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Pharmacological perspective of herbal galactagogues in dairy animals

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Abstract

Herbal galactagogues are being investigated as natural feed supplements to improve milk production in dairy animals. Several medicinal plants include bioactive compounds that may affect lactation through hormonal control and mammary gland function. This review examines the pharmacological properties, potential mechanisms, lactogenic effects and economic significance of several herbal galactagogues, with a focus on Shatavari (*Asparagus racemosus*), fenugreek (*Trigonella foenum-graecum*), anise (*Pimpinella anisum*), and black cumin (*Nigella sativa*). Supplementation with individual herbs or polyherbal preparations has been shown to boost milk yield, milk composition, nutrient utilization and economic returns in cattle, buffaloes, goats and experimental animals. The reported effects have been associated mainly with changes in prolactin secretion, estrogenic and dopaminergic activity, mammary gland development and nutrient metabolism. However, the response to herbal galactagogues varies with the plant used, dose, method of preparation, animal species and stage of lactation. Although the available findings are encouraging, limited information is available on their pharmacokinetics, standardized dosage, long-term safety and precise mechanisms of action. Further controlled studies are therefore required to establish their efficacy and safety and to support their practical use in dairy production.

Keywords: Herbal galactagogues, Dairy animals, Lactation, Milk production

1. Introduction

Animal husbandry plays a major role in Indian agriculture, particularly for small and marginal farmers and landless rural households, by offering income and livelihood options (Singh *et al.*, 2019) [40]. The majority of the country's milk production comes from cattle, buffaloes, and goats. Despite India's leading position in global milk production, dairy animal productivity remains below its potential. Poor nutrition, inadequate feeding, disease, and environmental and physiological stress are among the major factors restricting animal health and milk yield. (Saxena *et al.*, 2020) [37]. Concerns have also been raised about the use of synthetic hormones and pharmacological drugs to increase milk yield, as improper use can disrupt endocrine balance, ovarian function and reproductive health in dairy animals.

Increasing concern over antibiotic and hormonal residues, as well as the need for safe and natural livestock products, has stimulated the use of herbal feed additives as potential options for improving rumen function, nutrient utilization, animal health and milk production. (Baig and Bhagwat, 2009) [5]. The increasing demand for milk has encouraged the exploration of galactagogues, which are substances used to promote or enhance milk secretion and improve lactational performance in dairy animals. Galactagogues are natural or pharmacological agents, including herbs, dietary supplements and drugs, that may promote, maintain or enhance milk secretion in humans and dairy animals (Nasihin, 2025) [27]. Herbal galactagogues, particularly plant-based preparations, have received attention as a natural approach to lactation improvement, owing to their various bioactive constituents, nutritional benefits and possible medicinal use in both cattle and people. (Bora *et al.*, 2019) [7]. Their effects are linked to several endocrine regulators, most notably prolactin (PRL), but hormones and mediators such as growth hormone, cortisol, insulin, leptin, estrogen, progesterone, oxytocin, thyrotropin-releasing hormone (TRH) and recombinant bovine somatotropin (rBST) may also influence mammary development and milk production. Herbal preparations may help boost milk

production in women and dairy animals, such as cows and goats, and are thus becoming increasingly important in human lactation and the dairy business.

2. Lactation Physiology

Lactogenesis refers to the development of the mammary gland's capacity to produce and secrete milk, involving functional maturation of the mammary alveolar cells and occurring in two stages: secretory initiation and secretory activation (Pillay and Davis, 2023) [32]. Stage I (secretory initiation) occurs during late pregnancy, when mammary alveolar cells differentiate and develop a limited ability to synthesize milk components. Stage II (secretory activation) begins around parturition and continues during the early postpartum period, marked by a rapid increase in milk synthesis and secretion. This transition is accompanied by greater cellular activity, including increases in the RNA-to-DNA ratio, ribosome number, endoplasmic reticulum and mitochondria within the alveolar cells (Schmidt, 1971; Tucker, 1974; Forsyth, 1983) [38, 42, 18]. Galactopoiesis is the process of maintaining milk secretion after lactation begins. In dairy cows, milk production usually reaches its peak 2-8 weeks after calving and then gradually decreases. Frequent milk removal helps sustain milk production (Pillay and Davis, 2023) [32]. The maintenance of lactation depends on the coordinated action of growth hormone (GH), adrenocorticotrophic hormone (ACTH), glucocorticoids, insulin, thyroid hormones, parathyroid hormones and prolactin (Hannan *et al.*, 2023) [19].

3. Herbal Galactagogues

Studies on plant-derived galactagogues suggest that several herbal preparations may support milk synthesis in cattle, buffaloes, goats and humans, with many showing a favorable safety profile when used at appropriate doses. Their potential use as economical therapeutic agents and feed supplements in dairy animals has therefore received increasing attention (Penagos *et al.*, 2014) [31]. The pharmacokinetics, pharmacodynamics, optimal dosage and safety of herbal galactagogues remain inadequately studied, warranting further research across domestic animals and humans (Abascal and Yarnell, 2008) [1].

3.1 Mechanisms of Herbal Galactagogues

The lactogenic activity of some herbal galactagogues may involve phytoestrogenic and prolactin-mediated pathways. Phytoestrogens can exert estrogen-like effects and may influence estrogen receptors, prolactin receptor (PRLR) and epidermal growth factor receptor (EGFR), thereby promoting mammary epithelial cell activity and the synthesis of milk components such as casein and lactose. Estrogen signalling may also enhance prolactin production through estrogen receptor pathways and modulation of dopamine D2 receptor-cAMP/PKA signaling, ultimately supporting mammary gland function and milk secretion (Turkyilmaz *et al.*, 2011; Foidart *et al.*, 1998; Penagos *et al.*, 2014) [43, 24, 31]. These mechanisms should be regarded as proposed pathways, as the relative contribution of individual estrogen receptor subtypes, prolactin signaling and growth-factor pathways may vary among different phytoestrogens, animal species and physiological states.

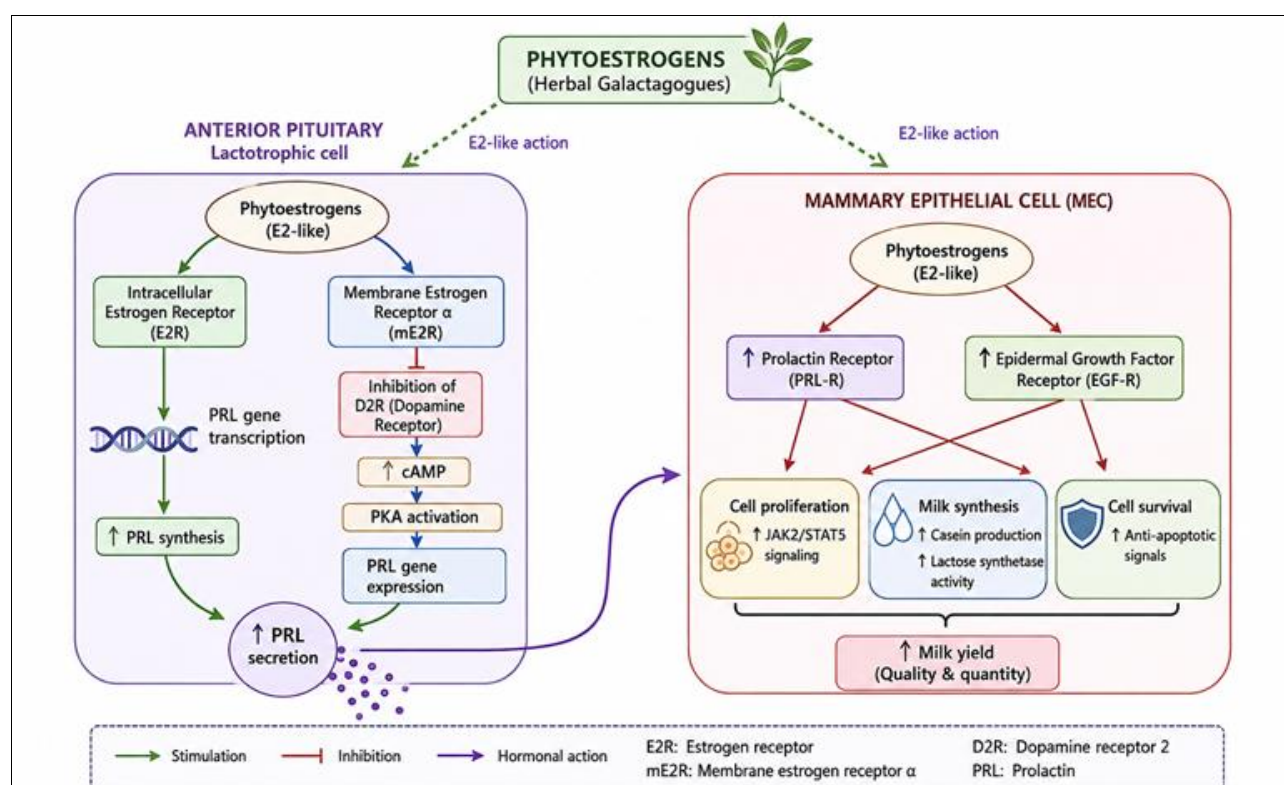


Fig 1: Proposed estrogen receptor-mediated mechanisms of phytoestrogen-induced galactagogue activity in pituitary lactotrophs and mammary epithelial cells PRL: prolactin; PRLR: prolactin receptor; EGFR: epidermal growth factor receptor; D2R: dopamine D2 receptor; cAMP: cyclic adenosine monophosphate; PKA: protein kinase A; MECs: mammary epithelial cells.

3.2 Shatavari (*Asparagus racemosus*)

Table 1: Taxonomic Classification of *Asparagus racemosus* (Pareek *et al.*, 2017) [28].

Taxonomic Rank	Classification
Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Monocots
Order	Asparagales
Family	Asparagaceae
Subfamily	Asparagoideae
Genus	<i>Asparagus</i>
Species	<i>Asparagus racemosus</i>

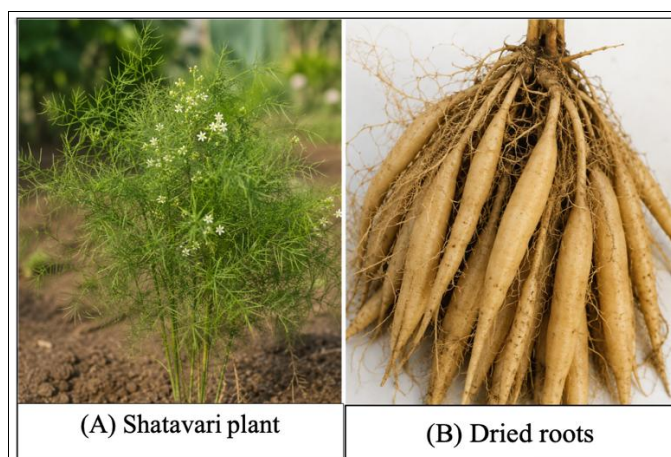


Fig 2: Shatavari (*Asparagus racemosus* Willd.) (A) Whole plant and (B) Dried roots.

Asparagus racemosus commonly known as Shatavari, Satavar or Shatmul, is a medicinal plant traditionally used in indigenous medicine, with its tuberous roots being the principal medicinal part. The roots contain several bioactive constituents, particularly steroidal saponins (shatavarins I-IV), isoflavones, racemosol, polysaccharides and mucilage, along with various vitamins and minerals. These phytoconstituents are considered responsible for its diverse pharmacological activities and support its traditional use as a herbal galactagogue (Chawla *et al.*, 2011) [8]. *Asparagus racemosus* supplementation has been reported to promote mammary gland development, including increased mammary gland weight and development of lobular and alveolar tissues. Its galactagogue activity may involve neuroendocrine modulation, particularly stimulation of prolactin and ACTH release. Bioactive steroidal saponins, including shatavarosides A and B and filiasparoside-C, have been proposed to contribute to these effects by influencing pituitary-adrenal and mammary gland function, thereby supporting mammary epithelial differentiation and milk production (Kumar *et al.*, 2023) [25]. In a feeding trial, supplementation of Shatavari at 50 g/day along with concentrate for 60 days improved milk yield in lactating cattle and buffaloes. Milk production increased by 12.72% (1.32±0.15 kg/day) in cows and 9.90% (0.80±0.34 kg/day) in buffaloes compared with the respective controls. The supplementation was also reported to be economically beneficial, with an estimated increase in income of ₹7.49 per animal per day, supporting the potential of *A. racemosus* as a practical herbal galactagogue in dairy animals (Tanwar *et al.*, 2008) [41]. Saini *et al.* (2018) [35] and Choudhary *et al.* (2024) [10] reported that supplementation with *Asparagus racemosus* root powder enhanced dry matter intake and milk yield in lactating cows. Improvements were also observed in milk fat, protein, lactose, solid-not-fat and

total solids indicating its potential to improve both milk production and composition as a herbal galactagogue.

3.3 Fenugreek (*Trigonella foenum - graecum*)

Table 2: Taxonomic classification of *Trigonella foenum-graecum* (Fenugreek).

Taxonomic Rank	Classification
Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Clade	Rosids
Order	Fabales
Family	Fabaceae
Subfamily	Faboideae
Genus	<i>Trigonella</i>
Species	<i>Trigonella foenum-graecum</i>



Fig 3: *Trigonella foenum - graecum* (A) Seeds and (B) Whole plant.

Trigonella foenum-graecum L., commonly referred to as fenugreek or methi, is a widely cultivated medicinal herb with a long history of traditional use. Its seeds are the principal

therapeutic part and have been traditionally employed to support lactation. The seeds contain diverse bioactive compounds, notably steroidal saponins, trigonelline, 4-hydroxyisoleucine, flavonoids, galactomannan and polyphenols, which may contribute to its pharmacological activities and proposed galactagogue effects (Choubey *et al.*, 2018; Visuvanathan *et al.*, 2022) [9, 44]. Fenugreek may promote lactation through multiple endocrine pathways, including modulation of the insulin-GH/IGF-1 axis, which may support mammary nutrient utilization and milk-synthesis processes. Its reported effects on pituitary oxytocin may additionally facilitate milk ejection, while changes in prolactin secretion observed in some studies suggest a possible role in lactogenic endocrine regulation. Nevertheless, the precise molecular basis of fenugreek-induced lactogenesis remains incompletely understood (Penagos Tabares *et al.*, 2014) [31]. Raw fenugreek seeds have a characteristic bitter taste, mainly attributed to their saponin content, which may affect their palatability and food acceptability. India is both a major producer and consumer of fenugreek, where the seeds are widely used for culinary purposes as well as in traditional medicinal practices (Agrawal *et al.*, 2015) [2]. Studies in dairy animals indicate that fenugreek supplementation may improve lactational performance, although responses vary among species. Degirmencioglu *et al.* (2016) [13] reported increased feed intake and milk yield in Anatolian water buffaloes fed ground fenugreek seeds, while Balgees *et al.* (2013) [6] observed improved appetite, hormonal changes and milk production in dairy goats without altering milk composition.

3.4 Anise Seed (*Pimpinella anisum*)

Table 3: Taxonomic classification of *Pimpinella anisum* (Anise Seed)

Taxonomic Rank	Classification
Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Clade	Asterids
Order	Apiales
Family	Apiaceae
Genus	<i>Pimpinella</i>
Species	<i>Pimpinella anisum</i>



Fig 4: Anise (*Pimpinella anisum*) (A) Whole plant and (B) Anise seeds

impinella anisum L., commonly known as anise, is an aromatic herb widely cultivated for its culinary and medicinal applications. The fruits (commonly referred to as seeds) are the principal plant material used traditionally and have been valued for their carminative, digestive, expectorant and antimicrobial properties (Shojaii and Abdollah, 2012) [39]. The essential oil of *Pimpinella anisum* is primarily composed of trans-anethole (93.9%), while estragole (2.4%) constitutes another important component. The lactogenic effects traditionally attributed to anise have been linked to its possible influence on the dopaminergic pathway, with anethole suggested to interfere with dopamine-mediated inhibition of prolactin secretion (Shojaii and Abdollah, 2012; Foong *et al.*, 2020) [39, 17]. Dietary supplementation with 50 g anise seeds/head/day, from six weeks prepartum through 15 weeks postpartum, improved nutrient digestibility and significantly increased total and daily milk yield, along with milk fat, lactose and total solids in lactating buffaloes (Sallam *et al.*, 2018) [36]. In lactating buffaloes, dietary inclusion of 50 g anise seeds/head/day was associated with better nutrient digestibility and feeding value, increased feed intake and milk production and improved economic efficiency of the ration (El-Garhy and Moustafa, 2005) [14]. In experimental studies, *Pimpinella anisum* seeds have shown potential lactogenic effects. However, the lactogenic response to *P. anisum* may differ across animal species, as supplementation with anise-containing diets did not produce significant improvements in milk intake or growth performance in lactating rabbits (Shojaii and Abdollah, 2012) [39].

3.5 Black Cumin (*Nigella sativa*)

Table 4: Taxonomic classification of *Nigella sativa* L.

Taxonomic rank	Classification
Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Order	Ranunculales
Family	Ranunculaceae
Genus	<i>Nigella</i>
Species	<i>Nigella sativa</i> L.



Fig 4: Black Cumin (*Nigella sativa*) (A) Black cumin seeds and (B) Black cumin plant

Nigella sativa L. is an annual herbaceous plant belonging to the family Ranunculaceae. It is widely distributed in southern Europe and parts of Asia, including Syria, Türkiye, Saudi Arabia, Pakistan, and India (Rajsekhar and Kuldeep, 2011) [33]. The seeds contain several bioactive constituents,

particularly thymoquinone, thymol, hymoquinone, carvacrol, nigellidine, nigellidine and fixed oils, which contribute to their antioxidant, anti-inflammatory, antimicrobial and immunomodulatory effects (Ahmad *et al.*, 2013; Dalli *et al.*, 2021) [3, 12]. In lactating rats, administration of aqueous and ethanolic extracts of *N. sativa* seeds increased milk production by approximately 31.3% and 37.6%, respectively, compared with the control group, with a corresponding increase in pup weight gain (Hosseinzadeh *et al.*, 2013) [21]. Dietary supplementation with *N. sativa* seeds has been reported to increase milk yield in lactating buffaloes and goats (El-Nor *et al.*, 2007; El-Saadany *et al.*, 2008) [15, 16]. The lactogenic effect of *N. sativa* may be related to increased prolactin secretion through modulation of dopaminergic pathways; however, its exact mechanism of action has not yet been established (Hannan *et al.*, 2021) [20].

4. Cost Effectiveness Analysis

In lactating Surti buffaloes, supplementation with a polyherbal galactagogue increased total milk yield by 14.24% and improved net returns by ₹339.90 per animal per month, along with a higher cost-benefit ratio than the control (Patel *et al.*, 2013) [29]. Similarly, feeding an equal proportion combination of Shatavari (*Asparagus racemosus*), Jivanti (*Leptadenia reticulata*), and fenugreek (*Trigonella foenum-graecum*) at 60 g/cow/day increased milk yield and daily returns in lactating Kankrej cows, with a 24.89% higher daily return than the control (Patel *et al.*, 2017) [30]. In another study, Shatavari root powder supplemented at 50 g/animal/day increased milk yield by 19.67% and improved daily income by ₹50.50 per animal in lactating buffaloes (Meena *et al.*, 2020) [26].

Table 5: Recent evidence on selected plants and plant preparations investigated for galactagogue activity.

Plant / preparation	Scientific name	Recent evidence / galactagogue effect	Reference
Barley malt + lemon balm	<i>Hordeum vulgare</i> + <i>Melissa officinalis</i>	A randomized controlled trial in mothers of preterm infants found greater expressed milk volume with the barley malt-lemon balm preparation than placebo over the study period.	Wesolowska <i>et al.</i> (2021) [45]
Garden cress	<i>Lepidium sativum</i>	Daily administration of 2.5 g seeds increased expressed milk volume after 28 days in hypogalactic mothers compared with controls, with no adverse drug effects reported.	Ranade and Mudgalkar, (2022) [34]
Lettuce	<i>Lactuca sativa</i>	Lettuce syrup increased breast-milk volume at several time points in mothers of preterm infants	Izaddoost <i>et al.</i> (2023) [22]
Moringa	<i>Moringa oleifera</i>	Systematic review of 8 randomized trials found increased milk volume (up to 400 mL/day) and higher prolactin levels; however, longer and better-controlled studies are still needed.	Ammar <i>et al.</i> (2025) [4]
Fenugreek	<i>Trigonella foenum-graecum</i>	Systematic review and meta-analysis of randomized trials found a significant overall effect of plant-based galactagogues on milk volume, with fenugreek showing a significant subgroup effect.	Jain and Tewari, (2026) [23]
Silymarin + goat's rue	<i>Silybum marianum</i> + <i>Galega officinalis</i>	Systematic review found low-certainty evidence of increased milk volume at day 7 with silymarin phytosomes combined with Galega.	Cragg <i>et al.</i> (2026) [11]

5. Conclusion

Overall, herbal galactagogues appear to have the ability to enhance milk production and lactational function in dairy animals. Shatavari, fenugreek, anise, and black cumin have all showed positive impacts on milk yield, milk composition, and economic returns in various trials. These effects may be attributed to changes in prolactin secretion, endocrine regulation, mammary gland activity, and food consumption. However, differences in plant preparations, dosage, animal species and study design make direct comparison difficult. Further well-designed studies are needed to establish their effective doses, mechanisms of action, safety and long-term benefits in dairy animals.

Conflict of Interest

Not available

Financial Support

Not available

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