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Assessment of Aluminum Levels in the Milk Supply of Tiruvallur district of Tamil Nadu

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Abstract **Introduction:** Aluminium is a predominant heavy metal found in everyday products like perfumes, antiperspirants, medication, milk, vaccinations, etc. Biologically available Aluminum is non-essential and toxic to the body. Excessive intake of Aluminum can lead to various negative consequences such as neurodegeneration of the brain, age-related changes, etc. Most of the aluminium exposure is through food and its products. Hence, this study aims to determine the Aluminium levels in milk. **Materials and Methods:** Twenty samples were collected and stored in the Tiruvallur district area, Chennai. They were broken down into nitric and perchloric acid (4:1 v/v) until a transparent solution was obtained. This was then filtered using Whatman filter paper and diluted. Aluminum content was estimated using a flame absorption spectrophotometer. **Results:** This study shows that the mean aluminum levels in the milk supply in Tiruvallur district are 116.25 ± 28.316. The current study also showed that the values are significant (p=0.000). **Conclusion:** Hence, the Aluminium levels of milk are within permissible levels, and care should be taken not to intake excessive amounts.

Key Words Aluminium, Estimation, Milk samples, Toxicity, RDI, Plants, Animals, Food supply

1. Introduction

An estimated 8% of the earth's crust is assumed to be composed of aluminum, the most abundant metal, and the third most common element. It can be found as both aluminosilicates and oxides [1]. Since they are enduring environmental pollutants, heavy metals are among the most dangerous substances that jeopardize human health. The most important of them are aluminium (Al), cadmium (Cd), and lead (Pb). Thus, metal substitutes are being looked for [2]–[4]. The industrial and agricultural processes have increased the amounts of heavy metals in the soil, water, and air. Consequently, plants or animals absorb these metals and eventually incorporate them into the food chain [5].

Dairy products may contain heavy metals because of the contamination of the original cow's milk. This can happen from the nursing cow consuming polluted feed and water or her exposure to environmental pollution. Furthermore, contamination of raw milk might occur during production [6], [7].

Given the widespread and potentially infinite human exposure to aluminum, we may reasonably say that we live in the "aluminum age." The free metal cation of aluminum has high biological reactivity. Biologically accessible aluminum is essentially toxic and unnecessary. Biologically reactive aluminum is found in every human body region [8]. While it can occasionally be extremely hazardous, the effects of chronic aluminum poisoning are significantly less well-known. One inevitable consequence is the presence of aluminum in the brain. Due to its ubiquity and omnipresence, aluminum is a neurotoxic metal that enters the brain at different stages of life, from fetal development to old age.

Aluminium actively participates in brain biochemistry and can substitute vital metals in critical biochemical processes, even though it is unnecessary for life. This may make neurodegenerative diseases worse [9]. The human population is continuously exposed to aluminum through vaccinations, antacid usage, antiperspirant use, and food. Increased aluminum consumption has been connected to inflammatory responses, oxidative damage, and changes in the body's iron metabolism [10]. Once aluminum enters the biotic cycle, it is unlikely to swiftly return to the lithospheric cycle, leaving biota vulnerable to an increasing amount of aluminum that may be physiologically accessible [11].

Published research often identifies diet as the primary source of aluminum exposure, whereas gastrointestinal absorption is the main route of exposure [12]. It was discovered that the average weekly exposure to aluminum through food consumption was nearly 50% of the 1 mg/kg of body weight (bw) per week tolerable weekly intake (TWI), as established by the EFSA. A substantial exceedance of the EFSA-derived TWI may be found when accounting for the total exposure to aluminum from food, cosmetics, medications, and FCM made of uncoated aluminum, increasing the risk for health issues [13]. Our research aims to determine the amount of aluminum present in the milk supply in the Tiruvallur district.

2. Materials and Methods

A study was done to evaluate the amount of the heavy metal aluminium in several milk samples from diverse sources, including cow milk and packet milk, in order to check the quality of the food and food products supplied to residents in Tiruvallur district.

Gathering of Milk Samples

Twenty milk samples were taken at Tiruvallur district between March and July 2022. One litre of cow milk and one litre of packet milk were sampled in clean, sterile bottles. The samples were labelled with the collection date, the type of milk, and the location. The Eco lab at Ramapuram, Chennai, was where the samples were taken after that.

Aluminium Estimation

Twenty samples were taken and kept at -20°C. They were broken down until a clear nitric and perchloric acid solution (4:1 v/v) was obtained. This was then diluted and filtered using Whattman filter paper. With the aid of a flame absorption spectrophotometer, aluminum concentration was evaluated.

Instrumental parameters: Nitric oxide acetylene flame, 309.3 nm wavelength, and 0.5 nm bandpass.

3. Results

The study findings show that the mean aluminium levels in the milk supply in Tiruvallur district is 116.25 ± 28.316. The current study also showed that the values are significant (p=0.000) when a one sample t test was performed and data was statistically analysed (Table 1).

The data after statistical analysis was represented in the form of a line graph (Figure 1).

4. Discussion

The study results showed that Aluminium levels fell from 103.00 to 129.50 ppm, with a mean value of 116.25 ppm and a standard deviation of 28.316.

In a 1991, the levels of aluminum in 44 different types of milk powders and simulated milk powders were measured using Inductively Coupled Plasma Spectroscopy (ICP-OES). The concentration of aluminum in the majority of the samples was less than 1 mg/kg. An investigation into the amount of aluminum present in particular foods permitted for consumption as the food was carried out in the United States. The aluminum content of the samples was ascertained by electrothermal atomic absorption spectrometry after their

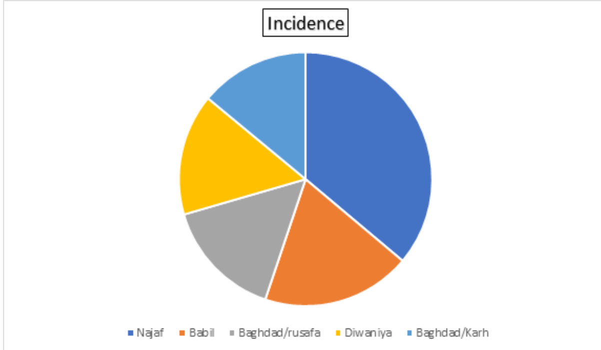

Figure 1: This line graph represents the aluminium levels present in each sample of milk from Tiruvallur district area, Chennai.

breakdown by acids or bases. The latter had a significantly higher aluminum content when ready-to-eat food than freshly prepared meals. Sodium aluminosilicate (50-600 mg Al kg-1), which can provide up to 1.5 milligrams of aluminum per serving, was included in several sachets of non-dairy creamer for one serving [14].

The leaching of aluminum from packaging and containers is another factor causing an increase in aluminum in food. When oiling milk, it was found that there was between 0.2 and 0.8 mg/kg of aluminum leaching. It was also found that the concentration of aluminum in human milk varied from 0.004 mg/l to 2.67 mg/l [15]. Breast milk, soy milk, bottled milk, dried milk, and evaporated milk were the six types of milk that had their amounts of 11 different minerals measured. Soy milk had the highest concentrations of copper, magnesium, molybdenum, aluminum, barium, and nickel. Nonetheless, aluminum consumption stayed below or relatively near the FAO/WHO recommended levels [16].

In a different investigation, graphite furnace atomic absorption spectrometry was used to determine the presence of aluminum in 282 cans of evaporated milk and infant formula sold in Canada. The average (range) concentrations of milk-based formula in ready-to-use, concentrated liquid, and powder formulas were 0.129 (0.010-0.36), 0.217 (0.17-0.56), and 0.717 (0.19-2.49) g/g ('as sold'), respectively [16], [17].

Aluminium has recently been linked to several clinical illnesses, including Alzheimer's disease, dementia brought on by kidney dialysis, etc. [1], [17]. It can cause behavioral and morphological alterations and age-related neurodegeneration even at low levels [18].

Al's toxic effects cause oxidative stress, immunologic changes, genotoxicity, a pro-inflammatory response, peptide denaturation, enzyme malfunction, metabolic derangement, amyloidogenesis, membrane disturbance, iron dyshomeostasis, apoptosis, necrosis, and dysplasia. There are also many pathological conditions linked to Al toxicosis, like infertility and oligospermia, osteomalacia, pneumonia, granulomas,

ELEMENT ESTIMATED	MEAN ± S.D	p value
ALUMINIUM (ng/dl)	116.25 ± 28.316	0.000

Table 1: Table represents the mean, standard deviation and significant value of aluminium level in milk samples in the Tiruvallur district area, Chennai, India.

pulmonary alveolar proteinosis, granulomatosis and fibrosis, thrombosis and ischemic stroke, toxic myocarditis, granulomatous enteritis, Crohn's disease, IBD, anemia, Alzheimer's disease [18].

This study has some restrictions, such as its limited sample size and sampling area. By determining the amounts of aluminium in everyday products, we can avoid being overexposed to this heavy metal and a host of ailments.

5. Conclusion

From the results obtained, the Aluminium levels present are statistically significant. However, they are within permissible limits and hence will not produce any toxic or harmful effects when taking an average amount of milk and milk products.

Conflict of interest

The authors declare no conflict of interests. All authors read and approved final version of the paper.

Authors Contribution

All authors contributed equally in this paper.

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