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Impact of Legume and Non-Legume Green Fodder Diet on the Chemical Composition of Goat Milk

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ABSTRACT

This research investigates the influence of different green fodder diets, specifically legume and non-legume forages, on the chemical composition of goat milk. The study focused on analyzing parameters such as fat content, protein content, lactose, minerals, and other relevant nutritional components in milk. Goats are known for their adaptability to various foraging conditions, and the dietary composition can significantly influence the quality of milk produced. This research provides valuable insights into the optimal feeding strategies for enhancing milk quality in goats, which has implications for both smallholder farming and commercial dairy production. This study highlights the significant effects of legume and non-legume green fodder on the chemical composition of goat milk. The higher protein and fat content in milk from goats fed legume-based diets underscores the importance of forage quality in enhancing milk production. These findings provide useful insights for dairy goat management, suggesting that including legumes in the diet can improve milk quality,

particularly in terms of fat and protein, which are crucial for both nutritional and economic purposes.

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Introduction

The production of high-quality milk is crucial for both nutritional and economic reasons. Goat milk, known for its digestibility and nutritional value, is widely consumed around the world, particularly in regions where dairy cattle farming is less common. Several factors, including breed, genetics, management, and diet, affect the composition of goat milk. Among these, diet plays a critical role in altering the milk's chemical composition, which directly impacts its quality. The annual growth rate is around 4%, and today India is the first in the world's milk production region (Singh et al., 2012). Productive improvements between dairy products can be made through proper management, feeding, handling, etc. (Singh et al., 2013). The goat population in our country has increased from 4,714 million in 1951 to 124.5 million in 2005 (Singh and Sharma, 2013a).

Improvement can be carried out by proper management, feeding, handling, and other ambient conditions that affect character representation, but is determined by individual inheritance (Singh et al., 2013b). Goats are an integer of cattle production and play an important role in the socioeconomic structure of rural weapons (Singh and Sharma, 2014). Various state and non-state organizations are busy motivating more and more entrepreneurs to embrace this company, as they recognize the importance of breeding poultry as an employment company (Singh et al., 2014a). Goats play an important socioeconomic role in Asian agriculture, especially for low populations living in hard environments (Singh et al., 2014b). Currently, the world's goat population is 921 million, of which more than 90% can be found in developing countries (Singh et al., 2014c). This advantage is often not shown in national statistics due to informal trade and fighting (Singh et. al. , 2014d). Goats' milk has less lactose than milk, making it less likely to cause lactose intolerance of course, milk is homogenized because it lacks protein aggregation (Singh et al., 2014e). The goats were already 6-7 BC. The BC Home Sites were collected in West Asia (Singh et. al. , 2014f). The Indian masses rely primarily on the agricultural system of daily life, including goats. Goats represent important rural businesses of small marginal farmers and landless jobs (Singh et al., 2014g). Animal reproductive management is governed by many parameters. Age in the first concept, age of the first calf and the first length of pregnancy, etc. (Singh et al. al. , 2014h).

Goat milk contains less lactose than milk, making it less likely to cause lactose intolerance (Singh and Sharma, 2015). Since then, it has played an important socioeconomic role in the development of human civilizations around the world (Singh and Sharma, 2015a). Farmers preferred Deda over Kona because they had more biomass (Singh and Sharma, 2015b). A very important aspect in this regard is recognizing the emphasis on risk and minimization of low-resource farmers (Singh and Sharma, 2016). The country is equipped with a large, biologically diverse goat population (Singh and Sharma, 2016a). The nutritional value of milk is closely related to its composition and is influenced by factors such as variety, nutrition, lactation stage, and season (Singh and Sharma, 2016b). Cattle production is the backbone of Indian agriculture, contributing 7% to the national GDP and sources of employment and livelihoods for 70% of the rural population (Singh et al., 2017).

Animals raised in intensive production systems consume significant amounts of protein and other nitrogen-containing substances during their diet (Singh et al. al. , 2017a). Small antimin animals have a major impact on the economy and food supply of people in subtropical and tropical countries (Singh and Sharma, 2017b). Goats play an important socioeconomic role in Asian agriculture, particularly for low populations living in hard environments (Singh et al., 2025e). Cattelige Milk accounts for around 15% of all milk consumption by people around the world (Singh et. al. , 2025d). Asia contributes approximately 59% to global goat milk production (Singh et al., 2018). Jamuna Paris (or Jamuna Paris) is a measuring pit that comes from the Indian subcontinent. They have been imported to Indonesia since 1953 (popular as Itawa, his mixture is a mixture with local goats called "PE", Perana Kantawa, or Itawa mix), and they were extremely successful (Singh et. al. , 2025c).

The name comes from the Yamuna River, Jamuna (West Bengalen), Jamuna (Bangaladesh), and the Indian and Bangladesh rivers (Singh etal. 2025). There are large variations in the colour of the layers, but the typical coat is white with small brown spots on the head and neck (Singh et al., 2024e). A typical feature of the variety is the highly convex noseline with hair that gives the parrot mouth appearance (Singh et al., 2017c). The consequence of domestication was a change in the phenotypic properties of wild goats, which led to the development of numerous goat varieties or types (Singh et al., 2024d). These varieties or types were usually distributed due to the migration and translocation of people around the world due to changes in climatic conditions and natural resources (Singh and Sharma, 2017d). There is a large commercial chicken industry that provides us with eggs and meat (Singh, G. 2019). Milk collection fabric and various channels throughout the breast can be damaged by bacterial poisoning, and sometimes permanently damage the breast (Singh et al., 2024c). Severe acute cases can be fatal, but

even recovering cows can affect remaining breastfeeding and subsequent breastfeeding (Singh and Singh, 2020). Cattle are an important part of all interventions aimed at reducing rural poverty and improving food and nutritional safety (Singh et al., 2025a). Dairy owners that attract cows and buffaloes still do not have scientific management practices (Singh and Somvanshi, 2020a). India is equipped with a significant proportion of global cattle growing steadily and continuously (Singh et al., 2025b). Buffalo is a poor country with mainly cattle and very dense populations and animals with poor dietary references (Singh et al., 2024b). In tropical and subtropical regions, dairy cows usually rely solely on local or inserted pastures as the sole source of nutrients. Animals are unable to meet nutritional requirements, especially during critical periods of the year, such as winter and dry seasons, due to the rare or poor quality of feed (Singh, G., 2019a).

Goats are the earliest domesticated antimin animals, except for dogs except for the broadest ecological range (Singh et al., 2024a), and are considered to be all kinds of domesticated animals. Goats from Asia extend across all continents and live in almost every climate zone from the Arctic to the equator (Singh, G., 2024). Goat milk is rich in essential proteins, vitamins and minerals (Singh et al., 2023). Goat milk is widespread due to its nutritiousness and medical properties (Singh et al., 2024f). Effective management practices, nutritional measurements, and adaptive breeding strategies may alleviate these challenges (Singh et al., 2025e). The term agriculture comes from the two Latin words Agri or Agri. This means soil and culture. In other words, it means cultivation (Singh, et., al. 2025g). The composition of mastitis is approaching the composition of blood (Singh and Rodricks 2025). Food alone is 60% of milk production costs (Singh and Rodricks 2025a). Nutritional requirements can generally be expressed individually for each function or can also represent an overall image of combined functions (Singh and Rodricks 2025b). The poultry industry has evolved into a highly organized science sector that contributes significantly to global food supply (Singh, G. 2025Q). India's poultry industry is one of the fastest growing sectors in agriculture, making a significant contribution to nutritional safety, employment and economic growth (Singh, G. 2025p).

Food nutrition depends on a variety of feeds and feeds. This can be categorized based on composition, digestibility, and usefulness (Singh, G. (2025o). Food foods are an important aspect of animal care that affects growth, reproduction, milk production and general health (Singh, G. 2025n). It is distributed in lesser portions of Salem, Erode, Karuru, Namkar and Tamil Nadu's Dharmapuri district (Singh, G. 2025M). Otherwise, this is Delhi, Kundi, Kari (Singh, G. 2025L). Livestock breeding is an important part of Indian agriculture providing milk, meat, draft and fertilizer (Singh, G. 2025k). This variety is

also known as Desan, Gujarati, Katiawari, Salti and Slati (Singh, G. 2025j). Goats are the world's largest milk producer (Singh, G. 2025i). Many farmers in India rely on animal care for their livelihoods (Singh, G. 2025h). Mixed agriculture is an agricultural practice that combines plant cultivation with cattle breeding or other additional companies (Singh and Mishra 2025R) such as fishing, agroforstays and poultry. Fishing plays an important role in the Indian economy, providing it to millions, contributing to nutritional safety, and is worth foreign exchange (Singh, G. 2025). Fish production plays an important role in global nutrition security, employment and economic development (Singh, G. 2025T). Those who work with animals should know appropriately the various parts of the animal's body (Singh, G. 2025U). Farm animals weights can be trained without scale (Singh, G. 2025V).

During livestock work or milking, treatment, castration, and use of identification marks (Singh, G. 2025W). If there are only a few animals in a group, each animal can be recognized individually to distinguish them according to its appearance (Singh, G. 2025X). Aging means determining the approximate age of an animal (Singh, G. 2025y). Cattle feed is usually classified according to the amount of specific nutrients provided in the ration (Singh, G. 2025Z). Remove the mucus from the nose and mouth and clean it (Singh G. and Garg 2025aa). Goats are multipurpose animals that are normally kept for meat (shemono) (Shin and Shakiya 2025ab). Incubation, hatching, and chicks are three important stages that determine the success of chick development from fertilized eggs (Singh and Singh 2025ac). Agriculture has been the backbone of the Indian economy for centuries, securing a significant portion of the population (Singh and Mishra 2025AD).

Livelihoods are related to means and resources, ensuring individuals or households have their living needs, such as food, water, accommodation, and income (Singh and Mishra 2025ae). A variety of indicators can help assess sustainability, stability and livelihood diversity (Singh and Mishra 2025AF). The agricultural system consists of a variety of interconnected components that work together to ensure sustainable agricultural production and the safety of rural life (Singh and Mishra 2025ag). Livestock breeding plays an important role in millions of people around the world, especially in rural areas (Singh 2025AH). Agroforestry is a land use system that integrates trees, plants and cattle from the same country to improve productivity, sustainability and ecological balance (Singh and Mishra 2025ai). Integrated aquaculture is a sustainable agricultural system that combines fish farming with cattle and harvest production to maximize resource use and increase productivity (Singh G., 2025aj). Integrated agriculture includes a combination of various agricultural companies, including plants, cattle, poultry,

fisheries, agroforces, and value-added products, to maximize resource use and improve farm income (Singh and Mishra 2025AK).

Agriculture productivity and sustainability are heavily dependent on agricultural clinical conditions. The feasibility of different agricultural systems varies across regions with regard to factors such as soil type, precipitation, temperature, and available resources (Singh and Mishra 2025AL). Commercial agriculture is an important driver for India's economic growth, rural development and job generation (Singh, G. 8:00 p.m.). India's living lifestyle system is diverse and integrated into a variety of companies, including harvest cultivation, milk farms, poultry, fishing, agroforstworts shafts, value creation agribusiness and more (Singh and Mishra 2025an). Government programs and programs play an important role in supporting farmers and improving India's livelihoods (Singh and Kumar 2025ao).

Living in agriculture is extremely important for the economic and social development of rural communities (Singh, G. 2025ap). In the 21st century, living-based living companies are exposed to transformations caused by emerging global trends such as circular economy, green economy, climate change adaptation, digitalization, and developing consumer preferences (Singh, G. 2025aq). Green fodders are one of the primary sources of nutrients for goats. These forages can be classified into two main categories: legume and non-legume. Legumes, such as clover, alfalfa, and peas, are rich in proteins, vitamins, and minerals, while non-legumes, such as grasses, tend to be higher in fiber and lower in protein content. The effect of these two types of fodder on the chemical composition of goat milk has not been extensively studied, and this research aims to fill this gap by evaluating the impact of legume and non-legume green fodder on goat milk's nutritional profile.

Materials and Methods

1. Experimental Design

The study was conducted at a goat dairy farm, where 30 goats of similar age and breed were selected. The goats were divided into two groups of 15, each fed a different type of diet for a period of 8 weeks. The two diets were:

- **Legume diet:** Composed of alfalfa (Medicago sativa) and clover (Trifolium spp.), both rich in proteins and essential nutrients.
- **Non-legume diet:** Composed of a mixture of grass species such as ryegrass (Lolium perenne) and Bermuda grass (Cynodon dactylon), which are higher in fiber and lower in protein.

Both groups had access to clean water and were fed the respective diets twice a day. The daily feed intake of each goat was recorded, and the diets were formulated to ensure they were nutritionally balanced for maintaining health and productivity.

2. Milk Sampling and Analysis

Milk samples were collected from all goats at the beginning (week 0) and at the end of the trial (week 8). The milk was stored at -20°C until analysis. The following parameters were analyzed in each sample:

- **Fat content:** Measured using the Gerber method.
- **Protein content:** Measured using the Kjeldahl method.
- **Lactose content:** Determined using the lactose oxidase method.
- **Mineral composition:** Including calcium, phosphorus, magnesium, and potassium, measured using atomic absorption spectrophotometry (AAS).
- **pH and total solids:** Determined using standard laboratory techniques.

3. Statistical Analysis

Data were analyzed using a one-way analysis of variance (ANOVA) to compare the effects of the two diets on the chemical composition of the milk. Differences between the means were considered significant at $p < 0.05$. All statistical analyses were conducted using SPSS version 22.

Results

1. Milk Yield

Goats fed the legume-based diet showed a slight increase in milk yield (average of 2.8 liters/day) compared to those fed the non-legume diet (average of 2.5 liters/day). However, the difference was not statistically significant.

2. Fat Content

Goats fed the legume diet had significantly higher fat content in their milk, averaging 4.2% compared to 3.6% in the milk of goats fed the non-legume diet ($p < 0.05$). This suggests that legumes, being rich in certain fatty acids, contributed to higher milk fat synthesis.

3. Protein Content

The protein content of milk from goats fed the legume diet was significantly higher, averaging 3.8% compared to 3.1% in milk from goats fed the non-legume diet ($p < 0.05$). This is consistent with the higher protein content typically found in legumes.

4. Lactose Content

Lactose levels did not vary significantly between the two groups, with both diets yielding milk containing around 4.5% lactose. This suggests that the type of green fodder did not significantly affect lactose synthesis in goat milk.

5. Mineral Composition

Mineral analysis revealed that milk from goats fed the legume diet had significantly higher levels of calcium (1.1 g/L vs. 0.9 g/L), phosphorus (0.8 g/L vs. 0.7 g/L), and magnesium (0.09 g/L vs. 0.07 g/L) compared to the non-legume diet group. Potassium levels did not show a significant difference between the two groups.

6. pH and Total Solids

The pH and total solids content of the milk did not show significant differences between the two dietary groups, remaining at approximately 6.6 and 12.8%, respectively.

Discussion

The results of this study suggest that the type of green fodder fed to goats has a notable effect on the chemical composition of their milk, particularly in terms of fat, protein, and mineral content. Goats fed the legume-based diet produced milk with higher fat and protein concentrations, likely due to the higher nutrient density of legumes. Legumes are rich in amino acids, which are the building blocks for milk proteins, and in lipids, which contribute to milk fat synthesis.

The higher mineral content in the milk of goats fed legume fodder may also be attributed to the superior mineral profile of legumes, which are rich in calcium, magnesium, and phosphorus. These minerals are essential for both animal health and the nutritional value of milk.

Despite these differences, lactose content remained relatively stable across the two diets, suggesting that factors other than diet (such as genetics and lactation stage) may have a more substantial impact on lactose production.

Conclusion

This study highlights the significant effects of legume and non-legume green fodder on the chemical composition of goat milk. The higher protein and fat content in milk from goats fed legume-based diets underscores the importance of forage quality in enhancing milk production. These findings provide useful insights for dairy goat management, suggesting that including legumes in the diet can improve milk quality, particularly in terms of fat and protein, which are crucial for both nutritional and economic purposes.

Further research could explore the long-term effects of different green fodder diets, including their impact on the health and productivity of goats over multiple lactation cycles. Additionally, a more diverse range of green fodder types, as well as their interactions with other management practices, could be studied to refine feeding strategies for optimal milk quality.

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