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Nutritional toxicology of tannins and related polyphenols in forage legumes.

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Proanthocyanidins (PA) (condensed tannins) and hydrolyzable tannins (HT) are the two major classes of tannins. Proanthocyanidins are flavonoid polymers. Hydrolyzable tannins are polymers of gallic or ellagic acid esterified to a core molecule, commonly glucose or a polyphenol such as catechin. Proanthocyanidins are the most common type of tannin found in forage legumes. Problems in the analysis of tannins are that sample processing and drying decrease extraction and reactivity, suitable standards are unavailable, and quantitative analytical methods are poorly correlated with enzyme inhibition, protein precipitation, and nutritional effects. Hydrolyzable tannins are potentially toxic to ruminants. Pyrogallol, a hepatotoxin and nephrotoxin, is a product of HT degradation by ruminal microbes. Proanthocyanidins are considered to be non-toxic because they are not absorbed, but they are associated with lesions of the gut mucosa. Research on tannins in forage legumes has determined their effects on protein digestion and metabolism but more research on tannin structure in relation to digestion of specific proteins is needed. The widely accepted explanation for positive effects of PA on protein digestion and metabolism is that PA-protein complexes escape ruminal degradation and the protein is available in the lower tract. This proposed mechanism may be incorrect because PA also complex carbohydrates, endogenous proteins, and microbial products and the degradability of PA-protein complexes by ruminal microbes has not been adequately studied. Several alternative hypotheses (to escape protein) that explain the effect of PA on protein digestion and metabolism in ruminants are also consistent with experimental results on forage legumes. These include increased microbial protein synthesis, increased use of endogenous nitrogen in the rumen, and increased secretion of salivary glycoproteins. Research on manipulating the content and type of PA in forage legumes is justified because they are associated with non-bloating legumes, lower soluble non-protein nitrogen in silage, and improved efficiency of protein utilization. Research on the biosynthesis, molecular genetics, and cell biology of PA in forage legumes needs to be integrated with research on toxicology and nutrition.

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