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The Effect of Some Anti Nutritional Factors on the Ruminants' Performance

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Abstract: *Condensed tannins and saponins are considered as anti-nutritional factors in the diets fed to the ruminants. Tannins are considered as inhibitors to growth of the ruminal bacteria by reducing the availability and digestibility of macro-nutrients and minerals, impeding cell wall function. Tannins bind with the dietary protein but are considered as anti-bloat in the rumen. However, saponins are found to be detrimental to the ruminal protozoa and are identified as defaunating agents. Saponins may cause the bloat in the rumen. Because tannins or saponins have some benefits for ruminants, it is not prefer to describe them as anti-nutritional factors.*

Keywords: Tannins, Saponins, Ruminants

INTRODUCTION

The utilization of tree leaves as feeds for ruminants is limited by their containing of anti-nutritional factors that might affect the availability of nutrients, palatability and feed intake. Common anti-nutritional factors include non-protein amino acids (mimosine and indospecine), glycosides (cyanogens and saponins) and polyphenolic compounds (tannins and lignin) (Makkar, 2003). The present review aims at illustrating the effect of tannins and saponins on the performance of the ruminants.

Tannins

Among the polyphenolic compounds, tannins are the most important in ruminant nutrition. Tannins are divided into hydrolysable tannins (HT) and proanthocyanidins (condensed tannins; CT). Hydrolysable tannins (HT) are more susceptible to the enzymatic hydrolysis than CT. Hydrolyzed tannins have not any effect on the nutrient digestibility in ruminants but, the microbial and acid-hydrolysis of it in the gut has produced metabolites that caused toxicity in the liver. In general, the condensed tannins are the most wide spread in the tree leaves and shrubs (Waghorn, 2008).

The condensed tannins effect on the ruminal microorganisms

Tannins inhibit the growth of microorganisms by reducing the availability and digestibility of macro-nutrients and minerals, modifying the cell wall function and interfering with the catalytic activity of extracellular enzymes and cell bound enzymes (Chung et al., 1998; Makkar et al., 1988)

However, in some cases, ruminal bacteria may be tannin-resistant bacteria. In these bacteria condensed tannins induce the extracellular polysaccharide secretion that separates the cellular walls of bacteria from reactive tannins, and formats a thick glycocalyx or glycoprotein that has a high binding affinity for tannins (Krause et al., 2003).

It has been reported that the condensed tannins reduce the population of cellulolytic and proteolytic bacteria in the rumen although the proteolytic bacteria have not been greatly affected (McSweeney *et al.,* 1999, 2001; Min *et al.,* 2002).

Effects of the condensed tannins (CT) on the ruminants' performance

The CT has an ability to bind with the dietary proteins and carbohydrate. The tannin–protein complexes are stable over the pH range 3·5–7 and dissociate at pH < 3 and > 8·5. The tannin–protein complex decreases the ruminal degradability of forage proteins, resulting in decreasing the rumen NH_3 concentration and increasing the amount of plant protein digested in the abomasal. Thus tannins may act as either a beneficial or detrimental factor (Robbins *et al.* 1987; Mangan, 1988).

The saponins

The foliage of some tree legumes might be toxic to rumen protozoa. Rumen protozoa can ingest and digest bacteria and fungi, degrading their cellular protein to NH_3. Due to the protozoal predation in the rumen, microbial protein turnover may result in increasing the net microbial protein outflow being less than half the total protein synthesized. Results from the previous experiments have clearly observed that duodenal flow of both undegraded dietary and bacterial protein was generally increased by defaunation. Because, until now, no practical method has been suggested to eliminate protozoa, the anti-protozoal plants may be safe, and considered as natural defaunating agents. Recently, it has been increased interest in plants containing saponins as means of suppressing or eliminating the ruminal protozoa (Wang et al. 2000 a).

What are saponins?

The saponins are glycosides that are generally considered as anti-nutritional factors. In ruminants saponins are toxic to the rumen protozoa. They are naturally occurring surface-active glycosides and their name is derived from their ability to form stable, soap-like foams in aqueous solutions. Saponins occur in many plant species either wild plants or cultivated crops. The triterpenoid saponins are generally predominant in the cultivated crops but the steroid saponins are common in the herbs used for their health-promoting properties. The triterpenoid saponins have been detected in the legumes such as soyabeans, beans, peas, Lucerne and also, theyare found in alliums, tea, spinach, sugar beet, quinoa, liquorice, sunflower, horse chestnut, and ginseng. But the steroid saponins are found in oats, capsicum peppers, tomato seed, asparagus, yam, fenugreek, and yucca. Yucca schidigera is the most common commercial source of the steroid saponins (Fenwick et al. 1991).

The saponins consist of a sugar moiety usually containing glucose or galactose or glucuronic acid or xylose or rhamnose or methylpentose glycosidically linked to a hydrophobic aglycone (sapogenin) which may be triterpenoid or steroid in nature. Generally, the immature plants of some species have been found to have higher saponin contents than more mature plants of the same species (Fenwick et al. 1991).

Role of saponins in plants

Many saponins are known to be antimicrobial, to be mould inhibitor and to be protective plants from insect attack. So, saponins could be considered as a part of plants' defense systems that include a large group of protective molecules found in plants named 'phytoanticipins' or 'phytoprotectants'. The first term describes the A and B avenacosides of saponins that are activated by the plant's enzymes in response to tissue damage or pathogen attack of the oat. The second describes the saponins that have an anti-microbial or anti-insect activity (Morrissey and Osbourn, 1999).

Effects of saponins on the ruminal protozoa

The saponins have been found to be detrimental to protozoa and identified as defaunating agents in the rumen. This property could be exploited in treatment of protozoal infections in the animals. The saponins have detrimental effects on the protozoa through their binding with sterols present on the protozoal surface. Sterols are absent on the bacterial membranes. The toxicity of saponins to protozoans seems to be wide spread and non specific and is the result of their detergent effect on the cell membranes (Wang et al., 2000a)

The triterpenoid and steroid saponins have been found to be detrimental to the infectious of the protozoans such as *Plasmodium falciparum*, *Giardia trophozoites* and *Leishmania species*.

Other effects of the saponins on the ruminants

In ruminants, the dietary saponins have significant effects on all phases of metabolism, from the feed ingestion to the wastes excretion. Lucerne and soya beans are the main examples of saponin-rich plants used in the ruminant diets. The significant effects of saponins were more pronounced by direct administered into the rumen rather than added to the feed (Cheeke, 1996; Wu et al. 1994).

The positive effects of saponins on ruminants could be simplified as follows:

1. Quillaja saponins increased the efficiency of in vitro rumen-microbial protein synthesis and decreased the feed protein degradability (Makkar and Becker, 1996).
2. Yucca extract can also bind NH_3 when ruminal NH_3 concentrations are high, and release it again when ruminal NH_3 is low, providing a continuous and adequate supply of NH_3 for the synthesis of the microbial protein (Hussain and Cheeke, 1995).
3. In ruminant nutrition, a positive effect of Yucca saponins was attributed to the increasing of the NH_3-N entrapment in the urea-supplemented straw. This effect increases the availability of nutrients to rumen bacteria and reduces the environmental pollution by decreasing losses of NH_3 to the air (Makkar et al. 1999) .
4. The saponin-containing yucca extract has the NH_3-binding properties. However, the reduction in rumen NH_3 concentrations when *Yucca schidigera* was fed is due to the suppression of the ciliate protozoa (Wallace *et al.* 1994).
5. Diets supplemented with the leaves of *Sesbania sesban*, known for its high saponin content, have been found to have the potential to improve the protein flow from the rumen by suppressing the protozoal action, and the rumen bacteria were observed to be capable to metabolize the antiprotozoal factor (Wang et al. 2000b).
6. Some studies have suggested that the dietary saponins effects on lambs are sex-dependent. Bosler et al. (1997) have observed that lambs fed up to 40 mg Quillaja saponins / kg added to the basal diet had significantly higher average daily weight gains than the control lambs but the weight gain of the females was lower than that in the males. Moreover, the workers have noticed that the dietary saponins reduced the fat deposition around the kidney in the females but increased it in the males of lambs.

The negative effect of saponins on ruminants

The dietary saponins have a role in causing the ruminant bloat, but the clear experimental proof for this is lacking (Sen et al. 1998).

Conclusion

Because the tannins or saponins have some benefits for ruminants, it is no longer appropriate to refer to them as anti nutritional factors.

References

1. Bosler DA, Blu¨mmel M, Bullerdieck P, Makkar HPS ; Becker K (1997). Influence of a saponin containing feed additive on mass development and carcass evaluation of growing lambs. Proceedings of the Society of Nutrition and Physiology 6, 46
2. Cheeke PR. (1996) Biological effects of feed and forage saponins and their impact on animal production.'In Saponins Used in Food and Agriculture pp.,377–386. [GR.Waller and Y Yamasaki, editors]. New York: Plenum Press
3. Chung, K.T., Lu Z., Chou, M.W. (1998). Mechanism of inhibition of tannic acid and related compounds on the growth of intestinal bacteria. Food Chem. Toxicol. 36: 1053–1060
4. Fenwick GR, Price KR, Tsukamoto C ; Okubo K (1991) Saponins. In Saponins in Toxic Substances in Crop Plants, [FJP D'Mello, CM Duffus and JH Duffus, editors]. Cambridge: The Royal Society of Chemistry.
5. Hussain I ; Cheeke PR (1995) Effect of Yucca scidigera extract on rumen and blood profiles of steers fed concentrate- or roughage- based diets. Animal Feed Science and Technology 51, 231–242
6. Krause, D.O., Denman, A.L., Mackie, R.I., Morrison, M., Rae, S.E., Attwood, G.T. ; McSweeney, C.S. (2003). Opportunities to improve fiber degradation in the rumen: microbiology, ecology, and genomics. FEMS Microbiol. Rev. 27: 663–693.
7. Makkar HPS ; Becker K (1996) Effect of Quillaja saponins on in vitro rumen fermentation. In Saponins Used in Food and Agriculture, pp. 377–386 [GR Waller and Y. Y. amasaki, editors]. New York: Plenum Press
8. Makkar HPS, Aregheore EM ; Becker K (1999) Effects of saponins and plant extracts containing saponins on the recovery of ammonia during urea ammoniation of wheat straw and fermentation kinetics of the treated straw. Journal of Agricultural Science, Cambridge 132, 313–321.
9. Makkar, H.P.S. (2003) Effects and fate of tannins in ruminant animals, adaptation to tannins, and strategies to overcome detrimental effects of feeding tannin-rich feeds Small Ruminant Research 49, 241–256 .
10. Makkar, H.P.S., Singh, B. ; Dawra, R.K. (1988). Effect of tannin-rich leaves of oak on various microbial activities of the rumen. Brit. J. Nutr. 60: 287–296.
11. Mangan JL (1988) Nutritional effects of tannins in animal feeds. Nutritional Research Reviews 1, 209–231.
12. McSweeney, C.S., Palmer, B., Bunch, R. ; Krause, D.O. (1999). Isolation and characterisation of proteolytic ruminal bacteria from sheep and goats fed the tannin-containing shrub legume Calliandra calothyrsus. Appl. Environ. Microbiol 65: 3075–3083
13. McSweeney, C.S., Palmer, B., Bunch, R. ; Krause, D.O. (2001). Effect of the tropical forage calliandra on microbial protein synthesis and ecology in the rumen. J. Appl. Microbiol. 90:78–88.
14. Min, B.R., Attwood, G.T., Reilly, K., Sun, W., Peters, J.S., Barry, T.N. ; McNabb, W.C. (2002). Lotus corniculatus condensed tannins decrease in vivo populations of proteolytic bacteria and affect nitrogen metabolism in the rumen of sheep. Can. J. Microbiol. 48: 911–921
15. Morrissey JP ; Osbourn AE (1999) Fungal resistance to plant antibiotics as a mechanism of pathogenesis. Microbiological and Molecular Biological Reviews 63, 708–724.
16. Robbins CT, Hanley TA, Hagerman AE, Hjeljord O, Baker DL, Schwartz CC ; Mautz WW (1987) Role of tannins in defending plants against ruminants: reduction in protein availability. Ecology 68, 98–107

17. Sen S, Makkar HPS. ;Becker K (1998) Alfalfa saponins and their implication in animal nutrition. Journal of Agricultural and Food Chemistry 46, 131–140.
18. Waghorn,G ., (2008) Beneficial and detrimental effects of dietary condensed tannins for sustainable sheep and goat production—Progress and challenges Animal Feed Science and Technology 147, 116–139.
19. Wallace RJ, Arthaud L ; Newbold CJ (1994) Influence of Yucca shidigera extract on ruminal ammonia concentrations and ruminal microorganisms. Applied Environmental Microbiology 60, 1762–1767.
20. Wang Y, McAllister TA, Yanke LJ ; Cheeke PR (2000a) Effect of steroidal saponin from Yucca schidigera extract on ruminal microbes. Journal of Applied Microbiology 88, 887–896
21. Wang YX, McAllister TA, Yanke LJ, Xu ZJ, Cheeke PR ; Cheng KJ (2000b) In vitro effects of steroidal saponins from Yucca schidigera extract on rumen microbial protein synthesis and ruminal fermentation. Journal of the Science of Food and Agriculture 80, 2114–2122
22. Wu Z, Sadik M ; Sleiman FT (1994) Influence of Yucca extract on ruminal metabolism in cows. Journal of Animal Science 72, 1038–1042.