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RESEARCH ARTICLE

Assessment of milk yield, composition and fatty acid profiling of Murrah buffaloes supplemented with cumin powder during hot dry and hot humid seasons under field condition

Gaurav Kumar[1], Sohan Vir Singh[2](✉),Apeksha Ukey[2] and Rajkumar[3]

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Abstract: Over six months and two seasons, a field study was conducted on lactating Murrah buffaloes under the Farmer FIRST project to assess the impact of cumin powder supplementation on milk production during hot dry and hot humid seasons. Twelve buffaloes were selected from Kathura village of Sonipat district and divided equally into two groups i.e., treatment (cumin supplemented) and control groups. Milk yield was recorded and its composition and fatty acid profiles were analysed. The results showed that cumin supplementation improved milk yield, composition, and fatty acid profile during both seasons. The treatment group produced higher and better quality milk than the control group. The cost-benefit ratio showed a return of Rs. 2.33 for every rupee spent on cumin supplementation. Therefore, cumin, widely available, can be used to enhance benefit, milk yield and quality, benefiting both calves and humans during heat stress.

Keywords: Cumin, Fatty acid Profile, Milk Yield, Murrah Buffaloes

Introduction

Due to climate change, Earth's temperature is expected to rise by 2°C between 2050 and 2060 (Sherman et al. 2022). Buffalo productivity and health are affected by their environment, high-yielding buffaloes being more sensitive to heat stress during peak lactation. Nutritional supplements like concentrates, high-energy diets, minerals, vitamins, and antioxidants are essential for livestock to perform optimally in heat stress conditions (Kumar et al. 2020).Cumin, a member of the Apiaceae family with physiological and therapeutic characteristics is consumed and produced in greater quantities in India than anywhere in the world (Azeez, 2008). Bhatt et al. (2009) found that the cumin possesses the galactopoietic characteristic. Certain feed additives such as cumin (Kumar et al. 2024) increases appetite of animals. Cumin supplementation during heat stress is a best choice to those cows that lose a lot of body electrolytes including potassium through perspiration (Mallonée et al. 1985). Cumin is a source of minerals, making it useful for replacing lost minerals and correcting acid-base imbalances. Dietary spices such as cinnamon, black cumin and cumin are strong natural sources of antioxidant molecules (phenolic compounds) (Shan et al. 2005). In both conventional and veterinary medicine, it is used to treat mild digestive disorders, broncho-pulmonary illnesses, puerperal disorders, analgesics and cough remedies. Among the many benefits of cumin include increased vision, endurance and milk production (Rathore et al. 2013). Ghafari et al. (2015) reported that the milk yield was increased curvilinearly with supplementing cumin seed at level of 0, 100, 200, and 300 g/cow/day (average 47.9, 52.5, 55.1, and 53.6 kg/day for the four levels, respectively). Dairy products are linked with to poor health status due to their high level of saturated fatty acids (SFAs) supplementing the dietary cumin increases conjugated linoleic acids (CLA) in the fat have been shown to play a significant role in reducing the relative risk of coronary heart disease and cancer etc. (Belury, 2002).Cumin seed extract when used as additive, the amount of C18:3-n3, C18:2n-6c, C18:1 trans11, monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and the ratio of polyunsaturated to saturated fatty acids increased ($P<0.05$) in milk (Heidarian et al. 2013). Jayanegara et al. (2012) reported that the polyphenols both tannins and non-tannins have the ability to influence the ruminal biohydrogenation at various steps of fatty acid metabolism. However, according to Bettaieb et al. (2011) cumin contains a unique fatty acid called petroselinic acid (C18:1n-12; 50% of the total fatty acids). Keeping in mind the above facts the present study was planned to investigate the impact of supplementation of cumin powder to lactating Murrah buffaloes on their milk yield, its composition and fatty acid profile.

[1] College of Veterinary and Animal Sciences, Rani Lakshmi Bai Central Agricultural University, Datia Campus (India) -475686
[2]ICAR-National Dairy Research Institute, Karnal (India)- 132001
[3]ICAR-Central Soil Salinity Research Institute, Karnal (India)- 132001

Sohan Vir Singh(✉)
Animal Physiology Department
ICAR-NDRI, Karnal -132001 (Haryana)
Phone- +91-9416552336
E-mail: sohanvir2004@yahoo.com

Materials and Methods

Experimental Location

Under the Farmer FIRST project, which was funded by the ICAR, New Delhi, India, the current study was carried out at Kathura village of Gohana block of District Sonipat, Haryana State (India). The location of Kathura is 29.086°N and 76.582°E. The land area of Kathura is 26.70 km³ (10.30893 sq miles). It is the biggest village in Sonipat District. It is situated at an average elevation of 222 metres (728.346 feet) above sea level.

Experimental animals and their management

The average annual rainfall was about 700 mm. The investigation was carried out on 12 healthy, lactating Murrah buffaloes (1-3 parity) between April to September of 2022. Animals of group I was fed the traditional diet, and group II animals were fed traditional diet plus cumin supplementation @ of 0.15 g/kg body weight per day/ animal. Before the start of actual experiment, fenbendazole was fed to all the experimental animals for mass deworming.

All the experimental animals were fed as per the availability of feed and fodders with the farmers i.e. bajra, sorghum, maize, and straw made from rice and wheat (NRC, 2001). The composition of concentrate mixture fed to the experimental animals were as follows: 33% maize, 20% wheat bran, 12% mustard oil cake, 11% deoiled rice bran, 21% ground nut cake, 1% common salt and 2% mineral mixture. Every animal had free access to fresh, clean water three times in a day. Monthly records of environmental data were also made in order to compute the temperature-humidity index (THI), which is used to evaluate the degree of heat stress experienced by buffaloes.

Meteorological parameters

Throughout the study, meteorological variables like minimum and maximum temperature, dry bulb and wet bulb temperature, and relative humidity were recorded. The temperature humidity index (THI) was computed using the dry bulb and wet bulb temperatures. Although various formulas exist for calculating THI, the formula from NRC (1971) was used in this investigation.

$$THI = 0.72\,(Dbt + Wbt) + 40.6$$

Where: Dbt- dry bulb temperature (°C) and Wbt-wet bulb temperature (°C)

Milk yield and its composition

Milk yield (kg) of lactating buffaloes was recorded for three consecutive days, both in the morning and evening, at monthly intervals and lactoscan was used to determine the composition of the milk.

Fatty acid profile of milk

For fatty acid profiling, fat was removed from milk samples. Milk fat, one of the most complex natural fats, contains about 400 different fatty acids. Gas liquid chromatography was used to identify the methyl esters of these fatty acids. The traditional technique of saponification converts fat or oil into methyl esters and alcohol in the presence of an aqueous alkali. After saponification, KOH or NaOH solution was added to the milk fat. To prevent the saponification of performed esters, crystalline sodium hydrogen sulphate was added to the mixture after a specific reaction time. The mass fraction of fatty acids in milk fat was measured as grams of individual free acids per 100 g of total fatty acids. Accurately weigh of 20.0 mg of the prepared milk fat was taken into a 15 ml centrifuge tube. 5.0 mL of hexane was assed to the tube to dissolve the fat. Mixed thoroughly by vortexing for 1 min until lipid is fully dissolved. Added 0.20 mL of the trans-esterification reagent to the hexane-fat solution. Immediately vortexed the tube vigorously for 1 min. Allowed the reaction to proceed for 5 min at room temperature. After the reaction time, added 5 g of sodium hydrogen sulfate to quench the reaction and assist phase separation. Mixed again by vortexing for 30–60 seconds. Centrifuged the tubes for 3 minutes at 3,000 rpm at room temperature to clarify the extract and separate any particulate or aqueous phase. After centrifugation, carefully withdrawn 1.5 ml of the clear upper hexane layer (supernatant) using a clean pipette and transfer it into a GC vial fitted with cap. If necessary, filter the aliquot through a small PTFE syringe filter (0.45 µm) directly into the GC vial to remove any remaining particulates.

Cost Benefit Ratio

Certain assumptions were used in order to calculate the cost-benefit ratio of cumin supplementation in rural areas: housing, nutrition, and health management were almost similar in both groups. The cost-benefit ratio was calculated by using the prices of milk and cumin from the local market.

Statistical analysis

Statistical analysis was conducted using SPSS version 16.0 to determine the mean and standard error. Two-way ANOVA and one-way ANOVA were used to identify significant differences between treatment and season. The post-hoc Tukey's-b multiple comparison test was performed for pair-wise mean comparisons. The correlation between components in each animal group was assessed using a correlation coefficient at the probability levels Pd"0.01 and Pd"0.05.

The following model was used for analysis

Yij = ì + Si × B j+ S × B + S × B.........+£ij

Where,

ì = overall mean

Yij = K[th] observation on i[th] treatment at j[th] interval

Si = effect of i[th] treatment

Bj = effect of j[th] interval

£ij = random error

The means of the fixed factor were compared using Tukey's-b multiple comparison test considering a significance level of 5% (P < 0.05).

Results and Discussion

The average highest ambient temperature (°C) was recorded during the month of June (36.44±0.50) with a THI value of 84.81±0.58. The maximum temperature was recorded > 47°C with diurnal variations of 10-15°C. The THI greater than 80 during the present investigation suggested that experimental animals were experienced the greater degree of heat stress (Table 1). These results are in accordance with those of Yadav et al. (2016) and Somagond et al. (2020) who also reported THI higher than 80 made Murrah buffaloes extremely susceptible to heat stress.

Milk yield

The milk yield of lactating Murrah buffaloes was 11.98±0.23 kg and 12.39±0.16 kg during hot humid season, and 10.97±0.20 kg and 11.54±0.27 kg during hot dry season for the control and cumin supplemented groups, respectively (Figure 1). During peak lactation, milk yield was non-significantly (P<0.05) lower in the hot dry compared to the hot humid season in both control and experimental groups. However, no significant difference was observed between the groups among the both season.

Milk fat

The fat content in the milk of lactating Murrah buffaloes was 6.15±0.11% and 6.46±0.08 % during hot dry season and 6.05±0.11% and 6.47±0.07% during the hot humid season for the control and cumin supplemented groups, respectively (Figure 2). No significant (P<0.05) variation was found in the milk fat (%) of either group of lactating buffaloes during the hot dry and hot humid season. In comparison to control group, the mean values of fat % was significantly (P<0.05) higher in the treatment group between the hot dry and hot humid seasons.

Protein

The average protein percentage in the milk of lactating Murrah buffaloes were 4.01±0.09 % and 4.01±0.04% during hot dry and 4.02±0.06% and 4.04±0.09% during hot humid season in control and cumin-supplemented groups respectively (Figure 3). The significant variation was found in the milk protein percentage among control and treatment group of buffaloes during hot humid season.

Lactose

The respective overall mean values of lactose (%) in the milk of control and cumin supplemented group of Murrah buffaloes were 5.69±0.18 and 5.34±0.14 during the hot dry and 5.03±0.09 and 5.06±0.09 during the hot humid season (Figure 4). Significant (P<0.05) higher milk lactose (%) was found during hot dry compared to the hot humid season in the control group, however, no significant (P<0.05) difference was observed among the groups in both seasons.

Solid not fat (SNF)

The mean values of milk SNF (%) of control and cumin supplemented group of lactating Murrah buffaloes were 11.40±0.13% and 10.96±0.16% during hot dry and 10.80±0.15% and 10.45±0.12% during the hot humid season respectively (Figure 5). The mean values of milk SNF during the hot humid season were significantly (P<0.05) lower than the hot dry season in both the groups.

The potential advantages of cumin supplementation might be due to its favourable impact on rumen microorganisms, as well as from its ability to stimulate the activity of digestive enzymes that improve digestibility, lactogenic enzymes that secrete milk and concentration of unsaturated fatty acids. The milk yield and composition recorded during the present study are in agreement with the several previous studies reported positive effects of cumin seed supplementation on milk yield of ruminant animals (Morsy et al. 2018; DeðiRmenciOðlu et al. 2020 and Modi et al. 2022). Feeding cumin seeds to the multiparous lactating cows at early stage of lactation also showed 20.64% increase in average

Table 1: Average values of environmental variables recorded during the experimental period (April, 2021 – September, 2021)

Months	Max. (°C)	Min. (°C)	DBT (°C)	WBT (°C)	R. H. (%)	THI
April	36.19±0.60	16.40±0.56	35.41±0.63	21.14±0.31	23.63±1.60	81.32±0.61
May	36.13±0.61	22.22±0.37	34.70±0.79	24.61±0.28	43.19±2.80	83.30±0.71
June	36.44±0.50	25.27±0.37	35.05±0.66	26.35±0.20	48.53±2.39	84.81±0.58
July	34.24±0.76	26.62±0.35	32.44±0.83	27.87±0.26	72.10±3.67	84.02±0.73
August	33.04±0.39	26.47±0.17	31.85±0.42	28.30±0.17	76.30±1.71	83.91±0.40
September	31.60±0.38	24.78±0.19	30.77±0.35	27.27±0.21	76.10±2.13	82.39±0.34

Fig. 1-5. Effect of cumin supplementation on milk yield (kg) and milk composition (%) of lactating buffaloes during hot dry and hot humid season

- The values are mean ±S.E of six observations on six animals.
- Different superscript (X, Y) depicts significant (*P*<0.05) difference within seasons among groups.
- Different superscript (A, B) depicts significant (*P*<0.05) difference between groups during both the seasons.

Figure 1

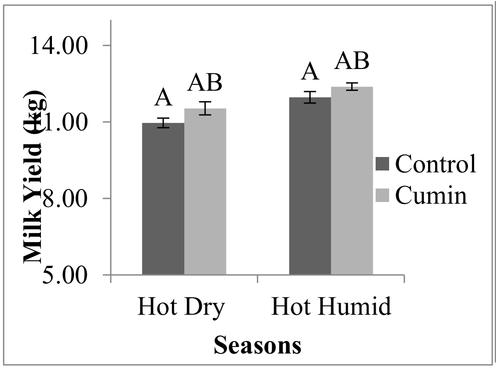


Figure 2

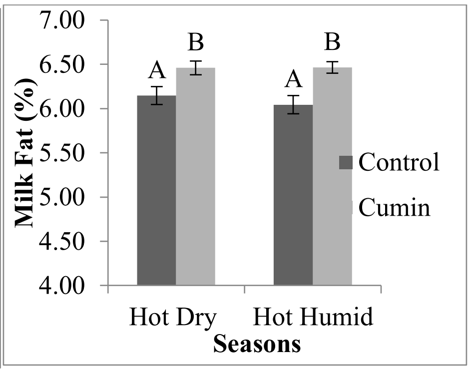


Figure 3

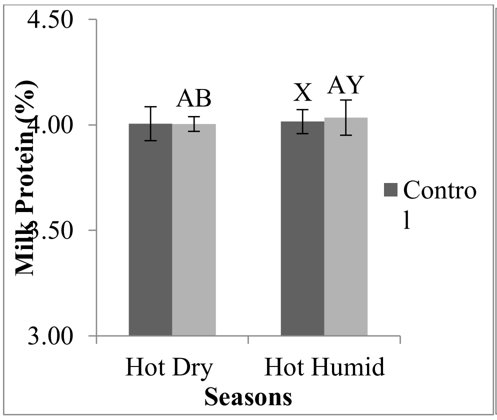


Figure 4

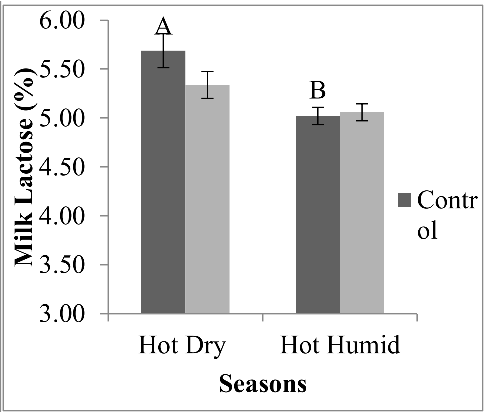
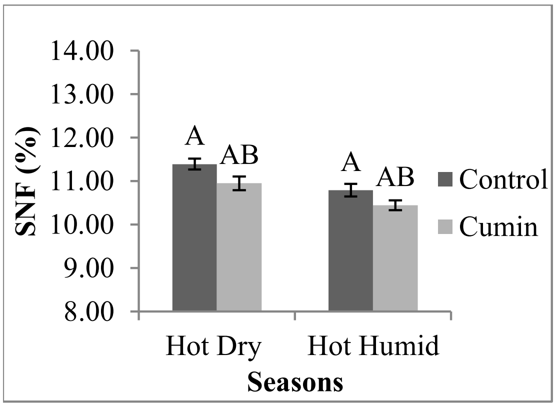


Figure 5



milk yield over control group (Bhargav et al. 2021). Mostafa (1998) also recorded an increase of 46% milk yield in goats fed with Nigella Sativa seeds (NSS). El-Saadany et al. (2008) also observed increased milk yield in Zairabi goats supplemented with NSS @100 mg/ kg body weight/ animal. This increased milk production performance might be partially attributed to galactopoietic properties of cumin seed, which were mediated by stimulating endogenous hormonal secretion (Bhatt et al. 2009). In cumin fed group, greater milk yield might be correlated to higher blood glucose levels, which enhanced the lactose synthesis in the udder from blood glucose absorbed by the basal membrane of mammary epithelial cells (Osorio et al.2016). Similarly higher milk production in cumin supplemented group of goats may also be due to higher milk lactose (Costa et al. 2019) and lactogenic hormones (Ahmad et al. 2021; Sadarman et al. 2021). During the present investigation milk fat was found significantly higher in cumin supplemented group than control group of buffaloes. Abd-ElMoty et al. (2015) also reported that the supplementation of 100 mg /head/day significantly increased milk yield and fat contents than non-supplemented Ossimi ewes.The mechanism to increased milk fat secretion might be attributed to an increase in the production of ruminal butyrate and its extensive metabolism by ruminal epithelial cells during absorption to yield beta hydroxyl butyrate (BHB), which is a precursor for milk fatty acid synthesis. Moreover, Penner and Oba (2009) found a positive association between plasma BHB and milk fat yield. Butyrate also constitutes small part of the fatty acids production in milk fat. During the present study milk protein and SNF did not differ significantly among the supplemented and control group of buffaloes.These result complies with the other studies (DeðiRmenciOðlu et al. 2020; Heidarian et al. 2013 and Ghafari et al. 2015) who also reported no significant differences in milk SNF and protein contents of buffalo, cow and goat milk fed ration supplemented with cumin seed (CS). Conversely, Nurdin et al. (2011) showed that milk protein contents were significantly (P<0.05) affected by CS supplementation.

Fatty acid profile

The mean and standard error values of various fatty acids (both saturated and unsaturated) and desaturase index of the cumin-supplemented and control group of the lactating Murrah buffaloes during hot dry and hot humid seasons have been presented in Table 2 .

Saturated fatty acids (SFA)

The mean values of SFA (g/100g) in the milk fat of lactating Murrah buffaloes were 61.61±1.02 and 59.90±0.60 during hot dry and 68.29±2.30 and 71.69±1.01 during the hot humid season in the control and cumin supplemented groups respectively (Table 2).When compared to the hot dry season, the values of SFA in the milk fat of lactating Murrah buffaloes during hot humid season was significantly (P<0.05) higher in both control and cumin supplemented groups. In both the experimental groups within the season, there was no statistically significant difference in the mean SFA values of lactating Murrah buffaloes (Table 2).

Unsaturated fatty acids (UFA)

The UFA (g/100g) mean values in the milk fat of control and cumin supplemented groups of lactating Murrah buffaloes were 23.05±0.90 and 29.49±1.01 during hot dry and 24.15±0.55 and 28.61±0.90 during hot humid season respectively (Table 2). During hot humid and hot dry seasons, the overall mean UFA levels in cumin supplemented group was significantly (P<0.05) higher than those of the control group.

Mono-Unsaturated Fatty Acids (MUFA)

The mean values of MUFA (g/100g) in the milk fat of Murrah buffaloes were 20.18±0.91 and 25.63±1.04 during hot dry and 21.38±0.57 and 25.22±0.91during hot humid season in control and cumin supplemented groups respectively (Table2). The overall mean values of MUFA was significantly (P<0.05) higher in cumin supplemented group compared to control group during hot dry and hot humid seasons.

Poly-Unsaturated Fatty Acids (PUFA)

The mean values of PUFA (g/100g) in the milk fat of Murrah buffaloes were 2.88±0.14 and 3.87±0.16 during hot dry and 2.77±0.11 and 3.39±0.20 during hot humid season in control and cumin supplemented groups respectively. The overall mean values of PUFA were significantly (P<0.05) higher in cumin supplemented group compared to control group during both the seasons (Table 2).

Total C18 Fatty Acids (C18)

The mean values of C18 (g/100g) in the milk fat of lactating Murrah buffaloes were 31.56±1.23 and 36.58±1.21during hot dry and 35.07±1.10 and 40.53±0.72 during hot humid season in control and cumin supplemented groups respectively (Table 2). The total C18 was significantly (P<0.05) higher in the milk fat of cumin supplemented group of buffaloes during both the seasons.

Desaturase Index -14 (DI -14)

The mean values of DI -14 in the milk fat of lactating Murrah buffaloes were 0.11±0.02 and 0.14±0.01 during hot dry and 0.09±0.01 and 0.13±0.01 during hot humid season in control and

Table 2: Effect of cumin supplementation on fatty acid profile of lactating buffaloes during hot dry and hot humid season

Fatty Acid Profile	Hot Dry		Hot Humid	
	Control	Cumin	Control	Cumin
SFA (g/100g)	61.61^{X}±1.02	59.90^{X} ±0.60	68.29^{Y}±2.30	71.69^{Y}±1.01
UFA (g/100g)	23.05^{A}±0.90	29.49^{B}±1.01	$24.15A^{A}$±0.55	28.61^{B}±0.90
MUFA (g/100g)	20.18^{A}±0.91	25.63^{B}±1.04	21.38^{A}±0.57	25.22^{B}±0.91
PUFA (g/100g)	2.88^{A}±0.14	3.87^{B}±0.16	2.77^{A}±0.11	3.39^{B}±0.20
CLA (g/100g)	2.57^{A}±0.14	3.50^{B}±0.16	2.48^{A}±0.10	3.04^{B}±0.20
Total C18	31.56^{A}±1.23	36.58^{B}±1201	35.07^{A}±1.10	40.53^{B}±0.72
DI (14)	00.11^{A}±0.02	00.14^{B}±0.01	00.09^{A}±0.01	00.13^{B}±0.01
DI (16)	00.04^{A}±0.01	00.06^{B}±0.01	00.04^{A}±0.01	00.06^{B}±0.01
DI (18)	00.57^{A}±0.02	00.64^{B}±0.01	00.54^{A}±0.02	00.53^{B}±0.03
DI (RA)	00.38±0.03	00.41±0.02	00.36±0.01	00.35±0.02
Total DI	00.25^{A}±0.01	00.30^{BX}±0.01	00.24±0.01	00.27^{Y}±0.01

The values are mean± S.E of six observations on six animals.
Different superscript (A,B) ina row depicts significant (P<0.05) difference between groups within season.
Different superscript (X,Y) in a row depicts significant (P<0.05) difference among seasons in a group.

cumin supplemented groups respectively (Table 2). The DI-14 values in the milk fat of lactating Murrah buffaloes were significantly (P<0.05) higher in cumin supplemented group compared to control group.

Desaturase Index -16 (DI -16)

The mean values of DI -16 in the milk fat of lactating Murrah buffaloes were 0.04±0.01 and 0.06±0.01 during hot dry and 0.04±0.01 and 0.06±0.01 during hot humid season in control and cumin, supplemented group respectively (Table 2). Significantly (P<0.05) higher mean values of DI-16 in the milk fat of lactating Murrah buffaloes were found in cumin supplemented group compared to control group during both the seasons.

Desaturase Index -18 (DI -18)

The mean values of DI -18 in the milk fat of lactating Murrah buffaloes were 0.57±0.02 and 0.64±0.01 during hot dry and 0.54±0.02 and 0.53±0.03 during hot humid season in control and cumin supplemented groups respectively (Table 2). Significantly (P<0.05) higher values of DI-18 in milk fat of lactating Murrah buffaloes was found in cumin compared to control group during both the seasons.

Desaturase Index of Rumenic Acid (DI -RA)

The mean values of DI -RA in the milk fat of lactating Murrah buffaloes were 0.38±0.03 and 0.41±0.02 during hot dry and 0.36±0.01 and 0.35±0.02 during hot humid season in control and cumin supplemented groups respectively (Table 2).

Total desaturase index (Total -DI)

The mean values of total DI in the milk fat of Murrah buffaloes were 0.25±0.01 and 0.30±0.01 during hot dry and 0.24±0.01 and 0.27±0.01 during the hot humid season in the control and cumin supplemented groups respectively (Table 2). Total DI of milk fat of Murrah buffaloes was found to be significantly (P<0.05) lower in the cumin supplemented group during the hot humid than hot dry season. During the hot dry season, the milk fat of cumin supplemented group of lactating Murrah buffaloes had significantly (P<0.05) higher values of total DI than the control group.

Conjugated Linoleic Acid (CLA)

The mean values of CLA (g/100g) in the milk fat of lactating Murrah buffaloes were 2.57±0.14 and 3.50±0.16 during hot dry and 2.48±0.10 and 3.04±0.20 during hot humid season in control and cumin, groups respectively (Table 2). Significantly (P<0.05) higher CLA content was found in cumin supplemented group than control group during both the seasons.

The significantly higher ratio of MUFA to MUFA+SFA indicating total desaturase index (DI), DIC14, DIC16, DIC18 and DIRA in goat receiving cumin seed extract (CSE) supplemented diet (Heidarian et al. 2013).The results might be due to increase in the activity of delta-9 desaturase enzyme in the mammary gland and another possible reason behind that the higher concentration of total C18 fatty acids in cumin extract supplemented goats reduced concentration of C14:0 and C16:0 in milk, because C18 fatty acids are powerful inhibitor of the de novo synthesis of fatty acids in the mammary gland (Chilliard et al. 2009). In addition, goats which were fed with 1g/L CSE produced milk with higher recovery of linoleic acid (LA) and linolenic acid (LNA) (Heidarian et al. 2015). Ghafari et al. (2015) reported that the supplementing lactating dairy cow diets with up to 200 g/d of cumin seed could improve performance, but a further increase in level of supplementation might result in reduced efficiency.

During the present study the CLA content was significantly (P<005) higher in milk fat of cumin supplemented group of buffaloes than control group (Table 2). Heidarian et al. (2013) also reported that the conjugated linoleic acid (CLA) significantly (P <0.01) increased by 20% in goat milk receiving the CSE supplemented diet. Several other authors also found that the concentrates and fodders are rich sources of polyunsaturated fatty acids. Foods of animal origin especially dairy products are the major sources of CLA for humans and are reputed to have therapeutic health values including anti-carcinogenic properties (Ip et al. 1999, Kewalramani et al. 2003). CLA exhibits numerous health benefits such as anti-obesity, anticarcinogenic, antihypertensive, antidiabetogenic, immunomodulatory and osteosynthetic effects, besides being used for the treatment of cardiovascular disease, metabolic syndrome, and asthma. Most of these biological effects have been attributed to the cis-9, trans-11 and trans-10, cis-12 CLA isomers (Badawy et al. 2023)

Cost benefit ratio

The cost of extra dietary supplements (cumin) in the treatment group was calculated based on the actual cost of cumin, i.e., Rs 165.00 per kg. Based on the market rate, the price of 1 kg of milk was Rs. 55.00. For the control group, no additional supplement was given, so the additional cost during the experiment period per day was zero. For the cumin group, cumin was additionally supplemented @ of 0.15 g/kg body weight/day. The additional cost of cumin per day, i.e., 70g of cumin, was supplemented per day per lactating buffalo. The cost of 70g of cumin was Rs. 11.55. The increased milk yield in the cumin supplemented group over the control group was 0.490 kg/day. The price of 0.490 kg of milk was 0.490 x 55 = Rs 26.95. Therefore, the cost-benefit ratio in the cumin supplemented group of lactating buffaloes was 26.95/11.55 = 2.33, i.e., 1:2.33. Therefore, supplementation of cumin to the lactating buffaloes during heat stress is economical.

Conclusions

Cumin is one of the very important spices and forms one of the major ingredients of several spice mixes which are consumed daily. Cumin contain alkaloid, coumarin, anthraquinone, flavonoid, glycoside, protein, resin, saponin, tannin and steroid. The group of buffaloes supplemented with cumin produced significantly higher milk during hot dry and hot humid seasons, suggesting that cumin had a heat stress ameliorating effect. Additionally, the beneficial fatty acids including the conjugated linoleic acid was increased significantly in cumin supplemented group indicated its beneficial effects on the health of calves and human beings. The cost-benefit ratio also showed a return of Rs. 2.33 on every rupee spent on cumin supplementation. Therefore, cumin which is available in every household can be supplemented to buffaloes for enhancing the milk yield, quality of milk and fatty acid composition during heat stress.

Conflict of interest

Regarding this article, the authors certify that there are no conflicts of interest.

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