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# Lead level in the poultry feed and egg/meat in Namakkal district of Tamil Nadu

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**Abstract**
Lead is a non-biodegradable toxic heavy metal, posing a serious problem in India, threatening the animal and human health and quality of the environment. In this study lead concentration in poultry feed and its products i.e., chicken egg and meat was estimated in Namakkal district of Tamil Nadu. The samples were collected from 90 poultry farms in the Namakkal district. The collected samples were digested in the microwave digester and digested samples were analyzed by flame atomic absorption spectrophotometer to determine the concentration of lead. The results of the study showed that the concentration of lead in poultry feed and egg/meat samples in the Namakkal district ranges from 0.68 ± 0.12 to 5.46 ± 0.53 ppm and 0.28 ± 0.05 to 1.06 ± 0.36 ppm respectively. Hence proper monitoring and regulations are needed to curtail the lead entry into the food chain and to prevent potential of lead in causing irreversible health effects.

**Keywords:** lead, poultry feed, poultry egg, Namakkal district, backyard poultry

## Introduction
Environmental pollution is one of the major current global problems which are posing a serious risk to human and animals. The important factors modulating the environmental pollution are rapid development of modern technology and industrialization [1]. As the heavy metals can bio-accumulate through food chain it is considered to be highly dangerous, causing hazardous effects on animal and human health [2, 3]. Among the heavy metals, lead is one of the earliest metals discovered by the human race and it is ubiquitous and non-biodegradable [4]. Lead is a highly toxic heavy metal occurring naturally in the Earth's crust as lead sulphide [5]. It also accumulates in food producing animals *via* contaminated feed, water and feed additives and ultimately may enter the human body through food chain and threaten human health [6]. Lead has been found in at least 1,272 of the 1,684 National Priority List (NPL) sites identified by the United States Environmental Protection Agency (EPA).
As per WHO, its Member States are need to protect the health of workers, children and women of reproductive age from lead, which is one of the ten chemicals of major public health concern. (https://www.who.int/en/news-room/fact-sheets/detail/lead-poisoning-and-health) [7]. Lead affects almost all systems of the body and in particular central nervous system and its development in young ones (Needleman, 2004) [8]. In recent years lead usage has been placed under strict regulation and the incidence of acute lead toxicity has been decreased significantly [9, 10]. Moreover, current research focuses on chronic low dose exposure and its toxicity [9, 10]. The exposure to lowest lead level during developmental stage may result in mental retardation, impaired cognitive function, behavioral problems and developmental delays and also associated with neurodegenerative disorders in later part of life [6].
In India, Namakkal district of Tamil Nadu is famous for its body building industry for heavy vehicles like trucks, trailers, tankers and rig unit. Moreover nearly 4000 small units are available for repairing heavy vehicle related problems [11]. Being a transport city, spilling of used engine oil, motor oil, improperly disposed batteries are common and these serve as a good source of lead toxicity. Because of the possible sources of lead in Namakkal district, some of the poultry feed constituents may contain higher amount of lead, and toxicity is possible in both birds and humans. Hence the present study was undertaken with the objective to estimate the levels of lead in poultry feed and eggs/meat from the poultry farms in different blocks of Namakkal district.

## Materials and Methods

The aim of the present study is to estimate the level of lead in samples like water, soil, feed and egg from 90 poultry farms of Namakkal district. Namakkal district was selected as the study area, as there is no previous study in exploring the lead level.

Namakkal district is bounded by Salem on the north, Karur on the south, Trichy and Salem on the east and Erode on the West. The Geographical area of the district is 3,36,335 Sq.Km which lies between 11.00 and 11.360 North Latitude and 77.280 and 78.300 East Longitude. It consists of 15 blocks namely Namagiripettai, Sendamangalam, Mohanur, Puduchatram, Rasipuram, Vennandur, Namakkal, Eumapatti, Kollihills, Elachipalayam, Mallasamudram, Tiruchengodu, Pallipalayam, Paramathi and Kabilarmalai [12]. Six poultry farms from each block were selected based on its location, which is either nearer to road/lorry repairing units/petrol bunk (Systematic Random sampling method was followed).

Feed and egg/meat samples were collected from each poultry farm. The feed samples were collected in polyethylene bag. Subsamples from six places in the feeder were taken and pooled to get the sample. Four whole eggs from each farm were collected and after collection the eggs were broken and pooled in to a single sample. 2 ml from the pooled sample was stored in deep freezer. The meat samples i.e., breast muscle (5 grams) were collected in the polyethylene bags and stored in the deep freezer until analysis (Based on the type of farm either broiler or layer, meat or egg samples were collected respectively).

The collected samples were digested in the microwave digester (Perkin Elmer) as per the instrument protocol at Central Instruments Laboratory, College of Veterinary and Animal Sciences, Mannuthy, Kerala and M/s Nawal Labs, Hosur, Tamil Nadu. The concentrations of lead in the digested samples were determined by flame atomic absorption spectrophotometer (AAS, Model 3030, Perkin - Elmer, USA) at the Centralized Instruments Laboratory, College of Veterinary and Animal Sciences, Mannuthy, Kerala [13].

For mapping, Namakkal district map was characterized by large scale detail. ArcGIS 10.1 geographic information system (GIS) software was used for compiling and analysing geographic data using maps. Geo-reference coordinates (Latitude and Longitude) along with block average of lead levels for each sample were fed to the software to create map with different colours (Choropleth map) with classes like low, moderate and high [14]. The data of the lead level in various samples from Namakkal district were analysed by one way ANOVA procedure using SPSS® 20.0 software package for windows. Post-hock analysis was done by Duncan's significance difference test [15].

## Results and Discussion

The concentration of lead in poultry feed and egg/meat samples collected from various blocks of Namakkal district is presented in Table 1. The lead levels in layer feed, egg and broiler feed, meat are given in Table 1a and Table 1b respectively. The results of the study showed that the concentration of lead in poultry feed and egg/meat samples in the Namakkal district ranges from 0.68 ± 0.12 to 5.46 ± 0.53 ppm and 0.28 ± 0.05 to 1.06 ± 0.36 ppm respectively.

The concentration of lead in feed is above the maximum permissible level (5 ppm as per FAO/WHO) in Vennandur and Tiruchengodu blocks of Namakkal district. Among the blocks, feed samples of Tiruchengodu showed numerically higher concentration of lead (5.46 ± 0.53). The feed samples from this block showed significantly ($P \leq 0.01$) higher concentration of lead when compared with Namagiripettai, Sendamangalam, Mohanur, Puduchatram, Rasipuram, Erumapatti, Kollimalai, Elachipalayam and Pallipalayam blocks. The lead concentration in poultry feed was above the permissible level in many reported studies.

**Table 1:** Lead level in poultry feed and egg/meat (Mean ± SE) samples collected from Namakkal district of Tamil Nadu

| S. No. | Name of the block | Poultry feed | Poultry egg/meat |
|---|---|---|---|
| 1 | Namagiripettai | 2.76abc ± 0.97 | 0.25a ± 0.07 |
| 2 | Sendamangalam | 3.21bcd ± 0.48 | 0.28a ± 0.05 |
| 3 | Mohanur | 2.44abc ± 0.35 | 0.64bcd ± 0.15 |
| 4 | Puduchatram | 3.23bcd ± 0.47 | 0.61bcd ± 0.09 |
| 5 | Rasipuram | 1.53ab ± 0.53 | 0.78cde ± 0.10 |
| 6 | Vennandur | 5.30bcde ± 0.78 | 0.81cde ± 0.09 |
| 7 | Namakkal | 3.53bcde ± 0.53 | 1.02e ± 0.06 |
| 8 | Erumapatti | 2.03ab ± 0.49 | 0.44ab ± 0.34 |
| 9 | Kollimalai | 0.68a ± 0.12 | 1.06e ± 0.36 |
| 10 | Elachipalayam | 2.84bc ± 0.65 | 0.90de ± 0.32 |
| 11 | Mallasamudram | 4.45cde ± 0.41 | 0.91de ± 0.74 |
| 12 | Tiruchengodu | 5.46e ± 0.53 | 0.81cde ± 0.46 |
| 13 | Pallipalayam | 1.07ab ± 0.63 | 0.33ab ± 0.13 |
| 14 | Paramathi | 3.63bcde ± 0.67 | 0.63bcd ± 0.57 |
| 15 | Kabilarmalai | 3.47bcde ± 1.28 | 0.49abc ± 0.42 |

n = 6, * Overall mean bearing different superscripts between rows differ significantly ($P \leq 0.01$)

For example the maximum and minimum concentration of lead in Bangladesh poultry feed 20.6498 ppm and 0.6019 ppm [16]. In another study, it was highlighted that the most alerts and notifications of Rapid Alert System for Food and Feed (RASFF) were on lead presence in complementary mineral feeds (mineral mixes). In the above mentioned study, it was further stated that the upward trend in the lead level was noted in aflatoxin binders, anti-caking agents and fish meal [17]. The average concentration of lead in common feed materials from Bulgaria varied from 0-32 mg/Kg, that too in wheat and fishmeal it was higher than the permissible level [18].

In Kollimalai block the lead concentration was significantly ($P \leq 0.01$) lower when compared to other blocks except Namagiripettai, Rasipuram, Mohanur, Erumapatti and Pallipalayam. It may be because in kollimalai, the collected samples were from backyard chicken and they are rearing their birds by feeding homemade feed mostly made of rice and with no feed additives. In all other farms in other blocks,

the samples were collected from commercial farms in which they were using commercial feeds with feed additives. From this study it is clear that further studies are needed to quantify the lead concentration in all the feed ingredients and feed additives to ascertain the exact source of lead.

The mean lead concentration in egg/meat samples of Kollihills was significantly ($P \leq 0.01$) higher when compared to average lead concentration in egg samples of Namagiripettai, Sendamangalam, Mohanur, Puduchatram, Erumapatti, Pallipalayam, Paramathi and Kabilarmalai blocks. Among the lead concentration in egg samples alone, 12 blocks in the Namakkal district showed higher value above the maximum permissible level (0.5 ppm). They were Mohanur, Puduchatram, Rasipuram, Vennandur, Namakkal, Kollimalai, Elachipalayam, Mallasamudram, Tiruchengodu, Pallipalayam, Paramathi and Kabilarmalai blocks.

**Table 2:** Lead level in layer feed and egg in Namakkal district of Tamil Nadu

| S. No. | Name of the block | Layer feed (ppm) | Egg (ppm) |
|---|---|---|---|
| 1 | Namagiripettai | 0.34 | 3.13 |
| 2 | Sendamangalam | 3.21 | 0.28 |
| 3 | Mohanur | 2.44 | 0.64 |
| 4 | Puduchatram | 0.67 | 2.92 |
| 5 | Rasipuram | 1.53 | 0.78 |
| 6 | Vennandur | 5.30 | 0.81 |
| 7 | Namakkal | 3.53 | 1.02 |
| 8 | Erumapatti | 2.03 | 0.44 |
| 9 | Kollimalai | 1.41 | 0.65 |
| 10 | Elachipalayam | 2.84 | 0.90 |
| 11 | Mallasamudram | 4.45 | 0.91 |
| 12 | Tiruchengodu | 5.46 | 0.81 |
| 13 | Pallipalayam | 3.59 | 0.86 |
| 14 | Paramathi | 3.63 | 0.63 |
| 15 | Kabilarmalai | 0.51 | 3.21 |

Among the lead concentration in meat samples alone Namagiripettai, Puduchatram, Kollimalai, Pallipalayam and Kabilarmalai blocks showed higher value above the permissible level (0.1 ppm). The lowest mean lead concentration was noticed in egg/meat samples of Namagiripettai block and it is significantly ($P \leq 0.01$) less when compared to the average egg concentrations of Mohanur, Puduchatram, Rasipuram, Vennandur, Namakkal, Kollihills, Elachipalayam, Mallasamudram, Tiruchengodu and Paramathi.

**Table 3:** Lead level in broiler feed and meat in Namakkal district of Tamil Nadu

| S. No. | Name of the block | Broiler feed (ppm) | Broiler meat (ppm) |
|---|---|---|---|
| 1 | Namagiripettai | 2.38 | 0.15 |
| 2 | Puduchatram | 4.75 | 0.29 |
| 3 | Kollimalai | 0.78 | 0.40 |
| 4 | Pallipalayam | 1.22 | 0.22 |
| 5 | Kabilarmalai | 4.74 | 0.29 |

The highest concentration of lead in egg samples of Kollimalai may be due its type of rearing i.e., backyard chicken. The soil content of lead on higher altitude will be higher when compared to plains. The above statement was proved in a study, that the concentration of lead in the soil up to the depth of 0.10 cm, in the highest altitude zone was significantly higher than those in lower zones [19]. The range of lead concentration in the liver samples from backyard chicken layer flocks in California were 0.9 - 41 µg/g [20]. In Assiut Governorate, Egypt, nearly 96% of egg samples collected from home reared backyard chicken showed the lead level ranged from 0.045 to 1.330 mg/kg with a mean value of 0.64 ± 0.05mg/kg [21].

In the current study, the concentration of lead in the feed is not in correlation with the concentration of lead in poultry egg/meat. It is because only 5-15% of ingested lead is absorbed and less than 5% of absorbed is retained. Intake-uptake relationship for lead is likely to be nonlinear [22]. It was also proved in a study, that in fasted rats, absorption was estimated at 42 and 2% following single oral administration of 1 and 100 mg lead/kg, respectively [23].

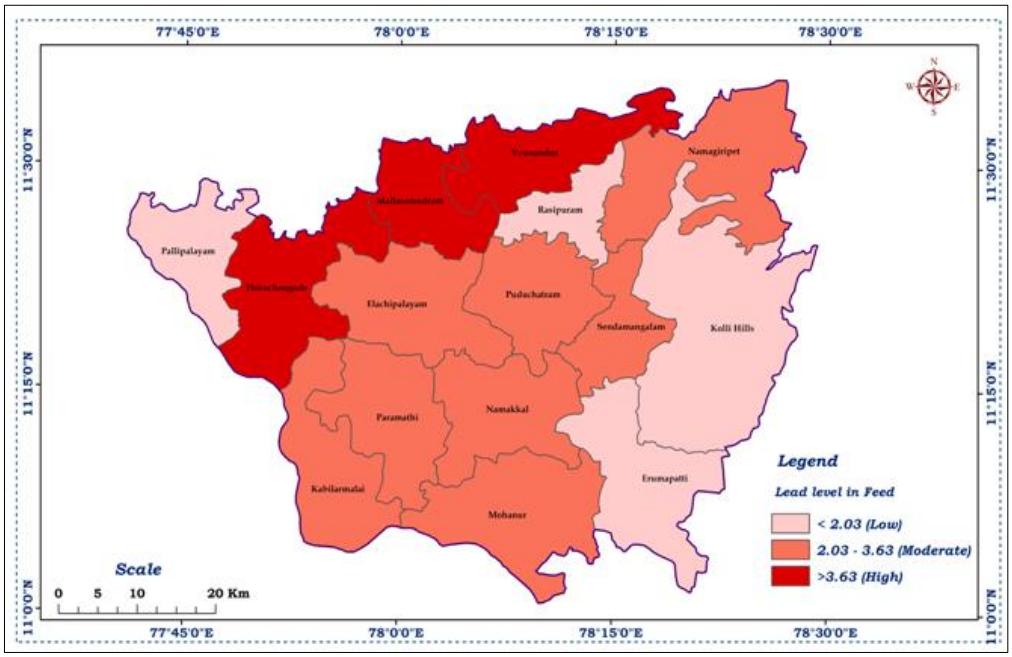


**Fig 1:** Lead level in poultry feed (ppm) in Namakkal district of Tamil Nadu

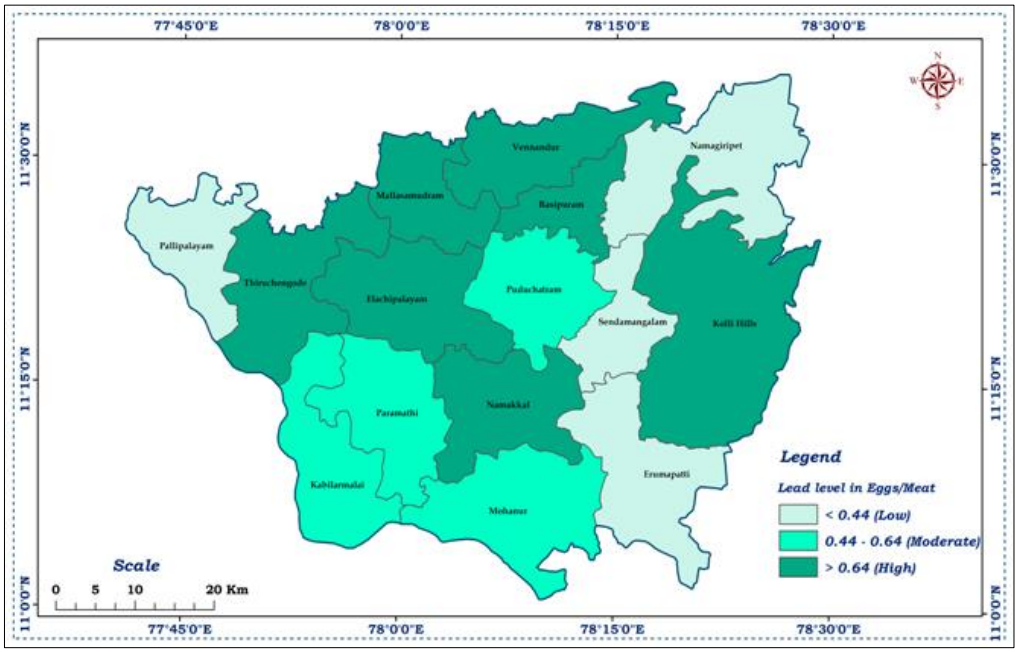


**Fig 2:** Lead level in eggs/meat (ppm) in Namakkal district of Tamil Nadu

## Conclusion

Proper surveillance, monitoring and regulations are needed to curtail the lead entry into the poultry feed, as it accumulates in the bird and through its products it will reach the human body with the potential of causing irreversible health effects. Thus to maintain the food chain safe from entering of heavy metals and subsequent consequences, it is necessary to have definite standards for heavy metals for all possible pathways towards food chain.

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