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Araştırma Makalesi

The Effect of Multiple Choices for Grain and Protein Sources of Differing in Ruminal Degradability on Diet Selection and Performance of Lactating Goats

Sabri Yurtseven[1], Murat Görgülü[2*]

[1] Harran University, Faculty of Agriculture, Animal Science, Sanlıurfa, Turkey.

[2] Cukurova University, Faculty of Agriculture, Animal Science, 01330 Adana, Turkey.

*e-posta: gorgulu@cu.edu.tr; Tel/Fax:+90 (322) 338 64 63

Abstract

Fifteen does were used to test the effect of multiple choices for grain and protein sources on diet preferences and lactation performance of goats. The treatments were; 1) corn+soybean meal (CSBM), 2) corn+corn gluten meal (CCGM), and 3) barley+corn+SBM+CGM (MC). The ingredients were offered along with wheat bran and alfalfa hay chopped into 1-2 cm. The does receiving MC preferred more protein sources (P<0.05) and less alfalfa (P<0.05) than those receiving CCGM. Preferences for SBM and CGM of the does along with corn were 5.50% and 1.81% of the selected diets, respectively. However, CGM preference increased substantially (1.81 % for CCGM and 9.03% for MC), when barley, corn, SBM and CGM were available simultaneously. Barley preference was higher (13.25% vs. 28.99%) than corn preference in MC treatment. The does fed on MC maximized ME (P=0.11) and crude protein (P<0.01), but minimized fat (P<0.01) contents of the selected diets. The does in MC treatment selected the diet containing 11.2 MJ ME, 181.4 g CP, 184 g ADF and 334.6 g NDF/kg DM. Milk yield (P=0.13) and fat-corrected milk yield (P=0.07) tended to increase when the does had free access to multiple choice compared to those fed on CSBM and CCGM. Protein yield and milk production efficiency increased markedly (P<0.05) by MC over other treatments. The results of the present study suggest that more alternatives for grain and protein sources in choice fed goats may improve performance and overcome imbalances in nutrient supply to rumen microorganisms and/or to the host animal.

Key words: choice feeding, diet selection, protein sources, grain sources, goat.

Laktasyondaki Keçilerin Yem Tercihi ve Performansları Üzerine Rumende Yıkılma Düzeyleri Farklı Tahıl ve Protein Kaynaklarının Çoklu Seçme Yolu ile Verilmesinin Etkileri

Özet

Çalışma süt keçilerinin yem tercihleri ve laktasyon performansları üzerine farklı rumen yıkım düzeylerine sahip tahıl ve protein kaynaklarının çoklu seçme yolu ile verilmesinin etkilerini incelemek amacı ile yapılmıştır. Bu amaçla ikinci laktasyon döneminde, ortalama 48.6±3.8 kg canlı ağırlıkta, laktasyondaki gün sayısı 101±4.0 olan ve 1438±113 g/gün süt verimine sahip 25 adet keçi denemeye alınmıştır. Muameleler; 1) mısır+soya küspesi (MSFK), 2) mısır+mısır gluten unu (MMGU), ve 3) mısır+arpa+SFK+MGU (çoklu seçmeli ÇS) şeklinde olup, tüm gruplarda buğday kepeği ve 1-2 cm ye kadar öğütülmüş yonca kuru otu bulundurulmuştur. ÇS grubundaki keçiler MMGU grubundakilerden daha fazla protein kaynağı ve daha az yonca tercih etmişlerdir (P<0.05). MSFK ve MMGU gruplarında seçilen rasyonlarda SFK ve MGU oranı sırası ile 5.50% ve 1.81% olmuştur. Ancak, MGU'nun tercih edilme oranı mısır, arpa, SFK ve MGU'nun birlikte verildiği ÇS grubunda önemli düzeyde artmıştır (MMGU; 1.81% ve ÇS; 9.03% MGU ve 1.91 % SFK). ÇS gruplarında arpa, mısırdan daha fazla tercih edilmiştir (13.25% ve 28.99%). Yem maddelerinin tercih oranlarına bağlı olarak ÇS grubundaki seçilen rasyonlar daha fazla ME (P=0.11) ve protein (P<0.01), daha az eter ekstrakt (P<0.01) içermiştir. ÇS gruplarındaki keçiler 11.2 MJ ME, 181.4 g HP, 183.6 g ADF ve 334.6 g NDF/kg KM içeren bir rasyon tercih etmişler ve süt verimi (P=0.13) ile düzeltilmiş süt verimi (P=0.07) bu gruplarda MSFK ve MMGU gruplarına göre artma eğilimi göstermiştir. Süt protein verimi ve süt üretim etkinliği (kg süt için kuru madde tüketimi) ÇS gruplarında yem tüketiminde azalış ve süt veriminde artmaya bağlı olarak önemli düzeyde iyileşmiştir (P<0.05). Mevcut denemenin sonuçları, farklı yıkılabilirlikteki nişasta ve protein içeren enerji ve protein kaynaklarının daha fazla alternatiflerle seçmeli olarak verilmesinin verim performansının iyileştirilebileceği ve rumen mikroorganizmaları ile konakçı hayvan için gerekli besin maddelerinin temin edilmesinde oluşabilecek dengesizliklerin önlenebileceğini destekler niteliktedir.

Anahtar kelimeler: seçmeli yemleme, rasyon tercihi, çoklu tercih, protein kaynağı, enerji kaynağı, keçi

Introduction

It is well known that the performance of ruminants depends mainly on nutrient supply to microorganisms in the rumen and to the host animal. Microbial protein synthesis in the rumen depends on fermentable organic matters and degradable protein in the diet (Nocek and Russell, 1988; NRC, 2001). It is possible to improve microbial growth and animal performance by matching energy and protein in the diet (Herrera-Saldana *et al*. 1990a) or assigning proper feeding method (Gorgulu *et al*. 1996; 2003; Yurtseven and Gorgulu, 2004).

It has been reported that highly degradable starch and protein in the diet increased microbial protein synthesis (Herrera-Saldana *et al*. 1990a; Aldrich *et al*. 1993), although no improvement in microbial protein synthesis due to synchrony between energy and nitrogen supply was observed in other studies (Henning *et al*. 1993; Kim *et al*. 1999). Khorasani *et al*. (1994) suggested that the stabilization of rumen fermentation and reduction of diurnal variation in ruminal pH and VFA concentration due to feeding more slowly degradable starch might stimulate microbial protein synthesis. In the above studies, barley, corn, soybean meal (or rumen degradable protein) and corn gluten meal (or rumen undegradable protein) were used to match energy and nitrogen release in the rumen, as they vary in respect to ruminal degradability; corn starch is less degradable than barley starch (Herrera Saldana *et al*. 1990b; Petit 2000), soybean meal protein is highly soluble and degradable than corn gluten meal protein (Reynal and Brodderick, 2003).

It is expected that matching energy and nitrogen release in the rumen by providing a diet containing feedstuffs differing in starch and protein degradability could result in synchronized nutrients supply to the rumen microorganism and/or to the host animal. However, the research findings have shown inconsistent results for microbial growth and animal performance (Herrera-Saldana *et al*. 1990a; Casper *et al*. 1999). This might be the result of inefficient synchronization with a man made diet as the feedstuffs differing in ruminal degradability were given in a single diet. Such synchronization could be realized by giving feedstuffs as a free choice separately as well.

In fact, animals can learn the consequences of food ingestion physiologically and can recognize feed ingredients offered as free choice according to their postingestive effects (Gorgulu *et al*. 1996; Fedele *et al*. 2002; Gorgulu *et al*. 2003, Yurtseven and Gorgulu, 2004). Furthermore, Fedele *et al*. (2002) and Gorgulu *et al*. (2003) reported that goats having free access to feed ingredient are able to select a diet that would meet their nutrient requirements and produce more milk compared to those fed by conventional feeding methods (e.g. total mixed ration or feeding concentrate and roughage separately). Choice feeding may give a liberty to animals for consumption time, meal size, meal length and meal order for each feedstuff that is provided as free choice during a day. Thus, choice feeding may overcome the aforementioned limitations of dietary manipulation for ruminal degradability of grain and protein sources by providing synchronized nutrient supply to the rumen microorganisms and to the host animal. However, success in diet selection depends markedly on quantitative and qualitative availability of feed ingredients to meet nutrient requirements of animals. Forbes (2001) reported that animals have ability for matching intake to requirements when feed ingredients offered are capable of providing a balanced diet and/or for coping with an optimal manner when food available is incapable of providing a balanced diet. Offering grain and protein sources differing in ruminal degradability simultaneously could provide an excellent opportunity for the animal to exhibit its innate ability for diet selection to meet nutrient requirements in a synchronized manner.

The present study, therefore, aimed to determine whether providing grain (corn and barley) and protein sources (soybean meal and corn gluten meal) differing in ruminal degradability as a multiple choice simultaneously would affect diet selection, milk yield and milk composition of German Fawn x Hair Crossbred goats during mid lactation.

Materials and Methods

In the study, 15 German Fawn x Hair first backcross does with twin kids were used in the second lactation period. The does, averaging 48.6±3.8 kg live weight, 1438±113 g d^{-1} milk, and 101±4 days after postpartum, were assigned to three treatment groups based on their individual live weight and milk yield in a completely randomized design, each group comprising 5 does. Each doe was housed individually in a 1.5 m x 3 m pen, equipped with a feed trough sizing 0.4m x1.2 m and a 15-L bucket for fresh drinking water. Each feed trough was divided into four (for the groups offered 4 feedstuffs) or six (for the group offered 6 feedstuffs)

equal parts to present feed ingredients as free choices separately.

The feed ingredients offered as free choice were designated according to their ruminal degradation rates for protein and starch. Barley and corn were selected due to the degradability of their nonstructural carbohydrate and protein. Barley has more rapidly degradable and fermentable nonstructural carbohydrate in the rumen and higher rumen degradable protein content than corn (Casper *et al.* 1999). Soybean meal (SBM) has higher amounts of soluble and more degradable protein than corn gluten meal (CGM, Holter *et al.* 1992). To meet the needs of goats for fiber and energy-diluting materials, wheat bran and alfalfa hay chopped into 1-2 cm were also offered as free choice in addition to energy (corn or barley) or protein (corn gluten meal or soybean meal) sources. The groups were designed as follows; 1) corn+wheat bran+SBM+alfalfa hay (CSBM), 2) corn+wheat bran+CGM+alfalfa hay (CCGM), and 3) corn+barley+SBM+CGM+alfalfa hay (MC). The does fed to CSBM and CCGM were designed to monitor their feeding behavior when they received grain and protein sources without alternatives differing in ruminal degradability of their starch and protein. These groups (CSBM and CCGM) were considered as control for MC group. The MC group was designed to overcome the limitation in supplying rapidly and slowly degradable starch and protein source for the ruminal microorganisms and/or for the host animal with CSBM and CCGM groups by supplying grain and protein sources with their alternatives simultaneously. The does in three treatments had free access to wheat bran and alfalfa hay in addition to protein and grain sources.

The experiment including one week training period at the beginning, lasted for 9 weeks. During the training period, wheat bran, corn and SBM or CGM along with alfalfa hay for CSBM and CCGM groups were supplied in the first, second and third day of training period, respectively. The same procedure was applied to the next three days and last day of training week and throughout the experimental period, all ingredients were offered simultaneously. Similar procedure was applied to the MC group, but the grain (corn and barley) and protein sources (SBM and CGM) were supplied simultaneously, such that the does in those groups received alfalfa, corn and barley simultaneously in the second day also received alfalfa, SBM and CGM simultaneously in the third day of training period. This procedure was repeated for the remaining three days of the training period. All feed ingredients were supplied to the does of MC group in the last day of training period and throughout the study.

Each of the feed ingredients, except alfalfa hay, was mixed with 2.8% limestone, 1.2% salt and 0.1% vitamin-mineral mixture to ensure the micronutrients intakes of choice-fed group and prevent any possible effect of micronutrients on feed selection. All ingredients and fresh water were offered *ad libitum* to goats during the entire study.

Chemical and Statistical Analyses

The compositions of feed ingredients were determined by AOAC (1998). NDF and ADF were analyzed based on the methods of Van Soest *et al.* (1991) using ANKOM fiber analyzer. Metabolizable energy content of the diets was calculated based on the table values published by NRC (1981).

Live weight change, milk yield and feed intake were determined weekly. Animals were milked by hand during the morning and milk samples were analyzed for milk fat by Gerber method. Milk samples were also analyzed for dry matter, ash, milk protein, NPN, casein nitrogen according to AOAC (1998). The rest of the nitrogen fractions were determined by calculation. Lactose was found by subtracting fat plus protein from milk organic matter as described by Sanz Sampelayo *et al.* (1998).

Data were analyzed using GLM procedure of SPSS (SPSS, 1999). Initial milk yields of the does were taken as covariant for performance parameters. The differences among treatments were separated by Duncan Multiple Range Test.

Results

The diets chosen by the does offered free choices are given in Table 1. Dietary treatments had significant effects on the preference of protein source ($P<0.03$) and alfalfa hay ($P<0.01$). The does receiving MC preferred more protein ($P<0.05$) and less alfalfa ($P<0.01$) than those received CCGM. Preferences for SBM and CGM of the does along with corn were 5.50% and 1.81% of the selected diets, respectively. However CGM preference increased substantially (1.81 % for CCGM and 9.03% plus 1.91 % SBM for MC) when corn, barley, SBM and CGM were available simultaneously. Barley preference of MC does was also higher than corn preference. (13.25% vs 28.99%).

Depending on these preferences, the does fed on MC

Table 1. Feed ingredient and chemical compositions of the diets selected by does (g/kg)

Diets	CSBM	CCGM	MC	SEM	Effect(P)
Corn/Barley	315.0	400.5	132.5/289.9	52.7	0.38
SBM/CGM	55.0ab	18.1b	19.1/90.3a	21.2	0.03
Wheat Bran	322.8	211.7	226.2	34.6	0.10
Chopped alfalfa hay	277.6ab	342.7a	211.1b	26.6	0.01
Premix[1]	29.6	27.0	30.9		
Chemical compositions (DM basis);					
ME, MJ/kg	10.8b	10.9ab	11.2a	0.08	0.11
CP	141.1b	125.5b	181.4a	10.1	0.01
RUP, %CP	40.25	44.79	42.42	1.47	0.14
ADF	202.2	221.3	183.6	13.2	0.18
NDF	318.9	325.0	334.6	18.2	0.84
Ether extract	29.3a	30.4a	24.5b	1.0	0.01

CSBM: Corn-soybean meal, CCGM: corn-corn gluten meal, SBM: Soybean meal, CGM: corn gluten meal, RUP: rumen undegradable protein, a,b: means in the same row having different letters are different (P<0.05). SEM:standard error of mean.
[1], amount of premix comes from supplementation of the feed ingredients except alfalfa with 2.8% limestone, 1.2% salt and 0.1% vitamin-mineral mixture providing 8000000 IU vitamin A ,1000000 IU vitamin D_3, 30000 mg vitamin E, 50000 mg Mn, 50000 mg Zn, 50000 mg Fe, 10000 mg Cu, 150 mg Co, 800 mg I and 150 mg Se per kg.

maximized ME (P=0.11, Table 2) and crude protein (CP, P<0.01, Table 2), and minimized fat (P<0.01) contents of the selected diets. Milk yield (P=0.13) and fat-corrected milk yield (P=0.07, Table 2) tended to increase when the does had free access to multiple choice compared with those of CSBM and CCGM. Protein yield and milk production efficiency were increased markedly by MC over other treatments due to increase in milk yield. CGM in the diet tended to increase casein level in milk (P<0.07, Table 2).

Discussion

The does fed to CCGM preferred less protein source compared to those of CSBM and MC and selected a diet having the lowest protein content (Table 1). However, less preference to CGM was recovered when corn, barley, SBM and CGM existed as choice simultaneously (MC group). The less preference to CGM could be resulted from its unpleasant flavor (Wu *et al*. 1994), high protein content supplying more amino acids to small intestine with less CGM intake with lower ruminal degradability (Mabjeesh *et al*. 1998) or unbalanced amino acid supply to small intestine due to lysine deficiency (Abe *et al*. 1997; Korhonen *et al*. 2002). However the increase in CGM preference by five fold (1.81% vs 9.03%) was observed when grain and protein sources were available simultaneously as choice indicated that the imbalance between rumen undegradable protein and rumen degradable protein in the diet and/or rumen and/or amino acid supply to small intestine with CGM played a more important role than the palatability of CGM for CGM preference in the present study. This was also supported by the differences between alfalfa preferences of the does in CCGM and CSBM groups. The does receiving corn and CGM as choice (CCGM) consumed more alfalfa hay than those receiving corn and SBM; this was probably resulted from the need for protein and/or rumen degradable protein of the does receiving corn and CGM, which are poor in rumen degradable protein (Mabjeesh *et al*. 1998; NRC, 2001). In the present study, alfalfa hay was used primarily as a fiber source or an energy-diluting material, but the does receiving corn and CGM consumed more alfalfa to meet protein and/or rumen degradable protein requirements due to its more degradable protein than corn and CGM (NRC, 2001). The does fed on corn and CGM diverted their preferences from CGM to alfalfa and the does fed on MC diverted their preference from corn to barley for grain sources and from SBM to CGM for protein sources. Diversification in feed preference of the does can be explained by discomfort from nutrient supply with particular feed ingredients (eg. corn-CGM and corn-SBM). Provenza (1995) and Forbes (2001) suggested that discomfort resulted from a nutrient deficiency in the diet may divert animal's preferences to foods to correct the deficiency.

In MC treatment, the does preferred more barley than corn; and more CGM than SBM when both grain and protein sources were available simultaneously. High preference to barley compared to corn probably resulted from the need for highly degradable or digestible starch of the ruminal microorganisms and/or the host animal. The high preference to barley may be attributed to its

degradability causing high rate of positive feedback by modulating intake rate and feedback from nutrient ingestion (Provenza (1995). However, Yurtseven and Görgülü (2004) revealed that grain content of diets selected by goats in mid lactation did not change significantly, when animals received corn-SBM and barley-SBM along with wheat bran and alfalfa hay as choice separately. High preference to barley over corn and high preference to CGM over SBM by the does of MC treatment could be explained with the ability of the treatment to match their nutrient intakes to the nutrient requirements when feed ingredients offered are capable of providing balanced or synchronous diet (Forbes, 2001). The does in MC treatment received proper feed ingredients (barley, corn SBM, CGM, wheat bran, alfalfa hay) to be able to make balanced and/or synchronized diets for the ruminal microorganisms and/or themselves.

On the other hand, the does in MC decreased alfalfa preference to 21%, but they did not suffer any metabolic problem. This could be explained by the increase in barley preference including relatively high level of fiber as compared to corn, in addition to the changes in feeding behaviour (order of feed ingredient consumptions, intermeal interval, meal size and meal length, etc., Abijaoude *et al*, 2000) of the goats having free access to feed ingredients (Görgülü *et al*. 2003) and pectin content of alfalfa hay with high buffering capacity (Van Soest *et al*. 1991). The does in all treatments selected diets with 18-22% ADF and 32-34% NDF. Dietary fiber is essential for maintaining ruminal environment within physiological limits (Van Soest *et al*. 1991). Similarly Fedele *et al*. (2002) showed that choice fed goats selected diets containing 74-85% concentrate with about 40% NDF in different physiological status. Small difference in NDF content between the studies could be attributed to the differences in animal and feed material and climatic condition.

Table 2. Lactation performance and milk composition of the does fed on multiple choices

Properties	CSBM	CCGM	MC	SEM	(P<)
LWC, g/day	75.0	72.0	75.0	30.0	0.99
Milk yield, g/day	932.5	1113.0	1446.1	157.7	0.13
4%FCM, g/day	866.7b	1003.3ab	1206.7a	80.0	0.07
Fat yield, g/day	32.6	37.2	42.6	4.0	0.27
Protein yield, g/day	32.6b	38.83b	50.21a	2.9	0.01
DMI, kg/day	2.48	2.34	2.21	0.2	0.62
ME Intake, MJ/day	26.9	25.7	24.7	2.0	0.78
CP g/day	352.4	292.5	400.8	33.6	0.12
MPE (DMI/milk yield)	2.69a	2.15ab	1.61b	0.2	0.01
ADF g/day	500.0	510.0	400.0	30.0	0.14
NDF g/day	790.0	750.0	740.0	60.0	0.84
Milk compositions;					
Lactose %	4.43	4.40	4.39	0.34	0.99
Protein, %	3.45	3.48	3.55	0.14	0.89
Fat, %	3.40	3.36	2.99	0.23	0.45
DM, %	11.97	12.00	11.63	0.41	0.78
Ash, %	0.68	0.75	0.69	0.03	0.38
Milk nitrogen fractions;					
Total N, g/L	5.40	5.45	5.56	0.23	0.88
True protein N, g/L (TrN)	5.20	5.24	5.19	0.24	0.98
Casein N, g/L (CzN)	4.02b	4.33a	4.07ab	0.08	0.07
Whey N, g/L	1.17	0.91	1.12	0.19	0.63
NPN, g/L	0.50	0.49	0.57	0.03	0.30
TrN/TN, %	91.38	91.60	90.25	0.73	0.43
CzN/TN, %	71.03	76.27	70.98	2.35	0.26

CSBM: Corn-soybean meal, CCGM: corn-corn gluten meal, LWC:live weight change, FCM: 4% fat corrected milk, DMI: dry matter intake, MPE: milk production efficiency, ME: metabolizable energy, CP: crude protein, NPN: nonprotein nitrogen, SEM:standard error of mean.

The does in all treatments selected diets with 10.8-11.2 MJ ME, 126-181 g CP, 184-221 g ADF, 319-335 g NDF/kg DM. They also settled rumen degradable protein to 40-45 % of crude protein. However the does in MC treatment maximized ME and CP content in the diet compared with other does when the does in MC treatment had opportunity to consume slowly or rapidly degradable starch and protein sources, with energy-diluting material and fiber sources allowing them to optimize ruminal condition and nutrient supply to the ruminal microbes and/or the host animal. Kijora *et al*. (2002) reported that 11.3-11.6 MJ ME/kg DM is enough, however 16% crude protein in the dry matter of the diet may cause surplus for protein for the German Fawn Goat in mid or late lactation. Santini *et al*. (1992) revealed that 18-22% ADF did not affect the performance of lactating goats especially when alfalfa hay was used as a main fiber source in the diet as was the case in the present study. Nutrient contents of the selected diets are generally in the range of recommendation, but recommendations on daily nutrient requirements of NRC (1981) are quite lower than those consumed by choice fed does in the present study. This was also already discussed for high yielding Damascus Goat in early lactation (Gorgulu *et al*. 2003) and German FawnxHair crosbred goats in mid lactation (Yurtseven and Gorgulu, 2004).

The findings related to milk yield and milk composition revealed that providing more alternatives for choices could improve the performance of lactating dairy goats. The lowest feed intake and the highest milk production (improved milk production efficiency) were observed for MC. DMI of the MC does was 5.55% and 11.88% lower numerically than those of the CCGM and CSBM, respectively. Rapid ruminal degradation of carbohydrate in the rumen such as barley's starch may adversely affect ruminal environment and digestion of fiber, and depress DMI by decreasing ruminal pH. Furthermore, decrease in DMI in MC does might also be a reflection of energy satiety (Glimp *et al*. 1989), as the animals consumed feed to meet their energy requirements (Forbes, 1983) unless there is any physical limitation in the stomach capacity. Petit (2000), Aldrich *et al*. (1993), Khorasani *et al*. (1994) and Casper *et al*. (1999) observed that corn in the diet increased dry matter intake over barley in lambs and cows. However DePeters and Taylor, (1985) and Hadjipanayiotu (2004) and Yurtseven and Görgülü (2004) did not observe any differences in dry matter intake in dairy cows and goats like in the present study.

Increase in milk and protein yield, milk casein by MC group could be attributed to increased amino acid supply to small intestine by corn and CGM and improved utilization of nutrient and synchronous nutrient supply to the ruminal microorganisms and/or to the host animal. Korhonen *et al*. (2002) reported lowered milk yield response to SBM compared to fish meal and CGM and suggested that this was mainly related to lower nitrogen and amino acid supplies due to high ruminal protein degradability of SBM. Corn and CGM are good sources for methionine, one of the first limiting amino acid in some conditions for lactating animals (Cozzi *et al*. 1995; NRC, 2001). Increasing dietary methionine may increase milk yield (Varvikko *et al*., 1999; Xu *et al*. 1998) and milk protein (Kowalski *et al*. 2003). It is also possible to suggest that CGM might have created better synchronization with different grains than SBM in the choice feeding conditions. Furthermore, CGM and alfalfa hay could have better complementary effect for amino acids used for milk protein synthesis. Similarly, Van Horn and Powers (1992) reported that the response of milk yield to substitution of SBM with rumen undegradable proteins were more positive for the diet based on alfalfa than for the forage containing lower protein.

The does in the present study offered different feed ingredient selected different diets in respect to ingredient contents (protein source and alfalfa hay, Table 1) and nutrient contents (ME, CP, Table 1). However they consumed similar amount of ME, CP, ADF and NDF (Table 2). These findings confirmed that lactating goats have a good nutritional wisdom that allowing them to select nutritionally balanced diet and to avoid feedstuffs causing nutritional discomfort when proper feedstuffs were supplied. In addition, dairy goats having free access to multiple choices giving opportunity to form balanced diets could match their nutrient requirements to their nutrient intakes by changing their diet preferences and intake level as reported in previous studies (Fedele *et al*, 2002; Görgülü *et al*. 2003; Yurtseven and Görgülü, 2004). Although the does in all treatments consumed similar amounts of nutrients, better milk yield and protein yield of the does in MC treatment indicated that offering more alternatives for grain and protein sources differing in ruminal degradability (or feed ingredients) in choice fed goats may improve nutrient utilization for milk production (increase in milk production efficiency, Table 2) by overcoming imbalances in nutrient supply to rumen microorganisms and host animal.

Conclusion

The results obtained in the study showed that offering alternatives for structural and nonstructural carbohydrate and protein sources differing in degradability in the rumen to lactating goats may help to overcome imbalances in nutrient supply to rumen microorganisms and/or host animal and increase milk yield.

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