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RESEARCH ARTICLE

Uptake of Heavy Metal Residues from Sewerage Sludge in the Milk of Goat and Cattle during Summer Season

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ABSTRACT

Uptake of different heavy metal residues including cadmium (Cd), chromium (Cr), nickel (Ni), led (Pb), arsenic (As), and mercury (Hg) were determined in goat and cattle milk collected from two areas, each consisted of three sites. Area 1 was selected in the North-East and Area 2 in the North-West of Faisalabad city along the main sewerage drains. Levels of Cd, Cr, Ni, Pb, As and Hg in the milk of goat and cattle were higher than the most reported values in the literature. The levels of heavy metal residues in the milk of cattle from Area 1 were higher than those present in cattle milk from Area 2. However, in case of goat milk the residual values from Area 1 and Area 2 were non-significantly different. It was concluded that the levels of Cd, Cr, Ni, Pb, As and Hg in the milk of goat and cattle were higher than reported values in the literature.

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INTRODUCTION

Heavy metals are the elements having density more than 5g/cm^3, atomic weight 63.546 to 200.590 (Kennish, 1992) and a specific gravity greater than 4.0 (Connell and Miller, 1984). Although heavy metals by and large remain in ground water and soil but in certain areas their level increase and they tend to accumulate to toxic levels in human and animal tissues deriving food from water and soils. Living organisms normally require some of these heavy metals up to certain limits and in case excess accumulation occurs it will lead to severe detrimental effects (Kennish, 1992; Chitmanat and Traichaiyaporn, 2010).

Foodstuffs grown on contaminated soil or irrigated with impure water accumulate metal contents and are a big source of heavy metals exposure to the animals and humans (Ward and Savage, 1994). Along with these factors many occupations involve direct contact of workers to the heavy metals like dental surgeons, painters and welders etc. (Olah and Tolgyessy, 1985; Mohammad *et al.*, 2008). Food animals reared on contaminated fodder become continuous source of heavy metal residues in edible tissues and milk. Heavy metal contamination in meat and other edible tissues is a matter of great concern for food safety and human health (Chitmanat C and S Traichaiyaporn, 2010). These metals are toxic in nature and even at relatively low concentrations can cause adverse effects (Mahaffey, 1977; Santhi *et al.*, 2008).

The preceding lines reflect the sensitivity of threat being posed to general public health. This problem needs an immediate attention of health regulatory authorities and the researchers as well. In this study we have determined the residues of heavy metals in milk of cows and goats from two areas in close proximity to sewerage drains in Faisalabad city.

MATERIALS AND METHODS

Milk samples were collected from two areas along the main sewerage drainage of Faisalabad city. Area 1 was selected in the North-East and Area 2 in the North-West of Faisalabad city. For the collection of milk samples, 15 animals were randomly selected from each of three sites in Area 1 (Chak Nos. 78, 235 and 236 R.B) and similarly the same number of animals were selected from other three sites in Area 2 (Chak Nos. 217-219 R.B). These three sites in each area were separated with a distance of almost five kilometer between each site.

Milk samples were collected from each site of both areas during a study period of five months. Every month 15 milk samples, each from goat and cattle, were collected from one site. In this way, during the months from April to August (summer season), a total of 180 x 5 milk samples of goat and cattle were collected. Each sample

was collected in a 25ml clean sterilized plastic bottle. Prior to collection, the udder was washed with water to avoid contamination. The samples were kept frozen at -4°C until analysis. Collected milk samples were subjected to wet digestion (Richards, 1968).

Heavy metal (Cd, Cr, Ni, Pb, As and Hg,) residues in milk were determined by an atomic absorption spectrophotometric method (Licata *et al.*, 2004). The concentration of samples was calculated as mean±SE and the data was subjected to statistical analysis using Student's t test (Steel *et al.*, 1997). The level of significance was P≤0.05.

RESULTS

In cattle milk (Table 1), the residual concentrations of Cd, Cr, Ni, Pb and Hg during summer season in Area 1 were significantly (P≤0.05) higher than their corresponding values in Area 2. The residual level of As was significantly higher (P≤0.05) in Area 2 than its respective value in Area 1 during summer season. However, comparative values of these metals in the milk of goat collected from Area 1 and Area 2 were non-significantly different from each other.

The interspecies difference in the residual concentration of heavy metals in the milk of goat and cattle collected from Area 1 and Area 2 has been presented in Table 2. Results showed significantly (P≤0.05) higher values of Cr, Pb, As and Hg in the milk of goat than the corresponding values obtained in the milk of cattle. However, mean value of Ni in cattle milk was found to be significantly (P≤0.05) higher than the value in goat milk during summer season (Table 2).

Table 1: Comparative values (mean±SE) of Cd, Cr, Ni, Pb, As and Hg (mg/L) in the milk of cattle collected from Area 1 and Area 2 during summer season.

Residues	Area 1	Area 2
Cd	0.171±0.006*	0.122±0.002
Cr	1.265±0.021*	1.134±0.014
Ni	23.522±0.329*	21.266±0.493
Pb	23.240±0.302*	16.704±0.516
As	0.034±0.002*	0.122±0.015
Hg	0.548±0.013*	0.432±0.011

*Significantly (P≤0.05) different from their respective values in a row.

DISCUSSION

Lactating animals exposed to high concentrations of toxic metals such as Cd, Cr, Ni, Pb, As and Hg, accumulate these metals in their milk which becomes a health hazardous to consumers (Jeng *et al.*, 1993). Present study indicated that higher levels (P<0.05) of heavy metal residues were found in cattle milk collected from Area 1, when compared with those in milk from Area 2, during summer season (Table 1). Higher levels of heavy metal residues may be accredited to the use of sewerage water for agricultural purposes from where these metal residues gathered in soil, vegetables and fodder produced in the selected areas. Animals reared on such fodder build up residual levels in their secretions such as milk. Moreover, animals of such localities have to drink sewerage water because there is no alternate source available for them (Javed *et al*., 2009). The present data strongly suggested that soil contamination with heavy metal residues and the use of sewerage water for drinking purpose ultimately affects the animals, which in the end reflected in human as they are the end users of these by products.

Table 2: Interspecies comparative values (mean ± SE) of Cd, Cr, Ni, Pb, As and Hg (mg/L) in the milk of goat and cattle collected from Area1 and Area 2 during summer season.

Residues	Goat	Cattle
Cd	0.145 ± 0.002	0.147 ± 0.003
Cr	1.277 ± 0.011*	1.199 ± 0.013
Ni	20.402 ± 0.248*	22.394 ± 0.301
Pb	43.414 ± 0.506*	19.972 ± 0.336
As	0.403 ± 0.011*	0.078 ± 0.008
Hg	1.226 ± 0.009*	0.490 ± 0.009

*Significantly (P≤0.05) different from their respective values in a row.

During present investigation the range of most values of heavy metal residues; Cd 0.083 to 0.145, Cr 0.983 to 1.277, Ni 20.402 to 20.421, Pb 41.762 to 43.414, As 0.381 to 0.403, Hg 1.205 to 1.226 and in cow milk; Cd 0.078 to 0.147, Cr 1.072 to 1.199, Ni 22.287 to 22.394, Pb 18.623 to 19.972, As 0.076 to 0.078, Hg 0.482 to 0.490 have been found higher than the most reported values in literature. The permissible values of the heavy metal residues in cattle and goat milk are scanty in literature. However, permissible values for Pb, 0.02mg/L (Licata *et al.*, 2004) in cattle milk is available which is far low than the value 19.972mg/L observed in present investigation. However, the permissible values of Pb and Cd have been reported in food stuff as 2.5 and 1.5 mg/kg, respectively (Wahab *et al.*, 2006). In present study high levels of heavy metal residues in milk of cattle and goat must be regarded as a potential health hazard in animals and human beings and must draw the attention of food regulatory bodies to adopt such measures that could bring the heavy metal residues in food chain up to permissible values not injurious for human health.

Interspecies differences in the residual concentration of heavy metals in the milk of goat and cattle during summer season were also investigated in the present study (Table 2). During, summer season the goat milk shows higher values of Cr, Pb, As and Hg and lower value of Ni than their corresponding values in the milk of cattle. The higher values of Cr, Pb, As and Hg in the milk of goat during summer season might be attributed to the peculiar behavior of goat for nibbling the emerging shoots, leaves, nodes and the tender parts of the plants where the levels of these heavy metal residues have been reported to be increased during summer season due to water evaporation from these parts of plants leaving behind relatively higher concentrations. In this respect Cr deposits have been found in much higher concentrations in these plant parts during summer (Hussain, 2000). Moreover, during grazing the goats are having more chances and access to the banks of main sewerage drains where possibly more heavy metals contaminated soil is available making the herbage richer in heavy metals (Ghafoor and Rasool, 1999). In present findings the higher concentration of Ni in the milk of cattle than that in goat may be due to more uptake of Ni in the forage from the more rich contaminated soil with this particular heavy metal.

Moreover, the higher Ni residues in milk of cattle may also be due to industrial effluents rich in Ni which is drained into sewerage water that ultimately increases the Ni uptake to the fodder from the soil.

Conclusions

On the basis of results it is concluded that the levels of Cd, Cr, Ni, Pb, As and Hg in the milk of goat and cattle were higher than the most reported values in the literature. The levels of heavy metal residues in the milk of cattle from Area 1 in North East were had higher than those present in cattle milk from Area 2 in North-West along the main sewerage drains of Faisalabad city. However, in case of goat milk the residual values from Area 1 and Area 2 were non-significantly different. Species variation was depicted in cattle and goat as the residual levels of Cd, Pb, As and Hg were higher in goat milk, while Ni and Cr residues were higher in cattle milk.

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