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EFFECT OF POLYETHYLENE GLYCOL-6000 ON CHEMICAL COMPOSITION AND DEGRADABILITY OF WHITE GRAPE POMACE IN BUFFALOES

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ABSTRACT

An experiment was carried out to study the effect of Polyethylene Glycol 6000 (PEG-6000) inclusion on chemical composition and degradability of dry matter (DM) and crude Protein (CP) of white grape pomace (WGP) in buffaloes. WGP contains some antinutritional factors such as tannins that may cause to decrease its feeding values. Some tanninification agents like Polyethylene glycol (PEG) can enhance the feeding value of tanniniferous feeds. PEG inclusion was done at 4 levels. The nylon bag technique was used to determine the rate of degradability of DM and CP with 3 rumen-fistulated Azeri buffalos. Results showed that DM content of white grape pomace (WGP) decreased with PEG addition. PEG addition was cause to decrease total tannins and total phenols of WGP. According to observations *a* fraction (rapidly degraded fraction) of DM content of WGP increased between treatments significantly ($P<0.05$). Also effective degradability (ED) of CP content of WGP decreased significantly ($P<0.05$). Different tannins in various plant samples may vary not only in total content but also in their ability to affect degradation, and to bind to proteins or fiber. Totally degradability results showed that PEG addition increased DM degradability values and enhanced soluble proteins of WGP.

Key words: Azeri buffaloes; white grape pomace; polyethylene glycol 6000, degradability.

INTRODUCTION

Grape pomace (GP), a remnant of wine making process, is one of the most important residues of the wine industry (Bumgartel et al, 2007), But it contains some antinutritional factors such as tannins that may cause to decrease the GP feeding value (Pirmohamadi et al, 2007). Various styles have been suggested by some scientists to improve the feeding value of tanniniferous feeds such as storage, drying, ensiling and adding some tanninification (tannin-complexing) agents like wood ash, urea, Polyethylene glycol (PEG) (Makkar, 2003). PEG-6000 was used in this study to evaluate and enhancement of degradation values of white grape pomace because of its higher affinity to tannins compared to other compounds (Makkar, 2003).

MATERIALS AND METHODES

The white grape pomace samples were procured from fruit juice factory located in Urmia city (TATAO factory, Urmia city, Iran), then dried up at 70ºC for 48 h, and ground to pass a 2 mm screen using a hammer mill. Ground WGP was sprayed (Ben Salem et al., 1999) with a PEG-6000 solution at 0, 15.60, 31.21, and 46.80 g PEG/kg DM of WGP, corresponding to treatments WGP0, WGP15, WGP31 and WGP46, respectively. The polyethylene glycol-6000 (PEG-6000) solution was prepared as 5 g PEG-6000 dissolved in 10 ml water (Bhatta et al., 2002). The nylon bag technique was used to determine ruminal degradability of white grape pomace dry matter (DM) and crude protein (CP) with three Azeri buffaloes fitted with permanent large rumen cannulae (AFRC, 1992). Diet consisted of alfalfa hay 38.21 %, wheat straw 21.65 %, beet pulp 29.21 %, wheat bran 10.82 %, and a vitamin and mineral supplement. The statistical analysis was carted out with SPSS Statistical Software Package (1999).

RESULTS AND DISCUSSION

The degradability of different DM fractions of untreated and treated white grape pomace (WGP) with some levels of PEG is indicated in Table 2. According to these observations *a* fraction (rapidly degraded fraction) significantly increased between untreated WGP (WGP No PEG) and WGP treated with different inclusion levels of PEG ($P<0.05$). This increase may be due to PEG breaking effect on tannin-carbohydrate and protein complexes in GP. PEG is breaking tannin-protein (Makkar, 2003), tannin-NDF (Makkar, 2003) and tannin-SP (structural polysaccharide) (Hagerman, 1992) bounds. The insoluble but fermentable

component (*b* fraction) of WGP (No PEG), WGP1 (15.60 g kg^{-1} PEG), WGP2 (31.21 g kg^{-1} PEG) and WGP3 (46.80g kg^{-1} PEG) were 25.63, 20.79, 20.69 and 18.98%, respectively (Table2). This outcome showed that (*b* fraction) of WGP decreased with increasing level of PEG addition (P<0.05). The decrease of *b* fraction is obviously due to increase of *a* fraction, which was discussed above. DM effective degradability (ED 0.05) of WGP.1 (37.24), WGP.2 (39.17) and WGP.3 (38.60) %, were significantly (P<0.05) higher than that of WGP (No PEG) (35.97) %, and WGP2 had the highest ED (0.05) value among the samples (P<0.05). These observations may show the positive effects of PEG addition to increase degradability value of WGP and confirm some other in situ rumen nylon bag report (Ahn, et al., 1989).

Table 1Chemical composition (g/kg, dry matter basis) and phenol and tannin content of untreated and treated white grape pomace

(WGP)						
	Treatments					
Chemical composition	WGP0	WGP15	WGP31	WGP46	P value	SEM
Dry matter (g/kg, as fed)	391.0^{a}	375.0^{b}	364.0^{c}	357.1^{d}	*	3.8742
Crude protein	132.5^{a}	114.1^{b}	108.0^{c}	105.6^{d}	*	3.1805
Neutral detergent fiber	504.0^{c}	530.3^{b}	531.1^{b}	532.4^{a}	*	3.5692
Ash	72.0^{a}	71.1^{ab}	64.4^{c}	70.2^{b}	*	0.9042
Total phenols (g/kg DM)	23.6^{a}	14.3^{d}	16.5^{b}	14.9^{c}	*	1.1190
Total tannins (g/kg DM)	18.6^{a}	9.0^{d}	11.9^{b}	10.2^{c}	*	1.1258

WGP0 = control treatment (untreated with polyethylene glycol (PEG)-6000), WGP15 = treatment with 15.6 g PEG-6000/kg DM of WGP, WGP31 = treatment with 31.21 g PEG-6000/kg DM of WGP, WGP46 = treatment with 46.80 g PEG-6000/kg DM of WGP.$^{a-d}$ Means within each row with different superscripts are significantly different (P<0.05). *= P<0.05

Table 2. Effects of polyethylene glycol-6000 on dry matter (DM) and crude protein (CP) degradation values and effective degradability of white grape pomace (WGP) in buffaloes

Items	Treatment				P value	SEM
	WGP0	WGP15	WGP31	WGP46		
Dry matter						
a^2	0.2558^{d}	0.2905^{c}	0.2986^{b}	0.3083^{a}	*	0.0059
b	0.2497^{a}	0.2029^{b}	0.1955^{c}	0.1828^{d}	*	0.0076
a+*b*	0.5055^{a}	0.4934^{b}	0.4942^{b}	0.4910^{c}	*	0.0016
c (h^{-1})	0.0356^{c}	0.0338^{d}	0.0481^{a}	0.0372^{b}	*	0.0016
Effective degradability (0.02 h^{-1})	0.416^{d}	0.418^{c}	0.437^{a}	0.427^{b}	*	0.0025
Effective degradability (0.05 h^{-1})	0.360^{c}	0.372^{b}	0.394^{a}	0.386^{a}	*	0.0041
Effective degradability (0.08 h^{-1})	0.333^{d}	0.351^{c}	0.372^{a}	0.366^{b}	*	0.0045
Crude protein						
a^2	0.001^{c}	0.120^{a}	0.109^{b}	0.120^{a}	*	0.0153
b	0.324^{a}	0.167^{b}	0.146^{c}	0.123^{d}	*	0.0238
a+*b*	0.325^{b}	0.287^{c}	0.345^{a}	0.243^{d}	*	0.0116
c (h^{-1})	0.040^{ab}	0.0301^{c}	0.0493^{a}	0.0390^{bc}	*	0.0023
Effective degradability (0.02 h^{-1})	0.298^{a}	0.221^{b}	0.213^{c}	0.202^{d}	*	0.0114
Effective degradability (0.05 h^{-1})	0.266^{a}	0.183^{b}	0.182^{b}	0.174^{c}	*	0.0113
Effective degradability (0.08 h^{-1})	0.239^{a}	0.166^{b}	0.165^{b}	0.160^{b}	*	0.0099

WGP0 = control treatment (untreated with polyethylene glycol (PEG)-6000), WGP15 = treatment with 15.6 g PEG-6000/kg DM of WGP, WGP31 = treatment with 31.21 g PEG-6000/kg DM of WGP, WGP46 = treatment with 46.80 g PEG-6000/kg DM of WGP.$^{a-d}$ Means within each row with different superscripts are significantly different (P<0.05). *= P<0.05.

Protein degradability of the WGP samples is shown in Table 2. Soluble fraction (*a*) of protein degradability of untreated WGP (No PEG) was 00.11 %, and for WGP1 (15.60 g/kg PEG), WGP2 (31.21 g/kg PEG) and WGP3 (46.80g/kgPEG) were 12.04, 10.93 and 12.00 %, respectively (Table2). These data indicated that *a* fraction of protein degradability of WGP increased with PEG inclusion (P<0.05). This may be due to formation of tannin-PEG complexes, which may release soluble proteins of WPG, thus increasing the degradation of soluble portion (Ahn et al, 1989 and Makkar, 2003). Insoluble or slowly degradable fraction (*b*) of untreated WGP (No PEG) was 32.34 %, and for WGP1, WGP2 and WGP3 were 16.69, 14.59 and 12.33 %, respectively (Table2). These results showed that (*b* fraction) of WGP proteins decreased with rising level

of PEG addition (P<0.05). The decrease of *b* is obviously due to increase of *a* fraction. Furthermore, rate of degradation (*c* fraction) of untreated WGP (No PEG) was 0.3262, and for WGP1, WGP2 and WGP3 were 0.0301, 0.0493 and 0.0390, respectively (Table2). These observations indicated that the speeds of protein disappearances of samples were decreased with inclusion of PEG (P<0.05). Nevertheless, Protein effective degradability (ED 0.05) of WGP.1 (18.30), WGP.2 (18.20) and WGP.3 (17.40 %) were significantly (P<0.05) lower than that of WGP (No PEG) (26.60 %). in addition, Protein effective degradability (ED 0.02) and (ED 0.08) of WGP1, WGP2 and WGP3 were significantly (P<0.05) lower than that of WGP (No PEG). It may be expected to increase ED values by inclusion of PEG, but these findings did not show it. It seems that tannin-containing feedstuffs may act variously and these data may be in accordance with Aharoni et al (1998). Moreover, Aharoni et al (1998) showed that the pattern of the degradation of curves in the presence or absence of PEG provided information on the mode of action of tannins in the rumen. Tannin effects could be evaluated by the difference between the estimated of effective degradation, assuming that PEG totally prevents the effect of tannins on the kinetics of in situ degradation. This effect could be explained in terms of combination of a reduction in the rate of degradation of potentially degraded material, and of a capacity to bind protein or fiber. The tannin effect was not related to the content of non-degradable material. Different tannins in different plant samples may vary not only in total content but also in their ability to affect degradation, and to bind to proteins or fiber. The model developed by Aharoni et al (1998) allows comparison between these complex effects of tannins on a quantitative basis, and therefore to predict how tannins in a certain plant will affect rumen degradability.

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