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Unveiling the Therapeutic Potentials of Ghee: Insights from Ayurvedic Texts and Contemporary Research

Review Article

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Abstract

Background: Recent research has brought attention to the bioactive properties of dairy fats, leading to a shift in the scientific community's perspective. Ghee, a clarified butter integral to Indian culture and cuisine, has been extensively documented in Ayurveda for its therapeutic benefits. Objective: To examine the health benefits of ghee as described in Ayurvedic texts and modern scientific literature, identifying areas of alignment and divergence. Methods: Ayurvedic Review: Analysis of 11 classical texts spanning 3000+ years, identifying 4000 references to milk derivatives, including 774 mentions of ghee. Benefits were categorised into 15 clusters. Modern Literature Review: Examination of studies published between 1990 and 2023, focusing on ghee's therapeutic applications. Results: Ayurvedic Insights: Ghee is highlighted for cognitive enhancement, gastrointestinal health, and nourishment, with 2913 references to the benefits of milk derivatives. Modern Insights: Research primarily emphasises ghee's role in wound healing, skin health, and cardiovascular benefits. Discussion: Ayurvedic and modern perspectives offer complementary insights. While modern science has explored ghee's topical and cardiovascular applications, Ayurveda underscores its systemic benefits, including cognitive and digestive health. Conclusion: The integration of Ayurvedic knowledge and modern science could unlock ghee's therapeutic potential, addressing chronic and age-related diseases. Future interdisciplinary research is crucial for validating traditional applications and discovering innovative treatments.

Keywords: *Ghee, Ayurveda,* Therapeutic Benefits, Bioactive Properties.

Introduction

Ghee, a cornerstone of Indian cuisine and culture, constitutes 30–35 % of milk transformation in India (1). Its sumptuous flavour and nutritional attributes have solidified its reputation as a wellness-enhancing ingredient. Ghee's culinary versatility is evident in its utilisation as a frying medium, spread, and topping, adding texture and structure to various dishes like Mysore pak (2, 3). With an average daily energy expenditure of 5.5% on a 2400 caloric diet, the average person's intake of Butter and ghee increased to 4.48 out of 5 kg/yr (12.3 g/person/day) from 2020 onward (4,5). This represents an increase of 120 calories per individual daily. While traditional Ayurvedic knowledge lauds ghee's therapeutic efficacy (6–11), modern nutritionists stress limiting dairy fat consumption due to saturated fatty acids. However, recent research on lipids and fatty acids has rekindled interest in ghee's distinctive profile (12, 13). This review seeks to explore ghee's therapeutic value in Ayurveda literature, generating fresh theories for research, including medical and pre-clinical studies, and examining the complementarity between modern scientific research and Ayurvedic focus. The review adopts a comprehensive methodology that combines traditional ayurvedic knowledge with contemporary scientific perspectives. Ayurvedic analysis includes an exhaustive examination of 11 classical texts, which span more than three millennia from the 15th century BC to the 17th century BC. This process indexed more than 4,000 references to milk and its derivatives, including 774 references specifically to ghee. These are classified according to source, production methods, therapeutic applications, and pharmaceutical characteristics, providing an overview of the wide use of Ghee in Ayurveda. For modern purposes, extensive literature research has been conducted in databases such as PubMed, Google Scholar, and Science Direct. This led to 246 first articles, which were refined to 109 studies after eliminating duplicates and irrelevant content. The analysis highlighted areas of alignment and divergence between the traditions of ayurvedic medicine and contemporary research, focusing on therapeutic benefits such as wound healing, gastrointestinal health, cognitive function and skin health. Despite its broad scope, the study faces some limitations. The interpretation of ancient Ayurvedic texts may be subject to linguistic and contextual prejudices that may have an impact on the accuracy of translations. In addition,

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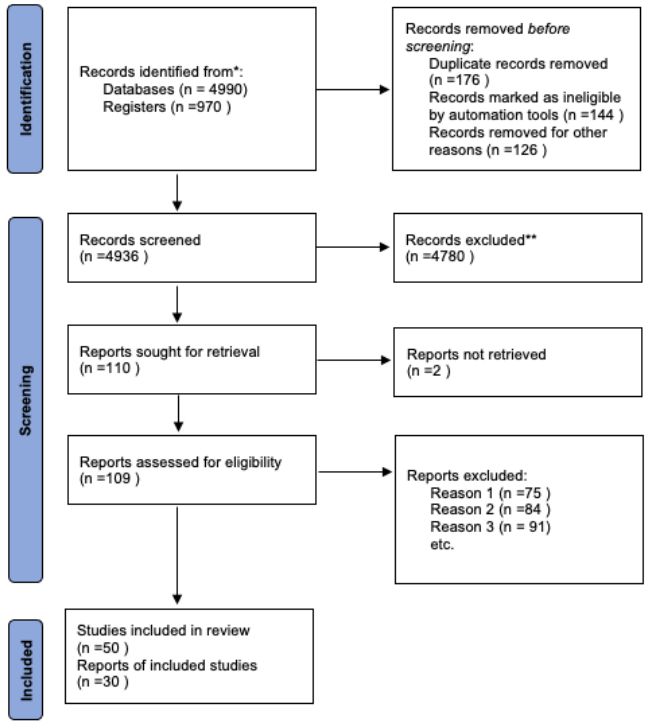
modern scientific literature is limited in some areas, such as the benefits for cognitive and digestive health, compared to the extensive documentation in the Ayurvedic texts. In addition, the comparative approach bridges traditional and modern knowledge, but may not include all therapeutic aspects of Ghee due to changes in research objectives and methodology. Finally, the applicability of the Ayurvedic findings to modern contexts requires more clinical validation to ensure their generalisation in various populations and health conditions.



Brief note on ghee

Ghee, a culinary product derived solely from milk, cream, or butter, boasts a distinctive flavour profile and physical attributes, comprising 99.5% lipid content and less than 0.5% moisture, as stipulated by CODEX Alimentarius and FSSAI (14, 15). Ghee is an exemplary source of lipophilic vitamins, including vitamins A, D, E, and K, and phospholipids, rendering it a valuable constituent of a salutary diet (16). Ghee's composition of fatty acids is varied, including monounsaturated, saturated, and polyunsaturated fats that are categorised according to chain lengths and degree of unsaturation, in addition to short, small and long-chain fatty acids (17). Ghee's unique and advantageous culinary component status stems from its converted linoleic acid content, omega-3 fatty acid and omega-6 fatty acid content, and lipid content.Scientific investigations have demonstrated the profound health benefits of these fatty acids, including anti-inflammatory and antioxidant effects, and their association with cognitive function and neural health (18). The scientific community has extensively probed the non-calorific roles that revealing their potential to mitigate disease progression and promote overall well-being (19). A detailed breakdown of ghee's fatty acid composition is provided in supplementary material (S1) (20, 21).

The approach used for the literature review on Ayurveda

To explore the Ayurvedic perspective on ghee, an exhaustive examination of pertinent sections in eleven ancient texts (*Charaka Samhita, Sushruta Samhita, Ashtanga Hridayam, Ashtanga Sangraha, Bhela Samhita, Kashyapa Samhita, Bhavaprakasha, Madhava Nidana, Sharangadhara Samhita, Chakradatta and Charaka Nighantu*) was conducted, spanning a vast timeline of more than three millennia, from the fifteenth century BCE to the seventeenth century CE. The review encompassed seven foundational treatises, two lexical compilations (*Nighantus*), and two classical texts, focusing on sections that elaborated on milk and its byproducts. The referenced texts and selected sections are listed in supplementary material (S3). The chapters on "*Ghrita Varga*" and poems describing the characteristics, uses, and classification of ghee, *ghrita, ajya, and sarpi* were the main focus of the examination. Every reference to ghee, milk, curd, melted butter, and buttermilk was painstakingly indexed, as were related details like the milk source, processing methods, pharmacological qualities, *rasapanchaka* traits, *tridoshik* steps, medicinal uses, health advantages, and limitations. An extensive understanding of ghee in Ayurveda was obtained from the 4000 references for milk and milk-derived items that this meticulous approach produced.

Review of ghee-related literature from Ayurvedic scriptures

Ayurvedic scriptures extensively cite ghee as a curative agent, both independently and as a constituent of complex medicinal concoctions (G*hrita*). Ayurvedic further acknowledges ghee as a healthful diet, and its Caraka Samhita lists it as a suggested everyday meal (*Nityasevaniya Ahaara*), highlighting its health benefits and nutritional significance.Various Sanskrit and vernacular appellations for ghee, such as *pavitra, ajya, amrita, and tejas*, accentuate its immaculacy, enduring nature, vitalising qualities, and efficacy. Among the four thousand mentions of milk and dairy-based items, 2913 mentions highlighted their therapeutic benefits, with ghee being the most frequently cited product (774 references, as depicted in Fig. 1). Ayurvedic texts describe two methods of ghee preparation, with the default method involving fermentation, separation, and heating, and the second method involving creaming, churning, and heating. The texts also mention various ghee qualifiers, including animal source, age, and phase, resulting in 10 types based on animal source, 7 types based on ageing duration, two types according to stage, and two types according to the production method. A detailed classification of ghee in Ayurveda is provided in supplementary material (S2).

Following a thorough examination of all references to ghee in Ayurvedic writings, cow ghee is among the most frequently mentioned varieties (Table 1), with goats, camels, buffaloes, and other types

following closely behind (Fig. 2) (22). Vintage ghee is highly esteemed for its numerous health benefits. Differences in *rasa, guna, virya, vipaka*, and *dosha karma* may be observed in the medicinal effects of various kinds of ghee. The six benefit subcategories (Fig. 3) were used to classify the 776 mentions of ghee. The top five advantages were eye, ear, nostril, and vocal health; nutrition; digestive wellness; and mental wellbeing. According to Ayurveda, ghee from various kinds of animals has various health advantages. While camel ghee is said to have advantages for the gastrointestinal tract, goat ghee is said to have benefits for breathing, and sheep ghee is said to have benefits for the system of elimination. Cow ghee is mentioned most for its strengthening and revitalising qualities. Based on Ayurvedic pharmacology, the research determines that ghee, regardless of origin, offers both a fundamental and unique set of advantages.

Figure 1: Number of mentions of milk and milk products in the selected Ayurveda texts. (131)

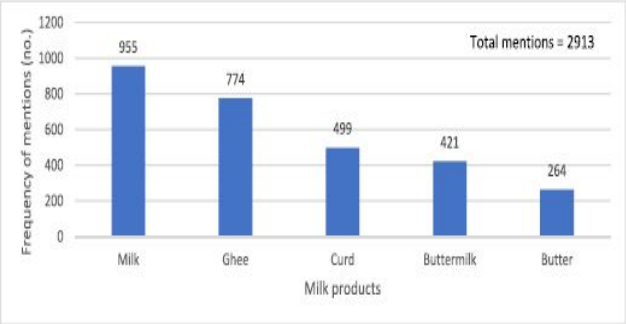
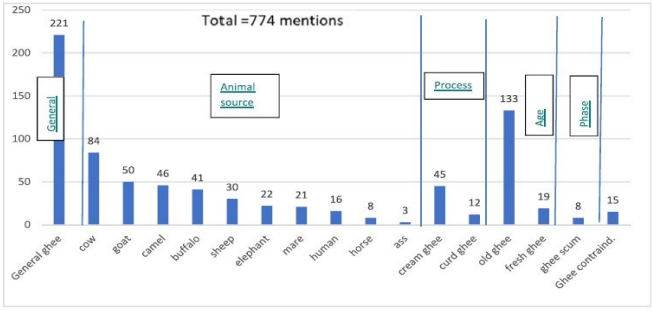
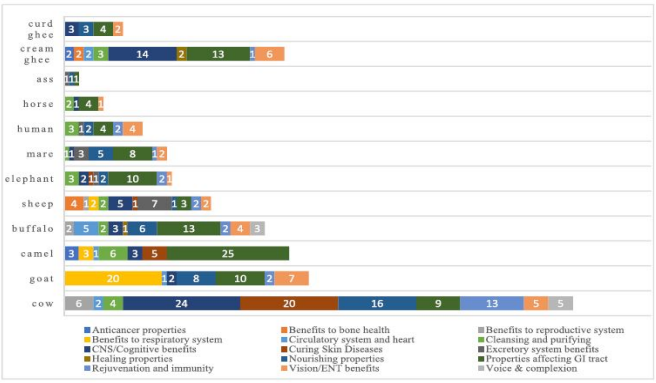


Figure 2: Number of mentions of ghee based on type - its animal source, process, age and phase



(Only the 774 mentions that had therapeutic annotations were considered for this analysis)
*Ghee contraind. = contraindications to ghee. (131)

Figure 3: Frequency of mentions of ghee based on its 'source' for the 15 benefit clusters (131)



[Mentions of ghee based on source (321 mentions) is a subset of 'all types of ghee' (774 mentions) given in Fig. 3].

Table 1: Ghee variability is modulated by tridosha and ayurvedic characteristics (rasapanchaka)

S.NO	Types of ghee	Vipaka	Virya	Guna	Rasa	Pitta	Vata	Kapha
1	Human ghee	Light	__	__	__	Decrease	Decrease	Decrease
2	Cow ghee	Sweet	Cold	Heavy	Sweet	Decrease	Decrease	Decrease
3	Mare ghee	Sour	Hot	Light	Saline	Decrease	-	-
4	Ghee(General)	Sweet	Cold	Heavy	Sweet	Decrease	Decrease	Increase
5	Camel ghee	Pungent	Hot	Light	Saline	-	-	-
6	Buffalo ghee	Sweet	Cold	Heavy	Sweet	Increase	Decrease	Decrease
7	Elephant ghee	Bitter	-	Heavy	Astringent	-	Decrease	Decrease
8	Goat ghee	Pungent	Cold	Light	Astringent	Decrease	Decrease	Decrease
9	Old ghee	Pungent	-	-	-	Decrease	Decrease	Decrease
10	Ass ghee	-	Hot	Light	Astringent	-	-	Decrease

Examining the different animal sources' fatty acid compositions in Ghee

The diverse fatty acid compositions of milk from animal fat, including chain length of sentence, saturated stages, double-bonded arrangement, triglyceride construction, and non-glyceride makeup as well, are believed to be contributing to the special benefits of ghee obtained from various sources (23). Significant differences are seen when the profiles of fatty acids in milk from different species are carefully investigated and gathered from published research (Table 2) (24–30). Although mare's milk is particularly rich in polyunsaturated fats, the fat from the milk of buffaloes, cows, and sheep is distinguished by a significant concentration of shorter-chain fatty acids. Comparing the percentages of saturated fatty acids found in cows with bovine milk fats (65.4% and 67.4%, respectively), milk from humans has a much lower proportion (39.9%).The medium-chain fatty acid concentration of elephant dairy fat is substantially greater compared to that of horse, sheep, and goat dairy fat, yet it is still significantly greater than that of bovine and buffalo milk fats (31–39). Even though the composition of fatty acids has unique characteristics, more investigation is required to pinpoint precise relationships. However, the study demonstrates the significant differences in the composition of fatty acids in ghee or fat from milk among many species, highlighting the unique qualities of all and their possible beneficial effects on health.

Table 2: The amount of fat in milk for different animal and human species (131)

Common name	Fat from mare milk	Fat from elephant milk	Fat from camel milk	Fat from human milk	Fat from sheep milk
Heptadecanoic acid	0.38±0.02	1.01±0.46	0.35±0.37	0.30±0.10	0.21±0.30
Linolenic acid	14.63±3.33	1.45±1.45	2.55±1.15	12.07±2.54	2.98±0.66
Capric acid	6.47±0.73	27.78±7.61	0.27±0.00	1.16±0.32	6.46±0.98
Oleic acid	20.86±1.06	18.07±6.06	25.44±5.39	33.37±2.66	21.15±3.22
Stearic acid	1.26±0.06	7.24±5.89	15.00±4.18	12.77±8.91	9.78±0.36
Palmitic acid	20.51±0.30	13.12±2.80	26.45±5.76	14.65± 10.06	25.24±0.97
Myristoleic acid	0.39±0.00	0.02±0.02	0.48±0.66	0.36±0.00	0.22±0.02
CLA	0.07±0.00	0.03±0.00	—	0.02±0.00	1.47±0.32
Reference	(3,637)	(3,839)	(30-32)	(33-35)	(27-29)

An analysis of current research on ghee in light of the 6 Ayurvedic benefits groups

A thorough investigation of the literature on PubMed was conducted to uncover the potential advantages of ghee, organised into 6 predefined categories based on traditional Ayurvedic wisdom. The initial search yielded 246 articles, which were then refined to eliminate duplicates and irrelevant studies, resulting in 109 selected studies that met the predetermined inclusion criteria. A comparative examination of the literature revealed distinct areas of emphasis between traditional Ayurvedic texts and modern scientific research, with the latter focusing on cardiovascular wellness, wound repair, and skin integrity, in contrast, vedic literature emphasises nourishment, digestive balance, and mental vigour (Table 3). The analysis of current studies also highlights the practical advantages of ghee utilisation, particularly the advantages of its short-chain fatty and CLA Contents, which are presented under respective subheadings according to their specific benefits.

Table 3: Ghee references for each of the 6 benefit classes are compared between ayurvedic along with PubMed literature (131)

S.No	Advantageous group	Ghee-related paper percentage in Pubmed (%)	Ghee Mentioned Rate in Ayurvedic Medicine (percent)
1	Curing skin diseases	17.43	2.20
2	Bone health	3.67	0.90
3	CNS/Cognitive benefits	8.26	21.45
4	Gastrointestinal health	0.92	18.73
5	Excretory system benefits	0.00	3.23
6	Healing properties	23.85	1.81

Advantages of ghee for cognition

Ghee is extensively touted in Ayurvedic literature for its profound impact on cognitive function, accounting for 22% of all references (40). It is associated with augmented memory, intellectual acuity, and mental clarity, as well as the management of neurological disorders like epilepsy and insanity. However, a comprehensive search of PubMed yielded only 9 studies on cognitive benefits, constituting less than 10% of all therapeutic benefit studies on ghee (40). The effects of ghee on brain function have not been thoroughly studied, but certain of its components—such as the compound conjugated linoleic acid (42), omega-3 fatty acids (41), and short-chain fatty acids(SCFAs) (42)—have shown promise in supporting brain health. These elements have anti-inflammatory impacts on dementia-impaired microglia that are advantageous for cognitive processes as well as anti-inflammatory properties in the central nervous system (43). These ingredients in ghee might be responsible for some of its cognitive benefits. Examining ghee's possibilities in cognitive health studies may lead to groundbreaking findings, especially given the elderly worldwide population (44). Furthermore, studies on herbal formulations containing ghee, such as *Kalyanaka Ghrita* (45), *Jyotismati* oil (46), *Sarasvata Ghrita* (47), *Kushmanda Ghrita* (48), and *Brahmi Ghrita* (49), have demonstrated remarkable results in enhancing cognitive abilities and neuroprotective activity. These findings suggest that ghee may enhance bioavailability and bio-assimilation when used as a base in herbal formulations.

Benefits to digestive health

Ayurvedic texts underscore the digestive advantages of ghee, accounting for 11% of its references, while contemporary research devotes less than 1% of its studies to this benefit (49). Ghee derived from camels boasts superior digestive properties. Although investigations into ghee's impact on gastrointestinal well-being are limited, its fatty acid profile reveals potential for optimizing gut function and overall digestive health (50). The fatty acid spectrum, encompassing Short-Chain Fatty Acids (SCFAs), Medium-Chain Triglycerides (MCTs), Conjugated Linoleic Acid (CLA), and Omega-3 Polyunsaturated Fatty Acids (n-3 PUFAs), contributes to enhanced nutrient absorption, immune system support, and energy homeostasis (51, 52). Further investigation is warranted to fully elucidate ghee's effects on gastrointestinal health and digestive processes.

Strengthening and regulating the immune system attributes

Ayurvedic scripts emphasise ghee's regenerative and immune-modulating attributes, constituting 13% of its citations (53). Contemporary research allocates minimal attention to these benefits, with less than 4% of studies dedicated to this area. Ghee is revered as a '*Rasayana*,' augmenting resilience and vitality (54). Although modern investigations into ghee's immune-modulating properties are scarce, its potential to modulate immune responses is promising. Ghee-based formulations have been utilised for centuries to promote holistic well-being, encompassing cardiovascular, pulmonary, cerebral, and immune health (55). Scientific inquiry has demonstrated the immunostimulant and cytoprotective effects of ghee-based formulations (56-59). Derivatives of ghee have also shown efficacy in managing allergic and autoimmune disorders (60, 61). A clinical trial has substantiated the positive impact of ghee on immune response (62).

Wellness of heart using ghee

Ghee's relevance to cardiac wellbeing is understated in Ayurvedic scripts, but biomedical literature emphasises its significance, constituting 27% of references (63). While some investigations raise concerns about ghee consumption due to its high saturated fatty acid content and potential formation of cholesterol oxidation by products (64), which may augment cardiovascular disease risk (65), other studies suggest ghee's benefits in reducing serum prostaglandin levels and inhibiting inflammatory leukotrienes (66). Research yields disparate results, with some studies indicating ghee's non-atherogenic properties (67) and others linking it to cardiovascular disease risk (68). Epidemiological studies also show conflicting results, with some finding a inverse relationship between markers for heart wellness and ghee intake, such as reduced coronary heart disease prevalence (69-73), while others found no association (74). Human clinical trials similarly produce varied results, with some showing improved serum lipid profiles, including increased high-density lipoprotein cholesterol and reduced triglycerides (75-80), and others indicating no effect or potential harm, such as increased low-density lipoprotein cholesterol and triglycerides (81-84). Despite these conflicting findings, ghee remains a popular culinary ingredient and is being investigated for its potential therapeutic benefits, including antioxidant and anti-inflammatory properties (85-87). Comprehensive research is necessary to fully understand ghee's effects on cardiac wellbeing and establish clear dietary guidelines, particularly in modern diets and lifestyles (88-91). This knowledge will clarify whether ghee is a beneficial or harmful component of our diets and whether its potential benefits outweigh its potential risks.

Qualities that prevent tumours

PubMed research (5.5%) explores ghee's anti-neoplastic properties, showing promise in reducing cancer risk. Ghee's bioactive constituents (vitamins A, E, K) prevent cellular deterioration and neutralise harmful reactive oxygen species (92–94). Ghee also hinders mammary tumorigenesis, modulating enzyme and receptor expression (95, 96). Additionally, cow ghee suppresses hepatic enzymes involved in carcinogen activation and enhances detoxification processes (97). Ghee-based nanoparticles show promise in treating glioblastoma (98). However, two studies link ghee consumption to increased lung and prostate cancer risk (99,100). Further research is needed to elucidate ghee's potential in cancer prevention and therapy.

Healing qualities of the skin

Ghee is extensively utilised in Ayurvedic medicine for epidermal health, despite not being among the most frequently cited substances in Ayurvedic texts (101). PubMed research (17%) indicates that ghee and cutaneous wellness are a significant investigative focus (102 -103). All studies report salutary outcomes for ghee or ghee-based formulations in managing dermatological irregularities (104-105). Ghee-based formulations exhibit potency in wound recuperation and treating various skin maladies, including vitiligo, eczema, and dry gangrene (106-107). These findings underscore ghee's potential utility in managing dermatological conditions, meriting further scrutiny and clinical investigation (108- 109)].

The ability to heal wounds and reduce inflammation

According to PubMed research, approximately 24% of studies on ghee explore its restorative properties. Ghee's lipid-based composition enables it to serve as a medium for various herbal remedies, augmenting their potency and efficacy in wound care (110). A review of ghee's wound healing properties reveals predominantly favourable outcomes, with the exception of one study linking ghee to neonatal tetanus because of the way it treats injuries on the umbilical cord (111). In instances of chronic pancreatitis, ghee is being found to possess anti-inflammatory qualities that decrease swelling in the pulmonary or pancreatic tissues (112). Ghee has been demonstrated to have a beneficial influence on scar healing processes because it also encourages keratinocyte migration as well as growth (113). Substantial wound rehabilitation possibilities, notably improved contraction of wounds, closure as well, and regeneration of tissues, have been shown by a number of ghee-based compositions, including *Jyatyadighrta, Manjishthadi ghee*, and polymers combining sugar and ghee (114–117). In addition, burn injuries have entirely healed after applying medicinal ghee mixed with *Tinospora cordifolia* leaves with fogging treatments (118). Positive results in recuperating persistent wounds with infections and enhancing individuals' overall health have been reported when ghee is employed in dressings for wounds (119). Additionally, compared with control categories, ghee demonstrated exceptional healing of wounds in rodent designs, with enhanced circulation and fast epithelial growth (114). All of those trials indicate how beneficial ghee may be as an adjuvant in the healing process.

Application in vision, eye disorders, and ocular health

Research on PubMed reveals that about 8% of investigations scrutinise ghee's impact on optic wellbeing, while Ayurvedic appraisals mention ghee and its potency on ocular health in roughly 4% of citations. Scientists have probed ghee's potential as a curative agent for various ocular afflictions (120). Surprisingly, Gupta and colleagues found that 12% of respondents used ghee as a customary treatment for treating eye problems (121). Research indicates that animal ghee improves the uptake of fluocinoloneacetonide in rats (122) as well as that it can successfully treat glaucoma caused by hyperglycemia in ovine optics (123) when it is mixed with the antioxidant vitamin E. Furthermore, cataract sufferers' retinal sensitivity is improved by oral intake of *Triphala*. The *ghrita* and intranasal application of ghee from cows (124). Moreover, *Mahatriphaladya Ghrita, or Jeevantyadi ghrita* demonstrated encouraging results in reducing the signs of myopia (125, 126). In addition, an investigation combining *Goghrita Manda Tarpana* and *Triphala Ghrita* in the medical management of dry eye disease showed significant improvements for individuals (127).

Bone well-being

According to PubMed research, roughly 4% of investigations examine ghee's influence on skeletal health, whereas less than 1% of Ayurvedic appraisals mention ghee in this context. Ghee is seldom considered an independent remedy for bone wellness, despite the fact that current studies on the topic yield extremely favourable findings. Nevertheless, *Panchatikta Ghrita* (PG) has been demonstrated to possess anti-osteoporotic consequences in rodents, as evidenced by raised bone rigidity, decreased osteoclastic exertion, decreased levels in the blood of calcium and phosphate, and a reduction of these substances in urine when compared to the ill category (128). Subsequent studies by the same researchers demonstrated the encouraging effects of PG in preventing osteoporosis following menopause (129). An increased standard of existence, bone-specific indicators, and density of bones were also observed after PG therapy (130). The findings raise the prospect of using PG as a preventive measure for osteopenia in particular, which calls for more research.

Conclusion

The synergy between Ayurvedic wisdom and modern scientific inquiry has the potential to unlock ghee's vast therapeutic potential. By bridging the knowledge gap between traditional and contemporary understanding, we may uncover novel applications for ghee in promoting cognitive resilience, gastrointestinal balance, and immune function. Furthermore, its potential as a functional food and carrier of medicinal ingredients warrants further exploration. Through collaborative research and rigorous clinical trials, we can harness ghee's benefits to enhance human health and wellbeing, paving the way for a new era of integrative medicine.

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