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A Comprehensive Review on the Role of Galactagogues in Enhancing Human Lactation

[1]Prarthana Mitra, [2]Anusha MB and [3]Poornima DS

[1-3]Department of Food Technology, MS Ramaiah University of Applied Sciences, Bangalore, Karnataka, India

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Corresponding Author: Anusha MB

Abstract

Breastfeeding is universally recognized as the ideal method of infant feeding, offering essential nutrients, immune protection, and long-term health benefits for both infants and mothers. However, insufficient milk production remains a common concern among lactating women and can lead to early cessation of breastfeeding. In such cases galactagogues, substances that promote or enhance lactation are often used to support milk production. This review presents an overview of the physiology of lactation, factors contributing to delayed or inadequate milk supply, and evaluates both pharmaceutical and herbal galactagogues. Particular emphasis is placed on traditional plant-based galactagogues, which are gaining popularity due to their accessibility, affordability, and perceived safety. Key herbs such as fennel (*Foeniculum vulgare*), fenugreek (*Trigonella foenum-graecum*), papaya (*Carica papaya*) leaves, moringa (*Moringa oleifera*), ginger (*Zingiber officinale*), garlic (*Allium sativum*), milk thistle (*Silybum marianum*), and shatavari (*Asparagus racemosus*) are explored in detail. Their mechanisms of action, active phytochemicals, clinical evidence, and safety profiles are discussed. Although existing studies support the lactogenic effects of these herbs, more rigorous clinical trials are needed to confirm efficacy, determine optimal dosages, and evaluate safety across diverse populations and over long-term use.

Keywords: Breastfeeding, Galactagogues, Infant Nutrition and Maternal Health, Lactation, Plant-based galactagogues

Introduction

Breastfeeding has been recognized for providing both short- and long-term benefits over formula feeding for many years (Forinash *et al*., 2012) [3]. Breast milk provides essential nutrients and bioactive components that support growth, immunity, and may even influence genetic regulation through DNA repair, methylation, and gene transcription (Li *et al*., 2024) [5]. Studies have shown that extended breastfeeding offers significant protective benefits for infants. Exclusive breastfeeding for at least three to four months can lower the risk of acute otitis media, atopic dermatitis, and hospitalizations due to lower respiratory tract infections. Continued breastfeeding beyond six months has been associated with a potential reduction in the risk of acute lymphocytic leukaemia, acute myeloid leukaemia, sudden infant death syndrome (SIDS), as well as the later development of asthma, diabetes mellitus, and obesity (Forinash *et al*., 2012) [3].

Lactation is the process where the mammary glands produce and release milk. Milk is produced by secretory cells in the alveoli, stored in the alveolar lumina, and ejected into the ductal system through contractions of myoepithelial cells during breastfeeding or pumping (Farah *et al*., 2021a) [1]. Breastfeeding mothers often worry about producing enough milk, a concern known as insufficient milk supply. To boost milk production, many turn to prescription medications, as well as herbs and foods known as galactagogues (Nice, 2015) [8].

Galactagogues may be considered for insufficient milk supply when non-pharmacologic methods are ineffective (Nice, 2015) [8]. Galactagogues are substances believed to help initiate, maintain, or increase breast milk production (Mortel & Mehta, 2013) [7]. They generally work by increasing prolactin levels, which helps trigger the milk letdown reflex and can also support milk ejection (Nice, 2015) [8]. They can include both pharmaceutical drugs and herbal supplements (Mortel & Mehta, 2013) [7].

Commercially available synthetic drugs can negatively impact the neuro-endocrine regulation of lactation and, with prolonged use, may lead to toxicity, posing risks to the overall health of both humans and animals. As a result, researchers have shown growing interest in traditional

herbs, as they are more accessible, affordable, and are believed to leave little or no toxic residues in breast milk. This review explores recent advancements in the use of traditional galactagogues, offering a concise overview of their roles in promoting breast milk production (Mohanty *et al*., 2014) [6].

Physiology of Breastfeeding

Several factors contribute to the development of breast milk. In early pregnancy, oestrogen and progesterone play crucial roles in preparing breast tissue. For lactation oestrogen promotes the development of milk ducts, while progesterone supports the formation of lobules, which are essential for milk production (Forinash *et al*., 2012) [3]. Milk production, or lactogenesis, is a complex neurophysiological process resulting from neuro-endocrine activity. It involves the interplay of various physical and emotional factors, along with the influence of several hormones, with prolactin playing a central role (Mohanty *et al*., 2014) [6]. Prolactin is the primary hormone responsible for stimulating the mammary glands. However, during pregnancy, elevated levels of oestrogen and progesterone inhibit prolactin's ability to initiate milk production. In addition, prolactin, along with human chorionic somatomammotropin, promotes the production of enzymes necessary for milk synthesis. Following childbirth, the sharp decline in oestrogen and progesterone levels enables prolactin to effectively activate the alveoli for milk production (Forinash *et al*., 2012) [3]. Dopamine agonists and antagonists influence the synthesis and secretion of prolactin by interacting with the hypothalamus and anterior pituitary, thereby playing a key role in regulating milk production. Therefore, an increase in prolactin levels is essential for boosting milk production, but it is not necessary for maintaining the ongoing milk supply (Mohanty *et al*., 2014) [6]. Milk secretion is mainly regulated by oxytocin, which triggers the contraction of myoepithelial cells, releasing stored milk into the ducts (known as letdown). For the milk to reach the infant, it must be ejected from the alveolar lumen into the milk ducts. Infant suckling stimulates the production of both prolactin and oxytocin. Milk secretion persists as long as suckling continues (Forinash *et al*., 2012) [3].

Lactogenesis

Lactogenesis occurs in two stages. The first stage, known as secretory differentiation or lactogenesis I, begins around the 20th week of pregnancy. During this phase, the mammary glands start to produce small amounts of milk. This stage continues until about the second or third day after birth. The second stage, called secretory activation or lactogenesis II, is governed by the endocrine system. It begins with the onset of abundant milk production, which is triggered by a sharp drop in progesterone levels following the delivery of the placenta. During this time, many women notice a sensation of breast fullness. Following this, galactopoiesis the process of maintaining milk production begins around the ninth day postpartum. This stage is regulated by the autocrine (local) system and relies on the regular removal of milk from the breasts. Therefore, without consistent suckling by the infant or milk expression (e.g., through pumping), milk production will gradually decrease (Farah *et al*., 2021b) [2].

Delayed onset of lactation and inadequate milk production

Impaired lactation may arise from either delayed lactogenesis, defined as the delayed onset of copious milk production beyond 72 hours postpartum or from insufficient lactation, where milk output is inadequate to meet the infant's nutritional needs. This insufficiency may stem from preglandular causes such as diabetes mellitus, maternal obesity, polycystic ovary syndrome (PCOS), retained placental fragments, Sheehan's syndrome, theca lutein cysts, or thyroid dysfunction. Glandular causes include previous breast surgery or insufficient glandular tissue, while postglandular factors involve infant-related issues like cleft lip/palate, poor sucking reflex, tongue or lip tie, as well as maternal medication use, smoking, and preterm birth (Farah *et al*., 2021b) [2].

Table 1. Categories and Related Causes of Impaired Lactation

Category of Impaired Lactation	Causes
Preglandular	Diabetes mellitus
	Maternal obesity
	PCOS
	Retained placental fragments
	Sheehan's syndrome
	Theca lutein cysts
	Thyroid dysfunction
Glandular	Breast surgery
	Insufficient glandular tissue
Postglandular	Infant factors, including cleft lip/palate, ineffective weak suck, ankyloglossia, lip tie
	Maternal medication
	Preterm birth
	Smoking

Abbreviation: PCOS, polycystic ovary syndrome.
Source: Morton.[15]

Fig 1: Causes of Impaired Lactation (Farah *et al*. 2021b) [2].

Potential Galactagogues

Fennel Seeds

A study revealed that fennel (*Foeniculum vulgare*) holds promising potential as a natural galactagogue, with a history of traditional use in promoting lactation. The paper elaborates that fennel contains naturally occurring phytoestrogens particularly anethole which possess oestrogen-like properties. These bioactive compounds are believed to promote lactation by enhancing prolactin secretion, thereby aiding in the stimulation of breast milk production. Traditionally used in various cultures, fennel is often consumed as a tea or extract by lactating women. The review also notes its additional benefit in relieving infant colic when passed through breast milk. While the findings support fennel's traditional use and biological plausibility, the authors stress the importance of further clinical research to establish its efficacy and safety in human lactation (Tănase Butnariu *et al*., 2021) [9].

Fenugreek Seeds

Findings from a study suggests that fenugreek (*Trigonella*

foenum-graecum) exhibits a notable galactagogue effect in lactating women. This lactogenic property is believed to be due to its bioactive compounds particularly diosgenin which may exert oestrogen-like effects and promote prolactin secretion. The analysis of five studies involving 122 participants found that fenugreek significantly increased breast milk production (WMD: 11.11–17.79 mL vs. placebo). However, its effect was lower than that of Coleus amboinicus (26.10 mL) and palm date (25.72 mL). While fenugreek remains a commonly used herbal galactagogue, further research is needed to determine optimal dosing and compare its efficacy with stronger alternatives.

Papaya Leaves

A study reveals that papaya leaf can be beneficial as a galactagogue (a substance that promotes breastmilk production) due to its high saponin content, which increases oxytocin levels. To improve acceptability, the study formulated cookies using papaya leaf, ensuring the saponin levels were maintained while minimizing its bitter taste. These cookies, especially those with 40% papaya leaf content, were found acceptable and could be safely consumed by lactating mothers to enhance milk production (Wijayanti *et al*., 2019) [10].

Moringa Leaves

A study investigated the effectiveness of Moringa oleifera leaves as a natural galactagogue to boost breast milk production in early postpartum women. In a randomized, double-blind, placebo-controlled trial involving 88 postpartum mothers, participants received either Moringa oleifera capsules (900 mg/day) or a placebo. On the third day postpartum, the median breast milk volume in the Moringa group was 73.5 ml, compared to 50 ml in the placebo group. Although this difference was not statistically significant ($p = 0.19$), it represented a 47% higher milk volume in the Moringa group. Furthermore, by 6 months postpartum, the exclusive breastfeeding rate in the Moringa group reached 52.3%, aligning with the World Health Organization (WHO) recommendations. While Moringa oleifera did not significantly increase breast milk volume in the early postpartum period, the notable increase in milk quantity and favourable long-term breastfeeding outcomes suggest it may be a beneficial herbal supplement to support lactation (Fungtammasan & Phupong, 2022) [4].

Ginger

A randomized, double-blind, placebo-controlled trial examined the effect of ginger (500 mg twice daily) on breast milk volume in early postpartum women. Conducted on 63 mothers, the study found that by day 3 postpartum, the ginger group produced significantly more milk (191 ± 71 mL/day) compared to the placebo group (135 ± 62 mL/day, $p<0.01$). However, by day 7, the difference was no longer significant. No adverse effects were reported, suggesting that ginger may be a safe and effective short-term galactagogue.

Garlic

A study conducted at Nootan General Hospital, Visnagar, India, aimed to assess the effect of garlic consumption on breastfeeding among postnatal mothers. Using a pre-experimental one-group pre- and post-test design, data were collected through a 12-point modified adequacy of breastfeeding checklist. The study involved non-probability convenience sampling. Results showed that the mean breastfeeding adequacy score increased significantly from 3.33 (pre-test) to 8.33 (post-test), with an average improvement of 5.47 points. The standard deviations were 2.56 (pre-test) and 2.57 (post-test), indicating consistency in responses. These findings suggest that garlic consumption may effectively enhance breastfeeding adequacy among lactating mothers.

Milk Thistle

A study evaluated the effectiveness of Silymarin, a standardized extract from *Silybum marianum*, as a galactagogue in breastfeeding women. Lactating women received either 420 mg/day of micronized Silymarin or a placebo for 63 days. The Silymarin group showed a significant 85.94% increase in daily milk production compared to a 32.09% increase in the placebo group. No adverse effects or dropouts occurred, and both compliance and tolerability were high. The findings suggest that Silymarin is a safe and effective option to enhance milk production in postpartum women.

Shatavari

Shatavari (*Asparagus racemosus*), a traditional South Asian herb, is widely used in Ayurveda as a galactagogue to enhance breast milk production. The root contains steroidal saponins (Shatavarin I–V), which are believed to increase prolactin levels, contributing to its lactogenic effect. Animal studies have shown that oral administration of Shatavari extract leads to hypertrophy of mammary glands, increased uterine weight, and signs of estrogenic activity. In lactating rats, doses of 270–540 mg/kg body weight significantly increased milk yield, comparable to domperidone, a known pharmaceutical galactagogue. A double-blind randomized clinical trial in lactating women also demonstrated a more than threefold rise in serum prolactin levels after Shatavari supplementation. Among its various forms, the milk decoction (Ksheerpaka) is considered the most effective. Despite its long-standing traditional use and emerging scientific support, Shatavari is not currently recognized as GRAS (Generally Recognized As Safe) by the U.S. FDA, highlighting the need for further clinical studies to confirm its safety and efficacy in humans (Sahu *et al*., 2022) [36].

Table 1: Summary of the Potential Galactagogues, their effect and efficiency

Galactagogue	Reported Effect	Increase in Milk Production
Fennel (Foeniculum vulgare)	Contains phytoestrogens (anethole); promotes prolactin secretion; relieves infant colic	Not quantified; traditional use supported
Fenugreek (Trigonella foenum-graecum)	Diosgenin promotes prolactin secretion; commonly used in supplements	11.11–17.79 mL vs. placebo (WMD); less than 25–26 mL seen with other herbs
Papaya Leaf (Carica papaya)	High saponin content; increases oxytocin levels	Not quantified; cookies with 40% leaf content were effective
Moringa (Moringa oleifera)	Contains nutrients and bioactives; improves long-term breastfeeding outcomes	47% higher volume vs. placebo on Day 3 (73.5 mL vs. 50 mL)
Ginger (Zingiber officinale)	Enhances early milk volume; safe in short term	Day 3: 191 ± 71 mL vs. 135 ± 62 mL (p<0.01)
Garlic (Allium sativum)	Improves breastfeeding adequacy; possible indirect stimulation	Not quantified; adequacy score improved significantly
Milk Thistle (Silybum marianum / Silymarin)	Increases prolactin; potent galactagogue	+85.94% vs. +32.09% in placebo over 63 days
Shatavari (Asparagus racemosus)	Increases prolactin; has estrogenic effects; traditional Ayurvedic remedy	>3x serum prolactin in women; no exact milk volume stated

Conclusion

Breastfeeding plays a vital role in infant nutrition and maternal health, yet challenges like delayed onset of lactation or insufficient milk production affect a significant number of postpartum women. While non-pharmacological interventions remain the first-line approach, galactagogues offer additional support when these methods prove insufficient. Among available options, herbal galactagogues are increasingly favoured due to their traditional use, natural origin, and perceived safety. This review has highlighted the physiological mechanisms that underlie lactation, identified the common causes of impaired milk production, and examined the scientific evidence behind several well-known herbal galactagogues including fenugreek, fennel, ginger, garlic, papaya leaf, moringa, shatavari, and milk thistle (Silymarin). Among them, Silymarin showed the most significant increase in milk production, indicating strong potential as a safe and effective herbal supplement. Other herbs like fenugreek and moringa also demonstrated lactogenic effects, though their efficacy varied and often depended on formulation, dosage, and study design. Despite encouraging results, the use of herbal galactagogues is still limited by a lack of regulatory oversight, standardized preparations, and large-scale clinical trials. Most available studies are small and context-specific, which limits generalizability. Additionally, safety during long-term use or in women with underlying health conditions is not well understood. Therefore, while herbal galactagogues hold promise, they should be used with caution and ideally under professional supervision. Future research must aim to clarify their mechanisms of action, optimal dosing, interaction with medications, and long-term impact on both mothers and infants. Bridging the gap between traditional knowledge and evidence-based medicine will be key in validating these natural agents as reliable tools in promoting successful breastfeeding outcomes globally.

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