Assessment of Lead, Cadmium and Copper concentrations in Raw Milk Collected from different location in Iraq

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Abstract

Raw milk is subjected to various physical, chemical and biological pollutants due to produce, a transporting and marketing processes. The current study was designed to examine raw milk samples which were collected from different locations of Iraq. The highest mean value of Pb content [1.801±0.311 ppm] was recorded while the lowest mean value [0.941±0.104 ppm]. The highest mean value [1.532±0.124 ppm] and gave the lowest mean value [0.063±0.044 ppm] of Cd content. This study has the highest mean value of Cu content was [0.931±0.092 ppm] and but the lowest mean value was [0.308±0.029 ppm]. Metals contents of raw milk in this study showed higher than standards of the International Dairy Federation [IDF].

Keywords: Raw Milk, Heavy Metals, Pollution.

تقييم تراكيز الرصاص والكادميوم والنحاس في الحليب الخام تم جمعها من مناطق مختلفة من العراق

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الخلاصة:

يخضع الحليب الخام لمختلف الملوثات الفيزيائية والكيميائية و البيولوجية يعود لانتاج ونقل وعمليات التسويق مثل بعض المعادن الثقيلة وقد تم تصميم الدراسة الحالية الى فحص عينات الحليب الخام التي تم جمعها من مواقع مختلفة اضهرت نتائج المعادن الثقيلة ان اعلى قيمة متوسط لمحتوى الرصاص [1,801±0,311جزء بلمليون] بينما سجل ادنى متوسط قيمة [0,941±0,104جزء في المليون] وسجل اعلى قيمة متوسط للكادميوم [1,532±0,124 جزء في المليون] وسجل ادنى متوسط قيمة [0,063 ± 0,044 جزء في المليون] بينما وجدت هذه الدراسة متوسط قيمة محتوى النحاس [0,931 ± 0,092 جزء في المليون] ولكن كان اقل متوسط قيمة [0,308 ± 0,029 جزء في المليون] وكانت نتائج تراكيز هذه المعادن اعلى من الحدود المسموح بها عالميا .

Introduction:

Heavy metals pollution can originate from natural and anthropogenic sources. Activities such as mining and smelting operation and agriculture have contaminated extensive area of world such as

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Japan, Indonesia, and China mostly such as Cd, Cu and Zn [1]. Cu and Pb in north Greece and Cu, Pb, Cu, Ni, Zn, and Cd in Australia [2]. In animal body, metals are entering through feeding, green fodder, drinking water and pharmaceutical medicines. Other sources are accidental access to limed field, mineral supplements with high content of trace metal and licking of painted surfaced containing metallic pigments [3].

Although, milk is an ideal source of macroelement [Ca, K and P] and microelemts [Cu, Fe, Zn, Se], addition amounts of contaminant metals might enter milk and dairy products reaching levels that are harmful to humans [3]. Milk and dairy products become contaminated with heavy metals either through food stuff and water or through manufacturing and packaging processes [4, 5].

The toxicity of lead comes from its ability to mimic other biologically important metals, most notably calcium, iron and zinc which act as cofactors in many enzymatic reactions. Lead is interact with many of the same enzymes as these metals but, due to its differing chemistry, does not properly function as a cofactor, thus interfering with the enzyme's ability to catalyze its normal reaction [6]. Lead is known to cause the disease called plumbism [7]. Lead exposure can lead to anemia, kidney toxicity and may result in damage to the central nervous system [8].

Cadmium is a toxic to virtually every system in the animal body. It is almost absent in the human body at birth, however accumulates with age. An average mean accumulates as about 30 mg cadmium in his body by the age of 50 years. Refined foods, water foods, water pipes, coffee, tea, coal burning and cigrates are all the most important source of Cd [9]. Cadmium exposure [namely inorganic cadmium] can produce health effects on the kidney, stomach and bones. Cadmium may also play role in human carcinogenesis [10].

Copper toxicity is a much overlooked contributor to many health problems; including anorexia, fatigue, premenstrual syndrome, depression, anxiety, migraine headaches, allergies, childhood hyperactivity and learning disorders. The involvement of copper toxicity and bioavailability in such a wide range of health conditions may seem unusual. It is our intent in this paper to show how copper is regulated in the body and why it is such a key mineral in so many metabolic dysfunctions [11].

In study [12] Concentrations of toxic heavy metals [cadmium [Cd], lead [Pb]] and major nutritional and trace elements [Ca, Mg, P, Cu, Fe, Mn, Se, Zn] were analyzed in the milk of Simmental and Holstein-Friesian cows from an organic farm. The conducted research showed that the milk of Simmental cows was characterized by the more advantageous mineral composition and lower concentration of noxious heavy metals compared to the milk of Holstein-Friesian cows. In the milk of Simmental cows, significantly lower concentrations of Pb and Cd [$P<0.001$] and Cu [$P<0.05$] and significantly higher concentrations of Fe and Mg [$P<0.05$] as well as nonsignificantly higher concentrations of Ca, Mn, and Se were found. In the milk of both breeds, very low Cu concentrations were recorded. The higher-than-recommended concentration of Pb in milk was also found.

Materials and Methods:

Samples of raw milk were collected from different 6 sites (Abu Ghraib, Fal'loga, Azizia, Essaouira, Madain and Ghazaliya) during the study period from October 2013 to March 2014. These samples were collected monthly with size of a liter for each raw milk sample and each was divided into 3 subsamples. Samples were kept in their original packages and transferred to the lab in an ice box. Subsamples of from each raw milk sample were oven-dried at 60^{o}C till constant weights were reached. Thereafter, dry samples were ground to powder using a grinder with stainless steel knife, then stored in clean glass vials for later analysis.

Duplicate sub-samples [about 2 g fine powder] from raw milk were digested in a mixture of 1:1 nitric: perchloric acids [Suprapur, Merck] using a heating block [13]. At the end of digestion, mixture volumes were adjusted to 10 ml using double distilled water. Blanks and reference material were run with the samples. Finally, concentrations of Pb, Cd and Cu were measured by a graphite furnace atomic absorption spectrophotometer (Shimadzu- GFAA- 6800).

Results and Discussion:

Table -1 includes mean value ± standard deviation of Pb, Cd and Cu content in raw milk samples collected from different sites during study period.

Table 1- Mean± SD raw milk content [ppm] of Pb, Cd and Cu in six samples examined for each month from Oct.2013 to Mar.2014.

Month	Milk sample	Mean (ppm) ± SD		
		Pb	Cd	Cu
Oct.	Abo-Ghraib	1.801±0.311	0.312±0.042	0.462±0.053
	Fal'loga	1.387± 0.438	0.287±0.043	0.500±0.036
	Azizia	1.362±0.382	0.350±0.066	0.425±0.029
	Essaouira	1.352±0.226	0.375±0.017	0.450±0.041
	Madain	1.523±0.384	0.242±0.052	0.601±0.033
	Ghazaliya	1.412±0.714	0.312±0.012	0.387±0.046
Nov.	Abo-Ghraib	1.765±0.105	1.532±0.124	0.459±0.037
	Fal'loga	1.654±0.098	0.123±0.010	0.308±0.029
	Azizia	1.345±0.076	0.828±0.038	0.401±0.042
	Essaouira	1.398±0.112	1.082±0.106	0.399±0.030
	Madain	1.675±0.132	1.005±0.067	0.600±0.068
	Ghazaliya	1.373±0.204	1.099±0.082	0.321±0.038
Dec.	Abo-Ghraib	1.458±0.184	0376±0.094	0.398±0.015
	Fal'loga	1.345±0.093	0.377±0.016	0.601±0.029
	Azizia	1.554±0.126	0.299±0.012	0.467±0.051
	Essaouira	1.366±0.066	0.965±0.052	0.387±0.020
	Madain	1.800±0.214	1.328±0.061	0.321±0.012
	Ghazaliya	1.456±0.187	0.256±0.018	0.376±0.034
Jan.	Abo-Ghraib	1.364±0.107	1.336±0.234	0.714±0.083
	Fal'loga	1.572±0.115	0.063±0.044	0.712±0.085
	Azizia	0.947±0.036	0.089±0.028	0.931±0.092
	Essaouira	1.567±0.094	1.416±0.156	0.674±0. 106
	Madain	1.131±0.061	0.072±0.066	0.689±0.205
	Ghazaliya	0.941±0.104	1.301±0.090	0.312±0. 013
Feb	Abo-Ghraib	1.334±0.205	1.522±0.237	0.445±0.067
	Fal'loga	1.387±0.113	0.067±0.008	0.476±0.132
	Azizia	1.466±0.316	0.097±0.012	0.600±0.148
	Essaouira	0.998±0.056	1.065±0.026	0.645±0.089
	Madain	1.667±0.294	1.500±0. 303	0.876±0.052
	Ghazaliya	0.955±0.093	1.232±0.232	0.476±0.104
Mar.	Abo-Ghraib	1.564±0.248	1.500±0.366	0.376±0.142
	Fal'loga	1.345±0.404	0.465±0.041	0.466±0. 104
	Azizia	1.388±0.542	1.332±0.154	0.387±0.096
	Essaouira	0.998±0.129	0.365±0.105	0.876±0.308
	Madain	1.456±0.316	0.376±0.094	0.931±0. 301
	Ghazaliya	1.255±0.144	0.098±0.029	0.454±0.036

Lead

In case of milk Pb content, the highest mean value [1.801±0.311 ppm] was recorded in Abo-Ghraib sample in October while the lowest mean value [0.941±0.104 ppm] in Ghazaliya sample in January [figure -1].

Analysis of variance has shown significant differences [P≤ 0.001] between raw milk samples of different sites and different collecting month. Also, LSD value [0.087 ppm] shows similar significant differences between raw milk samples.

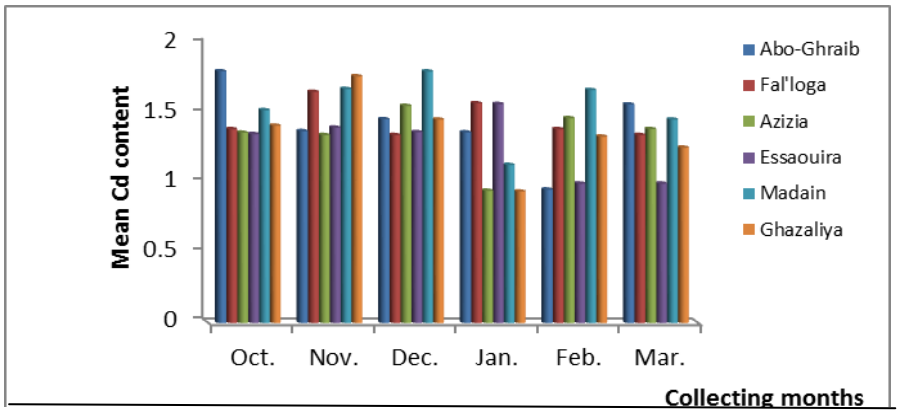

Figure 1 – Mean Pb content (ppm) in different raw milk samples examined study period.

Cadmium

For Cd raw milk content, again Abo-Ghraib milk sample had the highest mean value [1.532±0.124 ppm] in November and milk sample of Fal'loga gave the lowest mean value [0.063±0.044 ppm] in January [figure -2].

However, analysis of variance of Cd milk content shows significant differences [P≤0.001] between sites and collecting months and value of LSD test [P≤0.05] was found to be 0.066 ppm indicating clear difference between Cd milk content.

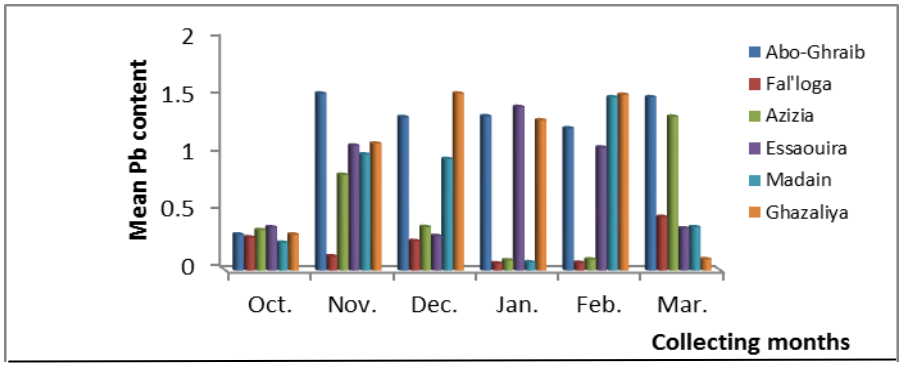

Figure 2- Mean Cd content (ppm) in different raw milk samples examined study period.

Copper

Regarding raw milk Cu content, this study has found that the highest mean value was [0.931±0.092 ppm] in Azizia milk sample during January and almost similar value [0.931±0. 301 ppm] was found in Madain sample but during March while the lowest mean value was [0.308±0.029 ppm] in Fal'loiga sample of November [figure -3].

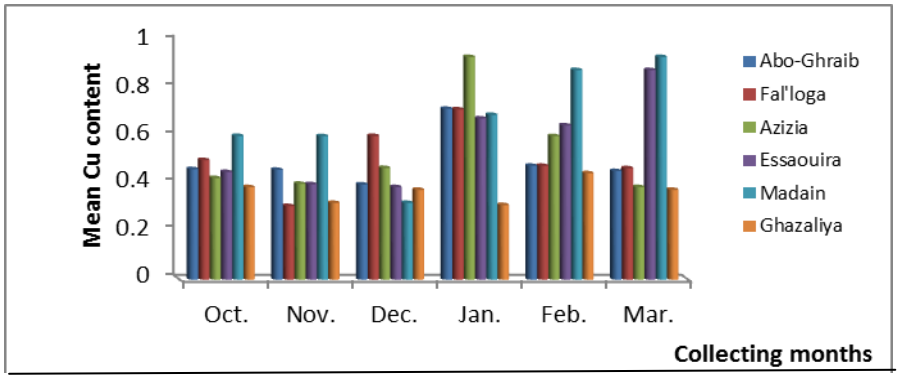

Figure 3- Mean Cu content (ppm) in different raw milk samples examined study period.

Analysis of variance of these data reveals no significant impact of sites on milk Cu content [P> 0.05] where no differences were found between mean value of different collecting sites but shows highly significant [P≤ 0.001] effects of collecting months giving significant differences [LSD=0.337 ppm] between mean values of different months.

The results showed the highest content of [Pb, Cd and Cu] are higher than standards of the International Dairy Federation [IDF] standards for permissible maximum are Cu = 0.01 parts per million [ppm], Cd = 0.0026 ppm, Pb = 0.02 ppm.

The different studies have higher finding of pb content than reported values in our study, such as [14] studied Estimation of Lead and Copper Levels in Milk. But much lower values from other studies from Lithuania [15], Turkey [5] and Egypt [16]. A study carried out in Afak city [Al-Diwaniya] [17] they showed the cow milk contaminated with the element of lead at a rate of concentration [0.07 mg/kg] less than which is found in current study. As well as in Egypt [18] appeared as average lead concentration in the milk of cows and buffaloes 0.084 and 0.066 mg / kg, and average concentration of copper in the cows and buffaloes 0.212 and 0.142 mg/kg, respectively less than in this study.

A study in Poland reported the average lead concentration in beef milk collection of 15 dairy plant in the summer [0.54 mg/kg], while in winter the rate was less than a [0.47 mg/kg] [15] as well as the result in our study that recorded high level in Pb and Cd during the summer and less level in winter.

The researchers found in a study of five aggregates cows spread over three areas in the north of Nigeria that the highest and lowest concentration of lead in milk [0.63-0.16 mg/kg], which is less than found in our study, while the highest and lowest concentration of copper [0.59-0.56 mg/kg] which is less than found in our study maximum [19].

Levels of metals in raw milk were having the following order: Pb>Cd>Cu, concentrations of Pb were the highest and those of Cu were the lowest. The results obtained show how this metal is ever more frequently found in milk samples, not only in regions with great industrial activity. The presence of Pb in milk samples could be due to various factors: cows graze along roads and/or motorways, fodder contamination, climatic factors, such as winds, and the use of pesticide compounds. One of the most important sources of lead contamination in milk is water, especially in more contaminated areas [20].

There are seasonal variations in heavy metals content of soil, wastewater, fodder, and particulate matter [21]. Moreover, the uptake of these metals by plants is influenced by soil pH and agriculture practices such as use of fertilizers. Level of soil ingestion by the animals and vegetation types in different seasons is the other factors which may lead to varying degree of heavy metals exposure to animals between summer and winter. The sources of heavy metals are multiple and their entry into dairy chain also depends on biological variables [e.g. rate of absorption into the animal body] [22].

The following conclusion may be drawn: Highest content heavy metals contamination was found in Raw milk which exceeded the recommendation limits by international and national facility. The results of this study were showed the Pb and Cd content in raw milk which was higher than other studies.

It is essential to extend this study to determine other most effective heavy metal contents in both raw and powder milk such as Al, As, V1 and Cr. The assessment of other environmental variables of breeding and producing products.

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