Effects of Dietary Tannins on Total and Extractable Nutrients from Manure

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Sustainable intensification of agroecosystems may include integration of livestock and crops with all or part of the animal's nutritional requirements derived from crops or residues, and excreta nutrients recycled locally. While the effects of condensed tannins on N dynamics in ruminants have been a topic of research for some time, much less work has focused on the effects of tannins on other nutrients in manure.

Lambs grazing sericea lespedeza* *Photo credit: Joan Burke, USDA-ARS, Dale Bumpers Small Farms Research Ctr., Booneville AR.

We employed a 4x4 Latin square sheep trial to determine if intake of sericea lespedeza (*Lespedeza cuneate*, SL; a condensed tannin source), at 0, 10, 20, or 40% of the ration, would affect concentrations of nutrients in manure and patterns of total excretion when fed with alfalfa (*Medicago sativa*).

We analyzed samples of forages and manure by Inductively Coupled Argon Cooled Plasma Spectrometry after acid digestion to quantify the concentrations of C, N, P, (P_2O_5), K (K_2O), S, Ca, Mg, Na, Zn, Fe, Mn, Cu, and B, and used this information together with measurements of manure production to determine SL effects on patterns of total excretion. Based on related studies of N, we hypothesized that tannins would increase the concentrations and total excretion of other nutrients in manure.

We also examined 1:100 water extracts of manure to determine if tannins influenced the solubility of excreted nutrients. Previous work showed adding tannins to soil reduced the solubility of N, increased that of P, but had little effect on cations such as Ca, Mg and K. We hypothesized that dietary tannins would produce similar patterns of soluble nutrients in manure.

The data provided partial support for the hypothesis that lespedeza tannins reduce digestibility of nutrients and increase outputs in manure but suggest that tannins can independently affect manure composition as well as excretion rates. Adding SL to rations increased concentrations of total C, N, S, Na, Mn, and B in manure, but decreased concentrations of Ca, Mg, Fe, and Cu, and had no effect on concentrations of P, K or Zn. Lespedeza also increased average daily rates of excretion by about 23% with the consequence that total daily outputs of C, N, K, S, Na, Mn, and B in manure were increased. The effects of reduced concentrations of Ca, Mg, and Fe outweighed those of increased rates of excretion and total daily outputs decreased. The outputs of P, Zn, and Cu were not affected by increasing rates of excretion.

The ratios of outputs in manure to inputs from feed (O/I) increased for mass, C, N, and B indicating that tannins in SL not only reduced ration digestibility, and increased the amount of manure produced, but could also enhance the throughput efficiency of some important nutrients (Fig. 1). The O:I ratios for C increased in a manner similar to mass, indicating tannin effects on C throughput were due mainly to their effects on

digestibility. The O:I ratios for N and especially B appeared to increase more strongly than those for mass suggesting tannin effects in addition to reduced digestibility. The O:I ratios for P and Mg were not significantly affected by SL.

The data also provided partial support for the hypothesis that dietary tannins influence soluble nutrients in manure. Adding SL to rations resulted in increased concentrations of water-extractable P, Na, and Mn and decreased concentrations of N, Mg, Zn, Fe, and Cu but produced no effect for K, Ca, and a mixed response for S, and B. The accompanying pattern of increasing rates of excretion resulted in daily outputs of soluble P, K, S, Na, Mn, and B in manure that increased with SL additions. Outputs of soluble N, and Ca in manure were not affected by SL treatment whereas the effects of reduced concentrations of Mg, Zn, Fe, and Cu were stronger than increases in excretion, yielding a net reduction in daily outputs of these metals.

Additions of SL also impacted the proportion of soluble nutrients in manure (S/O) for nearly every variable tested (Fig. 2). Additions of SL impacted the proportion of soluble nutrients in manure for nearly every variable tested. The S:O ratios for Ca, Mn, P, and Na increased while those for important macronutrients including N, S, B, Mg, and metals such as Zn, Fe, and Cu decreased as SL was added to the feed rations. Increasing O/I ratios, together with decreasing S/O ratios, observed for N and B, are consistent with interactions with condensed tannins that affix these two nutrients to insoluble fractions of manure and could thus affect nutrient cycling.

This work indicates that compounds in forages may affect manure quality and quantity that must be accounted for in integrated crop livestock systems. Decreased digestibility resulting in increased rates of excretion and outputs of nutrients in manure may be less than optimal from the animal nutrition perspective, but increased throughput of C and nutrients is likely to be beneficial from the perspective of increasing soil fertility and improving soil quality.

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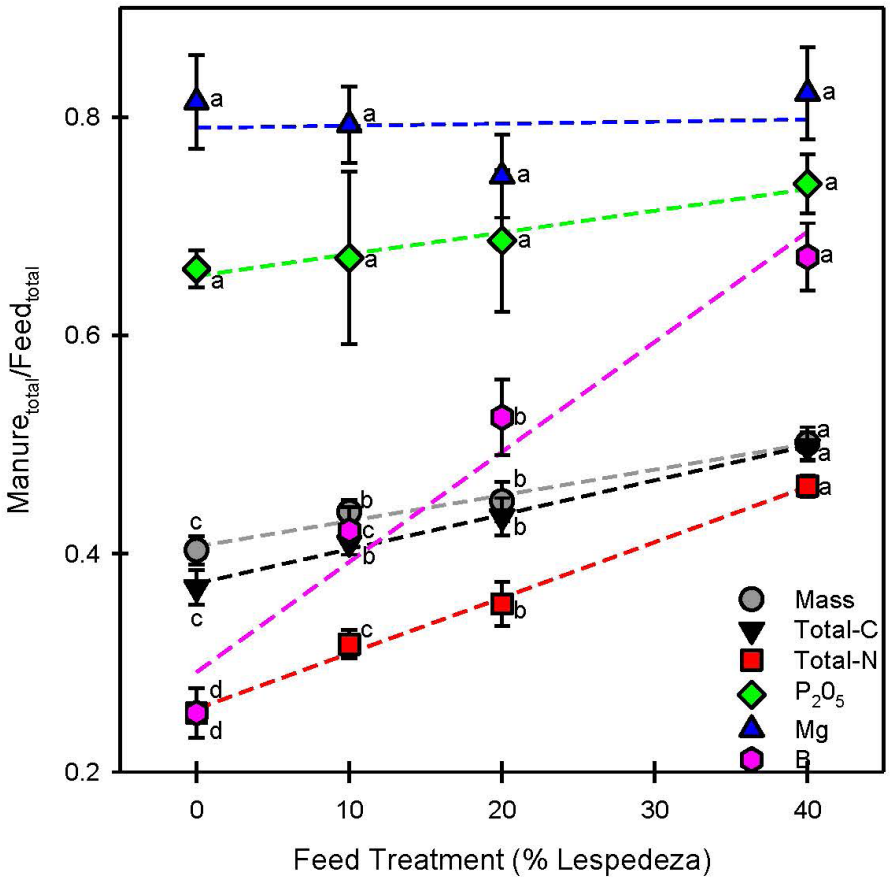

Figure 1. Average (n=4) ratios of total manure output to feed input (O/I). Error bars indicate the standard error of the mean. For each variable, differences among treatments are denoted by lower case letter ($P \leq 0.05$).

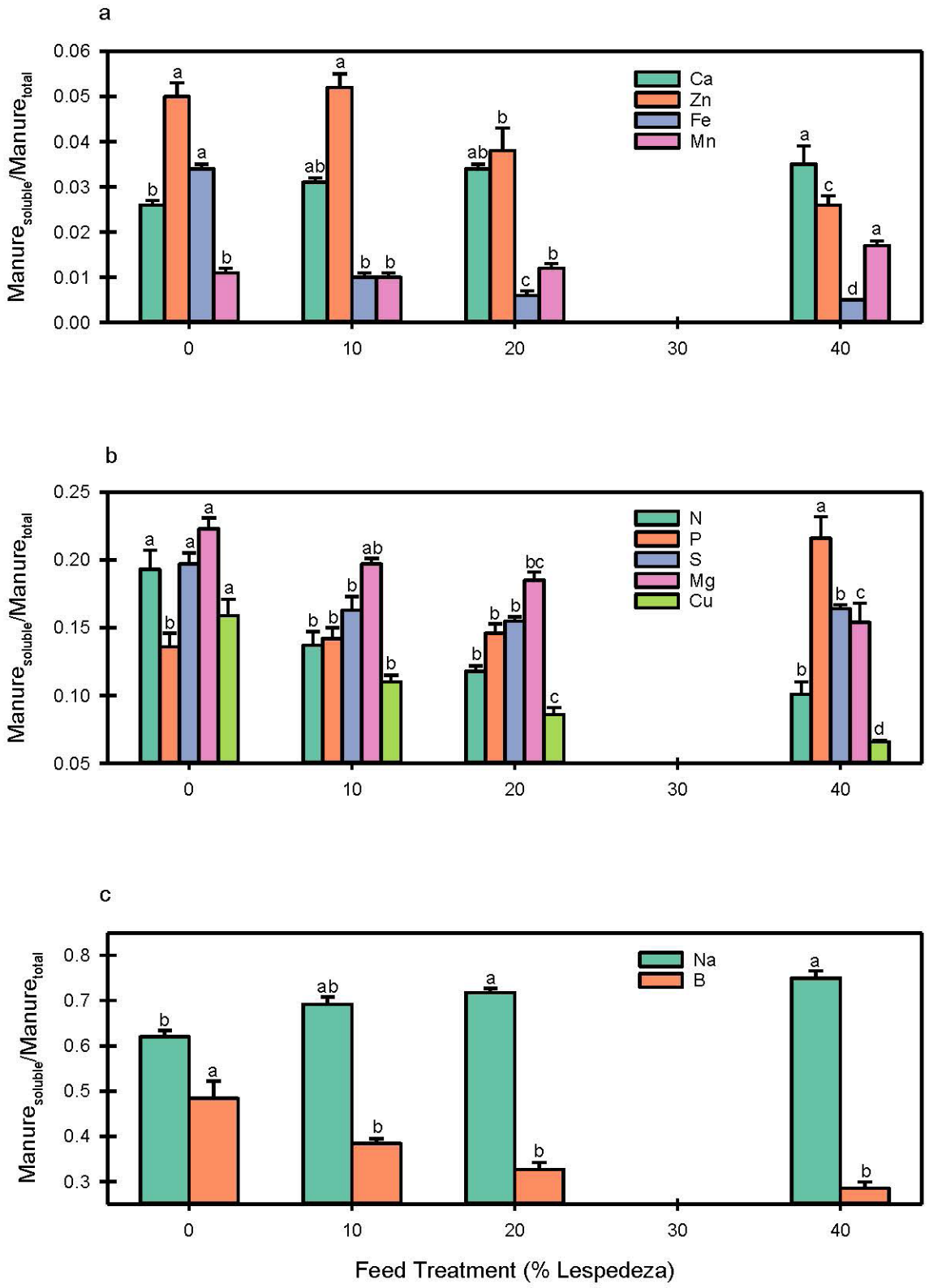

Figure 2. Average (n=4) ratios of soluble nutrient to total nutrient output in manure (S/O). Error bars indicate the standard error of the mean. For each variable, differences among treatments are denoted by lower case letter ($P \leq 0.05$).