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Effects of the Supplemental Protected Fat to Concentrate Feed on Performance and Some Milk Parameters in Dairy Goats

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Abstract: In this study, the effects of Protected Fat (PF) supplementation on the performance and some milk parameters were investigated on dairy goats. The experiment began after completion of the parturitions and lasted for 8 weeks. The animals were individually fed with an additional 100 g PF a day in the supplementary group. The data on Body Weight (BW), Concentrate Feed Intake (CFI), Dry Matter (CDM), Crude Protein (CCP), Metobalizable Energy (CME) intake in concentrate feed was observed every week. Moreover, Milk Yield (MY), Milk Dry Matter (MDM), Milk Fat (MF), Milk Ash (MA), Milk Density (MDEN) and Milk pH (MpH) was observed every 2 weeks during 8 weeks period. The results indicated that there was statistically significant differences in BW between weeks ($p<0.01$) although, a statically significant interaction between weeks and groups were found in terms of CFI ($p<0.01$). The BW increased from the beginning of experiment to the end of experiment. Although, CDM and CCP in PF group decreased, there was an increase in CME. Regarding MY, PF group was not significantly differed ($p>0.05$) from the NPF group. The results showed that the interaction between groups and weeks was statistically significant in terms of MF ($p<0.05$). While, the differences in MDM between both weeks and groups were statistically significant ($p<0.05$), there was significant divergence only between weeks regarding MA, MpH and MDEN ($p<0.01$). The findings of this study clarified that PF group had the higher MDM and MF.

Key words: Dairy goat, concentrate feed, protected fat, performance, milk parameters

INTRODUCTION

Early lactation is one of the critical periods of dairy goats like in other ruminants. The importance of this period is related with the reduced dry matter intake, which results in decreasing consumption of nutrients, especially in energy.

The energy density of the ration can be increased by either using high level concentrate mixtures or grains in the ration, or adding fat to prevent the energy deficiency in this stage.

The Protected Fat (PF) supplementation to the diet seemed to be a suitable method. This is because it does not cause the rumen acidosis and negatively influences the cellulose digestion in the rumen. There are many researchers studying on this property. Their results reported in literature emphasized the suitability of PF supplementation for small ruminants (Horton *et al*., 1992; Sanz Sampelayo *et al*., 2002a, b; Haddad and Younis, 2004).

Furthermore, the physico-chemical characteristics of goat milk have been satisfactorily studied. Therefore, there is enough information on biochemical composition and nutritional characteristics (Chandan *et al*., 1992).

It is stated that there are noticeable breed differences in fat composition. However, it is important to bear in mind that the quality and quantity of feeds, genetics, season, stage of lactation etc., influence the average percentage of goat milk fat (Chilliard *et al*., 2003).

In early 1980s, it was shown that the composition of milk could be changed by controlling dietary, which had not only opportunities but also restrictions. Jenkins and McGuire (2006) reported that the most sensitive component of milk to dietary manipulation was fat content, which could be changed over a range of 3 percentage units.

The purpose of this study is to determine the impacts of PF supplementation on concentrate feed intake, body weight, milk yield and the some milk parameters of dairy goats in early lactation stage.

MATERIALS AND METHODS

Seventeen Akkeci does (Saanen x Kilis), which were 1 year old with an average initial body weight of 45 kg

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Table 1: The composition of the PF, which was used in this experiment (%)

Chemical composition of PF	Fatty acid composition (%) of PF
Metabolizable energy, MJ kg^{-1}: 29	Myristic acid (C14:0): 1.5
Total fat: 84	Palmitic acid (C16:0): 44
Moisture: 3.5	Stearic acid (C18:0): 5
Ash: 12.5	Oleic acid (C18:1): 40
Calcium: 9	Linoleic acid (C18:2): 9.5

Table 2: The ingredients of BCM and the chemical composition of the BCM and DAH

Ingredients (%)	BCM	DAH
Barley	-	43.00
Wheat	-	31.00
Sunflower seed meal	-	17.00
Cotton seed meal	-	6.00
Limestone	-	2.20
DCP	-	0.10
Mineral premix*	-	0.10
Vitamin premix**	-	0.10
Salt	-	0.50
Chemical composition		
Dry Matter (DM, g kg^{-1})	893.0	931.60
Metabolizable energy (MJ kg^{-1} DM)	12.5	8.70
Crude protein (g kg^{-1} DM)	160.0	144.00
Ether extract (g kg^{-1} DM)	29.7	12.00
Crude fiber (g kg^{-1} DM)	55.0	333.20
Crude ash (g kg^{-1})	66.5	103.80

*Remineral 2.25 K include: 50,000 mg Iron, 10,000 mg Copper, 50,000 mg Manganese, 150 mg Cobalt, 50,000 mg Zinc, 800 mg Iodine, 150 mg Selenium, **Rovimix 302-S 25 K include: 15,000,000 IU Vitamin A, 3,000,000 IU Vitamin D_3, 30,000 mg Vitamin E, 5,000 mg Vitamin B_1,100,000 mg Niacin

were randomly assigned into two dietary treatments, one of which was non-supplementary group including 8 does and the other was the supplementary group with 9 does.

Animals were offered a basal diet of Dried Alfalfa Hay (DAH) *ad-libitum* intake and either of the two concentrates mixtures treatments, one of which was not supplemented with PF (NPF) and the other concentrate was supplemented (PF).

The composition of the PF (including calcium salts of free fatty acids), which was used in this experiment is given in Table 1. The ingredients and the Basal Concentrate Mixture (BCM) and the chemical composition of BCM and DAH are given in Table 2.

The concentrate parts of the ration were given 1000 g day^{-1} each doe in two equal meals at the milking. The PF group consumed 100 g day^{-1} supplemented PF per doe in the individual pens.

The experiment was continued 8 weeks. The kids were breast-fed for 1 week and then separated. Does were taken to experiment after 1 week from the parturition.

While, the Concentrate Feed Intakes (CFI, g day^{-1}), were recorded daily, the Body Weight (BW, kg), Dry Matter (CDM, g day^{-1}), Crude Protein (CCP, g day^{-1}), Metobalizable Energy (CME, MJ kg^{-1} dry matter) intake in concentrate feed and Milk Yield (MY, kg day^{-1}) was obtained weekly.

For the analysis of milk parameters, samples of 500 mL were taken from 5 animals from each group in the morning milking time at an interval of two weeks. Milk Dry Matter (MDM, %), Milk Fat (MF, %), Milk Ash (MA, %), Milk Density (MDEN, g cm^{-3}) and Milk pH (MpH) were analyzed in the milk samples by using standard methods (IDF, 1981; AOAC, 2003).

The obtained data was analyzed as repeated measurements factorial design, in which the time was the factor having repeated measurements by applying ANOVA (Winer, 1991).

RESULTS AND DISCUSSION

The data on BW and CFI were collected from PF and NPF groups during 8 weeks period and analyzed by applying ANOVA. The results of the analyses indicated that there was statistically significant differences in BW between weeks ($p<0.01$) although, a statically significant interaction between weeks and groups were found in terms of CFI ($p<0.01$). Duncan multiple comparison test was applied to investigate, which groups and/or weeks significantly differed from each other. The results of Duncan test are given in Table 3.

As shown in Table 3, there was a fluctuation in BW from week to week. However, the results of Duncan test verified that the BW measured at the 1st week was significantly different from the BW measured at the last week. The BW has a tendency to increase from the beginning of experiment on. Since, there was a statistically significant interaction between groups and weeks with regard to CFI, the groups were compared at each week and the weeks were compared at each group (Table 3). The groups were significantly different from each other at 4th-6th weeks, which NPF group had higher CFI value than that of PF group. When the CFI measured during 8 weeks were compared in PF group, the results showed that the CFI measured at the 5th week significantly differed from the other weeks.

During the experiment, CDM, CCP and CME were calculated every week for both groups and analyzed by applying ANOVA. The results of ANOVA confirmed that there was a statistically significant interaction between groups and weeks ($p<0.01$). First, Duncan test was applied to compare weeks with each other in groups and then the groups were compared with each other at each week (Table 4).

As shown in Table 4, in PF group, the lowest value of CDM was observed on the 5th week, which was significantly different from the other weeks. Similarly, in NPF group, the lowest value of CDM was obtained on the

Table 3: The results of Duncan tests applied to BW (kg) and CFI (g day^{-1})

Weeks	BW	Weeks	Groups	CFI
1	40.65±1.17^{d}	1	1 (n = 9)	947.61±9.88$^{a, A}$
2	43.06±0.98^{abc}		2 (n = 8)	958.0±15.1$^{a, AB}$
3	42.65±0.94^{bc}	2	1 (n = 9)	882.1±14.9$^{a, BC}$
4	43.82±0.97^{ab}		2 (n = 8)	916.4±21.4$^{a, B}$
5	43.79±0.98^{ab}	3	1 (n = 9)	944.8±15.5$^{a, A}$
6	44.29±1.00^{a}		2 (n = 8)	978.9±10.6$^{a, A}$
7	41.82±1.04^{cd}	4	1 (n = 9)	845.5±19.3$^{b, C}$
8	44.18±1.02^{a}		2 (n = 8)	944.6±16.3$^{a, AB}$
		5	1 (n = 9)	778.2±21.3$^{b, D}$
			2 (n = 8)	911.4±31.7$^{a, B}$
		6	1 (n = 9)	832.1±18.7$^{b, C}$
			2 (n = 8)	954.1±19.5$^{a, AB}$
		7	1 (n = 9)	921.2±19.4$^{a, AB}$
			2 (n = 8)	981.69±8.80$^{a, A}$
		8	1 (n = 9)	952.8±13.2$^{a, A}$
			2 (n = 8)	982.1±12.1$^{a, A}$

*The difference between the groups having same letter is not statistically significant (p>0.05), *The small letters for CFI are used to compare the groups at each week, *The capital letters for CFI are used to compare weeks at each group

Table 4: The results of Duncan tests applied to CDM, CCP and CME

Weeks	Group	CDM	CCP	CME
1	1 (n = 9)	843.37±8.80$^{a, A}$	133.25±1.39$^{a, A}$	13.48±0.11$^{a, A}$
	2 (n = 8)	852.60±13.4$^{a, AB}$	134.71±2.12$^{a, AB}$	10.69±0.17$^{b, AB}$
2	1 (n = 9)	785.1±13.3$^{a, BC}$	124.04±2.10$^{a, BC}$	12.75±0.17$^{a, BC}$
	2 (n = 8)	815.6±19.1$^{a, B}$	128.87±3.01$^{a, B}$	10.23±0.24$^{b, B}$
3	1 (n = 9)	840.8±13.8$^{a, A}$	132.85±2.17$^{a, A}$	13.44±0.17$^{a, A}$
	2 (n = 8)	871.22±9.44$^{a, A}$	137.65±1.49$^{a, A}$	10.93±0.12$^{b, A}$
4	1 (n = 9)	752.5±17.2$^{b, C}$	118.89±2.72$^{b, C}$	12.34±0.22$^{a, C}$
	2 (n = 8)	840.7±14.5$^{a, AB}$	132.83±2.29$^{a, AB}$	10.54±0.18$^{b, AB}$
5	1 (n = 9)	692.6±19.0$^{b, D}$	109.43±3.00$^{b, D}$	11.59±0.24$^{a, D}$
	2 (n = 8)	811.1±28.2$^{a, B}$	128.16±4.46$^{a, B}$	10.17±0.35$^{b, B}$
6	1 (n = 9)	740.5±16.7$^{b, C}$	117.01±2.63$^{b, C}$	12.19±0.21$^{a, C}$
	2 (n = 8)	849.2±17.3$^{a, AB}$	134.17±2.74$^{a, AB}$	10.65±0.22$^{b, AB}$
7	1 (n = 9)	819.9±17.2$^{a, AB}$	129.54±2.72$^{b, AB}$	13.18±0.22$^{a, AB}$
	2 (n = 8)	873.70±7.84$^{a, A}$	138.04±1.24$^{a, A}$	10.96±0.01$^{b, A}$
8	1 (n = 9)	848.0±11.7$^{a, A}$	133.98±1.85$^{a, A}$	13.53±0.15$^{a, A}$
	2 (n = 8)	874.0±10.8$^{a, A}$	138.10±1.70$^{a, A}$	10.96±0.14$^{b, A}$

*The difference between the groups having same letter is not statistically significant (p>0.05), *The small letters are used to compare the groups at each week. *The capital letters are used to compare weeks at each group

5th week. But, this was only significantly diverged from the 3rd, 7th and 8th weeks. The same results were acquired for the CCP and CME (Table 4). PF and NPF groups were also compared with each other every week (Table 4). As shown in Table 4, the two groups were significantly differed from each other in terms of CDM and CME on the 4, 5 and 6th weeks. Regarding CCP, the groups significantly diverged from each other on the 4-7th weeks. Although CDM and CCP in PF group decreased, there was an increase in CME. These findings of the study are in accordance with the results stated by Sanz Sampelayo *et al*. (2002a).

The data collected on milk yield and milk parameters studied were also analyzed by applying ANOVA. Regarding MY, PF group was not significantly diverged from the NPF group (p>0.05). These finding of the study agreed with the results stated by Sanz Sampelayo *et al*. (2002a, b). On the other hand, in some researches, it is stated that the amount of milk yield increased (p<0.05) with consumption of the fat supplemented concentrate (Sanz Sampelayo *et al*., 2000, 2004).

Table 5: The results of analyses for MY, MF, MDM, MA, MpH and MDEN, the results of analysis for MY

Weeks	N	MY (kg day^{-1})
1	17	1386.6±79.6^{c}
2	17	1454.5±74.1^{bc}
3	17	1360.9±67.9^{c}
4	17	1528.9±78.4^{b}
5	17	1790.9±92.1^{a}
6	17	1683.5±94.5^{a}
7	17	1788.5±94.6^{a}
8	17	1542.0±85.7^{b}

*The difference between the groups having same letter is not statistically significant (p>0.05)

Table 6: The results of analyses for milk parameters, namely MF

Weeks (n = 5)	Groups (n = 10)	MF (%)
2	1	4.66±0.37^{a,B}
	2	4.56±0.51^{a,A}
4	1	5.08±0.24^{a,AB}
	2	3.96±0.45^{b,AB}
6	1	4.88±0.29^{a,B}
	2	3.66±0.26^{b,B}
8	1	5.74±0.22^{a,A}
	2	3.90±0.32^{b,AB}

*The difference between the groups having same letter is not statistically significant (p>0.05). *The small letters are used to compare the groups at each week. *The capital letters are used to compare weeks at each group

However, there was an evidence of statistically significant difference in MY between weeks (Table 5). As shown in Table 5, there was a steady increase in it until, the 5th week, which significantly differed from the first 4 weeks. After that, there were fluctuations and was a sharp decrease in it at the 8th week, which was significantly deviated from the 5, 6 and 7th weeks.

Regarding MF, there was an evident of statistically significant interaction between groups and weeks (p<0.05). First of all, the differences between two groups were compared with each other every week. The results showed that the groups were significantly different from each other and the PF group had the higher MF (Table 6). After that, the weeks were compared with each other at PF and NPF groups. In PF group, increases and decreases in MF were observed until 6th week and then there was a sharp increase in it, which was significantly differed from 2nd and 6th week. However, there was a steady diminish in MF in NPF group through out the experiment (Table 6).

While, the differences in MDM between both weeks and groups were statistically significant (p<0.05), there was significant divergence only between weeks regarding MA, MpH and MDEN (p<0.01). To control, which groups significantly different from each other Duncan test was applied and the results of this are presented in Table 7.

The ANOVA results indicated that at least 2 weeks were significantly distinguished from each other in terms of MDM (p<0.05). When, controlled, the results showed that the 1st week was significantly different from the others, having the highest MDM. PF had the higher MDM, which was significantly unlike NPF. With respect to MA, there was statistically significant difference only

Table 7: The results of analyses for milk parameters, MF, MDM, MA, MpH and MDEN

Week (n = 10)	MDM (%)	Group (n = 20)	MDM (%)	MA (%)	MpH	MDEN (g cm^{-3})
2	14.22±0.45^{a}			0.80±0.02^{a}	6.58±0.02^{ab}	1.0290±0.0004^{a}
4	13.50±0.33^{b}	1	14.21±0.19^{a}	0.79±0.01^{ab}	6.39±0.02^{c}	1.0276±0.0004^{c}
6	13.19±0.28^{b}	2	12.93±0.24^{b}	0.78±0.01^{ab}	6.54±0.03^{b}	1.0284±0.0001^{b}
8	13.38±0.36^{b}			0.76±0.02^{b}	6.63±0.02^{a}	1.0273±0.0002^{c}

*The difference between the groups having same letter is not statistically significant (p>0.05)

between 2nd and 8th weeks. The lowest MpH was obtained on the 4th week, which was significantly different from other weeks. Furthermore, the lowest values of MDEN were achieved on the 4th and 8th weeks, which was statistically different from the other weeks (Table 7).

The findings of this study clarified that PF group had the higher MDM and MF, which was in accordance with the results reported by Chilliard *et al.* (2003) and Sanz Sampelayo *et al.* (2000, 2004).

CONCLUSION

The following conclusions can be drawn depending on the findings of this study:

- The supplementation of 100 g day^{-1} PF to concentrate feed of dairy goats in early lactation brought about a decrease in the dry matter and crude protein intake decreased while, an increment was achieved in metabolizable energy intake
- The supplementation of 100 g day^{-1} PF to concentrate feed of dairy goats in early lactation resulted in an increase in the dry matter and fat content of milk

The final conclusion of this study a researcher should bear in mind that the fat supplementation on goat milk fat content would be useful in improving the technological problems of the goat cheese industry, which are linked to a low milk fat content, especially when fat content falls below protein content.

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