Zoology
Explore – Journal of Research
Peer Reviewed Journal
ISSN 2278 – 0297 **(Print)**
ISSN 2278 – 6414 **(Online)**

https://www.patnawomenscollege.in/journal

Bioaccumulation of Heavy Metals in Indigenous Poultry Eggs from Poultry Farms, Patna

• **Shrishti Singh** • **Annie Anand** • **Anam Taban**
• **Sumeet Ranjan**

Received : December, 2021
Accepted : January, 2022
Corresponding Author : Sumeet Ranjan

Abstract: *Abstract: Heavy metal pollution is of great concern because of its great non-biodegradable and persistent nature in the environment. Due to its bioaccumulation and biomagnification, it poses threat to human health. Eggs are a major source of protein. With its increasing consumption, it is very important to analyze their residual heavy metal content. The present study has been conducted to determine Zinc (Zn), Lead (Pb), Iron(Fe), and Cadmium(Cd) concentration in egg, feed, water samples collected from different poultry farms in various districts of Bihar. The concentration of Zn ranged from 0.012 mg/l to 0.0451 mg/l in albumin and feed samples respectively.*

The concentration of Pb was found to be 0.000 - 0.023 mg/l and 0.000 - 0.034 mg/l in albumin and yolk of the same egg samples respectively.

The concentrations of Zn and Pb were above the permissible limit provided by WHO in the egg, feed and water samples collected from Hajipur and Phulwari.

The concentrations of Cd was 0.000mg/l in the egg feed and water samples. Fe concentration was found to be higher in yolk than the albumin of the same egg samples and also in the feed samples. In this study the Cd and Fe was lower than the permissible limit set by WHO.

Keywords: *Heavy metal, bioaccumulation, non-biodegradable, contamination.*

Shrishti Singh
B.Sc. III year, Zoology (Hons.), Session: 2019-2022,
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Annie Anand
B.Sc. III year, Zoology (Hons.), Session: 2019-2022,
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Anam Taban
B.Sc. III year, Zoology (Hons.), Session: 2019-2022,
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Sumeet Ranjan
Assistant Professor, Department of Zoology,
Patna Women's College (Autonomous),
Bailey Road, Patna–800 001, Bihar, India
E-mail : sumeet.crl@patnawomenscollege.in

Introduction:

Heavy metal pollution has unfolded over the globe, distressful the surroundings and motility serious health hazards to humans. The basic reason behind this downside is mostly controlled to by the speed of urbanization, changes in land use, and manufacture, particularly in developing countries with very high populations, like Asian nations and China (UN-HABITAT, 2004). Since the economic revolution and economic process, the variety of environmental contaminants has increased tremendously due to internal anthropogenic pressure. Therefore, the problems of food security became a world concern, significantly their indivisible association with human health (Clarke et al., 2011).

Significant metals are a unit of non-biodegradable pollutants, they accumulate and migrate in surroundings (Mahmood and Malik, 2014).

Significant metals don't get degraded or destroyed within the surroundings as they're non-perishable, and accumulate in fatty tissues of animals and plants by the process of biotransformation and bioaccumulation. Poultry eggs area are capable of accumulating significant metals from their encompassing surroundings. The prevalence of significant metals in eggs is frequent now a days. It is a result of the contamination of poultry egg through different agencies.

The estimation of heavy metals in nutritionaries is very significant for human health point of view. Restricted works are distributed in state and encompassing states on serious metal determination in poultry eggs . For this reason the study was conducted to estimate the concentration of some metals in poultry eggs, and its probable effects on human health. It will be serve as primary information for additional researches to be conducted on this subject .

Methodology:

Collection of Egg Sample : The present study was done at Central research lab, Patna Women's College, Bihar. The objective of the research was to estimate the extent of some harmful metals residues specifically Fe, Zn, Cd and Pb by AAS (Atomic Absorption Spectrophotometer), to gauge the presence of four metals in eggs. Daily intakes of the metals from eggs were measured and compared with World Health Organization (WHO) and Food and Agriculture Organization (FAO). Hen egg samples were collected from completely different poultry farms in Hajipur, Khagaul, Sabzibagh, and Phulwari in Patna.

Two eggs were collected from every location. The egg samples collected aseptically were carried tothe laboratory in sterile polythene bags. The samples were maintained at four degree Celsius. Before digestion the simple protein and nutrient of the eggs would be separated.

Sample Preperation :

Preperation of Egg Samples : The procedure maintained by Belton P.S. (2006) was adopted during this experiment for the preparation of the sample to see the significant metals like Iron, Zinc, Cadmium and Lead. The collected egg samples were cleaned and washed with distilled water. Every egg was cracked open with mis-treatment pointed extractor and dissecting scissors, that were sterilized and rinsed with water for every egg. Ingredient and albumin were separated on petri plates. 1 gram of each sample was placed in a chemically clean glass jar. Samples were dried at 60 degree till constant weight was obtained. The dried egg samples were subjected to digestion by digestion procedure. As per this methodology one gram of the sample was placed in an exceedingly 100ml digestion tube and 5ml of targeted HNO_3 and 5ml of targeted HCL. The sample was then heated for three hours at sixty degree so the temperature was increased to one hundred fifty degree Celsius at that the sample would be cooked for a minimum of eight hours till a transparent resolution would be obtained. Targeted acid was adscititious to the sample (5 milliliter would be adscititious a minimum of 3 times). The inside walls of the tube were washed with H_2O and therefore the tube were swirled throughout digestion to stay walls clean and forestall the loss of sample. The sample was filtered with Whattman No. 1 filter paper and <0.45 micrometer Millipore sludge paper. It also was transferred quantitatively to a 250 ml volumetric beaker by using distilled water. The filtered sample was also estimated for heavy essence by AAS using standard Logical procedure.

Preperation of Feed Samples : The feed samples collected from different locales in and near Patna quarter of Bihar, were dried in a hot air roaster at 105 degrees Celsius until a constant weight was achieved and the feed samples were crushed with the help of motor pestle. Also 1 g of each of the dried feed samples were placed in a beaker and digested with a mixture of concentrated HNO_3 and HCL. The digestion process was continued until the result came clear. The cooled samples were filtered using Whatman filter paper. The filtrates were collectively poured into volumetric beaker and made up to mark with distilled water. The sample results were also anatomized for Cadmium, Iron, Zinc and Lead using (AAS).

Preperation of Water Samples:

100 ml of water samples collected from the channel in flesh granges was analyzed for heavy essence similar as Cadmium, Zinc, Iron and Lead.

Analysis of Heavy Metals :

Samples were analyzed for heavy Metal in Atomic Absorption spectrophotometer. For each heavy Metal parameter spectrophotometer was calibrated with the pre supplied standard result. For Zinc it was calibrated with standard with 0.1,0.5,1.0,1.5 ppm strength. For Cadmium it was calibrated with standard 0.1, 1.0, 1.5 ppm strength. For Lead it was calibrated with standard 1, 2, 4, 8 ppm strength. For Iron it was calibrated with standard 1, 2, 3, 4 ppm strength.

The standard curve was attained after calibrating the output with the help of GBC software. The digested sample result was filtered and volume was made upto 100 ml in volumetric beaker. Each digested sample was tested using distil water as a blank. Reading was taken in triplet.

Statistical Analysis:

Eggs square measure usually preoccupied by human population as food. Therefore, we have a tendency to used egg albumen associated nutrient for evaluating the human health risk by an calculable daily intake (EDI) of metals and target hazard quotients (THQ).

a) calculable daily intake of metals (ED): The calculable daily intake of serious metals may be calculated victimization the formula-

$$(C\ X\ FIR)\ EDI = BW$$

Where, C is taken as mean of serious metals concentration in eggs (μg/g) in dry weight basis. For conversion of dry weight to wet weight, 4.8 factor is taken (Rahman et al.,2012). FIR (Food body process Rate) is that the daily consumption of poultry eggs (gram per day (g day^{-1}) per capita. the common FIR was 0.019 g $person^{-1}$ day^{-1} (FAO, 2016). BW is that the average weight, 65kilogram for adults and twenty five kg for youngsters.

b) Target hazard quotient (THQ): The THQ is that the estimate of non-carcinogenic risk level thanks to serious metals exposure (Islam et al., 2015). it's calculated victimization the subsequent equation (United States Environmental Protection Agency, 2011).

$$Efr\ x\ ED\ x\ FIR\ x\ C\ x\ 10{-}3\ THQ = RfDx\ BW\ x\ AT\eta$$

Where, Efr (Exposure frequency) is 365 d Y^{-1} , and impotency (Exposure Duration) is sixty nine.42 years. RfD (Reference Dose) assesses the health risk of overwhelming eggs , and ATn is that the time of average exposure for non-carcinogenic (365day × no. of exposure year). The information were applied mathematicsly analysed victimization the statistical package SPSS (version 16.0). The mean ± customary deviations of the metal concentration in eggs were analysed and according. it absolutely was seen that coefficient of correlation level, if $p < 0.05$, it absolutely was evaluated as there was a statistically vital distinction between the teams.

Results and Discussion:

Table 1. Concentration of Zinc in egg samples (mg/L)

S. No.	Sample	Concentration (mg/L)	% RSD	Mean Abs.
1	AP1	0.234	17.71	0.0031
2	AP2	0.102	High	0.0025
3	YP1	0.356	High	0.0037
4	YP2	0.321	High	0.005

5	AH1	0.089	High	0.0041
6	AH2	0.012	High	0.004
7	YH1	0.065	High	0.004
8	YH2	0.044	High	0.0061
9	ASB1	0.241	17.35	0.005
10	ASB2	0.056	19.65	0.0039
11	YSB1	0.024	10.64	0.0046
12	YSB2	0.031	5.84	0.0059
13	AK1	0.031	15.29	0.006
14	AK2	0.031	High	0.0063
15	YK1	0.234	14.65	0.0054
16	YK2	0.245	6.58	0.0055
17	FK	0.156	12.46	0.0052
18	FP	0.451	High	0.0051
19	FH	0.067	High	0.0045
20	Water	0.188	High	0.0055

Table 2. Concentration of Lead in egg samples (mg/L)

S. No.	Sample	Concentration (mg/L)	% RSD	Mean Abs.
1	AP1	0.003	17.71	0.0031
2	AP2	0.012	High	0.0025
3	YP1	0.000	High	0.0037
4	YP2	0.000	High	0.0050
5	AH1	0.011	High	0.0041
6	AH2	0.000	High	0.0040
7	YH1	0.005	High	0.004
8	YH2	0.001	High	0.0061
9	ASB1	0.011	17.35	0.0050
10	ASB2	0.001	19.65	0.0039
11	YSB1	0.034	10.64	0.0046
12	YSB2	0.001	5.84	0.0059
13	AK1	0.023	15.29	0.006
14	AK2	0.001	High	0.0063
15	YK1	0.003	14.65	0.0054
16	YK2	0.000	6.58	0.0055
17	FK	0.000	12.46	0.0052
18	FP	0.023	High	0.00051

19	FH	0.021	High	0.0045
20	Water	0.018	High	0.0055

Table 3. Concentration of Iron in egg samples (mg/L)

S. No.	Sample	Concentration mg/L)	% RSD	Mean Abs.
1	AP1	0.545	16.63	0.0112
2	AP2	0.332	9.57	0.0068
3	YP1	High	1.82	0.1486
4	YP2	High	2.34	0.1131
5	AH1	0.484	5.28	0.0099
6	AH2	0.297	3.37	0.0061
7	YH1	0.650	1.06	0.0133
8	YH2	High	3.35	0.492
9	ASB1	0.253	6.49	0.0052
10	ASB2	High	3.33	0.480
11	YSB1	0.848	5.32	0.0172
12	YSB2	0.900	3.8	0.0183
13	AK1	High	2.01	0.1089
14	AK2	0.21	15.72	0.0044
15	YK1	0.789	10.66	0.0161
16	YK2	0.804	11.7	0.0163
17	FK	High	2.09	0.1646
18	FP	3.431	2.47	0.065
19	FH	High	1.58	0.1178
20	Water	0.137	4.95	0.0028

Table 4. Concentration of Cadmium in egg samples (mg/L)

S. No.	Sample	Concentration (mg/L)	% RSD	Mean Abs.
1	AP1	0.000	High	-0.0013
2	AP2	0.000	9.35	-0.0018
3	YP1	0.000	10.23	-0.0026
4	YP2	0.000	High	-0.0013
5	AH1	0.000	15.87	-0.0028
6	AH2	0.000	15.58	0.0039
7	YH1	0.000	2.20	-0.0038
8	YH2	0.000	5.33	-0.0059

9	ASB1	0.000	12.08	-0.0043
10	ASB2	0.000	6.18	-0.0043
11	YSB1	0.000	5.00	-0.0047
12	YSB2	0.000	10.65	-0.0047
13	AK1	0.000	High	-0.0047
14	AK2	0.000	3.75	-0.0046
15	YK1	0.000	4.79	-0.0050
16	YK2	0.000	9.29	-0.0058
17	FK	0.000	7.20	-0.0054
18	FP	0.000	10.77	-0.0059
19	FH	0.000	4.28	-0.0053
20	Water	0.000	2.70	-0.0062

The concentration of serious metals within the egg, feed and water samples was within the magnitude order of Hajipur> Phulwari> SabjiBagh > Khagaul. Egg is that the major supply of protein and is consumed throughout Asian country. Thus, egg samples were taken during this study for the analysis of various serious metals. The trend of the serious metal concentration was Zn>Pb>Fe>Cd in most samples. The albumen and vitellus samples from Hajipur and Phulwari showed highest concentration of zinc and lead. High concentration of zinc and lead was conjointly found within the feed and water samples from the 2 places.

The concentration of zinc ranged from 0.012 mg/L in albumen sample to 0.0451 mg/L in feed sample. 0.000 - 0.023 mg/L of lead (Pb) and 0.000 - 0.034 mg/L of lead were found within the albumen and vitellus of a similar egg samples severally. During this study, the concentration of lead and zinc was found to be on top of the safe limit provided by World Health Organization, 2011.

The concentration of Cd was 0.000 µg/l in albumen and vitellus of all egg samples similarly as within the feed and water samples. The concentration of Fe was found higher in vitellus than albumen of a similar egg samples and conjointly within the feed sample. The concentration of Cd and Fe during this study was not up to the safe limit provided by the globe Health Organization, 2011 and Commission Regulation (EC, C. R., 2006).

In most cases, the serious metal concentration of vitellus is on top of albumen of a similar sample of egg. This is often as a result of the serious metals and most egg pollutants having response for vitellus thanks to their lot of solubility and addictive macromolecule wealthy surroundings that favors the chelating of extremely reactive auriferous ions inside the organic chain of phospholipids (Bargellini , et al., 2008). Consumption of feed and water also can be a supply of contamination, notably in areas wherever spring water is gift close to dangerous waste sites (Vodela et al., 1997).

Estimated Daily Intake:

The daily intake of metals depends on the metal concentration in eggs and also the daily egg quantity consumption. Additionally, the weight of the human will influence the tolerance if contaminants. So, calculable daily intake of metals in albumin, yolk, feed and water were calculated and following knowledge were obtained.

Table 5: Showing EDI of different samples

	EDI	METALS			
Children		Zn	Pb	Cd	Fe
	Albumin	0.0007	0.00003	0	0.0009
	Yolk	0.0003	0.000004	0	0.0015
	Feed	0.0001	0.00003	0	0.0028
	Water	0.0001	0.00001	0	0.0001

Adults		Zn	Pb	Cd	Fe
	Albumin	2.90	1.31	0	0.00036
	Yolk	4.82	1.63	0	0.0005
	Feed	6.56	1.28	0	0.0011
	Water	5.49	5.26	0	4.004

Target Hazard Quotient:

The THQ is the estimate of non-carcinogenic risk level of serious metals exposure. If THQ is less than one then the sample is detected as non-carcinogenic and if THQ calculated were more than one then the sample is detected as malignant and is very unsafe to health. According to the information obtained and formula, THQ of albumin, yolk, feed and water samples were calculated and the following results were obtained.

Table 6: Showing THQ of different samples

	THQ	METALS			
Children		Zn	Pb	Cd	Fe
	Albumin	1.890	8.587	0	2.404
	Yolk	3.134	1.063	0	3.798
	Feed	4.267	8.359	0	7.241
	Water	3.419	3.419	0	2.602
Adults		Zn	Pb	Cd	Fe
	Albumin	7.271	3.303	0	9.246
	Yolk	1.205	4.092	0	1.461
	Feed	1.641	3.215	0	2.785
	Water	1.315	1.315	0	1.001

Conclusion:

The present study unconcealed elevated concentrations of zinc and lead in unremarkably consumed eggs that were on top of the permissible levels of United Nations agency and also the extent of enrichment was within the order Zn>Pb>Fe>Cd in albumen and in vitellus. Higher concentration levels of all metals except Fe and Cd were found to be on top of the safe limit provided by the globe Health Organization,2011 in eggs. Higher concentration of serious metals is suggesting a substantial risk to customers. Elevated levels of zinc and lead will be related to malignant neoplastic disease risk to the patron. The sources of metal pollution in foodstuffs ought to be controlled. Feeds supplement side to the hen's diet ought to be measured and calculated its residues in eggs to avoid undesirable increase in their amounts. Since data of eggs metal levels is turning into more and more necessary and egg consumption may be a bio indicator additionally to observe environmental pollution

References :

A. M. S. Meshref , W. A. Moselhy, ad N. E.-H. Y. Hassan,(2014). "Heavy metals and trace elements levels in milk and milk products, "Journal of Food Measurement and Characterization, vol. 8, no. 2.

Ablude FO, Akinjaagunla YS, Omniyi A.(2006). An investigation into the effect of vehicular exhaust fumeson the levels of some heavy metals in cow's blood . Res J Biolog Sci. .

Aycicek M, Kaplan O, Yaman M, (2008). Effect of cadmium on germination , seedling growth and metal contents of sunflower (Helianthus annulus L.) . Asian J Chemistr;20(4).

B. Aslam, I. Javed, F. H. Khan, and Z. ur Rahman (2011). "Uptake of heavy metal residues from sewage sludge in the milk of goat and cattle during summer season," Pakistan Veterinary Journal, vol. 31, no. 1.

B.O. Clarke (2011). CRC Press, Taylor & Francis, Boca Raton, Florida, USA , Environ. Int. CRC Press, Taylor & Francis, Boca Raton, Florida, USA . Environ. Int., 37 .

Bargellini A., Marchesi I., Rizzi L., Cauteruccio L., Masironi R., Simioli M., Borella P. (2008). "Selenium interactions with essential and toxic elements in egg yolk from commercial and fortified eggs". Journal of Trace Elements in Medicine and Biology.

Bargellini A., Marchesi I., Rizzi L., Cauteruccio L., Masironi R., Simioli M., Borella P., (2008). "Selenium interactions with essential and toxic elements in egg yolk from commercial and fortified eggs". Journal of Trace Elements in Medicine and Biology.

G. Toth, T. Hermann, M.R. Da Silva, L. Montanarella (2016). Heavy metals in agricultural soils of the European Union with implications for food safety.

H. Ali, E. Khan, and I. Illahi, (2019). "Environmental chemistry and ecotoxicology of hazardous heavy metals: environmental persistence, toxicity, and bioaccumulation," Journal of chemistry, vol. 2019, no. 4, Article ID 6730305.

Islam MS, Kazi MAS, Hossain MM, Ahsan MA, Hossain AMMM (2014). "Propagation of heavy metals in poultry feed production" in Bnagladesh. Bangladesh J Sci Indust Res.

M. S. Kabeer, I. Hameed, S.-u.-R. Kashif et al. (2020). "Contamination of heavy metals in poultry eggs: a study presenting relation between heavy metals in feed intake and eggs," Archives of Environmental & Occupational Health, vol. 3 .

Mahmood A., Malik R.N. (2014) . Human health risk assessment of heavy metals via consumption of contaminated vegetables collected from different irrigation sources in Lahore, Pakistan. Arab. J. Chem

N. H. C. Sparks (2006). "The hen's egg-is its role in human nutrition changing?" World's Poultry Science Journal, vol. 62, no. 2, 308–315.

N. Tsipoura, J. Burger, M. Newhouse, C. Jeitner, M. Gochfeld, and D. Mizrahi (2011). "Lead, mercury, cadmium, chromium, and arsenic levels in eggs, feathers, and tissues of Canada geese of the New Jersey Meadowlands," Environmental Research, vol. 111, no. 6.

P.K. Rai (2018). Phytoremediation of Emerging Contaminants in Wetlands, Review of 'emerging' organic contaminants in biosolids and assessment of international research priorities for the agricultural use of biosolids.

UN-HABITAT (2004). Human Settlements Programme, Nairobi The State of the World's Cities: Globalization and Urban Culture.

Vodela, J., Renden, J., Lenz, S., McElhenney, W. and Kemppainen, B. (1997). Drinking water contaminants (arsenic, cadmium, lead, benzene, and trichloroethylene). 1. Interaction of contaminants with nutritional status on general performance and immune function in broiler chickens. Poult. Sci.