



USE OF FENUGREEK (*Trigonella foenum-graecum* L.) AS AN ALTERNATIVE FEED ADDITIVE IN THE NUTRITION OF SHEEP, LAMBS AND RAMS AND ITS EFFECTS ON SUSTAINABLE PRODUCTIVITY

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Abstract: Fenugreek (*Trigonella foenum-graecum* L.), a legume with high adaptability and nutritional value, has attracted attention as a potential feed additive in small ruminant nutrition. Its seeds are rich in carbohydrates, proteins, lipids, vitamins, minerals and bioactive compounds such as saponins, flavonoids and steroidal compounds, which may influence digestive efficiency, immune function and metabolic responses. Previous studies report variable outcomes: some indicate improvements in milk yield, growth performance and reproductive parameters in sheep, lambs and rams, while others show limited or no significant effects depending on breed, dosage and experimental design. This review synthesizes available findings on the nutritional composition and functional properties of fenugreek seeds and evaluates their potential role in sustainable sheep production systems. It also highlights research gaps regarding optimal inclusion levels, long-term safety and standardization in feed formulations.

Keywords: Fenugreek, Sheep nutrition, Alternative feed additives, Lamb performance, Ram fertility

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1. Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is a leguminous plant, named *Trigonella* ('little triangle' in Latin) due to its triangular flowers (Flammang et al., 2004). Fenugreek is one of the oldest medicinal plants with an exceptional medicinal and nutritional profile. Its seeds contain significant amounts of fiber, phospholipids, glycolipids, oleic acid, linolenic acid, linoleic acid, choline, vitamins A, B1, B2 and C, nicotinic acid, niacin and many other functional elements. It can grow well under a wide range of conditions, is moderately resistant to drought and salinity and can even be profitably cultivated on marginal land. Due to these characteristics and its heavy metal remediation potential, fenugreek adapts well to diverse cropping systems (dry or irrigated agricultural systems). In addition to its medicinal uses, it can serve as an excellent off-season forage and livestock feed supplement (Ahmad et al., 2016).

The high nutritional value of fenugreek makes it a high-quality forage crop but its anti-nutritional content cannot be ignored (Saleh, 2004). Fenugreek can increase milk production by stimulating endogenous hormone secretion, mainly through the action of diosgenin, which enhances prolactin and growth hormone release, promoting mammary gland development and milk flow

(Penagos Tabares et al., 2014; Sahoo et al., 2020). In addition, its antioxidant flavonoids such as vitexin and isovitexin reduce oxidative stress and improve immune responses (Ruwali et al., 2022).

Feed costs account for approximately 60–70% of livestock production expenses, making feed additives highly relevant for sustainable production (Boğa and Çevik, 2012). Recent studies in cattle and goats also demonstrate the potential of fenugreek supplementation to improve feed intake, nutrient utilization and milk composition (Taiwo et al., 2022; Akbağ et al., 2022; Yerou et al., 2023). Moreover, fenugreek has been investigated for its environmental role, with Zeng et al. (2024) emphasizing its ability to reduce methane emissions by modulating rumen microbial activity. These findings underline the broader functional value of fenugreek across livestock species.

However, in sheep and lambs, the available literature shows more variable results. For example, fenugreek seed supplementation increased milk yield and protein content in Awassi ewes (Shameon et al., 2017), enhanced microbial nitrogen synthesis in Barbarine lambs (Ibidhi and Salem, 2022) and improved growth performance and economic efficiency in Ossimi lambs when replacing cottonseed meal (Mousa et al., 2024). At the same time,



some trials reported limited or no significant effects under certain conditions (Al-Sherwany, 2015; Al-Wazeer, 2017).

Taken together, these results suggest that while fenugreek has strong potential as a functional feed additive, responses in small ruminants vary depending on breed, dosage, ration composition and management practices. This review therefore focuses specifically on sheep, lamb and rams, synthesizing existing findings to clarify fenugreek's potential role in sustainable small ruminant farming.

This review utilized Google Scholar, Web of Science and PubMed databases for literature search. Keyword searches included "Fenugreek seeds and their use in sheep feeding " "Fenugreek seeds and their use in sheep, lamb and ram feeding" Literature relevant to this article's theme was selected, summarized and finally, this review article was completed.

2. Nutritional Content of Fenugreek (*Trigonella foenum-graecum* L.)

Fenugreek seeds stand out as a functional feed ingredient due to their richness in macronutrients, minerals, vitamins and bioactive compounds. Reported chemical composition indicates that the seeds contain 58–62.5% carbohydrates, 23–28.6% protein, 4–7% fat, 25% fiber, approximately 6% essential oils and 3–3.2% ash (Sulieman et al., 2008; Syed et al., 2020). In contrast, the leaves have lower nutrient levels and contain about 6% carbohydrates, 4.4% protein and 1.1% fiber.

Processing methods, particularly germination, lead to measurable changes in nutritional composition. Germinated fenugreek seeds exhibit higher protein (24.1%) and ash content (3.1%) compared to raw seeds (23.3% protein and 3.0% ash), whereas oil content is lower (6.2% vs. 7.0%) (Rasheed et al., 2015).

Fenugreek is also rich in minerals such as potassium, magnesium, calcium, zinc, manganese, copper and iron (Srinivasan, 2006). In addition, it contains numerous vitamins, including vitamins A, B1, B2 and C, as well as niacin and nicotinic acid. Seventeen major fatty acids have been identified in fenugreek seeds, most of which are unsaturated; linoleic, oleic and linolenic acids are among the principal ones (Ahmad et al., 2016). Recent

analyses further confirm the high content of polyunsaturated fatty acids and antioxidant compounds in fenugreek, reinforcing its value as a health-promoting feed additive (Akbağ et al., 2022; Zeng et al., 2024).

Fenugreek seeds also contain approximately 1.6% starch and 0.4% soluble sugars. In a study focusing on physical characteristics, the geometric mean diameter, sphericity, thousand-seed weight, bulk density, kernel density, porosity and angle of repose of fenugreek seeds were reported as 1.86–2.10 mm, 49.99–63.09%, 14.05–14.85 g, 6.21–6.98 g/ml, 1.121–1.230 g/ml, 42.56–42.73% and 13.23°–13.86°, respectively. Moisture, oil, protein and ash contents of raw seeds were 11.21%, 7.0%, 23.30% and 3.0%, while germinated seeds contained 13.50%, 6.24%, 24.12% and 3.14%, respectively (Rasheed et al., 2015). Germination thus increases moisture, protein and ash content but lowers oil content relative to raw seeds. Overall, the nutritional and bioactive composition of fenugreek seeds highlights their relevance as a functional additive in animal feeding. The nutritional and physical composition of fenugreek seeds is shown in Table 1.

3. Fenugreek (*Trigonella foenum-graecum* L.) as a Source of Rough and Concentrated Feed

Fenugreek is a legume cultivated in Southern Europe, Asia and North Africa (Acharya et al., 2008). With high seed yield, nutritional value, and adaptability, it shows potential both as a forage and as a concentrate feed. Compared with alfalfa (*Medicago sativa* L.), fenugreek has equal or higher nutrient content across growth stages (Islam et al., 2017). Seed yields can reach ~1300 kg/ha depending on variety (Basu et al., 2009). As a legume, fenugreek contributes to soil fertility by fixing ~283 kg N/ha/year, reducing the need for synthetic fertilizers (Javan et al., 2017).

Nutritional composition varies across phenological stages. Crude protein content declines from 12.4% (pre-flowering) to 4.9% (harvest), while crude fiber increases (20.4% → 43.5%). Correspondingly, metabolizable energy decreases from 2243 to 1905 kcal/kg. Fenugreek seeds are richer in protein (23.5%), fat (5.5%) and energy (2790 kcal/kg for ruminants; 2649 kcal/kg for poultry) (Özçelik, 2017).

Table 1. Nutritional and physical composition of fenugreek seeds

Component / Property	Reported Range / Value	Source
Carbohydrates (%)	58–62.5	Sulieman et al., 2008; Syed et al., 2020
Protein (%)	23–28.6	Sulieman et al., 2008; Rasheed et al., 2015
Fat (%)	4–7	Syed et al., 2020; Rasheed et al., 2015
Fiber (%)	~25	Sulieman et al., 2008
Ash (%)	3–3.2	Sulieman et al., 2008; Rasheed et al., 2015
Essential oils (%)	~6	Syed et al., 2020
Minerals	K, Mg, Ca, Zn, Mn, Cu, Fe	Srinivasan, 2006
Vitamins	A, B1, B2, C, niacin, nicotinic acid	Srinivasan, 2006
Fatty acids	Linoleic, oleic, linolenic (major unsaturated)	Ahmad et al., 2016
Moisture (%)	11.2 (raw), 13.5 (germinated)	Rasheed et al., 2015

Table 2. Nutritional composition of fenugreek forage and seeds at different growth stages

Parameter	Pre-flowering	Post-flowering	Harvest	Seed (grain)
Crude Protein (%)	12.4	10.4	4.9	23.5
Crude Fat (%)	1.8	1.6	0.9	5.5
Crude Fiber (%)	20.4	28.1	43.5	15.8
Nitrogen-free extract (%)	45.1	40.7	35.1	45.4
ADF (%)	24.4	34.3	53.9	-
NDF (%)	24.8	36.5	57.2	-
ADL (%)	4.1	6.2	10.4	-
Dry Matter (%)	-	-	-	94.1
Metabolizable Energy (kcal/kg)	2243	2113	1905	2790 (ruminants) / 2649 (poultry)

In vitro fermentation studies further confirmed that fenugreek forage harvested at the vegetative stage has higher digestibility and energy values, making it a suitable roughage for ruminants. Seeds, on the other hand, due to their high protein and energy content, are better suited as concentrate ingredients in both ruminant and poultry diets (Özçelik, 2017).

More recent findings emphasize fenugreek's potential role beyond nutrition. For example, Zeng et al. (2024) reported that fenugreek supplementation in ruminants may reduce methane emissions by altering rumen microbial activity, thereby improving both feed efficiency and environmental sustainability. These results highlight fenugreek as not only a nutrient-rich feed but also a functional crop that supports climate-smart livestock production systems. The nutritional composition of fenugreek fodder and seeds at different growth stages is shown in Table 2.

4. The Effect of Fenugreek Seeds on Sheep Performance

The effects of fenugreek (*Trigonella foenum-graecum L.*) seeds on performance, milk yield and certain blood parameters in sheep have been supported by various studies. These studies indicate that fenugreek seeds may exert beneficial impacts on animal health and productivity.

In Aissi sheep, supplementation with 10–20 g/day of fenugreek seeds improved hematological traits (RBC, WBC, Hb) and increased serum protein fractions, while reducing glucose and cholesterol concentrations. No significant effects were observed on liver and kidney function markers, indicating that fenugreek could be safely used as a milk yield enhancer (Hassan, 2014).

In Sudanese desert sheep, oral administration of fenugreek at 2.5–5 g/kg body weight increased both milk yield and live weight. The authors attributed these improvements to the stimulatory effect of fenugreek on prolactin and thyroid hormone secretion (Samia et al., 2012). Similarly, supplementation in Barki ewes during late gestation improved weaning weight and average daily gain of lambs, enhanced feed efficiency and increased milk yield and solids, while decreasing serum cholesterol levels (

Saleh, 2004). In Hamdani sheep, fenugreek supplementation (0.6–1.2 g/kg body weight) had no significant effect on most blood parameters, suggesting breed-specific or dose-dependent responses (Al-Sherwany, 2015). In contrast, Awassi ewes supplemented with 1.5–3% fenugreek seeds showed significantly higher milk production and protein content, along with a reduction in fat percentage (Shameon et al., 2017).

Additional evidence from Ossimi ewes indicated that fenugreek seed powder, along with onion and garlic powders, could improve feed intake, blood metabolites and ruminal fermentation, further supporting its potential as a functional feed additive (Abu et al., 2018).

The findings suggest that fenugreek supplementation can enhance milk yield and hematological parameters in ewes, especially during lactation and late gestation. However, results are inconsistent across breeds and dosages. For example, while Hassan (2014) and Saleh (2004) observed clear improvements, Al-Sherwany (2015) reported no significant changes. Such discrepancies may be related to genetic differences, ration composition, environmental stressors and the form of fenugreek used (whole seed vs. ground).

Overall, studies indicate that fenugreek (*Trigonella foenum-graecum L.*) seeds can improve milk yield, growth performance and selected blood parameters in sheep. However, the magnitude of these effects varies depending on breed, dosage and the animal's physiological stage. Some studies report significant improvements in milk production, body weight gain and hematological values, while others show neutral results due to differences in experimental conditions and supplementation levels. Fenugreek seed supplementation is particularly recommended during lactation and late gestation to enhance milk yield and support feed efficiency. Nevertheless, optimal dosage and duration should be determined according to species and feeding strategies. Selected studies on the effects of fenugreek seeds in sheep nutrition are summarized comparatively in Table 3.

5. The Effect of Fenugreek Seed on Lamb Performance

Fenugreek (*Trigonella foenum-graecum L.*) seed has potential beneficial effects on growth performance, feed

intake and nutrient digestibility in lambs. Various studies have demonstrated that fenugreek seed may enhance animal productivity during the growth phase and positively influence metabolic parameters.

Table 3. Selected studies on the effects of fenugreek seeds in sheep nutrition

Study	Animal/Breed	Dose/Method	Main Findings
Hassan (2014)	Postpartum Aissi ewes	10–20 g/day	↑ RBC, WBC, Hb, ↑ serum proteins; ↓ glucose & cholesterol; ↑ milk yield
Samia et al. (2012)	Sudanese desert sheep	2.5–5 g/kg BW	↑ Milk yield, ↑ live weight, hormonal stimulation (↑ PRL, thyroid hormones)
Saleh (2004)	Barki ewes	Ground fenugreek (GFS)	↑ Weaning weight, ↑ lamb ADG, ↑ milk yield & efficiency, ↓ serum cholesterol
Al-Sherwany (2015)	Hamdani sheep	0.6–1.2 g/kg BW	No significant effect on most blood parameters; no adverse effects observed
Shameon et al. (2017)	Awassi sheep	1.5–3% of diet	↑ Milk yield & protein %, ↓ fat %; no effect of milking period
Abu et al. (2018)	Ossimi ewes	3% fenugreek seeds powder	↑ Feed intake, improved rumen fermentation, positive metabolic response

Table 4. Selected studies on the effects of fenugreek seeds in lamb nutrition

Study	Breed / No. of Lambs	Dose / Diet Inclusion	Main Findings
Mousa et al. (2024)	32 Ossimi lambs	Replaced 50% cottonseed meal (~5.1% DM)	↑ Feed intake, ↑ digestibility, ↑ growth, ↑ economic return
Ibidhi and Salem (2022)	24 Barbarine lambs	Intermittent fenugreek seed supplementation	No sig. effect on intake or digestibility; tendency ↑ ADG & microbial N synthesis
Al-Dain et al. (2019)	24 Awassi lambs	120 days, fenugreek, cumin, arugula seeds	↑ ADG, ↑ body dimensions; fenugreek comparable to other seeds
Al-Wazeer (2017)	Awassi lambs	0, 2.5, 5, 7.5 g/head/day	No significant improvement; no adverse effects
Nallathambi et al. (2016)	20 Rahmani lambs	8% fenugreek seed	Hypoglycemic effect, ↓ serum cholesterol, no organ damage
Dosky and Taher (2015)	20 Karadi lambs	Black cumin + fenugreek	Highest weight gain with black cumin; fenugreek moderate
Al-Dain and Jarjeis (2015)	Awassi lambs	Fenugreek vs. black cumin & arugula	Fenugreek ↑ ALT, AST activity; hormonal changes observed

Fenugreek seeds have been investigated as a potential feed additive to improve growth performance, feed intake and nutrient utilization in lambs. Several studies have demonstrated beneficial effects, though results remain partly inconsistent across breeds and experimental conditions.

Substituting 50% of cottonseed meal with fenugreek seed meal in Ossimi lamb diets enhanced feed intake, nutrient digestibility, growth rate and economic efficiency, highlighting its potential as a cost-effective protein source (Mousa et al., 2024). In Barbarine lambs, intermittent supplementation with fenugreek seeds did not significantly alter nutrient digestibility or blood metabolites but tended to improve daily weight gain and microbial nitrogen synthesis, while reducing ruminal protozoa and ammonia concentrations (Ibidhi and Salem, 2022).

Studies with Awassi lambs produced mixed outcomes. Supplementation with fenugreek or other oilseeds (black

cumin, arugula) improved growth rate, final body weight and body measurements (Al-Dain et al., 2019), while other trials reported no significant effects on growth performance or ruminal fermentation, although no adverse health effects were observed (Al-Wazeer, 2017). In Rahmani lambs, fenugreek supplementation had hypoglycemic and cholesterol-lowering effects without impairing kidney or liver functions (Nallathambi et al., 2016). By contrast, in Karadi lambs, black cumin seeds promoted greater weight gain and feed conversion than fenugreek, suggesting variability in response depending on seed type and animal genotype (Dosky and Taher, 2015). Additional evidence indicates that fenugreek, alongside other phytogenic feed additives, may influence serum enzyme activities and endocrine responses, reflecting potential metabolic modulation (Al-Dain and Jarjeis, 2015).

Overall, fenugreek seed supplementation in lamb diets demonstrates potential for improving growth

performance, feed efficiency and blood metabolites. However, results vary widely depending on the inclusion level, duration and combination with other seeds. Studies replacing conventional protein sources (e.g., cottonseed meal) with fenugreek seed meal show particularly

promising economic and nutritional outcomes (Mousa et al., 2024). Conversely, some trials report no significant benefits (Al-Wazeer, 2017), suggesting that breed, diet composition and management conditions may strongly influence outcomes.

Table 5. Selected studies on the effects of fenugreek seeds in ram nutrition

Study	Breed / No. of Rams	Dose / Diet Inclusion	Main Findings
Ibrahim (2019)	Awassi rams	0%, 5%, 10% of diet	↑ Ejaculate volume, ↑ semen consistency, ↑ sperm motility & viability; no effect on sperm concentration

Fenugreek (*Trigonella foenum-graecum* L.) seed can be considered an effective feed additive for enhancing growth performance and improving metabolic parameters in lambs. Particularly during the early growth phase, optimal dosage and consistent supplementation may support feed efficiency and body weight gain. However, longer-term and more comprehensive in vivo studies are recommended to determine species and age-specific applications. Selected studies on the effects of fenugreek seeds in lamb nutrition are shown in Table 4.

6. The Effect of Fenugreek Seed on Ram Performance

Fenugreek (*Trigonella foenum-graecum* L.) seed has gained attention as a natural feed additive that may support reproductive performance in rams. Current findings suggest that it can improve key semen parameters such as motility, viability and overall semen quality, although its effects are not uniform across all reproductive traits.

Research on rams is still limited compared to studies in sheep and lambs. Ibrahim (2019) reported that dietary fenugreek seeds enhanced semen motility and viability, which are critical for fertility, while sperm density showed no change. These mixed results indicate that the effectiveness of supplementation likely depends on factors such as dosage and duration of use.

The absence of long-term studies and the lack of trials involving different breeds or larger populations restrict the ability to make general recommendations. Future research should focus on controlled experiments with standardized feeding strategies to clarify fenugreek's role in ram fertility.

Overall, fenugreek seed appears promising for improving semen quality and sperm function, but its effects are not consistent across all parameters. For this reason, dosage and supplementation periods should be carefully optimized. While it can be considered a supportive natural additive in reproductive management, further research is needed to confirm its efficacy and safety under different conditions. Selected studies on the effects of fenugreek seeds in ram nutrition are shown in Table 5.

7. Conclusion

Fenugreek (*Trigonella foenum-graecum* L.) seeds are a promising natural and cost-effective feed additive for sheep, lambs and rams. Supplementation can improve feed efficiency, growth, reproductive performance, immune function and overall productivity, although outcomes depend on dosage, processing, animal characteristics and environmental conditions. Its rich nutritional composition, bioactive compounds and adaptability as a forage crop support its potential in sustainable livestock production. However, variable responses across studies and the lack of standardized feeding protocols indicate the need for further long-term, large-scale research. Future studies should aim to optimize inclusion levels, explore processing methods to enhance bioavailability and evaluate economic feasibility in commercial settings. With these efforts, fenugreek seeds could serve as a functional alternative to synthetic additives in small ruminant nutrition.

Author Contributions

The percentages of the author's contributions are presented below. The author reviewed and approved the final version of the manuscript.

	C.Y.
C	100
D	100
S	100
DCP	100
DAI	100
L	100
W	100
CR	100
SR	100

C= concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision.

Conflict of Interest

The author declared that there is no conflict of interest.

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