associated with pollutant exposure. The USEPA Region III Risk-based Concentration was used to determine THQ.

$$THQ = \frac{EF \times ED \times FIR \times CM}{BW \times AT \times RfD} * 10^{-3} \quad (3)$$

Where EF stands for exposure frequency (365 days per year) and ED for exposure duration (for humans), the latter of which is taken in this study to be 70 years for non-cancer risk. In addition, chickens are exposed for ten years (Park et al., 2021). FIR stands for food ingestion rate (g/person/day), CM for meat heavy metal content (mg/kg, w/w), BW for average human body weight (60 kg), and AT for average exposure time (EF*ED) for non-carcinogens (365 days/year for 70 years (i.e. AT = 25,550 days) (Chowdhury et al., 2023)

Target Cancer Risk (TCR)

$$TCR = \frac{EF \times ED \times FIR \times CM \times CPSO}{BW \times AT} \quad (4)$$

Where CPSO is the carcinogenic potency slope for oral route, FIR is the meat ingestion rate (g/day), TA is the carcinogen average time (365 days/year for 70 years), and CM is the metal content in meat (mg/kg) (Chowdhury et al., 2023). The Carcinogenic potency slope for oral route for cadmium is 0.38 (Hossain et al., 2023)

Results and Discussion

Concentration of Lead (mgkg⁻¹) in Chicken Feeds

The analysis of variance (ANOVA) revealed that the impact of Farms on Chicken Feed did not yield a statistically significant result of 0.01213 (P > 0.05). Similarly, the effect of

Chicken Feeds on Chicken Feed did not demonstrate a statistically significant outcome of 0.01225 ($P > 0.05$). Moreover, the interaction between Farms and Chicken Feeds did not result in a statistically significant finding of 0.01242 ($P > 0.05$). The mean square value for farms was determined to be 0.01213, indicating a lack of substantial differentiation in the quality of chicken feed among different farms. Similarly, the assessment of various chicken feed types showed no significant divergence in measurements, as indicated by the mean square for chicken feeds at 0.01225 (Table 1). Further examination of the mean concentration of Pb in Chicken Feeds exhibited ranges of 0.12-0.14 mgkg⁻¹ at Farm 1, while the Pb concentrations within distinct Chicken Feed samples showed values of 0.12-0.13 mgkg⁻¹ at Farm 2 (**Fig 2A**).

Concentration of Lead (mgkg⁻¹) in Chicken Edible Parts

Based on the results obtained from the analysis of variance, it can be concluded that the effect of farms on chicken feed was not statistically significant ($P > 0.05$), with a computed value of 0.000077. Furthermore, the association between chicken feeds and chicken feed did not display statistical significance ($P > 0.05$), as indicated by a value of 0.000365. Similarly, the interaction between farms and chicken feeds did not yield a statistically significant outcome, with a computed value of 0.000316 ($P > 0.05$). Since there was no discernible difference in the caliber of the chicken feed between farms, the mean square for farms was 0.01213. According to the mean square for chicken feeds, which was 0.000365, there were no appreciable differences in the measurements of the various types of chicken feeds (Table 1.) Pb content in chicken edible portions was 0.76 to 0.78 mg kg⁻¹ at Farm 1. Pb levels at Farm 2 were between 0.70 and 0.76 mgkg⁻¹(**Fig. 2B**).

Concentration of Lead (mgL⁻¹) in Chicken Blood

The results of data analysis showed that the effect of blood on chicken blood was not determined to be statistically significant ($P > 0.05$), 0.000057. The statistical significance of the interaction between Farms and Blood was determined to be 0.000533 ($P > 0.01$). There is a substantial difference in Chicken Blood among different Farms, as shown by the mean square for Farms being 0.000853. Blood's mean square value of 0.000057 indicates that there are no appreciable differences in the measurements of the various types of blood. The mean square for the interaction between Farms and Blood was 0.000533 implying a significant interaction effect between Farms and Blood (Table 1). The average level of Pb in chicken blood at Farm 1 was between 0.25 and 0.28 mgL⁻¹. Pb

levels in chicken blood were 0.26 to 0.28 mg L⁻¹ at Farm 2 (Fig 2C).

Concentration of Lead (mgL⁻¹) in Human Serum

The outcomes of the ANOVA analysis indicated that the influence of farms on chicken feed was not statistically significant ($P > 0.05$) with a value of 0.000252. Similarly, the relationship between chicken feeds and chicken feed was also not determined to be statistically significant ($P > 0.05$) with a value of 0.000253. Additionally, the computed value for the interaction between farms and chicken feeds was 0.000413 ($P > 0.05$), signifying no statistically significant relationship. Since there was no discernible difference in the caliber of the chicken feed between farms, the mean square for farms was 0.01213. According to the mean square for chicken feeds, which was 0.000253, the measurements of the various types of chicken feeds did not significantly differ from one another. A mean square of 0.01242 for the interaction between farms and chicken feeds indicates that there was no detectable interaction influence (Table 1). Pb levels in serum were 0.26 to 0.27 mgL⁻¹ at Farm 1. The mean Pb Serum content in Farm 2 ranged from 0.27 to 0.29 mgL⁻¹ (Fig 2D)

Table1: Analysis of Variance of Data for Pb in Chicken Feeds, Chicken Edible Parts, Chicken Blood and Human Serum

Chicken Feed			Chicken Edible Parts		
Source	D	MS	Source	DF	MS
	F				
Farms	1	0.01213 ^{ns}	Farms	1	0.000077 ^{ns}
Chicken Feeds	4	0.01225 ^{ns}	Chicken Edible Parts	4	0.000365 ^{ns}
Farms*Chicken Feeds	4	0.01242 ^{ns}	Farms*Chicken Edible Parts	4	0.000316 ^{ns}
Error	20	0.01518	Error	20	0.000173
Total	29		Total	29	
Chicken Blood			Human Serum		
Source	DF	MS	Source	DF	MS
Farms	1	0.000853**	Sites	1	0.000252 ^{ns}
Blood	4	0.000057 ^{ns}	Serum	4	0.000253 ^{ns}

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Farms*Blood	4	0.000533**	Sites*Serum	4	0.000413 ^{ns}
Error	20	0.000081	Error	20	0.000304
Total	29		Total	29	

Table 2: Pb Concentration in Chicken Feeds, Chicken Edible Parts, Chicken Blood and Human Serum (Mean±SEM) in Different Farms and Sites of Sargodha

Chicken Feed			Chicken Edible Parts		
Chicken Feeds	Farm 1	Farm 2	Chicken Edible Parts	Farm 1	Farm 2
Starter Feed	0.13±0.005	0.12±0.007	Heart	0.77±0.003	0.754±0.04
Grower Feed	0.12±0.008	0.12±0.006	Wings	0.78±0.00	0.744±0.01
Layer Feed	0.14±0.002	0.13±0.004	Drumsticks	0.76±0.01	0.708±0.01
Scratch Feed	0.12±0.008	0.13±0.012	Liver	0.77±0.02	0.780±0.06
Pearl Millet	0.12±0.006	0.12±0.011	Gizzards	0.78±0.04	0.762±0.03
Chicken Blood			Human Serum		
Chicken Blood	Farm 1	Farm 2	Human Serum	Site 1	Site 2
Starter Blood	0.28±0.01	0.26±0.002	Age 20-28	0.26±0.012	0.27±0.09
Grower Blood	0.25±0.001	0.28±0.003	Age 29-41	0.27±0.01	0.28±0.06
Layer Blood	0.26±0.001	0.27±0.005	Age 42-55	0.27±0.02	0.26±0.07
Broiler Blood	0.27±0.004	0.26±0.002	Age 56-61	0.27±0.01	0.28±0.04
Local Blood	0.26±0.002	0.28±0.009	Age 61-70	0.27±0.02	0.29±0.06

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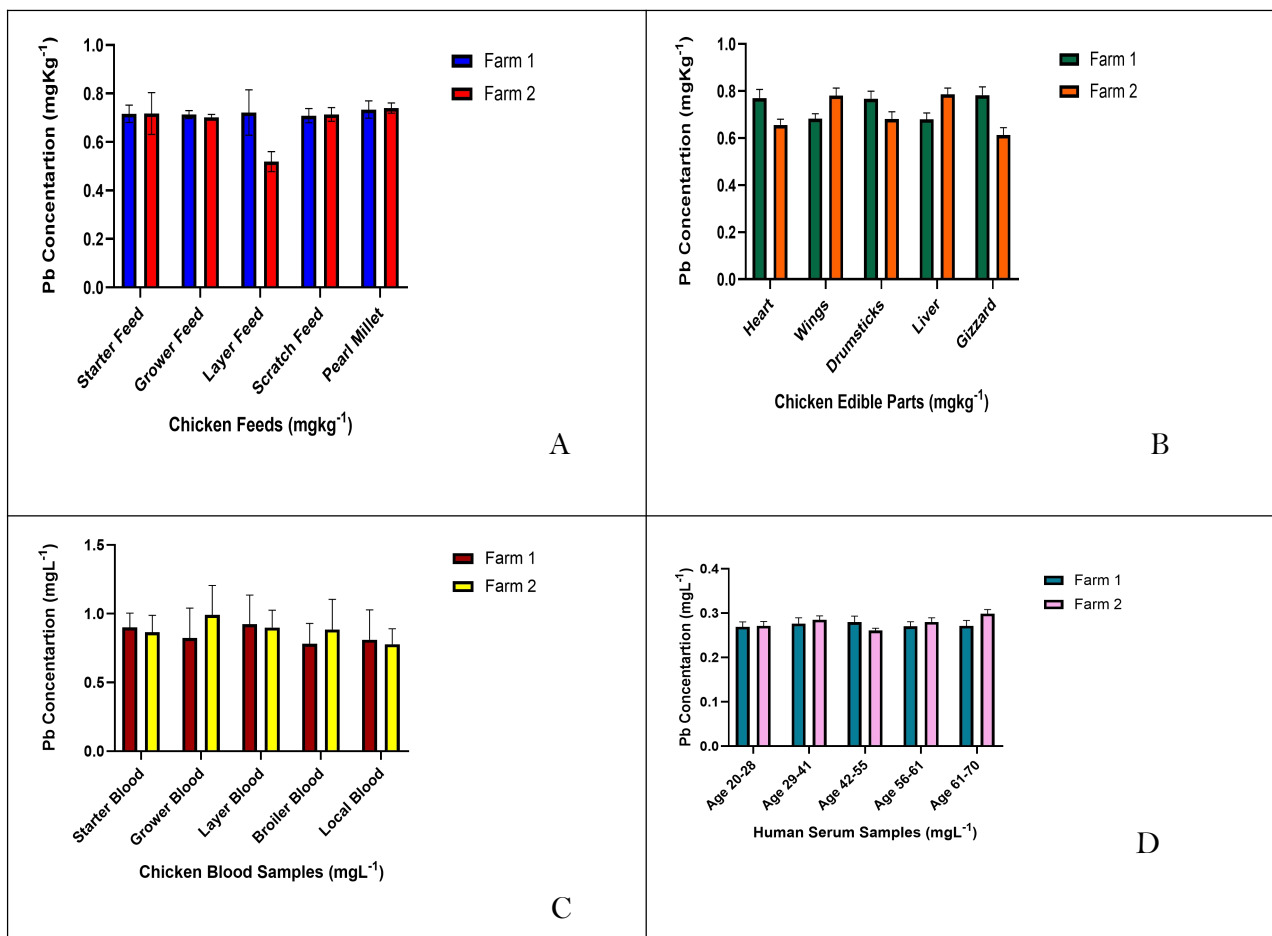
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Fig 2: A: Variation in the levels of Pb (mgkg⁻¹) in Chicken Feed Samples at two Farms B: Variation in the levels of Pb (mgkg⁻¹) in Chicken edible parts at two Farms, C: Variation in the level of Pb (mgL⁻¹) in Chicken Blood at two Farms, D: Variation in the levels of Pb (mgL⁻¹) in Human Serum at two Sites

Correlation of Lead

Using the Pearson correlation coefficient, the relationship between the metal values was solidified. For Feed-Chicken, there was a positive non-significant connection at Farm-1 while a negative non-significant correlation was seen at Farm-2 (**Fig 3**). The Farm-1 exhibited a positive non-significant correlation from Chicken-Humans, while the Farm-2 showed a negative non-significant correlation (**Fig 4**).

A non-significant positive connection between Chicken and Feed was found in (Table 3). Additionally Pb caused non-significant positive relationships between chicken and humans at Farm 1 and non-significant negative relationships at Farm 2.

Table 3: Correlation of Pb between Feed-Chicken and Chicken-Human

Farms	Feed-chicken	Chicken-human
Farm 1	.206 ^{ns}	.159 ^{ns}
Farm 2	.167 ^{ns}	-.248 ^{ns}

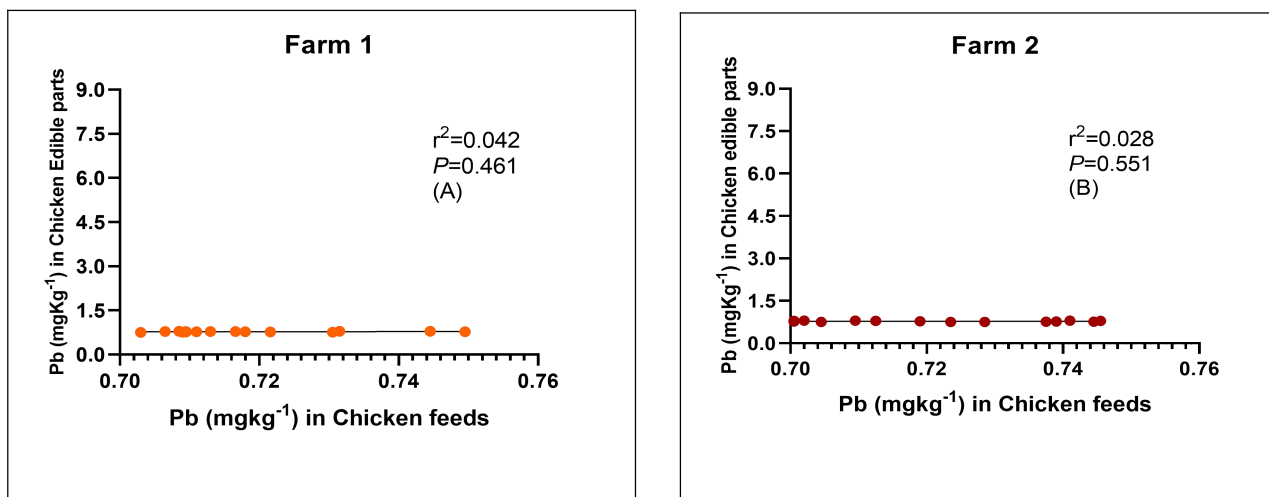


Fig 3: Correlation of lead between Feed and chicken edible parts (A) Correlation between the conc. of Pb in feeds and chicken edible part sat Farm 1(B) Correlation between the conc. of Pb in feeds and chicken edible part sat Farm 2.

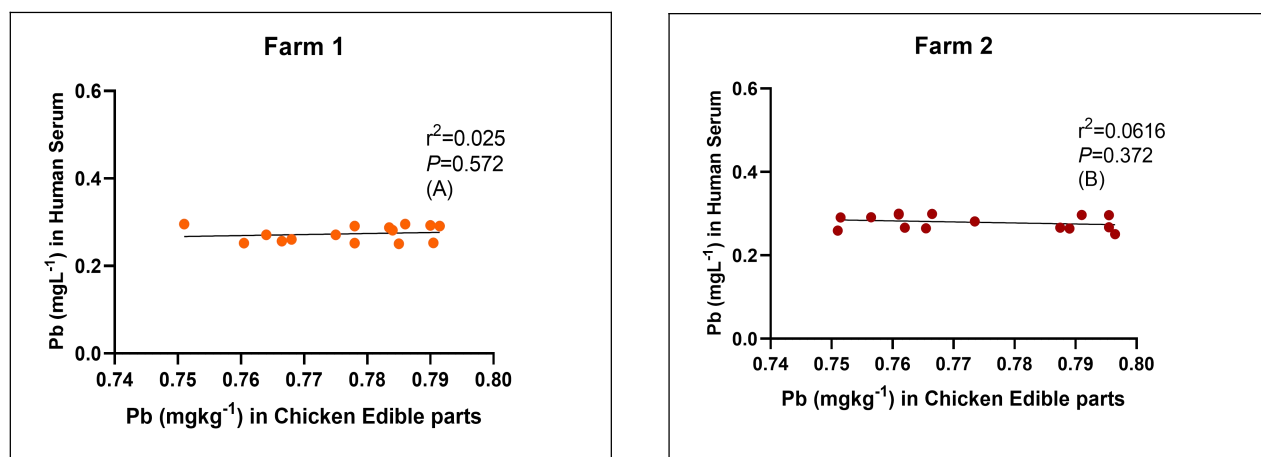
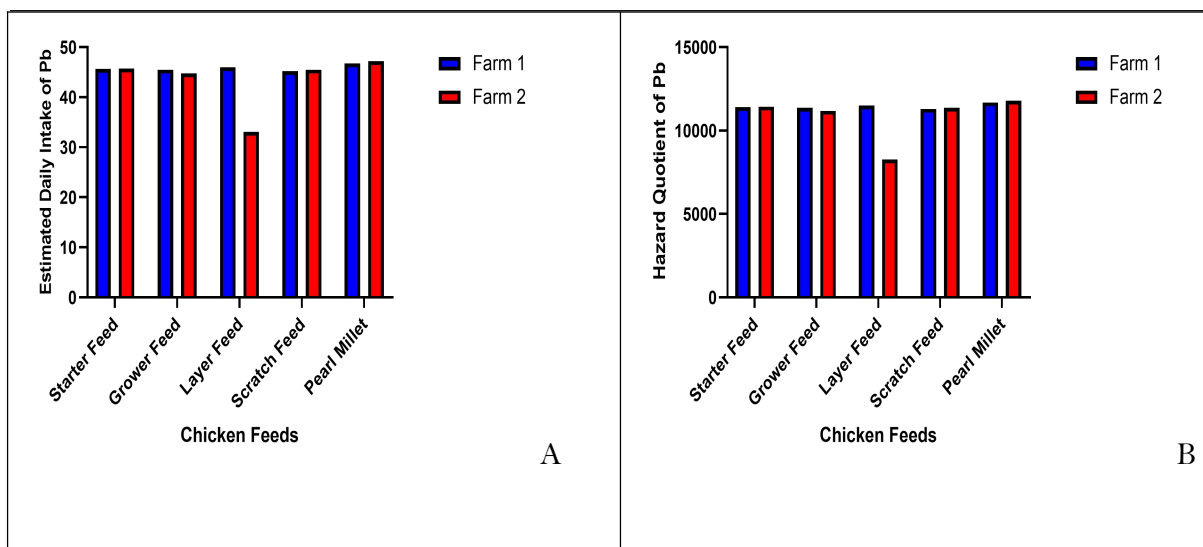


Fig 4: Correlation of Lead between chicken edible parts and Human serum(A) Correlation between the conc. of Pb in chicken edible parts and human serum at Farm 1(B)Correlation between the conc. of Pb in chicken edible parts and human serum at Farm 1

Heavy Metal Indices in Chicken Feeds: **Starter Feed:** When compared to Farm 1, Farm 2 had higher values for EDI (45.714), HQ (11428.5), THQ (0.261), and TCR (0.062). **Grower Feed:** When compared to Farm 2, Farm 1 had higher values for EDI (45.459), HQ (11364.8), THQ (0.259), and TCR (0.061). **Layer Feed:** Farm 2 had lower values for EDI (33.079), HQ (8269.9), THQ (0.189), and TCR (0.044), whereas Farm 1 had higher values for EDI (45.981), HQ (11495.4), THQ (0.262), and TCR (0.062) than Farm 2. **Scratch Feed:** When compared to Farm 1, Farm 2 showed higher values for EDI (45.472), HQ (11368.0), THQ (0.259), and TCR (0.061). **Pearl Millet:** When compared to Farm 1, Farm 2 had higher values for EDI (47.166), HQ (11791.7), THQ (0.269), and TCR (0.064). (Table 4)

Table 4: Heavy Metal Pollution Indices for Pb in Chicken Feeds:

Metal Indices	EDI		HQ		THQ		TCR	
Farms	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
Starter	45.644	45.71	11411.0	11428.5	0.260	0.261	0.062	0.062
Grower	45.459	44.74	11364.8	11186.4	0.259	0.255	0.061	0.060
Layer	45.981	33.07	11495.4	8269.9	0.262	0.189	0.062	0.044
Scratch	45.173	45.47	11293.1	11368.0	0.258	0.259	0.061	0.061
Pearl Millet	46.733	47.16	11683.4	11791.7	0.267	0.269	0.063	0.064



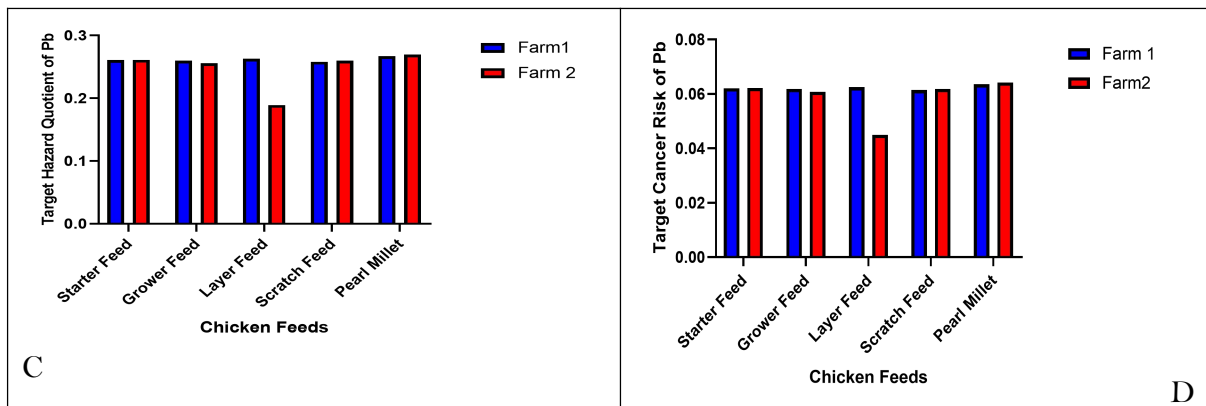


Fig 5: A Variation in Estimated Daily intake for Pb, B: Variation in Hazard Quotient for Pb, C: Variation in target hazard quotient for Pb, D: Variation in Target Cancer risk for Pb

Chicken Edible Parts: Heart: When comparing the Heart, Farm 1 had values of EDI (49.11), HQ (12277.5), THQ (19.644), and TCR (0.066) that were somewhat greater than those of Farm 2, which had values of EDI (48.16), HQ (12041.8), THQ (19.266), and TCR (0.065). **Wings:** In a similar vein, Farm 1 for Wings showed marginally better results than Farm 2 for all indices. **Drumsticks:** In comparison to Farm 1, which had values of EDI (48.91), HQ (12228.1), THQ (19.565), and TCR (0.066), Farm 2 had marginally higher values for EDI (49.82), HQ (12455.9), THQ (19.925), and TCR (0.067). EDI (50.07), HQ (12519.6), THQ (20.031), and TCR (0.068) readings from Farm 2 were somewhat higher than those from Farm 1 (EDI (49.65), HQ (12412.9), THQ (19.869), and TCR (0.068)). **Gizzard** Compared to Farm 2, which had values for EDI (48.60), HQ (12150.1), THQ (19.440), and TCR (0.066) (Table 5)

Table 5: Heavy Metal Pollution Indices for Pb in Chicken Edible Parts

Metal	EDI		HQ		THQ		TCR	
Indices								
Farms	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 2
Heart	49.11	48.16	12277.5	12041.8	19.64	19.26	0.066	0.065
Wings	49.86	49.76	12467.1	12440.1	19.94	19.90	0.067	0.067
Drumstick	48.91	49.82	12228.1	12455.9	19.56	19.92	0.066	0.067
Liver	49.65	50.07	12412.9	12519.6	19.86	20.03	0.067	0.068
Gizzard	49.90	48.60	12476.6	12150.1	19.96	19.44	0.067	0.066

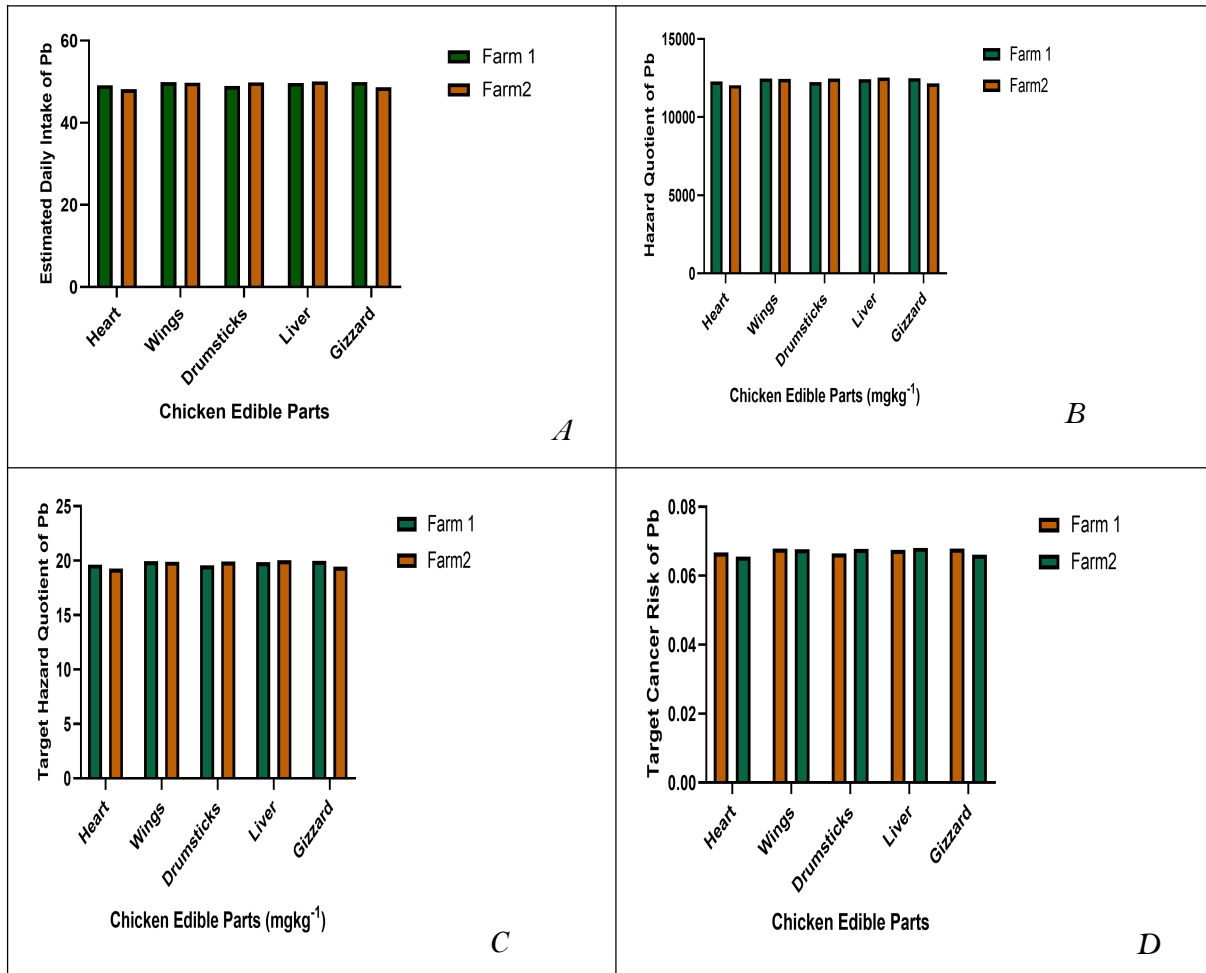


Fig 6: A Variation in Estimated Daily Intake of Pb in Chicken edible parts from two farms., B: Variation in Hazard quotient of Pb in Chicken edible parts., C Variation in Target hazard quotient of Pb in Chicken edible parts., D: Variation in Target Cancer risk of Pb in Chicken edible parts from two farms.

Human Serum: Age Group of 20-28: Site 2 exhibited higher values across all indices compared to Site 1. The maximum values were observed in Site 2 for EDI (12.887), HQ (3221.6) and indicating a potentially higher metal intake and associated health risks within this age group. **Age group of 29-41:** Site 2 again demonstrated higher values for all indices compared to Site 1. The maximum values in Site 2 for EDI (13.528) indicate a potentially elevated metal intake and health risks within this age range (Table 6)

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Table 6: Heavy Metal Pollution Indices for Pb in Humans Serum

Metal Indices	EDI		HQ		THQ		TCR	
Sites	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
					1	2		
Age 20-28	12.791	12.887	3197.9	3221.6	0.319	0.322	0.010	0.010
Age 29-41	13.133	13.528	3283.4	3382.2	0.328	0.338	0.011	0.01
Age 42-55	13.276	12.388	3319.0	3097.3	0.331	0.309	0.011	0.01
Age 56-61	12.839	13.314	3209.8	3328.5	0.320	0.332	0.010	0.01
Age 61-70	12.886	14.188	3221.6	3547.0	0.322	0.354	0.010	0.01

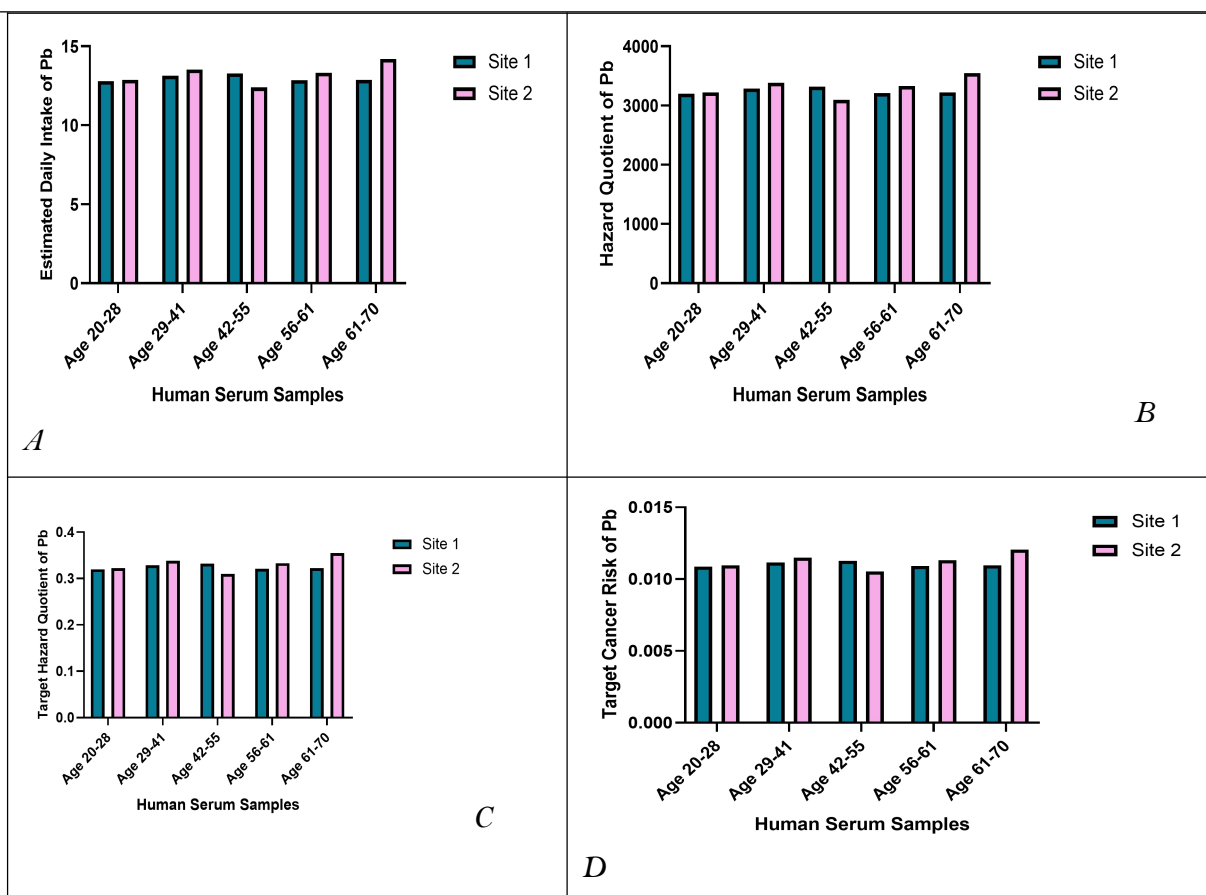


Fig 7 A Variation in Estimated daily intake of Pb in human serum from two sites, **B** Variation in Hazard quotient of Pb in human serum from two sites, **C**: Variation in Target Hazard quotient of Pb in human serum from two sites, **D** Variation in Target cancer risk of Pb in human serum from two sites.

Discussion

The mean value in the Starter Feed is $(0.13) \text{ mgkg}^{-1}$ was slightly lower than that resulted by (Zhang et al., 2012) which is 0.155. On the other hand, the Grower Feed $(0.12) \text{ mgkg}^{-1}$ showed a similar mean value to the (Suleiman et al., 2015) study. Moreover, In terms of the Layer Feed the current value in our data is $(0.14) \text{ mgkg}^{-1}$ had a higher mean value compared to both Starter Feed and Grower Feed reported by Zhang et al. (2012)

In terms of chicken edible parts our results showed that the heart has mean value $(0.77) \text{ mgkg}^{-1}$. Present research values of Pb in heart were higher than the values found by (Ramathuba, 2015) who conducted a study to appraise heavy metal composition of various body parts of chicken

Regarding Wings, our findings indicate that the Wings $(0.78) \text{ mgkg}^{-1}$ and Gizzards $(0.78) \text{ mgkg}^{-1}$ have similar mean value. However, the Liver $(0.77) \text{ mgkg}^{-1}$ and Heart $(0.77) \text{ mgkg}^{-1}$ exhibited slightly lower mean values. Furthermore, the recorded liver values of Pb in the present study were observed to be lower compared to the findings of Zhang et al. (2012), who investigated the impact of supplemented organic Zn and Mn on mineral uptake in broiler tissues, specifically tibia and liver. In contrast, the Pb levels in all edible parts of chickens in our study were found to be higher than the values established by the World Health Organization (WHO) in 1998.

In terms of Pb in chicken blood, the mean value of the Starter Blood and Broiler Blood in our data is $(0.28) \text{ mgkg}^{-1}$ and $(0.27) \text{ mgL}^{-1}$ showed higher Pb levels. Conversely, the Layer Blood $(0.26) \text{ mgkg}^{-1}$ and Local Blood $(0.26) \text{ mgL}^{-1}$ had similar Pb mean values related to (Kwiecień et al., 2017)

For human serum, our data showed a slightly higher mean copper concentration in Site 2 $(0.27) \text{ mgL}^{-1}$ compared to Site 1 $(0.26) \text{ mgL}^{-1}$ which is in line with the findings reported by (Focosi et al., 2020). In case of HQ the current HQ values range from 0.258 to 0.267 mgkg^{-1} .

CONCLUSION

In summary, our study successfully delves into the intricate interplay among agricultural techniques, livestock nourishment, and human well-being. Exploring various chicken feeds and their impact on the nutritional composition of edible portions has revealed a nuanced connection between farming methodologies and the nutritional quality of poultry-derived products.

A meticulous examination of metal concentrations in both chicken blood and human serum across diverse age groups has provided crucial insights into potential health implications associated with metal exposure. The analysis of metal indices underscores the necessity for continuous vigilance in monitoring metal accumulation, particularly considering their potential consequences for human health.

Our comprehensive investigation into the concentration of Lead (Pb) in chicken feeds, edible parts, blood, and human serum across different farms has yielded valuable insights into the presence and distribution of heavy metals in poultry products. The results indicate that while Pb concentrations exhibited variability within chicken feeds and edible parts, the influence of farms on these variations was not statistically significant. Furthermore, the interactions between farms and the presence of these heavy metals were not found to be statistically significant.

Comparing these findings to existing studies, we emphasize the uniqueness of our research in contributing to the understanding of heavy metal presence in poultry products. While consistent with some prior studies, our results diverge from others, and such discrepancies may be attributed to geographical, environmental, or management differences between farms.

This study underscores the critical importance of continuous monitoring of heavy metal concentrations in poultry products, emphasizing the need for strict quality control and management practices to ensure food safety and human health. In conclusion, our research not only expands knowledge regarding heavy metal distribution in poultry products but also emphasizes the significance of maintaining rigorous quality standards in their production and management. As we strive for safer and healthier food sources, it is crucial to remain vigilant in tracking and minimizing the presence of harmful elements in our food supply.

Authors Contribution

Author 1: Atika Shaban carried out the investigation, original draft preparation. Author 2: Asma Ashfaq supervised the study, data curation. Author 3: Zafar Iqbal Khan supervised the study. Author 4: Kafeel Ahmad supervised the study.

Ethics Declarations

Ethical Responsibilities of Authors

All authors have read, understood, and have compiled as applicable with the statement on

Ethical Responsibilities of Authors as found in the instructions for authors

Ethical Approval and Consent to Participate

The institutional Human Ethics Committee of University of Sargodha (Approval No.25-A18 IEC UOS) has allowed all the protocols used in this experiment. All the experimental methods of this study have followed all the appropriate guidance and regulations including NRC standards. In this study involving human participants, informed written consent to take part in the research have been obtained prior to the commencement of the study. The authors declare that manuscript has not been published previously.

Consent for Publication

All subjects gave their consent for the publication of details within the text (“Material”) to be published in the above Journal and Article.

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Competing Interests

The authors declare that they have no competing interests

Availability of Data and Materials

All data generated or analyzed during this study are included in this research article

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