

Effects of Fenugreek (*Trigonella foenum-graecum*) Seed as a Feed Additive on the Growth Performance, Hematological Parameters and Carcass Organs of Local Rabbits

Mahmud Elrghig¹ , Aiysha Jogdam²  and Mujahed Bushwreb^{1*} 

¹Department of Physiology, Biochemistry and Nutrition, Faculty of Veterinary Medicine, University of Tripoli, Tripoli, Libya

²The Libyan Authority for Scientific Research, Tripoli, Libya

*Corresponding Author: Dr. Mujahed Bushwreb. Department of Physiology, Biochemistry and Nutrition, Faculty of Veterinary Medicine, University of Tripoli, Tripoli, Libya. Mobile: +218912141534. Email: bushwreb@yahoo.com

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Abstract

Background: The use of certain synthetic feed additives was restricted in the European Union due to concerns regarding their adverse effects on animal health, human health, and the environment. Although feed additives are widely used to enhance feed quality, improve animal performance, and support health, some have been associated with issues such as antimicrobial resistance, toxicity, and environmental pollution. Consequently, there is increasing interest in natural alternatives. Recent research has emphasized the potential of herbs, medicinal plants, spices, and other plant-based products as safe and effective feed additives. Among these, fenugreek seeds are notable for their rich nutritional value and bioactive compounds, which offer multiple health benefits in animal production. **Aim:** This study investigated the effects of supplementing rabbit diets with varying levels of fenugreek seed powder on growth performance, carcass traits, and hematological parameters. **Methods:** Sixty local meat rabbits were used with four dietary treatments; a control group without supplementation and three experimental groups receiving 5, 10, and 15 g/kg feed of fenugreek seed powder. The animals were followed up weekly for the indicated study parameters for 42 days. **Results:** The results demonstrated that fenugreek supplementation improved growth performance and feed conversion efficiency across all inclusion levels, with the greatest benefits observed at 10 g/kg feed. Additionally, fenugreek positively influenced hematological indices and affected the relative weights of certain organs, indicating improved physiological status and health. **Conclusion:** Overall, these findings suggest that fenugreek seed powder is a promising natural feed additive that can enhance animal health, productivity, and efficiency in rabbit production systems.

Keywords: Fenugreek seed powder, growth performance, hematological profile, carcass traits, rabbit

Introduction

The European Union has raised concerns about certain feed additives used in animal nutrition because of their potential adverse effects on both animal and human health. While feed additives are widely used to improve feed quality, enhance growth performance, and support overall animal health, some have been associated with issues such as antimicrobial resistance, toxicity, and environmental pollution. These risks may ultimately affect human health through the food chain (Quzir *et al.*, 2016).

In light of these concerns, there is growing interest in natural alternatives to synthetic feed additives. Such alternatives may enhance animal health and productivity while reducing dependence on chemical substances and antibiotics (Abbas, 2010). As a result, the demand for feed free from synthetic and chemical additives has increased significantly within the livestock industry. Recent research has highlighted the potential of herbs, medicinal plants, spices, and other plant-based products as natural feed additives (Muddasir *et al.*, 2024). These substances can improve animal performance by stimulating digestive enzyme activity, enhancing nutrient absorption, and providing antimicrobial and

antioxidant effects, as well as strengthening the immune system (Athanasiadou *et al.*, 2007). Furthermore, the use of herbs and spices in animal feed has been associated with improved feed conversion efficiency and overall health status (Adejola *et al.*, 2019).

Among these natural alternatives, fenugreek (*Trigonella foenum-graecum*) is a well-known medicinal plant with a wide range of physiological and therapeutic properties (Duru *et al.*, 2013; Aliyu *et al.*, 2024). According to Palka *et al.* (2022), fenugreek seeds can help alleviate respiratory disorders, stimulate appetite, improve digestion, and provide essential bioactive compounds. Moreover, fenugreek seeds are rich in nutrients and phytochemical compounds that support various physiological functions. Studies by Mamoun *et al.* (2014), Qureshi *et al.* (2015), and Sallam *et al.* (2019) have demonstrated their significant role in enhancing animal nutrition, health, and productivity.

Therefore, this study aimed to evaluate the effects of fenugreek seed powder as a natural feed additive on growth performance, carcass traits, and selected hematological parameters in local rabbits.

Materials and methods

Animals

A total of sixty unsexed local meat rabbits were purchased from a local market for use in this study. The rabbits were acclimatized for one week, after which they were individually weighed and randomly assigned to four dietary treatment groups. Each treatment consisted of three replicates, with five rabbits per replicate. The rabbits were reared for 42 days in well-maintained and adequately ventilated hutches. Throughout the experimental period, good hygienic conditions were maintained to ensure a healthy environment for the animals.

Dietary treatments and experimental follow-up

Four dietary treatments (T) were used during experimentation; T1 (Control): basal diet (Table 1) without fenugreek seed powder supplementation, T2: basal diet supplemented with fenugreek seed powder at 5 g/kg feed, T3: basal diet supplemented with fenugreek seed powder at 10 g/kg feed and T4: basal diet supplemented with fenugreek seed powder at 15 g/kg feed.

Rabbits were provided with clean drinking water *ad libitum*, and feed was offered twice daily at 09:00 am and 17:00 pm. The basal diet (Table 1) was formulated to meet the nutrient requirements recommended by the National Research Council (1995).

Body weights were recorded individually at the beginning of the experiment and subsequently at weekly intervals. Feeding troughs were removed in the morning before weighing to ensure accurate measurements.

Table 1. Ingredient composition of the basal experimental ration.

Yellow corn	40
Soya bean	20
Barley	15
Wheat bran	22
Methionine	0.25
Lysine	0.13
D. phosphorus	0.9
Limestone	1.1
Premix*	0.3
salt	0.33
Total	100
Crud protein	16.98
ME kcal/kg	2826

ME: Metabolizable energy, *Lohmann Animal Health GmbH & Co., Cuxhaven, Germany: Vitamin A, 4000000 IU; Vitamin D3, 833333 IU; Vitamin E, 6.666 g; Vitamin K3, 3666 mg; Vitamin B1, 666 mg; Vitamin B2, 1666 mg; Vitamin B5, 10 mg; Vitamin B6, 1000 mg; Vitamin B12, 5 µg; Vitamin Biotin, 33333 µg; Folic acid, 333 mg; Choline chloride, 166 mg; Methionine, 3331333 mg; Calcium, 3333 mg; Manganese 33333 mg; Copper, 2500 mg; Cobalt, 33 mg; Iodine, 166 mg; Selenium, 33 mg; Iron, 10 mg.

Feed intake was recorded daily and used to calculate weekly feed consumption. Weekly body weight gain was determined by subtracting the body weight recorded at the beginning of each week from that recorded at the end of the same week. Feed conversion ratio (FCR) was

calculated weekly by dividing feed intake by body weight gain.

At the end of the experimental period, one rabbit from each replicate, with a body weight close to the replicate mean, was selected for blood collection. Blood samples were obtained from the ear vein using heparinized vacuum tubes at 09:00 am. Hematological analyses were conducted at a local pathology laboratory. The parameters evaluated included white blood cell count (WBC), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC), following the procedures described by Feldman (2000).

For carcass evaluation, one rabbit from each replicate, representing the average body weight of the replicate, was randomly selected at the end of the experiment. The selected rabbits were fasted before slaughter, with free access to water, to empty the gastrointestinal tract. Following slaughter and skinning, the weights of the heart, liver, kidneys, lungs, spleen, and full intestine were recorded.

Statistical analysis

Data were analyzed using Statistical Analysis System (Version 9.0, SAS Institute Inc., Cary, NC, USA) and analysis of variance (ANOVA) for a completely randomized design (CRD). Treatment means were compared using Duncan's Multiple Range Test. Results were expressed as means $\pm$ pooled standard error (SE), and differences among treatments were considered statistically significant at $p < 0.05$.

Ethical approval

The experimental procedures described in this study were reviewed and approved by the Bioethics Committee at the Biotechnology Research Center (BEC-BTRC) at Tripoli, Libya (Ref. No.; NBC: 001.A.26.30). All animals were handled and managed in accordance with institutional guidelines and internationally accepted standards for the care and use of animals in research. Every effort was made to minimize animal stress and discomfort throughout the study.

Results and discussion

The findings of this study indicate that dietary inclusion of fenugreek improved feed intake, final body weight, and body weight gain in rabbits compared with the control group (Table 2). Although feed intake tended to decrease and both final body weight and body weight gain increased, no statistically significant differences ($p > 0.05$) were observed among the treatment groups throughout the experimental period.

These results are consistent with the findings of Aliyu *et al.* (2024), who reported no significant ($p > 0.05$) effects of varying inclusion levels of fenugreek on the growth performance of rabbits. However, Zewail (2015) reported improved body weight in rabbits fed fenugreek-based diets, possibly due to the presence of bioactive compounds with antibacterial, antifungal, anti-inflammatory, and antioxidant properties. Similarly, Elbushra (2012) observed a slight increase in body weight gain in broiler chicks supplemented with fenugreek.

Table 2. Effect of fenugreek (*Trigonella foenum-graecum*) seed powder on performance in rabbits.

	Feed Intake (g)	Final weight (g)	Gain Weight (g)	FCR
T1	1229.10±85.20	922.08±63.92	357.65±47.01	3.51±0.21 ^a
T2	1149.66±57.35	991.98±71.47	423.56±39.82	2.78±0.22 ^b
T3	1025.10±48.02	979.17±58.53	481.59±28.82	2.14±0.06 ^b
T4	1049.49±38.30	951.40±35.55	422.03±23.81	2.49±0.05 ^b

g: Grams, FCR: Feed conversion ratio, Significant ($p < 0.05$) differences are shown for the mean having variable superscript.

Table 3. Effect of fenugreek seed powder on hematological parameters in rabbits.

	WBC ($10^3/\mu\text{l}$)	RBC ($10^6/\mu\text{l}$)	MCV (fl)	MCHC (g/dl)	MCH (pg)	HB (g/dl)
T1	10.81±0.74	6.87±0.27	61.68±4.28	32.09±2.22 ^b	19.17±1.33 ^b	11.82±0.82 ^b
T2	11.11±0.55	6.81±0.34	61.58±1.47	31.70±3.32 ^b	19.79±1.64 ^b	10.73±0.77 ^b
T3	10.02±0.59	6.72±0.26	61.64±2.88	32.46±1.94 ^b	19.44±1.16 ^b	12.30±0.74 ^b
T4	10.75±0.76	6.98±0.26	64.00±3.22	34.73±2.45 ^a	24.73±1.06 ^a	13.64±0.61 ^a

Significant ($p < 0.05$) differences are shown for the mean having variable superscript.

Table 4. Effect of fenugreek seed powder on carcass organs of rabbits.

	Liver	Heart	Kidney	Spleen	Lung	Intestine
T1	23.50±1.63	3.67±0.25 ^a	6.68±0.46 ^b	1.32±0.09 ^a	7.80±0.54 ^c	178.98±12.41 ^b
T2	23.57±1.69	3.44±0.25 ^a	5.69±0.41 ^c	1.18±0.08 ^b	10.21±0.74 ^a	201.42±14.51 ^a
T3	23.92±1.43	3.62±0.22 ^a	7.53±0.45 ^a	1.14±0.07 ^b	10.86±0.65 ^a	185.85±11.11 ^b
T4	24.53±1.73	2.39±0.19 ^b	7.92±0.56 ^a	1.15±0.08 ^b	9.35±0.66 ^b	198.55±14.03 ^a

Weights expressed in grams. Significant ($p < 0.05$) differences are shown for the mean having variable superscript.

In contrast, Eiben (2004) found no significant effect of fenugreek supplementation on rabbit body weight, suggesting variability in animal response. Conversely, Weerasingha and Atapattu (2013) and Mamoun *et al.* (2014) reported significantly higher body weights in fenugreek-fed animals. These discrepancies may be attributed to differences in species, breed, management practices, dietary composition, or experimental conditions.

The slightly higher body weight gains observed in rabbits receiving fenugreek supplementation (T2, T3, and T4) compared with the control group are consistent with the findings of Bhale (2015). This improvement may be associated with the rich nutritional composition of fenugreek seeds, particularly their high-quality protein and essential fatty acid content, which may enhance digestive efficiency and growth performance.

Feed intake decreased in rabbits supplemented with fenugreek at levels of 5, 10, and 15 g/kg feed compared with the control group. This observation agrees with Abdel-Azeem *et al.* (2022), who reported reduced feed intake at higher fenugreek inclusion levels. However, Weerasingha and Atapattu (2013) and Mamoun *et al.* (2014) reported improved growth performance accompanied by optimized feed intake, whereas Yassin (2020) observed increased feed intake, which was attributed to enhanced palatability. These contrasting findings suggest that the effects of fenugreek on feed

intake may depend on dietary formulation, inclusion level, animal species, and management conditions.

The feed conversion ratio (FCR) was significantly improved ($p < 0.05$) in rabbits fed fenugreek-supplemented diets. The recorded FCR values were 3.51, 2.78, 2.14, and 2.49 for T1, T2, T3, and T4, respectively, with T3 (10 g/kg) exhibiting the greatest feed efficiency. These findings agree with those of Hamden *et al.* (2010), Rahimian *et al.* (2018), and Yassin *et al.* (2020), who also reported improvements in FCR following fenugreek supplementation. The enhanced feed efficiency may be attributed to improved digestion, nutrient absorption, and modulation of gut microflora, possibly resulting from the antimicrobial activity of fenugreek flavonoids.

Hematological analysis (Table 3) revealed no significant differences ($p > 0.05$) among treatment groups for most parameters, except mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and hemoglobin (HB), which were significantly higher ($p < 0.05$) in the T4 group (fenugreek at 15 g/kg feed). These findings are consistent with those of Javed *et al.* (2009), who reported no significant changes in white blood cell counts following fenugreek supplementation.

The elevated MCH, MCHC, and HB values observed in T4 may indicate an improved oxygen-carrying capacity of the blood and enhanced physiological status. These effects may be associated with the antioxidant properties

of fenugreek, as reported by Dixit *et al.* (2005). Similar improvements in hematological parameters were reported by Abdul-Rahman (2012) and Bhaisare *et al.* (2014).

The effects of fenugreek supplementation on organ weights (Table 4) showed significant differences ($p < 0.05$) for most organs, except the liver and spleen. Kidney weights were significantly higher ($p < 0.05$) in T3 and T4 compared with the control group. Likewise, lung and intestinal weights increased significantly ($p < 0.05$) in rabbits receiving fenugreek supplementation at all tested levels. These findings are in agreement with those reported by Yesuf *et al.* (2017) and Medina *et al.* (2020). Heart weight was generally unaffected by fenugreek supplementation, although a slight reduction was observed in the T4 group. These results are consistent with the findings of Abbas (2010) and Hamid *et al.* (2018), who also reported no significant changes in heart weight following fenugreek supplementation.

Overall, dietary supplementation with fenugreek positively influenced growth performance, feed efficiency, hematological parameters, and certain organ weights in rabbits. These beneficial effects may be attributed to its rich nutritional composition and bioactive compounds. The present findings support previous reports by Tag El-Din (2016), Mersso and Bekele (2017), and Adejola *et al.* (2019), highlighting the potential of fenugreek as an effective natural feed.

Conclusion

The findings of this study support the use of natural feed additives, particularly fenugreek seed powder (FSP), as an effective strategy for improving rabbit health and productive performance. Dietary supplementation with fenugreek positively influenced growth performance and feed conversion efficiency across the tested inclusion levels, with the most pronounced effects observed at the highest supplementation level of T3 (10 g/kg feed).

In addition to enhancing growth performance, fenugreek supplementation improved several hematological parameters, suggesting an enhanced physiological status and overall health of the rabbits. Furthermore, significant effects on certain organ weights were observed, indicating potential beneficial influences on organ development and function. Fenugreek supplementation improved growth performance, feed efficiency, and hematological parameters, although the optimal response varied depending on the trait evaluated.

The positive responses observed in this study may be attributed to the rich nutritional composition and bioactive compounds present in fenugreek seeds. These findings highlight the potential of fenugreek seed powder as a valuable natural feed additive in rabbit nutrition and production systems.

However, further research is needed to elucidate the biological mechanisms underlying these beneficial effects. Future studies should focus on identifying the optimum inclusion level of fenugreek seed powder and evaluating its potential synergistic effects when combined with other natural feed additives to maximize animal health, growth performance, and production efficiency.

Author contributions

Mahmud Elrghig and Aiysha Jogdam contributed to the sampling, data collection, and manuscript revision. Mujahed Bushwreb worked out the proposal trial, the laboratory analysis, and the manuscript writing. All authors read and approved the final version of the manuscript.

Conflict of interest

The authors declare no conflict of interest related to the publication of this work.

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