



THE INTERPLAY OF AGNI AND BHAJANA SAMSKARA IN MODULATING THE THERAPEUTIC PROPERTIES OF *GODUGDHA*

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ABSTRACT

Since milk contains nearly every ingredient required for a person to consume food on a regular basis, it is a complete food. In particular, cow milk is consumed globally more often than the milk from other mammals. Cow milk's properties include *Madhura* (sweet), *Sheeta* (cool), *Mrudu* (soft), *Snigdha* (unctuous), *Bahala* (thick), *Shlakshna* (smooth), *Picchila* (sliminess), *Guru* (heavy), *Manda* (dull), and *Prasanna* (inspires enthusiasm). It also possesses the traits of *Jeevaniya* (vitalizer) and *Rasayana* (rejuvenate). *Samskara* is a method that involves boiling, cleaning, storage in various vessels, and other procedures to generate changes in the qualities of any substance. These *Samsakara* may enhance the substance's quality or degrade it. The purpose of this review article is to highlight the importance of utilizing the proper metal utensil and milk boiling technique, as well as the application of this knowledge in the prevention of metal contamination and milk-borne illnesses. A comprehensive literature search was conducted using Ayurveda texts and databases like Google Scholar, SCOPUS, and PubMed, focusing on keywords related to heavy metals, milk, and heat. Studies assessing heavy metals in cow milk, the effects of heat on milk proteins,

and contamination through unprocessed milk were included, while studies on other species' milk, non-English articles, and abstracts were excluded. Data were extracted and synthesized using a narrative and quantitative approach to highlight trends and gaps. This review supports the facts about boiling and storing milk. Milk should be boiled in Earthen pot/ Clay vessels or in non-reactive metal vessels like stainless steel. Boiled milk should be stored in an Earthen or Wooden vessel.

KEYWORDS: *Godugdha* (cow milk), *Samskara* (processing), boiling, vessels, Pasteurization, *Ayurveda*.

INTRODUCTION

Since cow milk makes up a large portion of an infant's diet who is not breastfed, it is a complete food. A nutrient-dense food, cow's milk has different proportions of fat, protein, carbohydrates, vitamins, and minerals. Cow milk functions as *Jivaniya Dravya* and *Rasayana* and possesses the same properties as *Oja*, according to *Acharya Charaka*. Its attributes are as follows: *Madhura* (sweet), *Sheeta Virya* (cool), *Mrudu* (softening of the cells/tissues), *Snigdha* (demulcent), *Bahala* (thick), *Shlakshna* (smooth), *Picchila* (sticky in nature), heavy in the nature of the *Guru*, dull in nature, *Manda* (dull), and rousing of zeal.^[1] "*Aahara Samskara*" is "the processing which causes transformation in a substance during which there takes place the contribution of *Gunas* and elimination of *Doshas*," according to *Acharya Charaka*. The *Samskara* modifies the *Swabhavika Gunas*, or inherent qualities.^[2] *Samskara* is the term used to describe the process of altering the inherent properties of food through the use of water, heat, and other techniques such as washing, cleaning, churning, storage location, timing, flavouring, recipe form, levigation, and utensils (with modifications like coating the inner surface by various medicinal herbs). This review article aims to shed light on specifically two *Samskaras* in milk which are *Agni* and *Bhajana Samskara* and the changes in the qualities of milk by these *Samskaras*. These *Samskaras* need to be highlighted today for the prevention of milk borne disease and chemical contaminations through milk handling, consuming and storing.

2. MATERIALS AND METHODS

2.1 Literature Review

For this review, a comprehensive literature search was conducted across Ayurveda classics and international scientific databases. These databases included Google Scholar, SCOPUS, and Medline (with PubMed as the search engine). Keywords such as "*Samskara*," "heavy

metals," "milk," and "heat and milk" were used to identify relevant studies. The search terms were applied to fields including titles, abstracts, and keywords to ensure the capture of a wide range of articles. The time frame of the search was not restricted, allowing for a broad examination of the available literature.

2.2 Inclusion and Exclusion Criteria

2.2.1 Inclusion Criteria

The following inclusion criteria were used to select studies for the review:

- Studies that analysed heavy metal levels in raw cow milk and processed cow milk.
- Research investigating the effects of heat treatment on cow milk proteins.
- Studies examining milk contamination due to the use of unprocessed cow milk.

2.2.2 Exclusion Criteria

Exclusion criteria were established to refine the focus of the review. The following types of studies were excluded:

- Studies involving milk from species other than cows, such as goat, camel, or sheep milk.
- Articles not published in the English language.
- Review articles, conference abstracts, letters to the editor, or any studies available only in abstract form.
- Studies conducted in specific localities that focused primarily on milk handling practices unique to that area.

2.2.3 Data Extraction

Data from the selected studies were extracted using a predefined template. Key information such as study design, sample size, methods used for detecting heavy metals, heat treatment protocols, and contamination outcomes were recorded. Where possible, quantitative data on heavy metal concentrations and protein degradation were extracted and tabulated for comparison.

2.2.4 Data Synthesis

The data synthesis process involved categorizing the studies based on their research focus, whether it was heavy metal contamination, the effect of heat on milk proteins, or milk contamination through unprocessed milk. A narrative synthesis was employed to summarize the findings from the studies, while data on heavy metal concentrations were synthesized quantitatively where feasible. Trends and discrepancies across the studies were highlighted,

and potential explanations were provided. Any gaps in the research were also identified for future study recommendations.

RESULTS

List of reviewed articles are mentioned in table no 1.

Highlights from the reviewed articles

Effect of heat treatment on milk's qualities

1. Breast milk exhibits significant bactericidal action against *E. coli*, preserved better with Holder pasteurization. Effect of Pasteurization includes reduced activity of protective components like lysozyme, lactoferrin, and immunoglobulin; growth factors and interleukins remain stable. High and low-temperature pasteurization reduces *E. coli* growth, with minimal impact on bactericidal action after storage. Thermal treatment reduces antibacterial activity in human milk; Holder pasteurization preserves activity better than flash method.^[3]
2. Heat-treatment impacts whey protein denaturation and whey-casein combination. Denaturation and combination degrees rise with higher temperature and longer time. Relationship between denaturation/combination and heat treatment follows quadratic regression. Crucial for dairy industry to select optimal heat treatment for protein stability and nutrition preservation.^[4]
3. The epigenetic machinery in milk throughout postnatal development is crucial for the metabolic programming of a person's lifetime. Through continued use of pasteurized cow's milk, epigenetic signaling in milk is abused, increasing the risk for modern diseases.^[5]
4. After in vitro digestion, OH (over heated) milk's calcium solubility was lower than that of UHT (ultra- high temperature) milk's, which may have been caused by thermal protein degradation and a rise in MRP, as shown by MR marker studies. differences in the amounts of fat and protein in the samples, impacted by the diet of the animals. Pasteurization caused a decrease in viscosity. Surface tension and viscosity have an inverse relationship following pasteurization. higher concentration of chloride, as seen by increased conductivity following pasteurization.^[6]
5. The effect of heat treatment on the physical-chemical properties of milk Experimental study When milk is heated, less water is added, increasing the milk's durability and causing the calcium concentration and viscosity to decrease.^[7]

6. Effective control of PPC (post pasteurization contamination) is possible. Better detection and trace-back methods needed. Improved prevention procedures are necessary. "Seek and destroy" methods could help. Reconsider mid-shift clean-up strategies.^[8]

Effect of metal contamination upon milk:

1. Iron overload has seen increasing over recent years due to mutations in iron-regulatory molecules which cause failure of excretion of iron. It results in accumulation of iron. Further studies related to iron related molecules, including hepcidin and HFE (hereditary hemochromatosis protein) protein along with genetic mutations can be done.^[9]
2. A number of physiological and metabolic processes, including as angiogenesis, skin development and expression, and the stabilization of extracellular skin proteins, depend on copper, an essential mineral. Copper also possesses strong biocidal effects. Copper's combination of these two separate qualities makes it a very appealing active substance for improving skin well-being.^[10]
3. Milk products in Beni-Suef governorate contain significant levels of aluminium, posing health risks. Market milk and rice pudding are major contributors to weekly aluminium intake. Processing and storing milk in aluminium utensils increase aluminium content, especially in acidic products like yoghurt and cheese.^[11]
4. Cow milk is a vital nutrient source worldwide. High concentrations of Pb, Cu, Ni, Fe, and Cd have been found, particularly in emerging nations. India reported highest Pb, Ni, Cu, Cd, Fe, Turkey with high Al and Pakistan with high Hg in contaminated milk. Developing countries show higher heavy metal concentrations due to lax regulations. Al and Fe levels in milk deemed safe, but Hg poses risk in Faisalabad, Pakistan. Increased THQ levels in a number of locations for Pb, Cd, Ni, and Cu.^[12]
5. Contaminants in raw cow's milk indicate illegal use in agriculture and animal husbandry. Lack of Maximum Residue Limits (MRLs) for many contaminants poses health risks. Pasteurization ineffective for degrading or eliminating contaminants. Limited industrial-scale methods for removing contaminants. Hormones present in milk without specific elimination methods. Alternative methods show promise, especially in nano-biotechnology and biochar.^[13]

Ayurvedic concept about qualities of *Godugdha* (cow milk) -

Charak Acharya states that *Godugdha* has the following qualities: *Madhura* (sweet), *Sheeta* *Virya* (cool), *Mrudu* (softening of cells/tissues), *Snigdha* (demulcent), *Bahala* (thick),

Shlakshna (smooth), *Picchila* (sticky in nature), *Guru* (heavy), *Manda* (dull), and *Prasanna* (inspiring). serves as *Oja Vruddhi*, *Rasayana* (vitalizer), and *Rasa-Rakta-Mamsa-Meda-Asthi-Majja-Shukra* (increases essence of all the seven *Dhatus*. As said by *Sushrut Acharya Alpa Abhishyandikaraka* (not much causes the channels to get blocked), *Snigdha* (demulcent), *Guru* (heavy), *Rasayana* (tissue vitalize), *Rakta-Pitthara*, *Sheeta* (cold) in potency, *Madhura* (sweet) in taste, *Madhura Vipaka* (sweet) at the end of digestion, *Jeevaniya* (sustains life), and *Vata-Pitta Nashaka* (subsides *Vata* and *Pitta Doshas*) are all present in cow milk.^[14]

Godugdha is known for its life-promoting (*Jivaniya*) qualities, acts as a vitality enhancer (*Rasayana*), and is beneficial for injuries and emaciation (*Kshataksheena Hita*). It serves as a brain tonic (*Medhya*), a general tonic (*Balya*), promotes breast milk production (*Stanyakara*), and has laxative properties (*Sara*). It also cures lethargy and exhaustion (*Shrama*), confusion (*Bhrama*), intoxication (*Mada*), dyspnoea (*Shwasa*), cough (*Kasa*), excessive thirst (*Atitrishna*), excessive appetite (*Kshudha*), chronic fever (*Jeerna Jwara*), dysuria (*Mutrakrichra*), and haemorrhage (*Raktapitta*).^[15]

According to *Raj Nighantu*, *Godugdha* is considered *Pathya* (beneficial for all diseases), *Ruchikaraka* (enhances taste), *Swadista* (tasty), *Snigdha* (soothing), *Pitta* and *Vata Vikara Nashaka* (alleviates *Vata* and *Pitta* disorders), *Kantiprada* (improves complexion), *Prajna* (enhances knowledge), *Buddhi* (boosts memory), *Medha* (preserves memory), *Angapusthiprada* (strengthens the body), and *Virya Vriddhikara* (increases virility).^[16]

Physio-chemical Qualities of cow milk

Since milk contains almost every ingredient required for a daily diet, it is a complete food. The main components of cow milk are water (87.4%) and milk solids (12.6%), of which the solids are made up of salt, vitamins, minerals, trace elements, proteins, and carbohydrates (approximately 5%, 3.5%, and 3-4%, respectively).^[17] About 4.8% of carbohydrates come from lactose, with smaller amounts coming from glucose, galactose, and oligosaccharides. Each cup contains 12–12.5 grams of lactose. The majority of fat in cow milk is found as triacylglycerols, or fatty acid esters containing glycerol, along with trace amounts of phospholipids, sterols, waxes, and free fatty acids. In cow's milk, casein makes up 80% of the protein while whey makes up 20%. Whey protein is more heat stable than caseins.

Whey protein is found in the forms of alpha lactalbumin, beta lactoglobulin, bovine serum albumin, and minor proteins like lactoferrin and lactoperoxidase. Casein protein is present in the forms of alpha casein, beta casein, kappa casein, and gamma casein. The milk is classified as A1 or A2 type based on the variations of beta casein (30% of the protein in cow's milk). The A1 protein variation is frequently detected in the milk of European and crossbred cattle breeds. A2 milk is produced by most native (Desi) cows and buffaloes. The single amino acid difference between the milk variations A1 and A2 causes divergent secondary structure and enzymatic hydrolysis; for example, A1 beta casein releases beta casomorphin-7 (BCM7). BCM7 causes alterations in brain development, immunological response, digestion, and type 1 diabetes.^[18]

➤ Milk contamination

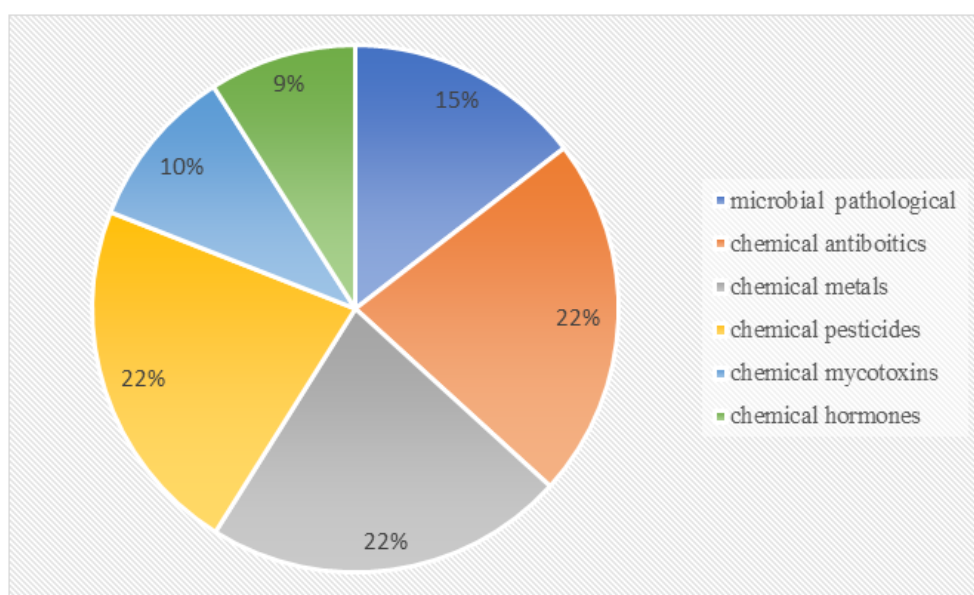


Fig. 1: Distribution of literature related to contaminants in bovine milk between 2010-2021.^[19]

The above showed figure indicates the distribution of literature related to contaminants in bovine milk between 2010-2021. Among these studies most studies were related to chemical metals, chemical antibiotics and chemical pesticides and a few are on chemical hormones, mycotoxins and pathogens.

Samskara^[20]

One of the major ideas of *Ayurveda* is "*Samskara*." "*Samskara*" describes the technique or tool that is utilized to modify *Dravya* as required. In *Ayurveda*, the term "*Samskara*" can

indicate many things depending on the context. *Paradi Gunas* (therapeutic qualities) includes *Samskara*. Additionally, it is listed under "*Ashta Aahara Vidhi Vishesh Ayatanas* (the factors responsible for wholesome and unwholesome effects of food and its methods of consumption)." *Samskaras* is defined by *Charak* as "*Karan* (interchanging in qualities)." For "*Bheshja*," the word "*Karan*" has mostly been utilized in *Charak Samhita*.

Samskaras explained by Charaka - They are *Toya- Agni Sannikarsha* (water & fire), *Shoucha* (cleaning/ washing), *Manthana* (churning), *Desha* (place of storage), *Kala* (specific time/ season), *Bhaajana* (vessels/ utensils), *Kaala Prakarsha* (time factor), *Vaasana Samskara* (flavouring) & *Bhavana Samskara* (levigation).

Agni Samskara

Contact of *Agni* (fire) gives lightness. Cooking makes the food sterile and safe for eating by killing germs i.e., lightness of *Raktashali* is enhanced by cooking. Milk often contains bacteria that cause tuberculosis. On boiling, the bacteria get killed and milk becomes safe for drinking. As mentioned in classics that all food stuffs have to be cooked in a low flame.^[21]

On the basis of *Agni Samskara* milk can be categorized in different groups which includes^[22, 23, 24]

- *Apakwa* (Raw Milk)
- *Pakwa* (Boiled Milk on 63⁰ c for 30 minutes or 72⁰ c for 15 seconds)
- *Atipakwa* (Overheated Milk at 95⁰c for 10 min.) / *Atishrita* (Milk that is freed of water and is reduced)
- *Dharoshna* (Milk that is warm by its flow)
- *Ushita* (milk that is allowed to stand for three *Muhurtas* (45 min) without boiling it)
- *Shrita Sheetal* (Milk that is cooled after boiling)

Qualities of cow milk based on *Agni Samskara* described in table no. 2.

Bhajana Sanskara^[25]

We utilize a variety of metallic and non-metallic utensils for storing, cooking, and serving. The foods that are cooked in utensils can react in ways that are either desired or undesirable. Milk boiled and stored in different metal vessels show changes in its physical and chemical constituents as well as its effect on human body. Material of utensils & their effects on body

and specific utensil for serving food and medicaments is given in Table 3 and 4 respectively.^[26, 27]

Qualities of Milk based upon Boiling in different Vessels

Use of *Tamra Patra* (Copper Vessel) for boiling milk is beneficial to relieving *Vata Vikara*. And its excessive use leads to leaching which can cause Indian Childhood Liver Cirrhosis.^[28] Use of *Suvarna Patra* (Gold vessel) for boiling milk is beneficial to relieving *Pitta Vikara* and due its non-reactivity it is not harmful. Use of *Raupya Patra* (Silver Vessel) for boiling milk is beneficial to relieving *Shleshma Vikara*. Use of *Ayasa Patra* (Iron Vessels) for boiling milk is beneficial to relieving *Krimi Roga*, *Pitta-Kapha Nashaka*, *Tridosha Nashaka* and work as *Rasyana* and its excess use in disturbed excretory function may cause risk of hepatic fibrosis and cirrhosis.^[29] Use of *Kamsya Patra* (Bronze Vessel) for boiling milk is beneficial for *Raktaprasadana* (blood purification). Use of *Mritpatra* (earthen pot) for boiling milk is helpful in managing *Prameha*, *Kushtha*, *Krimi*, *Gulma*, *Antrashula*. Stainless Steel Vessels are a non-reactive metal so it is safe for food preparation. Use of aluminium vessels for boiling milk is harmful as it causes Anaemia, Osteomalacia, Neurological Syndrome, Dialysis encephalopathy with chronic renal failure.^[30]

DISCUSSION

Cow milk and contamination

Cow milk gets contaminated through the process of handling, storage or transport. Cow milk is contaminated by microbial pathogens, antibiotics, metals, pesticides, mycotoxins and hormones. To avoid the harms related to contamination of milk heating or pasteurization processes are necessary. In developing countries there is high level of heavy metals are found in cow milk such as Pb, Ni, Cu, Cd, Fe, Al and Hg.

Methods of pasteurization (*Agni Samskara*) and their effect on milk

There are numerous methods of pasteurization such as Holder vat method, UHT and HTST. Ultra-high temperature process resulted in denaturation of all whey proteins and reduction in calcium absorption. In *Ayurveda* it can be correlated with *Atipakwa Dugdha* which has the qualities of *Guru*, *Brimhama*, *Pranaalambi*, *Tarpana* and *Vrishya*. Boiling milk at optimum temperature of 63⁰ c for 30 minutes or 72⁰ c for 15 seconds is called *Pakwa*. *Pakwa Dugdha* becomes *Laghu* and *Anabhishtyandi*, it kills pathogens and extends its shelf life, provides water soluble vitamin better, increases viscosity of milk and maintains its nutritive values. Heat treatment impacts whey protein denaturation and whey-casein combination.

Denaturation and combination degrees rise with higher temperature and longer time. Relationship between denaturation/combination and heat treatment follows quadratic regression. Commercialization of breast milk brought the risk of its contamination which originate the need of pasteurization. Pasteurization of breast milk is bactericidal against *E. coli*. It reduces the activity of protective components like lysozyme, lactoferrin and immunoglobulin; growth factors and interleukins remain stable. One study has suggested that post pasteurization contamination is also a cause of health problems which can be prevented by better detection and trace back methods.^[31]

***Bhajana Samskara* (role of vessel's material used for milk boiling)**

Vessels plays an important role in boiling of milk. In *Ayurveda* literature vessels has given a big importance in *Aahara* as there is different vessels mentioned for different procedure or different food preparations. Copper, iron and aluminium vessels have leaching properties due to overheating which cause worsen health impacts. Aluminium vessels have harmful impacts on health such as Anaemia, Osteomalacia, Neurological Syndrome, Dialysis Encephalopathy with chronic Renal Failure. Iron vessels are useful for cooking to control anaemia, *Krimiroga*, *Tridosha Prakopa* but it should be avoided in disturbed excretory functions because there is a risk of hepatic fibrosis and cirrhosis. Copper vessels are useful is skin well-being and *Vata Vikara*. Leaching of copper in milk found as cause of Indian Childhood Liver Cirrhosis which may be due to overheating. Gold, silver and glass vessels are non-reactive and beneficial for *Pitta Vikara* and *Kapha Vikara* respectively. Earthen pot found best for boiling milk as it controls *Prameha*, *Kushtha*, *Gulma*, *Krimi* and *Antrashula*, and it does not have worsen effects. A good quality stainless steel vessels are commonly used nowadays which are inexpensive and have least harm effects.

The primary outcome measure of the review was changes in qualities of milk with respect to boiling in different temperature and different vessels. The secondary outcome measure of this review is to find alternative solutions to avoid harmful health impacts of temperature and metals.

The review article offers a thorough exploration of cow milk's qualities and processing methods through the lens of Ayurvedic principles and modern science. Its strengths lie in its comprehensive approach and practical recommendations, while its limitations include potential biases, variability in study quality, and a lack of quantitative analysis. Addressing these limitations could enhance the review's robustness and applicability in both traditional

and contemporary contexts. There are no such systematic reviews on *Samskara* and their practical application on milk and its qualities. There could be a systematic review on both parts of this review as effects of boiling milk in different vessels and on different temperature. This study enhances the understanding of milk processing and safety by integrating traditional Ayurvedic principles with modern scientific evidence. It provides practical recommendations for improving patient care and informs policy development to ensure safer milk consumption practices. The mechanisms discussed offer insights into how processing methods and materials influence milk quality and health outcomes. While the study offers significant insights, it also raises several controversies related to the integration of traditional and modern knowledge, the impact of processing methods, the effects of metal vessels, the applicability of findings, and practical considerations in implementing recommendations. Addressing these controversies requires a balanced approach that considers both scientific evidence and practical implications. Future research areas on this field are validation of ayurvedic practices with modern science, impact of heat treatments on nutrient retention, effects of metal vessels on milk quality, cultural and geographical variations, health outcomes related to processing methods, consumer awareness and education, regulatory and policy implications and alternative processing techniques.

CONCLUSION

In conclusion, this review highlights the complex interplay between traditional Ayurvedic principles and modern scientific approaches in understanding cow milk contamination and processing methods. The contamination of cow milk by microbial pathogens, heavy metals, antibiotics, and other substances necessitates effective pasteurization techniques to ensure safety. While modern pasteurization methods such as UHT and HTST are effective in pathogen elimination, they also have varying impacts on milk's nutritional properties, including the denaturation of proteins. Ayurvedic insights, particularly the concept of *Pakwa Dugdha*, offer valuable perspectives on balancing heat treatment with nutritional retention.

Furthermore, the choice of vessels for boiling milk plays a significant role in its quality. Different materials, such as copper, iron, and aluminium, influence the chemical composition of milk through leaching, with some metals posing health risks. Traditional practices favour the use of non-reactive materials like gold, silver, and earthen pots for safer milk processing. This review emphasizes the need for further research to validate Ayurvedic practices in milk processing with modern science. The study also suggests potential policy implications and

consumer education to promote safer milk consumption. Future research could explore the effects of heat treatments on nutrient retention, the health impacts of metal vessels, and alternative processing methods, bridging traditional wisdom with contemporary practices for enhanced milk quality and safety.

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हिन्दी सारांश

अंत में, यह समीक्षा गाय के दूध के संदूषण और प्रसंस्करण विधियों को समझने में पारंपरिक आयुर्वेदिक सिद्धांतों और आधुनिक वैज्ञानिक दृष्टिकोणों के बीच जटिल परस्पर क्रिया पर प्रकाश डालती है। माइक्रोबियल रोगजनकों, भारी धातुओं, एंटीबायोटिक्स और अन्य पदार्थों द्वारा गाय के दूध के संदूषण से सुरक्षा सुनिश्चित करने के लिए प्रभावी पाश्चुरीकरण तकनीकों की आवश्यकता होती है। जबकि आधुनिक पाश्चुरीकरण विधियां जैसे यूएचटी और एचटीएसटी रोगजनक उन्मूलन में प्रभावी हैं, प्रोटीन के विकृतीकरण सहित दूध के पोषण गुणों पर भी उनका अलग-अलग प्रभाव पड़ता है। आयुर्वेदिक अंतर्दृष्टि, विशेष रूप से पक्का दुग्धा की अवधारणा, पोषण प्रतिधारण के साथ उष्ण उपचार को संतुलित करने पर मूल्यवान दृष्टिकोण प्रदान करती है।

यह समीक्षा आधुनिक विज्ञान के साथ दूध प्रसंस्करण में आयुर्वेदिक प्रथाओं को मान्य करने के लिए आगे के शोध की आवश्यकता पर जोर देती है। अध्ययन में सुरक्षित दूध की खपत को बढ़ावा देने के लिए संभावित नीतिगत निहितार्थ और उपभोक्ता शिक्षा का भी सुझाव दिया गया है। भविष्य के शोध पोषक तत्वों के प्रतिधारण पर गर्मी उपचार के प्रभावों, धातु के जहाजों के स्वास्थ्य प्रभावों और वैकल्पिक प्रसंस्करण विधियों का पता लगा सकते हैं, दूध की गुणवत्ता और सुरक्षा को बढ़ाने के लिए समकालीन प्रथाओं के साथ पारंपरिक ज्ञान को पाट सकते हैं।