# Assessment of Lead in Raw Milk of Rural and Urban Areas of Kota, Rajasthan

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***Abstract*— Milk and dairy products are considered as complete food as it is a good source of proteins, fats, vitamins, and minerals. The Presence of heavy metals in milk is a grave problem and a challenge to the researchers. In this study, the concentration of Pb in 80 cow milk samples from four different types of urban areas as well as 130 samples from five rural areas of Kota region were assessed by using Atomic Absorption Spectrophotometer (ASS-6300). The Mean concentrations of lead in the milk samples of urban and rural areas were found to be 0.1471, 0.0376, 0.0921, 0.0754 and 0.0146. 0.0058, 0.0089, 0.0049, 0.0094 respectively. Results showed that lead concentration in the milk sample of urban areas exceeded the permissible limit whereas samples from the rural area were found to be within the limits. Statistical analysis was carried out for each sample and estimated daily intake, health risk index, and metal pollution index were also calculated. This electronic document is a "live" template and already defines the components of your paper [title, text, heads, etc.] in its style sheet.**

***Keywords:- Milk, Lead, Atomic Absorption Spectrophotometer.***

## I. INTRODUCTION

Milk and dairy products have been recognized all over the world as complete food as it is a good source of proteins, fats, sugars, vitamins, and minerals mainly they are quantitatively important in the diet and their regular consumption is recommended especially for young children [1]. According to the latest reports, India is the number one producer of milk in the world and Rajasthan is the second-largest milk producing state in India. The per capita availability of milk in India is 427g/day.

Although milk is an ideal source of macro elements (Ca, K, and P) and microelements (Cu, Fe, Zn, and Se), additional amounts of metals might enter in milk and dairy products reaching levels that they are harmful to humans [2]. Milk and dairy products become contaminated with heavy metals either through foodstuff and water or through manufacturing and packaging processes [3,4]. Heavy metal pollution of surface and groundwater sources results in considerable agriculture soil pollution. When these soils are polluted, these metals are taken up by plants and consequently accumulate in their tissues [5]. Animals that graze on such contaminated plants and drink polluted water also accumulate such metals in their tissues and milk if lactating. Humans are in turn exposed to heavy metals by consuming contaminated milk and their products.

Among the heavy metals, Lead is one of the major causes of pollution globally. Due to anthropogenic activities percentage of lead in the environment increases day by day. According to the US reports around approximate 200000 tons of lead is being released per year by vehicles, which directly affects the soil plants and water bodies [6]. Major industrial uses [7] and human activities including burning fossil fuels, mining, and manufacturing also increase the amount of lead in the environment. The other sources are gasoline, plumbing pipes [8], house paint, toys, and faucets [9]. The most common use of lead is in the production of batteries, and cosmetics [10]. Mental and behavioural disabilities [11,12] and edema [13] were reported due to elevated levels of lead in the human body. According to EPA (environmental protection agency) lead is considered a carcinogen [14]. Acute exposure of lead results to loss of appetite, hallucination, arthritis, and vertigo [15]. Chronic lead poisoning causes brain and kidney damage [10], psychosis, autism, dyslexia, weight loss, and paralysis, etc. A significant source of blood lead burden in the human body is all because of the accumulation of lead [7].

Kota city has a 1200 MW coal-based power plant in the centre of the city which produces an approximate of 3000 metric tons of fly ash per day. Kota has a number of large and small-scale industries, including DCM Shriram Consolidated Limited (DSCL), Multimetals Limited, Samtel Glass Limited, Chambal Fertilizers and Chemicals Limited (CFCL), Shriram Fertilizers and Metal India, and Shriram Rayons, as well as several Kota stone units. Anthropogenic sources of contamination of metals in urban areas are comparatively high than the rural areas. However, no investigations have been reported on the assessment of heavy metals in milk samples of Kota. The current study was carried out on milk samples that were collected from urban areas and rural areas of the Kota region. In this paper, we report the presence of lead in the milk samples of both rural and urban areas of Kota.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

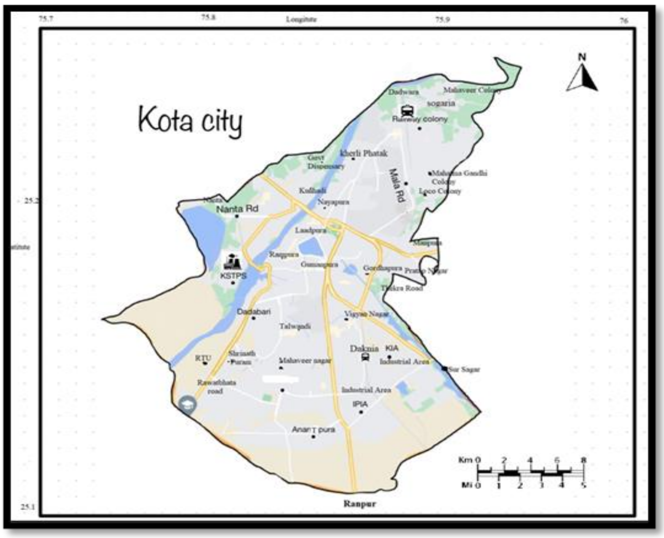


Fig.1-Study map of urban area of Kota milk sampling site.

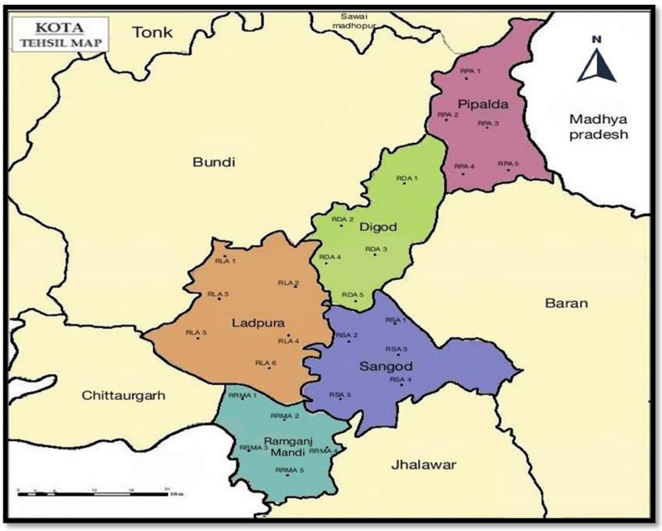


Fig.2: Study map of rural area of Kota region milk sampling site

## II. MATERIAL AND METHODS

### A. Study Area

The Kota is situated on the banks of the Chambal River in the Rajasthan, state of northern India. Study area is divided in urban (Fig. 1) and rural (Fig. 2) area of Kota. In rural area we collected 80 samples of raw cow milk from four different types of urban areas—industrial, local farm, residential, and riverside. We chose 26 sample collecting locations (shows in fig 2) for rural areas from the five tehsils of Ladpura, Sangod, Digod, Pipalda, and Ramganjmandi in the Kota region. We collected 130 sample, five samples from each sampling location, each from a different hamlet within a 2 to 8 kilometre radius.

### B. Sample Collection

Around 80 samples were collected from urban area of Kota city which includes industrial area, Thermal Area, main Kota city dense residential area, local farms and nearby areas of Chambal River. 130 samples were collected from rural areas of Kota tehsil- Digod, Ladpura, Sangod, Pipalda and Ramganjmandi. The milk samples were taken in PTFE bottles, and stored in deep freezer at -20°C.

### C. Sample Digestion

Among four wet digestion techniques, one of which was most suitable for our work after performing recovery test, was taken. The recovery for the studied metal varied from 83.72 to 97.67. In this method we had taken 5 ml of milk sample in which 5 ml of 65% HNO3 and 30% H2O2 were added and then digested on hot plate at 90°C. The temperature was increased gradually up to 120°C and heated until the evolution of brown fumes stopped. Digested samples were filtered and diluted up to 25 ml in a volumetric flask.

### D. Sample Analysis

All digested samples were analysed by using Shimadzu AAS - 6300 for the determination of lead concentration in the sample. Instrumental analysis of Pb, were conducted by air acetylene Flame Atomic Absorption Spectrophotometer. Calibration standard were regularly analysed to ensure the stability of instrument.

### E. Data Analysis

a. *Statistical Analysis*: - Statistical analysis was carried out for each sample. Mean, standard deviation and variance was performed.

b. *Estimated Daily intake* : - Estimated daily intake (EDI) was calculated by using the mean concentration of lead (mg/kg), the daily consumption of milk and average body weight [16].

$$EDI = (C_{metal} \times W_{milk}) / Bw \quad \text{.........eq. 1}$$

Where $C_{metal}$ is the estimated concentration of metal in milk (in mg/kg), $W_{milk}$ stands for the daily average consumption of milk is 427 g/day in India [17] and Bw is the average body weight of an Indian adult (in kg) which is used as 60 kg for the study [18].

c. *HRI (Health Risk Index)*: - The health risk index was calculated as the ratio of estimated daily intake and oral reference dose Rf D for lead is 0.0035[19,20]

$$HRI = EDI/R_f D \quad \text{........ eq. 2}$$

HRI indicate potential health risk when it is ≥ 1 (equal and higher than 1).

d. Metal pollution index (MPI): - Metal pollution index was obtained by calculating the geometrical mean of concentrations of Pb metals in the milk [21,22] of different areas.

$$MPI = (Cf_1 \times Cf_2 \times Cf_3 .. \times Cf_n)^{1/n} \quad \text{.......eq. 3}$$

where $Cf_n$ = concentration of metal n in the sample.

## III. RESULT AND DISCUSSION

Concentration of Pb in 80 samples of cow's milk of four different urban area of Kota are reported in Table No. 1. As the data presented in Table 1 shows, the concentration of Pb in industrial area was the highest which ranges from 0.0171 mg/kg to 0.2781 mg/kg. The lowest concentration of lead was found in the local farms of Kota where the minimum concentration of lead recorded was 0.0111 mg/kg and the maximum concentration was 0.1023 mg/kg. The average concentration of milk of all four places exceeded the maximum permissible limit of lead i.e. 0.02 mg/kg according to the Codex Alimentarius Commission 2011, IDF 1979 [23,24]. The mean values of Industrial Area > Kota City (Residential Area) > Riverside > Local farm are 0.1471> 0.0921 > 0.0754 > 0.0376 respectively as shown in Fig. 3.

Table1: - Concentration of lead (mg/kg) details in cow milk from different urban areas of Kota city

| | Industrial Area N = 20 | Local Farm N= 20 | Residential Area N = 20 | Riverside N = 20 |
|---|---|---|---|---|
| Min | 0.0171 | 0.0111 | 0.0132 | 0.0126 |
| Max | 0.2781 | 0.1023 | 0.1746 | 0.1453 |
| Mean | 0.1471 | 0.0376 | 0.0921 | 0.0754 |
| SD | 0.0946 | 0.0251 | 0.0467 | 0.0392 |

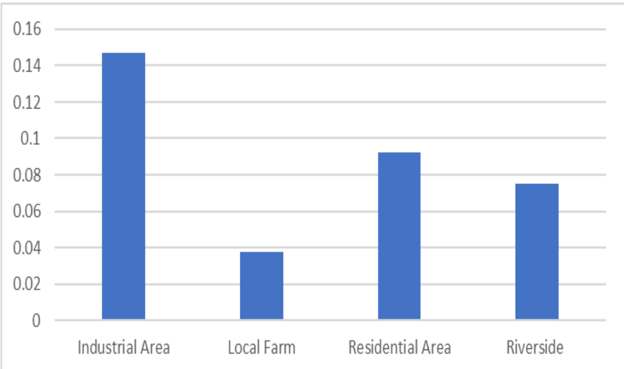


Fig. 3: Average concentration of Lead (mg/kg) in different urban Areas of Kota

To study the milk samples from the places where the anthropogenic activities are comparatively low, villages of five tehsils of Kota were taken into account for the study of concentration of Pb. 130 samples of cow's milk of five different tehsils from 26 sampling points (Shown in fig. 2) of Kota were taken and their minimum, maximum and mean values are reported in Table No. 2. Data presented in table 2 shows that the concentration of Pb in rural areas was very low as compared to the urban areas. The minimum concentration of all five places were found to be below detection limit, and the maximum concentration ranges from 0.0.034 to 0.084. The lowest mean concentration of lead was found 0.0049 mg/kg in the Pipalda tehsil of Kota whereas the maximum mean concentration recorded was 0.0146 mg/kg at Ladpura. The average concentration of Pb in milk of all five places did not exceed the maximum permissible limit (.02mg/kg) recommended for lead by different agencies [23,24].

Table 2: - Concentration of lead (mg/kg) details in cow's milk from different rural areas of Kota tehsils

| | Laadpura N = 30 | Sangod N= 25 | Digod N = 25 | Pipalda N = 25 | Ramganj Mandi N = 25 |
|---|---|---|---|---|---|
| Min | BDL | BDL | BDL | BDl | BDL |
| Max | 0.0841 | 0.0605 | 0.0791 | 0.0341 | 0.0752 |
| Mean | 0.0146 | 0.0058 | 0.0089 | 0.0049 | 0.0094 |
| SD | 0.0127 | 0.0148 | 0.0137 | 0.0122 | 0.0142 |

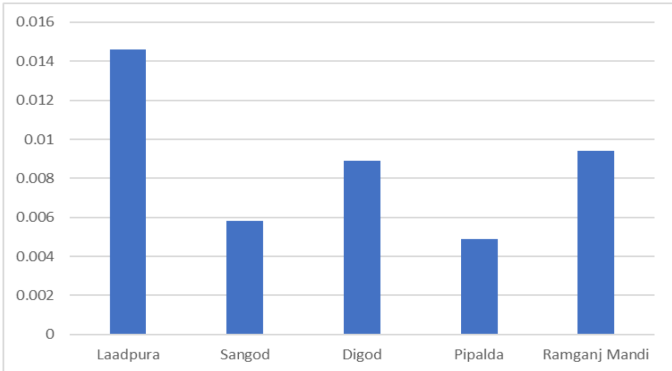


Fig. 4: Average concentration of lead (mg/kg) in different rural area (Tehsils) of Kota

Table 3: Estimated daily intake of lead through milk, health risk index, and Metal Pollution Index in urban and rural areas of Kota region

| Sample Site | | EDI | HRI | MPI |
|---|---|---|---|---|
| Urban Area of Kota City | Industrial Area | 1.04E-03 | 2.99E-01 | 0.0934 |
| | Local Farm | 2.67E-04 | 7.65E-02 | 0.0751 |
| | Residential Area | 6.55E-04 | 1.87E-01 | 0.0629 |
| | Riverside | 5.36E-04 | 1.53E-01 | 0.0308 |
| Rural Area of Kota | Laadpura | 1.04E-04 | 2.97E-02 | 0.0035 |
| | Sangod | 4.12E-05 | 1.18E-02 | 0.0004 |
| | Digod | 6.34E-05 | 1.81E-02 | 0.0005 |
| | Piplada | 3.48E-05 | 9.96E-03 | 0.0002 |
| | Ramganj Mandi | 6.69E-05 | 1.91E-02 | 0.0007 |

EDI- Estimated daily Intake in mg/kg bw/day, HRI- Health Risk Index, MPI- Metal Pollution Index

Result of estimated daily intake, health risk index and metal pollution index shown in table 3 clearly indicates that the effect of Pb concentration on human health is very low in rural areas of Kota region as compared to the urban area.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Although both the areas are under the safe limit but long-term exposure especially to children is a matter of concern.

## IV. CONCLUSION

The study revealed that the major pollution is caused by the anthropogenic activities. The elevated levels of Pb were found maximum in the milk of those cattle who grazed and drank water near the industrial areas. It is highly recommended to minimize the contamination by controlling the anthropogenic activities and treating industrial effluents. Continuous monitoring is also necessary.

## V. ACKNOWLEDGMENT

The authors thank the DST, New Delhi for instrumental support provided through DST– FIST project sanctioned to Govt. College, Kota.

***Conflicts of interest***: - The authors declare no conflict of interest.

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