

A2 Milk from Indigenous Cattle: A Sustainable Pathway for Rural Livelihoods and Dairy Development in India

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ABSTRACT

With a total output of 247.87 million metric tonnes in 2024, India is currently the largest producer of milk in the world. Dairy farming accounts for the economic foundation of rural India, with over 80 million dairy farmers making their living from this industry, the majority of which are small to medium-sized farms. While the shift to crossbred and exotic cattle breeds has increased both production and productivity, the increased input costs and increased susceptibility to disease have been compounded by an alarming decrease in the number of indigenous cattle genetic resources and breeds. A2 milk is produced by indigenous breeds of cattle in India (e.g., Gir, Sahiwal, Red Sindhi, Tharparkar, Kangayam) and is being promoted as a potential remedy for these problems. Native Indian breeds are the only source of A2 β -casein, which is the form of β -casein in milk from these breeds. The difference between A1 and A2 β -casein is one amino acid (A1 β -casein contains histidine, while A2 β -casein contains proline). Research on A2 milk is currently being conducted and is showing a greater degree of gastrointestinal tolerance than conventional milk when consumed by many people.

INTRODUCTION

India comes 1st in the world in milk production, with the production volume at 247.87 million MT in 2024-25. The evolution from 17 MT in 1950 to this volume today has been nothing less than phenomenal. Dairy is the backbone of rural India, more than 80 million farmers (mostly small and marginal-size land holders and women) depend on it for their livelihoods. Livestock contributes around 31% of agriculture GVA and approximately 5-5.5% of the national economy hence livestock rearing forms a major pillar supporting rural development, food security and overall strengthening the national economy.

Indigenous cattle farming has been an important and integral part of the Indian rural farming systems. However, in the last few decades, to increase production, they have introduced crossbred and exotic cattle into the rural setups. This has improved the overall dairy production, but it has also created many new problems, including higher input costs, increased risk of disease, and has put the Indian native genetic resources on the brink of extinction. So, there is a grave need to strengthen rural India and conserve the native indigenous breeds once again. The revival of rural India can be accomplished through A2 milk. The main difference between these two variants (A1 milk and A2 milk) lies in their amino acid sequence, specifically at position 67, where A1 β -casein contains histidine, while A2 β -casein contains proline (Jeong *et al.*, 2024). The A2 milk comes from a breed of cows that produces only the A2 type of beta-casein protein, which is predominant in many of the native Indian cow breeds (eg. Gir, Sahiwal, Tharparkar and Red Sindhi) (Priyashantha *et al.*, 2025). If A2 milk and value-added products (including A2 ghee, paneer and yogurt) are promoted as a source of alternate income for farmers, then they will not

only create a sustainable livelihood but also maintain the genetics of their native breeds. Ultimately, by utilizing traditional knowledge with current market trends focused on healthier dairy products, a positive impact on rural economies can also occur.

What makes A2 milk different

Beta-casein is the second most abundant protein found in cow's milk, accounting for approximately 30% of the total protein content. There are several genetic variations of beta-casein, but the two most studied are A1 beta-casein and A2 beta-casein (Chitra. 2022). Milk containing A1 or A2 β -casein is mostly same in nutritional values, However, the casein protein variant differs at amino acid position 67. A1 milk contains histidine, while A2 milk contains proline. This one amino difference plays a role in how the protein is processed by the body. As a result, during digestion, A1 beta-casein can release a peptide, known as beta-casomorphin-7 (BCM-7), while A2 beta-casein cannot effectively release this peptide (Cattaneo *et al.*, 2023). It is studied that A2 milk releases significantly less BCM-7 compared to A1 milk due to its proline structure, which reduces potential absorption and associated adverse outcomes (Kay *et al.*, 2021). Most of the milk sold in stores (often derived from cross-bred or exotic cows) is a combination of A1 and A2 beta-casein, while A2 milk products contain only the A2 beta-casein protein. Many studies have suggested a potential link between BCM-7 and gastrointestinal discomfort in people.

Breeds producing A2 milk

Producing A2 milk from cattle breeds that carry the A2A2 β -casein genotype, such as indigenous breeds, opens up an exciting opportunity to create high-value-added (HVA) dairy products. This can help strengthen rural

economies by offering health-focused products that fetch premium prices in the market. In India, native breeds like Gir, Sahiwal, Red Sindhi, Tharparkar, and Kangayam (Sodhi *et al.*, 2022) are especially promising. These indigenous breeds offer dual advantage: they support the conservation of genetic diversity (Rai *et al.*, 2023), while also providing a strong foundation for developing unique, region-specific, high-value dairy products that promote local resources.

Health benefits

Current scientific evidence on the health benefits of A2 milk is still limited. Most of the credible research so far points mainly to better gastrointestinal tolerance rather than broad health benefits. Two important systematic reviews - Daniloski *et al.* (2021) and Küllenberg de Gaudry *et al.* (2019), concluded that consuming A1 β -casein is associated only with slightly increased gastrointestinal transit time and mild digestive discomfort in some people. Importantly, they found no convincing links between A1 milk and serious chronic diseases.

One of the most well-studied benefits of A2 milk is improved digestibility. Many studies have showed that people with stomach discomfort after having regular milk shows better tolerance towards A2 milk (Jianqin *et al.*, 2016; He *et al.*, 2017). The proposed reason behind this difference is the lower release of a peptide called beta-casomorphin-7 (BCM-7) from A2 milk. That said, recent analytical studies have shown that A2 milk can still produce small amounts of BCM-7, though significantly less than A1 milk and claims linking A1 β -casein to serious conditions like cardiovascular disease and diabetes are also there (Asledottir *et al.*, 2017, Danilosk *et al.*, 2021, Cattaneo *et al.*, 2023). Similarly, there is some interest around possible neurological effects because BCM-7 has shown opioid-like properties in lab studies and may affect the brain in certain conditions (Jeong *et al.*, 2024).

One study by Sokolov *et al.* (Sokolov *et al.*, 2014) found higher levels of BCM-7 in infants with developmental delays. However, despite the lack of many strong scientific reasons, the perceived health benefits of A2 milk continue to strongly appeal to consumers and are driving steady growth in market demand.

Boosting rural incomes and strengthening India's dairy economy

Producing value-added products from A2 milk, such as cheese, paneer, yogurt, ghee, or flavored milk, is one of the best ways to help strengthen the rural economy of India today. Milk produced from native cows such as Gir, Sahiwal, Red Sindhi, Tharparkar and Kangayam can be processed into premium value-added products by farmers and dairy co-operatives who will receive much higher prices than for plain milk, therefore helping to increase household incomes and provide local jobs in processing, packaging, and distribution. The creation of these products adds value to the economy while helping to conserve native breeds of cattle as well. With respect to certification, the Food Safety and Standards Authority of India (FSSAI) does not have any official standards or certification for A2 milk; however, any claims made regarding A2 must be substantiated with scientific evidence (genetic testing of cows with A2A2 genotype, and protein analysis) to prevent being misleading and misrepresentative. Farmers and processors may have their products tested at accredited laboratories, and when an authorized label is applied, they may sell their products as FSSAI-compliant.

The potential of the products from the milk and ghee market in India is vast, and as more and more health-conscious urban consumers are developing an interest in purchasing premium-priced products, the growth rate in both segments is expected to be double digits. The ability of A2 dairy products to drive development in rural communities as well as

the livestock sector in India through branding, traceability, and value addition will lead to significant changes to the overall dairy industry in both India and around the world.

CONCLUSION

The story of the journey of A2 milk exemplifies a successful blending of culture and modern science that enables us to create benefits for people and the planet. India's continued growth in global milk production creates an opportunity to rediscover our indigenous cow breeds using A2 milk and value-added products. This new approach can help revitalize rural communities, preserve our limited genetic diversity, and respond to the increased demand for healthy dairy options. Consumer interest in A2 milk remains steady and growing, especially as scientific evidence on the health benefits of A2 is being published (currently showing the most evidence for better digestive comfort). Therefore, farmers and cooperatives that invest in proper genetic testing, value addition, branding, and certification could position themselves to turn A2 milk into a profitable opportunity with a premium price in both domestic and international markets. Promoting A2 milk is more than just producing better dairy; it is about empowering millions of rural families, protecting our native livestock heritage, and creating a sustainable and resilient dairy sector. The revival of India's indigenous cattle breeds through A2 technology could create a win-win-win for farmers, consumers, and the environment. Now is the time to invest in this exciting opportunity.

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