Condensed Tannin in Drinking Water of Cattle and Sheep to Reduce Their Urine Urea Excretion and Subsequent Ammonia Pollution

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Abstract

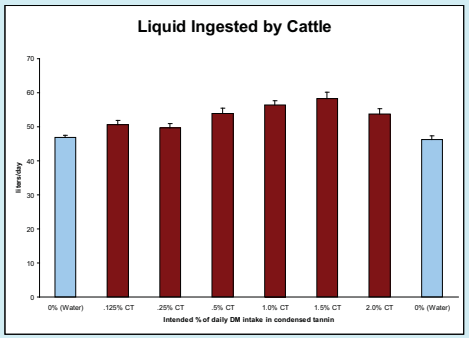
Methods are needed to reduce urine urea excretion and consequent ammonia emission that is associated with ruminant meat and milk production while not reducing productivity. Ingestion of small amounts of naturally-occurring condensed tannin by ruminants can reduce their urine urea excretion and improve their productivity. However, providing grazing ruminants with pasture forages such as birdsfoot trefoil (*Lotus corniculatus*) that contain condensed tannin is problematic. Therefore, I have conducted trials to determine if sheep and cattle will readily drink water containing small amounts of condensed tannin and found that they will. This paper reports results of a trial with a latin-square design where four wether sheep (mean body weight 64.8 kg ± 5.4 SD) were fed alfalfa (*Medicago sativa*) pellets (3.5% nitrogen) and given tap water or tap water with low (0.5% of daily dry matter intake (DDMI) assuming they drank similar amounts of this liquid as they did of tap water), medium (1.0% of DDMI with the same assumption) or high (1.5% of DDMI with the same assumption) amounts of quebracho tannin (QT) in it and their urine urea excretion was measured. There was a linear effect of QT intake on daily urine urea excretion as a percentage of nitrogen intake (P = 0.03). Ingestion of water containing the low, medium and high levels of QT resulted in reductions in daily urea excretion as a percentage of nitrogen intake of 3.5, 6.5, and 12.5%, respectively. Results from my other studies indicate that greater reductions in urine urea excretion may be possible by placing small amounts of condensed tannin in the drinking water of cattle and sheep. This can likely by done while maintaining or improving their productivity.

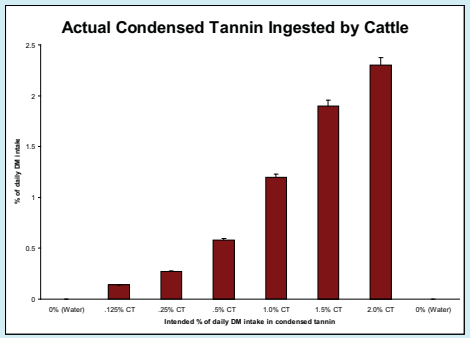
Introduction

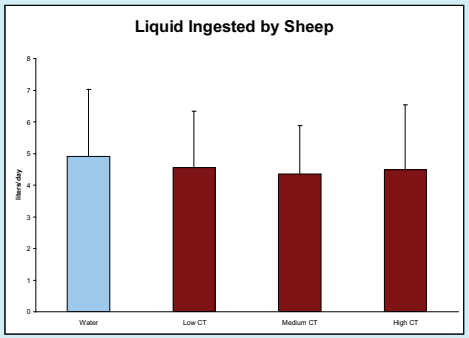
Urea in ruminant urine is an important precursor of ammonia and nitrous oxide (Doak, 1952; Sherlock and Goh, 1984; Thomas et al., 1988). Ingestion of forage containing condensed tannins by ruminants can improve their nitrogen use efficiency and reduce their urine urea concentration and overall nitrogen excretion (Egan and Ulyatt, 1980; Waghorn et al., 1987a and b; Waghorn et al., 1994), and the optimal daily intake of condensed tannin when ingested as a constituent of forage appears to be 2 to 4% of dry matter (DM) intake (Waghorn and Shelton, 1995; Min et al., 2003). For grazing cattle and sheep, the benefits described above are limited by lack of condensed tannins in most grasses and some important herbaceous forage species (e.g. alfalfa, *Medicago sativa*) and difficulty, for many areas, in establishing and (or) maintaining single or mixed species pastures with herbaceous forages that contain condensed tannins (e.g. birdsfoot trefoil (*Lotus corniculatus*) and sainfoin (*Onobrychis viciaefolia*)). For penned cattle and sheep, obtaining adequate intake of condensed tannins may be possible by mixing them with their feed, but obtaining appropriate and uniform intake of a feed supplement containing condensed tannins will be difficult when cattle and sheep are grazing (Bowman and Sowell, 1997). Therefore, the possibility of putting condensed tannin in the animals' drinking water to allow for consistent ingestion of low amounts of condensed tannin, improved nitrogen use efficiency and reduced urine urea excretion is worthy of evaluation. Our intake trials with cattle and sheep have demonstrated that these ruminants will reliably drink normal amounts of water with low levels of condensed tannins in it with acceptable variability among individuals (see figures for cattle), and the research herein reported demonstrates that their ingestion of small amounts of condensed tannin in water can reduce urine urea.

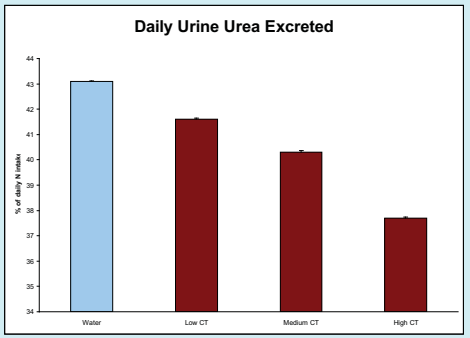
Methods

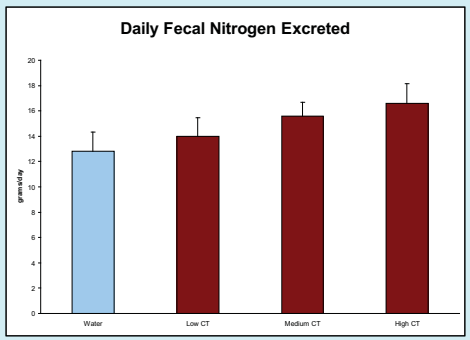
Four wether (castrated male) sheep (mean body weight 64.8 kg ± 5.4 SD) were kept in metabolism stalls in a barn maintained at 7.2ºC. They were fed alfalfa (*Medicago sativa*) pellets (3.5% nitrogen, DM basis) at 2.5% of their body weight with half their ration fed at 0630 and the other half fed at 1530. Using a Latin-square experimental design each sheep was offered four different liquids (one per period) to drink in *ad libitum* amounts from a self-activated drinking bowl, and daily intake of liquid was measured with a water meter placed on the supply line. The four liquids were tap water or tap water with low (0.5% of daily dry matter intake (DDMI) assuming they drank similar amounts of this liquid as they did of tap water), medium (1.0% of DDMI with the same assumption) or high (1.5% of DDMI with the same assumption) amounts of quebracho tannin from the quebracho tree (*Scinopsis balansae*) in Argentina. Quebracho tannin was obtained from the Tannin Corporation (Peabody, MA). For each of four periods, an 8-day adaptation phase preceded a 2-day collection phase in which daily urine output was measured and sampled using 12-hour collection intervals. Sulfuric acid was placed in the urine collection containers to prevent loss of urea. Urine samples were promptly frozen after collection and analyzed for urea concentration using standard frprocedures. Mean urine urea output (grams/day) for both days of each period was determined as was forage nitrogen intake (grams/day) to produce the dependent variable daily urine urea excretion as a percentage of daily nitrogen intake. These data were analyzed using PROC Mixed (SAS 1996) with animal as the random variable. The covariance structure used was the variance components.











Results and Discussion

Tannin intake that was necessary to achieve the desired intake of tannin and actual tannin intake for the low tannin (Low CT) liquid was 8.1 and 9.9 g/day (0.6% of daily DM intake), respectively.

Tannin intake that was necessary to achieve the desired intake of tannin and actual tannin intake for the medium tannin (Medium CT) liquid was 16.2 and 19.4 g/day (1.2% of daily DM intake), respectively.

Tannin intake that was necessary to achieve the desired intake of tannin and actual tannin intake for the high tannin (High CT) liquid was 24.3 and 29.2 g/day (1.8% of daily DM intake), respectively.

Intakes of all three tannin solutions were more than adequate to obtain the desired intakes of condensed tannin.

Drinking the low, medium, and high tannin solutions resulted in urine urea outputs (as a percentage of nitrogen intake) that were 3.5, 6.5, and 12.5% lower, respectively, than urine urea output with tap water (P < 0.0001). There was a linear effect of condensed tannin intake on daily urine urea excretion as a percentage of nitrogen intake (P = 0.03).

Daily fecal nitrogen output was 12.8, 14.0, 15.6, and 16.6 g/day for the tap water and low, medium, and high tannin liquids, respectively, but this nitrogen is not readily converted to ammonia as is urea in urine.

These results are consistent with results from studies in New Zealand with sheep fed forages containing condensed tannins (Egan and Ulyatt, 1980; Waghorn et al., 1987a and b; Waghorn et al., 1994; Waghorn and Shelton, 1995; Aerts et al., 1999; Min et al., 2003).

These results indicate that ammonia and nitrous oxide emissions derived from urea in urine spots from cattle and sheep grazing forage containing high levels of nitrogen may potentially be reduced by introducing small amounts of condensed tannin into the drinking water of these animals.

This procedure may also improve the nitrogen use efficiency of ruminant livestock and potentially improve their productivity and production efficiency.

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