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Assessment of heavy metals in milk and dairy cattle feed in Syria: Correlation analysis

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ABSTRACT

The aim of this study was to examine correlation between heavy metals (cadmium, lead, nickel, and chromium) presence in milk and dairy cattle feed in Homs Governorate in Syria. One hundred milk and feed samples were randomly obtained from dairy cows that were offered different diets and were examined for heavy metals concentrations using atomic absorption spectrophotometer. The results of this study showed that there is no existent to any correlation between the concentration of heavy metals in milk and feed. For all measured heavy metals (except for nickel), contamination factors other than feed can be responsible for milk contamination by heavy metals that may mask correlation existence between heavy metals in dairy cattle feed and milk.
Keywords: heavy metals, milk, feed, dairy cow, correlation.

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INTRODUCTION

The release of pollutants such as heavy metals has been increased during the past decades due to expanding in the human population, industrialization and the state of war [1]. The presence of most heavy metals in the human diet has been reported to have no nutritional benefits on health and wellbeing [2]. On the contrary, the presence of heavy metals in human diet and animal feed above their maximal limit have been reported to negatively influence human health [3] and animal performance and welfare [4]. The presence of heavy metals in milk has been recorded in many countries worldwide [5]. Despite the fact that heavy metals exhibit various chemical characteristics in the soil, their losses from the soil are very low [6]. Many heavy metals pollution factors and sources have been reported in literature that resulted in their accumulation in dairy cattle body including consumed milk such as contaminated drinking water [7], pharmaceutical medicines [8], contaminated soil with sewage and waste produced from industry [7], inhaled air and skin exposure [4], licking of painted areas possessing heavy metals and animal feed [8]. The magnitude of heavy metals contamination in milk will be influenced by the impact of direct and indirect contamination sources and exposure. Therefore, the main objective of this study was to examine the correlation existence of heavy metals level in dairy cattle and the level of heavy metals in milk obtained from Homs Governorate. Absence or weak correlation existence between heavy metals in feed and milk (in case there was an increased concentration in milk) will indicate the presence of other contamination sources other than feed.

MATERIAL AND METHODS

Raw milk samples (500 mL) from 100 dairy cows were randomly obtained from local farms distributed in Homs Governorate–Syria. Dairy cows were offered different diets composed of different feed ingredients including corn, barley, cottonseed meal, wheat bran, soya bean meal, wheat, sesame meal, vetch and vitamins, and minerals. Milk and feed samples were directly collected and stored in the refrigerator until further analysis. Heavy metals (cadmium, lead, nickel, and chromium) were analyzed according to the procedure described by Gogoaşă *et al*.[11]. For the sack of simplicity, simple linear regression analysis was performed to measure the existence of a correlation between the concentration of heavy metals in milk and diet suing an excel sheet (Microsoft, 2007). Pearson's correlation coefficient (r) is used to measure the strength of the correlation between the heavy metals in milk and feed.

RESULT AND DISCUSSION

Cadmium

The result of this study showed that there is no existent to any correlation between the concentration of cadmium (figure 1) in milk and their related concentration in the feed. The maximal tolerable cadmium concentration in cattle diet has been reported not to exceed 0.5 ppm [12]. In all analyzed diets in this study, cadmium concentration was higher than the maximal tolerable cadmium concentration recommendation. Cadmium levels in dairy diets ranged from 5 to 30 ppm have been reported to decrease dairy performance by disturbing the absorption of zinc and copper [4]. The maximum tolerable limit for cadmium in milk given by the International Dairy Federation (1979) is 0.0026 ppm. In this study, cadmium concentration in all milk samples was higher than 0.02 ppm. The absence of any correlation between cadmium concentration in milk and feed could be attributed to that cadmium is known as heavy metal that retained within the animal body especially in renal and liver tissues and has been reported to be excreted very slowly from the animal body [4]. Furthermore more, cadmium concentration in milk has been reported not to be increased by the high concentration of cadmium in the diet because the mammary gland limits cadmium transport [13, 14]. In addition, low cadmium absorption (<1%) has been reported in ruminants [15] which may mask existed correlation between cadmium concentration in milk and feed.

Lead

The result of this study showed that there is no existent to any correlation between the concentration of Lead (figure 2) in milk and their related concentration in the feed. The maximal tolerable lead concentration in cattle diet has been reported not to exceed 30 ppm [12]. In all analyzed diet in this study, lead concentration was lower than the maximal tolerable lead recommendation. The maximum tolerable limit for lead in milk given by the Codex Alimentarius Commission (2011) is 0.02 ppm [16]. In this study, lead concentration in all milk samples was higher than 0.02 ppm. Lead has been reported to be easily transmitted to milk [17]. However, two factors may explain the absence of correlation between the concentration of Lead (figure 2) in milk and their concentration in the feed. Firstly, less than 10 percent of lead intake has been reported to be absorbed by adult ruminants [18] which may mask the correlation exists between lead concentration in milk and feed. Secondly, the differences among ingredients composition of fed diets and thus nutrient composition have been reported to alter the retention level of lead within the animal body [19, 20].

Nickel

The result of this study showed that there is no existent to any correlation between the concentration of nickel (figure 3) in milk and their related concentration in the feed. Nickel is moderately nontoxic with a maximal tolerable dietary concentration of 50 ppm for cattle diet [12]. In all analyzed diet in this study, nickel concentration was below the maximal tolerable nickel recommendation. The tolerable intake level of nickel through human food sources have been reported to range from 0.1-1 ppm [21]. Nickel concentration in all milk samples was within less than 0.08 ppm.

Chromium

The result of this study showed that there is no existent to any correlation between the concentration of chromium (figure 4) in milk and their concentration in the feed. Chromium concentration that is required to achieve optimal performance in dairy cattle is not clear [4]. Inorganic forms of chromium are very weakly absorbed and thus chromium is widely used as a marker for performing digestibility studies. Poorly absorbed chromium may mask the correlation that exists between lead concentration in milk and feed.

For all measured heavy metals in this study, extra contamination factors that have been reported for milk contamination by heavy metals may mask correlation existence between heavy metals in dairy cattle and

milk. The heavy metals may enter inside the animal body through different routes such as polluted drinking water or through air inhalation and/or even skin contact [5, 22, and 23]. No correlation existence has been reported between heavy metals in milk and mixed feed suggesting that milk is being contaminated by various other sources but not through offered feed [1].

Figure 1. Correlation analysis between Cadmium concentration between in feed and milk

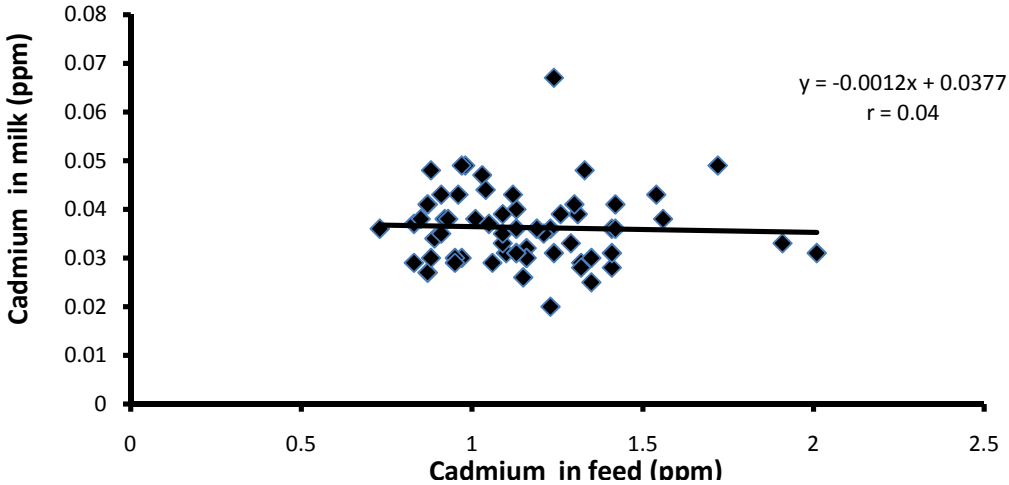


Figure 2. Correlation analysis between Lead concentration between in feed and milk

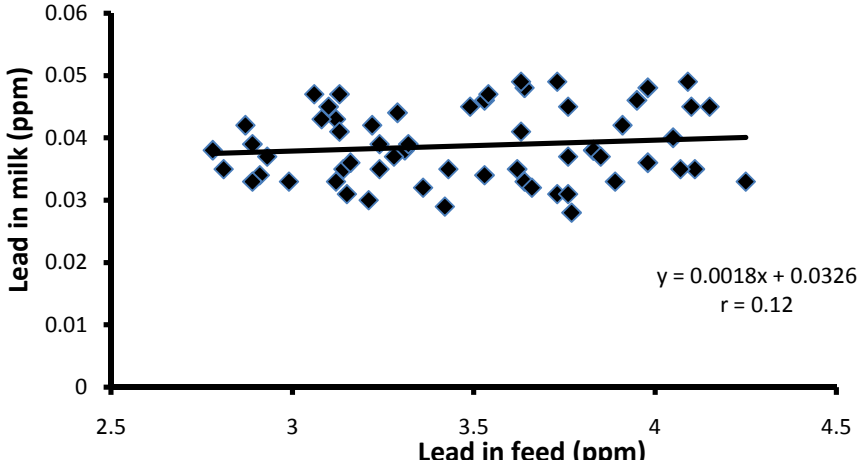


Figure 3. Correlation analysis between Nickel concentration between in feed and milk

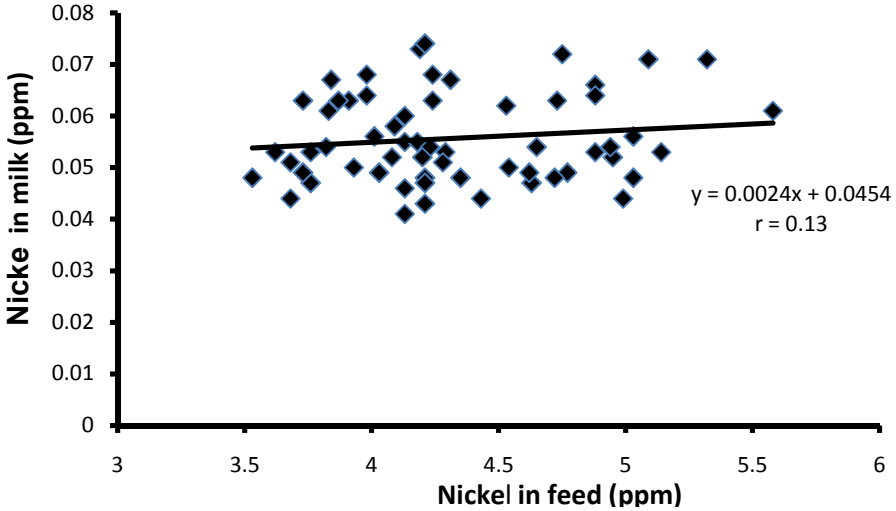
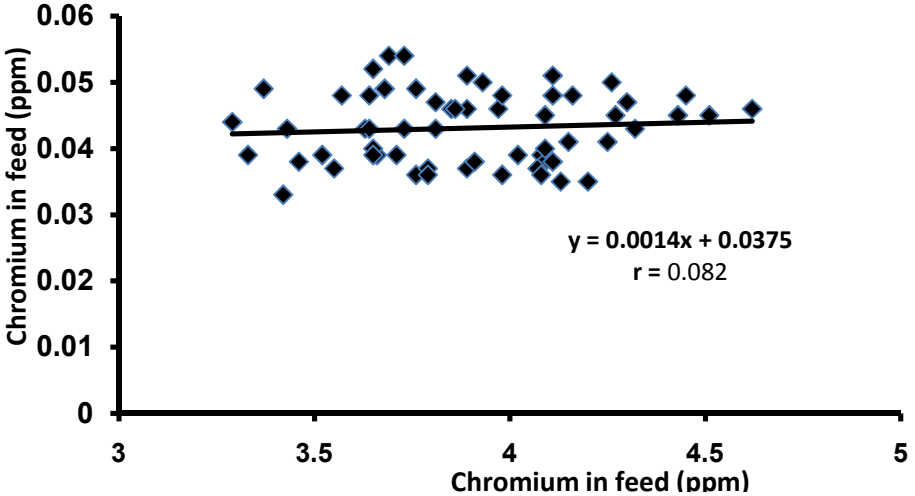


Figure 4. Correlation analysis between chromium concentration between in feed and milk



CONCLUSION

It can be concluded from this study that, under current experimental conditions, no correlation exists between studied heavy metals concentration in milk and fed diets. Measuring heavy metals in feed does not give a good estimation to heavy metals concentration in milk in Syria. Drinking water, industrial activities and environmental conditions should be taken into consideration to have a good estimate for heavy metals consideration in milk.

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