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Estimation of lead and copper residues in sheep, goat milks and Karish cheese

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ABSTRACT

Dairy products are considered as one of important foods in the human diet. They are good source of protein, fat, and major minerals. Heavy metals are persistent toxic chemicals that have a public health concern. Milk of small ruminants such as sheep and goat is considered as a very important source for animal-derived protein in many Arabian countries and Egypt. However, studying the heavy metal load in milk of small ruminant had received less attention. Thus, this study aimed to estimate the residual concentrations of lead (Pb) and copper (Cu) in milk of sheep, goat' milk and cheese manufactured from sheep milk. The public health importance of the existed metals was also discussed. All examined samples had Pb concentrations higher than the maximum permissible limits (MPL) set by WHO/FAO. Similarly, goat milk samples had Cu concentrations higher than MPL, while in case of sheep 70% and 90% of examined milk and cheese samples had Cu levels higher than MPL.

Key words: goat's milk, karish cheese, sheep's milk, copper, lead.

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1. INTRODUCTION

Milk and milk products such as Karish cheese are considered as important foods in the human diet. They are good sources of protein, fat, and major minerals (Lampert, 1984). Sheep and goat herds in Egypt have a free access for grazing in and around green lands that may be heavy metal-contaminated. Manufacturing dairy products from these animal's milk especially those reaching local markets without any monitoring of heavy-metal load despite the using of such monitoring programs in many countries with the purpose of avoiding the distribution of foodstuffs that could pose a risk to human health (Milićević et al., 2009). In Egypt, pollution by heavy metals has increased due to anthropogenic activities such as agricultural projects, industrial and other activities along the Nile Delta (Darwish et al., 2015) and this considered a big problem as heavy metals are persistent toxic chemicals, due to their cumulative nature in the different body organs leading to adverse effects (Sathawara et al., 2004) and their tendency to bioaccumulate in the environment and biomagnify in food chains (Caggiano et al., 2004), reaching to toxic concentrations even when found in low concentrations in the environmental samples. Milk of small ruminants such as sheep and goat is considered as a very important source for animal-derived protein in many Arabian countries and Egypt. However, studying the heavy metal load in milk of small ruminant had received less attention. Therefore, the present study aimed to evaluate levels of the heavy metals such as lead (Pb) and copper (Cu) in sheep and goat milk and Karish cheese manufactured from sheep milk marketed at Sharkia Province markets. Additionally, the public health hazards of these metals were discussed.

2. MATERIALS AND METHODS

2.1. Samples

A total of ninety raw sheep and goat milk samples and Karish cheese manufactured from sheep milk (30 of each) were collected randomly from different localities in Zagazig city, Sharkia governorate, Egypt. Collected samples were transferred directly to the Central laboratory, Faculty of Veterinary Medicine, Zagazig University, Egypt for heavy metal measurement.

2.2. Analytical method

Heavy metal (Pb and Cu) levels in examined samples were measured according to the method described by Finerty et al. (1990). One g/ml of each sample was mixed with 10 mL 3:2 HNO_3 (65%v/v): $HClO_4$ (70%v/v). The mixture was allowed to be digested overnight in the cold and later heated for 3 h in a water bath at 70ºC with swirling at 30 min intervals to ensure complete digestion. After cooling, the digest was transferred into 20 mL standard flasks, rinsing with de-ionized water and made up to the mark. Prepared sample solutions were kept in acid-leached polyethylene bottles at room temperature until metal analyses.

All reagents used were analytical grade and standard solutions of Pb and Cu were purchased from Merck, Darmstadat, Germany. Metal concentrations were measured using an atomic absorption spectrophotometer (model PerkinElmer 2380), using hollow cathode lamps, equipped with air-acetylene flame, the level of Pb was measured at 217 nm, while that of Cu was measured at 308.2 nm.

Certified standards for all examined metals were used. Mean recoveries were ranged from 95 to 105% to all tested elements. Samples were analyzed in triplicates. All of the obtained results were corrected according to the recovery percentage. All glassware, were washed, before use, with distilled water, soaked in nitric acid (30%), then rinsed in redistilled water and air dried. The glassware kept in clean place, to avoid contamination. After the analysis of all the samples, minimum, maximum, mean ± SE values were calculated. Student's *t*-test was used to analyze the significance of the results at $p < 0.05$.

3. RESULTS

In this study, it is evident from the results recorded in table (1) that the mean concentrations (ppm) of Pb in sheep and goat milks were 3.96 ± 0.35 and 1.22 ± 0.13, respectively, and in case of Karish cheese manufactured from sheep milk, the mean Pb residual concentration was 3.92 ± 0.27 ppm. While, the mean concentrations (ppm) of Cu in sheep and goat milks were 0.43 ± 0.06 and 0.86 ± 0.05, respectively, and in case of Karish cheese manufactured from sheep milk, the mean Cu residual concentration was 0.52 ± 0.06 ppm as declared in table (2). In other words, sheep had significantly higher Pb residual concentrations than goats, and the recorded results in (Figure 2) declared that goats had significantly higher Cu residual concentrations than sheep,

Based on the maximum permissible limits set by WHO/FAO (1999), all the examined samples (100%) in both sheep and goats were exceeding the permissible limits of Pb. Although, all examined samples (100%) in goats were higher than the maximum permissible of Cu, 70% and 90% of examined sheep dairy products, milk and cheese were higher than MPL.

Table.1. Lead residual concentrations in examined sheep, goat milk samples and Karish cheese

	Sheep milk	Goat milk	Karish cheese
Mean ± SE	3.96 ± 0.35^a	1.22 ± 0.13^b	3.92 ± 0.27^a
Minimum	2.64	0.55	2.34
Maximum	5.66	1.81	4.87
Percentage exceeding MPL	100 %	100 %	100 %

Maximum permissible limit (MPL) of Pb in milk is established as 0.05 ppm according to WHO/FAO, 1999. Means carrying different superscript letter are significantly different with each other at $p<0.05$.

Table 2. Copper residual concentrations in examined sheep, goat milk samples and Karish cheese

	Sheep milk	Goat milk	Karish cheese
Mean ± SE	0.43 ± 0.06^b	0.86 ± 0.05^a	0.52 ± 0.06^b
Minimum	0.20	0.60	0.24
Maximum	0.84	1.21	0.86
Percentage exceeding MPL	70 %	100 %	90 %

Maximum permissible limit (MPL) of Cu in milk is established as 0.3 ppm according to WHO/FAO, 1999. Means carrying different superscript letter are significantly different with each other at $p<0.05$.

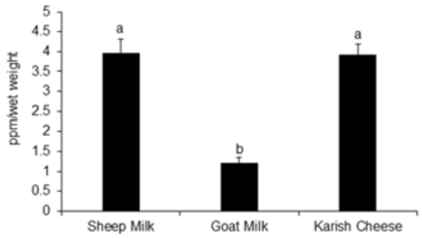

Fig.1. Lead residual concentration (ppm/wet weight) in examined sheep, goat milks and Karish cheese Values expressed as mean ± SE. Columns carrying different superscript letter are significantly different with each other at $p<0.05$.

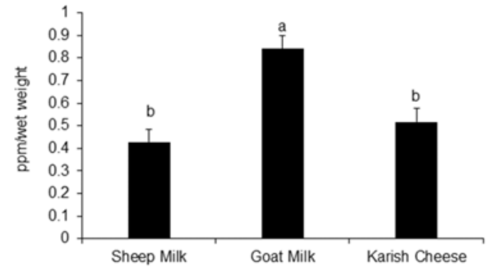

Fig.2. Copper residual concentration (ppm/wet weight) in examined sheep, goat milks and Karish cheese Values expressed as mean ± SE. Columns carrying different superscript letter are significantly different with each other at $p<0.05$.

4. DISCUSSION

Sheep and goat milks contain important elements such as potassium, phosphorous, magnesium, sodium, chlorine and a wide range of microelements, which are important for human health. The nature of sheep and goat rearing and their feeding habits as scavengers for plant roots and grazing on open access to some contaminated lands allow an increase in the concentration of heavy metals in their bodies and subsequently reach to consumers through consumption of their milk and dairy products. However, this kind of pollution has given rise to concern on the intake of harmful metals in humans; there are only few studies which discuss the heavy metal load in sheep and goat milk and milk products. Generally, metal levels in uncontaminated milk is low, but by inhalation of polluted air, intake of contaminated feeds and absorption through the skin, many dangerous elements or compound such as heavy metals accumulate along the food chain (Darwish et al., 2015).

Exposure to Pb via ingestion of contaminated food and drink or by inhalation is common in Pb polluted areas worldwide. Recently, Pb has been encountered in many poisoning cases, especially in children, in many locations such as Bagega community, Zamfara, Nigeria (Ajumobi et al. 2014); in Kabwe, Zambia (Yabe et al. 2014), and in Changchun, Jilin Province, China (Xu et al. 2014). Thus, it is very important to estimate Pb concentrations in milk and milk products.

It is clear from the recorded results that sheep had significantly higher Pb residual concentrations than goats (Figure 1), which may be due to the physiological differences in xenobiotic metabolism between the two species examined. It notes worthy that all examined samples (100%) in both sheep and goats were higher than the maximum permissible limits set by WHO/FAO (1999), this may give indication to the high Pb pollution level in the environment where these animals live or in the food, they ingest. Furthermore, we observed that there is no significant difference between Pb concentrations in the sheep milk and Karish cheese manufactured from sheep milk as clear in table (1), this gives clear indication that processing of milk has no effect on Pb concentration.

The obtained Pb concentrations in sheep milk and cheese were in correspondence with the concentrations recorded in Italy (Anastasio et al., 2006), but higher than that recorded by Poti et al. (2012) in Hungary**.** The recorded Pb residues in goat milk were lower than that reported in Pakistan (Javed et al., 2009).

Lead is considered toxic to the developing brain, and at high levels results in numerous poisoning symptoms especially to children. In addition, at the low doses common today in many countries, lead has subtle effects on neurological functions, including learning, memory and attention span. Because the infant brain is developing rapidly both before birth and for several years after birth, lead exposures during this critical period are particularly detrimental to the future intellectual potential of children (Oskarsson et al., 1995).

Although copper is essential microelement, has a variety of biochemical functions in all living organisms and important industrial uses, its potential toxicity to humans and animals is a source of concern. Therefore, it is necessary to estimate Cu residues in dairy products of sheep and goat.

It is clear from the recorded results that goats had significantly higher Cu residual concentrations than sheep (Figure 2), which may be due to the physiological differences between the two species examined. Notably, that all examined samples (100%) in goats were higher than the maximum permissible limits set by WHO/FAO (1999). In sheep dairy products, 70% and 90% of examined milk and cheese were higher than MPL. This high level of contamination indicates high Cu levels in the environment or in the trace elements provided to these animals. Similarly, to Pb, we observed that there is no significant difference between Cu concentrations in the sheep milk and Karish cheese manufactured from sheep milk as clear in table (2), this gives an idea that processing of milk did not alter Cu concentration.

Activities such as mining & smelting operation and agriculture have contaminated extensive area of world such as Japan, Indonesia, and China mostly with Cu and Pb (Herawati et al., 2000). Cu and Pb pollution was reported in north Greece (Zantopoulos et al., 1999); Cu, Pb, Zn, and Cd in Australia (Smith et al., 1996); Pb, Cd, Zn, Cu and Fe in Egypt (Malhat et al., 2012). In humans, frequent exposure to even small concentrations of Pb or Cu may have direct biological effects involving leading to disruption of xenobiotic metabolic pathways. As a result, a broad range of biochemical, physiological, pathological, and behavioral changes in the body may occur (Hsu and Guo 2002; Masso-Gonzalez and Antonio-Garcia 2009). Thus, it is advisable to control the levels of toxic metal and trace element concentrations in milk and dairy products to avoid the hazards effects on consumers' health.

5. REFERENCES

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