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The Health Benefits of Ghee: A Comparative Analysis of Ayurvedic and Modern Scientific Perspectives: A Review

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ABSTRACT

The scientific perspective on dairy fats, including ghee, is evolving. In the past, dairy fats were thought to have adverse health effects, but recent research is revealing their functional benefits and the positive aspects of their fatty acids. This shift in scientific understanding has sparked interest in ghee, a clarified butter derived from milk, which holds cultural significance in India and plays a prominent role in Ayurvedic medicine. While modern scientific studies on ghee's benefits are limited, Ayurvedic literature extensively documents its therapeutic potential, categorizing different types of ghee based on factors like milk source, manufacturing methodand maturation. To explore ghee's therapeutic potential further, researchers conducted a review comparing Ayurvedic literature to modern scientific studies. These mentions were grouped into various health benefit clusters. While recent research emphasized cardiovascular health and skin benefits, Ayurveda, an ancient medical system, has emphasized cognitive benefits, gastrointestinal healthand overall nourishment. These aspects are gaining significance as the world's population ages and chronic diseases become more common. As scientists work to address these health issues, they can look to the detailed descriptions in Ayurvedic texts. These texts provide information about the animal sources of ghee, how it is processedand how it is aged, as well as its associated health benefits. This knowledge could offer valuable insights for guiding future research efforts. Exploring ghee's traditional usage and formulations could lead to new scientific discoveries and potentially innovative approaches to addressing modern health challenges.

Key words: Cardiovascular, Functional ghee, Nourishment, Therapeutic.

A fundamental component of Indian cuisine and culture is ghee. According to statistics, 30-35 per cent of milk in India is made into ghee (Intodia, 2017). Traditional foods have been created and improved over time to add variety to our diets. These foods have evolved to help prevent boredom and offer new flavors and textures in meals (Sudha *et al.,* 2024). Over the decades, ghee's rich flavour has led to an increase in its use in Indian cuisine, establishing it as a flavourful and healthful ingredient. Similar to cocoa butter in chocolate, ghee contributes textural and food structural properties to intricate dishes. Examples of this may be found in Indian desserts such as ladoo, mysore pakand halwa. It is utilized as a frying medium because, compared to most other edible oils, it has a high smoke point (~250°C) and is quite stable when exposed to high temperatures (Deosarkarn *et al.,* 2016).

India's per capita consumption of butter and ghee ascended from 2.7 kg/yr (7.4 g/person/day) in 2007 to 4.48 kg/yr (12.3 g/person/day) in 2020 (Muehlhoff *et al.,* 2013). To put this figure into context, the daily energy from dairy fat on a 2000-calorie diet is around 110 calories per person per day or 5.5% when clarified ghee and butter are consumed. Dairy products are an important part of diets worldwide. They provide essential nutrients that are beneficial for health and are commonly consumed in many cultures (Arkan *et al.,* 2024). Ghee is still a contentious food ingredient because of the divergent opinions of modern nutritionists and codified ancient medical knowledge systems, despite being a significant food product both culturally and commercially. While traditional knowledge systems like Ayurveda view ghee as a nutritious diet with medicinal significance, current nutritionists believe that dairy fat consumption should be restricted because it contains saturated fatty acids. However, there are growing arguments against this one-sided perspective on ghee's effects on human health (Heileson, 2020). People are

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becoming more interested in ghee because researchers are studying how the fats in it affect our bodies. This has led to a lot of attention on ghee compared to other types of oils and fats (Micinski *et al.,* 2012).

Review of ghee-related literature from ayurvedic scriptures

Ghee is cited widely in Ayurveda as a curative on its own and as an element in complicated medicine formulations (ghrita), according to an assessment of traditional literature (Sumantran *et al.,* 2011). Ghee is mentioned as a food in Ayurveda as well. The Charaka Samhita, it is included in the list of eleven foods that are advised to be consumed daily (Nityasevaniya Ahaara) (Wange and Wange, 2017). The virtue of ghee is denoted by several Sanskrit and colloquial terms, including pavitra, which signifies its purity, ajya, which depicts its longevity, amrita, which denotes the life-giving properties of nectarand tejas, which denotes its potency.

Ghee can be made in two different ways, according to Ayurveda. The standard procedure is to ferment milk to produce curd, spin the curd to separate butter from buttermilkand then slowly boil the butter until all the water evaporates (Halder *et al.,* 2021). During this process, the milk particles in the butter settle down slowly and are filtered out. This results in a clarified liquid that eventually cools down to form a semi-solid state, which is ghee. The resultant product is known as ghee and unless otherwise specified, the Ayurvedic literature often views ghee produced using this method as the typical procedure for creating different varieties of ghee. The second ayurvedic approach is to remove water and solids from milk by creaming it, churning butterand then slowly heating it. This second approach makes no mention of the fermentation process. According to Ayurveda, ghee also had to meet certain criteria about the age and stages of the product as well as the animal-derived milk used to make it (Panse *et al.,* 2023).

In Ayurveda, curd ghee is highly recommended, even though cream ghee received more comments while discussing the methods for making it (Gandhi and Binorkar, 2023). The curd ghee method, a traditional technique, was recommended for making ghee from different types of animal milk, aged gheeand various other ghee varieties. According to Ayurveda, old ghee, or Purana ghrita, is highly valued and has several health advantages.

According to Ayurveda, ghee produced from the milk of many animal species has a variety of useful uses of all the ghee species, cow ghee receives the most praise for its nutritional qualities and restorative effects. The benefits of camel's ghee for the digestive system (Munawar *et al.,* 2023), goat's ghee for respiratory health (Gohri *et al.,* 2023) and sheep's ghee for the excretory system are the most frequently mentioned (Kala, 2021). Based on this data, it appears that there are benefits specific to the various animal sources of ghee in addition to a baseline of benefits that are provided across the board.

Herbal ghee

Ghee is widely used in the Ayurvedic medical system for therapeutic purposes (Kumar, 2019). In Ayurvedic medicine, ghee is considered an efficient "bearer" of the lipid-soluble fraction of herbs and spices to various parts of the body. Ghee is regarded by Ayurveda as a therapeutic ingredient. In addition to being a nutritious and savory food, ghee is a great way to transport herbs. More and more health-conscious people are becoming interested in using herbs because of their health benefits. Herbs are known for their ability to help improve nutrition, support immunity and boost overall health. This growing trend is due to the healing and functional properties that herbs can offer (Kumar *et al.,* 2024). Herbs in ghee are an easy method to incorporate herbs into our daily diet. To extract all of the medicine's fat-soluble constituents, (Table 1) herbal ghee is often supplemented with herbs only (Sharma and Kumari, 2022).

The advantages of ghee

There are numerous studies on certain components of ghee, such as omega-3 fatty acids, conjugated linoleic acids (CLAs)and short-chain fatty acids (SCFAs), which have a promising role in enhancing brain health, despite the lack of research on the influence of ghee on brain health. Studies indicate that SCFAs produced by gut bacteria may have anti-inflammatory effects on Alzheimer's disease-affected microglia. Studies have shown that other healthy fatty acids in ghee, such as DHA, EPA and CLAs, have positive impacts on brain inflammation and cognitive processes. Even though n^{-3} fatty acids and CLAs are in trace amounts in ghee, the combination of SCFAs and other minor fatty acids may be responsible for some of the Ayurvedic literature's claims about the oil's advantages for cognitive function.

Research on Kalyanaka Ghrita demonstrates that it improves memory and cognitive functions (Singh *et al.,* 2023). Moreover, Kalyanaka Ghrita has been found to lower acetylcholinesterase levels, reduce oxidative stressand decrease inflammatory cytokines in the brain (Singh *et al.,* 2023). Similarly, rats' fear and spatial memory significantly improved when Jyotismati oil and ghee were combined. It has been shown to have neuroprotective properties through the inhibition of acetylcholinesterase activity, the production of brain-derived neurotrophic factor, the reduction of malondialdehydeand the increase of antioxidant enzyme levels (Shelar *et al.,* 2018). In cases of clinically confirmed depression, Kushmanda Ghrita greatly improved the clinical symptoms and psychometric measures (Soni and Rajmal, 2015). Likewise, Brahmi Ghrita, along with yoga practice, has shown potential to enhance cognitive functions among older adults dealing with mild cognitive impairment. This includes improvements in learning, attention, processing speedand working memory (Shalini *et al.,* 2021). According to these studies, using ghee as the foundation for herbal formulations may improve bioavailability and bio assimilation.

Table 1: Herbal ghee and Its benefits.

Herbal ghee (Ghrita)	Treatment	Reference
Arjuna ghrita	Heart disease	Raj *et al.,* 2020
Astamangal ghrita	Child disease	Singh, 2019
Ashvagandha ghrita	G.I. disorders	Joshi and Joshi, 2021
Patoladhya ghrita	Eye disease	Hemalatha and Rati, 2017
Panchgavya ghrita	Hysteria	Mamidi and Gupta, 2023
Phal ghrita	Feminine Disorders	Varsakiya *et al.,* 2021
Bindu ghrita	Digestive disorder	Ramya *et al.,* 2021
Brahmi ghrita	Hysteria	Kaushik *et al.,* 2021
Kushadhya ghrita	Stone	Khare, 2004
Chitrak ghrita	Spleen and liver disorder	Choudhary *et al.,* 2021
Tikta ghrita	Leucoderma	Kumar *et al.,* 2019
Vasa ghrita	Asthma	Paneliya *et al.,* 2015
Shatavari ghrita	Feminine Disorders	Pal and Mishra, 2014
Mahakalyan ghrita	Madness	Balkrishna *et al.,* 2012
Mahatriphaladi ghrita	Eye diseases	Jyothi *et al.,* 2019
Varunadi ghrita	Piles	John *et al.,* 2010
Chagaladhya ghrita	Tuberculosis	Gaba *et al.,* 2023

Gastrointestinal health benefits

Studies on the absorption of glucose and the glycemic response of rice suggest that using ghee in rice cooking and stir-frying may help regulate the postprandial glycemic reaction (Amjad *et al.,* 2023). The importance of fatty acids contained in ghee has been researched in terms of enhancing digestion and GI health, despite the paucity of research on ghee and its impact on GI health. SCFA strengthens the gut's immune system, aids digestion and maintains the integrity of the intestinal membrane. In addition to offering energy, medium-chain triglycerides (MCTs), CLA, SCFAsand n^{-3} PUFAs also have satiating properties that assist reduce energy consumption (Basak *et al.,* 2022). The combined benefits of FAs and CLAs, which encourage the gut microbiota to create more SCFAs, also enhance gut health (Peng and Biswas, 2017). Research on the effects of specific fatty acids on gastrointestinal (GI) health highlights the importance of exploring how ghee might affect various aspects of GI health and digestion.

Rejuvenating and immunomodulatory properties

According to Ayurveda, ghee is a "Rasayana," a Sanskrit word that means to nourish and circulate nutrients throughout the body. In Ayurveda, "Rasayana" therapy is used to improve immunity, prolong life, rejuvenateand delay the aging process (Aswathy *et al.,* 2021). Ghee and each of its ingredients have been shown in studies to have a positive impact on immune response modulation. While Ayurveda views ghee as having rejuvenating and immunomodulatory qualities, numerous lipid-based polyherbal compositions have been utilized for thousands of years to support immunological, lung, brain and cardiovascular health.

Using Swarna Bindu Prashana, a mixture containing gold nanoparticles in ghee, can help strengthen children's immune systems (Nelaturi *et al.,* 2021). Rats treated with the Ayurvedic formulation "Amalaki Rasayana," which contains "Amalaki" (Emblica officinalis), exhibited modest cytoprotective effects and considerable immunostimulant activity (Al-Harrasi *et al.,* 2022). In Ayurveda, cow-derived products are utilized either on their own or in conjunction with herbs and botanicals to cure a variety of ailments (Bajaj *et al.,* 2022).

Ghee's components, like butyric acid, boost immunity and aid in the intestinal tract's production of killer T cells (Zhang *et al.,* 2009). The treatment of autoimmune, inflammatoryand allergy disorders has shown benefits from linolenic fatty acids (omega-3 fatty acids) (Kelley, 2001). According to a scientific experiment, giving 3 g/d of CLAs to people aged 25 to 50 significantly improved their immune response (Song *et al.,* 2005). Therefore, ghee, its components and multiherbal ghee-based mixtures known as "ghritas" could potentially be beneficial in bolstering the immune system and reducing the severity and likelihood of various illnesses.

Ghee and cardiovascular health

The compositional focus of ghee has received a lot of negative attention because it is high in saturated fat and cholesterol, both of which have been related to health problems having previously been at risk for cardiovascular diseases (CVDs). The possibility of cholesterol oxidation products (COPs) forming when ghee is heated or cooked, as well as a potential link between these COPs and an increased risk of atherogenicity, have been other concerns. However, according to research by (Nath and Murthy, 1988). Fresh ghee clarified at 120°C did not contain COPs (Cholesterol Oxidation Products). Studies have shown that consuming ghee can reduce the production of inflammatory leukotrienes and lower blood prostaglandin

levels in rats, indicating that it may not contribute to the development of artery-clogging plaque (atherogenesis). According to Zeb and Uddin (2017), a study conducted on rabbits found that regular ghee suppresses the harmful effects of oxidized ghee on blood fat profiles. The research suggests that even though ghee consumption up to 10% levels can alter blood fat levels, it doesn't raise the risk of cardiovascular diseases. Several functional components in ghee may assist lower its atherogenic index, even though ghee's high SFA and COP content has been associated with CVDs. LDL, VLDL, cholesterol and TG levels decreased in a study when ghee was added at 2.5 per cent of total energy levels (Chinnadurai *et al.,* 2013). This reduction was dose-dependent. Additionally, it lowers cholesterol levels and the development of fatty streaks in rabbits' coronary arteries (Hosseini *et al.,* 2012). Studies on the impact of ghee-based formulations on cardiovascular health biomarkers have also been conducted. In a study examining the effectiveness of Guggulutikthaka gritha (GTG), an Ayurvedic ghee-based product used to treat dyslipidemia, rats' blood glucose and serum lipid levels were significantly reduced (Sheik *et al.,* 2022).

The relationship between ghee consumption and cardiovascular health biomarkers has also been explored in human clinical trials. According to (Shankar *et al.,* 2005), adding 10% ghee to the diet may enhance the blood lipid profile by lowering triglycerides (TGs) and raising high-density lipoprotein (HDL) levels, which may in turn reduce the risk of cardiovascular diseases (CVDs). Based on a randomized clinical trial involving 206 healthy adults aged 20 to 60, it was found that consuming ghee led to significantly lower levels of triglycerides (TGs) and total cholesterol, along with higher levels of Apo-A and HDL cholesterol compared to consuming oil (Mohammadifard *et al.,* 2010).

Some varieties of ghee, such as Eve's ghee (Avika Ghrita), enhance QTc, which may increase the risk of CVDs (Shukla *et al.,* 2012). In a different study, it was shown that consuming large amounts of ghee in addition to a meal heavy in carbohydrates changed the balance of inflammation and reduced glucose tolerance (Smvk *et al.,* 2022). A diet high in fat and carbohydrates also caused the development of metabolic syndrome and had a detrimental effect on the lipid profile in mice that were intolerant to glucose (Wong *et al.,* 2018).

Ghee remains a staple diet in many countries and plays a vital role in traditional medical systems like Ayurveda, despite contradictory scientific research on the relationship between ghee consumption and cardiovascular health.

Anti-tumor properties

Ghee may help lower the risk of several malignancies, according to studies with positive results. Vitamins A, E and K, which are found in ghee, can prevent cell damage and lessen the impacts of free radicals, which may reduce the risk of cancer (Bhattacharya *et al.,* 2006). Ghee has been found to slow down the development of breast cancer by reducing the production of cyclooxygenase^{-2} and increasing the expression of peroxisome proliferator-activated receptor-gamma (PPAR-γ) in breast tissue (Rani and Kansal, 2011). Additionally, cow ghee improves the liver's and mammary tissues' detoxification processes by inhibiting the activity of liver enzymes that activate carcinogens. These results imply that the regulation of enzyme activity linked to the metabolism of carcinogens may benefit from cow ghee (Hosseini *et al.,* 2014). Ghee solid lipid nanoparticles, which are used to deliver temozolomide (TMZ), a medication used to treat glioblastoma cells, exhibit superior drug dispersion and carrier qualities (Balasubramanian *et al.,* 2017). Exploring these pathways will shed light on the potential uses of ghee in the prevention and treatment of cancer.

Skin healing properties

The use of cow ghee in skin disease formulations is partly due to its stability even in the presence of infused botanicals and its potential to transport active ingredients from herbs to specific tissues in Ayurvedic medicine (Prasad *et al.,* 2006). Good antibacterial activity and cell viability in ghee-honey blended alginate hydrogel facilitate scarless cutaneous wound healing (Gope *et al.,* 2022). Jatyadi ghrta was found to promote quicker re-epithelialization and the deposition of collagen fibers to help repair wounds on skin tissue exposed to radiation (Gupta *et al.,* 2021). Turmeric formulations based on ghee demonstrated encouraging outcomes in the healing of wounds in dogs following surgery related to periodontal therapy (Habiboallah *et al.,* 2008). In a case study, Kaishore Guggulu, Sanjivani Vatiand the local application of ghee and Dashanga Lepa showed that dry gangrene might be healed (Bharati *et al.,* 2019). Treatment for Vitiligo (shvitra) is beneficial using Ghee, honeyand Apamarga Kshara Yoga Lepa (Jadav *et al.,* 2015). Ghee and the powdered forms of Bhringaraja and Guduchi showed encouraging benefits when used to treat eczema (Kaur and Chandola, 2010). These results demonstrate the possible health benefits of ghee and the Ayurvedic method of treating a variety of skin conditions with lipid-based formulations containing functionalized herbal ghee.

Wound healing and anti-inflammatory properties

Ghee is a lipid-based product that acts as a carrier for a variety of herbs, improving the active ingredients' solubility, extrudabilityand spreadability when applied topically to wounds (Wawre *et al.,* 2023). An analysis of ghee's ability to heal wounds reveals largely positive remarks. When ghee was applied to an umbilical cord wound, it was linked to neonatal tetanus, which was the sole drawback noted in the review (Bennett *et al.,* 1995). According to studies, ghee has anti-inflammatory properties that lessen inflammation in the lung and pancreatic tissues in cases of acute pancreatitis (Tarasiuk *et al.,* 2021). Moreover, ghee stimulates keratinocyte migration and cell proliferation, suggesting that it has a favorable impact on wound-healing

processes (Kotian *et al.,* 2019). Jyatyadi ghrta's effectiveness in wound healing has been highlighted by its demonstration of considerable wound contraction, faster closureand enhanced tissue regeneration (Jamadagni *et al.,* 2016).

In a 45-patient randomized control clinical experiment, "Manjishthadi Ghrita" showed better wound healing capabilities (Gupta *et al.,* 2011). A hydrogel infused with ghee and honey demonstrated antimicrobial properties and enhanced cell viability, aiding in the healing of wounds without scarring (Shindhe *et al.,* 2023). Burn burns completely healed after using medicinal ghee containing Tinospora cordifolia leaves and fumigation therapy (Udwadia, 2011). All of this research shows how beneficial ghee is as a healing agent for wounds.

Use in ocular health, vision and eye diseases

Several eye conditions have been studied with the use of ghee as a treatment (Dudhal-Honrao, 2017). In rats, cow ghee has been shown to help increase the medication's penetration of fluocinolone acetonide (Gupta *et al.,* 2019). Another study revealed that vitamin E and cow ghee were useful in treating cataracts caused by hyperglycemia in sheep eye lenses (Rajagopala *et al.,* 2020). Retinal sensitivity in glaucoma patients is improved by oral consumption of Triphala Ghrita or nasal delivery of cow ghee (Dhiman *et al.,* 2016). The usage of Mahatriphaladya Ghrita for Tarpana alleviated myopia symptoms and indications (Gupta *et al.,* 2010). In terms of easing the symptoms of myopia, Jeevantyadi ghrita administered through Akshitarpana showed encouraging results (Kataria and Singh, 2024). Furthermore, a comparison of Goghrita Manda Tarpana and Triphala Ghrita in the treatment of dry eye disease revealed moderate to significant improvement in patients (Timmapur and Fiaz, 2020). Overall, these findings point to the possibility that ghee can help support eye health and make it easier for medications to reach the deeper tissues of the eye.

Bone health

Even though the modern study on bone health had only favorable annotations, ghee was hardly ever addressed alone as a treatment for bone health. Based on a study, Panchatikta Ghrita (PG) has been found to possess anti-osteoporotic properties in rats. Rats with osteoporosis-induced PG treatment showed improved levels of serum and inorganic phosphate, decreased levels of calcium and phosphate in the urine, a decrease in osteoclastsand an increase in bone hardness in comparison to the sick group (Munshi *et al.,* 2016). The same authors' further research demonstrates the potential benefits of PG in preventing postmenopausal osteoporosis (Munshi *et al.,* 2021). BMD scores, quality of lifeand biomarkers specific to bones were all improved by PG administration. According to these findings, PG may be used as an osteopenia preventive treatment (Munshi *et al.,* 2019).

CONCLUSION

This paper discusses the differences between Ayurvedic literature and modern scientific studies regarding the benefits of ghee, a type of clarified butter. In Ayurveda, ghee is valued for its various health benefits, such as cognitive health, nourishment, rejuvenation, immunity and gastrointestinal health. However, modern scientific research has mainly focused on the potential cardiovascular risks associated with consuming ghee, primarily due to its saturated fatty acid content. While Ayurvedic texts highlight the positive aspects of ghee, modern scientific studies have largely neglected its potential benefits in various areas such as cognitive health, gastrointestinal health, wound healing, dermatological applications and eye health. A few small studies have shown encouraging findings, indicating that ghee might have potential benefits in preventing and treating different health conditions like tumors/cancers, skin problems, eye issuesand wound healing. Further research, including comprehensive interventional trials, is needed to fully understand the mechanisms behind these potential benefits and establish clear guidelines for ghee consumption. Additionally, exploring the individual fatty acid constituents of ghee and its potential as a carrier of medicinal ingredients could open up new avenues for research and collaboration between Ayurveda and modern medicine. This collaboration could lead to the development of new formulations and optimized use of ghee for improving health outcomes.

Confilict of interest

All authors declare that they have no conflicts of interest.

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