Polyphenol and conditioning effects on forage protein solubility and degradability

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Increasing the degree of tissue disruption during mechanical harvesting of forages may augment protein interactions with polyphenols and other cellular constituents, enhancing protein utilization by reducing protein solubility and shifting its degradation from the rumen to the intestine. In 2002 and 2003, 1st and 2nd cuttings from replicated plots of alfalfa, red clover, and three birdsfoot trefoil populations (selected for low to high tannin levels) were conventionally roll conditioned or severely macerated and then conserved as silage or hay. Forages were analyzed for total condensed tannins, crude protein (CP), soluble protein (SP), protease "rumen-undegradable" protein (RUP), and acid-detergent insoluble protein (ADIP). Intestinal available protein (IAP) was estimated as RUP minus ADIP. CP varied little among treatments, averaging 207 g/kg of dry matter. Condensed tannins, absent in alfalfa, ranged from 9 to 119 g/kg CP in trefoil populations and from 2 to 18 g/kg CP in clover. On CP basis, SP in roll-conditioned alfalfa averaged 440 g/kg for hay and 734 g/kg for silage. Compared to alfalfa, average SP levels for roll-conditioned clover were 107 g/kg lower in hay and 219 g/kg lower in silage. Among roll-conditioned trefoil hays and silages, the high tannin population had the lowest SP levels, averaging 70 g/kg less than alfalfa. Shifting from roll conditioning to maceration reduced SP in all hays by an average of 115 g/kg. Maceration effects were more pronounced in silages, reducing SP by an average of 147 g/kg in alfalfa and clover and by 188 g/kg in all trefoil populations. On a CP basis, RUP in roll-conditioned alfalfa averaged 255 g/kg for hay and 199 g/kg for silage while IAP was slightly lower, averaging 221 g/kg for hay and 165 g/kg for silage. RUP and IAP levels in roll-conditioned clover were greater than alfalfa by 145 g/kg for silage and 110 g/kg for hay. Among roll-conditioned hays and silages of trefoil, RUP and IAP levels were greatest in the high tannin population, averaging 93 g/kg more than alfalfa. Changing from roll conditioning to maceration increased RUP and IAP in alfalfa by 15 g/kg in hay and 44 g/kg in silage. In trefoil populations, maceration increased PUP and IAP by an average of 53 g/kg in hay and 138 g/kg in silage, surprisingly yielding greater RUP and IAP levels in silage than in hay. Unexpectedly, shifting from roll conditioning to maceration of clover reduced RUP and IAP by an average of 65 g/kg in hay and 28 g/kg in silage. In roll-conditioned trefoil, tannins accounted for 67 to 84% of the variation in SP, RUP, and IAP for hay and about 60% of the variation in SP, RUP, and IAP for silage. Presumably because of *o*-quinone interactions with protein, roll-conditioned hays and silages of clover had lower SP levels and higher RUP and IAP levels than trefoil containing similar tannin levels. Concentrations of SP, RUP, and IAP were more highly related to tannin levels in macerated trefoil, accounting for 80 to 96% of the variation in hays and about 82% of the variation in silages. Surprisingly, shifting from roll conditioning to maceration had little or no effect on regression slopes of SP, RUP, and IAP verses tannin, suggesting that maceration altered protein fractions by mechanisms independent of tannins. Interestingly, RUP and IAP in macerated clover hays and silages responded identically as trefoil to variations in tannin levels suggesting that maceration abolished *o*-quinone protection of proteins, leaving tannins as the only polyphenolic component limiting protein degradability.

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