Kocatepe Veterinary Journal

Kocatepe Vet J. (2021) 14(2):177-186

DOI: 10.30607/kvj. 865918

RESEARCH ARTICLE

Investigation of Availability of Dried Mulberry Pomace Instead of Barley for Ruminants

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ABSTRACT

In this study, it was aimed to determine the effect of substitution of barley with the different amounts of dried white mulberry pomace (DWMP) and dried red mulberry pomace (DRMP) on *in vitro* true digestibility (IVTD) values. The mixtures were formed as: barley (100%), DWMP (100%), DRMP (100%), barley+DWMP (75%+25%), barley+DWMP (50%+50%), barley+DWMP (25%+75%), barley+DRMP (75%+25%), barley+DRMP (50%+50%), barley+DRMP (25%+75%). There were no differences for IVTD, *in vitro* true dry matter digestibility (IVTDMD), and *in vitro* true organic matter digestibility (IVTOMD) values between barley and barley+DWMP (75%+25%). Although, IVTD, IVTDMD, and IVTOMD values of barley+DWMP (75%+25%) and barley+DWMP (50%+50%) were similar, the same digestibility values of the mixture containing barley+DWMP (50%+50%) were lower (P<0.05) than those of barley. While substitution of barley with DWMP increased (R^2=0.7754) *in vitro* true neutral detergent fiber digestibility (IVTNDFD), substitution of barley with DRMP did not change IVTNDFD. In conclusion, due to nutrient composition and digestibility of DWMP, barley may be substituted with DWMP up to 50% in diets of livestock raised for meat or milk production. Further studies are needed to determine the effects of barley substitution with DWMP on *in vivo* digestibility, rumen fermentation, fattening performance or milk production.
Key Words: Barley; *In vitro* true digestibility; Dried mulberry pomace; Ruminant

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Ruminantlar için Arpa Yerine Kurutulmuş Dut Posasının Kullanılabilirliğinin Araştırılması

ÖZ

Bu çalışmada, arpanın, kurutulmuş beyaz dut posası (KBDP) ve kurutulmuş kırmızı dut posası (KKDP) ile farklı düzeylerde ikamesinin *in vitro* gerçek sindirilebilirlik (IVGS) değerleri üzerine etkisinin belirlenmesi amaçlanmıştır. Karışımlar şu şekilde oluşturuldu: arpa (%100), KBDP (%100), KKDP (%100), arpa+KBDP (%75+%25), arpa+KBDP (%50+%50), arpa+KBDP (%25+%75), arpa+KKDP (%75+%25), arpa+KKDP (%50+%50), arpa+KKDP (%25+%75). Arpa ve arpa+KBDP (%75+%25) arasında IVGS, *in vitro* gerçek kuru madde sindirilebilirlik (IVGKMS) ve *in vitro* gerçek organik madde sindirilebilirlik (IVGOMS) değerleri açısından bir farklılık yoktu. Arpa+KBDP (%75+%25) ve arpa+KBDP (%50+%50)'ya ait IVGS, IVGKMS ve IVGOMS değerleri benzer olmasına karşın, arpa+KBDP (%50+%50) içeren karışımın aynı sindirilebilirlik değerleri arpaya göre daha düşük (P<0,05) bulundu. Bununla beraber, arpanın %25 düzeyinde KKDP ile ikamesine ilişkin IVGS değerleri arpanınkilerden daha düşüktü (P<0,05). Arpanın KBDP ile ikamesi *in vitro* gerçek nötral deterjan fiber sindirilebilirlik (IVGNDFS) değerini arttırırken (R^2=0,7754), arpanın KKDP ile ikamesi IVGNDFS değerini etkilememiştir. Sonuç olarak, KBDP'nin besin madde bileşimi ve sindirilebilirlik değeri nedeniyle, arpa, et veya süt hayvanlarının rasyonlarında %50'ye kadar KBDP ile ikame edilebilir. Arpanın KBDP ile ikamesinin *in vivo* sindirilebilirlik, rumen fermentasyonu, besi performansı veya süt verimi üzerine etkilerini belirlemek için çalışmalara ihtiyaç vardır.
Anahtar Kelimeler: Arpa; *In vitro* gerçek sindirilebilirlik; Kurutulmuş dut posası; Ruminant

To cite this article: Kaya İ.B. Selçuk Z. Investigation of Availability of Dried Mulberry Pomace Instead of Barley for Ruminants. Kocatepe Vet J. (2021) 14(2):177-186

Submission: 21.01.2021 **Accepted**: 04.04.2021 **Published Online**: 08.04.2021
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INTRODUCTION

The use of agro-industrial by-products for livestock nutrition is old as the domestication of animals by humans (Bampidis and Robinson 2006). The cereals are common ingredients in human and animal nutrition. The use of agro-industrial by-products as an ingredient in livestock diets can be resulted in a decrease in requirement of cereals and, also a diminish in needs for waste management programs which are highly cost (Grasser et al. 1995). Therefore, these industrial by-products, rich in structural carbohydrates and where they are regionally available, have a potential for ruminant nutrition and they could provide some nutrients necessary for growth and development of the rumen microbial ecosystem. (Bampidis and Robinson 2006).

The pomaces, produced by the food industry as by-products, might be major alternative feed sources in the world and in Turkey (Çapçı et al. 2002). Recently, the use of these industrial by-products as animal feed has become widespread by farmers living in regions where they can be obtained. In animal nutrition, there are many studies conducted with by-products such as tomato pomace (Ebeid et al. 2015, Sargın and Denek 2017, Selçuk et al. 2019), apple, peach and apricot pomaces (Yalçınkaya et al. 2012), apple pomace (Ülger et al. 2018) and its mixture with tomato pomace (Abdollahzadeh et al. 2010), sugar beet pulp (Boguhn et al. 2010, Aldemir and Karslı 2012), grape pomace (Özdüven et al. 2005, Dinic et al. 2015) and mulberry pomace (Zhou et al. 2012, Niu et al. 2016).

Mulberry (Morus spp.) can develop in different climatic conditions ranging from temperate to tropical climate. The fruits of the mulberry tree are used in human consumption, its leaves are used in silkworm cultivation, medicine production and animal nutrition (Sharma and Zote 2010). Mulberry pomace, mostly consists of stem and peel parts of the mulberry and constituting approximately 8% of the weight of the fresh mulberry taken into processing, is a by-product of the production of mulberry juice (Elmacı and Altuğ 2002). In general, mulberry pomace is either utilized as a soil fertiliser or discarded in landfill sites, which causes to environmental pollution (Zhou et al. 2014).

Zhou et al. (2012) stated that water-soluble carbohydrate, protein and neutral detergent fiber (NDF) contents of mulberry pomace are 20.85, 21.86 and 49.06%, respectively. In a study (Zhou et al. 2014), corn grain and cotton seed meal were partically replaced by ensiled mulberry leaves and sun-dried mulberry fruit pomace at the level of 8 and 6.3%, respectively. The diets, prepared isocaloric and isonitrogenous and supplemented with these two mullbery products, had been resulted in similar effects on performance, blood biochemical parameters and carcass features of steers. However, experimental diets, partly substituted by ensiled mulberry leaves or sun-dired mulberry fruit pomace, were resulted in variable levels of ruminal volatile fatty acids and lower intramuscular fat contents compared to control diet (Zhou et al. 2014).

Niu et al. (2016) investigated the effects of diets supplemented with 8% ensiled mulberry leaves or 6.3% ensiled sun-dried mulberry fruit pomace on rumen bacteria and archaeal populations in finishing steers. According to the results of the study conducted by Niu et al. (2016), the partical replacement of corn grain and cotton seed meal with ensiled mulberry leaves or sun-dried mulberry fruit pomace had no substantial effects on the rumen bacteria or archaea population.

Available local agro-industrial by-products containing structural carbohydrate might be an alternative feed ingredients in ruminant nutrition due to the rumen microbial ecosystem utilizing these by-products (Bampidis and Robinson 2006). Although, some studies (Zhou et al. 2012, Zhou et al. 2014, Niu et al. 2016) have reported that the using of mulberry leaves silages and sun-dried mulberry pomace in ruminants, the effect of partial use of dried mulberry pomace instead of cereals in ruminant nutrition on digestibility is unknown. The aim of this study was to determine the effect of substitution of barley with the different amounts of dried white mulberry pomace (DWMP) and dried red mulberry pomace (DRMP) on *in vitro* true digestibility (IVTD) values.

MATERIALS and METHODS

Feed Material

Barley, DWMP and DRMP were used as feed material in the study. The mixtures were prepared to substitute barley with DWMP and DRMP at different levels (Table 1). The prepared mixtures were ground to pass through a 1 mm sieve for nutrient analysis and Ankom Daisy[II] *in vitro* fermentation system.

Chemical Analyses

Ash, dry matter (DM), ether extract (EE) and crude protein (CP) contents of the samples were analysed according to AOAC (2006). Acid detergent fiber (ADF) and NDF analyses were performed according to Van Soest et al. (1991) using Ankom Fiber Analyzer. Metabolizable energy values of samples were calculated by TSI (1991).

Determination of *In vitro* True Digestibility

Preparation of filter bags

After F57 filter bags were rinsed in acetone for three minutes and allowed to dry, they were weighed and marked. 0.5 g of barley, DWMP, DRMP and their mixtures which contain barley+DWMP and barley+DRMP passed through a 1 mm sieve were weighed into each filter bag (8 bags for barley, DWMP, DRMP and their each mixture) for 48 hours digestion. The bags were sealed by an impulse bag sealer. A bag as a blank was used without sample.

Rumen Content

Rumen content obtained from cows freshly slaughtered at a local slaughterhouse was collected into a prewarmed thermos (39 °C under a CO2 atmosphere) and immediately transferred to the laboratory, and then rumen content was filtered through four layers of cheese cloth. pH value of rumen fluid was measured as 6.35. Anaerobic conditions were maintained throughout the preparation stages of rumen fluid and conduct of the experiment.

***In vitro* digestion method**

The Ankom Daisy^{II} *in vitro* fermentation system was used for determination of *in vitro* true digestibility. The Ankom Daisy^{II} *in vitro* fermentation system has an equipment designed with four rotating digestion jars. Buffer solutions for *in vitro* fermentation system were prepared and poured into each digestion jar of incubator according to described by Ankom. The procedure for *in vitro* fermentation system was conducted according to the operating instructions supplied by Ankom. The temperature of buffers was set 39 °C before 400 mL rumen fluid and prepared bags were added to each digestion jar. After each digestion jar was aerated with CO2 immediately, incubator was activated for 48 hours. After incubation period, the incubation medium inside of each digestion jar was discharged. The bags were gently washed under running water until they were completely clean and then they were placed in the Ankom Fiber Analyzer and NDF procedure was performed. *In vitro* true digestibility (IVTD), *in vitro* true dry matter digestibility (IVTDMD), *in vitro* true NDF digestibility (IVTNDFD) and *in vitro* true organic matter digestibility (IVTOMD) values of the samples were calculated with equations consisting the difference between the amount of incubated and the residue after NDF analysis for the different treatments.

Statistic Analysis

The data were summarized in the form of arithmetic means and standard errors. The statistical significance for each feed mixture used in the study was determined by one-way variance analysis. Tukey Posthoc test was used to determine statistical differences. Relationship between increasing levels of DWMP or DRMP in the mixtures and IVTD values was determined by regression analysis. SPSS (2012) package program was used for statistical analysis.

Table 1. The feed mixtures

Mixtures	B %	DWMP %	DRMP %
B	100	0	0
DWMP	0	100	0
DRMP	0	0	100
75%B+25%DWMP	75	25	0
50%B+50%DWMP	50	50	0
25%B+75%DWMP	25	75	0
75%B+25%DRMP	75	0	25
50%B+50%DRMP	50	0	50
25%B+75%DRMP	25	0	75

B: Barley, DWMP: Dried White Mulberry Pomace, DRMP: Dried Red Mulberry Pomace

Table 2. Nutritional value (%) and metabolizable energy value (MJ/kg) of B, DWMP, DRMP and substitution of B with DWMP and DRMP

Mixtures	DM	Ash	OM	CP	EE	CF	ADF	NDF	ME
B	90.76	2.55	88.21	13.18	1.73	4.62	7.60	25.31	11.75
DWMP	93.83	3.72	90.11	9.62	6.43	10.28	16.39	19.09	11.68
DRMP	92.61	2.93	89.68	17.12	12.18	19.10	25.83	30.80	11.12
%75B+%25DWMP	91.82	2.79	89.03	12.18	2.99	6.24	10.26	30.25	11.76
%50B+%50DWMP	92.88	3.17	89.71	11.43	3.93	7.25	11.59	21.54	11.80
%25B+%75DWMP	93.19	3.47	89.72	10.17	4.95	8.47	14.19	23.41	11.85
%75B+%25DRMP	91.37	2.53	88.84	13.14	5.42	8.10	11.93	25.77	11.79
%50B+%50DRMP	91.51	2.54	88.97	13.95	7.13	11.60	16.24	27.42	11.49
%25B+%75DRMP	92.10	2.94	89.16	15.58	9.65	15.03	21.68	28.38	11.34

B: Barley, DWMP: Dried White Mulberry Pomace, DRMP: Dried Red Mulberry Pomace, DM: Dry Matter, OM: Organic Matter, CP: Crude Protein, EE: Ether Extract, CF: Crude Fiber, ADF: Acid Detergent Fiber, NDF: Neutral Detergent Fiber

Table 3. IVTD, IVTDMD, IVTOMD and IVTNDFD values (%) of B, DWMP, DRMP and the substitution of B with DWMP and DRMP.

Mixtures	IVTD $x \pm Sx$	IVTDMD $x \pm Sx$	IVTOMD $x \pm Sx$	IVTNDFD $x \pm Sx$
B	88,90±0,42[a]	87,77±0,46[a]	88,73±0,46[a]	21,07±0,46[c]
DWMP	80,23±0,63[d]	79,46±0,67[d]	80,98±0,98[de]	26,11±0,20[a]
DRMP	68,52±0,62[f]	66,01±0,67[f]	67,48±0,68[g]	20,80±0,35[c]
%75B+%25DWMP	86,75±0,53[ab]	85,57±0,58[ab]	86,12±0,60[ab]	23,60±0,23[b]
%50B+%50DWMP	84,53±0,55[bc]	83,34±0,60[bc]	84,33±0,58[bc]	24,17±0,19[b]
%25B+%75DWMP	80,48±0,61[d]	79,05±0,65[d]	80,20±0,64[e]	25,80±0,29[a]
%75B+%25DRMP	83,91±0,32[c]	82,39±0,35[c]	83,18±0,33[cd]	20,73±0,44[c]
%50B+%50DRMP	80,31±0,42[d]	79,03±0,46[d]	79,92±0,46[e]	21,95±0,45[c]
%25B+%75DRMP	77,28±0,32[e]	75,33±0,35[e]	76,35±0,33[f]	21,46±0,34[c]

Different letters within the same columns indicate differences among groups ($P<0.05$).

B: Barley, DWMP: Dried White Mulberry Pomace, DRMP: Dried Red Mulberry Pomace, IVTD: *In vitro* True Digestibility, IVTDMD: *In vitro* True Dry Matter Digestibility, IVTOMD: *In vitro* True Organic Matter Digestibility, IVTNDFD: *In vitro* True Neutral Detergent Fiber Digestibility

RESULTS

In the study, the nutrient compositions of barley, DWMP, DRMP and the substitution of barley with DWMP or DRMP at the different levels for ruminants were investigated by *in vitro* fermentation system. The nutrient composition and IVTD values of barley, DWMP, DRMP and their mixtures which contain barley+DWMP and barley+DRMP were presented in Table 2 and 3, respectively.

Whereas the IVTDMD value of barley was the highest (87.77% ± 0.46), the IVTDMD value of DRMP was the lowest (66.01 ± 0.67). Although the IVTD, IVTDMD and IVTOMD values of barley substitution with DWMP at the level of 25% were similar to those of barley. The same IVTD values for the substitution of barley with DRMP at the level of 25% were lower than those of barley (Table 3).

There was a decrease in IVTDMD values of the mixtures which were combined with at the level of 50% DWMP or more than this level compared to barley (Figure 1). Substitution of barley with increasing level of DRMP in the mixtures was resulted in a decrease in the values of IVTDMD (Figure 2). While the replacement of barley with DWMP increased IVTNDFD (Figure 3, R^2 = 0.7754), substitution of barley with DRMP did not affect IVTNDFD (Figure 4).

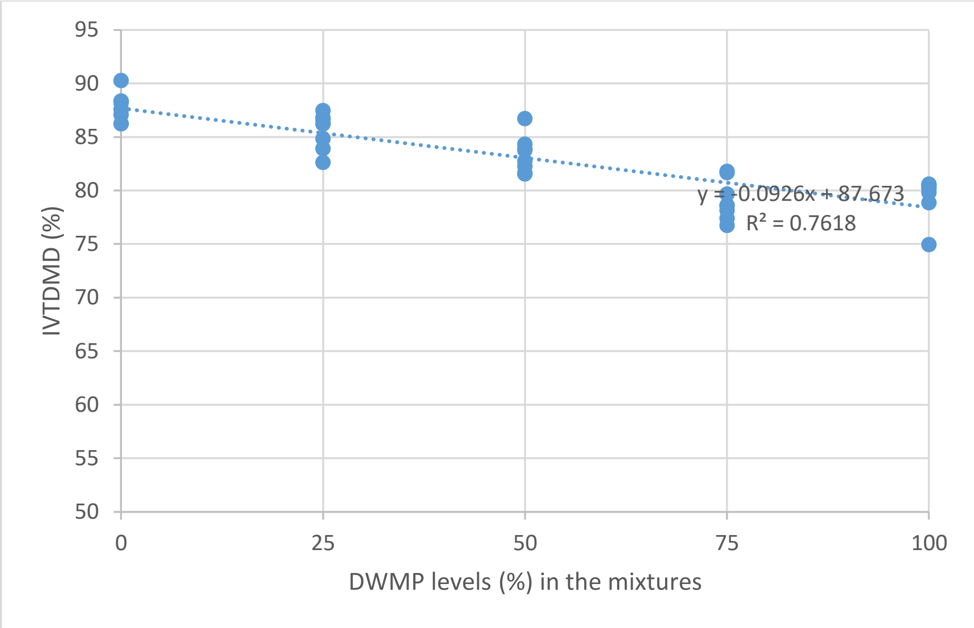

Figure 1. Regression between increasing levels of dried white mulberry pomace (DWMP) in the mixtures and *in vitro* true dry matter digestibility (IVTDMD)

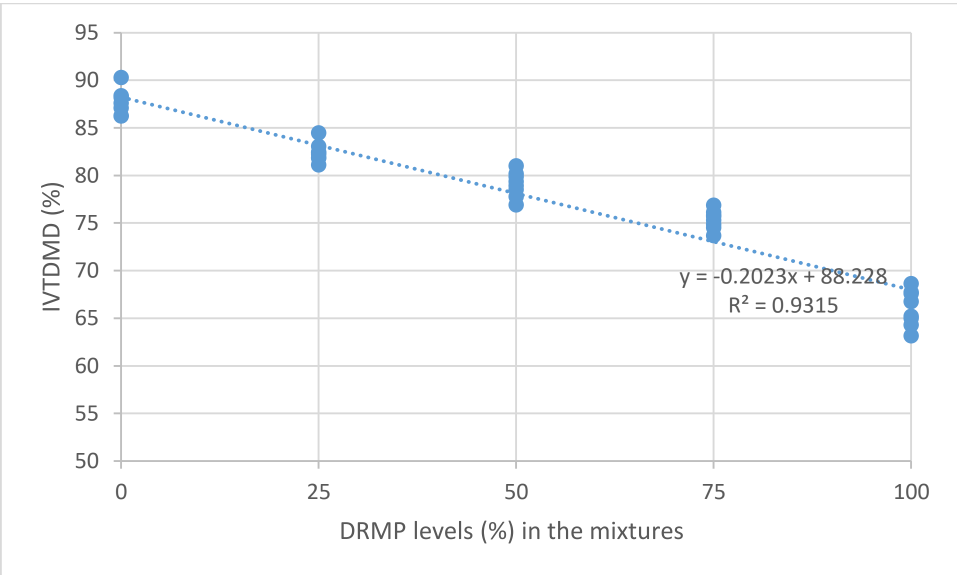

Figure 2. Regression between increasing levels of dried red mulberry pomace (DRMP) in the mixtures and *in vitro* true dry matter digestibility (IVTDMD)

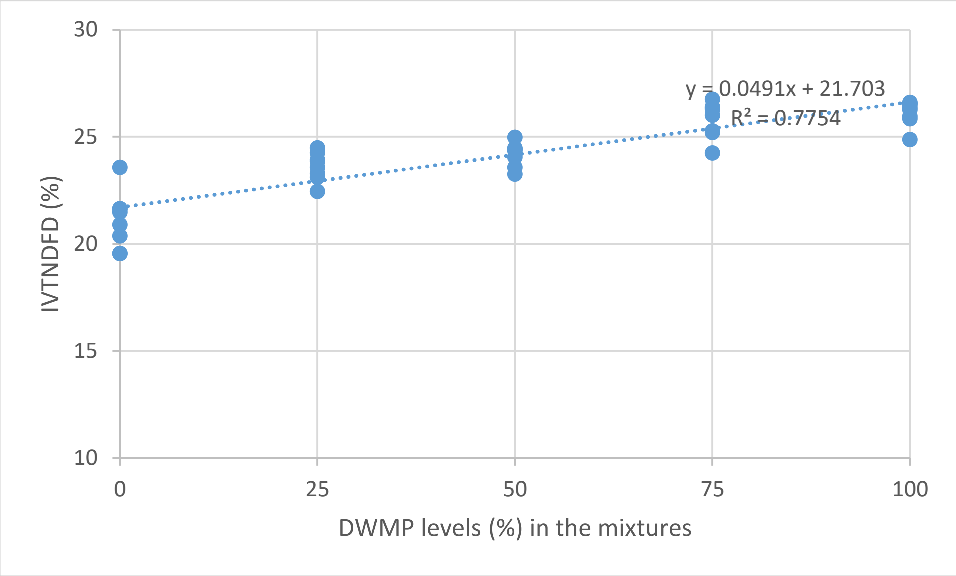

Figure 3. Regression between increasing levels of dried white mulberry pomace (DWMP) in the mixtures and *in vitro* true neutral detergent digestibility (IVTNDFD)

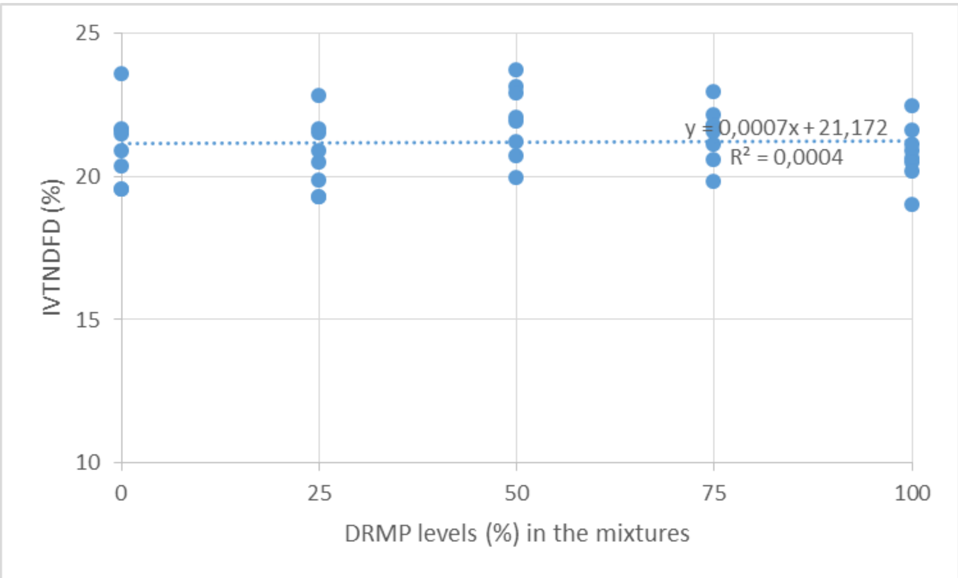

Figure 4. Regression between increasing levels of dried red mulberry pomace (DRMP) in the mixtures and *in vitro* true neutral detergent digestibility (IVTNDFD)

DISCUSSION

Ruminants can effectively utilize by-products as other feedstuffs. Since ruminants are able to utilize fiber content due to their rumen microorganisms, cereals may be partially replaced by agro-industrial by-products for reducing the competition between human and animal nutrition. Furthermore, the evaluation of these by-products can be economically worthwhile, because of an increase in price of conventional feedstuffs from day to day. Most by-products generally have low nitrogen values but more fibre contents (Mirzaei-Aghsaghali and Maheri-Sis 2008).

Despite many advantages of ruminant anatomical features and digestive physiology, the use of many agro-industrial by-products that have valuable nutritional value(s) as an alternative feed source is quite limited. Since the use of alternative feed sources may provide for a cost benefit in livestock production industry, it has been prominently attractive to determine their nutritional values for animal species among animal nutrition specialists (Klinger 2017).

In the earlier studies, the dry matter (Toprak et al. 2018, Yahaghi et al. 2012, Denli and Demirel 2016), CP and EE (Sevim et al. 2017) contents of barley were found about 90%, between 12.60-13.10% and between 1.59-1.80%, respectively. The results of the study for dry matter, CP and EE contents of barley were compatible with the previous studies. Toprak et al. (2018) and Denli and Demirel (2016) stated that the ash contents of barley were 3.60 and 5.5%, respectively. Alkan and Kandemir (2015) reported that the ADF and NDF values of varieties of barley were ranged from 6.53-9.07% and 19.77-26.61%. Although, the result of this study for ash content of barley was lower than those of Toprak et al. (2018) and Denli and Demirel (2016). The different barley kinds and varieties used in the studies and their production conditions (soil, region, precipitation, climate, fertilization etc.) may cause the differences among studies. ADF and NDF contents of barley were generally compatible with those which was reported by Alkan and Kandemir (2015) previous.

Since no study about using of different kind of dried mulberry pomace or the effect of its use for substitution of grains on *in vivo* or *in vitro* digestibility in ruminants had been found in the literature review, the results obtained from other agro-industrial by-products were used for comparing digestibility and chemical composition of dried mulberry pomace. Omer and Abdel-Magid (2015), Selcuk et al. (2013) and Keklikci and Selçuk (2018) reported that dry matter contents of tomato pomace were 92.00, 94.45 and 92.20%, respectively. In this study, dry matter contents of DWMP and DRMP were similar to those of Omer and Abdel-Magid (2015), Selcuk et al. (2013) and Keklikci and Selçuk (2018) and higher than that of dried apple pomace whose dry matter content was reported 89.56% (Ayhan et al. 2009). In a study conducted by Zhou et al. (2012), sun-dried blackberry pomace crude protein content were found as 21.86%. Selcuk et al. (2019) stated that crude protein value of tomato pomace was 19.50%. Palangi et al. (2013) reported that crude protein contents of orrange, grapefruit, lemon and tangerine pomaces were 8.68, 8.01, 7.82 and 6.81%, respectively. In the present study, although crude protein levels of both DWMP and DRMP were higher than those of orrange, grapefruit, the same content was lower than that of sun-dried blackberry pomace. The crude protein content of DWMP was lower than that of tomato pomace but the same content of DRMP higher than that of tomato pomace. In this study, the ash contents of DWMP and DRMP were lower than that of tomato pomace (4.50%) stated by Selcuk et al. (2019), orrange (5.1%), grapefruit (4.00%), lemon (6.9%) and tangerine (4.8%) pomaces reported by Palangi et al. (2013). Omer and Abdel-Magid (2015) and Keklikci ve Selcuk (2018) stated that ADF and NDF contents of tomato pomace were 40.93 and 49.48%, respectively. NDF value(s) of tomato pomace were reported as 65.24% (Omer and Abdel-Magid 2015) and 56.91% (Keklikci and Selcuk 2018). Zhou et al. (2012) reported that the ADF and NDF values of sun-dried black mulberry pomace were 49.06 and 37.96%, respectively. In this study, the results for ADF and NDF contents of DWMP and DRMP were lower than tomato pomace and sun-dried black mulberry pomace. The reason why the differences in the results for nutrient composition between the present study and the previous studies may caused by the different fruit and vegetable pomaces used in the previous studies and their production conditions.

Moghaddam et al. (2013), Alipour and Rouzbehan (2007) and Mirzaei-Aghsaghali et al. (2011) stated that metabolizable energy values of grape pomace investigated as an alternative feed source were 13.63, 6.69 and 7.40 MJ/kg dry matter, respectively. Keklikci and Selçuk (2018) reported that metaboliz energy value of tomato pomace was 8.16 MJ/kg dry matter. In the present study, metabolizable energy values of DWMP and DRMP were higher than that of Alipour and Rouzbehan (2007), Mirzaei-Aghsaghali et al. (2011) and Keklikci and Selçuk (2018) except for that of Moghaddam et al. (2013). This may be primarily attributed to the differences in the kind of pomace, the amount of shell and seed parts in the composition of the pomaces. However, metabolizable energy values of DWMP and DRMP were similar to that of barley.

In vitro dry matter digestibility is widely used to estimate feed digestibility since there is a strict correlation between *in vitro* dry matter digestibility and *in vivo* digestibility (Marten and Barnes 1980). Holden (1999) has stated that Daisyıı incubator, simple to use and allowing determine *in vitro* true dry matter digestibility of varied feeds, is commonly used for estimation of digestibility value. Aldemir and Karslı (2012) showed that dry matter and organic matter degradability of barley were 80.46 and 89.85%, respectively after 48 hours of incubation in rumen using the nylon bag method. Yahaghi et al. (2012) investigated the effects of replacing barley by corn or sorghum on rumen fermentation characteristics and performance in lambs, and they informed that the dry matter degradability was 87.8% after incubation of concentrate containing 84% barley in the rumen for 48 hours. The IVTDMD value of barley in the present study was similar to that of Yahaghi et al. (2012) but higher than that of Aldemir and Karslı (2012). However, the IVTOMD value of barley was similar to that of Aldemir and Karslı (2012). Tahseen et al. (2014) stated that dry matter and NDF degradabilities of greenhouse wastes (tomato and cucumber) were 72 and 69.10%, respectively. Keklikci and Selcuk (2018) determined IVTDMD value of tomato pomace was 68.70%. Selçuk et al. (2019) reported that the IVTD and IVTOMD values of tomato pomace were 74.90% and 72.50%, respectively. Kılıç and Abdiwali (2016) determined that IVTD value of grape pomace was 73.80%. Palangi et al. (2013) stated that in situ dry matter degradability values of orange, grapefruit, lemon and tangerine pomaces were 90.20, 93.20, 83.20 and 88.50%, respectively after 48 h incubation in the rumen. The results for IVTD and IVTOMD of DWMP in the current study were higher than those of Selçuk et al. (2019) who reported for dried tomato pomace and lower than those of Palangi et al. (2013) who stated in situ dry matter degradability values of citrus pomace. IVTD values of DRMP were lower than the values reported for dried tomato, grape and citrus pomaces. The reason for the differences between our study and the others may be due to the kind of pomaces used in the studies.

In the current study on the substitution of barley with different levels of DWMP and DRMP, the highest and the lowest IVTDMD values belonged to barley and DRMP, respectively. IVTD, IVTDMD and IVTOMD values of the mixtures which were consisted of barley and 25% and 50% of DWMP were similar to each other. In the mixtures formed with barley and DRMP, as the level of DRMP increased, IVTD, IVTDMD and IVTOMD values decreased. Similar decreases in the values for IVTD, IVTDMD and IVTOMD were also determined in the mixtures containing 50% and more than DRMP.

Selcuk and Keklikci (2018) and Selçuk et al. (2019) reported that the IVTNDFD values of dried tomato pomace were 23.60% and 27.10%, respectively. In this study, IVTNDFD values of barley and DRMP were similar to each other but lower than that of DWMP. Although the IVTNDFD value of DWMP of the study was similar to that of Selcuk et al. (2019), the IVTNDFD value of DRMP was lower than the results of Keklikci and Selcuk (2018) and Selçuk et al. (2019). However, the positive correlation between the replacement of barley with DWMP at increasing levels and IVTNDFD was similar to the correlation mentioned by Selçuk et al. (2019) for the mixtures containing increasing dried tomato pomace and alfalfa hay.

CONCLUSION

In conclusion, due to nutrient composition and digestibility of DWMP, barley may be substituted with DWMP up to 50% in diets of livestock raised for meat or milk production. Since replacing of barley with DRMP at the level of 25% was resulted in decreasing in IVTD values compared to barley, this substitution does not suggested. Further studies are needed to determine the effects of barley substitution with DWMP on *in vivo* digestibility, rumen fermentation, fattening performance or milk production.

Ethics Committee Information: This study is not subject to the permission of HADYEK in accordance with Article 8 (k) of the "Regulation on Working Procedures and Principles of the Animal Experiments Ethics Committees". In addition, the authors have declared that Research and Publication Ethics are observed.

Conflict of interest: The authors declare that there is no actual, potential or perceived conflict of interest for this article.

Financial support: The authors would like to extend their sincere appreciation to Ondokuz Mayis University Research Fund (Project number: PYO.VET.1904.18.016) and the study is the summary of the first author's Master's thesis.

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