Review Article

Potential Role of Fenugreek and Giloy as Nutraceuticals and Galactagogue in Animal Husbandry: A Detailed Review

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Abstract | Herbal medicines have always been a form of therapy for livestock among resource-poor smallholder farmers. This article is a review of present literature data of Fenugreek and Giloy as potential nutraceuticals and galactagogue in animal husbandry. Both these herbs are known to have pharmacological effects which include hypoglycemic, hypo-lipidemic, antidiabetic, hepato-protective, anti-carcinogenic, anti-inflammatory, antibacterial, antifungal and galactagogue activity. The commercially available drugs pose health threats and prove detrimental to both human and animal health. The traditional use of herbal preparations suggests that they are safe and effective, however, scientific validation is still required for many of them especially for animal use. The phyto-pharmacological research on these two natural products show a ray of hope for the discovery of new active compounds with a novel structure that has potential to serve as a natural lead compound for the development of new nutraceuticals and galactagogue for animal health.

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Introduction

Ever since the creation of mankind, the major thrust has been on the search for food for existence. Milk is almost a complete food while being deficient in some micro minerals and vitamins. The demand for milk and milk products is rapidly increasing. In the past, a substantial increment in production was achieved with the implementation of a comprehensive dairy development program named Operation flood. It is contended that the future increase in milk production will have to be met by increasing the productivity of dairy animals (Gautam et al., 2010). India is blessed with vast dairy resources and is not only the largest milk producer but also is one of the fastest-growing and lowest cost milk producers in the world. Total milk production in the year 2018-2019 was 187.70 million tonnes (Statistics, NDDB India website). The livestock sector in India is characterized by a very large number and very low productivity across all species. India has the world's largest livestock population accounting for over 37.28 per cent of cattle and 21.23 per cent of buffalo (Sonavale et al., 2020).

NDDB is currently engaged actively in documentation of ethno-veterinary medicine for several common ailments which reduces milk production, including mastitis. The use of ethno-veterinary medicine to manage common ailments drastically reduces the usage of medicines, especially antibiotics with an average cure rate of around 82 per cent (Annual

Report 2018-19 NDDB). India being a developing country, where nearly 80% of the population is below poverty line, mainly adopts agrarian economy. Animal agriculture is now a growing concern as it can satisfy unmet needs of the poor and can provide some income to the family (Pradhan and Mishra., 2018).

The use of supplements based on indigenous technical knowledge on lactating dairy animals is best suited for marginal farmers of country.

Galactagogues

Bergman and Turner in 1940 suggested the term "galactopoietic" or "galactagogue" for substances that augment established lactation. Independently, Folley and Young suggested the term "galactopoietic" describes hormone preparations that enhance milk production in an animal already lactating (Shaw et al., 1954). Galactagogues are synthetic or plant molecules that mediate complex processes involving interaction between physical and physiological factors. Among the most important factors are hormones such as prolactin. Milk production is essential for the optimal feeding of infants and has a direct impact on growth, development, and health in the neonatal period. Nutritional and non-nutritional factors (associated with endocrinology, health, climate, and management) affect milk synthesis and secretion. (Tabares et al., 2014).

Herbal galactagogues

Over centuries, people have developed their own system of keeping animal's healthy and productive using age-old home remedies, surgical and manipulative techniques and religious practice (Phondani et al., 2010) Ethno-veterinary and herbal medicinal products ideally have multiple effects and are helpful in a variety of disease conditions as well as for beneficial effects on the health of domestic animals. Even though the modern developments in the therapeutic field brought about a rapid decline in traditional medicine, the plant-based remedies are still having a crucial role as the potential source of therapeutic aids in health systems all over the world for both humans and animals (Chakraborty and Pal, 2012).

Prohibition of most of the antimicrobial growth promoters in animal feed because of their residual effects, plant extracts are becoming more popular. Plant extracts act as antibacterial, antioxidant, anti-carcinogenic, antifungal, analgesic, insecticidal, anticoccidial and growth promoters (Tipu et al., 2006). Most of the herbs and spices stimulate the function of pancreatic enzymes and some increase the activity of digestive enzymes of the gastric mucosa (Srinivasan, 2005). Microbial ecosystem in the rumen is composed of the complex anaerobic microbial population of bacteria, fungi, protozoa, and methanogenic-archaebacterium. Numerous metabolites produced in the rumen during microbial fermentation affect the basic digestive and metabolic functions and productivity of the host (Frankic et al., 2009). Thus, herbal preparations are helpful in overall health and productivity as they increase the rumen bacteria and protozoa post-treatment (Bhatt et al., 2009).

Shatavari (*Asparagus racemoscisliliaceac*) roots have been found to increase the prolactin secretion which augments the lactation. After feeding of Shatavari, increased milk production in the guinea pig, goats and buffaloes have been reported (Behera et al., 2013). Supplementation of the fresh root of Shatavari at the rate of 0.5 kg per day has been reported to increase the milk yield of buffaloes significantly ($p<0.01$) (Kumar et al., 2008). Milk thistle (*Silbanum marianum*) has been indicated as a galactagogue (Sehgal and Sood, 2013). It has been reported to increase the circulating prolactin levels in female rats and increase the blood flow to the mammary glands (Patel et al., 2013). Various plants as herbal Galactagogues have been listed in literature but the information on the exact mechanism of action and their effect on lactating animals remain scarce. In general, they act through exerting an influence on an adrenal-hypothalamohypophyseal-gonadal axis by blocking hypothalamic dopaminergic receptors or by inhibiting dopamine-producing neurons (Mohanty et al., 2014).

The main objective of this paper is to evaluate the nutraceutical and galactagogue potential of Fenugreek (*Trigonella foenum-graecum*) and Giloy (*Tinospora cordifolia)* whichare widely distributed across the topography of Indian states.

Fenugreek (Trigonella foenum-graecum)

Fenugreek (*Trigonella foenum-graecum*) is a leguminous herb cultivated in India. The endosperm of the seed is rich in galactomannan and the young seeds mainly contain carbohydrates and sugar. Mature seeds contain the amino acid, fatty acid, vitamins, and saponins. Fenugreek is rich in carbohydrates, proteins, fiber

and various bioactive compounds such as diosgenin, trigonelline, galactomannan etc. (Pathak and Agrawal, 2014). Fenugreek is known to have several pharmacological effects which include hypoglycemic, hypolipidemic, carminative, gastric stimulant, antidiabetic and galactagogue activity. Newer research has identified, antioxidant, hepatoprotective, anti-inflammatory, antibacterial, antifungal, antiulcer and anticarcinogenic properties too (Toppo et al., 2009).

Effect on blood parameters: A fenugreek seed extract has been reported to decrease total cholesterol, VLDL and LDL levels in the blood (Petit et al., 1993). It is in agreement with the studies in later years that fenugreek treatment selectively reduces the LDL and VLDL fractions of total cholesterol without any toxicological effects (Al-Habori and Raman, 1998). HDL fractions showed an opposite trend in rats fed with fenugreek-soluble dietary fiber whereas triglycerides, cholesterol and LDL were found to decrease significantly (Hannan et al., 2003).

Fenugreek saponins and galactomannan induce a notable delay in the absorption of LDL-cholesterol and triglycerides along with a remarkable increase in levels of HDL cholesterol. Saponin fraction significantly increased the hepatic glycogen content and suppressed the blood glucose level (Hamden et al., 2010). Saponins have been indicated to be the hypocholesterolemic component in fenugreek seeds that interact with bile salts in the digestive tract (Stark and Madar, 1993).

The hypoglycemic activity of fenugreek seeds (*Trigonella foenum-graecum*) in experimental animals is well documented (Raghuram et al., 1994). *In vivo* hypoglycemic activity has been reported to be mediated, at least in part, by the activation of an insulin signaling pathway in adipocytes and liver cells (Vijayakumar et al., 2005). Treatment with alkaloid extract of fenugreek dried seeds resulted in a significant reduction of blood glucose and an increase in serum insulin which may be thought to occur by their contents of alkaloids (El-Soud et al., 2007). Lower blood glucose ($p<0.05$) and urea ($p<0.01$) levels were reported in goats when fed on with fenugreek seeds (Alamer and Basiouni, 2005) (Al-Janabi et al., 2012). Galactomannan found in fenugreek seeds has also been reported to inhibit diabetes-induced kidney injury by lowering the urea and creatinine content in plasma (Hamden et al., 2010).

Blood plasma total protein, albumin, globulin, cholesterol, glucose and total lipids were found to have no significant difference in fenugreek supplementation in a study conducted on dairy goats (Al-Shaikh et al., 1999). Experiment with fenugreek feeding showed that levels of total protein, globulin and glucose were significantly increased, while cholesterol and blood urea were significantly decreased as fenugreek seed powder was added to basal ration at level 50 or 100 g/cow/day (Nasser et al., 2013). A study showed decreased blood cholesterol but indicated no significant effect on triglycerides, total protein and globulin in Friesian cows (Maher and N.M.B., 2013). It has been reported that fenugreek alone or in combination with giloy was effective in lowering the Total Cholesterol and LDL levels in the blood of lactating Jersey crossbred dairy cows (Sharma et al., 2017).

Fenugreek seeds treatments showed significantly ($p<0.05$) increased blood glucose, total protein, albumin, and creatinine in buffaloes (Abo El-Nor et al., 2007). Contrarily, fenugreek seeds have been evaluated for significantly decreased serum glucose, creatinine levels in streptozotocin-induced diabetic rats (Eidi et al., 2007). Supplementation of fenugreek seed powder has also been studied on the broiler diets which significantly decreased serum cholesterol, total protein, albumin and calcium (Mamoun et al., 2014). Treatment with fenugreek seed powder restored the levels of serum urea and creatinine levels as well as alkaline phosphatase, aspartate aminotransferase and alanine aminotransferase activities in gamma radiation irradiated rats which showed an increase in these biochemical parameters post-exposure (El-Tawil, 2009).

Effect on milk production and composition: Fenugreek seeds fed in the diet to dairy cows have been found to improve the profile of functional fatty acids in the milk, reduced blood cholesterol concentration and produced lower concentrations of cholesterol in milk without altering milk flavor or taste in a study done on dairy cows, (Shah and Mir, 2004). An experimental study on lactating buffaloes concluded that milk yield, SNF and lactose were significantly ($p<0.05$) increased in the treatment group, while protein and fat content was similar for fenugreek-treated animals and control (Abo El-Nor et al., 2007).

Higher milk yield in goats has also been reported

in fenugreek fed animals (Al-Shaikh et al., 1999). A study in Saudi goats leads to an observation that goats fed with 60g/day fenugreek seed powder had significantly higher ($p<0.05$) milk yield than in the control group (1236±38 vs. 1093±43 mL/day) (Alamer and Basiouni, 2005). A similar observation in goats fed with fenugreek was established with respect to increased milk yield ($p<0.05$) along with the decrease in milk fat content with an inconsistent pattern of protein, lactose and SNF (Elman et al., 2013). Ewes fed with fenugreek seeds at level 0.6 and 1.2g/kg live body weight as compared to control group showed that daily milk yield, milk protein percentage and SNF increased significantly ($p<0.05$), while the percentage of milk fat and milk lactose were significantly decreased (Al-Sherwany, 2015).

Substances that increase the prolactin concentration will certainly augment milk production in animals. A study concluded that fenugreek fed to Damascus crossbred goats exhibited significantly higher ($p<0.05$) serum prolactin and increased milk production as compared to the control group which might be mediated via prolactin hormone stimulation (Al-Janabi et al., 2012).

Giloy (Tinospora cordifolia)

Commonly known, as "Giloy" or "Guduchi", it is an important drug of Indian Systems of Medicine and used in medicines since times immemorial (Sinha et al., 2004). It is a large, deciduous, climbing shrub belonging to family *Menispermaceae*, found throughout India. It is known as heart leaved moonseed plant in English, 'Guduchi' in Sanskrit and 'Giloy' in Hindi.

Various pharmacological properties that have been studied include antioxidant, antidiabetic, renoprotective, anticarcinogenic, hepatoprotective, cardioprotective, antibacterial, antifungal, antiviral, anti-inflammatory, anti-arthritic, hypoglycemic, hypolipidemic and hypocholesterolemic activities. In human subjects, giloy has been found to improve concentration and memory along withwith its immunomodulatory activity (Mittal et al., 2014). Giloy is used for enhancing lactation in dairy animals by the state farmers (Sehgal and Sood 2013).

Effect on blood parameters: The root extract of giloy (*T. cordifolia*) showed the hypolipidemic effect in alloxan diabetic rats (Stanley et al., 1999). The root extract which is reported to have the hypoglycaemic and hypolipidaemic effect was found to reduce serum and tissue cholesterol, phospholipids and free fatty acids (Stanley et al., 2000). Oral administration of the extract of *T. cordifolia* roots for 6 weeks resulted in a significant reduction in blood and urine glucose and lipids in serum and tissues in alloxan diabetic rats (Stanley et al., 2003). Feeding of Giloy stem powder lead to significantly lower levels of blood glucose in the blood of lactating dairy cows (Sharma et al., 2018).

The extracts, however, had no significant effect on total lipid levels in normal as well as in alloxan-treated diabetic rabbits. It has been reported that extracts of the leaves of *T. cordfolia* have insulin-like action and can significantly reduce the blood glucose but not the total lipid levels in normal rabbits and in alloxan-induced diabetic rabbits (Wadood et al., 1991). The same herb has been evaluated for mammary gland immunity and the therapeutic potential of *Tinospora cordifolia* against bovine subclinical mastitis (Mukherjee et al., 2009).

*T. cordifolia*treated rats serum showed an increase in the immunoglobulin level. A significant increase in the White blood cell count and bone marrow cells indicated a stimulatory effect on the haemopoietic system. It was thus concluded from this study that *T. cordifolia* (stem) shows potent immunomodulatory action (Aher and Wahi, 2010). The alcoholic extract of *T. cordifolia* (500mg/kg body weight, orally) decreased the increased levels of serum creatinine, blood urea nitrogen and alkaline phosphatase in cisplatin-induced nephrotoxicity in rats. The results of this study revealed that the alcoholic stem extract of *Tinospora cordifolia* has the curative action against Cisplatin-induced nephrotoxicity (Khanam et al., 2011).

T. cordifolia supplementation in lactating Murrah buffaloes during the winter season at 120g/animal/day from day 3 to day 75 of lactation caused an overall higher plasma catalase activity and growth hormone concentration as compared to control. No significant difference was observed in cortisol, non-esterified fatty acids and glucose concentration of control and treatment buffaloes (Mir et al., 2013). *T. cordifolia* supplemented group showed that plasma glucose concentration, the level of somatotropin were higher ($p>0.05$) than the control. The average level of non-esterified fatty acids and cortisol in the treatment group was significantly ($p<0.05$) lower than the

control (Mir et al., 2014).

Effect on milk production and composition: The dietary supplementation of giloy (*T. cordifolia*) peripartum in 15 pregnant Karan Fries crossbred cows showed an increase ($p<0.05$) of milk production over 305 days of lactation. Milk composition (fat, protein, lactose, and SNF) was similar for the control and treatment group. A significant ($p<0.05$) reduction in somatic cell count was also observed during the experimental period (Mallick and Prakash, 2011). Giloy (*T. Cordifolia*) supplemented diet in Murrah buffalo lead to the finding that there was a significant increase ($p<0.05$) in average milk yield (kg/day) in treatment group (8.07±0.14) than the control (7.16±0.10), while the differences in milk constituents (Protein, Fat, SNF and Lactose) between the groups were non-significant (Mir et al., 2014).

A similar study on production parameters of lactating Murrah buffaloes supplemented with giloy (*T. cordifolia*) showed a significant increase ($p<0.05$) in milk yield, along with no change in milk fat percent (%), lactose percent (%) and SNF percent (%). However, a significant change was observed in milk protein percent (%) of the treatment group when fed at the dose of 120g/day/animal (Mir et al., 2015).

Conclusions and Recommendations

Commercially available synthetic drugs induce an adverse effect on the neuroendocrine axis of the lactating animal. Their prolonged use can cause toxicity which opens a detrimental platform to the normal health status of both humans and animals. Plant-derived substances with minimal processing are believed to exert no or minimal harmful effects on the livestock. Whereas, the synthetic preparations used in animals have been seen to adversely affect the health of animals.

Most of the animal husbandry practices are taken up by rural people of the state. Small landholdings, low income, lesser veterinary facilities and minimal exposure to new products and technology make it difficult for the state farmers to have high monetary gains. A thorough study about various cultivated and wild plant ingredients as herbal galactagogues shall pave a way towards a cheap, economical and easily accessible way of augmenting milk production, thus the income of farmers.

Authors Contribution

All the authors have worked in a collaborative way while writing the review.

Conflict of interest

The authors have declared no conflict of interest.

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