Protein Digestibility

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Although high levels of dietary tannin can interfere with protein utilization [Salunkhe, D.K.; Chavan,J.K.; Kadam, S.S. 1990. "***Dietary tannins: Consequences and remedies***"; CRC Press: Boca Raton, 1990], there is little evidence that tannins consumed in moderate amounts are detrimental to health. There is some evidence that low levels of dietary tannins are beneficial to ruminants [Lees, G.L. 1992. In: Hemingway, R.W. & Laks, P.E. (Editors), ***Plant Polyphenols. Synthesis, Properties, Significance***, Page 915, Plenum Press: New York] and perhaps to humans [e.g., Jankun, J.; Selman, S.H.; Swiercz, R.; Skrzypczak-Jankun, E. ***Nature*** 1997, 387, 561], and some mammals have developed mechanisms for accommodating even rather high levels of dietary tannins [McArthur, C.; Hagerman, A.; Robbins, C.T. 1991. In: Palo, R.T. & Robbins, C.T. (Editors), ***Plant Defenses against Mammalian Herbivory.*** Page 103, CRC Press: Boca Raton].

Reports of tannin toxicity are generally linked to ingestion of large amounts of tannin or introduction by routes other than oral ingestion. Chemical modification of the tannin, which may occur during food preparation or cooking, may increase or decrease the toxicity of the tannin to certain animals.

A major family of proteins secreted by the salivary glands of some animals constitutes the best characterized of the "defense mechanisms" against the possible toxic effects of dietary tannins. The parotid and submandibular salivary glands of some mammals synthesize a group of proteins which are unusually high in proline, the so-called salivary proline-rich proteins (PRPs) . The PRPs are characterized by four general regions: a signal peptide, a transition region, a repeat region, and a carboxyl-terminal region [Carlson, D.M.; Zhou, J.; Wright, P.S. ***Prog. Nucl. Acid Res. Mol. Biol.*** 1991, 41, 1]. These unusual proteins undergo various post-translational modifications including proteolysis, phosphorylation, and glycosylation. PRPs collectively constitute about 70% of the proteins in human saliva, and several functions for these proteins have been proposed, including calcium binding, inhibition of hydroxylapatite formation, and formation of the dental-acquired pellicle. Recent evidence suggests that a primary role for these proteins may be protection against dietary tannins.

PRPs are constitutive in human saliva, but are induced by treatment with the beta-agonist isoproterenol in parotid and submandibular glands of rats, mice, or hamsters . In rats, dietary tannins induce the same biochemical and morphological changes and polyploidy events in the parotid glands (but not the submandibular glands) as does isoproterenol treatment. When young rats are fed a high tannin diet (2-4% tannin) they lose weight during the first three days, but after induction of the PRPs on the third day of the diet the animals start to gain weight at about the same rate as those on the control diet [Mehanso, H.; Hagerman, A.; Clements, S.; Butler, L. Rogler, J.; Carlson, D.M. ***Proc. Natl. Acad. Sci. (USA***), 1983, 80, 3948].

The logical conclusion is that the PRPs are induced by dietary tannins to "neutralize" the detrimental effects of the tannins. Further evidence for the ability of PRPs to neutralize tannins is provided by observations with hamsters. Dietary tannins do not induce PRP synthesis in hamsters, and tannins have pronounced detrimental effects on hamsters. If weanling hamsters are fed a diet containing 2% tannin the animals fail to gain weight, and increasing the tannin level to 4% causes most of the animals to die within three days.

Salivary tannin-binding proteins have been found in some wild herbivorous mammals which consume tannin-containing plants. For example, mule deer saliva contains a protein which has high affinity for tannin; mule deer are generalist herbivores and can accommodate tannin in their diets [Hagerman, A.E.; Robbins, C.T.; Weerasuriya, Y.; Wilson, T.C.; McArthur, C. ***J. Range Manag.*** 1992, 45, 57]. Herbivores such as sheep, which do not produce salivary tannin-binding proteins, prefer to consume tannin-free forages [Austin, P.J.; Suchar, L.A.; Robbins, C.T.; Hagerman, A.E. ***J. Chem. Ecol.*** 1989, 15, 1335] and are unable to accommodate dietary tannin [Hagerman, A.E.; Robbins, C.T.; Weerasuriya, Y.; Wilson, T.C.; McArthur, C. ***J. Range Manag.*** 1992, 45, 57]. The affinity of salivary tannin-binding proteins for specific types of tannin may be related to the feeding preferences of herbivores. Moose and beaver are specialist herbivores, and have very selective tannin-binding proteins. The tannin-binding proteins of generalist herbivores such as mule deer and bear show little selectivity for binding specific tannins [Hagerman, A. E.; Robbins, C.T. ***Can. J. Zool.*** 1993, 71, 628]. Although the amino acid sequences have not been reported for the salivary tannin-binding proteins from any wild mammals, the protein found in mule deer saliva is proline-rich.