RESEARCH ARTICLE

Effect of Fennel (*Foeniculum vulgare*) Seed Supplementation on Growth Performance, Haemato-Biochemical Parameters and Faecal Microbiota of Mehsana Goat Kids

Shrikant S. Patil[1], Mahesh M. Pawar[1]*, Mayank P. Patel[2], Sandip S. Patel[3], Chetna P. Modi[1], Jayveer R. Patel[1]

Abstract

A study was carried out to assess the effect of fennel (*Foeniculum vulgare*) seed powder supplementation on growth performance, haemato-biochemical parameters and faecal microbiota of Mehsana goat kids. Eighteen Mehsana kids (average age 1 month, weight 6.92 kg) were randomly divided into three equal treatment groups, *viz.,* T_1: Basal diet (control), T_2 and T_3: Basal diet + 2.5 and 5.0 g/animal/day of fennel seed powder supplementation, respectively. The duration of experiment was of 60 days. There was no significant difference in final body weights and weight gain among treatment groups. The faecal counts (log_{10} cfu/g in fresh faeces) of lactobacillus on 60th day and overall average were significantly ($p<0.05$) increased, while coliform counts were reduced numerically in T_3 and T_2 groups as compared to T_1 group. There was no impact of fennel seed supplementation on the haematological parameters. No difference was observed in serum concentrations of glucose, total proteins, albumin, globulin, urea, cholesterol, ALT and AST among the treatment groups. However, serum concentrations of triglycerides were numerically reduced in fennel seed supplemented groups (17.25 and 15.68 mg/dL) as compared to the control (21.29 mg/dL) group. It may be concluded that supplementation of fennel seed powder improved beneficial faecal microbiota with higher faecal lactobacillus count and lower faecal coliform count in Mehsana kids without any adverse effect on growth performance and haemato-biochemical profile.

Key words: Blood metabolites, Faecal microbes, Fennel seed, Goat kids, Growth performance.

Ind J Vet Sci and Biotech (2024): 10.48165/ijvsbt.20.6.04

Introduction

In India, goats play a significant role in providing supplementary income and livelihood to millions of poor farmers and landless laborers. Goats contributed nearly 14.47% of total meat production, while milk share was 3.30% in the total milk production across the country during year 2022-23 (Anonymous, 2023). Gujarat possesses about 48.67 lakh heads of goats with six distinct goat breeds. Among these, Mehsana is a dual-purpose breed and is raised for both milk and meat production. The biggest cause of economic loss for goat farmers is the mortality of kids before weaning, thus every effort should be made to safeguard their survivability to boost productivity and profitability. The morbidity and mortality can be reduced by better management and nutrition of the kids. The use of in-feed antibiotics to improve growth performance in animals has been criticized in terms of the emerging public health crisis due to antibiotic resistance (Anee *et al.,* 2021). Therefore, there has been growing interests in the use of plants rich in bioactive compounds which acts as growth promoter, enhance nutrient utilization and has antimicrobial activity (Pawar *et al.,* 2019).

Fennel (*Foeniculum vulgare*) seed rich in essential oils with bioactive molecules has been tried as an alternative to promote the growth and health of young animals (Kargar *et al.,* 2021; Ansari *et al.,* 2022). Fennel is an aromatic plant belonging to the Apiaceae family. Anethole and limonene are the main phytochemicals of fennel (Noreen *et al.,* 2023). Fennel seed extract has role in reduction of inflammation, oxidant stress, apoptosis, and infection in an experimental necrotizing enterocolitis (Yakut *et al.,* 2020). Moreover, it was

[1]Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Sardarkrushinagar -385506, Gujarat, India

[2]Livestock Research Station, Kamdhenu University, Sardarkrushinagar-385506, Gujarat, India

[3]Department of Veterinary Microbiology, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Sardarkrushinagar-385506, Gujarat, India

Corresponding Author: Dr. M.M. Pawar, Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Sardarkrushinagar-385506, Gujarat, India. e-mail: mahespawar@gmail.com

How to cite this article: Patil, S. S., Pawar, M. M., Patel, M. P., Patel, S. S., Modi, C. P., & Patel, J. R. (2024). Effect of Fennel (*Foeniculum vulgare*) Seed Supplementation on Growth Performance, Haemato-Biochemical Parameters, and Faecal Microbiota of Mehsana Goat Kids. Ind J Vet Sci and Biotech. 20(6), 16-20.

Source of support: Nil

Conflict of interest: None

Submitted 05/07/2024 **Accepted** 15/08/2024 **Published** 10/11/2024

shown that fennel seeds regulate the appetite and improve hyperlipidemia, mainly by influencing the expression of insulin and leptin receptors (Zakernezhad *et al.,* 2021). Also, the encapsulated essential oil and aqueous extract from fennel seeds had shown considerable reduction in the blood glucose content (Zolkepli *et al.,* 2022). Recent studies have reported that supplementation of fennel seed powder and extract in growing animals improved feed intake, growth performance, lipid profile and gut health (Shahsavari *et al.,* 2022; Singh *et al.,* 2023; Ansari *et al.,* 2024). To test the hypothesis that feeding of fennel seed powder would improve growth performance and beneficial faecal microbiota in kids, this study was conducted to assess the effect of fennel (*Foeniculum vulgare*) seed powder supplementation on growth performance, haemato-biochemical parameters and faecal microbiota of Mehsana goat kids.

Materials and Methods

The present study was conducted following approval by the IAEC (VetColl/IAEC /2021/17/PROTOCOL-04) at Livestock Research Station, Kamdhernu University, Sardarkrushinagar, Gujarat, India, located at the latitude of 24.32° North and longitude of 72.31° East and at an elevation of 189 meters above the mean sea level, Eighteen Mehsana goat kids (average age 1 month, weight 6.92 kg) were randomly divided equally into three treatment groups, *viz*. T_1: Basal diet (control), T_2: Basal diet + 2.5 g/animal/day of fennel seed powder supplementation, and T_3: Basal diet + 5 g/animal/day of fennel seed powder supplementation. The experiment was conducted in a completely randomized design and consisted of 10 days of adaptation period and 60 days of experimental feeding. The samples of feeds, fodders and fennel seed were analyzed for dry matter, crude protein, crude fibre, ether extract and total ash according to AOAC (2007).

The body weight of each kid was recorded by using electronic weighing balance at the beginning and thereafter at fortnightly intervals during the experimental feeding. The body weight gain was calculated by subtracting initial body weight from final body weight. Rectal faecal samples from each kid were collected on day 0, 30th and 60th of experimental feeding to determine the faecal microbial populations of *Lactobacilli* and coliforms. Bacterial populations were enumerated by serial 10-fold dilutions (10^{-1} to 10^{-8}) with the total volume of 10 mL including 1 g homogenized faeces and 9 mL normal saline (0.9% NaCl) and plated in triplicate onto selective media - MRS agar for *Lactobacilli* (Himedia); EMB agar, Levine (Himedia) for coliforms (Sharma *et al.,* 2018). The agar plates were incubated aerobically at 37°C for 24 h. Colonies on the agar plates were counted as colony-forming units (CFU) per g faeces and then converted to $\log_{10}$ cfu/g. At the end of experimental feeding (60th day) blood samples from jugular vein were collected from each kid in the sterilized vials with and without anticoagulant. The fresh blood samples were analyzed for haemoglobin, haematocrit, total erythrocytes and leucocytes count using Exigo EOS Vet Haematology Analyser (Boule Medical AB, Sweden). The serum samples were analyzed for glucose, total proteins, albumin, urea, triglycerides, cholesterol, alanine amonotransferase (ALT) and aspartate aminotransferase (AST) using Randox Monaco Analyser (Randox Laboratories Ltd., UK).

The experimental data obtained on body weight changes and haemato-biochemical parameters were analysed statistically by one-way ANOVA using SPSS v.20 (SPSS Inc., Chicago IL). The data for faecal *Lactobacilli* and coliforms counts were analysed using two-way ANOVA. The difference between the means was declared significant at $p<0.05$.

Results and Discussion

The chemical composition of feeds, fodder and fennel seed fed to the experimental animals is given in Table 1. The content of crude protein was 20.2, 5.82, 11.08 and 9.38% in concentrate feed, green maize fodder, groundnut straw, and fennel seed powder, respectively. The contents of dry matter, ether extract, and ash were relatively higher in fennel seed powder, with intermediate crude fiber and nitrogen free extract. In line with the present findings, Noreen *et al.* (2023) reported the content of dry matter, protein, fat and fiber in fennel seed as 93.7, 9.5, 10.0 and 18.5%, respectively.

The fortnightly and final body weights of kids did not vary significantly among the treatment groups. The overall body weight gain in kids was 4.38, 4.41 and 4.44 kg in T_1, T_2 and T_3 groups, respectively. The difference was statistically not significant (Table 2). In contrast to our findings, earlier studies reported significant improvement in weight gain in kids supplemented with fennel seeds (Hajalizadeh *et al.,* 2019; Mohammadabadi *et al.,* 2021). These variations in findings among the different experiments might be due to variations in experimental design, species, diet compositions, doses supplemented, and physiological stage of experimental animals.

Table. 1: Proximate composition of feeds and fennel seed

Composition (%)	Concentrate feed	Green maize	Groundnut straw	Fennel seed
Dry matter	91.83	44.4	90.01	93.76
Crude protein	20.2	5.82	11.08	9.38
Crude fibre	6.90	28.54	36.50	18.21
Ether extract	3.07	1.58	0.99	9.76
Ash	7.63	7.98	8.90	12.97
NFE	62.2	56.08	42.53	49.68

The data on faecal microbiota (Table 3) indicated that there was a positive effect of fennel seed supplementation on faecal lactobacillus count. The faecal lactobacillus counts (log_{10} cfu/g in fresh faeces) at 60th day and average were significantly ($p<0.05$) increased in T_3 group followed by T_2 group as compared to the control group. The faecal coliform counts (log_{10} cfu/g in fresh faeces) at 60th day and average were numerically reduced in T_3 group as compared to T_2 and T_1 groups. The presence of soluble fibre in fennel seeds acts as prebiotics in caecum and colon. Prebiotics in the caecum and colon are readily fermented by beneficial bacteria such as *lactobacillus* which produce antimicrobial agent and metabolic compounds, which may have bactericidal action against Gram negative bacteria (Anee *et al.,* 2021). The fennel's essential oil exhibits considerable antibacterial action due to its active component, anethole, which was shown to be particularly abundant in the oil of fennel (Barrahi *et al.,* 2020). The earlier study reported that fennel seed essential oil was efficient against a variety of microbes, including bacteria, yeast, and fungal strains (Barrahi *et al.,* 2020). The fennel essential oils had extensive antibacterial activity particularly against *E. coli* (Noreen *et al.,* 2023), moreover it reduced *E. coli* population in the intestines of broiler chickens (Ghiasvand *et al.,* 2021).

The effect of fennel seed supplementation on haemato-biochemical parameters of Mehsana kids is shown in Table 4. There was no effect ($p>0.05$) on the haemoglobin, haematocrit, total erythrocytes count and total leucocytes count among the treatment groups. No difference was observed in serum concentrations of glucose, total proteins, albumin, globulin, urea, triglycerides, cholesterol, ALT and AST concentrations among the treatment groups. In agreement with the present findings, no effect on serum glucose concentrations was reported in previous study (Fahim *et al.,* 2022). In contrast, the increase in plasma glucose concentration was found in other studies (Mahmoud *et al.,* 2020; Moosavi-Zadeh *et al.,* 2023).

Table. 2: Effect of fennel seed supplementation on growth performance (kg) of Mehsana kids

Days of Experiment	Dietary Groups			SEM	P value
	T_1	T_2	T_3		
Initial	6.92	6.93	6.91	0.09	0.996
15	7.95	7.93	7.97	0.11	0.990
30	9.06	9.08	9.12	0.11	0.980
45	10.20	10.29	10.26	0.10	0.946
60	11.30	11.34	11.35	0.10	0.978
Overall BW gain	4.38	4.41	4.44	0.05	0.906

Table. 3: Effect of fennel seed supplementation on faecal microbiota of Mehsana kids

Attributes on days	Dietary Groups			Period average	SEM	P value		
	T_1	T_2	T_3			T	P	T*P
Lactobacillus (log_{10} cfu/g of fresh faces)								
Initial	7.39	7.36	7.39^{A}	7.38^{A}	0.07	0.023	0.040	0.585
30 day	7.47	7.59	7.94^{AB}	7.67^{AB}	0.13			
60 day	7.65^{a}	7.84^{ab}	8.14^{bB}	7.88^{B}	0.11			
Average	7.50^{a}	7.60^{ab}	7.82^{b}					
SEM	0.11	0.18	0.08					
Coliform (log_{10} cfu/g of fresh faces)								
Initial	7.77	7.78	7.78	7.78	0.05	0.720	0.504	0.884
30 day	7.86	7.85	7.83	7.85	0.05			
60 day	7.84	7.81	7.70	7.78	0.02			
Average	7.82	7.81	7.77					
SEM	0.04	0.03	0.06					

Means with different superscripts (A, B) in a column (a, b) in a row differ significantly ($p<0.05$).

Table. 4: Effect of fennel seed supplementation on haemato-biochemical parameters of Mehsana kids

Parameters	Dietary Groups			SEM	P value
	T_1	T_2	T_3		
Haematological parameters					
Haemoglobin (g/dL)	8.13	8.10	8.07	0.21	0.992
Hematocrit (%)	19.97	19.82	20.18	0.59	0.972
TEC (10^6/µL)	12.24	12.20	12.22	0.30	0.999
TLC (10^3/µL)	13.35	13.42	13.42	0.39	0.997
Blood biochemical parameters					
Glucose (mg/dL)	57.30	58.80	58.12	0.689	0.698
Total protein (g/dL)	5.47	5.55	5.49	0.063	0.870
Albumin (g/dL)	2.53	2.50	2.52	0.063	0.980
Globulin (g/dL)	2.93	3.05	2.97	0.095	0.891
Urea (mg/dL)	7.97	8.24	8.02	1.245	0.996
Triglycerides (mg/dL)	21.29	17.25	15.68	1.325	0.212
Cholesterol (mg /dL)	85.10	82.10	83.73	2.570	0.904
ALT (U/L)	24.57	26.12	24.78	2.061	0.952
AST (U/L)	100.85	104.78	103.52	2.832	0.861

In the present study, the lack of significant effect of fennel seed on serum concentrations of total proteins, albumin, globulin and urea may imply that no alterations in the demand and competition for amino acids occurred and, in turn, shows no challenge to hepatic synthesis of albumin or globulin, required to sustain nutrient transportation and normal immune function (Kargar *et al.,* 2018). However, serum concentrations of triglycerides were numerically reduced in fennel seed powder supplemented groups (17.25 and 15.68 mg/dL) as compared to the control (21.29 mg/dL) group. Cholesterol and triglycerides are two main indicators of lipid metabolism, and their concentrations are highly associated with health and diminished early mortality in young animals (Renaud *et al.,* 2018). Similar to the present findings, fennel seed supplementation decreased serum triglycerides in dairy calves (Lakhani *et al.,* 2019). In the present study, serum concentration of ALT and AST was not affected by treatment indicating no adverse effect of fennel seed supplementation in kids. However, the dietary supplementation of fennel seed in growing lamb reduced serum levels of ALT and AST (Mohammadabadi *et al.,* 2021; Shahsavari *et al.,* 2022).

Conclusion

Based on the results of the present study, it may be concluded that supplementation of fennel (*Foeniculum vulgare*) seed powder improved beneficial faecal microbiota with higher faecal *lactobacillus* count and lower faecal coliform count in Mehsana kids without any adverse effect on growth performance and haemato-biochemical profile.

Acknowledgement

The authors are thankful to the Director of Research, Kamdhenu University, Gandhinagar, Gujarat for providing the financial assistance and necessary facilities to carry out this research work.

References

Anee, I.J., Alam, S., Begum, R.A., Shahjahan, R.M., & Khandaker, A.M. (2021). The role of probiotics on animal health and nutrition. *Journal of Basic and Applied Zoology, 82*(1), 1-16.

Anonymous, (2023). Basic Animal Husbandry Statistics. Department of Animal Husbandry and Dairying. Ministry of Fisheries, Animal Husbandry and Dairying, Government of India. https://dahd.nic.in/sites/default/filess/BAHS2023.pdf

Ansari, M., Kargar, S., Eslami, M.A., Falahati, R., Albenzio, M., Caroprese, M., Zamiri, M.J., & Kanani, M. (2022). Potential benefits of early-life supplementation of liquid feed with fennel (*Foeniculum vulgare*) seeds or oregano (*Origanum vulgare*) leaves on growth, health, and blood metabolites in Holstein dairy calves. *Journal of Dairy Science, 105*(8), 6639-6653.

Ansari, M., Kargar, S., Falahati, R., Kanani, M., & Ghaffari, M.H. (2024). Effects of pre-weaning supplementation with fennel seed powder in two terms on growth performance, health status, and blood metabolites of Holstein dairy calves. *Animal Feed Science and Technology, 308,* 115861.

AOAC, (2007). *Official Methods of Analysis*, 18th edn. Association of Official Analytical Chemists, Gaithersburg.

Barrahi, M., Esmail, A., Elhartiti, H., Chahboun, N., Benali, A., Amiyare, R., Lakhrissi, B., Rhaiem, N., Zarrouk, A., & Ouhssine, M. (2020). Chemical composition and evaluation of antibacterial activity of fennel (*Foeniculum vulgare Mill*) seed essential oil against some pathogenic bacterial strains. *Caspian Journal of Environmental Sciences, 18*(4), 295-307.

Fahim, N.H., Kholif, A.E., & Azzaz, H.H. (2022). Fennel and ginger improved nutrient digestibility and milk yield and quality in early lactating Egyptian buffaloes. *Annals of Animal Science, 22*(1), 255-270.

Ghiasvand, A.R., Khatibjoo, A., Mohammadi, Y., Akbari Gharaei, M., & Shirzadi, H. (2021). Effect of fennel essential oil on performance, serum biochemistry, immunity, ileum morphology and microbial population, and meat quality of broiler chickens fed corn or wheat-based diet. *British Poultry Science, 62*(4), 562-572.

Hajalizadeh, Z., Dayani, O., Khezri, A., Tahmasbi, R., & Mohammadabadi, M.R. (2019). The effect of adding fennel (*Foeniculum vulgare*) seed powder to the diet of fattening lambs on performance, carcass characteristics and liver enzymes. *Small Ruminant Research, 175,* 72-77.

Kargar, S., Mousavi, F., & Karimi-Dehkordi, S. (2018). Effects of chromium supplementation on weight gain, feeding behaviour, health and metabolic criteria of environmentally heat-loaded Holstein dairy calves from birth to weaning. *Archives of Animal Nutrition, 72*(6), 443-457.

Kargar, S., Nowroozinia, F., & Kanani, M. (2021). Feeding fennel (*Foeniculum vulgare*) seed as potential appetite stimulant to newborn Holstein dairy calves: Effects on meal pattern, ingestive behavior, oro-sensorial preference, and feed sorting. *Animal Feed Science and Technology, 278,* 115009.

Lakhani, N., Kamra, D.N., Lakhani, P., & Alhussien, M.N. (2019). Immune status and haemato-biochemical profile of buffalo calves supplemented with phytogenic feed additives rich in tannins, saponins and essential oils. *Tropical Animal Health and Production, 51,* 565-573.

Mahmoud, A.E.M., Rahmy, H.A.F., & Ghoneem, W.M.A. (2020). Role of caraway, fennel and melissa addition on productive performance of lactating Frisian cows. Pakistan *Journal of Biological Sciences, 23*(11), 1380-1389.

Mohammadabadi, M., Masoudzadeh, S.H., Khezri, A., Kalashnyk, O., Stavetska, R.V., Klopenko, N.I., Oleshko, V.P., & Tkachenko, S.V. (2021). Fennel (*Foeniculum vulgare*) seed powder increases Delta-Like Non-Canonical Notch Ligand 1 gene expression in testis, liver, and humeral muscle tissues of growing lambs. *Heliyon, 7*(12), e08542.

Moosavi-Zadeh, E., Rahimi, A., Rafiee, H., Saberipour, H., & Bahadoran, R. (2023). Effects of fennel (*Foeniculum vulgare*) seed powder addition during early lactation on performance, milk fatty acid profile, and rumen fermentation parameters of Holstein cows. *Frontiers in Animal Science, 4,* 1097071.

Noreen, S., Tufail, T., Badar Ul Ain, H., & Awuchi, C.G. (2023). Pharmacological, nutraceutical, functional and therapeutic properties of fennel (*Foeniculum vulgare*). *International Journal of Food Properties, 26*(1), 915-927.

Pawar, M.M., Kamra, D.N., Chaudhary, L.C., Agarwal N., & Charturvedi, V.B. (2019). Nutrients utilization, methane emission, immune function, blood metabolites and performance of buffalo calves fed *Trachyspermum copticum* seed oil. *Indian Journal of Animal Sciences, 89*(1), 63-67.

Renaud, D.L., Duffield, T.F., LeBlanc, S.J., Haley, D.B., & Kelton, D.F. (2018). Clinical and metabolic indicators associated with early mortality at a milk-fed veal facility: A prospective case-control study. *Journal of Dairy Science, 101*(3), 2669-2678.

Shahsavari, M., Mohammadabadi, M., Khezri, A., Borshch, O., Babenko, O., Kalashnyk, O., Afanasenko, V., & Kondratiuk, V. (2022). Effect of fennel (*Foeniculum vulgare*) seed powder consumption on insulin-like growth factor 1 gene expression in the liver tissue of growing lambs. *Gene Expression, 21*(2), 21-26.

Sharma, A.N., Kumar, S., & Tyagi, A.K. (2018). Effects of mannan-oligosaccharides and *Lactobacillus acidophilus* supplementation on growth performance, nutrient utilization and faecal characteristics in Murrah buffalo calves. *Journal of Animal Physiology and Animal Nutrition, 102*(3), 679-689.

Singh, A.K., Kumar, A., Kumar, S., & Kumar, S. (2023). Effect of supplementation of fennel seed powder on intake, growth performance, gut health and economics in goats. *Tropical Animal Health and Production, 55*(6), 359.

Yakut, H.I., Koyuncu, E., Cakir, U., Tayman, C., Koyuncu, İ., Taskin Turkmenoglu, T., Cakir, E., Ozyazici, A., Aydogan, S., & Zenciroglu, A. (2020). Preventative and therapeutic effects of fennel (*Foeniculum vulgare*) seed extracts against necrotizing enterocolitis. *Journal of Food Biochemistry, 44*(8), e13284.

Zakernezhad, F., Barati, M., Sanadgol, N., Movahhedi, M., Majd, A., & Golab, F. (2021). The association between fennel extract, serum lipid profile, and leptin receptor expression. *Basic and Clinical Neuroscience, 12*(6), 711.

Zolkepli, H., Widodo, R.T., Mahmood, S., Salim, N., Awang, K., Ahmad, N., & Othman, R. (2022). A review on the delivery of plant-based antidiabetic agents using nanocarriers: current status and their role in combating hyperglycaemia. *Polymers, 14*(15), 2991.