

Alfalfa (*Medicago sativa* L.) as a Promising Herbal Galactagogue for Dairy Cows: A Review

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Abstract - Milk production in dairy cows can be enhanced through herbal-based approaches like alfalfa (*Medicago sativa* L.), which is known for its richness in nutrients and bioactive compounds with the potential to act as an herbal galactagogue. This study reviews scientific publications from 2015 to 2025 in the Google Scholar database to explore the use of alfalfa and its benefits for dairy cow performance. The results indicate that alfalfa can increase milk production and quality, particularly in fat, protein, and lactose content. Phytoestrogen compounds such as isoflavones and coumestrol in alfalfa stimulate prolactin hormone production and promote udder tissue growth. Phenolic compounds help improve milk yield and quality, while alkaloids enhance the milk ejection reflex. Additionally, saponins serve as defaunation agents in the rumen, increase nitrogen utilization efficiency, and support metabolic balance, positively impacting overall cow health. However, high doses of alfalfa may lead to reproductive issues due to excessive estrogenic activity, such as anestrus and infertility. The effectiveness of alfalfa also depends on factors like material quality, dosage, the cow's physiological condition, and management practices. Therefore, alfalfa should be used carefully and in balanced amounts as a functional feed to maximize benefits and prevent physiological side effects in dairy cows.

Keywords: alfalfa, bioactive compound, milk production, phytoestrogen, phyto-galactagogue

INTRODUCTION

Dairy cattle are a key commodity that helps meet global milk demand. With their ability to produce large amounts of milk with high nutritional value, dairy cows are an essential source of nutritious food for people. As the demand for milk grows, more attention is given to sustainably maintaining and increasing milk production. This involves not only genetics and husbandry management but also approaches that support the physiological processes of lactation to boost milk yield (N. Khan, 2020; Scholz-Ahrens et al., 2020).

The advancement of science has promoted various methods to support the milk production process to meet the increasing demand for milk, including the use of substances known as galactagogues. Galactagogues are substances, herbs, supplements, or drugs that can stimulate, sustain, and increase milk production in humans and dairy animals (Kalaimathi & Kingsly, 2019; Neela et al., 2016). In recent years, the use of natural galactagogues from herbal ingredients, especially plants (phyto-galactagogues), has increased because they are viewed as safer, cause fewer side effects, and offer high nutritional value with broad therapeutic potential for both livestock and human health (Bora et al., 2019).

One of the herbs with potential as a natural galactagogue is alfalfa (*Medicago sativa* L.), known for its various benefits in both food and feed. This plant is called the "Father of All Plants" or "Father of All Herbs" because it is rich in nutrients such as protein, minerals, vitamins, and other compounds that provide nutritional and health benefits for both livestock and humans (Kumar et al., 2023; Latif et al., 2023; Nasihin & Fadhlurrohman, 2025). Additionally, alfalfa contains many bioactive compounds, such as saponins and isoflavones, which are believed to help stimulate milk production. Alfalfa has been traditionally used in feed formulations to increase milk yield (Thakur et al., 2023).

The nutritional content and bioactive compounds, such as saponins and isoflavones, make alfalfa a promising herbal galactagogue. Studies on the nutritional benefits of alfalfa for dairy cattle are abundant, but detailed discussions of its galactagogue mechanisms are limited. Understanding how alfalfa functions as a herbal galactagogue, including the role of its bioactive compounds in lactation physiology, could help optimize its use as a supportive solution in dairy farming. This article provides a brief review of alfalfa's role as an herbal galactagogue and offers an overview of its use as a natural strategy to increase milk production and quality in dairy cows.

MATERIALS AND METHODS

This article was prepared using a traditional literature review method, following the guidelines by Chinn (2021) and Sogunle et al. (2023), to examine the potential of alfalfa (*Medicago sativa* L.) as an herbal galactagogue, focusing on its key bioactive compounds and how they affect lactation physiology and dairy cow health. This approach was chosen for its flexibility in exploring and synthesizing information from various sources.

The literature search was conducted manually using Google Scholar, employing a combination of keywords such as “alfalfa,” “lucerne,” “galactagogue,” “herbal galactagogue,” “physiology lactation,” “milk production,” “milk quality,” and other relevant terms. As a **traditional literature review**, this method does not focus on quantifying the number of literature screened or reporting them step-by-step, as is common in systematic literature reviews (Li & Wang, 2018). Instead, the selection of literature was based on relevance and contribution to understanding the bioactive mechanisms of alfalfa as an herbal galactagogue for dairy cows. The inclusion criteria used for selecting the literature are shown in Table 1.

Table 1. Inclusion criteria for literature selection

Aspect	Inclusion Criteria
Publication period	Published between 2015 and 2025
Type of publication	Research articles, review papers, or e-books
Topic relevance	Discusses alfalfa, herbal galactagogues, or bioactive mechanisms related to milk production and quality in dairy cows
Scientific quality	Clear methodology, pertinent findings, and meaningful contribution to understanding galactagogue mechanisms

The analysis was conducted descriptively and narratively by gathering and synthesizing relevant literature based on the available data and information. Each finding was interpreted and integrated to develop a comprehensive understanding of the role of alfalfa's bioactive compounds as an herbal galactagogue for dairy cows. This synthesis was then organized into a detailed discussion to draw conclusions aligned with the review's objectives.

RESULT AND DISCUSSION

1. Physiology of Milk Secretion in Dairy Cows

Milk production in dairy cows involves a highly complex set of physiological processes that include various interacting systems within the body. These mechanisms involve the digestive and circulatory systems and depend heavily on the endocrine, nervous, and lymphatic systems. The hormonal and nervous systems work together to regulate metabolic activity in the udder tissue, which is the primary site of milk secretion (Truchet & Honvo-Houéto, 2017). The main center of milk production is located in the udder gland at the bottom of the cow's belly (Figure 1). The gland consists of many small, grape-like sacs called alveoli. Inside each sac is a lumen where milk

is produced. Specialized cells in the walls of these sacs function like small factories, taking nutrients from the blood and converting them into milk (Safitri et al., 2020).

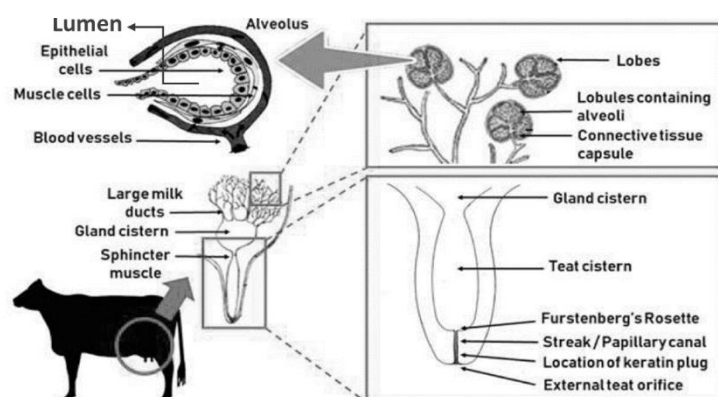


Figure 1. Anatomy of the udder in dairy cows (Adapted from: S. Khan et al.(2020))

The process of milk secretion can occur after dairy cows enter the lactation phase, which consists of three phases, namely mammogenesis, lactogenesis, and galactopoiesis, involving various morphological and endocrinological changes (Salum & Etyemez, 2023). Each phase in the lactation process is influenced by a specific group of hormones that act synergistically to regulate udder tissue growth, secretory cell activity, and maintenance of milk production (Figure 2). During gestation, the mammary gland tissue development stage is the mammary gland phase (Salum & Etyemez, 2023). In this phase, reproductive and metabolic hormones influence the cow's body. Estrogen and progesterone, as the main reproductive hormones, play a role in stimulating the growth and differentiation of the ducts and alveoli of the udder gland. Estrogen supports growth hormone activity in stimulating IGF-1 synthesis, accelerating the proliferation of udder epithelial cells. On the other hand, metabolic hormones such as insulin, cortisol, and thyroid also contribute to cell division and tissue maturation and prepare the udder to carry out its production function properly when lactation begins (Demir & Aksu, 2021; Grewal et al., 2019; Rezaei et al., 2016).

When approaching parturition, the cow undergoes hormonal changes that trigger the lactogenesis phase, which starts milk secretion (Salum & Etyemez, 2023). During this phase, the primary hormone involved is prolactin, which increases sharply as progesterone significantly decreases. This marks the beginning of milk production by the udder gland. Prolactin stimulates the alveolar epithelial cells to produce milk components such as lactose, casein, and fat. Once the milk is formed, it is stored in the cisternal space until it receives the signal to be released through the teat duct (Demir & Aksu, 2021; Posan et al., 2023; Truchet & Honvo-Houéto, 2017).

After lactogenesis, the cow's body enters the galactopoiesis phase, maintaining continuous milk production during lactation (Salum & Etyemez, 2023). Among the three phases of lactation, galactopoiesis is one of the crucial stages because it determines the quantity and continuity of milk production during lactation. The hormones that play a role in this phase are called galactopoietic hormones, which include growth hormone, insulin, insulin-like growth factor-I, thyroid hormone, and cortisol. These hormones are essential for maintaining udder gland function and supporting milk synthesis sustainably. Therefore, if galactopoietic hormones are disrupted, it can directly inhibit milk production in quantity and quality (Demir & Aksu, 2021).

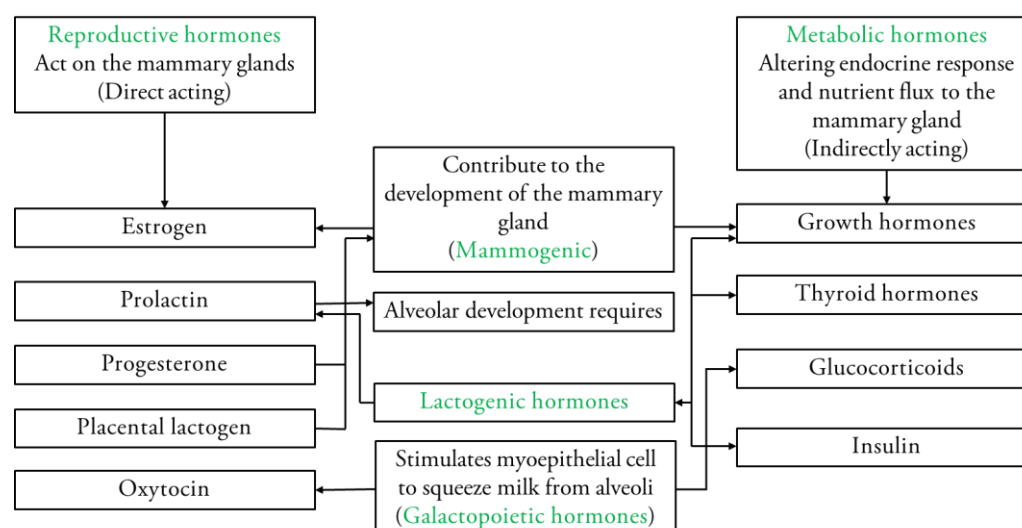


Figure 2. Physiology of milk secretion and its supporting hormones (Adapted from: Sahu et al. (2022))

2. Galactagogue for Dairy Cows

The use of galactagogues has become a strategy to address galactopoietic hormone imbalance that leads to decreased milk production in dairy cows. Galactagogues are commonly used in livestock management to increase milk yield on large-scale dairy farms. Naturally, the mammalian body produces endogenous galactagogues such as prolactin, insulin, and somatotropin hormones, which are involved in the physiological lactation process. Under certain conditions, milk production can be enhanced with synthetic galactagogues like domperidone and metoclopramide, artificial compounds designed to stimulate milk synthesis. Additionally, herbal galactagogues derived from plants containing phyto-galactagogue compounds work through hormonal and physiological mechanisms to boost milk production (Nanditha & Varun, 2022).

In dairy farming, using galactagogues requires careful consideration of safety and cost-effectiveness. Synthetic galactagogues effectively increase milk production, but long-term use can lead to chemical residues and cause side effects, such as disruptions in the neuroendocrine system that regulates lactation. Additionally, herbal ingredients that are more abundant, easily accessible, and lower in cost can make herbal galactagogues a practical and economical choice for dairy farmers. Consequently, plant herbal ingredients are commonly used to support livestock health and productivity, especially in developing countries that prefer natural solutions and cost-effective methods (Posan et al., 2023; Sanghai et al., 2023).

Herbal galactagogues are often used as feed supplements because of their bioactive compounds that can provide beneficial physiological effects. Several herbs, such as fenugreek (*Trigonella foenum-graecum*), fennel (*Foeniculum vulgare*), blessed thistle (*Cnicus benedictus* L.), alfalfa (*Medicago sativa* L.), and goat's true (*Galega officinalis* L.), are known to promote increased milk production due to phytoestrogens, compounds that have structures similar to estrogen. Some of these plants also possess antimicrobial properties that can help maintain udder health and support the smooth process of milk production during lactation (Nanditha & Varun, 2022).

3. Characteristics and Potential of Alfalfa as a Galactagogue

Alfalfa or lucerne (*Medicago sativa* L.) is a perennial leguminous plant of the Fabaceae family and Medicago genus that has been widely recognized in the livestock sector as the "King of Forage" or "Queen of Forage" because of its high protein content, nutritional quality, significant biomass productivity, good adaptability, and its benefits in improving soil fertility through nitrogen

fixation. *Medicago sativa* L. generally has characteristics of trifoliate leaves (three leaflets) with purplish flowers (Figure 3). This plant can grow up to 30–120 cm in height and has a root system that can penetrate up to 2–4 meters deep (Ananda et al., 2021; Appiah et al., 2024; Burezq, 2022; El-Ramady et al., 2020; Ma et al., 2022; Suwignyo et al., 2023).



Figure 3. General appearance of alfalfa (*Medicago sativa* L.) (Fernandez et al., 2019)

Alfalfa originated in the Southwest Asia region, as evidenced by the discovery of wild varieties of this plant in the Caucasus Region, Afghanistan, and Iran. Over time, alfalfa has been widespread and cultivated in more than 80 countries, with a planting area reaching more than 30 million hectares globally, dominated by temperate regions such as the United States, Europe, and China (Acharya et al., 2020; Roy et al., 2016; Wang & Zhang, 2023). However, alfalfa has also been developed in tropical areas such as Indonesia. One of the varieties developed in the tropics is *Medicago sativa* L. cv Kacang Ratu BW, which has been recognized as one of Indonesia's biodiversity (Fatimah et al., 2024).

Alfalfa is considered one of the best forage crops in the world due to its high protein and calcium content, low fiber, and high digestibility (Javaid et al., 2020). The detailed nutritional content and bioactive components of alfalfa are presented in Table 2, providing an overview of the various nutrient content and bioactive compounds. Alfalfa contains 18–25% crude protein, 72% digestibility, and approximately 20–30% fiber content. It also contains vitamins (such as A, B, C, D, E, and K) and minerals like calcium, potassium, iron, and magnesium (Patra & Paul, 2019). Liu et al. (2023) reported that alfalfa contains 13.18%–17.25% amino acids, consisting of 5.70%–9.09% essential amino acids and 6.32%–9.36% non-essential amino acids. The nutritional content of alfalfa leaves is higher in crude protein and lower in crude fiber than that of stems (M. Guo et al., 2023). These nutritional values may vary depending on cutting age, cultivar, and other factors. To achieve optimal nutritional value and palatability, alfalfa should be harvested at the early flowering stage (Gashaw, 2015; Karayilanli & Ayhan, 2016; Monirifar et al., 2020).

Table 2. Nutrient content and bioactive compounds of alfalfa

Classification	Component
Proteins:	β -amylase, protein phosphatase 2A holoenzyme, ferritin
Vitamins:	A, B (B1, B6, and B12), C, D, E, K, pantothenic acid, niacin, biotin, folic acid
Minerals:	Ca, P, Mg, K, Na, Zn, Fe, Al, B, Co, Cr, Cu, Mn, Mo, Si, Se, Sn
Amino acids:	Lysine, methionine, arginine, medicanine, histidine, aspartic acid, tyrosine, asparagine, alanine, serine, threonine, phenylalanine, glutamic acid, leucine, isoleucine, valine
Non-protein amino acid:	L-Canaverin
Organic acids:	Lactate, malate, malonate, citrate, benzoate, succinate, fumarate
Phenolic compounds:	P-coumaric acid, p-hydroxybenzoic acid, salicylic acid, ferulic acids, chlorogenic acid, caffeic acid, tannic acid, vanilic acid, cinnamic acid, gallic acid, silicic acid, naringenin, heterosides, sinapic acids, hesperetin, naringenin
Phytoestrogens:	Coumestrol, isoflavons (daidzein, genistein, formonnetin, and biochanin)
Phytosterols:	β -sitosterol, stigmasterol
Sterols:	α -spinasterol, β -sitosterol, stigmasterol, campesterol, esculetin, scopoletin, myrsellinol, 24-methylcholest-7-enol
Plyamines:	Norspermine, norspermidine
Flavonoids:	Catechins, apigenin, luteolin, rutin, sativan, vestitol, tricin, medicarpin, formononetin, myricetin, quercetin,
Alkaloids:	Asparagines, stachydrine, trigonelline, L-homostachydrine
Coumarins:	4-coumaric acid, esculetin, scopoletin, myrsellinol,
Saponins:	Medicagenic acid, hederagenin, soyasapogenols
Thyrotropin:	Releasing hormone analog
Volatile components:	Terpenes, furanoids, limonene, linalool, transocimene
Digestive Enzymes:	Isoflavone reductase, vestitone reductase, iminopeptidase, aminopeptidase
Other components:	Tannins, β -carotene

Source: Apostol et al., (2017); Mandle & Chaudhari (2021); Shah et al. (2020); Srisaikhram & Rupitak (2021)

In addition to its main nutrient content, alfalfa is also reported to contain various bioactive compounds, such as non-protein amino acids, organic acids, polyols, alkaloids, carotene, coumarins, digestive enzymes, flavonoids, phenolic compounds, phytosterols, polyamines, and phytohormones. The diversity of the compound content can provide significant benefits to the physiological functions of livestock, such as maintaining body health, maintaining the immune system, and supporting the balance of reproductive hormones (Xu et al., 2018). This makes alfalfa widely used as animal feed, especially dairy cows, as an effort to increase milk production and quality, supported by several bioactive compounds such as flavonoids, saponins, alkaloids, and tannins, which are known to have potential as a phyto-galactagogue (Koko et al., 2019; Qingbin & Yang, 2020). Several studies on feeding alfalfa in dairy cow diets have demonstrated positive effects on milk production, nutrient content, and health conditions, summarized in Table 3.

Table 3. Summary of several studies on alfalfa supplementation and its effects on dairy cows

Form	Treatment	Main result	Reference
Wilted alfalfa	5 kg/head/day	- Boosts milk production by as much as 32%	Raju et al. (2018)
Alfalfa Flavonoid Extract (AFE)	60 mg/kg BW	- Increases milk production slightly. - Changing milk composition - Enhances digestive efficiency - Enhances antioxidant properties - Boosts immunity	Zhan et al. (2017)
Pellet	Alfalfa + ryegrass fiber in pellet KitN°10	- Increase milk production by as much as 52% - Increases milk protein content by 6.7% and lactose by 6.3%.	Albouchi et al. (2023)
Silage	Alfalfa silage + 3% fat	- Boost milk production - Adjusting CLA (Conjugated Linoleic Acid) levels in milk - Raises rumen blood metabolite levels	Sharifi et al. (2016)
Hay	Alfalfa hay + Amaranth hay (50:50)	- Boosts milk fat content. - Improve antioxidant capacity	Ma et al. (2024)

4. Mechanism of Alfalfa as a Galactagogue

The galactagogue effect of alfalfa supplementation in dairy cows is presumably not only due to its nutritional value as a high-quality forage but also due to the presence of bioactive compounds. According to Rani et al. (2024), the galactagogue mechanism in general can be explained through several main pathways, including increased stimulation of prolactin hormone, stimulation of mammary tissue growth, reinforcement of milk ejection reflexes, and improved metabolism that support overall health. These mechanisms may also underlie the potential effect of alfalfa as a galactagogue.

Prolactin Stimulation

One of the central pathways in the mechanism of action of alfalfa as a galactagogue is its ability to increase the secretion of prolactin hormone, the primary hormone in the process of lactogenesis and galactopoiesis. Prolactin is produced in the adenohypophysis (anterior part of the pituitary gland) and is responsible for initiating and maintaining milk production (Fails & Magee, 2018). Alfalfa (*Medicago sativa* L.) is known to contain phytoestrogen compounds such as coumestrol and isoflavones (genistein, formononetin, daidzein, and biochanin), which are known to have similar structures to estrogen (especially 17 β -estradiol), so that they can have a regulatory effect on estrogen hormones. These compounds support reproductive health and lactation, primarily through hormonal mechanisms (Kumai et al., 2020; Mandle & Chaudhari, 2021).

Phytoestrogens work by inhibiting dopamine activity, a neurotransmitter that typically suppresses prolactin release. This reduction in dopamine activity caused by phytoestrogens allows for a natural rise in prolactin secretion without needing external drugs. The higher levels of prolactin in the blood signal the alveoli cells in the udder to begin producing milk components (Fails & Magee, 2018; Nanditha & Varun, 2022). Other compounds, such as flavonoids, saponins, alkaloids, and phenolics, also enhance the galactogenic effect in alfalfa. These compounds may support this process indirectly by modulating the hypothalamic-pituitary-thyroid axis, which controls the body's metabolism and hormonal balance, including prolactin, a key hormone in the lactogenesis and galactopoiesis phases (Kulkarni & Jamdade, 2017; Singh et al., 2025). By maintaining thyroid stability and increasing mammary gland tissue sensitivity to hormones, these compounds create ideal conditions for milk production and secretion.

Stimulation of Udder Tissue Growth

The response to increased prolactin is followed by activation of the udder tissues, especially the alveoli structures in the udder. Prolactin works synergistically with other hormones such as insulin and cortisol in epithelial cell differentiation and secretory function activity in early lactation (Muhammad et al., 2016). Phy-togalactagogue compounds can widen blood vessels (vasodilation), leading to increased blood flow to the udder tissue. This vasodilation accelerates the distribution of prolactin hormone and essential nutrients to mammary epithelial cells, thereby promoting structural development of the udder gland, including an increase in the number and size of alveoli, the functional units for milk secretion and storage (Pahuja et al., 2024; Pratiwi et al., 2023). Based on this mechanism, alfalfa, which contains phytoestrogens, may amplify these effects by enhancing hormone response in target tissues. Phyto-galactagogue compounds in alfalfa can also induce vasodilation, leading to increased blood flow to the udder tissue.

Improved Milk Production and Quality

Once the hormonal system and udder tissue are in optimal condition, marked by increased prolactin levels and well-developed alveoli structure, milk production can proceed efficiently. Several studies, as shown in Table 3, report that incorporating alfalfa into dairy cattle diets positively affects milk production and nutrient levels, such as protein, fat, and lactose. The boost in milk yield and quality from alfalfa supplementation may be due to the bioactive compounds it contains (Abdul & Olii, 2021). Phenolic compounds in alfalfa also contribute to increased milk production and protein content (Garba et al., 2025).

Protein and fat are key to determining milk quality (Shkirin et al., 2021). Alfalfa has a high protein content and a variety of amino acids, which are essential in the milk biosynthesis process. Amino acids serve as precursors in the synthesis of casein, the main component of milk protein, thereby influencing the protein content of milk. Combining amino acids with microbial proteins can improve milk production by increasing the availability of amino acids in the mammary gland (Z. Guo et al., 2021). Additionally, the supply of amino acids helps increase lactose content so that alfalfa feeding can raise lactose levels in dairy cows' milk (Elsaadawy et al., 2022). Marques et al. (2022) also noted that alfalfa feeding can boost milk fat content due to its high fiber content, which promotes bacteria in the rumen to produce more fatty acid precursors for milk fat synthesis.

Enhanced Milk Let-down Reflex

The milk let-down reflex is crucial for effective milking. Milk release from the udder occurs through neurohormonal reflexes, triggered by stimuli such as touch on the teat or suckling by the calf. These stimuli activate nerves to the brain and stimulate the release of the hormone oxytocin from the pituitary gland. Oxytocin travels through the bloodstream to the udder, causing the muscle cells around the alveoli to contract so milk can be expelled (Adriani, 2021). Alkaloid compounds in alfalfa can help enhance the milk let-down process because they interact directly with all smooth muscle tissues in the body.

Pratiwi et al. (2023) explained that alkaloid compounds work by triggering muscle contraction by affecting nerve signal transmission and the sensitivity of muscle cells to hormonal stimuli. These effects support the hormone oxytocin's role in activating the let-down reflex, making milk flow smoother and more efficiently during milking. Increased milking efficiency can also lower the risk of mastitis in dairy cows, which can hinder productivity. A milking process that takes too long or isn't thorough can irritate the teat tissue, creating conditions favorable for mastitis. By enhancing the milk let-down reflex, milking becomes more efficient and helps reduce residual milk in the udder, allowing for thorough milking and lowering the risk of mastitis (Abebe et al., 2016; Hayati et al., 2019; Winnicki et al., 2017; Zigo et al., 2021).

Health Support

In addition to direct hormonal and physiological effects, alfalfa has been shown to provide overall health benefits to dairy cows through its nutritional, ruminotoric, and antioxidant effects (Table 3). Its high fiber content stimulates rumen fermentation activity, producing short-chain fatty acids (acetate and propionate) that support digestive tract health and metabolic efficiency. Protein and essential amino acids support milk synthesis and endurance, while vitamins and minerals play a role in metabolic function and tissue growth. Additionally, bioactive compounds such as flavonoids and saponins have antioxidant and anti-inflammatory effects that can help maintain the health of dairy cows during lactation (Ma et al., 2022). Saponins in alfalfa also act as natural rumen modifiers, suppressing the ciliate protozoa population, increasing microbial protein synthesis, and reducing methane production. This helps the efficient use of nitrogen and energy allocated to the galactopoiesis process, ultimately improving dairy cow performance (Kholif, 2023). The mechanism of action of saponins involves interaction with protozoa, supporting the efficient use of nutrients in the rumen. This effect increases substrate availability for milk synthesis and maintains the physiological balance of dairy cows during lactation by improving rumen function, enhancing nutrient absorption, and supporting overall metabolic stability (Pahuja et al., 2024).

5. Effectiveness of Alfalfa Use

Several studies, such as those shown in Table 3, indicate that using alfalfa in dairy cow feed can have positive effects. However, its effectiveness depends on the quality of the alfalfa, the age and health of the animals, how it is combined with other balanced feeds, and overall husbandry practices (Tomovska et al., 2023; Wyse et al., 2021). Correct feeding proportions are also essential for improving dairy cows' productivity and overall health. Additionally, the levels of bioactive compounds in alfalfa, especially phytoestrogens, require attention. Excessive phytoestrogen levels

can disturb hormonal balance, increasing the risk of infertility, disrupting the estrus cycle, and causing anestrus in livestock (Mohammed & Sanahmmed, 2024; Wyse et al., 2022).

CONCLUSION

This study indicates that alfalfa has strong potential as a herbal galactagogue, which can improve both the production and quality of dairy cows' milk. The presence of bioactive compounds such as phytoestrogens, saponins, flavonoids, and alkaloids helps stimulate lactation through hormonal effects and by enhancing livestock's metabolic and immune functions. However, its use must be carefully managed to prevent adverse effects, particularly on the reproductive system, due to its phytoestrogen content. Overall, this study highlights alfalfa as a promising herbal galactagogue, but further long-term research is needed to fully understand its extended effects and develop safe, practical guidelines for dairy cow nutrition.

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