Journal of Equine Veterinary Science 45 (2016) 98–106

Contents lists available at ScienceDirect

Journal of Equine Veterinary Science

journal homepage: www.j-evs.com

Review Article

Environmental Implications of Nitrogen Output on Horse Operations: A Review

Rebecca C. Bott [a,*], Elizabeth A. Greene [b], Nathalie L. Trottier [c], Carey A. Williams [d], Michael L. Westendorf [d], Ann M. Swinker [e], Sara L. Mastellar [a], Krishona L. Martinson [f]

[a] Department of Animal Science, South Dakota State University, Brookings, SD
[b] School of Animal and Comparative Biomedical Sciences, University of Arizona, Tucson, AZ
[c] Department of Animal Science, Michigan State University, East Lansing, MI
[d] Department of Animal Sciences, Rutgers, The State University of New Jersey, New Brunswick, NJ
[e] Department of Animal Science, Pennsylvania State University, University Park, State College, PA
[f] Department of Animal Science, University of Minnesota, St. Paul, MN

ARTICLE INFO

Article history:
Received 26 June 2015
Received in revised form 20 August 2015
Accepted 26 August 2015
Available online 31 August 2015

Keywords:
Horse
Protein
Nitrogen
Lysine
Digestibility
Environment

ABSTRACT

Nutrients such as nitrogen (N), which go unused during the digestive process, are then excreted into the environment via urine, gas, or fecal matter. Excess N released in this manner may contribute to a reduction of the quality of air and groundwater sources. Many states have introduced or developed legislation mandating nutrient management plans on livestock operations to reduce environmental N losses. Strategies for reducing the environmental impacts of N on equine operations are twofold, including a reduction in N inputs and better management of N outputs. The practice of precision feeding, or feeding to accurately meet, but not exceed the nutrients requirements of an animal is a plausible method for reducing N inputs. This approach is not widely implemented, as feeding protein in excess of requirements is a common practice in the equine industry. Also, precision feeding is predicated on a body of data containing the nutrient availability and digestibility in different feed sources; data which are not fully elucidated in the horse. Management of N outputs on equine operations is largely based on data extrapolated from other livestock operations as well as a few preliminary efforts on horse farms. The potential impact of equine operations on N losses is explored in this review, shedding light on areas where further research and management strategies are needed.

Published by Elsevier Inc.

1. Introduction

Feeding practices with the goal of precisely meeting the dietary requirement of the first limiting amino acids (AA) have been implemented in many livestock systems to optimize performance and, recently, to minimize nitrogen (N) excretion into the environment, for example, the swine industry [1]. Paradoxically, feeding protein in excess of requirement has been a common practice in the horse industry [2]. Fecal and urinary N from livestock contributes to ground water contamination and decreased environmental air quality [3]. With increasing public awareness and emerging regulations to limit N losses to the environment, nutrient management plans may be mandated in the future to ensure sustainability of equine facilities, especially in increasingly urbanized areas. Strategies to mitigate the impact of equine-feeding practices on the environment are contingent on knowledge of factors that impact protein utilization of common feeds for equids. Because of the complexity of the equine digestive tract and the vast difference in feed types, including forages and cereal grains, prediction of feed protein digestibility and N output

* Corresponding author at: Rebecca C. Bott, Department of Animal Science, South Dakota State University, Brookings, SD 57007.
E-mail address: Rebecca.Bott@sdstate.edu (R.C. Bott).

0737-0806/$ – see front matter Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.jevs.2015.08.019

remains a challenge [4]. The goals of this review are to provide an overview of the current knowledge on N utilization in equids in relation to the environment and to identify knowledge gaps that preclude the progress in designing prediction models of N excretion in equids. The specific objective of this review is to assess the potential impact of N excretion from equids on the environment.

2. Environmental Implications of Excreted N

Nitrogen in the feces and urine must be managed to prevent consequences to the environment, such as water contamination and decreased air quality [5]. Excess N in the air and water will eventually reach larger bodies of water, where it can contribute to the deterioration of fisheries and fish habitats through harmful nutrient loading [6]. Manure nutrients (N, phosphorus, and organic matter) can be major pollutants in lakes and estuaries as well as rivers. Nitrogen attached to eroded soil particles may reach waterways through surface runoff or wind deposition. These waters, rich in N and other manure nutrients, promote a proliferation of plant life, especially algae. This process is called eutrophication [7]. Algae growth and the decomposition of organic matter in water bodies reduces the dissolved oxygen content of the water, which may lead to fish kills, odors, and other negative impacts on the aquatic ecosystem [8]. Although the larger environmental concern for N is surface runoff, N volatilization as ammonia presents other problems including nonpoint source pollution through rain, and the effects of volatilized ammonia on human health [9].

Nitrogen in manure can be converted to ammonia through bacterial degradation, primarily the conversion of urinary urea to ammonia. Urease, an enzyme produced by microorganisms in feces, reacts with urinary urea to form ammonia. Urease activity in feces is high; therefore, urea is rapidly converted to ammonia after excretion. It is the physical process of combining urine and feces after deposition on a floor surface, which results in ammonia volatilization in the barn. Ammonia emissions (kg/LU, livestock unit 500-kg live weight) are predicted to be lower in horses than in cattle, pigs, poultry, or sheep [10]; however, ammonia emitted by horses is no less able to impact the environment on a unit-by-unit basis.

Other factors can influence ammonia volatilization in livestock housing. They include temperature, air velocity, pH, surface area, manure moisture content, and storage time. For example, high pH and temperature favor increased ammonia emissions. Horse manure pH typically ranges from 7.7 to 8.2 when calculated from soiled stall waste, depending on the bedding source [11]. The pH of horse manure samples collected between 2007 and 2014 and analyzed at the Pennsylvania State University Ag Analytical Services Laboratory ranged from 6.9 to 8.2 with an average of 7.8, which allows for fairly rapid emission of ammonia into the atmosphere [12]. Only a few studies have been conducted to calculate the amount of N and/or ammonia concentration of horse stall waste; however, the amount will depend on a myriad of factors including location, time of exposure, and bedding type. Horse stables are noted to have higher ammonia concentrations than pastures. This correlated with higher equine exhaled breath condensate pH in stables compared to pastures [13]. One study looked at four different bedding types for the purpose of calculating composting rate [11]. The study found that when long straw is used for bedding, it has a higher percentage of total N before composting than a pelletized straw and pelletized wood product. However, the amount for long straw was not statistically different than when wood shavings were used for a bedding source. This study also found that ammonia did not decrease after composting and therefore indicating that it was not completely converted to nitrate (NO_3) or that the organic matter was not completely degraded by the composting. Table 1 indicates N and phosphorus content of feces and different bedding sources from soiled stalls in different studies.

The Environmental Protection Agency considers ammonia a threat to air quality because of contribution to surface water eutrophication, NO_3 contamination of

Table 1
Concentrations of ammonia gas (NH_3 gas), ammonium (NH_4), total nitrogen (N), nitrate, and pH collected from various studies.

Study Reference	Experimental Conditions	Bedding or Treatment Types	NH_3 Gas (ppm)	NH_4 (ppm)	Total N %	Nitrate (ppm)	pH
Komar et al, 2011 (mean ± SE)	Soiled bedding collected from stalls for 30 d	Pelletized straw	—	10.1 ± 2.65	0.71 ± 0.04	0	7.8 ± 0.1
		Long straw	—	14.6 ± 2.65	0.94 ± 0.04	0	8.2 ± 0.1
		Pelletized wood	—	13.5 ± 2.65	0.63 ± 0.04	0	7.7 ± 0.1
		Wood shavings	—	17.1 ± 2.65	0.78 ± 0.04	0	7.9 ± 0.1
Williams et al, 2011 (mean ± SE)	Feces only collected for 5 d from horses on a low or high protein diet	Feces only low protein diet	25.4 ± 3.4	300 ± 80	0.24 ± 0.01	—	—
		Feces only high protein diet	37.8 ± 3.4	700 ± 80	0.28 ± 0.01	—	—
Fleming et al, 2008 (mean ± SD)	Feces and urine added to containers under standardized conditions with bedding for 14 d	Wheat straw	237 ± 118	530 ± 168	—	10 ± 17	—
		Wood shavings	207 ± 116	805 ± 235	—	0	—
		Hemp	193 ± 114	842 ± 81	—	162 ± 58	—
		Linen	178 ± 88	783 ± 47	—	0	—
		Straw pellets	80 ± 51	377 ± 68	—	0	—
		Paper cuttings	217 ± 120	843 ± 54	—	0	—
Garlipp et al, 2011 (mean ± SE)	Feces and urea added to containers with bedding under standardized conditions for 19 d	Wheat straw	5.75 ± 0.8	—	1.07 ± 0.07	—	6.9 ± 0.11
		Rye straw	4.07 ± 0.8	—	1.14 ± 0.07	—	6.8 ± 0.11
		Wood shavings	2.31 ± 0.8	—	0.61 ± 0.07	—	6.4 ± 0.11

Abbreviations: SD, standard deviation; SE, standard error.
Cells with empty (—) values were not tested in a given study.

Download English Version:

https://daneshyari.com/en/article/2394328

Download Persian Version:

https://daneshyari.com/article/2394328

Daneshyari.com