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Impact of dietary fenugreek seeds on lactational performance and blood biochemical and hematological parameters of dairy goats under hot summer conditions

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Abstract

High ambient temperature is considered as the major constraint on animal production in the tropics and sub-tropics regions. Thus, the objective of this study was to evaluate the effects of dietary fenugreek seeds on lactational performance and blood biochemical, hematological and antioxidant parameters of dairy goats under stressful summer conditions. Forty-two dairy Baladi goats were randomly divided into three equal groups (14 animals in each group). The first (control) group was fed a basal diet without any additives. The second (FG_1) and third (FG_2) groups were fed the basal diet supplemented daily with 50 g and 100 g fenugreek seeds per animal, respectively. Compared to the control group, Baladi goats in FG_1 and FG_2 groups had a significantly increased daily milk yield at a rate of 8.2 and 34.2%, respectively ($p<0.05$). Furthermore, milk protein percentages were increased by daily supplementation with either 50 or 100 g fenugreek seeds ($p<0.05$), but fat percentage was only decreased in the FG_2 group ($p<0.01$). Serum glucose ($p<0.05$), triglycerides ($p<0.01$), cholesterol ($p<0.01$) and triiodothyronine ($p<0.01$) were significantly reduced after supplementation of fenugreek seeds in the diet, either FG_1 or FG_2 groups. Compared to the control group, both fenugreek-supplemented groups had a significantly greater serum globulin and thryoxine level ($p<0.01$ and $p<0.05$, respectively). Additionally, both fenugreeks-supplemented groups had a significantly higher total antioxidant capacity ($p<0.01$) and catalase activity ($p<0.01$). The current results indicate that supplementation of dietary fenugreek seeds may improve the milk yield, physiological and hematological parameters, and antioxidant capacity of heat-stressed goats.

Key words: goat, heat stress, fenugreek, lactation, physiological traits

Introduction

Considering the history of domestication, dairy goats are one the earliest domesticated farm animals. Additionally, goat's milk has been processed for making dairy products in ancient Egypt (Edelstein, 2014). Recently, it was proved that goat will continue to bear the hard environment, including tropical, subtropical, and Mediterranean climates (Silanikove and Koluman, 2015). Stress is a physiological response of the body to a stimulus that disturbs homeostasis and usually associated with detrimental impacts (David et al., 1990). Furthermore, dairy animals are undergoing several forms of stress, such as nutritional, behavioural and thermal stressors. High ambient temperature is considered to be the major constraint on animal productivity in

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the tropics and sub-tropics (Nardone et al., 2010). Heat stress reduces milk yield in dairy animals; either due to decreased dry matter intake (Rhoads et al., 2009), or lowered secretion of growth hormone with a subsequent lowering of blood flow to the udder (Lough et al., 1990). Furthermore, heat stress could also alter the milk composition. As a response to thermal stress, Menéndez-Buxadera et al. (2012) reported losses in annual fat plus protein yields of Payoya (1.9 %) and Murciano-Granadina (3.1 %) dairy goats.

Heat tolerance is known as the ability of the animals to keep the outcomes of their hereditary potential during their lifetime when raised in hot climates (Marai and Haeeb, 2010). Recently, Temperature-humidity index (THI) is a broadly used value, allowing the investigators to understand better the effects of thermal conditions (El-Tarabany and Nasr, 2015). Although goats have been considered to be more tolerant at high THI values compared to dairy cows, Brown et al. (1988) reported that Alpine goats reared at a moderate level of heat stress (THI equal 79) have a lowered milk yield. Furthermore, Kumar et al. (2015) reported that dairy goats suffer from heat stress beyond their comfort zone, which is considered to be environmental temperature between 13 and 27 °C.

It has been demonstrated that changes in the biological functions of domestic goats due to exposure to heat stress include reduction in feed intake, disruption in the metabolic pathways of protein, energy and mineral balances, enzymatic activities, and hormonal synthesis (Al-Dawood, 2017). Thus, a wide variety of techniques have been developed by small ruminant producers to alleviate the negative effects of heat stress, including the use of shades, feeding strategies, handling time, and the use of efficient evaporative cooling (Caulfeld et al., 2014).

Fenugreek (*Trigonella foenum-graecum*) is a leguminous annual crop, cultivated in several parts of the world (Acharya et al., 2006). It is considered as one of the oldest known medicinal plants in the recorded history. The fenugreek seeds contain series of different compounds, including alkaloids, flavonoids, amino acids, saponins, tannins and particular steroidal glycosides (Yadav et al., 2011). Johnson et al. (1986) reported that some saponins (like Gypsophylla) enhance the permeability of intestinal mucosa. Herbs containing saponin could be utilized to meet the nutrient requirements and activate the endocrine system (Wang et al., 2000). Additionally, saponin-rich materials have the potential to partition a greater proportion of the substrate to gases, short chain fatty acids and microbial mass through altering the process of protein degradation (Goel et al., 2008). Other researchers recorded the ability of fenugreek seeds to modulate the key glucose metabolizing enzymes that controlling glycolysis or gluconeogenesis processes (Devi et al., 2003). The supplementation of fenugreek seeds has been shown to have a positive impact on lactation performance in ruminants such as dairy cows, buffaloes and goats (Abo El-Nor et al., 2007; Balgees et al., 2013). To the best of our knowledge, this is the first trial to investigate the potential benefits of fenugreek supplementation to alleviate the negative effects of summer thermal stress in dairy goats. Therefore, the objective of the current study was to explore the influence of dietary fenugreek seeds on lactational performance and blood biochemical, hematological and antioxidant parameters of dairy goats during the hot summer season in Egypt.

Materials and methods

The experimental procedures of the current research were approved by the Committee of Animal Care and Welfare, Nuclear Research Center, Atomic Energy Authority, Inshas, Egypt. This work was carried out at the experimental farm belonging to the Nuclear Research Center, Egypt.

Animals and management

Forty-two Baladi goats (35.5±2.9 kg of BW) were selected from the experimental farm of the Nuclear Research Center. The study was conducted under hot summer conditions, for a period of three months. The selected dairy goats were multiparous (second, third and fourth parities) with apparently healthy and symmetrical udders and used at the early stage of lactation (42±5.3 DIM; 1.33±0.18 L/d). Goats were kept in an open shelter for the duration of the study, providing approximately 3.5 m^2 of a shaded slatted floors and 3 m^2 of concrete-surfaced yard/goat. Animals were randomly allocated into three equal groups (14 animals in each group). The control group (CON) was fed a basal diet without additives. On a daily basis, the second (FG_1) and third (FG_2) groups were fed the basal ration and supplemented with 50 g and 100 g fenugreek seeds per head, respectively. Individually, all animals in both fenugreek-supplemented groups were fed the recommended amount of fenugreek seeds (whole seeds) before the morning feeding. Goats were fed individually, and feed intakes were measured for each dairy goat. The basal diet delivered in a form of well-formulated total mixed ration, comprised alfalfa hay, wheat straw and concentrates on meeting their requirements (NRC, 2007). The alfalfa hay, straw, and concentrate were in a 35:20:45 ratios. The concentrate mixture consisted of yellow corn, soybean meal, undecorticated cotton seed cake, wheat bran, sugar beet bulb, and vitamin premix. The chemical composition (DM; dry matter basis) was checked by the standard protocol (AOAC 1990; Table 1). The chemical composition of fenugreek seeds on a dry matter basis (%) was: DM (90.89); crude protein (29.13); ether extract (3.76); neutral detergent fiber (14.52); metabolizable energy (2342 kcal kg^{-1}). The feed was given in well-constructed mangers (feeder space per animal = 0.35 m), and water in the shades was available at all time. The experimental goats were non pregnant, lactating dairy animals. Furthermore, male effect was excluded from the management system in the experimental herd.

Meteorological data

The current research was conducted under hot summer conditions, for a period of three months (June-August). The daily measures of ambient temperature and relative humidity in the farm area were collected from the local meteorological station, approximately 10 kilometers from the experimental farm. These data were utilized to estimate the daily THI values, using a previously reported formula (Kendall and Webster, 2009). $THI = (1.8 * AT + 32) - [(0.55 - 0.0055 * RH) \times (1.8 * AT - 26)]$, where AT = Air temperature (°C), RH = Relative humidity (%). On a monthly basis, the average temperature and estimated THI values are illustrated in Figure 1.

Table 1. Ingredients and chemical composition of the concentrate mixture during the experimental period

Item	[1]BD	Ingredients					
		[2]YC	[3]CSM	[4]WB	[5]SBB	[6]AH	[7]S
Ingredients (%)							
Yellow corn	25.00						
Wheat bran	20.00						
Sugar beet bulb	30.40						
Soybean meal	7.00						
Undecorticated cotton seed meal	15.00						
Dicalcium phosphate	1.00						
Sodium chloride	1.00						
Mineral mixture*	0.50						
Vitamin mixture	0.10						
Chemical composition (%)							
[8]CP	17.68	8.42	28.74	15.55	9.39	18.8	3.6
[9]CF	15.50	2.23	17.38	42.8	20.92	32.2	31.1
Fat (ether extraction)	2.87	3.99	7.58	4.05	0.94	1.7	1.3
Nitrogen-free extract	47.28	72.08	29.40	38.51	56.72	34.4	42.3
Ash	6.01	1.29	5.15	4.96	11.63	7.7	16.4
Net energy (MJ/kg)	6.02	14.17	7.94	9.04	3.42	6.8	4.1

*According to A.O.A.C. (1990)
[1]BD: basal diet (DM basis); [2]YC: yellow corn; [3]CSM: cotton seed meal; [4]WB: wheat bran; [5]SBB: Sugar beet bulb; [6]AH: alfalfa hay, [7]S: straw; [8]CP: crude protein; [9]CF: crude fiber.
*Premix provided per each kg: VA17500 IU VE 43mg, VD3 3500 IU,VB525.74 mg, Mn (as manganese sulfate) 31 mg, Zn (as zinc sulfate) 92.5 mg, Cu (as copper sulfate) 30 mg, Co (as cobaltous sulfate) 0.72 mg, I (as potassium iodide) 1.25 mg.

Milk yield and composition

The daily milk yield (DMY) of individual animals was registered throughout the study; however, milk composition was assayed biweekly. Hand milking had been done daily (once at 0800 h) by two expert milkers who have the same fitness (gentle handling and efficient evacuation of the udder). Milk samples (approximately 50 mL) were collected, protected by means of Broad Spectrum Microtabs II and preserved at 4 °C until analysis of the milk gross composition: protein, milk fat, total solids, and lactose contents (MilkoScan 6000; Foss Electric A/S, Hillerød, Denmark, using the method described by Sánchez et al., 2007).

Hematological and biochemical parameters

Monthly and before the morning feeding, two blood samples were collected from the jugular vein into sterilized vacutainer tubes containing EDTA (3 mL, for hematological parameters) and plain sterilized tube (mL, for biochemical assay in serum). In order to evaluate the hematological profile, an automated analyzer (Autolyser AL 820, Swiss) was utilized to calibrate blood erythrocyte counts (RBC), hemoglobin content (Hb) and the total leucocytes count (WBC). The level of serum total protein (g dL^{-1}) was determined by the Biuret method. Serum cholesterol concentration was measured by a colorimeter. Also, serum glucose level was measured as previously described by Barham and Trinder (1972). The hemolysate of the erythrocytes was separated to determine the activity of total antioxidant capacity (TAC; expressed as mmol dL^{-1}). The activity of serum catalase (U/gHb) was measured by a commercially available kit (Catalase Assay Kit, Oxford Biochemical Research, Inc., USA). Serum triiodothyronine (T_3) and thyroxine (T4) concentrations were determined using RIA techniques using solid phase coated tubes kits purchased from Diagnostic Systems Laboratories (Inc., Webster, Texas, USA). The cortisol concentration was assessed in serum samples (Radio Immuno Assay corticosterone kit; ICN Pharmaceuticals, Orangeburg, NY). The intra- and inter-assay coefficients of variation were 0.04 % and 1.06 %, respectively.

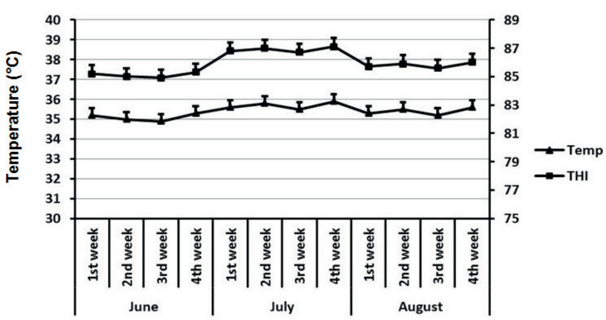

Figure 1. The weekly average temperature (▲) and temperature-humidity index (THI) (■) in the area of the farm

Statistical analysis

All statistical procedures were conducted using the SAS, V9.1 statistical system Package (SAS Institute, Cary, NC, USA). The experimental unit is considered as individual dairy animal nested within each treatment group. The Kolmogorov-Smirnov test was used to confirm the normality of the data. The analytical procedures indicated that all parameters matched the normal distribution ($p>0.05$). The SAS MIXED procedure (repeated measure GLM procedures) was applied to analyze the repeatedly measured variables (milk yield and composition, biochemical and hematological parameters). The statistical model included the fixed effects of treatment (three levels: CON, FG_1, and FG_2), parity and the random effects of the animal nested within parity.

Results and discussion

Effect of fenugreek supplementation on milk yield and composition in Baladi goats

Data summarizing results for the effect of the fenugreek supplement on milk production traits are included in Table 2. In comparison with the control group, goats had increased DMY by 8.2 and 34.2 % for FG_1 and FG_2 groups, respectively ($p<0.05$). The average protein content was increased by daily supplementation with either 50 or 100 g fenugreek seeds ($p<0.05$). On the contrary, milk fat content was reduced by daily supplementation with only 100 g (FG_2) fenugreek seeds ($p<0.01$). However, there were no significant differences in the contents of lactose, total solids and solid not fat among different groups.

Effect of fenugreek supplementation on blood biochemical parameters in Baladi goats

The results for the effect of the fenugreek supplementation on blood biochemical parameters in Baladi goats are summarized in Table 3. The concentrations of serum glucose ($p<0.05$), triglycerides ($p<0.01$), cholesterol ($p<0.01$) and triiodothyronine ($p<0.01$) were significantly reduced after supplementation of fenugreek seeds in the diet, either FG_1 or FG_2 groups. In comparison with the control group, Baladi goats had increased serum total protein in a rate of 7.7 and 12.6 % for FG_1 and FG_2 groups, respectively ($p<0.01$). Furthermore, both fenugreek supplemented groups had a significant greater serum globulin and thyroxine levels ($p<0.01$ and $p < 0.05$, respectively) than those reported in the control group. Additionally, no significant ($p>0.05$) differences have been reported in serum albumin and cortisol levels among different groups.

Table 2. Effect of fenugreek supplement on average feed intake, milk yield and composition in Baladi goats under hot summer conditions

Traits	Experimental groups				
	[1]CON	[2]FG_1	[3]FG_2	[4]RSD	*p*-value
[5]ADFI (kg, DM basis)	1.08	1.13	1.16	0.15	0.172
[6]DFI (%, BW)	3.09	3.18	3.22	0.14	0.102
Initial BW (kg)	35.35	35.25	35.87	1.47	0.348
Final BW (kg)	36.01	36.56	37.18	1.38	0.218
[7]DMY (kg)	1.58^c	1.71^b	2.12^a	0.22	0.038
[8]Total-MY (kg)	141.92^c	154.03^b	190.50^a	13.8	0.001
Protein (%)	3.16^b	3.55^a	3.71^a	0.31	0.014
Fat (%)	3.61^a	3.42^a	3.08^b	0.24	0.008
Lactose (%)	3.99	4.01	4.02	0.35	0.231
Total solids (%)	11.39	11.38	11.40	0.89	0.165
[9]SNF (%)	7.78	7.96	8.32	0.48	0.073

[1]CON: Control group; [2]FG_1: Group fed 50 g fenugreek; [3]FG_2: Group fed 100 g fenugreek.
[4]RSD: residual standard deviation; [5]ADFI: averaged daily feed intake; [6]DFI: daily feed intake (% from BW); [7]DMY: daily milk yield; [8]Total-MY: total milk yield; [9]SNF: solids not fat.
[a,b,c] Values within a row with different superscripts differ significantly

Table 3. Effect of fenugreek supplement on blood biochemical parameters in Baladi goats under hot summer conditions

Traits	Experimental groups				
	[1]CON	[2]FG_1	[3]FG_2	[4]RSD	*p*-value
Glucose (mg dL^{-1})	70.07^a	58.29^b	56.21^b	6.45	0.021
[5]TP (g dL^{-1})	6.53^c	7.03^b	7.35^a	0.54	0.001
Albumin (g dL^{-1})	3.25	3.30	3.33	0.29	0.628
Globulin (g dL^{-1})	3.28^c	3.73^b	4.03^a	0.38	0.001
[6]TG (mg dL^{-1})	137.9^a	131.5^b	118.8^c	9.59	0.001
[7]CH (mg dL^{-1})	149.6^a	117.2^b	114.8^b	13.09	0.001
[8]T_3 (ng mL^{-1})	1.96^a	1.51^b	1.42^b	0.12	0.001
[9]T_4 (ng mL^{-1})	21.7^b	32.0^a	32.8^a	3.28	0.013
Cortisol (ng mL^{-1})	12.8	12.2	11.9	1.37	0.206

[1]CON: Control group; [2]FG_1: Group fed 50 g fenugreek; [3]FG_2: Group fed 100 g fenugreek.
[4]RSD: residual standard deviation; [5]TP: Serum total protein; [6]TG: triglycerides; [7]CH: cholesterol;
[8]T_3: Triiodothyronine; [9]T_4: Thyroxine.
[a,b,c]Values within a row with different superscripts differ significantly.

Effect of fenugreek supplement on hematological and antioxidant parameters in Baladi goats

Data summarizing results for the effect of the fenugreek supplement on blood hematological and antioxidant parameters in Baladi goats are illustrated in Table 4. In comparison with the control group, both FG_1 and FG_2 groups had significant elevated blood erythrocyte count (p<0.05) and hemoglobin concentration (p<0.05). On the contrary, animals in the FG_2 group had significantly lesser total leucocytes count (p<0.05) than that reported in the control group. Regarding the serum antioxidant activity, both fenugreeks supplemented groups had a significantly higher total antioxidant capacity (p<0.01) and catalase activity (p<0.01) in comparison with the control group.

Both ambient temperature and humidity impact the magnitude of heat stress that dairy goats undergo. Recent research has shown that milking dairy Baladi goats start to decrease milk production when the temperature-humidity index (THI) exceeds 80 (El-Tarabany et al., 2017). Thus, the main objective of the current work was to examine the efficacy of fenugreek supplements to ameliorate the negative effects of stressful summer conditions in dairy Baladi goats. The current research reported an improvement of milk yield in heat-stressed goats supplemented with fenugreek seeds. These results were consistent with those reported previously in Nubian goats (Balgees et al., 2013). They reported that milk yield increased significantly with the increased levels of fenugreek seed supplement (5 %, 10 %, and 15 %). In Anatolian buffaloes, Degirmencioglu et al. (2016) concluded that the diet containing ground fenugreek seed significantly (P<0.01) increased milk production (7.34-8.01 kg day^{-1}) in comparison to the basal control diet. Abo El-Nor et al. (2007) observed a significantly increased milk yield in early lactating Egyptian buffaloes supplemented with fenugreek seeds (7.56 kg day^{-1}) in comparison to the basal control diet (6.08 kg day^{-1}). However, other trials reported that fenugreek supplement had non-significant effects on milk yield (Shah and Mir, 2004). The increase in prolactin hormone level represents a possible endocrine pathway for the galactopoietic effect of fenugreek (Abdul Khaliq, 2012). The increased milk yield may be attributed to the presence of phytoestrogens, which are plant chemicals similar to the female sex steroid hormone, estrogen, which is a key compound to increase milk flow (Balgess et al., 2013). In accordance to the significant differences in average daily feed intake among different experimental groups, the decreased milk yield in the heat-stressed control group may be attributed to an increased energy requirement (Atterbery and Johnson, 1969) or circulating glucocorticoids (Collier et al., 1995), which are associated to the increased proteolyitc activity and urinary nitrogen excretion. The lesser percentage of milk fat in both fenugreek supplemented groups might be attributed to the increment in milk yield. These results were similar to the outcomes obtained by El-Alamy et al. (2001), who concluded that feeding fenugreek seeds to buffaloes increased milk production characterised by a significantly lower fat content. However, Balgees et al. (2013) reported that in Nubian goats, the milk fat content was reduced in animals given 10 and 15 % fenugreek seeds compared to groups given 0 and 5 % fenugreek seeds. The milk lactose content in the current research was not affected by supplementation of fenugreek seeds, which supports previous work in Nubian goats (Balgees et al., 2013).

Table 4. Effect of fenugreek supplement on hematological and antioxidant parameters in Baladi goats under hot summer conditions

Traits	Experimental groups				
	[1]CON	[2]FG_1	[3]FG_2	[4]RSD	*p*-value
[5]RBC (x10^6 μL^{-1})	9.76^b	10.36^a	10.42^a	0.78	0.050
[6]Hb (g dL^{-1})	8.94^b	9.02^b	9.68^a	0.92	0.036
[7]TLC (x10^3 μL^{-1})	9.23^a	8.94^{ab}	8.60^b	0.66	0.045
[8]TAC (mmol dL^{-1})	6.17^c	6.89^b	7.10^a	0.49	0.001
[9]CAT (U/gHb)	268.6^c	341.6^b	420.3^a	22.87	0.001

[1]CON: Control group; [2]FG_1: Group fed 50 g fenugreek; [3]FG_2: Group fed 100 g fenugreek.
[4]RSD: residual standard deviation; [5]Red blood cells; [6]Hemoglobin; [7]Total leucocytes count; [8]TAC: Total antioxidant capacity; [9]CAT: catalase.
[a,b,c]Values within a row with different superscripts differ significantly.

According to the obtained results there was a significant reduction of serum glucose level in heat-stressed goats supplemented with fenugreek seeds. The hypoglycemic effect of fenugreek seeds in our trial supports the findings reported by Kassaian et al. (2009). In some trials it was also demonstrated that fenugreek seeds delayed the gastric evacuation and caused suppression of glucose transport as the seeds contain a higher percentage of pectin that compose a colloid suspension when hydrated and can reduce the rate of gastric emptying and decelerate carbohydrate absorption (Gupta et al., 2001). Insulin stimulates cellular glucose uptake in muscles and adipose tissues through induction of translocation for glucose transporter-4 (Glut-4) from an intracellular pool to the plasma membrane (Mohammad et al., 2006). Another possible mechanism assumed that fenugreek seeds capable of modulating key glucose metabolizing enzymes controlling glycolysis or gluconeogenesis processes (Devi et al., 2003). Additionally, the current trial reported a significant increase in the serum total protein in both heat-stressed groups supplemented with fenugreek.

The current trial demonstrates a significant decrease in serum triglycerides and cholesterol levels in Baladi goats supplemented with fenugreek seeds. It was believed that fenugreek seeds contain a biological significant level of saponins. Ribes et al. (1986) suggested that saponin would elevate fecal excretion of bile acids and subsequent increase of conversion of cholesterol to bile salts and could decrease plasma cholesterol concentration. Other researchers supposed that hypolipidemic role could also be the result of the retardation of carbohydrate and fat absorption due to the existence of bioactive fiber in the fenugreek seeds (Hannan et al., 2007) or induction of hepatic lipogenic enzymes (Raju et al., 2001).

Triiodothyronine (T3) and thyroxine (T4) hormones are required for normal physiology in dairy animals. Increasing levels of supplementation of fenugreek seeds resulted in a significant decrease in serum T3, while increasing T4 concentration. This may be attributed to estrogenic fractions in fenugreek seeds, which indirectly increased T4 level (Sauvaire et al., 1991). Other workers reported that decreased level of serum T3 following the fenugreek seed supplementation may be a consequence of the inhibition in the peripheral conversion of T4 to T3 in the extrathyroidal tissues (Panda et al., 1999). Heat stress activates the hypothalamic-pituitary-adrenal (HPA) axis and stimulates the secretion process of adrenocorticotropic hormone (ACTH) by the anterior pituitary. The ACTH boosts the synthesis and release of glucocorticoids (cortisol) from the cortex of the adrenal gland. Although fenugreek supplementation resulted in a non-significant reduction of cortisol level, the well-being of heat-stressed dairy goats seem to be improved.

The fenugreek seed has numerous volatile oils, phenolic compounds, and flavonoids and is therefore a potent source of antioxidants (Bukhari et al., 2008). Concerning antioxidant activity in the current work, heat-stressed goats supplemented with fenugreek seeds had an improved total antioxidant capacity and catalase activity. Additionally, previous reports confirmed the ameliorative effect of fenugreek on lipid peroxidation in animals and promote free-radical scavenging activity (Naidu et al., 2010). Choudhary et al. (2001) reported that dietary supplementation with fenugreek seeds at a rate of 1 or 2 % resulted in an enhanced glutathione S-transferase activity in the liver homogenate of rats. Concerning hematological measures, supplementation of Fenugreek seeds promotes the erythropoiesis, which reflected in a significant increment in the erythrocytes count and hemoglobin content. This improvement in erythropoiesis may be related to the enhancement of antioxidant activity in fenugreek supplemented animals (Jain, 1989).

Conclusion

The heat-stressed goats supplemented with fenugreek seeds (FG_1 and FG_2) have an eminent milk yield at a rate of 8.2 and 34.2 %, respectively. Most physiological (serum globulin and thyroxine), hematological (blood erythrocyte count and hemoglobin content) and antioxidant (total antioxidant capacity and catalase) parameters have been improved too. Hence, the obtained results point towards supplementing fenugreek seeds (100 g/animal/day) to alleviate negative impacts of thermal stress (THI greater than 80) in dairy Baladi goats.

Conflict of interest

None of the authors have any conflict of interest to declare.

Utjecaj dodatka sjemenki piskavice na laktacijske performance, hematološke i biokemijske parametre u krvi koza u uvjetima visokih ljetnih temperatura

Sažetak

Visoke ambijentalne temperature smatraju se najvećim naporom za životinje u poljoprivredi u tropskim i suptropskim područjima. Stoga je cilj ovog istraživanja bio odrediti utjecaj dodatka sjemenki piskavice u hranidbi mliječnih koza na laktacijske performanse, hematološke i biokemijske parametre pri stresnim ljetnim uvjetima. Četrdeset dvije mliječne koze pasmine *Baladi* nasumično su podijeljene u tri jednake skupine (14 jedinki u svakoj skupini). Prva (kontrolna) skupina hranjena je osnovnim režimom bez uporabe ikakvih dodataka. Druga (FG_1) i treća (FG_2) skupina hranjene su režimima koji su bili obogaćeni dodatkom 50 g odnosno 100 g sjemenki po jedinki. U usporedbi s kontrolnom skupinom, koze pasmine *Baladi* u grupama FG_1 i FG_2 imale su značajno veću sposobnost laktacije koja je iznosila 8,2 odnosno 34,2 % (p<0,05). Osim toga, dodatak 50 ili 100 g sjemenki piskavice (p<0,05) značajno je utjecao na povećanje udjela proteina u mlijeku, dok je udio mliječne masti bio niži u mlijeku koza skupine FG_2 (p<0,01). Koncentracije glukoze (p<0,05), triglicerida (p<0,01), kolesterola (p<0,01) i trijodtironina (p<0,01) u krvnom serumu bile su znatno niže nakon dodatka sjemenki piskavice, bez obzira na količinu dodatka. U usporedbi s kontrolnom skupinom, obje skupine koza hranjenih dodatkom sjemenki piskavice imale su značajno više koncentracije globulina i tiroksina (p<0,01 i p<0,05) u krvnom serumu. Dodatno, obje skupine koza hranjenih dodatkom sjemenki piskavice imale su i značajno veći antioksidacijski kapacitet (p<0,01) i aktivnost katalaze (p<0,01). Dobiveni rezultati ukazuju kako dodatak sjemenki piskavice u hranidbi može poboljšati mliječnost, fiziološke i hematološke parametre te antioksidacijski kapacitet mliječnih koza izloženih toplinskom stresu.

Ključne riječi: koze, toplinski stress, piskavica, laktacija, fiziološki parametri

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