Effect of Cumin Seeds (*Cuminum cyminum*) in Feed Diets of Anatolian Water Buffaloes on Shelter into Gass Concentration, Milk Yield and Composition

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Abstract

The research was carried out to determine the effects of cumin seeds in food diets of Anatolian water buffaloes (AWB) in shelter about gas concentration, milk yield and composition. The animal material of the experiment was conducted with 27 buffaloes at Karaoglan Village located in Mustafakemalpasa, Bursa. Three different buffalo shelters (E_1, E_2 and E_3) and three different diets (S_1; S_2; and S_3) (0, 10 and 30 g grounding cumin seeds (GCS) kg^{-1}) in 3x3 a replicated Latin square design was used with nine replicates of one buffalo each. Periods lasted 21 days, in which the first two weeks were preliminary for adaptation and data for statistical analysis collected in week 3. In conclusion, It has been determined that 30 g cumin supplementation to AWB diets (S_3; one kg of diet) significantly increased total dry matter intake and milk yield of AWB (P<0:01). Meanwhile; there were no significant effects of diets containing cuminun seeds in milk composition, somatic cell count (SCC) and shelter about gas concentrations (CH_4, NH_3 and CO_2).

Keywords: Cumin seeds, Anatolian water buffaloes, shelter into gass concentration, milk yield

Introduction

Cumin seeds (CS), whose scientific name is Cuminum cyminum L. and belonging to the apiacea family is a well-known herbal medicine in Iran (Tuncturk and Tuncturk 2006). The positive effects of CS on anti-fungal and anti-bacterial activity have been proved (De *et al.* 2003). This herbal is a very good source of iron which is a mineral that plays many vital roles in the body. CS has traditionally been noted to be of benefit for digestive system and also has anti-carcinogenic properties (Nurdin and Arief 2009). Moreover, Cumin fruit has been used to stimulate breast milk production in Iranian traditional medicine (Hashemian *et al.* 2013). Johnson *et al.* (1986) reported that some saponins (such as Gypsophylla) enhance the permeability of the intestinal mucosa. Herbs containing saponin could be utilized to meet the nutrient requirements and activate the endocrine system (Wang *et al.* 2000; Wenk 2000; Kumar *et al.* 2008; Bhatt *et al.* 2009). As it is known, the milk yield of an animal after giving birth reaches its peak level in 8-10 weeks. On the contrary, the ability to consume food cannot

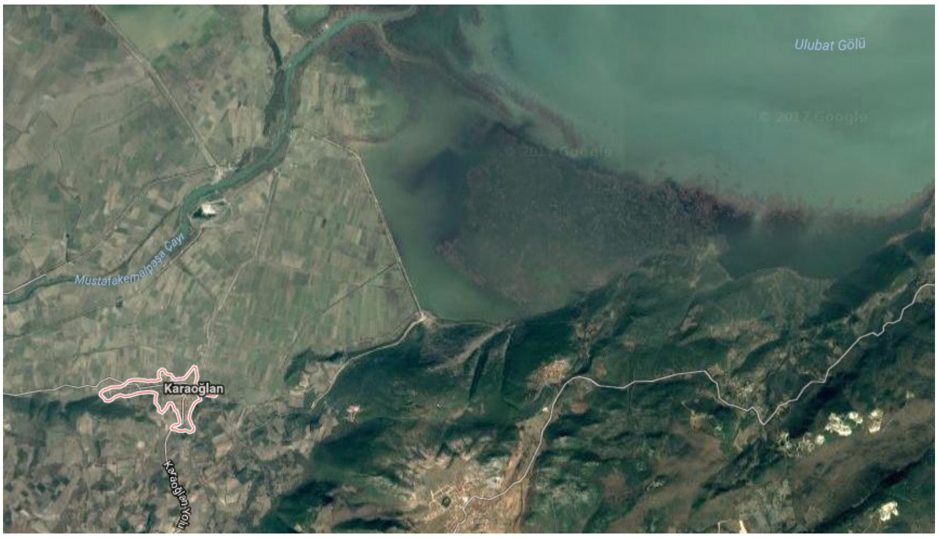

Figure 1. Location of Karaoglan District (Google Earth 2017)

rise rapidly to meet the increase in milk yield (Bell (1995). The energy imbalance seen in this period is called as a negative energy balance (Görgülü *et al.* 2009). During this period, animals try to compensate their energy insufficiency by breaking up fat tissues in their bodies. The risk of metabolic disease increases significantly when fat breakdown exceeds physiological limits (Knaus *et al.* 2001). In this period, however, the use of aromatic plants in livestock increases feed consumption, thereby reducing the energy imbalance (Degirmencioglu 2018). Khan and Chaudhry (2010) observed that CS significantly affected DM and OM degradability of some roughage in sheep rumen. The milk yield-increasing effect of CS has been investigated mainly in ruminants. Positive effects of CS on milk production in ruminants have been reported by Nurdin *et al.* (2011); Heidarian Miri *et al.* (2013) and Ghafari *et al.* (2015). Methanogesis (methane formation) is the phenomenon of methane (CH4) reduction by methanogenic bacteria of CO_2 and H_2, which are the results of anaerobic fermentation of nutrients in the ruminants' rumen (Klieve and Hegarty 1999; Görgülü *et al.* 2009). Methane gas contains energy; ruminant animals cannot benefit from this energy and is thrown into the atmosphere through burping (ructus). This, in turn, leads to problems as ecologically andeconomically (Öztürk 2008; IPCC 2001). Greenhouse gas is emitted in the atmosphere with both natural resources and human impact. In the world, about 80-115 million tons of methane gas are produced annually by ruminant animals. The share of this gas in global warming; It is 23 times more than CO_2 and it accounts for 15-20% of man-made methane production. Gases such as CO_2, CH_4, N_2O and NH_3 are the main greenhouse gases contributing to global warming (IPCC, 2001). For this reason, methane emission reducing strategies and studies are gaining priority. In the rumen methanogenic bacteria live close to protozoon's, even in their endoplasmic reticulum, and produce CH_4 gas using hydrogen ions, the end product of protozoan metabolism (Krumholz *et al.* 1983). Recent research has reported that plants containing both saponin and tannin reduced methane production by reducing the number of protozoa in the rumen (Newbold *et al.* 1988; Moss *et al.* 2000). Many studies on the subject have shown that the use of cumin reduces methane gas emissions in the rumen fluid (Kilic *et al.* 2011, Azizabadi *et al.* 2011 and Chaudhry and Khan 2012). The objective of the present study was to investigate the effects of cumin seeds in feed diets of Anatolian water buffaloes (AWB) on shelter about gas concentration, milk yield and composition.

Materials and methods

Study site

This experiment was conducted at Karaoglan District located in Mustafakemalpasa, Bursa in June and July (Figure 1). The study was conducted in summer months because of ablactation of buffaloes in autumn months. The climate of the

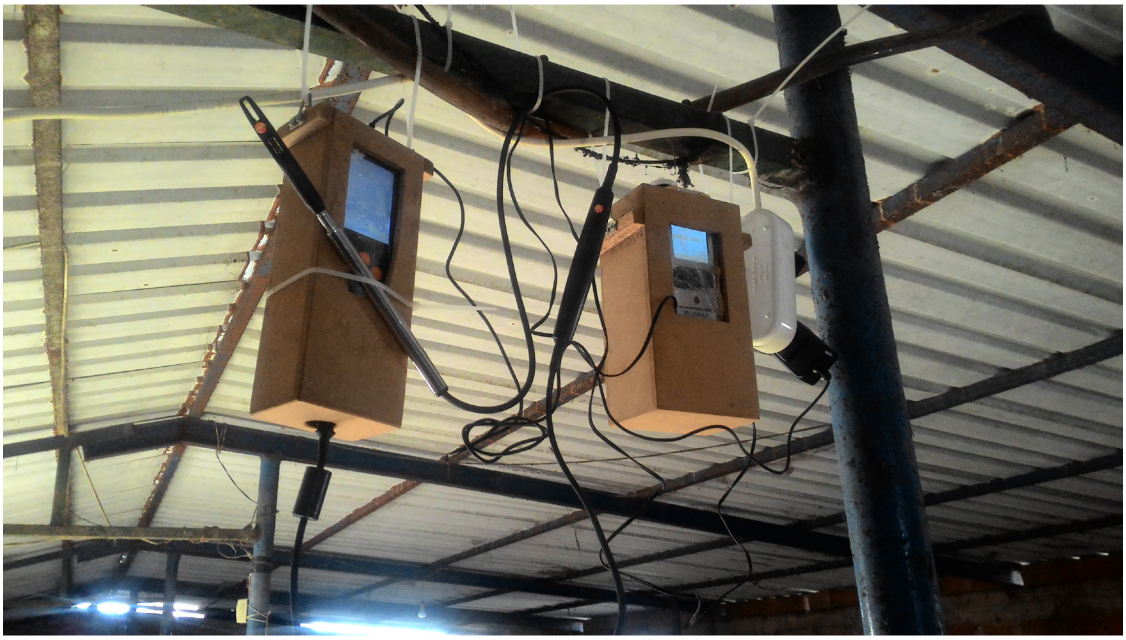

Figure 2. General condition of measuring devices in the shelter

district is within the influence of the Marmara climate. The economy of the district is based on agriculture, especially buffalo breeding. Apart from that, dry beans and chickpeas are planted and Deveci pear is grown.

Animals, shelters, addition and experimental design

A total of 27 multifarious AWB (4 and 5 years old, 472-485 kg live weight) for 40-50 days of lactation was used in a replicated 3x3 Latin square designed trial. Buffaloes at shelter were selected primarily according to their milk yield prior to the start of the experiment (Table 1). The cumin seeds (CS) material used for the study was purchased at a market. The treatment of CS was proceeded at 3 mm size. The chemical composition of CS contained dry matter (DM) 92.43%, crude protein (CP) 19.64%, fat 15.68%, fiber 11.23% and crude ash (CA) 6.95% (Table 2). Periods lasted for 21 days, in which the first 15 days were used for adaptation, with data for statistical analysis being collected in the final 7 days. Thus, the total experimental period lasted for 63 days. In each of the three periods, 9 buffaloes, lived in one of the three different shelters (E_1, E_2 and E_3) were randomly assigned to one of three dietary (S_1, S_2 and S_3) treatments DM basis (Table 3).

Experimental rations were as follows;

Control (S_1; concentrate feed mixture (CFM) contained no grounded *cumin* seeds GCS), treated rations S_2; control ration plus 10 g GCS kg^{-1}, and S_3; control ration plus 30 g GCS kg^{-1}. The CFM consisted of 33% barley, 34% wheat, 31% sunflower meal, 1% marble powder, 0.75% salt and 0.25% vitamin+mineral mix (Table 3). During the trial, all buffaloes were allowed to ad libitum pasture and received corn silage (16 kg day^{-1}), alfalfa hay (5 kg day^{-1}) and 0.70 kg of the experimental diet (per 1.0 kg of milk per day) (S_1, S_2 and S_3: 193.9, 191.8 and 190.0 g CP/kg DM and 2830, 2834 and 2842 ME (kcal kg DM^{-1})). The buffalo ration was formulated to correspond to 4.0 kg day^{-1} of milk production with 7.0% fat and 5.0% protein in the lactation stage (40–45 days), according to National Research Council (NRC) (2001) recommendations. For both groups, alfalfa was offered at 6:30 a.m., and silage was offered once a day at 7:30 p.m. The buffaloes had ad libitum access to water and pasture. DM intake was measured at the end of the sample collection period by weighing the offered diet and refusals from the previous day. Pasture consumption was not determined because of free pasturing.

The study was conducted simultaneously in three buffalo's shelters with features that could represent the capacity and structural features of other enterprises. Temperature, relative humidity and air velocity were measured with Testo 435 (Testo, Germany) and CH_4, NH_3 and CO_2 gases were measured with MultiRAE Lite multi-gas

Table 1: Basic information of the examined buffaloes

Buffaloes shelter	Number of Buffaloes	Body weight (kg)	Days in milk	Milk yield (kg d^{-1})
E_1	9	482.22±4.83	40.00 ± 3.53	4.30±0.13
E_2	9	472.22±2.70	40.56 ±6.03	4.33±0.13
E_3	9	495.56±10.28	49.56 ±2.10	4.38±0.08
Significance level		NS	NS	NS

NS – non significant, Group's average of body condition score (BCS) is 2.5-3.

Table 2: Chemical composition of Cumin seeds DM (%)

DM	OM	CP	EE	CELL	CA	NFE	ADF	NDF	ADL	ME (kcal kg^{-1})
92,43	85.48	19.64	15.68	11.23	6.95	38.93	20.66	44.90	11.00	2461.07

DM- Dry Matter; OM- Organic Matter; CP- Crude Protein; EE- Ether Extract; CELL- Cellulose; CA- Crude Ash; NFE- Nitrogen Free; Extract ADF- Acid Detergent-Fibre; NDF- Neutral Detergent Fibre; ADL- Acid Detergent Lignin; ME- Metabolizable Energy calculated according to the equation of Lodhi et al. (1976).

meter (Wireless Portable Multi-Gas Monitor- RAE Systems by Honeywell, USA) in order to show indoor conditions and air quality indicators. In-house measurements were carried out in June and July. In this period, in order to be able to evaluate the general situation in the barns, the measurement points were determined in such a way as to reach the horizontal and vertical midpoint of the shelters and data records were measured continuously 24 hours for 4 days (Figure 2).

Chemical composition

Ration samples were collected daily to determine DM consumption according to DM analysis of the feed (at 105°C overnight). After drying, the samples were ground (1 mm) for chemical analysis. The feed was evaluated to determine CP according to the Association of Official Analytical Chemists (AOAC 1990) and fibre fractions (NDF and ADF) (Robertson and Van Soest 1981). The metabolisable energy value of the feed was calculated based on chemical analyses using computer software from the National Research Council (NRC 2001). The solids-non-fat content (SNF) and fat and protein components of the milk were analyzed using a Milcosan FT-120 device. SCC was determined with a Somacount 150 (Bentley Instruments, Chaska, USA).

Statistical analysis

Data for milk yield, dry matter intake and gas parameters in shelter were tested by analysis of variance using the SPSS version15.0 Statistical Package (2006) and means were analysed with the general linear models procedure using the following model described by Cochran and Cox [1957]:

$$Y_{ijklm} = \mu + T_i + U_j + R_k + K_l + E_{ijklm}$$

where;

Y_{ijklm} – observation,

μ – population mean,

T_i – dietaries (i= S_1, S_2 or S_3),

U_j – shelters (j = (E_1, E_2 or E_3),

R_k – animals (k=1, 2, 3,....26 or 27),

K_l –period (l, 2 or 3) and

E_{ijklm} – residual error.

Means were separated by Duncan's multiple range tests.

Results and discussion

The effects of f cumin seeds

Chemical composition of diets, alfalfa hay and corn silage are presented in Table 3. During the experimental period, silage DM consumption in buffaloes fed the S_1, S_2 and S_3 diets was 5.10, 5.12 and 5.48 kg day^{-1}, respectively (P<0.05; Table 4). Alfalfa DM consumption of the buffaloes was 4.78, 4.94 and 5.21 kg day^{-1}, respectively (P<0.05). Similarly, GCS application significantly increased to a total DM consumption (P<0.01; 11.69, 12.14 and 13.01 kg day^{-1} for S_1, S_2 and S_3 diets, respectively). The total DM consumption was higher in buffaloes fed by S_3 diet than in buffaloes fed by the S_2 and S_1 diets (6.68 % and 10.14 %, P<0.01). The differences between the mean total DM consumption values of diet S_3 and diets S_1

Table 3: Composition of feed mixtures and roughages fed by experimental buffaloes (%)

Compound (g kg^{-1})	Diet (1000 g)			Roughages for buffaloes	
	S_1 0 g GCS $^{-1}$	S_2 10 g GCS	S_3 30 g GCS	Alfalfa hay	Corn silage
Barley	330	330	330		
Wheat	340	340	340		
Sunflower meal	310	300	280		
Cumin	0	10	30		
Marble powder	10	10	10		
Salt	7.5	7.5	7.5		
Vitamin+minerals[1]	2.5	2.5	2.5		
Total	1000	1000	1000		
Nutrient composition (g kg^{-1})					
DM[2]	887.0	891.7	895.0	894.4	310.3
OM	850.7	853.4	848.5	803.8	261.1
CP	193.9	191.8	190.0	146.5	66.2
EE	19.4	19.7	21.4	15.2	23.2
CELL	114.2	117.8	126.1	330.4	190.0
CA	36.3	38.3	46.5	90.6	49.2
NFE	523.2	524.1	511.0	311.7	18.2
Starch	332.0	351.0	336.9	20.0	218.1
NDF	220.0	220.4	226.2	409.9	428.6
ADF	174.0	176.4	179.6	370.4	307.2
ADL	43.0	50.1	44.0	90.6	63.2
ME (kcal/kg DM)[3]	2830	2834	2842	1780	696

[1]Trace minerals and vitamins (per kg)- 50.000 mg, Niacin- 150 mg, Co- 800 mg, Iyot- 150 mg, Se- 50.000 mg, Mn- 50.000 mg, Fe Zn- 50.000 mg, Cu- 10.000 mg, 15.000.000 IU, Vitamin A- 3.000.000 IU, Vitamin D3-20.000 mg, Vitamin E.
[2]DM- Dry Matter; OM- Organic Matter; CP- Crude Protein; EE- Ether Extract; CELL- Cellulose; CA- Crude Ash; NFE- Nitrogen Free Extract; NDF- Neutral Detergent Fibre; ADF- Acid Detergent Fibre;[3] ADL- Acid Detergent Lignin; [3]ME-Metabolizable Energy.

Table 4: The effects of Grounding c*umin* seeds on DM intake, milk yield and composition (mean ± SE)

Parameter	Diets			Significance level
	S_1	S_2	S_3	
Silage DM intake (kg d-^{1})	5.10±0.06^{a}	5.12±0.07^{b}	5.48±0.15^{b}	*
Alfalfa DM intake (kg d^{-1})	4.78±0.13^{a}	4.94±0.13^{ab}	5.21±0.09^{b}	*
Concentrate DM intake	1.81±005^{a}	2.08±0.08^{ab}	2.32±0.09^{b}	**
Total DM intake[1]	11.69±0.20^{a}	12.14±0.20^{a}	13.01±0.27^{b}	**
Milk yield (kg d^{-1})	5.83±0.09^{a}	6.17±0.14^{a}	6.68±1.28^{b}	**
4 % FCM	7.73±0.21^{a}	7.46±0.25^{ab}	8.38±0.19^{b}	*
Fat (%)	6.27±0.32	5.45±0.30	5.62±0.25	NS
SNF (%)	10.32±0.08	10.14±0.06	10.15±0.06	NS
Protein (%)	4.53±0.10	4.24±0.08	4.20±0.07	NS
SCC(x log10 mL^{-1})	159.74±39.00	153.78±20.51	92.29±9.60	NS

1Total DM intake values for buffaloes were not added to pasture consumption. 4 % FCM- 4% fat-corrected milk; SNF-Solids-not-fat; SCC-Somatic Cell Count; SE-Standard error, NS- Not significant; *P<0.05, ** P<0.01.

Table 5: Effects of cumin seeds (Cuminum cyminum L.) in AWB diets related with indoor shelter gas concentration

Buffaloes shelters	Diets			Significance level
	S_1	S_2	S_3	
E_1	5±0.33	4±0.33	4±0.33	
E_2	5±0.57	3±0.57	4±0.57	
E_3	5±0.66	3±0.66	3±0.66	
CH_4 (%)	5±0.0	3.33±0.19	3.66±0.19	NS
E_1	9 ± 2.33	9 ± 2.33	2 ± 2.33	
E_2	2±1.20	5±1.20	1±1.20	
E_3	4±10	7±10	7±10	
NH3 (ppm)	5±2.08	7±1.15	3±1.92	NS
E_1	700 ±66.74	700 ±66.74	500 ±66.74	
E_2	500 ±57.80	600 ±57.80	400 ±57.80	
E_3	400 ±66.74	600 ±66.74	400 ±66.74	
CO2(ppm)	533 ± 50.91	633 ±19.24	500 ±33.33	NS
E_1	25.55±0.71	28.00±0.71	27.00±0.71	
E_2	27.02±1.14	27.77±1.14	30.77±1.14	
E_3	26.89±1.20	27.01±1.20	23.33±1.20	
Temperature (^{0}C)	26.48±0.47	27.59±0.29	27.03±2.15	NS
E_1	0.060±0.041	0.190±0.041	0.070±0.041	
E_2	0.050±0.006	0.066±0.006	0.070±0.006	
E_3	0.060±0.002	0.060±0.002	0.053±0.002	
Wind (m/s)	0.05±0.033	0.10±0.042	0.06±0.005	NS
E_1	43.40±3.36	46.00±3.36	54.56±3.36	
E_2	63.36±8.40	38.09±8.40	63.19±8.40	
E_3	63.27±4.32	58.96±4.32	48.72±4.32	
Humidity (%)	56.67±6.64	47.68±6.09	55.49±4.20	NS

NS= Not significant

and S_2 were significant P<0.01). These findings were consistent with the results of Ghafari *et al.* (2015), showing that increase in dry matter intake was associated with the addition of CS (0.1, 0.2 and 0.3 g d^{-1}) in lactating cows (9.54 %, 12.43 % and 13.76 %; P<0.01). In another study, Forster *et al.* (1980) observed that herbal feed additives stimulate DMI. Increased DMI in buffaloes fed by GCS, might have been mediated by improved nutrient digestibility (Johnson *et al.* 1986; Suresh and Srinivasan 2007). Furthermore, CP, EE and NFE content of CS is considerably rich as for the aspect of nutrients (Table 2). These nutrients may be attributed to degradability of forage by rumen microbial (Khan and Chaudhry 2010). However, Heidarian Miri *et al.* (2013) reported that in goats fed by cumin had no effect on DMI. In the present experiment, the daily milk yields for buffaloes fed by the S_1, S_2 and S_3 diets were 4.30, 4.33 and 4.38 kg/day, respectively, at the beginning of the study (P>0.05). The milk yields of buffaloes were positively affected with increasing levels of GCS. In buffaloes fed by diet S_3 with 30 g GCS increased milk yield by 0.85 kg d^{-1} but this increment was only 0.34 kg d^{-1} in buffaloes fed by diet S_2 with 10 g GGCS kg^{-1}. The differences between the mean milk production values of diet S_3 and diets S_1 and S_2 were significant (P<0.01). Significant increases in milk production associated with CS have previously been reported in dairy cows and goats (Nurdin *et al.* 2011; Ghafari *et al.* 2015; Heidarian Miri *et al.* 2013). Ghafari *et al.* (2015) reported

Table 6: Effects of cumin seeds (Cuminum cyminum) in AWB diets related with indoor shelter gas concentration

Buffaloes shelters	Diets			Significance level
	S_1	S_2	S_3	
E_1	5±0.33	4±0.33	4±0.33	
E_2	5±0.67	3±0.67	5±0.67	
E_3	5±0.33	4±0.33	4±0.33	
PEAK CH_4 (%)	5±0.0	3.66±0.33	4.33±0.33	NS
E_1	25.00 ± 5.07	20.00 ± 5.07	8.00 ± 5.07	
E_2	8.00±5.01	19.00±5.01	2.00±5.01	
E_3	5.00±6.04	23.00±6.04	23.00±6.04	
PEAK NH3 (ppm)	12.66±6.27	20.66±1.20	11.00±6.28	NS
E_1	1400 ±232.55	1800 ±232.55	1000 ±232.558	
E_2	1200 ±153.822	1100 ±153.822	700 ±153.822	
E_3	500 ±268.534	1300 ±268.534	1300 ±268.534	
PEAK CO2(ppm)	1033 ± 274.75	1400 ±209.62	1000 ±174.41	NS
E_1	27.44±1.29	30.96±1.29	31.55±1.29	
E_2	32.81±0.23	32.04±0.23	32.19±0.23	
E_3	31.56±1.22	31.56±1.22	27.92±1.22	
PEAK Temperature (^{0}C)	30.60±1.63	31.52±0.31	30.55±1.33	NS
E_1	0.030±0.003	0.040±0.003	0.040±0.003	
E_2	0.060±0.008	0.040±0.008	0.030±0.008	
E_3	0.030±0.006	0.050±0.006	0.050±0.006	
PEAK Wind (m/s)	0.040±0.010	0.043±0.003	0.040±0.005	NS
E_1	79.73±3.39	70.74±3.39	68.67±3.39	
E_2	88.74±8.65	60.62±8.65	83.61±8.65	
E_3	84.30±7.06	78.70±7.06	60.89±7.06	
PEAK Humidity (%)	84.25±2.60	70.02±5.23	71.05±6.67	NS

NS= Not significant

that milk yield of cows increased significantly with the increased levels of CS supplement and also that the difference between 100 - 300 g of CS levels had no effect on milk yield. Heidarian Miri *et al.* (2013) reported that in lactating goats, the milk yield was increased in lower supplemented group (12.7 extract of CS g/kg DM), compared with higher supplemented group (25.3 extract of CS g/kg DM). Another study showed that the supplementation of 0.03% body weight of Cumin significantly increased (P<0.01) milk yield, and significantly decreased mastitis status in dairy cows (Nurdin *et al.* 2011). Kumar *et al.* (2008) observed that the galactagoue herbs increased in milk production by stimulating the endogenous hormonal secretion in mammals. Similarly Bhatt *et al.* (2009) reported that cumin had galactopoietics properties, which were mediated by stimulating endogenous hormonal secretion. Higher DMI and improved nutrient digestibility caused by GCS supplementation and therefore increased nutrient supplied to mammary glands might have led to an increased production of milk Ghafari *et al.* (2015).

In this study, it was determined that 30 g of CS was the most suitable dosage in AWB. This value is lower than the 100g d^{-1} reported by Ghafari *et al.* (2015) however; Heidarian Miri *et al.* (2013) reported that the most appropriate dosage was approximately 12.7 g CS /kg in lactating goats. A similar trend was also recorded for 4% FCM yield. The 4% FCM yield in buffaloes fed both by S_1 and S_2 diets occurred lower than that of the S_3 diet.

Significant differences were observed between S_1, S_2 diets and S_3 diet (P<0.05). In this study, CS supplementation did not affect the protein, fat and SNF content of buffalo milk and this result complies with the other studies (Heidarian Miri *et al.* 2013 and Ghafari *et al.* 2015) who reported that differences in SNF, protein and fat contents of cow's and goat milk fed ration supplemented with SC were not significant. Conversely, Nurdin *et al.* (2011) showed that milk protein contents were significantly (P<0.05) affected by CS supplementation. Somatic cell counts of milk were determined as 159.74, 153.78 and 92.29 SCC (log10 mL-1) for S1, S2 and S3, respectively. There were no significant effects of diets containing cumin seeds on milk composition, somatic cell count (SCC) and indoor gas concentration (CH_4, NH_3 and CO_2).

The daily average and maximum indoor CH_4, NH_3 and CO_2 gas concentration are shown in Table 5 and 6. These values averaged 3,33-5 ppm and 5 ppm maximum for CH_4, 3-7 ppm and maximum 25 ppm for NH_3 and 500-633 ppm and 1800 ppm, CO_2 respectively. Again average and maximum temperature, wind speed and relative humidity values were determined in the shelter environment. Accordingly, while the mean was between 23.33-28 °C, the highest value was 32.81 °C in the S_1 diet in E_2 barn. The mean air velocity was 0,05-0,010 m/s and the highest in the E_2 bar was 0,06 m/s in the S_1 diet. The relative humidity average ranged from 38 to 63%, the highest being 88.74% in the S_1 diet in E_2 barn.

These values determined in the shelter environment are 1000 ppm for CH_4, 25 ppm for NH_3 and 5000 ppm for CO_2 (ACGIH, 2005), when the threshold limit values for animal and employee health are examined. Accordingly, it is seen that the threshold limit value is reached at the NH_3 gas concentration determined to be only 25 ppm. Irritation in the nose and throat may occur in a period of 10 minutes over the concentration of this value. Other data are not at a level to harm animal and employee health. It can be said here that the water buffaloes were frequently taken out during the measurements and that the weather changes in the barns were good. Although there was no difference in gas concentrations between shelter and diet application, CH_4 gas was the lowest in the S_2 diet. From this it can be said that S_2 has a methane reducing effect. On the other hand, NH_3 and CO_2 gas concentrations were slightly higher than others. When we take all the measured gases, it can be said that the S_3 diet shows better results in the shelter environment than the other data.

The average values of the temperature and relative humidity were within allowable limits in all three shelters. There was no significant difference between them. Despite the buffalo tropical origin, the extremity is quite sensitive to climate conditions. In reality, the buffaloes are easily affected when the temperature and humidity are high. Optimum temperature value for buffalo is between 10-27 ºC (Schein and Hafez 1969). It should be noted that the mean values exceeded the comfort threshold in certain periods and that the heat stress were inevitable during the highest temperature for animals. For this reason, buffaloes were taken into the river and lake in the region during the summer period. While not intending the relative humidity exceeds 80 %, the highest values were found to be 88%.When the temperature and relative humidity are high, it is possible to put the animals into heat stress, and the milk yield may decrease accordingly. As a matter of fact, at high temperatures, the milk yield was reduced by 10-50%. It can also lose 20-30% of fertility (De Rensis and Scaramuzzi, 2003).

Conclusion

According to the conclusions provided in Table 5 and 6, our study showed that the 30 g CS added to the early lactating AWB resulted in a significant increase in milk production of 0.85 kg day^{-1} and total DM intake of 1.32 kg day^{-1}. However, 10 g lower (S_2; one kg of diet) than that of the 30 g CS did not affect the performance of AWB positively. Therefore, diet S_3 with 30 g GCS kg^{-1} can be offered for buffalo farms.

In this study, data were collected from three water buffalo barns during summer season. The CH_4, NH_3 and CO_2 concentrations, indoor temperature, air velocity and relative humidity were measured continuously 24 h for 4 days in the barns. Gas concentrations were similar in all shelters. The measured gas concentrations were within the threshold limit values excluding ammonia. Ammonia concentrations increased with lower air velocity and high temperature.

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