Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Garbage waste induced heavy metals on roaming cattle

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Abstract

Emerging evidence has shown that municipal garbage waste contains higher amount of heavy metals and increases health and environmental hazards. Little is known, however, about such wastes use as animal food to fate in products level, in dairy cattle roaming freely. To address these, garbage waste as cattle feed, feces and milk samples from roaming dairy cattle were collected from four areas and simultaneously assess heavy metals concentrations. The study areas were Aqua Morolbari (AM; used as control area), Kachijuli Bazar (KB), Machua Bazar (MB), and Mymensingh Medical College (MMC). Emerging evidence has shown that municipal garbage waste contains higher amount of heavy metals and increases health and environmental hazards. Although faeces and milk samples expressed similar trends, feces samples was solely maintained higher chromium concentrations than to garbage waste and milk samples. A significant changes of zinc (Zn) concentrations was observed in collected garbage waste of MB and MMC than to AM and KB. Milk samples showed similar results. In contrast, an increased zinc concentration was found in areas of KB, MB and MMC feces samples as compared to AM. Compared to Aqua Morolbari area, Machua Bazar and Mymensingh Medical College area's garbage contained significant amount of lead (Pb) levels. There was an increase amount of lead presence in feces and milk samples compared to the control zone. A significant amount of cadmium (Cd) was found in KB, MB and MMC compared to AM. Feces samples were responded similarly. In contrast, both MB and MMC showed a higher concentration of cadmium in milk samples than rest of the two sites. From the results, it was clearly revealed that roaming cattle were daily consumed garbage wastes which possessed heavy metals such as Cr, Zn, Pb, and Cd, to a major extent, resulting in introduction of trace elements in the human food chain.

Key words: heavy metals, garbage waste, milk, feces, roaming dairy cattle, urban areas

 Bang. J. Anim. Sci. 2017. 46 (1): 24-28

Introduction

Bangladesh is an agricultural country where more than 60% of the people live in rural areas whose sole income is agriculture. The poverty rate and malnutrition is the main triggering issues for the rural people in Bangladesh. For that reason, in every year, a significant number of people move from rural to urban areas for their better livelihood. It is expected that by the year 2025, about half of the rural populations will be living in urban centers and thus poverty will have increasingly moved from rural to urban areas in Bangladesh. Indeed, with the declining purchasing power in the urban areas, many urban households have responded with diversification of income sources, the most notable one being urban animal agriculture (Greenhow, 1994). Animal agriculture in Bangladesh mainly based on cattle, goat, sheep, and buffaloes and they represents about 28%, 67%, 3% and 2%, respectively (FAO, 2013). About 2% of the total livestock are available in urban and peri-urban areas of Bangladesh (Alam *et al.,* 2016). Interestingly, urban livestock production system is operating unplanned and densely populated neighborhoods which has negative impact on public health and also introduces environmental pollutions (Smit et al., 2001). Our groups (Alam et al., 2016) have recently found that local political leader is kept the highest number of animals in municipal areas

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whereas self-employer or trader takes the second position. Dairy cattle share a lion number (67%) over other species. More than 75% livestock holders keep their animals over 3 years and only 6% keepers sell their animals within 6 months. Most of the livestock keepers (56%) use their calf as replacement stock. The majority (66%) of the livestock depends on grazing and scavenging for feed from government and municipal lands, unfenced open land, roadsides, rubbish dumps. Most of the livestock owner (66%) does not supplement to their animals with feeds other than free scavenging throughout the rearing time. More than 50% of the respondents choose dung and urine disposal, malodor and blocked roads are the major damages caused by livestock. It is also shown that most of the roaming cattle in municipal areas eat mixed form of wastes such as food and kitchen leftover, green waste, papers, paints, chemicals, fertilizer, pesticides, herbicides, tannery wastes and medical wastes (Alam *et al.,* 2016). Smith (2009) has reported that all types of municipal waste contain heavy metals and roaming cattle in urban areas are usually taken those wastes (Alam et al., 2016). Therefore, no doubt such composite form of wastes may contain a significant amount of heavy metals such as zinc, copper, nickel, lead, cadmium, chromium and mercury. No systematic work has yet been carried out to characterize such diversified production systems in view of environmental hazard. Such information is important in assessing food safety and also to reform the policy. Therefore, the present research is designed to quantify heavy metals content in urban feed wastes, feces and milk of dairy cattle.

Materials and methods

Selection of study site

Mymensingh Medical College area (MMC), Machua Bazar area (MB), Kachijuli Bazar area (KB) and Aqua Morolbari area under Mymensingh Municipal Corporation were selected to conduct the research. Aqua Morolbari was used as control area of this study. The study areas were chosen on the basis of having a higher concentration of roaming cattle in Mymensingh Municipal Corporation.

Selection of dairy cattle owner

Ward councilor or local community police gave necessary informations regarding dairy herd owner in those selected municipal areas. The study time was July-August 2016. The cattle keepers were selected who rear dairy cattle and able to give information when necessary.

Sample collection

Garbage wastes were collected from marked two dustbins or scattered wastes from each site and then packed for laboratory analysis. Four dairy cattle were chosen from each study site and collar marked for identification. A representative amount of feces and 1 kg of milk were collected from each cow. During feces and milk collection, a close monitoring and observation was continued during study time so that accurate sample of milk and feces were being collected from those animals which usually used the marked wastes collection zone.

Quantification of heavy metals

Collected samples such as garbage waste, feces and milk were prepared according to standard protocol of heavy metals quantifications. Samples were analyzed at laboratory of soil science division under Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. Brielfly, in a 150 beaker, 10 ml of 1:1 HNO_3 to 2 g of air-dried polluted garbage waste (<1mm) was added. The beaker was placed on a hot plate, covered with a watch glass and heated (reflux) at 95 ^{0}C for 15 minutes. The digest was cool down and again added 5 ml of conc. HNO_3 and heated for an additional 30 minutes at 95 ^{0}C. The last step was repeated thus reduced the solution to about 5 ml without boiling (by only partially covering the beaker). Furthermore, the sample was cooled and added 2 ml of deionized water and 3 ml of 30% H_2O_2. With the beaker covered, the sample was headed gently to start the peroxide reaction. Addition of 30% H_2O_2 was continued in 1 ml increments, followed by gentle heating until the effervescence subside. Then 5 ml of 1N. HCl and 10 ml of deionized water was added and heated the sample for an additional 15 minutes without boiling. The sample was cool down again and did filter through a Whitman No. 42 filter paper. The sample was diluted to 50 ml with deionized water and analyzed for Cr, Cd, Pb, Ni and Zn by atomic absorption spectrophotometer (AAS). The above protocols were followed in case of feces and milk for the determination of heavy metals concentrations.

Statistical analyses

Data were analyzed using the statistical analysis system (SAS, 1985). Data were first analyzed by a general linear model analysis using variance procedure and the means were compared using Duncan's least significance multiple-range test. All data were expressed, in the form of mean ±standard error. Differences were considered significant for values of $p<0.05$.

Results and Discussion

Table 1 shows the results of chromium concentrations in garbage waste, feces and milk of cattle roaming freely on Mymensingh Municipal streets. Garbage waste of KB, MB and MMC showed a significant increase in chromium (Cr) concentrations as compared to AM.

Table 1. Concentrations ($mg.kg^{-1}$ or $mg.L^{-1}$) of chromium in garbage waste, feces and milk from urban cattle

Location	Garbage waste	Feces	Milk
AM	5.44 ± 0.038^{d}	8.76 ± 0.11^{d}	1.19 ± 0.01^{d}
KB	16.71 ± 1.60^{c}	36.87 ± 1.46^{c}	9.51 ± 2.18^{c}
MB	24.02 ± 1.77^{b}	45.80 ± 2.44^{b}	14.79 ± 2.39^{b}
MMC	44.74 ± 1.84^{a}	64.06 ± 1.96^{a}	18.49 ± 1.79^{a}

$^{a-d}$ means (±SE) within a row showing different superscripts are significantly different ($p<0.05$). Duncan's least significant multiple-range test was applied to compare means. AM (Aqua Morolbari), KB (Kachijuli Bazar), MB (Machua Bazar), MMC (Mymensingh Medical College).

Although feces and milk samples expressed similar trends, a higher chromium concentration was maintained by feces samples than to garbage waste and milk samples. These results suggest that the dairy cow acts like a very good filter for air-born heavy metals. It appears conclusive that a homeostatic mechanism regulates the transfer of most of the heavy metals into milk, at least for the range of concentrations studied.

Table 2. Concentrations ($mg.kg^{-1}$ or $mg.L^{-1}$) of zinc in garbage waste, feces and milk from urban cattle

Location	Garbage waste	Feces	Milk
AM	1.25 ± 0.05^{c}	1.83 ± 0.07^{d}	0.69 ± 0.06^{c}
KB	2.89 ± 0.88^{bc}	8.09 ± 0.59^{c}	2.10 ± 1.45^{c}
MB	6.47 ± 1.72^{b}	13.20 ± 1.07^{b}	3.35 ± 2.43^{b}
MMC	17.02 ± 2.30^{a}	33.16 ± 2.25^{a}	9.03 ± 2.41^{a}

$^{a-d}$ means (±SE) within a row showing different superscripts are significantly different ($p<0.05$). Duncan's least significant multiple-range test was applied to compare means. AM (Aqua Morolbari), KB (Kachijuli Bazar), MB (Machua Bazar), MMC (Mymensingh Medical College).

Table 2 shows the results of zinc concentrations in garbage waste, feces and milk of urban cattle. A significant changes of zinc concentrations was observed in collected garbage waste of MB and MMC than to AM and KB. Milk samples showed similar results. In contrast, there was a sharp increase of zinc levels were found in KB, MB and MMC feces samples as compared to AM. Ogundiran et al., (2012) found a higher amount of zinc in feed, feces and milk sample of cows reared in contaminated sites. Both results suggested that there had a higher chance of zinc accumulation in feed to animal products.

Table 3. Concentrations ($mg.kg^{-1}$ or $mg.L^{-1}$) of lead in garbage waste, feces and milk from urban cattle

Location	Garbage waste	Feces	Milk
AM	2.52 ± 0.23^{c}	4.54 ± 0.06^{d}	0.74 ± 0.06^{d}
KB	6.04 ± 1.70^{bc}	11.39 ± 1.42^{c}	2.52 ± 0.30^{c}
MB	8.24 ± 1.19^{ab}	21.54 ± 1.79^{b}	3.92 ± 1.15^{b}
MMC	20.41 ± 4.08^{a}	32.66 ± 1.72^{a}	6.64 ± 1.99^{a}

$^{a-d}$ means (±SE) within a row showing different superscripts are significantly different ($p<0.05$). Duncan's least significant multiple-range test was applied to compare means. AM (Aqua Morolbari), KB (Kachijuli Bazar), MB (Machua Bazar), MMC (Mymensingh Medical College).

Table 3 shows the results of lead concentrations in garbage waste, feces and milk of cattle roaming freely on Mymensingh Municipal streets. Compared to AM area, MB and MMC area's garbage contained significant amount of lead levels. Although AM, KB and MB areas garbage showed statistically no significant changes in lead concentrations, MMC had higher levels of lead as compared to the counterparts. There were increased amount of lead presence in feces and milk samples compared to the control zone. Interestingly, MMC area was more prone to lead affect. A significant amount of lead was available in any form of feed samples analyzed from contaminated sites (Christos et al., 2012; Ogundiran et al., 2012).

Table 4. Concentrations (mg.kg^{-1} or mg.L^{-1}) of cadmium in garbage waste, feces and milk from urban cattle

Location	Garbage waste	Feces	Milk
AM	0.68 ± 0.51^{c}	1.21 ± 0.09^{c}	0.17 ± 0.03^{b}
KB	3.78 ± 1.44^{b}	9.11 ± 1.13^{b}	1.42 ± 1.47^{b}
MB	9.40 ± 1.72^{ab}	16.43 ± 1.42^{ab}	2.11 ± 2.35^{a}
MMC	17.45 ± 2.28^{a}	23.35 ± 4.22^{a}	3.82 ± 4.09^{a}

$^{a-c}$ means (±SE) within a row showing different superscripts are significantly different ($p<0.05$). Duncan's least significant multiple-range test was applied to compare means. AM (Aqua Morolbari), KB (Kachijuli Bazar), MB (Machua Bazar), MMC (Mymensingh Medical College).

Table 4 shows the results of cadmium concentrations in garbage waste, feces and milk of cattle roaming freely on Mymensingh Municipal streets. A significant amount of cadmium was found in KB, MB and MMC compared to AM. Feces samples were responded similarly. In contrast, both MB and MMC showed a higher concentration of cadmium in milk samples than rest of the two sites. Lane et al. (2015) suggested that ruminant feed in municipal areas could contain higher amount of cadmium which agrees to the present findings. Moreover, Ogundrian et al. (2012) reported that cows milk and feces of contaminated sites had higher levels of cadmium than the controlled animals.

Conclusion

It was concluded that garbage waste, feces and milk content heavy metals to a major extent. Heavy metals in milk came from that contaminated garbage waste. More pronounced levels of heavy metals were found in Mymensingh Medical College (MMC) area in terms of all assessed heavy metals.

Acknowledgement

The research work was financially supported by Bangladesh Agricultural University Research System (No. 2015/51/AU-GC)

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