Chapter

Use of Aromatic Seeds as Feed Additives to Improve the Production of Anatolian Water Buffaloes

Taşkın Değirmencioğlu

Abstract

Buffaloes have a strong population of rumen microorganisms that can utilize different feeds. Other features that make this animal unique are its compatibility with nature, its ability to withstand difficulties, and the nutrient richness of animal products. Today, the emergence of residues such as animal origin diseases, pesticides and antibiotics in animal food products has led organic products to be preferred more by consumers. Due to the increase in consumption demand of natural products, the share of buffalo products in the world market is gradually increasing. Focusing on the use of natural additives in buffalo feeding is important for the diversity of healthy products. Examples of natural additives are cumin and fenugreek seeds. In addition to being natural products, these seeds are reported to have versatile functions in the animal body. The purpose of this chapter is to show how to use aromatic seeds as feed additives in the feeding of Anatolian water buffaloes. The chapter also includes various articles on the use of aromatic seeds in buffalo rations in international fields. This review focuses on the current research relating to the use of aromatic seeds as feed additives to improve the production of Anatolian water buffaloes. Based on the scientific results presented in this chapter, authors drew the following main conclusions: (1) The use of aromatic seeds as feed additives of Anatolian water buffaloes feeding enabled in enhancing milk production, without changing the taste and chemical composition of the milk. (2) Milk production can be improved up to 0.67 kg and 0.85 kg day-1 by adding 50 g Fenugreek seeds and 30 g Cumin seeds to the ration of buffaloes in the early lactation period. (3) The use of aromatic seeds in the feeding of water buffaloes has been proven therefore, their use in the buffalo sector should be encouraged.

Keywords: Cumin seeds, fenugreek seeds, feed consumption, milk yield, organic animal

1. Introduction

With the increase in population, the product range for commercial purposes has gradually expanded in the food industry. Especially in the feed sector, new feed sources, corn chips, biscuits and chocolate residues were offered to animals. However, the reliability of these feed sources is a matter of debate. In intensive

dairy buffaloes, green feeds are harvested and brought to the feet of the animal. Buffalo cows are fed with blended feed consisting of alfalfa hay, corn silage, straw, concentrate feed and sometimes food agricultural residues (such as tomato peel, beer grinder residues, sugar beet pulp). The Anatolian buffalo has a great potential in terms of organic animal husbandry because of its resistance to diseases, its diet based on pasture, not adding synthetic additives to its feed, and its usefulness for human health. On the other hand, considering the insufficient technological and economic infrastructure of the breeders, the drying of wetlands to agriculture, the risk of drug residues, the use of genetically modified feed in feed factories, the above-mentioned negative effects constitute a serious risk in terms of this potential [1]. Organic (ecological, biological) animal production is a production method of ecological balance, animal welfare and product quantity, criteria of health criteria in product quality [2]. In organic animal production enterprises, species and breeds which are resistant to environmental and climatic conditions and diseases should be selected [3]. Buffaloes are resistant to sudden feed changes and can feed on low-quality forages. They are also resistant to diseases caused by blood parasites in their feet and mouth, namely BSE, IBR-IPV [4]. Therefore, because the Anatolian water buffalo does not need a special care, they are sought for organic livestock. In organic livestock, hormones, antibiotics and the like substances cannot be used to speed up the growth rate and maximize the feed utilization. Genetically modified (GMO) feeds, chemically treated feeds or synthetic additives cannot be used [5]. Studies have been carried out to improve natural consumption and rumen conditions as well as natural additives in rations of Anatolian water buffaloes. As example of this additive can be given aromatic plants [6]. 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 can not rise rapidly to meet the increase in milk yield [7]. The energy imbalance seen in this period is called as negative energy balance [8]. 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 [9]. In this period, however, the use of aromatic plants in livestock increases feed consumption, thereby reducing the energy imbalance The milk yield-increasing effect of aromatic seeds has been investigated mainly in ruminants. The milk productivity of AWB is very low because of traditionally feeding based on pasture. Milk supply can be increase with some herbal in cattle.

2. Anatolian water Buffalo

Buffaloes in our country have their origins in the Mediterranean buffalo, one of the subspecies of river buffaloes, and are defined as the Anatolian water buffalo (AWB). (Bubalusbubalis). It is a domestic race registered by the race registration committee with the communiqué dated 12.12.2004 and numbered 25668 of the Official Gazette 2004/39 [10]. The AWB showing a distribution to all parts of Turkey mainly the Black Sea region and the north of the Central Anatolia has a live weight ranging between 400 and 450 kg in adult females and 450–500 kg in adult males. It has a height of 129 to 136 cm in the shoulder region (cidago height). The AWB has a rough, angular and muscular body, a low rump and thick and strong joints. The hair color is black and dark gray in adult buffaloes. Some individuals may have whiteness at their heads, feet and tails (**Figure 1**).

The lactation period ranges between 200 and 250 days and the total milk yield in the lactation period ranges between 800 and 1000 kg. The fat ratio in the milk varies between 6 and 8% [11]. During the Ottoman Empire period, Turks passing to the Balkans took their buffaloes with them. The Turkish buffalo spread to a wide area

Figure 1.
Anatolian water Buffalo (Bupalusbupalis).

in the Balkan countries with wet and fertile lands (Mecadonia, Western Thrace and Bulgaria) [1]. There is a wide range of AWB products. For example, Ney is the only woodwind of Turkish Classical Music and the head instrument of Turkish Sufi Music. Ney is one of the instruments whose sound is closest to human voice. A mouthpiece called baspare is attached on the top hole in order to obtain a clearer sound and to prevent the lips from being hurt. Baspare is usually made of water buffalo horn. Similarly, buffalo horn is used in the production of Turkish bows and combs. Yoghurt, cream and mozzarella cheese are made from its milk and sausages are made from its meat. According to the recent scientific findings it can be stated that milk and meat yields of buffaloes are lower than those of cattle. However, products obtained from buffalo can be sold at a low cost and a higher price than cattle [12].

3. Aromatic seeds

The Saponins are naturally occurring surface-active glycosides. Chemically, saponins are high-molecular-weight glycosides in which sugars (glycone) (1–8 residues) are linked to a triterpene or steroidal aglyconemoiety [13]. Johnson et al. [14] found that some saponins increase the permeability of intestinal mucosal cells. Herbal containing saponin can contribute to nutrient requirements, stimulate the endocrine system and affect intermediate nutrient metabolism [15, 16]. In addition saponin-rich materials increase the partitioning of nutrients towards microbial mass, mainly by affecting protein degradation and by having anti-protozoal effects [17]. The seeds of fenugreek and cumin contain alkaloids, flavonoids, saponins, amino acids, tannins and some steroidal glycosides [18].

Fenugreek seeds (FS) (*Trigonellafoenumgraecum*) is an annual crop belonging to the legume family [19]. Fenugreek has a positive effect on the lactation performance of ruminants. Diocin is a natural saponin found in Fenugreek and has a structural similarity to estrogen [20].

There are two main purposes of grinding the fenugreek substance. The first is to separate the grain into small particles that can be found in the same proportion throughout the mixed feed. The other should be given roughly broken in order to facilitate digestion in buffaloes. Otherwise, a significant portion of the seeds is thrown out without being digested. Treatment of grinding fenugreek seeds proceeded at 3-mm intervals (**Figure 2**).

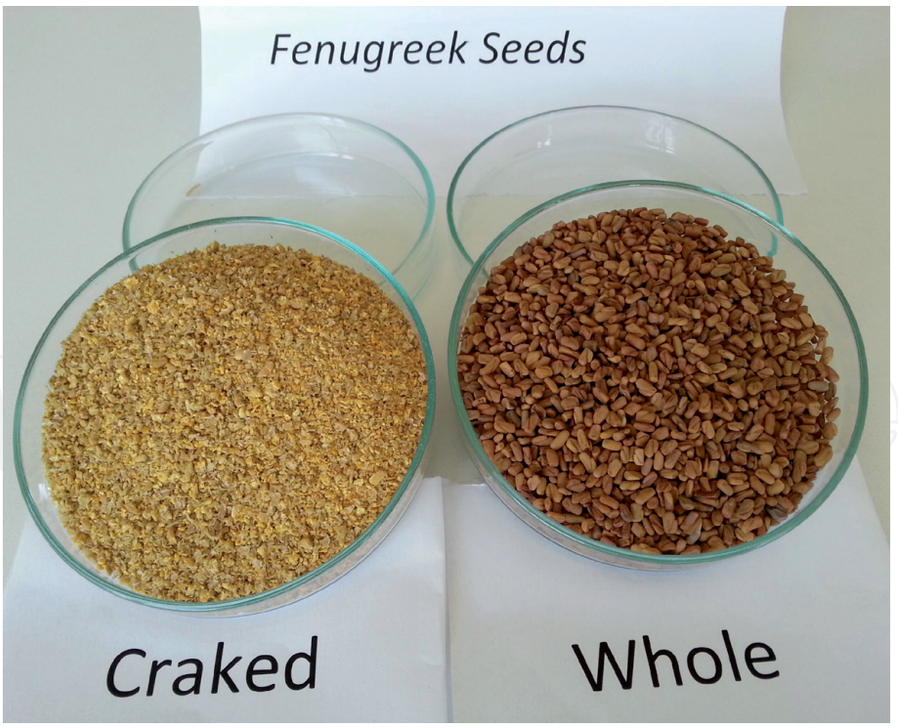

Figure 2.
The form of the fenugreek seed used in trial.

Cumin seeds (CS), whose scientific name is *Cuminumcyminum* L. and belonging to the apiacea family is a well-known herbal medicine in Iran [21]. Its fruits contain 2–5% volatile oil, usually obtained by steam distillation of the dried and crushed fruits. This oil has the ability to easily diffuse across cell membrane to induce biological reactions. Cuminaldehyde is one of the major flavoring components of cumin essential oil that can induce different biological activities. Previous studies showed that the antimicrobial and fungitoxic activity could be linked to the main compound, cuminic aldehyde [22]. Positive effects of CS on feed consumption in ruminants have been reported by some researchers [23, 24].

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 [25]. Moreover, Cumin fruit has been used to stimulate breast milk production in Iranian traditional medicine [26]. The nutrient composition of seed depending on the raw material source and the storage conditions. Many studies have shown that the protein content of FS varies between 27.42–42%, and However, the oil content was low, below 10%, Linolenic acid (18: 3) was present at low relative level (below 1.0%) [27], totalcarbohydrate 56.14%, neutral detergent fiber 18.62%, acid detergent fiber % 4.38 and hemi cellulose 14.24% [28]. The chemical composition of FS and CS respectively contained on dry matter basis (DM) 91.11 and 92.43%, crude protein (CP) 29.49 and 19.64%, ether extract (EE) 3.86 and 15.68%, crude ash (CA) 3.23 and 6.95% ME 2373.67 and 2461.07 kcal/kg. Chemicalcomposition of FS and CS seeds are presented in **Table 1**.

As can be seen in **Table 1**, crude cellulose content of FCS and CS and was 6.20 and 11.23% depending on the crust ratio in the seed. The chemical composition of FS and CS respectively contained on dry matter basis (DM) 91.11 and 92.43%, crude protein (CP) 29.49 and 19.64%, ether extract (EE) 3.86 and 15.68%, crude ash (CA) 3.23 and 6.95% ME 2373.67 and 2461.07 kcal/kg (**Table 1**).

The crude protein of FS is higher than the CS. However, the ether extract, cellulose, crude ash, ADF and NDF content of the CS was higher compared with the FS.

Feed	DM	OM	CP	EE	CE	CA	NFE	ADF	NDF	ME (kcal kg^{-1})
Fen.	91.11	87.88	29.49	3.86	6.20	3.23	48.33	11.50	14.44	2373.67
Cum.	92,43	85.48	19.64	15.68	11.23	6.95	38.93	20.66	44.90	2461.07

Cumin DM: Dry Matter; OM: Organic Matter; CP: Crude Protein; EE: Ether Extract; CE: Cellulose; CA: Crude Ash; NFE: Nitrogen Free Extract; ADF: Acid Detergent-Fiber; NDF: Neutral Detergent Fiber; ADL: Acid Detergent Lignin; ME: Metabolizable Energy calculated according to the equation of [29].

Table 1.
Chemical composition of fenugreek [30] and cumin seeds [31] DM (%).

Figure 3.
Concentrate feed mixture (CFM).

In addition to the crude protein content of over 29%, fenugreek seeds are increasingly replacing plant-based meal feeds with its nutrient profile.

Experimental rations were as follows: control Concentrate feed mixture-(CFM) and CFM consisted of 31% barley, 32% wheat, 30% sunflower meal, treated 5% Fenugreek seed 1% marble powder, 0.75% salt and 0.25% vitamin+ mineral mix (**Figure 3**) [30].

3.1 The use of aromatic seeds in buffaloes

To summarize thousands of studies on aromatic seeds in this review it does not seem possible. Therefore, this chapter focuses only on the most important aromatic seeds those can be considered in buffaloes feeding.

3.2 The effects of aromatic seeds on dry matter intake

Daily intake of dry matter (DM) in an animal defines its capability of feed consumption. Dry matter consumption; It is affected by factors such as animal factor, environmental factor and feed [1]. Positive effects of aromatic seeds on dry matter intake in buffaloes have been reported by some researchers. When studies on milk buffaloes were examined, it was seen that aromatic seeds were used in early lactation buffalo rations.

Değirmencioglu et al. [30] 24 lactating Anatolian buffaloes at lactation stage 30–45 days of lactation were randomly selected and distributed into two different groups with 12animals in each group. Animals in Group I fed by control ration and in Group II fed by control ration plus fenugreek seeds (GFS) 50 g kg^{-1}. In a related study, Total DM consumption in group 2 was higher than in the control group 1 (5.92% ($P < 0:05$)); it was determined that the grinding fenugreek seeds (GFS) at a level of 5% had a significant effect on dry matter consumption (0.83 kg/day) in buffalo rations (**Table 2**) [30].

In another study, Değirmencioğlu et al. [31] A total of 27 multifarious AWB at stage 40–50 days of lactation were randomly selected and distributed into three different groups with 9 animals in each group. Animals in Group I fed by control ration, in Group II fed by control ration plus cumin seeds (GCS) 10 g kg^{-1} and in Group III fed by control ration plus 30 g GCS kg^{-1}. GCS application significantly increasedto a total DM consumption ($P < 0.01$; 11.69,12.14 and 13.01 kg day^{-1} for S1, S2 and S3 diets, respectively). The total DM consumption washigher in buffaloes fed by S3 diet than in buffaloesfed by the S2 and S1 diets (6.68% and 10.14%, $P < 0.01$) (**Table 3**) [31].

Parameter	Groups		Significance
	Group I (Control) n = 12	5% (GFS)[1] Group II n = 12	
Total DM intake[2]	13.17 ± 0.41	14.00 ± 0.34	*
Milkyield (kg d^{-1})	7.34 ± 0.24	8.01 ± 0.19	**
Fat (%)	5.80 ± 0.19	6.06 ± 0.17	NS
SNF (%)	10.18 ± 0.05	10.30 ± 0.04	NS
Protein (%)	4.95 ± 0.15	5.11 ± 0.21	NS
SCC(x log10 mL^{-1})	60.35 ± 6.83	53.70 ± 7.57	NS

[1]*Ground fenugreek seed (GFS).*
[2]*Total 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; The difference between the treatment was significant at P = 5% (*) and 1% (**) level, respectively.*

Table 2.
The effects of grounding fenugreek seeds on the performance of Anatolian water buffalo (mean ± SE) [30].

Parameter	Groups			Significance 2
	Group I (Control) n = 9	1% (GCS)[1] Group II n = 9	Group III 3% GCS n = 9	
Total DM intake[2]	11.69 ± 0.20[a]	12.14 ± 0.20[a]	13.01 ± 0.27[b]	**
Milkyield (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

[1]*Ground cumin seed (GCS) SE = Standard error, NS = Not significant; The difference between the treatment was significant at P = 5% (*) and 1% (**) level, respectively. Different superscripts in the same row indicate significant differences among treatments. Significant levels are defined in the footnote of* **Table 2.**

Table 3.
The effects of grounding cuminum seeds on the performance of Anatolian water buffalo (mean ± SE) [31].

In another study, Kirar et al. [32] 12 lactating Murrah buffaloes of 1st to3 parity were randomly selected and distributed into two different groups with six animals in each group. Animals in Group I were control without any supplementation and in Group II were supplemented with soaked fenugreek seeds 50 g per animal per day (**Table 4**) [32].

In another study, Choubey et al. [28] a total of 18 lactating Surti buffalos at stage 55.52 ± 8.61 day of lactation) were selected and divided into 3 homogenous groups with 6 animals in each group. Animals in Group I fed by control ration, in Group II fed by control ration plus fenugreek seeds (GFS) 1.5% and in Group III fed by control ration plus 3.0% FS. During the research, organaleptic taste tastes were determined in the milk obtained from I, II and III groups. 6.47, 6.80 and 6.84 As a result of the study, it was determined that the use of fenugreek in milk did not affect the aromatic structure of the milk negatively (**Table 5**) [28].

As it can be seen in **Tables 2** and **3**, it is seen that the use of aromatic seeds in the ration has a significant effect on the total dry matter intake of buffaloes.

Parameters	**Group I Control diet n = 6**	**Group II 50 g FS[1]/head n = 6**
Milkyield (kg d^{-1})	5.40 ± 0.13	6.80 ± 0.08
Fat (%)	6.47 ± 0.11	6.45 ± 0.11
Milk SNF (%)	9.63 ± 0.10	9.95 ± 0.15
Milk protein (%)	3.57 ± 0.05	3.55 ± 0.06
Milk lactose (%)	4.95 ± 0.08	5.08 ± 0.06

[1]*Fenugreek seed (FS).*

Table 4.
Effect of fenugreek on the performance of Murrah buffaloes (mean ± SE) [32].

Parameter	**Groups**			**Significance[2]**
	Group I (Control) n = 6	**Group II 1.5% FS[1] n = 6**	**Group III 3.0% FS n = 6**	
Milkyield (kg d^{-1})	3.72^{a} ± 0.20	4.05^{b} ± 0.22	3.87^{ab} ± 0.34	0.049
Fat (%)	8.21 ± 0.86	8.19 ± 0.86	7.72 ± 0.77	0.697
Density	31.94 ± 1.40	32.99 ± 0.88	33.01 ± 0.51	0.452
SNF (%)	9.95 ± 0.37	10.24 ± 0.13	10.10 ± 0.20	0.453
Protein (%)	4.19 ± 0.21	4.33 ± 0.16	4.44 ± 0.25	0.442
Laktose (%)	5.10 ± 0.17	5.15 ± 0.18	5.15 ± 0.07	0.806
Appearance	6.47 ± 0.09	7.06 ± 0.08	7.24 ± 0.09	0.133
Flavor	6.51 ± 0.09	6.76 ± 0.05	6.80 ± 0.13	0.060
Palatability	6.47 ± 0.11	6.80 ± 0.11	6.84 ± 0.16	0.073

[1]*Fenugreek seed (FS).*
[2]*Different superscripts in the same row indicate significant differences among treatments. Significant levels are defined in the footnote of* **Table 2.**

Table 5.
Effect of fenugreek on the performance of Surti buffaloes (mean ± SE) [28].

The positive effects on DM consumption of aromatic seeds could be explained by effect hypothalamus to stimulate hunger centers in the brain and increasing the desire for eating [33]. Fenugreek may also increase food consumption through inhibition of leptin secretion [34]. In addition, due to the rich nutrient content of aromatic seeds, increases the number of rumen microorganisms, which positively affects the degradability of roughage.

3.3 The effects on milk production

As it can be seen in **Tables 2-5**, in the case of using aromatic seeds in the water buffalo's diet, this could be resulted in significant increasing in milk yield 8.36%, 12.72%, ($P < 0:01$) 20.58%($P > 0:01$) and 8.14%.

Fenugreek seeds contain a fair amount of steroidal saponnin which may improve the nutrient absorption by altering the mucosal permeability of intestine [35]. Stimulation of endogenous hormone secretion could be hypothesized through a mechanism by which fenugreek exerts its action on milk yield. In buffaloes, fenugreek feeding increased plasma levels of prolactin [36]. However, the role of this hormone in the lactating ruminants is not far away from understanding [37, 38]. Present results indicate that growth hormone might be a possible candidate as a mediator of fenugreek action on milk production. Growth hormone (GH) is known to have a strong galactopoietic effect on lactation performance in ruminants since the exogenous administration of bovine somatotropin stimulates milk yield [39]. GH levels reported to increase in response to fenugreek feeding [40]. These seeds posses, an estrogen like substance which is also supposed to accomplish its galactagogue role [41–43] observed that the herbs increased in milk production by stimulating the endogenous hormonal secretion in mammals. They have also proved their worth as component of herbal preparation to improve the lactation performance and health of dairy buffalo [30] found an improvement in milk yield (0.67 kg/day) through supplementation of grounded FS (50 g/kg in concentrate) in Anatolian water buffaloes (**Table 2**). Other researchers [28, 32], like showed that supplementation of fenugreek seeds (100 g/day) and (% 1.5) on lactating Murrah buffaloes and surti buffaloes resulted in a increase in milk production although nonsignificant, no change in milk composition (**Tables 4** and **5**). With the progress of experiment, there appeared an improvement in the daily milk yield due to supplementation of soaked fenugreek seeds at both the dosage level. It was decided to be used of lowest dosage in diet so that could not pass bad smell into milk and as well as economic costing [30]. Değirmencioğlu et al. [31] also reported that supplementation of 30 g cumin seeds significantly ($P < 0.01$) increased mean daily milk production (0.85 kg) in Anatolian water buffaloes (**Table 3**). In these studies, CS and FS supplementation did not affect milk composition of buffalo and this result complies with the other studies [28, 32] who reported that differences in SNF, protein and fat contents of buffalo milk fed ration supplemented with SC were not significant (**Tables 4** and **5**). Conversely, [25] showed that milk protein contents were significantly ($P < 0.05$) affected by CS supplementation. Similarly [44] reported that decreasing in milk fat of goats due to FS supplementation at very high dosage. There was a concern that the pungent aroma or taste of the fenugreek seeds could be transmitted to milk and alter milk flavor. Some of the prior studies, suspect that a higher dose supplementation of any herbal supplement having distinct aroma or taste may impart off flavor to milk [45]. Each raw milk sample was tasted to assess sweetness, saltiness, bitterness or rancidity. Thus a sensory evaluation was carried out to determine the organoleptic acceptability of milk. Shah and Mir [46] reported that dietary fenugreek seeds did not adversely affect milk production, DM intake and organoleptic acceptability of milk of cows, and can be used to improve milk quality by reducing milk cholesterol

content and increasing desirable functional fatty acids in milk. Similarly researcher determined a positive effect on the flavor and palatability of milk with increasing fenugred dose p = 0.060 and p = 0.073 (**Table 5**) [28]. This can be explained by the powerful antioxidant effect of fenugreek. It is stated that the milk with fenugreek prevents oxidative loss in the fat during heating, and thus a flavor and aromatic structure is formed in the milk [47].

4. Conclusion

Based on the scientific results presented in this chapter, the following main conclusions can be drawn:

1. The use of aromatic seeds as feed additives of Anatolian water buffaloes feeding enabled in enhancing milk production, without changing the taste and chemical composition of the milk.

2. Milk production can be improved upto 0.67 kg and 0.85 kg day^{-1} by adding 50 g Fenugreek seeds and 30 g Cumin seeds to the ration of buffaloes in the early lactation period.

3. The use of aromatic seeds in the feeding of water buffaloes has been proven therefore, their use in the buffalo sector should be encouraged.

Author details

Taşkın Değirmencioğlu
Department of Milk and Fattening, Karacabey Vocational School, Bursa Uludag University, Bursa, Republic of Turkey

*Address all correspondence to: taskin@uludag.edu.tr

References

[1] Değirmencioğlu, T[a]. 2020 The Nutrition of Buffaloes," ISBN: 978-625-402-317-0. Nobel publishing house. Ankara. 320 p

[2] Y. Sayan, and M. Polat, "Ekolojik Tarımda Hayvancılık". Türkiye 2.Ek. Tar. Semp. 14-16 Antalya. 2001, pp 95-104.

[3] Anonim, "Organik Tarımın Esaslarıve Uygulamasına İlişkin Yönetmelik" http://www.resmigazete.basbakanlik.gov.tr/eskiler/2010/08/20100818. htm. 2010.

[4] Anonymous, "T.C. Tarımveköyişlerib akanlığıtarımsalaraştırmagenelmüdürlüğü," Türkiyeevcilhayvangenetikkaynaklarıtanıtımkataloğu, 22s. http://www.tarim.gov.tr/TAGEM/Belgeler/yayin/Katalog%20Türkçe.pdf. 2009.

[5] Anonim,"Organik Tarımın EsaslarıveUygulamasınaİlişkin Yönetmelik" http://www.resmigazete.basbakanlik.gov.tr/eskiler/2010/08/20100818. htm. 2010.

[6] Değirmencioğlu, T. 2018. 'Anatolian Water Buffalo's Role in the Organic Animal Product' 11th International Conference on Agriculture, Biological, Environmental and Medical Sciences (ABEMS-18), Bangkok (Thailant) 51-56.

[7] Bell A.W., 1995. "Regulation of organic nutrient metabolism during transition from late pregnancy to early lactation". J. Anim.Sci., 73:2804-2819.

[8] Gorgulu, M. 2009. "Büyükve Küçükbaş Hayvan Besleme", Çukurova Üniv. ZiraatFak., Ders Notu, 282 s.

[9] Knaus, W.F. Steinwidder, A.and W. Zolltsc, 2001 "Energy and Protein Balance in Organic Dairy Cow Nutrition-Model Calculations Based on EU Regulations In: Breeding and Feeding For Animal Helath and Welfare in Organic Livestock Systems", Proceedings of the Fourth NAHWOA Workshop, 24-27 March, Wageningen, Holland

[10] Anonymous, http://www.mevzuat.gov.tr/Metin.Aspx?MevzuatKod=9.5.6109&MevzuatIliski=0&sourceXmlSearch. 2016.

[11] Atasever, S and Erdem, H "Manda YetiştiriciliğiveTürkiye'dekiGeleceği". O.M.Ü. Zir. Fak.Derg., 23(1):59-64. 2008.

[12] Kucukkebabcı, M and Aslan S. 2002, "Evcildişimandalardaüremeözellik". Lala.,HayvAraştEnstDerg, 42 (2): 55-63.

[13] Hostettmann, K., and Marston, A.: Saponins. Cambridge: Cambridge University Press, 1995.

[14] Johnson IT, Gee JM, Price K, Curl C, Fenwick GR, 1986. Influence of saponins on gut permeability and active nutrient transport in vitro. J. Nutri., 116: 2270-2277.

[15] Wang Y, McAllister TA, Yanke LJ, Cheeke PR, et al. 2000. Effect of steroidal saponin from Yucca schidigeraextract on ruminal microbes. J. App. Microbiol. 88: 887-896.

[16] Wenk C. 2000. Why all discussion about herbs?. Biotechn. In the feed industry. proc. of alltech's 16th Annu. Symp.Alltech technical publications, Nottginham Univ. Press. Nicholasvile, KY.79-96.

[17] Goel, G., Makkar, P.S.H., and Becker, K.: Effects of Sesbaniasesban and Carduuspycnocephalus leaves and Fenugreek (Trigonellafoenum-graecum L.) seeds and their extracts on partitioning of nutrients from roughage- and concentrate-based feeds to methane, Animal Feed Science and Technology, 147, 72-89. 2008.

[18] Yadav R., Tiwari R., 2011 Chowdhary P., and Pradhan C.K.: A pharmacognostical monograph of trigonellafoenum- graecum seeds, Int J Pharm PharmSci, Vol 3, Suppl 5, 442-445, 2011.

[19] Acharya, S., Srichamroen, A., Basu, S., Ooraikul, B., and Basu, T.: Improvement in the nutraceutical properties of fenugreek (Trigonellafoenum-graecum L.), Songklanakarin J. Sci. Technol. Vol.28 (Suppl.1), 2006.

[20] IndhuPrathibha A, BhanuRekha V, Ajay Kumar VJ, NithyaQuintoil M and Abhishek Madan 2020 The Pharma Innovation Journal Interventions in feeding systems and management of dairy animals- food security strategy in livestock sector 9(8): 109-111

[21] Tuncturk R, Tuncturk M. 2006. Effects of different phosphorus levels on the yield and quality components of cumin (Cuminumcyminum L.)Res.j. Agric.Biol. Sci.2:336-340.

[22] De M, De AK, Mukhopadhyay R, Banerjee AB, Miro M et al. 2003. Antimicrobial activity of Cuminumcyminum L. ArsPharmaceutica, 44(3): 257-269.

[23] Hammer KA, Carson CF, Riley TV. 1999 Antimicrobial activity of essential oils and other plant extracts. Journal of Applied Microbiology, 86, 985-990.

[24] Khan MMH, Chaudhry AS. 2010. Chemical composition of selected forages and spices and the effect of these spices on in vitro rumen degradability of some forages Asian-Aust. J. Anim. Sci., 23 p. 889-900.

[25] Nurdin E, Arief. 2009. The Effectivity of Cumin as natural-antioxidant to improve rumen ecology of mastitis dairy cow's. JurnalProduksiTernak (University of JenderalSoedirman). 11(3):114-119.

[26] Hashemian N, GhasemiPirbalouti A, Hashemi M, Golparvar A, Hamedi B, et al. 2013. Diversity in chemical composition and antibacterial activity of essential oils of cumin (Cuminumcyminum L.) diverse from northeast of Iran. Aust. J. Crop Sci. 7: 1752-1760.

[27] Nour Ahmed Osman, Salah Elhussein, Ahmed Abdurrahman Taha2015 Content of Crude Protein, Fixed Oil and Lecithin in Sudanese Seed Accessions of Fenugreek (Trigonellafoenum-graecum L.) Pakistan Journal of Nutrition 14(12):907-912 DOI: 10.3923/pjn.2015.907.912

[28] Choubey, M Patel, V R Raval A P and singh R R 2018 Effect of fenugreek seed supplementation on lactation performance of Surti buffaloes Indian Journal of Animal Sciences 88 (3): 322-325, March 2018/Article

[29] Lodhi, G.N., Singh, D., and Ichponani, J.S. 1976: Variation in nutrient content of feedstuffs rich in protein and reassessment of the chemical methods for metabolizable energy estimation for poultry. J. Agric. Sci. Camb., 86, 293-303.

[30] Değirmencioglu, T., UnaL, H., Ozbilgin, S. Kuraloglu, H. 2016. " Effect of Ground Fenugreek Seeds (Trigonellafoenumgraecum) on Feed Consumption and Milk Performance in Anatolian Water Buffaloes" Arch. Anim. Breed, Arch. Anim. Breed., 59 (3): 345-349. Germany Doi: 10.5194/aab-59-345-2016

[31] Değirmencioğlu,T[b]. Şimşek, E., Unal,H., Kuraloğlu,H., Özbilgin., S. 2020. 'Effect of cumin seeds (cuminumcyminum) in feed diets of anatolian water buffaloes on shelter into gass concentration, milk yield and composition" Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Animal Science and Biotechnologies 77(1):41-50.

[32] Kirar, M. Ghosh, S.. Baghel , R.P.S. Jain, A. Lakhani G.P, Roy B. and Jain A.K 2018 Int. J. Curr. Microbiol. App. Sci 7(7): 70-77

[33] Petit, P., Sauvaire, Y., Ponsin, G., Manteghetti, M., Fave,A., and Ribes,G.: 1993 Effects of a fenugreek seed extract on fedingbehaviour in the rat: Metabolic endocrine correlates. Pharmacol. Biochem.Behav., 45, 369-374,

[34] Kandhare, A.D.; Bandyopadhyay, D.; Thakurdesai, P.A. Low molecular weight galactomannans-based standardized fenugreek seed extract ameliorates high-fat diet-induced obesity in mice via modulation of FASn, IL-6, leptin, and TRIP-Br2. RSC Adv. 2018, 8, 32401-32416. [CrossRef]

[35] Pandian R S, Anuradha C V and Viswanathan P. 2002. Gastroprotective effect of fenugreek seeds (Trigonellafoenumgraecum) on experimental gastric ulcer in rats. Journal of Ethnopharmacology 81: 393-97.

[36] Abo-EL-Nor, S.A.H., 1999. Influence of fenugreek seeds as a galactagogue on milk yield, milk composition and different blood biochemical of lactating buffaloes during midlactation. Egypt. J. Dairy Sci., 27: 231-238.

[37] Hart, I.C., 1973. Effect of 2-Bromo-Ergocryptine on milk yield and the level of prolactin and growth hormone in the blood of the goat at milking. J. Endocrinol., 57: 179-180.

[38] Forsyth, I.A. and P.D. Lee, 1993. Bromocriptine treatment of periparturient goats: Long suppression of prolactin and lack of effect on lactation. J. Dairy Res., 60: 307-317.

[39] Bauman, D.E., 1992. Bovine somatotropin: Review of an emerging animal technology. J. Dairy Sci., 75: 3432-3451.

[40] Alamer M A and Basiouni G F. 2005. Feeding effects of fenugreek seeds (Trigonellafoenum-graecum L.) on lactation performance, some plasma constituents and growth hormone level in goats. Pakistan Journal of Biological Sciences 8: 1553-56.

[41] Tiran D. 2003. The use of fenugreek for breast feeding women. Complementary Therapies in Nursing and Midwifery 9: 155– 56.

[42] Kumar, S Mehla, R.K. and Dang, A.K 2008 "Use of shatavari (Asparagus racemosus) as a galactopoietic and therapeutic herb – a review". Agric. Rev. 29, 132-138.

[43] Bhatt N, Singh M, Ali A. 2009. Effect of feeding herbal preparations on milk yield and rumen parameters in lactating crossbred cows. Int. J. Agric. Biol. 11, 721-726.

[44] Balgees A, Atta Elmnan N M, Jame S A, Rahmatalla E O, Amasiab A and Mahala G. 2013. Effect of fenugreek (Trigonellafoenumgraecum) seeds supplementation on feed intake,some metabolic hormones profile, milk yield and composition of nubian goats. Research Journal of Animal Sciences 7: 1-5.

[45] Randby A T, Selmer-Olsen I and Baevre L. 1999. Effect of ethanol in feed on milk flavor and chemical composition. Journal of Dairy Science 82: 420-28.

[46] M. A. Shah and P. S. Mir 2004 Effect of dietary fenugreek seed on dairy cow performance and milk characteristics. CANADIAN JOURNAL OF ANIMAL SCIENCE 725-729

[47] Wani S A and Kumar P. 2016. Fenugreek: A review on its nutraceutical properties and utilization in various food products. Journal of the Saudi Society of Agricultural Sciences.(In press).doi: doi.10.1016/j. jssas.2016.01.007