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Chemical Composition and Digestibility of Dried White and Red Grape Pomace for Ruminants

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Abstract: Due to a shortage of ruminant feeds, especially in developing countries, agro-industrial by products is of important to animal production because they do not compete with human food and also are cheep. The aim of this study was to assess digestibility value dried Grape Pomace (GP) originating from either white or red wine species. The white GP had higher protein, but lower neutral detergent fiber concentration than the red GP. Four mature wether sheep used for determination of digestibility. For measurement of digestibility, GP was mixed with a basal diet and digestibility was considered for the basal diet and test diets containing GP. Animals were allowed 14 day adjustment before a 5 day collection period. The inclusion of GP in the diet significantly decreased the apparent Digestibility of Dry Matter (DMD), Organic Matter (OMD), Dry Matter in Organic Matter (DOMD), Crude Protein (CPD) and Neutral Detergent Fiber (NDFD) ($p<0.01$), this decrease were more for red GP than that of white. DMD, OMD, DOMD, CPD, NDFD and content ME calculated by difference for red (and white) GP were 31.64% (38.97%), 30.28% (37.17%), 28.3% (34.31%), 8.61% (35.o1%) and 14.94% (22.39%), 4.53 (5.48) MJ Kg^{-1}, respectively.

Key words: Digestibility, grape pomace, ruminant, dried white and red grape, chemical composition

INTRODUCTION

Grape Pomace (GP) is one of the world's largest fruit crops, with an approximate annual production of 58 million metric tons (FAO, 2001). GP is a by product of the wine industry that contains a variable proportion of grape skin, stalks and seed. This by product has high tannin and lignified cell wall contents (Dumont and Tsserand, 1978). A note in point that considerable quantities of crop residues agro-industrial by products suitable feeding livestock are generated every year in developing countries in the tropic and sub tropic, that correct use of this by product can help in solving problem shortages of feed resources in ruminant. However, due to lack of technical-know-how they are lost or under utilized (Aregheore and Chimwano, 1991). Therefore, the inclusion of alternative feedstuffs such as fibrous by product (example GP) in ruminant diet in stead alfalfa (major fiber source) at least in low amounts might be interesting in some circumstances (relative price, feed quality), but it is limited because of the lack of information about their nutritive value. For increasing nutritive value of GP, some workers have suggested to use chemical and physical processing of GP such as ensiling, drying and addition poly ethylene glycol (Alipour and Rouzbehan, 2006; De Pina and Hogg, 1999; Baumgartel *et al*., 2007). Motta Ferreira *et al*. (1996) conducted replacing GP instead of alfalfa as a fiber source in rabbit diet.

Although dried or ensiled GP is low in energy content, but it can be used as a part of diets for ruminants fed close to maintenance level especially sheep(Abel and Icking, 1984) However, inclusion of GP reduced digestibility of the diet (Baumgartel *et al*., 2007; Kumar and Singh, 1984; Kibon and Orskov, 1993).

MATERIALS AND METHODS

An *in vivo* digestibility experiment was carried out according to Givens *et al*. (2000) difference method. Four mature Makoiy wether sheep with a mean body weight of 40±1.2 kg was used in this experiment. The experiment was achieved at the research center of animal science department of Urmia University. Animals were penned in individual metabolism cages that allowed collection separation of feces. They had ad libitum access to water. After a 14 day period of adaptation to each diet, feces were totally gathered for 5 days and put into nylon bags daily before morning feeding and stored at -20°C.

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Chemical analyses were made for the feces samples. Diets were fed twice daily around 8: 00 and 20:00. Experimental diets were including a basal diet with alfalfa hay that was formulated to meet the nutrient maintenance requirements (NRC, 1985) and then 50% of the basal diet was substituted (DM basis) with white and red grape pomace, respectively (Table 1). The diets were supplemented with the same amounts of minerals and vitamins.

Pomace was obtained from juice factory TATAO located in the urmia city of Iran. Pomaces were dried under sunlight completely. Sub samples were taken, freeze dried and ground to pass through a 1 mm screen for chemical analyses. The chemical composition of GP was determined using methods recommended by AOAC (1990), (Table 2). Neutral Detergent Fiber (NDF) was determined using the methods of Van Soest *et al.* (1991). Determinations of N were conducted using the Kjeldahl method in an automated Kjelfoss apparatus (Foss Electric, Copenhagen Denmark). Total Phenolic (TP) were measured using the Folin Ciocalteau method (Makkar, 2000). Total Tannin (TT) was determined after adding insoluble Polyvinyl Poly Pyrrolidon (PVPP) and reacting with Folin Ciocalteau reagent (Makkar, 2000).

The Digestibility Coefficient (DC) for nutrients was calculated for each diet on the basis of quantitative data for intake and output (Givens *et al.*, 2000):

$$DMD = \frac{\text{DM intake} - \text{Faecal DM excreted}}{\text{DM intake}} \quad (1)$$

DMD = Dry Matter Digestibility

The digestibility of other feed fractions was determined by substituting them for dry matter in the above equation. The by-difference digestibility coefficient (%) of nutrients GP was calculated as follows (Givens *et al.*, 2000):

$$\text{DMD of test feed (GP)} = \frac{\text{DM intake from test feed (GP)} - (\text{Faecal DM} - \text{Faecal DM from excreted basal feed})}{\text{DM intake from test feed (GP)}} \quad (2)$$

Metabolizable energy value calculated from digestible organic matter of the food (McDonald *et al.*, 1995):

$$ME\ (MJ\ Kg^{-1}\ DM) = 0.016\ DOMD \quad (3)$$

DOMD = Digestible Organic Matter per Kg Dry matter.

Table 1: Daily ration to sheep in the three digestibilities trails (g DM)

	Basal diet (trail 1)	Test diet[1] (trail 2)	Test diet[2] (trail 3)
Alfalfa	700	350	350
Vitamin and minerals premix	10	10	10
White grape pomace	-	350	-
Red grape pomace	-	-	350

1. Contained white grape pomace, 2. Contained red gape pomace

Table 2: Analyzed chemical c omposition of the pomace under study and alfalfa user in the digestibility and palatability trails with sheep (g kg^{-1} dry matter)

Chemical composition	Alfalfa	White grape pomace	Red grape pomace
Dry matter (g kg^{-1})	895	920	906
Organic matter	901	923	935
Crude protein	165	122	89
Crude fat	20	50	71
Crude fiber	290	176	324
Neutral detergent fiber	530	515	580
Acid detergent fiber	370	484	526
Acid detergent lignin	100	394	446
Total phenol	-	19.6	25.6
Total tannin	-	15.4	20.2
pH	5.78	3.86	3.93

RESULTS AND DISCUSSION

Chemical composition of experimental feedstuffs is shown in Table 2. White GP had higher protein, but lower NDF concentration than red GP. Furthermore, white GP had lower total phenol and total tannin than those of red GP. Our results for NDF and phenolic compounds are in agreement with Alipour and Rouzbehan (2006) and Baumgartel *et al.* (2007). Our GP's crude protein was the same as reported by Alipour and Rouzbehan (2006) but in contrast with Baumgartel *et al.* (2007). This inconsistency may be due to GP varieties, planting and different methods of wine processing (Baumgartel *et al.*, 2007).

Daily experimental diets (Table 1) offered to animals were consumed completely by them. The amounts of daily presented diets in all treatments were the same.

Digestibility for all fractions was significantly higher in the basal diet than test diets (GP contained) (Table 3). Lower digestibility of GP than basal diet might be due to presence of tannins and or high lignin in GP. Lignin is known to have lower digestibility, furthermore, Abel and Icking (1984) observed a decrease in nutrient digestibility with inclusion of dried GP in diets for wethers up to 12%.

Digestibility of all nutrients in the test diet containing red GP was lower than white GP (Table 4). For example, DM digestibility of white GP (38.97%) was higher than that of red GP (31.64%). Our results were the same as reported by Ozduven *et al.* (2005) who worked on GP digestibility for sheep, however was not in agreement with Baumgartel *et al.* (2007) for protein digestibility. This discrepancy is due to the differences of their protein content of GP with ours which mentioned above. While

Table 3: Digestibility coefficient (%) and energy contents (MJ kg^{-1} DM) Calculated with sheep for the basal diet and test diets including pomace

	Basal diet	Test diet[1]	Test diet[2]	SEM
DMD	61.25[a]	51.86[b]	47.78[c]	0.28
OMD	58.88[a]	51.58[b]	47.48[c]	0.32
DOMD	53.05[a]	47.04[b]	43.85[c]	0.29
CPD	63.30[a]	53.29[b]	49.90[c]	0.56
NDFD	61.37[a]	44.30[b]	38.91[c]	0.33
ME[3]	8.49[a]	7.53[b]	7.09[c]	0.04

Different superscripts in a row indicate significant differences according to the Tukey test (p = 0.01). 1. Contained white grape pomace, 2. Contained red gape pomace, 3. Calculated from digestible Organic matter in dry matter according to Eq. 3

Table 4: By difference digestibility coefficients (%) and energy contents (MJ kg^{-1} DM) calculated for the both pomace[1]

	White grape pomace	Red grape pomace
DMD	38.97	31.64
OMD	37.18	30.28
DOMD	34.31	28.30
CPD	35.01	8.61
NDFD	22.39	14.94
ME[4]	5.48	4.53

1. calculated from Eq. 2

organic matter from white GP was digested at 37.18%, the value was only 30.28% for red GP. This may partly be reflection of lower NDF and higher CP concentrations in white variety than those of red. Digestibility of crude protein for red GP (8.61%) was considerably lower than that of white GP (35.01%). Baumgartel *et al.* (2007) observed such results in adverse order for white and red GP. This is also due to different composition of our GP with their, but other nutrient digestibility values were almost the same.

Undesirable low digestibility of CP in red GP is due to higher presence of phenolic compounds (25.6g kg^{-1} DM) in red GP. Fundamentally, tannin with nutrients especially crude protein makes binding and formation of tannin-protein complexes (Baumgartel *et al.*, 2007). In different experiments, reasons for reduction of digestibility of crude protein were related to binding of tannin and protein and consequent protection of feed particles from degradation by microbes in rumen (Makkar, 2003; McNeill *et al.*, 2000; McSweency *et al.*, 2001). Furthermore, Silanikove *et al.* (2001) postulated that negative effect of tannin can be as associated with increase in binding protein and reduce degradation rate of the degradable matter in rumen. Additionally, Robbins *et al.* (1987) observed that dietary tannin diminishes protein and dry matter digestibility in some mammals. Moreover, tannin can inhibit activity of enzymes especially protease enzymes and protection of feed particles from degradation and also reduce proteolytic population in rumen sheep (Gatechew *et al.*, 2001; Min *et al.*, 2003). Likewise, several studies (Kumar and Singh, 1984; Kibon and Orskov, 1993; Martinez and Fernandez, 1980; Pariyi-Bini and Chiericato, 1980; Perez de Ayala *et al.*, 1991) indicated that tannins reduce digestibility of protein. Besides, Helena *et al.* (2000) found that even at concentrations lower than 1% DM; tannins may have negative effects to protein degradation *in vitro*.

Digestibility of NDF for red GP was lower than that of white GP. It can be associated with tannin. Barry *et al.* (1986), concluded that tannins may reduce cell wall digestibility by binding to bacterial enzymes and or forming indigestible complex with cell wall carbohydrates. Additionally, Grant (1997) suggested that increased ruminal rate of passage may be responsible for lower ruminal NDF digestibility, that might be due to small particle size and high specific gravity. On the other hand, Schofield *et al.* (2001) concluded that tannin can bind to microbes and reduced fiber digestion in ruminants. Moreover, Makkar *et al.* (1995b) reported that concentration of tannins may not be too high to reduce the digestibility of the substrates. In another study, Hagerman (1988) confirmed anti-nutritional effect of tannins in reduction of food protein bioavailability in both lambs as well as kids.

Lower ME value obtained for GP in comparison to basal diet (alfalfa). ME content of white GP was higher than red GP (5.48 vs. 4.53 MJ Kg^{-1} DM). This is due to higher DOMD value of white GP (34.31%) than that of red GP (28.30%). Our results are in agreement with DLG (1997).

CONCLUSION

According to results of this research it may conclude that GP can be considered as a good source of fiber and may use in diets of low yielding animals to meet the requirements of energy and nitrogen. For increasing nutritive value of GP, it may be better to use chemical and physical processing of GP such as ensiling, drying and addition poly ethylene glycol which needs more investigation to be done.

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