



Characterization of Goat Milk in Ethiopia: A Review

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Abstract

In Ethiopia, livestock is a crucial component of the agricultural industry and the foundation of the country's economy. The goat milk production and usage in Ethiopia needs further characterization in-terms of its social value and benefits obtained from it; therefore, the objective of this review is to further characterize goat milk in detail as likely as practicable. Ethiopia is home to a sizable population of goats, which are kept in a variety of production methods and agro-ecological zones including highlands, sub-humid, semi-arid, and arid environments. Ethiopia has the largest livestock population in Africa. There are many factors that may create a usage of goat milk different from that of cow's milk in Ethiopia; such as, cultural preferences, environmental conditions, nutritional qualities, and market opportunities. The country's family consumption of goat milk is low compared to cow milk, with indigenous goat production in semi-arid areas. Factors like disease, feed shortage, and lack of superior genotype hinder goat productivity. Non-Governmental Organizations and federal government efforts aimed at improving the living and livelihoods through goat milk production that offers wholesome benefits and is preferable over cow's milk. Goat milk contains higher nucleotides, higher uptake and retention of copper, selenium, and zinc, making it more bio-available than cow's milk. A popular dairy product, particularly in rural areas where goats are widely kept for meat, milk, and skins. It has historical roots, dating back to ancient times and has been used as a medicine by ancient Egyptians and mentioned in the Bible as a gift from Abraham to his guests. Goat milk is rich in protein, calcium, phosphorus, magnesium, potassium, iron, vitamin A, and medium-chain fatty acids. It is easier to digest than cow's milk due to its lower lactose content and smaller fat globules. Goat milk is also associated with cultural and religious practices in Ethiopia, such as being used as a symbol of hospitality and friendship among some ethnic groups, and as a sacred food for purifying the body and soul. On the other hand, many challenges and perceptions in the country hindered it from being utilized habitually by the whole public. Some opportunities for goat milk development are needed for improvement in goat breeds supported by further research.



Introduction

Livestock is an integral part of the agriculture sector in Ethiopia and the backbone of the economy. Ethiopia has the largest livestock population in Africa, with over **60 million cattle, 31 million sheep, 30 million goats**, and over **1.5 million camels**. Livestock contributes over **15% of Ethiopia's GDP** and **45% of the agricultural GDP**. The country also has the highest draft animal population in the continent [1]. Goat (*Capra hircus*) is one of the most important components of the world's livestock-based farming system, as they are multi-purpose animal producing meat, milk, hide, fiber, manure and hauling light loads [2]. Being the largest livestock population in Africa, Ethiopia is a homeland of a large number of goat populations which are kept in various production systems and different agro-ecological zones of highlands, sub-humid, semi-arid and arid environments. Goats are an important and integral part of livestock in Ethiopia [3].

According to the latest report from the Central Statistical Agency of Ethiopia (CSA), the estimated number of goat population in Ethiopia is **52.5 million**. This number accounts for about 99.97% of the indigenous goat breeds, which are adapted to different agro-ecological zones of Ethiopia. Some of the indigenous goat breeds of Ethiopia are Abergel, Afar, Arsi-Bale, Eastern and South Eastern, Gumuz, Highland, Keffa and Woyto-Gojam. These breeds have different phenotypic and genetic characteristics, as well as production and reproduction performance [4].

Goats are found in all agro-ecological zones in Ethiopia and are important animals for diversifying livestock production and, thus, are an integral part of tropical agricultural systems. They are attractive to people of Ethiopia because of their ability to resist challenges, easily adapt to different ecological regions, and need small land to rear and small initial capital in which poor people can engage in the production system [5]. To rear goats for milk in Ethiopia, it is necessary to have a good understanding of the nutritional requirements of the animals and the management practices that are necessary to ensure that they are healthy and productive. Having access to good quality feed and water, as well as appropriate housing and equipment is also main requirements. In addition, you need to have a good understanding of the market for goat milk and be able to sell your product at a competitive price [6].

According to a research paper on Smallholder Goat Production in Tropical Africa, goat milk production is found in many African countries, including Nigeria, Sudan, Chad, Ethiopia, and Kenya. Even though milk production and productivity of Ethiopian indigenous goat breed is poor, the communities in Ethiopia, especially those who are living in pastoralist and agro-pastoralist and people in arid and semiarid areas used consuming goat milk [7]. Although goat milk drinking has nutritional and medicinal benefits, goat milk and milk products consuming is affected due to different factors in Ethiopia. The breeds of goats in Ethiopia are poor productive of meat and milk due to several factors. Despite their low productivity, goat has many socio-cultural, socio-economic and national benefits [8].

Pronounced with ample amount of protein, calcium, and other minerals, it also contains medium-chain fatty acids and the precursor to vitamin A. One cup of goat milk has about 168 calories and 10 grams of fat, which is slightly more than cow's milk. The nutrient content of goat milk is not superior to that of pasteurized milk [9]. Some of the values of goat milk are that it may be easier to digest than cow's milk. Some people who are lactose intolerant or allergic to cow's milk may tolerate goat's

milk better. This is because goat's milk has less lactose and different types of proteins than cow's milk. Goat's milk also forms smaller and softer curds in the stomach, which may aid digestion [10].

It may have anti-inflammatory and antimicrobial properties. Goat's milk contains compounds called oligosaccharides, which are similar to those found in human breast milk. These compounds may help prevent infections and inflammation in the gut and other tissues. Goat's milk also has higher levels of lysozyme, an enzyme that kills bacteria, than cow's milk [11]. It may support bone health and prevent anemia. Goat's milk is rich in calcium, phosphorus, magnesium, and potassium, which are essential minerals for bone health. It also has more bioavailable iron than cow's milk, which means it is better absorbed by the body. Iron deficiency can cause anemia, a condition that reduces the oxygen-carrying capacity of the blood [12].

However, goat milk also has some drawbacks, like harmful bacteria if not pasteurized. Raw goat milk does not go through pasteurization, the process of heating milk to destroy harmful bacteria. Raw milk poses food safety risks, such as salmonella, *E. coli*, listeria, and brucellosis. These bacteria can cause serious illnesses, especially in children, pregnant women, older adults, and people with weakened immune systems. Government health organizations recommend avoiding raw milk from any animal source. It may be expensive and hard to find. Goat milk is not as widely available as cow's milk or plant-based milks in many countries. It may also be more expensive than other types of milk, depending on the supply and demand. Some people may also find the taste and smell of goat's milk unpleasant or unfamiliar [13]. It may not provide enough vitamin B₁₂ or iodine. Goat's milk has less vitamin B₁₂ than cow's milk, which is an important nutrient for red blood cell formation and nerve function. Vitamin B₁₂ deficiency can cause anemia, fatigue, weakness, numbness, and neurological problems. Goat's milk also has less iodine than cow's milk, which is essential for thyroid function and metabolism. Iodine deficiency can cause goiter, cretinism, and mental retardation. People who rely on goat's milk as their main source of dairy may need to supplement these nutrients or obtain them from other foods [14]. The goat milk production and usage in Ethiopia is under diver seen counters, which needs further appraisal. Thus, the core objectives of this review are:

- (i) To state the **trend, consumption, challenges and opportunities** of goat milk production in Ethiopia.
- (ii) To highlight the **quality and composition** of goat milk and to compare it with cow's milk and
- (iii) To set a gap for further research supported by **community-based breeding programs** in order to promote goat productivity and associated income.

Goat milk production in Ethiopia

Ethiopia has a large population of goats, and goat milk is an important source of nutrition for many Ethiopians. Although there is no specialized dairy goat rearing for the purpose of milk production, there is milk production from indigenous goats for family consumption in different parts of the country, especially in arid and semi-arid areas [15]. There was a study that suggested an overview of milk production performance of Ethiopian goats and inputs for Marker-assisted selection. According to various sources, there are **eight main indigenous goat breeds** in Ethiopia, distributed across different regions and agro-ecological zones [16].

These Ethiopian goat breeds are **Arsi-Bale breed** found in the Oromia region, mainly in the Bale and Arsi zones. They have short hair, drooping ears, and various coat colors. They are mainly kept for milk and meat production. **Abergelle breed**, which is found in the Amhara region, mainly in the Sekota and Lalibela districts. They have long hair, drooping ears, and various coat colors. They are mainly kept for meat production. **Afar breed**, which is found in the Afar region, mainly in the lowland areas. They have short hair, upright ears, and predominantly black or brown coat color. They are mainly kept for milk production [17]. **Central highland breed** found in the Amhara and Tigray regions, mainly in the highland areas. They have short hair, upright ears, and predominantly white or brown coat color. They are mainly kept for meat production. **Eastern and South Eastern breed**, found in the Somali region, mainly in the eastern and south eastern lowlands. They have long hair, drooping ears, and various coat colors. They are mainly kept for milk production [4].

Goat milk consumption in Ethiopia

About **16.7%** of milk consumed in Ethiopia is obtained from goat production. Although some parts of the community consume goat milk, the majority of the communities in the country are not consuming goat milk and milk products. However, people in pastoralist and agro-pastoralist areas and those living in arid and semi-arid areas consume goat milk [18]. The consumption of goat milk in Ethiopia is affected by different factors such as cultural attitude of the community towards consuming goat milk and milk products, poor productivity of indigenous goats of milk production, lack of awareness of the communities to consume milk of goat. Other factors that affect the consumption include shortage of feed and water, prevalence of disease, poor management, lack of breeds improvement and shortage of improved dairy goat, lack of productivity recording and socio-cultural image to consume goat milk [19].

Nutritional value of goat milk

Goat milk is characterized many times to determine its nutritional value and quality. Goat milk naturally has small, well-emulsified fat globules, which means the cream will stay in suspension for a longer period of time than cow's milk; therefore, it does not need to be homogenized [14]. Calcium, protein, and other nutrients are abundant in goat milk. Medium-chain fatty acids and the vitamin A precursor are also present. In comparison, goat milk has a bit higher calories and grams of fat, which is slightly more than cow's milk. The nutrient content of goat milk is not superior to that of pasteurized milk [20].

Naturally, it is an excellent source of calcium, magnesium, and potassium; it also contains the precursor to vitamin-A in the milk fat letting it be readily bioavailable. There are many recipes that use goat milk such as to make cheese, yogurt, ice cream, and even soap. For example-Goat Milk Fudge, Goat Milk Soap, Goat Milk Ice Cream, Goat Cheese, and Goat Milk Yogurt are some recipes we can get from goat milk [21].

Benefits and challenges of goat milk production in Ethiopia

Goat milk has many benefits for human health and nutrition, but there are also some challenges that limit its production and consumption in Ethiopia. Lack of clear milk marketing system. Goat milk producers and processors face difficulties in accessing markets and getting fair prices for their products. There is no well-established formal market chain for goat milk and its products, and most of the transactions are done informally or

through intermediaries [22]. There is also a lack of market information, quality standards, and regulations for goat milk and its products. Goat milk consumption is affected by the socio-cultural and religious beliefs and preferences of different communities in Ethiopia. Some people may have negative perceptions or prejudices about goat milk, such as its smell, taste, or color. Some people may also avoid goat milk during certain periods or occasions, such as fasting or holidays, due to religious reasons [8].

Due to inaccessibility of market and lack of transport, goat milk producers and processors often face challenges in reaching markets and consumers in rural areas. The roads are often unpaved, narrow, or damaged, making it difficult or costly to transport goat milk and its products [23]. The lack of cold chain facilities also affects the quality and shelf life of goat milk and its products. It can also be determined by seasonal based demand. Goat milk production and consumption vary depending on the season and the availability of water and pasture. In the dry season, when water and feed resources are scarce, goat milk production declines and so does the demand for goat milk and its products. In the wet season, when water and feed resources are abundant, goat milk production increases but the demand for goat milk and its products may not match the supply [24].

Lack of effective extension service to use newer technologies and practices can also be one of the encounters with goat milk production. Goat milk producers and processors often lack access to improved technologies and practices that can enhance their productivity and quality. There is a shortage of trained extension workers who can provide technical support and advice to goat milk producers and processors on issues such as breed improvement, feed management, disease control, hygiene, processing, packaging, and marketing. In addition, lack of credit facilities that can enable goat milk producers and processors to invest in improved technologies and practices [25]. Goat milk producers and processors often do not keep records of their productivity or performance indicators, such as milk yield, fat content, or income. This makes it difficult to monitor their progress or identify their strengths and weaknesses [26].

Likewise, a lack of awareness and promotion of the benefits of goat milk consumption among the general public made it often perceived as inferior or less desirable than cow's milk or other types of dairy products. Most of the goat breeds in Ethiopia are indigenous breeds that have low productivity of meat and milk [9]. They are adapted to harsh environments and feed scarcity, but they have low genetic potential for growth, reproduction, or lactation. They are also susceptible to diseases, parasites, and predators that affect their health and performance. There is a lack of improved dairy goat breeds that can produce more milk with better quality under local conditions [27].

Possible solutions to overcome the challenges of goat milk in Ethiopia

There are some possible solutions or recommendations to overcome the challenges of goat milk in Ethiopia. Establishing a clear milk marketing system. Goat milk producers and processors need to have access to reliable and profitable markets for their products. This can be achieved by creating market linkages, cooperatives, or associations that can facilitate the collection, transportation, and distribution of goat milk and its products. There is also a need to develop and enforce quality standards and regulations for goat milk and its products, as well

as to provide market information and feedback to goat milk producers and processors [4]. Promoting the culture and religion of goat milk consumption. Goat milk consumption can be increased by raising awareness and education among the general public about the nutritional and medicinal benefits of goat milk, as well as its cultural and religious significance for some communities. There is also a need to improve the sensory attributes of goat milk and its products, such as its smell, taste, or color, by using improved technologies and practices [28]. There has to be a respect and accommodation of the diverse preferences and beliefs of different consumers regarding goat milk consumption [29].

When seen in relation to the accessibility of market and transport, goat milk producers and processors need to have access to adequate infrastructure and transportation facilities that can enable them to reach markets and consumers efficiently and effectively. This can be achieved by improving the road network, cold chain facilities, and communication systems in rural areas. There is also a need to reduce the costs and risks of transportation by providing subsidies, insurance, or security measures for goat milk producers and processors [30].

Balancing the seasonal based demand, goat milk production and consumption need to be stabilized throughout the year, regardless of the season or the availability of water and pasture. This can be realized by improving the feed and water management, disease control, and breeding practices for goats, as well as by providing storage and preservation facilities for goat milk and its products. There is also a need to diversify the products and markets for goat milk, as well as to create demand-driven production systems that can respond to the changing needs and preferences of consumers. Providing effective extension service to use newer technologies and practices [8]. Goat milk producers and processors need to have access to improved technologies and practices that can enhance their productivity and quality. This can be attained by providing technical support and advice from trained extension workers who can disseminate relevant information and knowledge on issues such as breed improvement, feed management, disease control, hygiene, processing, packaging, and marketing. Furthermore, there is a need to provide credit facilities that can enable goat milk producers and processors to invest in improved technologies and practices [31].

Improving productivity recording and socio-cultural image to consume goat milk. Goat milk producers and processors need to keep records of their productivity or performance indicators, such as milk yield, fat content, or income. This can help them monitor their progress or identify their strengths and weaknesses [32]. There is also a need to promote the socio-cultural image of goat milk consumption among the general public by highlighting its benefits, values, or traditions. Moreover, there is a need to involve different stakeholders, such as government agencies, NGOs, media outlets, or celebrities in creating a positive image of goat milk consumption [27].

Improving the productivity of indigenous goat breeds is imperative in that goat breeds in Ethiopia need to be improved in terms of their productivity of meat and milk. This can be done by using selective breeding, crossbreeding, or genetic improvement techniques that can increase their genetic potential for growth, reproduction, or lactation. Besides this, introducing improved dairy goat breeds that can produce more milk with better quality under local conditions. As a final point, conserving the genetic diversity of indigenous goat breeds that have unique characteristics or adaptations is very necessary [33].

Comparison of goat and cow's milk

Goat and cow's milk are both important sources of dairy in Ethiopia, but they differ in terms of production and consumption patterns. There are some comparisons between the two types of milk. Goat milk production is more common in pastoral and agro-pastoral areas, where goats are widely kept for their meat, milk, and skins [34]. Goat milk is mainly produced by indigenous breeds that are adapted to harsh environments and feed scarcity. Goat milk production is seasonal, depending on the availability of water and pasture. Goat milk is usually consumed fresh or processed into traditional products, such as butter, cheese, yogurt, and ayib. Goat milk consumption is influenced by cultural and religious preferences, as well as nutritional and medicinal values [35]. Cow's milk production is more common in mixed crop-livestock systems, where cows are integrated with crop production. Cow's milk is mainly produced by crossbred or exotic breeds that have higher productivity but require more inputs and management. Cow's milk production is more stable throughout the year, depending on the availability of feed and veterinary services. Cow's milk is usually sold to formal or informal markets or processed into modern products, such as pasteurized milk, cream, and ice cream. Cow milk consumption is influenced by income levels, urbanization, and consumer preferences [36].

According to the latest agricultural sample survey, Ethiopia has about 52.5 million goats and 59.5 million cows. The total annual milk production from goats is estimated at 1.4 billion liters, whereas that from cows is estimated at 5.2 billion liters. The average annual milk yield per goat is about 27 liters, while that per cow is about 87 liters. The per capita annual consumption of goat milk is about 14 liters, while the per capita annual consumption of cow milk is about 51 liters [37]. Goat milk is considered special compared to other milk because it has a unique fatty acid profile which makes it easier to digest for the reason that it contains more short- and medium-chain fatty acids as compared to cow milk. It also contains less lactose than cow's milk, which makes it a good alternative for people who are lactose intolerant. In Ethiopia, cow milk is the main source of milk production. However, small quantities of milk are also obtained from goats and camels in some regions, particularly in pastoralist areas [8].

Goat milk and cow milk contain substantially higher protein and ash, but lower lactose than human milk which have the unique metabolic ability to provide energy in growing children and treat malabsorption patients [11]. Cow's milk and goat milk have different nutritional profiles, taste, and digestibility. Goat milk has smaller fat globules, less lactose, more calcium, potassium, vitamin-A, and oligosaccharides than cow milk. Cow milk has more vitamin B₁₂, selenium, folic acid, and riboflavin than goat milk. Goat milk has a distinctive 'farmy' flavor and is naturally homogenized, while cow milk is fairly neutral and the cream separates from the milk [9].

Aspects of goat milk production in Ethiopia

Goat milk is one of the most commonly consumed types of dairy in Ethiopia, especially in rural areas where goats are widely kept for their meat, milk, and skins. Goat milk has nutritional and medicinal benefits, as well as cultural and religious significance for some communities. There are some historical facts about goat milk usage in Ethiopia. Its production and consumption in Ethiopia dates back to ancient times [38]. According to some sources, goat milk was used as a medicine by the

ancient Egyptians, who learned it from the Ethiopians. Goat milk was also mentioned in the Bible as a gift from Abraham to his guests. Goat milk is traditionally processed using different methods to produce various products, such as butter, cheese, yogurt, and ayib (a soft cheese similar to cottage cheese). These products are consumed fresh or stored for later use. Some of the traditional processing methods include boiling, churning, fermenting, salting, smoking, and sun-drying [39].

Goat milk is valued for its nutritional and medicinal properties. Goat milk is rich in protein, calcium, phosphorus, magnesium, potassium, iron, vitamin-A, and medium-chain fatty acids. It is also easier to digest than cow's milk due to its lower lactose content and smaller fat globules. Goat milk is believed to have anti-inflammatory, antimicrobial, and anti-allergic effects. It is also used to treat various ailments, such as diarrhea, malnutrition, anemia, ulcers, tuberculosis, asthma, and skin diseases [13]. Goat milk is also associated with some cultural and religious practices in Ethiopia. For example, goat milk is used as a symbol of hospitality and friendship among some ethnic groups, such as the Afar and the Somali. Goat milk is also offered as a sacrifice or donation to God or saints by some Christian and Muslim communities. Goat milk is also considered as a sacred food that can purify the body and soul [40].

Conclusion

Goat milk is a valuable source of nutrition and income for some communities in Ethiopia, where goats are adapted to different agro-ecologies and have diverse characteristics. However, goat milk production and consumption face many challenges which can be counteracted by some opportunities for goat milk development. In general, goat milk production and consumption in the country has been hindered by shortage of feed and water for goats, lack of health extension and veterinary services, lack of management practices, and so forth. Therefore, depending on many encounters and perceptions against goat milk production and consumption in Ethiopia, the following recommendations are forwarded:

- ☑ Improving the availability and quality of feed and water for goats, by using crop residues, agro-industrial by-products, improved forages, rainwater harvesting, and irrigation.
- ☑ Controlling and preventing diseases and parasites by improving veterinary services, vaccination, deworming, hygiene, and quarantine.
- ☑ Enhancing the management practices and extension services for goat farmers, by providing training, record keeping, breeding, housing, marketing, credit, and cooperatives.
- ☑ Adapting goat breeds for local conditions, increasing milk yield, and enhancing productivity through improved artificial insemination services.

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