academicJournals

Vol. 5(10), pp. 265-268, November, 2013
DOI: 10.5897/JECE2013.0297
ISSN 2141-226X ©2013 Academic Journals
http://www.academicjournals.org/JECE

Journal of Environmental Chemistry and Ecotoxicology

Full Length Research Paper

Is roadside grass suitable for use as livestock forage in Botswana?

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Accepted 6 November, 2013

The aim of this research was to assess the suitability of roadside grass for use as livestock feed to combat lack of forage resources in Botswana. Fifty grass samples were collected along the roadside in the A1 Highway corridor running between the Ramatlabama and Ramokgwebana border gates (629 Km), and analysed for Ni, Cu, Pb, Zn and Cd. The maximum content levels detected in grass samples for Ni, Cu, Pb, Zn and Cd were 0.432, 0.187, 0.180, 0.154 and 0.03 mg/kg respectively. Assessment of the results against international maximum allowable limits of undesirable substances in animal feed showed that the content levels of heavy metal contaminants in grass resources found along the roadsides in the A1 Highway corridor in Botswana were far below maximum allowable limits. Therefore, this study supported the use of roadside grass for production of forage to combat scarcity of livestock feed in the country. However, the study recommended the establishment of an environmental management and monitoring approach to facilitate continued monitoring of the quality of forage produced from roadside grass and ensure protection of human and animal health.

Key words: Roadside grass, forage quality, livestock, heavy metals.

INTRODUCTION

Roadside soils serve as sinks for heavy metal pollutants from vehicular emissions (Jaradat and Momani, 1999; Viard et al., 2004; Yahaya et al., 2010). Heavy metal pollutants deposited on roadside soils affect the flora and fauna inhabiting roadside areas (Garcia and Millan, 1998; Sures et al., 2003; Ateyese et al., 2008). At low concentrations, some heavy metals are described as trace elements and are essential for maintenance of all forms of life (Ayodele and Oluyomi, 2011). However, research indicated that excessive concentrations of heavy metals in animal and plant systems often cause fatal metabolic disturbances (Delbari and Kulkarni, 2011). Some heavy metals are not only toxic at high concentrations, but also non-biodegradable and persist in the environment (Okunola et al., 2007).

Contamination of food chain is a pathway for the entry of heavy metal pollutants into the human body (Ateyese et al., 2008; Delbari and Kulkarni, 2011). Heavy metals have potentials to undergo processes of geo-accumulation, bio-accumulation and bio-magnification (Pratt and Lottermoser, 2007; Delbari and Kulkarni, 2011) which may lead to the ingestion of excessive amounts of heavy metals by humans and animals. Consequently, contamination of food chain by heavy metals has recently attracted the attention of many researchers (Ateyese et al., 2008; Delbari and Kulkarni, 2011; Ayodele and Oluyomi, 2011).

Unreliable rainfall and frequent droughts have compelled many farmers in Botswana to use roadside grass as feed for livestock without regard for its potential health risks. Some farmers around the country gather grass at relatively smaller scale using hand-held equipment and small vehicles. At the time of this research, such farmers did not need to obtain permission

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Figure 1. Photographs of farmers harvesting, packaging and transporting forage produced from roadside grass along the A1 highway corridor.

from the government to harvest roadside grass for livestock feed. However, few farmers had started commercializing the practice of roadside grass harvesting by using sophisticated and efficient methods and equipment (Figure 1) for large scale harvesting, packaging and transport of roadside grass for use as livestock feed. Individuals undertaking commercial harvesting of roadside grass require written conditional permission from the government. However, no research work on the suitability of roadside grass for use as livestock feed has been conducted in Botswana. Therefore, the aim of this research was to investigate the suitability of roadsides grass for use as livestock feed to combat lack of forage resources in Botswana.

MATERIALS AND METHODS

The A1 Highway (Figure 2) running between the Ramatlabama and Ramokgwebana border gates (629 Km) was used for this study. This is the busiest highway where harvesting of roadside grass is prevalent in Botswana. Fences have been constructed on both side of the highway to prevent movement of stray livestock into the road. The standard distance of such fences from the centre line of a highway is 31.5 m and may vary depending on the activities occurring at different points within the highway surroundings. The fences form a corridor in which livestock grazing is prohibited. Consequently, grasses normally grow in abundance within the corridor.

Fifty grass samples were collected along the roadsides in the A1 highway corridor during the months of March and April in 2013. It was observed during sampling that the fences were located about 3 m from the edge of the road at some sampling points. Therefore, sample collection was conducted at 3 m away from the road on both sides at each sampling point and the samples were pooled to make composite samples. The sampling points were separated by a distance of 25 km except where sampling points coincided with the location of settlement areas.

Grass samples were dried in an oven at 80°C for 24 h and pulverised using Fritsch pulverisette 5 machines. The pulverisette cups were cleaned with deionised water after processing each sample and the glassware used for analysis was also cleaned and soaked overnight in 6 N HNO_3 to avoid sample contamination. The glassware was then rinsed with deionised water before use. A mixture of 8 ml concentrated HNO_3 and 2 ml H_2O_4 was used to digest 0.500 g of each grass sample in a closed vessel microwave system (Milestone Ethos EZ, equipped with a Mutliprep-41 Rotor). Standard reference plant material (Oriental Tobacco leaves CTA-OTL1) from Institute of Nuclear Chemistry and Technology in Poland was included in the analysis for quality control purposes. The Atomic Absorption Spectrometer (AAS - Varian 220 FS) was used to determine the concentration of Pb, Zn, Cu, Ni and Cd. In addition to analysing a reslope standard after running a series of ten samples, duplicate analysis of samples was conducted and the AAS was configured to read the samples in triplicates to further ensure quality control.

RESULTS AND DISCUSSION

The average concentrations of heavy metals in the roadside grass are presented in Table 1. The results showed that out of the grass samples analysed, Cd, Pb and Zn content levels were below the detection limit of the AAS in 77, 62 and 27 % of the samples respectively. The maximum content levels detected in the grass samples for Ni, Cu, Pb, Zn and Cd were correspondingly 0.432, 0.187, 0.180, 0.154 and 0.030 mg/kg. Legal provisions on the maximum allowable limits in animal

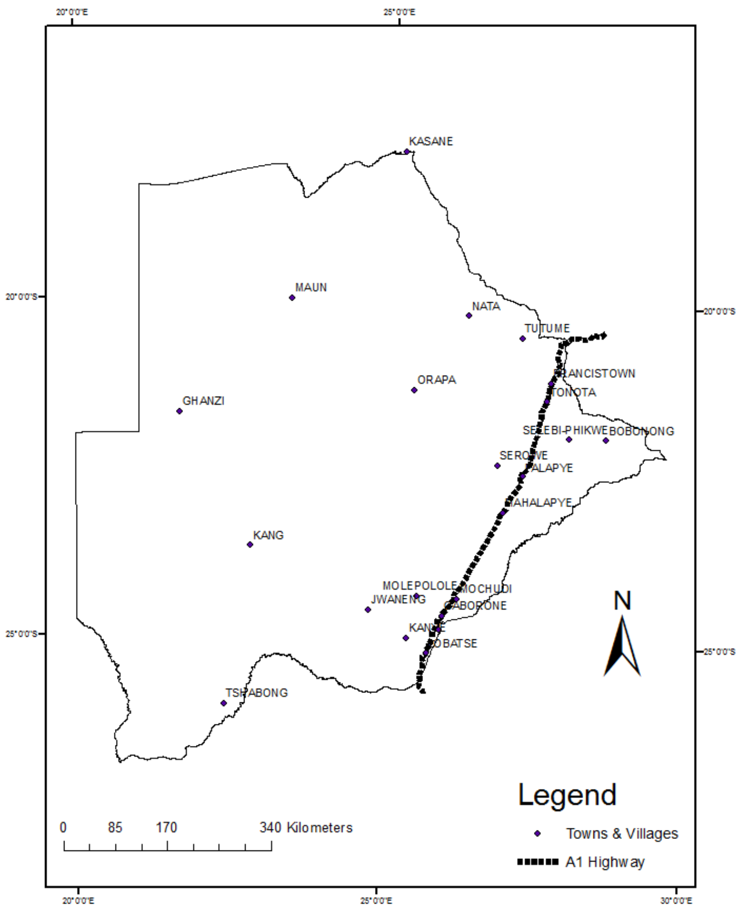

Figure 2. The map of the study site showing the A1 highway.

Table 1. Total mean concentrations of heavy metal in the roadside grass.

Metal	Mean Content ± SD (mg/g)
Pb	0.102 ± 0.047
Zn	0.058 ± 0.003
Cu	0.097 ± 0.002
Ni	0.299 ± 0.096
Cd	0.014 ± 0.001

do not pose any danger to human health, animal health or adversely affect productivity in the livestock industry are widely documented.

According to the European Union (EU) Directive (2002/32/EC and 2005/87/EC) on undesirable substances feed which were established to ensure that animal feed in animal feed, the maximum allowable amounts of Pb and Cd in fodder are 30 mg/kg and 1 mg/kg respectively. The EU regulations (1831/2003) state the maximum allowable limit of Cu in animal feed as 35 mg/kg. The maximum tolerable Zn content is 300 mg/kg for sheep and 500 mg/kg for cattle (National Research Council, 2005). Church (1971) indicated that the maximum permissible content of Ni in cattle feed is 100 mg/kg, while Gillespie (1987) mentioned that the tolerable content of Ni in cattle feed is 50 mg/kg.

Assessment of the results of the study against the aforementioned international maximum allowable limits of undesirable substances in animal feed showed that heavy metal content levels in grass growing along the roadsides in the A1 highway corridor in Botswana were far below maximum allowable limits. This suggested that the grass growing along the roadsides in the A1 highway corridor in Botswana had experienced insignificant vehicular deposition of heavy metal contaminants at the time of this research work. However, similar studies conducted elsewhere (Cherney et al., 1990; Atayese et al., 2008; Ayodele and Oluyomi, 2011) showed that roadside vegetation is susceptible to heavy metal contamination associated with heavy traffic along major highways.

The population of Botswana (2 024 904) is low relative to the population of other nations in Africa (Statistics Botswana, 2013) and the total surface area of land in the country. Low levels of heavy metal contaminants in roadside grass were possibly linked to low numbers of vehicles relative to the general land surface area of the country. On the basis of the insignificant heavy metal content levels detected in the roadside grass growing along the A1 highway corridor, this study supported exploitation of the grass resources for production of forage to offset the impacts of shortage of forage resources in Botswana.

Statistics Botswana (2011) indicated that between the year 2002 to 2011, the number of licensed vehicles in Botswana increased by 125.5% from 162, 807 to 367, 155. The statistics also showed that from the year 2010 to 2011, the national vehicle stock increased by 6.5% from 344, 719 to 367, 155 (Statistics Botswana, 2011). In view of the statistical trends showing high rate of increase in the national vehicle stock, growth of vehicular movement along the A1 highway over time was considered inevitable. Therefore, this study advocated for the establishment and implementation of environmental monitoring and management approach to facilitate continued monitoring of the quality of forage produced from roadside grass and avoid the risks that contaminated forage may pose to human and animal health.

Conclusion

This study concluded that grasses growing along the roadsides in the A1 highway corridor stretching between the Ramatlabama and Ramokgwebana border gates was not contaminated with heavy metals and that it was thus suitable for use in the production of forage material to address shortage of forage resources in Botswana. The authors moreso, recommend continued management and monitoring of grass quality to ensure that forage material produced from roadside grass harvested along the roadsides in the A1 highway corridor does not exceed the maximum allowable limits of heavy metal content in animal feed.

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