ABSTRACT

Considering that pollutants transformed to human body through food consumption, food safety is of great concern to consumers. Because consumption of milk contaminated with heavy metals poses serious threats to consumer's health. This study was conducted to evaluate the concentration of heavy metals and its risk with the consumption of milk and milk products in Aswan Province. A total of 20 samples of raw fresh buffalo, cow, sheep and goat milk and 16 samples of milk products of Kareish cheese, Domiati cheese, Mish and Samna were analyzed for the presence of heavy metals of Cadmium (Cd) and Lead (Pb) and trace elements of Copper (Cu) and Zinc (Zn) via Atomic Adsorption Spectrophotometer (AAS). The results showed that the concentration of total heavy metals differed between different areas, it was the highest in Edfu but the least in Toshka. With the analysis of metals concentration in milk of different species, the results showed higher concentration of total metals in sheep and goat milk combined with low content of Cd and high content of Zn and Cu than that of cow and buffalo milk. Comparing the Cd, Pb, Cu and Zn concentrations in locally manufactured milk products with the permissible upper limit of EOS (1993), the results are within the permissible limit. The health risk assessment of metals was assessed on the basis of determining of EDI and THQ for inhabitants through the consumption of contaminated milk and milk products. The EDI of Cd and Pb contributed to 59.7% and 20.48% of PTDI, while Zn contributed to 0.0345 to 2.582% and 0.0475 to 3.55% of RDA for male and female, respectively, but the Cu contributed to 0.0555 to 7.466 % of RDA. The results also showed that THQ of all metals under study are less than one via the consumption of milk and milk products which means that inhabitants in Aswan Governorate will not expose to health risk from the consumption of raw milk and milk product.

INTRODUCTION

In recent days, the rapid increase in industrial and agricultural activities has contributed to increased levels of heavy metals in the environment, for example in the air, soil and water (Pack et al., 2014). Heavy metals like cadmium, lead, mercury, arsenic, chromium and some trace elements like zinc, copper are worldwide problem. The toxicity induced by excessive levels of these elements are well known, as it poses serious threats to consumer's health (Monika and Vlasta, 2005). Globally, there has been many reports on heavy metal intake by humans through food contamination (Muchuweti et al., 2006). Heavy metals accumulate in tissues of dairy animals and ultimately excrete in milk because of their non-biodegradable and persistent nature (Burger and Elbin, 2015). Consumption of adulterated milk by consumers results in various health problems, and is a most important concern in the food industry (Singh et al., 2010).

Studies on milk contamination with heavy metals in Aswan Governorate are very scarce, except a study accomplished since 25 years ago by Rashed (1992). As the level of environment contamination is directly correlated with the level of industrialization (Tubaro and Hungerford, 2007). At present, Aswan governorate have many industrial activities that cause excessive pollutions for the environment. Metal industry, mining industry, float-hotels transportation, sugar industry and phosphate mining and other small industries are representing the major industrial activities at Aswan governorates. These activities are spread out of the most of the governorate and can cause pollution for the environment which expected to contaminate soil, water and more specifically agricultural lands. These pollutants transmit directly or indirectly to food commodities.

So, due to the rapid increase in industrial and agricultural activities; the assessment of milk and dairy products for the contamination with toxic metals of cadmium, lead, copper and zinc being a big target. So, the objectives of this study are to determine the concentrations of some heavy and trace elements in milk and dairy products and to evaluate their potential health risks to humans.

MATERIALS AND METHODS

This research work was carried out to determine contamination of raw fresh milk and some milk products, like Kareish cheese, Domiati cheese, Mish cheese and Samna by toxic heavy metals (cadmium, Cd and lead, Pb) and trace metals (copper, Cu and zinc, Zn) at Aswan Province. A total of 20 raw milk samples of different species of cows, buffalos, goats and sheep milk were obtained from the households lactating animals at different locations, namely, Edfu, Kom-Ombo and Toshka. As well as, 16 samples of different traditionally cheese types and Samna that manufactured locally (4 samples each) were collected from Aswan grocery shops and markets.

All samples were collected and stored in sterilized and washed with deionize-water bottles and immediately transferred to laboratory for analysis.

All samples were analyzed for the detection of cadmium (Cd), lead (Pb), copper (Cu) and zinc (Zn) in milk, Kareish cheese, Domiati, mish cheeses and Samna by ashing method described by James (1995). The obtained ash was dissolved in 5 ml HCL (36.6%) and the volume was completed to 50.0 ml by deionized water.

The concentration of Cd, Pb, Cu and Zn metals was assessed by Atomic Absorption Spectrophotometer (AAS) Model: A SP 1900 Pie Unicom Flame Atomic Absorption Spectrophotometer, at Unit of the Environmental Studies and Development, Faculty of science, Aswan University.

RESULTS AND DISCUSSION

The concentration of heavy and trace metals in milk and milk products depend on many circumstances, which are related to geographical locations and intensity of the industrial activity in these locations. The intensity of heavy metals contamination of milk and milk products at different sites in Aswan governorate, namely, Edfu, Kom-Ombo and Toshka is determined and the results are shown in Tables (1 and 2). The results in Table (1) indicates to the concentration of cadmium (Cd), lead (Pb), copper (Cu) and zinc (Zn) in milk at these locations. There is a wide
The concentration of heavy metals in milk of different species households at these locations are evaluated. In Egypt, many studies mentioned the differences in heavy metals contaminations in different cites (Abou-Arab, 1991; Rashed, 1992; Enb et al., 2009; Sayed et al., 2012, Malhat et al., 2012; Abd-El Aal et al., 2012; Meshref et al., 2014 and El-Ansary, 2017).

### Table 1. Concentration range of metals in milk of different locations

<table>
<thead>
<tr>
<th>Metal</th>
<th>Edfu</th>
<th>Kom-Ombo</th>
<th>Toshka</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>0.013–0.060</td>
<td>0.002–0.036</td>
<td>0.000–0.016</td>
</tr>
<tr>
<td>Pb</td>
<td>0.159–0.737</td>
<td>0.173–0.430</td>
<td>0.143–0.183</td>
</tr>
<tr>
<td>Cu</td>
<td>0.041–0.336</td>
<td>0.058–0.315</td>
<td>0.148–0.295</td>
</tr>
<tr>
<td>Zn</td>
<td>0.417–1.420</td>
<td>0.737–1.135</td>
<td>0.649–1.173</td>
</tr>
<tr>
<td>Total</td>
<td>0.630–2.453</td>
<td>0.970–1.916</td>
<td>0.940–1.667</td>
</tr>
</tbody>
</table>

Concerning the lead (Pb) concentrations in different milk samples, a wide range was found. The range is 0.143 mg/kg to 0.737 mg/kg (Table 2). The least values are found in milk of Toshka (0.183 mg/kg) while the highest values are found in Edfu and Kom-Ombo (0.430–0.733 mg/kg). These results confirmed the last conclusion of the higher contamination in milk of Edfu cite than others. Concerning the interspecies differences, sheep milk recorded the highest Pb concentration (0.737 mg/kg), compared with goat milk (0.143 mg/kg). While, the lead concentration in buffalo and cow milk are 0.159–0.733 and 0.209–0.430 mg/kg, respectively.

Comparing the Pb concentration in milk of different species, the results indicated that there are variations in different locations in Egypt. El Sayed et al., (2011); Meshref et al., (2014) and El-Bassiony et al., (2016) found Pb values in line with our study (0.327, 0.4086 and 0.2016 mg/kg, respectively). While, Enb et al., (2009) and El-Ansary, (2017) found lower values (0.066 and 0.084; and 0.0934 and 0.05878 mg/L) for cow's and buffalo's milk, respectively, but, Malhat et al., (2012) found higher values (1.850 to 4.404 µg/mL).

By evaluation the milk safety against Pb concentration, the results are compared with the permissible maximum limit for Pb of 0.02 mg/kg as reported by International Dairy Federation (1979) The results in Table (3) in...
pected that milk of all species at all locations are higher in Pb than the permissible maximum limit of 0.02 mg/kg. The high concentration of Pb in milk might be explained by the Pollution of the environment with this metal. Lead alkyl additives into petrol are combusted and emit ed into the atmosphere and can be responsible for high concentration of lead in some vegetation, roadside, soil, a ir, water and plant (Tunegova et al., 2016).

Copper has been greatly known in the whole world as a good source of biological significance in milk, whereby excess copper content in milk contribute towards fast lipid oxidation and contribute towards acceleration of many diseases (Nazir et al., 2015). The possible contamination of milk with copper can occur from animal feed, higher copper content in water and also from copper bearing and copper alloys used in equipment (Mitchel, 1 981 and Temiz and Soylu, 2012). The Cu Content was 0.041 mg/kg to 0.336 mg/kg (Table 2). Goat’s and sheep’s milk are higher in Cu content than of cow’s and buffalo’s milk. The Cu concentrations are: 0.041 – 0.079, 0.111 – 0.133, 0.148 – 0.315 and 0.254 – 0.336 mg/kg in buff alo, cow, sheep and goat milk, respectively. Comparing the Cu concentration in milk of this studied area with th e Cu concentration in milks of other parts of Egypt, the r esults in Tables (1 and 2) indicated lower values of Cu t han that reported at other locations of Egypt, i.e. Assiut, Beni-Suif, Giza, Great Cairo and El-Qaliubia (Kamel et al., 2012; Sayed et al., 2012; Meshref et al., 2014; Enb et al., 2009; and Abou Arab, 1991). Also, the study showed that the Cu concentration is lower than that reported ed by Nnadozi et al., (2014) who found higher values of 0.143 and 0.721 mg/kg in cow milk and sheep milk, respectively. In all milk samples at different location, the concentration of copper was above the maximum residual limit (Table 3) of 0.01 mg/L as recorded by WHO and Joint Expert Committee on Food and Agriculture (Busher a et al., 2014).

Zinc is an essential element for human health, it is important for normal growth and development in the human body. Results in Table (2) indicated that the range of Zn content in examined milk samples is 0.417 to 1.4 20 mg/kg. Zn concentration in sheep and goat milk sho wed higher concentration values than that of buffalo and cow milk 1.420 and 1.368 mg/kg vs 0.961 and 1.128 mg/kg, respectively. Literature revealed wide variations in Zn concentration between studies, (Licata et al., 2004; Park 2000; Levkov et al., 2017; Nnadozi et al., 2014; Güle 2007; Park et al., 2007 and Zoapa et al., 2012).

Zinc concentrations in all milk samples at different location of this study are higher than the permissible limit of 0.328 mg/kg as reported by International Dairy F}

cedration (1977) standard. Results in Table (3) are 100 % over the permissible limit of Zn. The high level of Zn in concentration in milk is a result of soil contamination with zinc which it contributes to increased concentration in the vegetation that serves as fodder for the sheep (Alabanova et al., 2015).

Table 3. Frequency distribution of heavy metals in milk of different species

<table>
<thead>
<tr>
<th>Metal</th>
<th>Permissible Limit</th>
<th>Samples within permissible limit</th>
<th>Samples exceeded permissible limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Milk sample No. %</td>
<td>Milk sample No. %</td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.0026 mg/kg</td>
<td>Buffalo 0 0</td>
<td>Buffalo 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cow 0 0</td>
<td>Cow 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Goat 1 20</td>
<td>Goat 4 80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep 0 0</td>
<td>Sheep 5 100</td>
</tr>
<tr>
<td>Lead</td>
<td>0.02 mg/kg</td>
<td>Buffalo 0 0</td>
<td>Buffalo 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cow 0 0</td>
<td>Cow 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Goat 0 0</td>
<td>Goat 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep 0 0</td>
<td>Sheep 5 100</td>
</tr>
<tr>
<td>Copper</td>
<td>0.01 mg/l</td>
<td>Buffalo 0 0</td>
<td>Buffalo 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cow 0 0</td>
<td>Cow 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Goat 0 0</td>
<td>Goat 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep 0 0</td>
<td>Sheep 5 100</td>
</tr>
<tr>
<td>Zinc</td>
<td>0.328 mg/kg</td>
<td>Buffalo 0 0</td>
<td>Buffalo 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cow 0 0</td>
<td>Cow 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Goat 0 0</td>
<td>Goat 5 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sheep 0 0</td>
<td>Sheep 5 100</td>
</tr>
</tbody>
</table>

a: Codex Alimentarius Commission (2014)  
b: IDF Standard (1979)  
c: IDF Standard (1977)

Heavy metal concentrations in some traditionally milk products:

The heavy metals concentration in different milk products is shown in Table (4) The results indicated that the concentration of total heavy metals in milk products are in the order of: Kareish cheese > Domiatli cheese > Mish > Sanna. The total heavy metals in Kareish cheese is 2702 – 41 81 µg/kg while it is 277 – 911 µg/kg in sanna. Although the results indicated to high differences in the concentration of total heavy metal between milk products, the differences between individual heavy metals, exactly in Cd and Pb, are negligible. Cadmium concentration varied between 8 to 21 µg/kg with highest concentration of 21 µg/kg in Domiatli cheese and the least of 8 µg/kg in Kareish. The Cd concentration differed widely between studies as mentioned in literature. Concerning our results, the Cd concentration is lower than Abdulkhalig et al., (2012) for white cheese (29.28 µg/kg), Meshref et al., (2014) and Al-Ashmaywiy et al., (201) for Kareish cheese (90 and 87 µg/kg) respectively. As well as with Ibrahim (2004) in Kareish cheese and Domiatli cheese. This range of Cd concentration in examined milk products is in the permissible limit of 0.05 mg /kg. Slight differences are found between milk products wit
h an optional value of 111 µg was found in Domiati cheese. In the examined milk products (Table 4), a low Pb concentration was observed compared with other studies (Ibrahim, 2004; Meshref et al., 2014; Anastasio et al., 2006 and Ayar et al., 2009). The lead (Pb) concentration in Samna (Table 4) ranged between 163 to 179 µg/kg which is lower than that mentioned by Enb et al., (2009) who found 269 and 414 µg/kg of lead in Samna of cow and Buffalo milk, respectively; and higher than Shahriar et al., (2014) who found 15 µg/kg of lead in ghee.

Lead concentrations in this study exceeding the maximum limit of 0.02 mg/Kg w.w. (EU Regulation 2001/46 6) for bovine milk, while it is within the maximum permissible limit of 0.3 mg/kg according to EOS (1993).

The results of Cu concentrations in milk products as shown in Table (4) ranged between 10 to 206 µg/kg. The lowest concentration was found in samna (83 µg/ kg), compared with 0.183 to 0.206 µg/ kg for other milk products. The Cu level in Kareish cheese is much lower than those reported in other studies in Egypt as reported by Ibrahim, (2004); Deeb, (2010); Meshref et al., (2014); Sayed et al., (2012); Ghafari and Sobhanardakani, (2017); and AbdulKhaliq et al., (2012). Guideline value of EOS (1993) for permissible limit of copper in cheese (Max. 0.3 mg /kg) means that Cu concentrations in all examined milk products are in permissible limit.

Results in Table (4) revealed that the range of Zn concentration in milk products is 93 µg in Samna to 3796 µg/kg in Kareish cheese. The increase in Zn concentration in cheese products (Kareish, Domiati and Mish) than in Samna ma be explained on the basis that 97% of Zn in milk is bound in casein. In the literature, higher values of Zn are mentioned for Kareish cheese by Meshref et al., (2014); Deeb (2010); Maas et al., (2011) and Ghafari and Sobhanardakani i (2017).

From the foregoing results, it could be concluded that the heavy metals concentrations in milk products manufactured at Aswan vicinity are in permissible limit according to EOS, (1993).

**Estimated Daily Intake (EDI) of Metals and Their Respective Human Health Risks:**

The human health risk assessment is determined not only by pollutant concentrations in milk products, but also by milk consumption rates. So it is necessary to calculate health risk assessments according to the daily intake of metals.

**A- Estimated daily intake of heavy metals and trace elements in milk at different locations:**

The estimated daily intake (EDI) of metals depends on metal concentration, body weight of human and daily food consumption. The EDI of metals was determined by the following equation, as described by (Meshref et al., 2014).

$$EDI = \frac{C_{metal} \times w_{food}}{BW} \text{mg/kg b.w/day}$$

Where $C_{metal}$ (mg/kg, on fresh weight basis) is the concentration of heavy metals in contaminated foods, $w_{food}$ represents the daily average consumption of food and BW represents the body weight. The average daily consumption of milk per adult person (60 kg BW) was considered to be 200 mL.

The estimated daily intake of heavy metals and trace elements in milk at different locations is presented in Table (5). The results indicated that the permissible limit of max. 0.3 mg/kg according to EOS (1993).

### Table 5. Estimation of Daily Intake (EDI) of metals (mg/kg b.w/day) via consumption of milk by adult (BW=60 kg gm) at different locations:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Location</th>
<th>Edfu</th>
<th>Kom-Ombo</th>
<th>Toshka</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td></td>
<td>0.2</td>
<td>0.12</td>
<td>0.053</td>
</tr>
<tr>
<td>Pb</td>
<td></td>
<td>2.46</td>
<td>1.43</td>
<td>0.61</td>
</tr>
<tr>
<td>Cu</td>
<td></td>
<td>1.12</td>
<td>1.05</td>
<td>0.983</td>
</tr>
<tr>
<td>Zn</td>
<td></td>
<td>4.73</td>
<td>3.78</td>
<td>3.91</td>
</tr>
</tbody>
</table>

Assuming that a value of 200 (ml/day) of raw bovine milk consumption in Egypt. The estimated daily intake (EDI) of Cadmium, Lead, Copper and Zinc at different locations were determined and recorded in Table 5. The EDI of total metals is highest in Edfu cite, 8.51 and lowest in Tos hka, 5.556 mg/kg/day. The high EDI of heavy metals in Edfu coincide with the result of Table (1) which mentioned high total metals concentrations, compared with other locations. Zinc (Zn) is the highest EDI metal (4.73mg/kg/day) at Edfu, while the least EDI metal is Cd (0.053 µg/kg/day) at Toshka. The risks to health from certain elements in food can be assessed by comparing estimates of daily intake with the Provisional Tolerable Daily Intake (PTDI) as mentioned by (Tripathi et al., 1999). It is worth to mention that the Joint FAO/WHO Expert Committee on Food Additives [2012] withdrew the previous provisory tolerable weekly intake (PTWI) and considered it no longer health protective.

As the tolerable upper intake level of toxic heavy metals of Pb and Cd are 3.57 and 0.8-1.0 µg/kg/day, respectively (Tripathi et al., 1999). The calculated values of EDI of Cd and Pb at all locations are lower than the upper limits as it represented 20-25 % and 17.08 to 68.9 of tolerable upper intake, respectively. So, we concluded that milk consumption at these locations is safe concerning the concentration of Cd and Pb.

**B- Estimated daily intake of heavy metals in consequence of consumption of milk of different species and milk products:**

The EDI values of Cd, Pb, Cu and Zn for adult (60 kg body weight) via the consumption milk of different species (200 ml) and milk products (22 g cheese, Kareish, Domiati and Mish and 6 g samna) (FAO, 2009) are calculated and presented in Table 6. The Results indicated that the people consumed goat milk intake high amount of heavy metals compared with the consumption of milk of other species, as total metals estimated daily intake (TEDI) for cow milk is 5.76 E-03 compared with 8.30 E-03, 6.06 E-03 and 6.6 7 E-03 mg/kg/day for sheep, buffalo and goat milk, respectively.

By comparing the EDI of individual metals, the EDI of Cd is highest with the consumption of buffalo milk, the EDI of Pb and Zn are highest with sheep milk consumption while the consumption of goat milk gave highest EDI of Cu. These differences in the patterns of EDI for different metals with the consumption of milk of different species are due to of the differences in the concentration of these heavy metals in milk (Table 2).

Concerning the TEDI of milk products, the consumption of Kareish cheese is the highest followed by Domiati cheese, Mish and Samna. The TEDI of heavy metals for these products are: 1.53 E-03, 1.1 E-03, 5.24 E-04 and 9.11 E-05 mg/kg/day for Kareish cheese, Domiati cheese, Mish and a...
cheese and Samna, respectively. The least EDI of samna is due to the low retention level of fat for heavy metals during manufacturing process (El Sayed et al., 2011). By taken in to account the EDI of individual elements (Table 6), the res ults showed variations between EDI of the different metals according to following trend: Zn > Pb > Cu > Cd. This be havior of the EDI for different metals is the same in differ nt studies, as Yu et al., (2015); and Ghasfari and Sobhanard akani (2017) found the same order. Yu et al., (2015) found the EDI of Zn, Pb, Cu and Cd with the consumption of fer mented milk and sterilized milk are 2.11 E-03 and 1.65 E-0 3; 3.08 E-06 and 3.54 E-06; 3.54 E-05 and 2.5 E-05 and 1. 94 E-06 and 1.07 E-06 mg/kg/day, respectively.

Table 6. Estimated daily intake of milk and milk products: Ismail et al., (2017) and Ghasfari and Sobhanardakani (2017) found lower values of EDI for Pb and Cd (3.57 and 0.8 – 1.0 µg/kg/day, respectively) lower than the upper limits of tolerable daily intake level ors also contribute in the calculation for total daily intake of heavy metals. Though, it cannot be concluded that there was no risk for human health. It is seemly necessary to war n about the hazardous effects of these toxic elements on bo th child and adult.

The daily intake of trace elements of Zn and Cu (mg /day) was compared with the recommended dietary allowances (RDAs) values expressed for females and males establish ed by Institute of Medicine [2001], with the assumption that the average adult woman and the average adult man consume the same diet. The results shown in Table (7) indicated th at daily intake (mg/day) for Zn in the milk and dairy product s ranged from 0.0038 to 0.284 mg/day, The results showed t hat EDI values of Zn contributed from 0.0345 to 2.582 and 0 .0475 to 3.55% of RDA for zinc for males and females, respec tively. These results are very low compared with Meshref e et al., 2014 who found that EDI of Zn contributed to 0.33–11. 44 and 0.45–15.73 % of the RDA values of 11 mg/day for a dult males and 8 mg/day for adult females respectively. The low EDI of Zn in Dairy products may be attributed to the fac t that only 1–3 % of Zn in milk is related to the lipid fraction, while the remaining part (97 % of Zn is bound to casein frac tion) can be found in the skim milk fraction and consequentl y shift mostly to the curd during dairying. On the other hand, the EDI of Cu in this study ranged between 0.0005 to 0.067 2 mg/kg/day, which contributed to 0.0555 to 7.466 % of RD A. In comparison with the results of Meshref et al., (2014), the EDI of Cu in this study is higher for most of studied sam ples except for buffalo and Samna samples, which contribute d 1.755 and 0.0555 % of RDA respectively. Therefore, Milk and dairy products are considered a very poor source of cop per; however, copper deficiency is uncommon except in con ditions with severe malnutrition.

Table 7. Trace metals daily intake (mg/day) through the consumption of milk and milk products in com parison to RDA, values

From the foregoing results, although the EDI values for Pb and Cd in milk and milk products of studied area are lower than the upper limits of tolerable daily intake level for Pb and Cd (3.57 and 0.8 – 1.0 µg/kg/day, respectively) Tripathi et al., (1999) but still they have the potential to res ult in serious problems as other dietary and non-dietary fact ors also contribute in the calculation for total daily intake of heavy metals. Though, it cannot be concluded that there was no risk for human health. It is seemly necessary to war n about the hazardous effects of these toxic elements on bo th child and adult.

The daily intake of trace elements of Zn and Cu (mg /day) was compared with the recommended dietary allowanc es (RDAs) values expressed for females and males establish ed by Institute of Medicine [2001], with the assumption that the average adult woman and the average adult man consum ed the same diet. The results shown in Table (7) indicated th at daily intake (mg/day) for Zn in the milk and dairy product s ranged from 0.0038 to 0.284 mg/day, The results showed t hat EDI values of Zn contributed from 0.0345 to 2.582 and 0 .0475 to 3.55% of RDA for Zinc for males and females, respec tively. These results are very low compared with Meshref e et al., 2014 who found that EDI of Zn contributed to 0.33–11. 44 and 0.45–15.73 % of the RDA values of 11 mg/day for a dult males and 8 mg/day for adult females respectively. The low EDI of Zn in Dairy products may be attributed to the fac t that only 1–3 % of Zn in milk is related to the lipid fraction, while the remaining part (97 % of Zn is bound to casein frac tion) can be found in the skim milk fraction and consequentl y shift mostly to the curd during dairying. On the other hand, the EDI of Cu in this study ranged between 0.0005 to 0.067 2 mg/kg/day, which contributed to 0.0555 to 7.466 % of RD A. In comparison with the results of Meshref et al., (2014), the EDI of Cu in this study is higher for most of studied sam ples except for buffalo and Samna samples, which contribute d 1.755 and 0.0555 % of RDA respectively. Therefore, Milk and dairy products are considered a very poor source of copper; however, copper deficiency is uncommon except in con ditions with severe malnutrition.

The THQ has been recognized as a useful parameter for evaluation of risks associated with the consumption of metal contaminated food (Zhuang, et al., 2009). The THQ for the local inhabitants through the consumption of contaminated milk and dairy products were assessed based on a ratio of determined dose of a pollutant to a reference oral dose (RDF d) for that substances and can be calculated according to the f ollowing question:

\[
\text{THQ} = \frac{\text{EDI}}{\text{RFD}}
\]
The RFD values of Cd, Pb, Cu and Zn are set to be 0.001, 0.0035, 0.04, and 0.3 mg/kg bw/day respectively (US EPA, 2008). The THQ <1 means that the exposed population is assumed to be safe. The THQ of all metals (Pb, Cd, Cu and Zn) via milk and dairy products consumption are shown in Table 8. The THQ of all metals (Cd, Pb, Cu, and Zn) via milk and dairy products consumption were less than one. These values suggesting that the inhabitants in Aswan governorate will not be exposed to a potential health risk from consumption of milk and dairy products.

Table 8. THQ for daily intake of metals through consumption of milk and dairy products.

<table>
<thead>
<tr>
<th>Milk and milk products</th>
<th>Cd</th>
<th>Pb</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFD</td>
<td>0.001</td>
<td>0.0035</td>
<td>0.04</td>
<td>0.3</td>
</tr>
<tr>
<td>Buffalo</td>
<td>0.2</td>
<td>0.686</td>
<td>0.0065</td>
<td>0.0106</td>
</tr>
<tr>
<td>Cow</td>
<td>0.12</td>
<td>0.400</td>
<td>0.011</td>
<td>0.0126</td>
</tr>
<tr>
<td>Goat</td>
<td>0.10</td>
<td>0.2428</td>
<td>0.028</td>
<td>0.0153</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.097</td>
<td>0.7017</td>
<td>0.0262</td>
<td>0.0156</td>
</tr>
<tr>
<td>Kareish</td>
<td>0.005</td>
<td>0.0178</td>
<td>0.0018</td>
<td>0.0046</td>
</tr>
<tr>
<td>Domiaty</td>
<td>0.008</td>
<td>0.0182</td>
<td>0.0019</td>
<td>0.0032</td>
</tr>
<tr>
<td>Mish</td>
<td>0.006</td>
<td>0.0181</td>
<td>0.0017</td>
<td>0.0013</td>
</tr>
<tr>
<td>Samna</td>
<td>0.002</td>
<td>0.0051</td>
<td>0.0002</td>
<td>0.0002</td>
</tr>
</tbody>
</table>

CONCLUSION

From the foregoing results, we conclude that the heavy metals concentrations in milk products manufactured at Aswan vicinity are in permissible limit according to EOS (1993). The THQ of all metals (Cd, Pb, Cu and Zn) via milk and dairy products consumption were less than one. These values suggesting that the inhabitants in Aswan governorate will not be exposed to a potential health risk from consumption of milk and dairy products, but still they have the potential to result in serious problems as other dietary and non-dietary factors also contribute in the calculation for total daily intake of heavy metals. Though, it cannot be concluded that there was no risk for human health. It is seemly necessary to warn about the hazardous effects of these toxic elements on both child and adult.

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Khalil, O. S. F.


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