Pakistan J. Zool., pp 1-9, 2022. **DOI**: https://dx.doi.org/10.17582/journal.pjz/20210817140841

Effects of Supplemental Feeding of Fenugreek (*Trigonella foenum-graecum* L.) Seed on Milk Yield, Composition, Sensory Properties and Some Blood Parameters in Lactating Goats

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Article Information
Received 17 August 2021
Revised 04 October 2021
Accepted 19 October 2021
Available online 12 May 2022
(early access)

Authors' Contribution
HÇ, FC and AŞ designed and executed of the study, analysed the data and contributed in writing the manuscript. HÇ, HüÇ and AGF collected the data and performed the laboratory and sensory analyses. AŞ did the statistical analyses. HÇ prepared the first draft of the manuscript. AŞ finally approved the manuscript.

Key words
Fenugreek seed, Supplemental feeding, Milk yield, Milk composition, Dairy goat

ABSTRACT

The aim of this study was to investigate the effects of supplemental feeding of fenugreek (*Trigonella foenum-graecum* L.) seed on milk yield, composition and some blood parameters in lactating goats. In this study, ten lactating goats in the second lactation were used. Their milk yields were closer to each other. Experimental goats were divided into 2 groups as control (C) and Fenugreek (F), equally. They were individually kept in pen sized 2x2 m. C goats did not consume fenugreek seed while F goats were allowed to consume daily 50 g fenugreek seed for each just before the meal in the mornings. The experiment lasted for 63 days of which 7 days are for adaptation and 56 days are for treatment period. Results showed that fenugreek seeds supplementation increased feed intake (2876.4 vs 2716.4 g, P<0.01) and milk yield (1010.6 g vs 879.7 g, P<0.01) in lactating goats. Fat corrected milk yield was higher in F goats (865.2 g) than that of C goats (780.0 g) (P<0.01). Serum glucose, total cholesterol and protein levels were not affected while serum triglyceride level and prolactin hormone level increased by fenugreek seed supplementation (P<0.05). Fenugreek seed supplementation did not affect milk organoleptic properties such as smell, taste and appearance. To conclude, fenugreek seed in lactating goats can be used as natural supplement to increase milk yield since fenugreek seed had no effect on sensory properties of milk.

INTRODUCTION

In order to meet dietary requirements of dairy goat different feeding methods and feed additives have been used in many studies (Kholif, 2017; Kotsampasi *et al*., 2018). Especially, the recent advances in dairy goat nutrition have been well documented by Goetsch (2019).

Fenugreek (*Trigonella foenum-graecum* L.) seed normally used as human diet supplement have been used in this study as diatary supplement for dairy goat to enhance milk production (Kwan and Abdul-Rahman, 2021). Fenugreek is a single-year plant belonging to the legumes family grown in many parts of the world especially for use as spices. It is cultivated commonly in Southern Europe, North Africa, Central Asia, South America and some parts of Australia (Khattab *et al*., 2010) and also in Konya, Isparta, Aksaray, Karaman, Afyon, Corum and Ankara provinces of Turkey (Tunçtürk and Çiftçi, 2011).

Fenugreek seeds are known to be used for lowering plasma cholesterol and triglyceride levels, stimulating digestion, as antidiabetic and as carminative. It is also known for its protective and antioxidant properties against fatty liver syndrome. In addition to stimulating the immune system in humans, it is also reported to have a stimulating effect on lactation in breast-feeding women (Chaudhary *et al*., 2018; Dronca *et al*., 2018; Tunçtürk and Çiftçi, 2011; Wani and Kumar, 2018).

Fenugreek can be given to the animals as both forage and seed. It has a pleasant smell and has an appetizing effect on animals (Alemu and Doepel, 2011; Pałka *et al*., 2021). This appetizing effect would increase feed intake and consequently increase milk yield in lactating animals.

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0030-9923/2022/0001-0001 $ 9.00/0

Fenugreek seed contain high amount of protein, vitamins and essential amino acids. It is well digested by ruminants. It contains approximately 46.0-58.0% carbohydrates, 23.0-28.5% crude protein, 4.0-10.0% ether extract, 9.3% crude fiber and 3.2-4.2% crude ash (Degirmencioglu *et al*., 2016; Dronca *et al*., 2018; Özçelik and Şahin, 2018; Pavlovskaya and Nesterova, 2013; Tunçtürk and Çiftçi, 2011; Wani and Kumar, 2018). Additionally, its seeds contain biochemical components such as galactomannan, saponin, coumarin, fenugreekine, nicotinic acid, sapogenin, phytic acid, scopoletin, trigonellin and diosgenin. It is also rich in amino acids valine, phenylalanine, lysine, glycine, aspartic acid, glutamic acid, serine and leucine contents (Degirmencioglu *et al*., 2016; Pałka *et al*., 2021). Fenugreek seed contains 26.8% galactomannan as a carbohydrate (Dhull *et al*., 2020). This may be a galactogous substance to increase milk yield (Mohanty *et al*., 2014). Evidently, it was reported that the dietary supplementation of fenugreek seed in lactating animals increased their milk production and improved milk component (Al-Sherwany, 2015; Alemu and Doepel, 2011; Chaudhary *et al*., 2018; Degirmencioglu *et al*., 2016; Dronca *et al*., 2018; Hasin *et al*., 2019; Kirar *et al*., 2020; Sahoo *et al*., 2020; Smit, 2014; Wani and Kumar, 2018). In addition, fenugreek seed improved the digestibility of nutrients with having positive effects on live weight gain and feed conversion ratio in animals, as reported in some studies (Al-Janabi, 2012; Alemu and Doepel, 2011; Ciftci *et al*., 2011; Dronca *et al*., 2018; Elmnan *et al*., 2013).

Although there are some studies examining the effects of fenugreek seed supplementation on milk yield, milk composition and blood parameters in farm animals (Al-Sherwany, 2015; Hasin *et al*., 2019), there are only a few studies on dairy goats, no study particularly on supplemental feeding. There has been no study particularly investigating the effects of fenugreek seed on Saanen crossbred.

As usually known, prolactin secretion is related to milk production in both lactating animal and women. In women, fenugreek seed feeding 3 times a day with 575 mg tended to increase prolactin level and milk volume (Reeder *et al*., 2013). In another study, a 3 times 200 ml of fenugreek tea (50 g of fenugreek seeds) drinking in women increased lactogenesis at early stage and prolactin level (Abdou and Fathey, 2018). In an animal study carried out by Al-Janabi (2012), 4 and 6% dietary fenugreek seed powder increased milk production in Damascus crossbred goats. This effect might be attributed to the increased prolactin level by fenugreek seed treatment. In the current study, we do not know that whether supplemental feeding of fenugreek seed will increase prolactin secretion in lactating goats or not since this seed is not part of animal feed all the day. In addition, there has been no study to investigate the underlying mechanism of its milk increasing effect. Therefore, we have investigated in this study the effects of supplemental feeding of fenugreek seed on feed intake, some blood parameters such as galactomannan in blood prolactin level, milk yield with its composition and sensory properties in lactating goats.

MATERIALS AND METHODS

Experminatal animals and their maintenance

Ten Akkeçi goats (Saanen×Kilis Crossbereds F1, called Akkeçi) in the second lactation phase were used. Their mean live weight was 51.18 ± 2.64 kg. Before the experiment started, our animals were treated against external and internal parasites. The experimental practices and procedures of this study were approved by the Kırşehir Ahi Evran University Animal Experimentation Local Ethical Committee (Registration No: 22.11.2015/4). Experimental goats were kept in individual experimental pens each sized 1.5 x 2m. Fenugreek seeds used in experiment were purchased from a grain dealer representing farmers in Central Anatolia ecological condition. Experimental animals were divided into two groups control (C) and treatment (F). Each group included five animals for setting repetition, as each animal was one replicate. While C goats were not allowed to consume fenugreek seed, F goats were offered daily supplemental 50 g fenugreek seed individually as supplement just before the meal at the mornings. F goats were fed on concentrate 50 g less than that of C goats to help their dietary arrangement of isonitrogenous and isocaloric status of experimental diets. Concentrate included 24% barley, 14% corn, 26% wheat bran, 11% sunflower meal, 12% corn bran, 4.30% soya bean meal, 5% molasses, 3% limestone powder, 0.50% salt, 0.20% premix. Sainfoin (*Onobrychis viciifolia*) hay was offered *ad libitum* for both groups. Daily feed intakes were determined 24-h after each day feeding at 0900 hours Feeding procedure was based on the nutrient requirements of goats (NRC, 1981). The ingredients and nutritional contents of concentrate, hay and fenugreek seeds are presented in Table I. Fresh and clean water were available ad libition animals during experimental period.

The experiment lasted for 63 days. Before the experiment, animals were subjected to 7-d adaptation period to be accustomed to organoleptic and metabolic properties of feeds and pen condition. Milk yields were determined during the adaptation period to decide the amount of concentrated feed to be given to experimental animals. Hay and concentrate intakes were determined on daily basis.

Nutritional analysis of animal feed

Nutritional contents of hay, fenugreek seed and concentrate used in the trial (Table I) were determined by the methods reported in AOAC (1998). Acid detergent fiber, neutral detergent fiber and acid detergent lignin analyses were determined by using ANKOM Fiber Analyzer device, based on the method reported by Van Soest *et al*. (1991). Based on these chemical analysis, daily dry matter intake, organic matter intake, crude protein intake, ether extract intake, neutral detergent fiber intake and acid detergent fiber intake, metabolizable energy intake of animals were, also calculated.

The metabolizable energy (ME) content of feeds was calculated by using the following ME formula developed Turkish Standards Institute TSE 9610 for ruminant animals (TSE, 1991).

$$ME\ (kcal/kg\ OM) = 3260 + 0.455(A) - 4.037(H) + 3.517(B)$$

$$ME\ (kcal/kg\ OM) = 3260 + 0{,}455A - 4{,}037H + 3{,}517B$$

$$A = Crude\ protein, g/kg\ organic\ matter = CP, g\ kg/OM$$

$$H = Crude\ fiber, g/kg\ organic\ matter = CF, g\ kg/OM$$

$$B = Ether\ extract, g/kg\ organic\ matter = EE, g\ kg/OM$$

Table I. The nutritional contents of concentrate, hay and fenugreek seed on dry matter basis.

Chemical contents, (g/kg)	Concentrate	Sainfoin hay	Fenugreek seed
Dry matter	913.3	880.9	938.5
Organic matter	935.4	923.0	958.4
Crude protein	175.5	162.8	250.4
Ether extract	51.5	28.6	58.6
Crude fiber	89.5	451.1	171.2
Ash	64.6	77.0	41.6
Nitrogen free extract	618.9	280.5	531.4
Acid detergent fiber	970.6	600.3	910.0
Neutral detergent fiber	776.7	506.0	686.9
Metabolizable energy for ruminants[1], (Kcal/kg OM)	2950.0	1362.0	2738.0

Milk samples and analysis

During the experiment, the animals were milked once a day at 08:00 am and recorded daily. Milk samples were taken once a week for their chemical analysis using the Funke Gerber LactoStar 3510 device. Fat corrected milk yield (FCM, 6%) was calculated by using the formula below:

$$FCM, 6\% = (0{,}28 + 0{,}12 * milk\ fat\ concentration; \%) * milk\ yield, g/day)$$

Milk production efficiency was calculated according to the ratio of FCM g milk/g kcal ME (Kotsampasi *et al*., 2018; Martins *et al*., 2021).

Biochemical analysis of blood

Blood samples were taken from the vena jugularis veins of all animals after 2 h from morning feeding on 1st, 14th, 28th, 42nd and 56th day of experiment. The collected blood samples were centrifuged at 4000 rpm at 30 °C for 5 min. Serum was separated and then stored at -20 °C until analysis. Serum total protein, glucose, total cholesterol and triglyceride levels were measured with Olympus AU400 device using photometric method. Prolactin hormone levels were determined by the Roche Cobas 6000 analyzer using the CLIA method.

Organoleptic properties of milk

Organoleptic properties of milk samples were tested by the method given by Temiz and Kezer (2015) in order to determine whether there were any differences between C and F milks with respect to smell, taste and appearance. This evaluation was run in two periods by 28 technical persons who were familiar with the sensory properties of milk. Odour, taste and appearance of milk were examined and scored between 1 and 10 (1=very bad, 10=very good) for each character.

Statistical analysis

The data regarding routine measurements from the same animal during the experiment were subjected to Repeated Measurement Analysis in GLM Procedure of SPSS 17.0 for Windows. The data related to other measurements were subjected to One Way ANOVA test within the same software.

RESULTS

Milk profuction efficiency

The effects of supplemental feeding of fenugreek seed on feed intake, milk yield and its composition are presented in Table II.

As seen in Table II, the mean daily feed intakes, concentrate intakes and hay intakes in C and F group were as 2716.4 and 2876.4 (P<0.01); 717.8 and 725.1 (P>0.05); 1998.6 and 2151.3 (P<0.01), respectively. When calculated, the daily dry matter intakes, organic matter intakes, crude protein intakes, ether extract intakes, neutral detergent fiber intakes, acid detergent fiber intakes and metabolizable energy intakes in C and F groups were as 2416.1 and 2512.9 (P<0.01), 2238.2 and 2328.2 (P<0.01), 401.7 and 421.0 (P<0.01), 84.1 and 86.1 (P<0.05), 1400.0 and 1434.6 (P<0.05), 1693.2 and 1734.5 (P<0.01) and 1443.9 and 1464.6 (P>0.05), respectively (Table II).

Fenugreek seed supplementation increased both daily

milk yield and fat corrected milk yield (P<0.01). Daily milk yield of F goats was higher (1010.6 g) than that of C goats (879.7 g) (P<0.01). Fat corrected milk yield was higher in F goats (865.2 g) than that of C goats (780.0 g) (P<0.01). Total solids content of milk was higher in C goats (14.32%) compared to F goats (13.42%) (P<0.01). Solids-not fat was determined in C goats (9.27%) compared to F goats (8.61%) (P<0.01). Milk fat content in C goats was higher (5.05%) than that of F goats (4.81%) (P>0.05). Milk protein content was higher in C goats (4.04%) than that (3.71%) of F goats (P<0.01). The higher milk lactose content was found in C goats (4.31 %) compared with F goats (3.97%) (P<0.01). The higher milk ash was determined in F goats (1.00%) compared with C goats (0.94%) (P<0.01). Milk production efficiency was calculated as 0.54 and 0.59 in the C and F goats, respectively (P<0.01) (Table II).

Table II. Effect of supplemental fenugreek seed feeding on feed intake and milk yield performance of goats.

Parameters (per goat)	C	F	SEM	P values
Daily intakes, g/d				
Daily feed intake	2716.4	2876.4	40.21	0.001
Concentrate intake	717.8	725.1	12.16	0.521
Hay intake	1998.6	2151.3	40.81	0.001
Dry matter intake	2416.1	2512.9	44.93	0.006
Organic matter intake	2238.2	2328.2	41.46	0.006
Crude protein intake	401.7	421.0	7.43	0.002
Ether extract intake	84.1	86.1	1.27	0.048
Neutral detergent fiber intake	1400.0	1434.6	22.11	0.044
Acid detergent fiber intake	1693.2	1734.5	26.33	0.045
Metabolizable energy intake, kcal/d	1443.9	1464.6	20.74	0.198
Milk yield, g/d				
Daily milk yield	879.7	1010.6	23.61	0.002
Fat corrected milk (FCM), 6%	780.0	865.2	18.47	0.007
Milk composition, %				
Total solids	14.32	13.42	0.138	0.001
Solids-not fat	9.27	8.61	0.098	0.001
Milk fat	5.05	4.81	0.062	0.074
Milk protein	4.04	3.71	0.051	0.001
Milk lactose	4.31	3.97	0.051	0.001
Milk ash	0.94	1.00	0.012	0.001
Milk production efficiency (MPE)[1]	0.54	0.59	0.019	0.007

C, Control; F, Fenugreek seed; [1]MPE= FCM g milk/g kcal ME.

As seen in Figure 2, fenugreek seed supplementation affected milk yield and fat corrected milk yield cumulatively. This effect is more visible during the first 3 weeks of experiment.

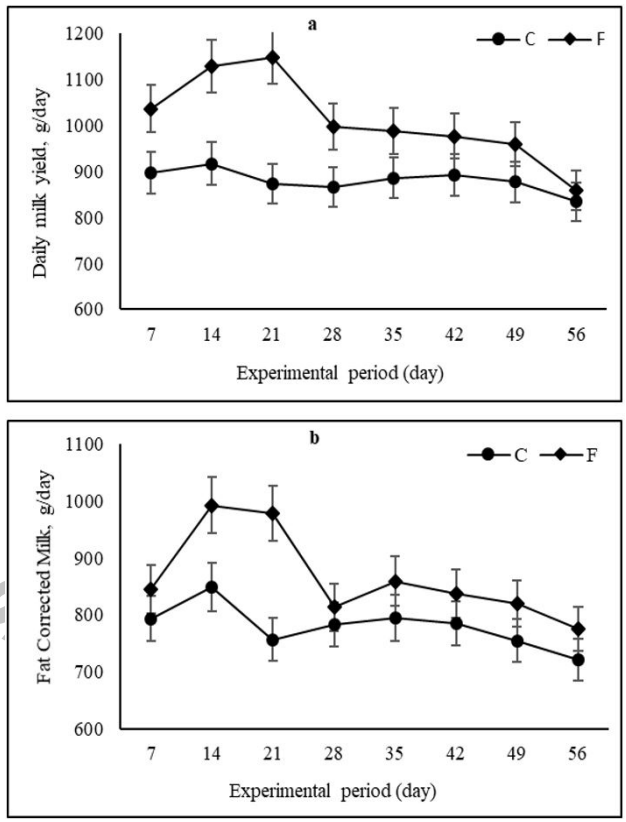

Fig. 2. The effect of supplemental fenugreek seed feeding on daily milk yield (a) and fat corrected milk yield (b).

Effect of fenugreek on biochemical component of blood

The effects of supplemental fenugreek seed feeding on serum glucose, total cholesterol, total protein, and triglyceride and prolactin hormone levels in animals are presented in Table III.

Overall mean of serum glucose levels were determined as 53.68 and 55.72 mg/dL (P>0.05); total cholesterol levels 56.32 and 58.96 mg/dL (P>0.05); total protein levels 7.33 and 7.39 g/dL (P>0.05); triglyceride levels 25.84 and 29.80 mg/dL (P=0.01) and prolactin hormone levels 0.073 and 0.217 ng/mL (P<0.01) in C and F goats, respectively. The effects of fenugreek seed supplementation on serum glucose, total cholesterol and protein levels in goat were not significantly different between experimental groups (P>0.05). However, triglyceride level was significantly different between groups (P<0.01). Similarly, prolactin hormone level was higher in F goats compared to C goats (P<0.05).

Table III. The effects of supplemental fenugreek seed feeding on blood glucose, total cholesterol, protein, triglyceride and prolactin hormone levels in animals.

Blood parameters	C	F	Reference range	SEM	P values
Glucose, (mg/dL)	53.68	55.72	50-75	1.455	0.200
Total cholesterol, (mg/dL)	56.2	58.96	55-200	1.143	0.103
Total protein, (g/dL)	7.33	7.39	6-7.9	0.076	0.659
Triglyceride, (mg/dL)	25.84	29.80	0-25	1.954	0.010
Prolactin hormone, (ng/mL)	0.073	0.217	-	0.036	0.037

C, control; F, fenugreek seed.

According to Figure 3, fenugreek seed feeding increased blood prolactin hormone level 3-6 times in F goats compared to control. This efficacy of fenugreek seed was increased during experiment period.

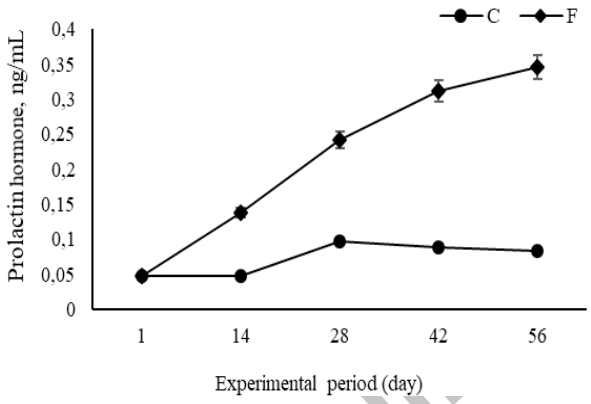

Fig. 3. The effects of supplemental fenugreek seed feeding on blood prolactin level in goats.

Sensory analysis of milk

The sensory analysis results of experimental milk comaped with pasteurized cow's milk are given in Table IV. There was no difference among milks obtained from animals consuming and not consuming fenugreek seeds, and pasteurized cow milk, in terms of their smell, taste and appearance characteristics.

Table IV. Sensory analysis results of C and F milks compared to pasteurized cow's milk.

Milk	N	Odour	Taste	Appearance
C	28	7.68	6.71	8.68
F	28	7.04	6.79	8.50
Cow milk	28	6.82	7.11	8.71
SEM		0.234	0.274	0.150
P values		0.300	0.827	0.827

C, control; F, fenugreek seed.

DISCUSSION

Fenugreek seed supplementation did not cause any illness in treated goats since all experimental animals were healthy during experimental period. Namely, F goats were healthy and having good welfare as much as C goats due to unchanged blood parameters such as glucose, cholesterol and protein. Therefore, it can be said that fenugreek seed can be used as dietary ingredients or additives in the small ruminant diets.

Fenugreek seed feeding increased daily feed intakes, hay intakes and dry matter intake significantly without affecting concentrate intakes. The higher daily feed and dry matter intakes in F goats can be explained higher tendency of consumption of hay compared to control, more likely, due to appetitive effect of fenugreek seed (Sahin *et al*., 2003). The increase in dry matter intake was the results of more consumption of hay by F goats. This might be due to the organoleptic properties of fenugreek seed. For this reason, F goats consumed more hay to get rid of bitter taste of fenugreek seed. Actually, fenugreek seeds contains some bitter substances such as protodioscin, which is a furostanol saponin (Wani and Kumar, 2018). The increase in dry matter intake naturally reflected to the other nutrients. Likewise, fenugreek seed supplementation tended to increase organic matter intake, crude protein intake, ether extract intake, neutral detergent fiber intake and acid detergent fiber intake in goats. These results were similar to the findings of Elmnan *et al*. (2013), which reported that the supplementation of fenugreek seed increased dry matter and crude protein intakes. Our F goats increased macronutrient intakes without affecting metabolizable energy intake by slightly showing preference between concentrate and hay. Goats have the ability to make diets, which make them physiologically, and metabolically more comfortable (Görgülü *et al*., 2008). At the same time, apart from arranging bitter taste, F goats, most likely, had tuned their diets to compensate the nutritional requirements increased by the increased milk yield, as seen in their higher milk production efficiency value.

Fenugreek seed feeding increased daily milk yield ($P<0.01$) and fat corrected milk yield ($P<0.01$) (Fig. 2). These findings are consistent with the results of Smit (2014), Al-Sherwany (2015), Degirmencioglu *et al*. (2016) and Kirar *et al*. (2020), who found that there was significant increase on milk yield with fenugreek seed feeding in animals. This can be explained by the increased blood prolactin hormone level in F goats. Indeed, prolactin hormone is well known to be mammogenetic and lactogenic in mammalian farm animals. Related to milk production, prolactin affects feed intake to fulfill their nutritional requirements for increased milk synthesis

(Lacasse *et al*., 2016). Likewise, Al-Janabi (2012) found out that the dietary inclusion of 4 and 6% fenugreek seed powder increased milk production in Damascus crossbred goats. He suggested that this effect might be attributed to the increased prolactin level by fenugreek seed inclusion. Similarly, in sheep, the oral administration of fenugreek seed (2.5 and 5.0 g/kg bodyweight/day) for 7 weeks increased both prolactin hormone level and, consequently, milk yield (Hassan *et al*., 2012). These similarities showed that fenugreek seed affect milk yield via prolactin hormone.

Fenugreek seed feeding increased milk yield and fat corrected milk yield cumulative manner during the experimental period. Its effect is more predominant during the first 3 weeks of experiment. This result showed that the degree of the effects of fenugreek seed supplementation on milk yield was gradually decreased after 3 weeks of experiment, but cumulatively showed difference between C and F goats. Similar effect was seen in women subjects that fenugreek seed tea increased lactogenesis just after postpartum period (Abdou and Fathey, 2018). In the current study, the increased prolactin level may had kept the effect of fenugreek seed on milk yield at the same level, as seen in Figure 2. In another study, the effect of fenugreek on milk synthesis was explained as fenugreek might extend the duration of peak milk synthesis through modulation of the insulin/GH/IGF-1 axis and increase milk ejection by activation of oxytocin secretion (Sevrin *et al*., 2020).

Total solids content, solids-not fat, milk protein and lactose contents were decreased by fenugreek seed feeding due to the increased volume of milk compared to that of control goats (Table II). In other words, decrease in these contents could be explained by increased daily milk yield. The similar tendency was observed in milk fat without statistical significance ($P>0.05$). In addition, milk ash content increased significantly by fenugreek seed feeding ($P<0.01$, Table II). This may be explained extra hay intake (plus fenugreek seed intake) in F goats. As is known, Ca content of legumes is quite high. Milk production efficiency was affected by fenugreek seed feeding significantly ($P<0.01$, Table II).

Unlike fenugreek's hypoglycemic effects (Fazlani *et al*., 2020), fenugreek seed feeding did not affect serum glucose, total cholesterol and protein levels ($P>0.05$), while serum triglyceride ($P<0.01$) and prolactin levels significantly were increased by its feeding ($P<0.05$, Table III). Similarly, Al-Janabi (2012) and Hasin *et al*. (2019) reported that the supplementation of fenugreek seed increased blood prolactin levels, as found in the present study. The present prolactin concentration may be the result of the galactogogues substance of fenugreek seed, galactomannan (Mohanty *et al*., 2014). As previously discussed, the increased prolactin level may have triggered increased daily milk yield in goats. Because prolactin plays an important role in regulating mammary function in ruminants. This hormone together with growth and leptin hormones regulates nutrient distribution to the udder (Smit, 2014). This explain why the triglyceride concentration was high in the blood. Apart from prolactin and triglyceride concentration, our results are consistent with Al-Sherwany (2015), who reported that the results of blood analysis that the treatment did not have any significant effect on blood parameters, showing that fenugreek seed feeding did not cause any metabolic problem in F goats.

Supplemental fenugreek seed feeding did not affect the organoleptic properties of milk with respect to smell, taste and appearance characteristics (Table IV). This might be due to the feeding method of fenugreek seed as separately from the diet no mixing in supplemental feeding style. This would be advantageous of supplemental feeding. This shows that the daily 50 g fenugreek seed feeding can increase milk yield of dairy animals without causing any negative consequences on odor, taste and appearance of milk. This gave nutritionist an opportunity to feed dairy animals with fenugreek seeds just before milking. It shows that fenugreek seed did not affect the aromatic and sensory characteristics of milk. However, we did not analyze the milk with respect to the biochemical content of fenugreek seed to say something about more tangible. That is why there is a need more study to monitor the biochemical contents of fenugreek seed in milk.

CONCLUSIONS

Supplemental fenugreek seed feeding increased milk yield without causing any detrimental effects on lactating goats with respect to health, welfare and milk production efficiency. From this perspective, a 50 g fenugreek seed without subjecting to any processing can be applied as dietary supplement just before morning meal to improve milk yield in lactating goats, especially in dairy farm animals. This did not cause any anorexia. Goats show appetitive behavior when they grazed the small amount of medicinal plants in the nature. In the current study, we saw this in F goats in smaller extent. This application will increase the profitability of the animal farms. Beside, fenugreek seeds may be natural feed additive for ruminants. However, the more comprehensive studies are needed to determine the exact mechanism of its action in lactating animals.

ACKNOWLEDGEMENTS

We acknowledge the Kırşehir Ahi Evran University Office of Coordinatorship of Scientific Research Projects

(Project No: ZRT.A3.16.005) for the financial support of the study.

Statement of conflict of interest

The authors have declared no conflict of interest.

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