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Traditional milk preservation techniques used by tribal communities in central India: A review

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Abstract

Traditional milk preservation techniques employed by tribal communities in Central India, particularly in Chhattisgarh, were reviewed to understand their significance in ensuring food security, maintaining cultural heritage, and promoting sustainable practices. These techniques, developed over generations, are deeply rooted in indigenous knowledge systems and are adapted to local climate, resources, and sociocultural practices. The methods involve a combination of natural fermentation, heat treatment, herbal additives, and smoke-based disinfection, often using readily available materials in forested and agrarian environments. The key characteristics of these techniques include their dependence on local resources, low energy input, microbial management, cultural integration, and sustainability. The Gond, Baiga, Oraon, Halba, and Muria tribes of Chhattisgarh employ unique preservation methods such as ghee production and storage, fermented milk products, sun-drying of curd, and the use of medicinal plants and natural packaging materials. Despite the effectiveness of these techniques, they face challenges due to modernization, urban migration, and the adoption of non-native dairy practices. Preserving and documenting this traditional knowledge is crucial for maintaining cultural heritage, ensuring food security, and promoting sustainable practices in tribal and rural communities. Integrating these traditional techniques with modern practices offers a promising approach to enhancing milk preservation while respecting cultural heritage and meeting contemporary safety and quality standards. Further research is needed to validate the efficacy of these methods and explore their potential applications in broader contexts.

Keywords: Traditional, milk preservation, tribal communities, fermentation, indigenous knowledge, cultural heritage

Introduction

Milk is a vital source of nutrition in rural and tribal communities, as it offers proteins, fats, vitamins, and minerals. However, their perishability poses a challenge in regions that lack access to electricity and cold storage. Tribal communities in central India have developed unique and time-tested methods for preserving milk, often relying on locally available resources and indigenous knowledge passed down through generations (Alemu 2018) [4]. These traditional techniques are not only essential for ensuring food security but also represent a significant part of the sociocultural heritage of these communities (Modha *et al*., 2014) [38]. Central India's tribal populations have historically relied on indigenous preservation methods to prevent spoilage and ensure year-round milk availability in various ways. These methods are closely tied to the local culture, climate, and available resources, showcasing the community's adaptive strategies to maintain food safety and sustainability. Fermentation, an ancient food preservation method that predates even drying, has gained traction with the rise of civilization, enhancing food preservation, and diversifying flavors and sensory experiences (Patel *et al*., 2023) [43]. Traditional food handling and storage practices, often involving specific microbes, have been meticulously passed down through generations within communities and tribes (Ghosh *et al*., 2019) [25]. These methods frequently involve harnessing natural antimicrobial agents, thermal treatments, or manipulating the atmosphere surrounding milk to inhibit microbial growth and extend its shelf life (Umiyati *et al*., 2020) [61]. Understanding and documenting these traditional milk preservation techniques are vital for several reasons. This offers insights into sustainable and culturally appropriate food preservation practices (Mallappa *et al*. 2020) [35]. This provides a basis for further research into the scientific principles underlying these methods, potentially leading to the development of novel preservation technologies (Patel & Hati, 2017) [44]. Moreover, it helps preserve the cultural heritage and traditional knowledge of tribal communities in the face of modernization and changing lifestyles.

1. Overview of milk preservation in tribal communities

Milk is a perishable yet essential food in tribal communities, valued not only for its nutritional importance but also for its cultural and medicinal roles. Tribal communities in Central India have developed diverse milk preservation techniques rooted in local resources and cultural practices (Mishra *et al*., 2021) [36]. These methods, shaped by climate, geography, and available materials, often involve fermentation, heating, drying, and smoking, which impart unique flavors and textures to preserved milk products (Naveen *et al*., 2021) [39]. In many tribal regions across

India, particularly in Central India, including Chhattisgarh, Madhya Pradesh, and Odisha, tribal populations lack access to modern refrigeration and cold chains. In this context, traditional milk preservation techniques have evolved as adaptive, low-cost, and eco-friendly solutions to extend the shelf life of milk and its derivatives. These preservation methods are deeply rooted in indigenous knowledge systems, passed down orally through generations, and shaped by the local climate, flora, fauna, and sociocultural practices. (Verma *et al*. 2021; Sharma and Mishra 2019) [63, 48]. These techniques involve a combination of natural fermentation, heat treatment, herbal additives, and smoke-based disinfection, often using materials that are readily available in forested and agrarian environments. Lactic acid fermentation is one of the most ancient preservation methods, applicable not only to milk but also to a variety of substrates, such as meat, fish, vegetables, and cereals (Zamfir *et al*., 2022) [66]. This fermentation process relies on either the natural microflora present in the raw materials or addition of starter cultures (Skowron *et al*., 2022) [52]. Fermentation extends the shelf-life of food and enhances its safety, digestibility, and nutritional value (Adesulu-Dahunsi *et al*. 2019; Ghosh *et al*. 2019; Sionek *et al*. 2023) [1, 25, 51]. Fermented milk products are produced globally (Yang *et al*. 2023) [65]. Understanding these traditional practices is crucial for preserving cultural heritage, promoting sustainable food systems, and exploring their potential applications in modern food preservation. Traditional milk preservation methods are closely linked to the specific environment and cultural practices of these communities. The techniques used vary depending on the availability of resources, climatic conditions, and type of milk being preserved.

In tribal societies, dairy animals, such as indigenous cows and buffaloes (e.g., the Chhattisgarhi buffalo), provide milk in small quantities, often seasonally. Surplus milk is preserved using techniques that require no electricity, utilizing natural fermentation, sun drying, smoke sterilization, herbal additives, and storage in earthenware. These methods are not only functional, but also interwoven with social customs, festivals, and traditional health practices (Jain, 2015; ICAR-NDRI, 2018) [31, 29].

2. Key Characteristics of Traditional Milk Preservation in Tribal Communities

Preservation methods passed down through generations are frequently environmentally friendly, use locally accessible resources, and produce little waste. To retain the inherent nutritional value of milk, conventional methods usually entail minimal processing, which results in products that are closer to their natural state. These methods are inextricably linked to the cultural heritage of tribal groups and are essential to the preservation of traditional foodways and cultural identity. Traditional milk preservation methods are adapted to the particular climatic and environmental conditions of each location, which guarantees their effectiveness in a range of settings.

Table 1: Key Characteristics of Traditional Milk Preservation in Tribal Communities

Feature	Description
Resource-dependent	Locally available materials such as clay pots, wooden churners, herbs, and smoke from native trees.
Low energy input	It does not require electricity and relies instead on natural processes such as fermentation and evaporation.
Microbial management	Leverages beneficial microbial actions (e.g., lactic acid bacteria in curdling) and inhibits spoilage through acidity, dryness, and antimicrobial herbs.
Cultural integration	Preservation techniques are linked to rituals, festivals, and medicinal traditions.
Sustainability	It is environmentally friendly, produces minimal waste, and utilizes biodegradable materials.

For instance, Gond and Baiga tribes in Chhattisgarh prepare ghee by churning fermented milk and clarifying the butter over fire, often storing the ghee in smoke-treated or ash-sealed earthen pots, which significantly extends shelf life (Mishra *et al*., 2020) [37]. Some communities add neem leaves or bael bark to milk as natural preservatives owing to their antimicrobial properties. In other areas, sun-drying of curd or conversion of milk into fermented products such as buttermilk (*chhachh*) is practiced to avoid spoilage during the summer months (Kumar & Rao, 2016) [33]. These methods allow tribal households to store milk safely for several days or convert it into longer-lasting products, such as curd, buttermilk, ghee, and fermented derivatives, which are easier to transport, barter, or consume over time. (Kala, 2021) [32] These practices also ensure year-round access to dairy nutrition, particularly in seasons when milk production declines or food scarcity prevails.

Despite modernization and changing dietary habits, many tribal communities continue to use these practices, especially in remote areas. (Yadav & Singh, 2023) [64] Their practicality and sustainability make them relevant not only for ethnographic documentation but also for potential integration into rural dairy development strategies. These practices are important for food security, health resilience, and biodiversity conservation. They ensure access to milk-derived nutrition during lean periods and reflect a holistic, sustainable approach to dairy management that aligns with the principles of One Health and Climate Resilience (FAO, 2017) [22].

Despite their effectiveness, these techniques are under-documented and face erosion due to modernization, urban migration, and the adoption of non-native dairy breeds and practices. There is an urgent need to systematically document, scientifically validate, and revive these indigenous techniques, both to preserve cultural heritage and develop low-cost milk preservation alternatives for resource-constrained regions.

3. Traditional Milk Preservation Practices Among Tribes of Chhattisgarh

Chhattisgarh is home to several major tribal groups, including the Gond, Baiga, Oraon, Halba, Maria, and Muria tribes, each of which has developed unique milk processing and preservation techniques suited to their local environments, resources, and cultural practices. These communities traditionally rear indigenous cattle and buffalo

breeds, such as the Chhattisgarhi buffalo and local desi cows, which are well-adapted to forest-based diets and low-input systems. (Gebisa *et al*., 2022) [23] Due to the absence of refrigeration in many tribal areas, these groups rely on time-tested traditional methods to preserve milk and its derivatives for short and long-term use. (Shukla, 2021) [50].

A. Gond Tribe

Gond is one of the largest tribal groups in Central India, with a significant presence in the Bastar, Kanker, Rajnandgaon, and Dhamtari districts.

Traditional Techniques

Ghee Production and Storage: Gonds convert curd into butter using a hand-operated churner (locally called *ghotni*) and then clarify it into ghee. Ghees are stored in smoke-treated earthen pots and are often sealed with natural materials, such as banana leaves, cow dung, or mud. (Alemu, 2018) [4].

Fermented Milk Products: They prepare fermented milk products such as mattha (buttermilk) and rabri (thickened milk dessert). Transforming milk into fermented products such as yogurt or cheese extends its shelf life because of the production of lactic acid, which inhibits spoilage bacteria. Lactic acid, a natural preservative produced during fermentation, effectively inhibits the growth of spoilage organisms and extends the shelf-life of milk products. Lactic acid produced during fermentation inhibits spoilage organisms, thus extending the shelf life of milk products.

Herbal Preservation: Some tribal communities add specific herbs and spices to milk and leverage their antimicrobial properties to inhibit bacterial growth (Sweesi *et al*. 2021) [57]. They added crushed neem leaves, bael bark, or giloy (*Tinospora cordifolia*) during boiling or storage of milk to prevent spoilage.

Smoke Sterilization: Storage containers fumigated with sal or mahua wood smoke are believed to have antimicrobial effects. (Bais, 2018) [6].

B. Baiga Tribe

The Baiga tribe, considered one of India's Particularly Vulnerable Tribal Groups (PVTGs), inhabits northern Chhattisgarh and parts of Kabirdham and Bilaspur.

Traditional Techniques

Sun-Drying of Curd: Curd is sun-dried into flakes or thick paste, known locally as sukha dahi, which is used later in cooking. Drying milk, often by sun drying or smoking, reduces water activity and inhibits microbial growth and enzymatic reactions that lead to spoilage (Ullah *et al*., 2022) [60].

Ghee for Medicinal Use: Ghee made from cow's milk is used in postnatal care, wound healing, and mixed with herbs to treat internal ailments.

Use of Medicinal Plants: Herbs such as *ashwagandha*, *satavar*, and *bhui amla* are added to milk before storage, especially during the monsoon months (Barak & Mudgil, 2022) [7]. The utilization of preservative plants in smoking or cleaning milk handling utensils imparts desirable flavors and aromas while reducing microbial loads, thereby increasing the shelf life (Shambel *et al*., 2021) [47].

C. Oraon Tribe

Predominantly located in the Jashpur and Surguja districts, the Oraon tribe is known for its agricultural and livestock rearing practices. The Oraon are primarily concentrated in the Jashpur district in northern Chhattisgarh, known for its hilly terrain and dense forest

Traditional Techniques

Khoa Making: Milk is reduced to khoa on open fire and shaped into pedas or barfis, enhancing its shelf life. (Brahmini *et al*., 2021) [11].

Fermented Milk Drinks: They prepare fermented beverages, such as chhaas and lassi, flavored with wild berries or forest herbs**.** (Trajkovska *et al*., 2024) [59].

Preservation in Bamboo Containers: Milk is stored in bamboo tubes or containers lined with teak leaves. (Ginting, 2018) [26] Utilizing natural packaging materials with antimicrobial properties, such as specific leaves or tree bark, further contributes to milk preservation by preventing microbial contamination. Antimicrobial packaging is used to control microbial growth in food ingredients using packaging materials, edible films, coatings containing antimicrobial agents, and sometimes by modifying the atmosphere within the package (Dutta *et al*., 2008) [20].

Quick Fermentation: Old curd is used as a starter culture for new batches to speed up souring, a method similar to backslopping. (Zamfir *et al*., 2022) [66].

Milk Film (Malai) processing: Thickened milk skin (malai) is mixed with salt or jaggery and stored for future use.

Clay Pot Storage: Milk and curd are stored in unbaked clay pots, which are porous and help keep contents cool via evaporative cooling.

D. Halba and Muria Tribes (Bastar Region)

These tribes reside deep within the forested Bastar and Dantewada regions and primarily rely on buffalo milk. The Halba and Muria tribes reside in southern Chhattisgarh, particularly in the Bastar and Kondagaon districts, which are known for their unique cultural heritage and tradition.

Traditional Techniques

Buffalo Ghee as Currency: Ghee is bartered for grain or forest products.

Smoke Preservation of Ghee: Burnt **tendu leaves** are used to smoke clay pots before ghee storage, thereby increasing its shelf life.

Cow Dung Ash Sealing: Ghee or butter containers were sealed with a mixture of cow dung and ash to protect them from insects and spoilage.

4. Common Cross-Tribal Practices

Across tribal communities, some common threads have emerged in traditional milk preservation practices, reflecting shared ecological contexts and cultural adaptations (Ghosh *et al*., 2019) [25]. For instance, fermentation is a widespread technique that transforms raw milk into products, such as yogurt or cheese, which have extended shelf lives and enhanced nutritional profiles (Ghosh *et al*., 2019) [25]. Drying milk into powder or cake form is another prevalent method, particularly in arid regions where moisture promotes spoilage. These dried products can be reconstituted with water, which provides a valuable source of nutrition during the lean season. The use of natural preservatives, such as herbs, spices, and plant extracts, is also common, leveraging their antimicrobial properties to inhibit the growth of spoilage microorganisms. Furthermore, traditional storage techniques, such as using clay pots or woven baskets, help regulate the temperature and humidity and create favorable conditions for preservation. Back-slopping, a traditional method, involves the use of a portion of a previous batch of fermented food to inoculate the next batch, ensuring the continuation of desirable microbial cultures and consistent product quality (Yang *et al*., 2023) [65]. By crossing these tribes, several shared traditional practices can be observed.

Table 2: A Common Cross-Tribal Practices

Practice	Description
Churning of curd	Use of wooden *madani* or *ghotni* to separate butter from buttermilk.
Use of herbal preservatives	Neem, tulsi, giloy, and turmeric were used to inhibit the microbial growth.
Earthen pot storage	Clay pots naturally cool and slow microbial spoilage.
Seasonal ghee making	During the flush season (monsoon/post-monsoon), excess milk is converted into ghee for long-term use.

Traditional milk preservation techniques among tribal communities in central India reflect a profound understanding of natural resources and ecological balances (Saeed *et al*., 2019) [46]. Combining traditional preservation methods with modern food processing technologies could lead to sustainable strategies for enhancing food safety and security in tribal regions (Gould 1996) [27]. Combining traditional preservation methods with modern food-processing technologies may lead to sustainable strategies for enhancing food safety and security in tribal regions (Alemu, 2018) [4]. Preservation and enhancement of food safety are significantly enhanced by natural preservatives. A review paper indicated that natural antimicrobial agents that inhibit bacterial and fungal growth for better quality and shelf life have been of considerable interest in recent years (Teshome *et al*., 2022) [58]. The use of natural antimicrobials is one way to improve the safety and quality of milk (Pina-Pérez *et al*. 2015) [45].

5. Evaluation of Preservation Techniques

The effectiveness of traditional milk preservation techniques can be evaluated using several criteria.

A. **Shelf-Life Extension:** Determining how long each method extends the shelf life of milk compared to raw unprocessed milk is crucial.
B. **Microbial Analysis:** Analyzing the microbial content of milk preserved using traditional methods can provide insights into their effectiveness in inhibiting bacterial growth.
C. **Nutritional Content:** Assessing the impact of preservation techniques on the nutritional content of milk is essential to ensure that the preserved product retains its nutritional value.
D. **Sensory Evaluation:** Evaluating the taste, smell, and texture of preserved milk can help to determine the acceptability of the product to consumers.

Preservation strategies are essential for managing food spoilage and ensuring safety, with the utilization of natural antimicrobials emerging as a promising approach, supported by increasing research and commercial applications. Many natural antimicrobials such as organic acids, bacteriocins, essential oils, and extracts have been shown to inhibit or inactivate spoilage microorganisms and pathogens in food systems.

Traditional methods of food preservation are deeply ingrained in human history, with practices such as fermentation, drying, smoking, and salting being employed for centuries to extend shelf life and ensure the availability of food (Teshome *et al*., 2022) [58]. These methods, which are often passed down through generations, reflect a deep understanding of the local environment and its resources (Lee and Paik, 2016) [34].

6. Importance of preserving traditional knowledge

Preserving traditional knowledge about milk preservation techniques is essential for several reasons. First, it safeguards cultural heritage and ensures continuity of indigenous practices (Ghasemkhani *et al*. 2014) [24]. Traditional methods often reflect a deep understanding of the local resources and environmental conditions. Second, these techniques may offer sustainable and cost-effective solutions to food preservation, particularly in resource-limited settings. Third, traditional knowledge can contribute to the development of novel preservation strategies that combine traditional wisdom with modern scientific principles (Considine *et al*., 2008; Bhat *et al*., 2018) [17, 8]. It is imperative for researchers and policymakers to document, validate, and promote these traditional practices to ensure their survival and contribution to food security and cultural diversity. Traditional methods, which are often passed down through generations, represent a wealth of knowledge regarding local resources, climate conditions, and sustainable practices. Traditional preservation methods are crucial for maintaining food security, cultural heritage, and environmental sustainability, particularly in tribal and rural communities. Understanding and preserving these practices can lead to the development of sustainable and culturally appropriate food preservation strategies, ensuring food security and promoting cultural heritage. The integration of traditional knowledge with modern scientific approaches can lead to innovative solutions that are both effective and

environmentally sound. The preservation of traditional knowledge is crucial for maintaining cultural heritage, ensuring food security, and promoting sustainable practices in tribal and rural communities (Cadwallader & Weenen, 2002) [13].

Local wisdom and cultural heritage in rural communities results from adapting to nature and the environment (Sumarwati *et al*. 2020) [55]. Traditional knowledge empowers local communities to address their challenges in a cost-effective manner (Veen 1997). [62] Preserving indigenous knowledge involves cultural transmission processes that facilitate intergenerational knowledge transfer to youth (Opare, 2016) [42]. Traditional knowledge plays an important role in sustainable development and biodiversity conservation. Traditional knowledge refers to the skills, practices, and beliefs held by communities that enable sustainable resource management. Traditional knowledge is crucial for maintaining cultural heritage, ensuring food security, and promoting sustainable practices (Chiboola 2020) [15]. Indigenous knowledge is in danger of being lost as custodians pass away, so it is crucial to preserve it (Bhushan *et al*., 2018) [10]. Documenting and revitalizing traditional knowledge are essential for maintaining cultural heritage and promoting sustainable development (Ahearn *et al*., 2019; Nijar, 2013; Supyan *et al*., 2021; Zhao *et al*., 2025) [3, 40, 56, 67].

Cultural heritage significantly affects food security through various pathways. Cultural heritage embodies indigenous cultures, values, and traditions inherited from previous generations (Britwum & Demont, 2022) [12]. Preserving local cultural heritage in the modern world is a major challenge (Dai *et al*. 2018) [19]. Tribal communities often depend on traditional food crops and agricultural practices to enhance community resilience and ensure food security (Shava *et al*., 2009) [49]. Promoting traditional cuisine maintains society's history and way of life, reflecting their culture. Traditional knowledge is a component of culture since it encompasses society's customs, knowledge, cooking abilities, and food consumption habits at specific cultural or traditional events (Atrinawati, 2021) [5]. Indigenous peoples' traditional knowledge is an invaluable resource for humanity, contributing to linguistic and cultural diversity (Obiero *et al*., 2022) [41]. Indigenous knowledge is continuously developed and adapted to gradually changing environments, passed down from generation to generation, and closely interwoven with people's cultural values (Bhattacharya, 2020) [9].

7. Comparison with modern preservation methods

Modern preservation techniques, such as pasteurization, sterilization, irradiation, and the use of chemical additives, offer an effective means of extending the shelf life of milk and ensuring its safety (Atrinawati, 2021) [5]. These methods often involve sophisticated equipment and controlled environments that allow large-scale production and distribution. However, they may also have drawbacks, including high energy consumption, potential alteration of the nutritional and sensory properties of milk, and concerns regarding the use of synthetic chemicals (Cannarella & Piccioni, 2011) [14]. Traditional methods, on the other hand, often rely on natural processes and locally available resources, making them more accessible and sustainable for small-scale producers (Alemu, 2018) [4]. A comparative analysis of traditional and modern methods is essential for identifying the best practices and potential synergies for improving milk preservation in diverse contexts. Innovation in food-processing methods can also improve food preservation and safety (Islam *et al*., 2022) [30]. Modern methods, such as pasteurization, sterilization, and irradiation, are very effective in extending the shelf life of milk. Although these techniques enable mass production and distribution, they have several disadvantages such as energy consumption and alteration of the nutritional and sensory qualities of milk. (Srour *et al*., 2022) [53]

Traditional techniques are easily available to small-scale producers because of their dependence on natural resources and processes. The energy consumption of traditional methods is often lower than that of modern methods, which makes them more sustainable in resource-limited settings. Traditional methods are typically less energy intensive than modern methods because they depend on locally available materials and natural processes. By utilizing traditional methods, small-scale producers can reduce their environmental impacts and ensure the long-term viability of their operations (Hailemeskel, 2020) [28]. In comparison, modern methods frequently require significant energy inputs that contribute to carbon emissions and resource depletion.

Modern methods have potential drawbacks, including high energy consumption, alteration of the nutritional and sensory qualities of milk, and apprehensions about the use of synthetic chemicals. The use of artificial preservatives has increased the shelf life and preserved the quality of food for extended periods (Sulieman *et al*., 2023) [54]. The sensory qualities of milk may be altered by certain modern preservation techniques, changing the flavour, texture, and aroma that consumers find appealing. It is possible that consumers will object to changes in sensory qualities, particularly if they depart from the anticipated flavour profiles of fresh milk. Traditional methods frequently result in products with distinctive flavour profiles that are highly valued by local communities, making them more culturally and economically sustainable.

8. Potential for integrating traditional techniques with modern practices

Integrating traditional methods with modern practices offers a promising approach to enhancing milk preservation, particularly in tribal and rural communities. This integration combines traditional knowledge with modern technology. By integrating traditional methods with modern technology, it is possible to create effective and sustainable preservation strategies that respect cultural heritage and satisfy contemporary safety and quality standards. Combining traditional fermentation techniques with controlled fermentation processes can improve the safety and consistency of fermented milk products. Combining traditional smoking methods with modern packaging technologies can improve the shelf life and marketability of smoked milk products. Future research should focus on validating the efficacy of traditional methods, optimizing their applications, and assessing their potential for integration with modern technologies. This approach could involve the scientific validation of traditional practices, optimization of traditional processes using modern

equipment, and development of hybrid preservation strategies that combine the best aspects of both approaches. Further research is needed to determine the efficacy of traditional methods. This would ensure the safety and quality of milk products, while preserving their cultural significance. Traditional methods, which have been developed over generations, embody a deep understanding of local ecosystems and biodiversity. This knowledge is increasingly threatened by urban migration and modernization, causing a loss of essential skills and practices among the younger generations. However, as noted in the context of agricultural knowledge preservation, the involvement of youth in these traditional practices can facilitate a valuable exchange of ideas, enriching both cultural and agricultural sustainability (Elgar G.,2013) [21]. Moreover, by harnessing contemporary food preservation technologies, such as refrigeration and pasteurization, alongside these age-old techniques, communities can optimize milk storage while maintaining nutritional and sensory qualities. This fusion of old and new offers a pathway to both preserve cultural identities and meet modern dietary needs effectively (Lange C.,2016) [16].

9. Historical challenges faced by tribal communities in milk preservation

Milk is a perishable food item with a short shelf life that poses significant challenges for tribal communities, especially those in remote areas with limited access to refrigeration. Traditional methods, although effective to some extent, often result in product variability and may not always guarantee food safety (Agrawal *et al*., 2025) [2]. Throughout history, tribal communities in Central India have encountered numerous challenges in the preservation of milk, which has both nutritional and cultural significance. These challenges stem from a combination of environmental factors such as unpredictable climate and lack of access to modern preservation technologies, which have historically hindered effective milk storage. Additionally, socioeconomic marginalization has limited these communities' ability to employ scientific advancements, often relying on traditional techniques that may not suffice under changing conditions. The disruption of local knowledge systems, exacerbated by colonial history and neocolonial legacies, has further complicated these preservation practices. Such interlinked issues highlight the importance of recognizing how historical contexts shape contemporary milk preservation practices. Efforts to revitalize traditional methods must consider the social justice dimensions inherent in these communities' struggles, acknowledging their local knowledge as a vital resource for sustainable practices within the broader discourse on agricultural governance (Coombe *et al*.,2018) [18].

Conclusion

The milk preservation techniques of tribal communities in Central India, particularly in Chhattisgarh, are a testament to indigenous innovations and sustainable food systems. These practices offer viable alternatives to industrial dairy preservation, especially in low-resource rural settings, and are relevant in the current context of climate change, energy conservation, and biodiversity protection. In conclusion, this comprehensive review highlights the intricate and sustainable traditional milk preservation techniques employed by tribal communities in Central India, underscoring their vital role in maintaining food security and cultural heritage. These methods, steeped in local knowledge and environmental adaptability, demonstrate the community's profound connection to its ecological surroundings. As interest in sustainable practices grows globally, recognizing and supporting these indigenous techniques could offer valuable insights into contemporary food preservation challenges.

While modernization and changing lifestyles have led to a gradual decline in these practices, their revival and integration into formal dairy development policies can significantly enhance nutritional security, cultural preservation, and rural livelihoods. By scientifically validating and promoting these time-tested techniques, policymakers and researchers can harness the traditional wisdom for resilient and inclusive dairy development. Moreover, integrating traditional wisdom with modern scientific approaches could yield innovative solutions for dairy preservation. Future research is essential not only to document these practices but also to explore their potential applications in broader contexts. By adopting a holistic approach that values both traditional wisdom and scientific innovation, we can create a more resilient and sustainable food system for tribal communities in Central India and beyond.

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