

Traditional Indian Medicine

A systematical review of traditional Ayurvedic and modern medical perspectives on *Ghrita* (clarified butter): a boon or bane

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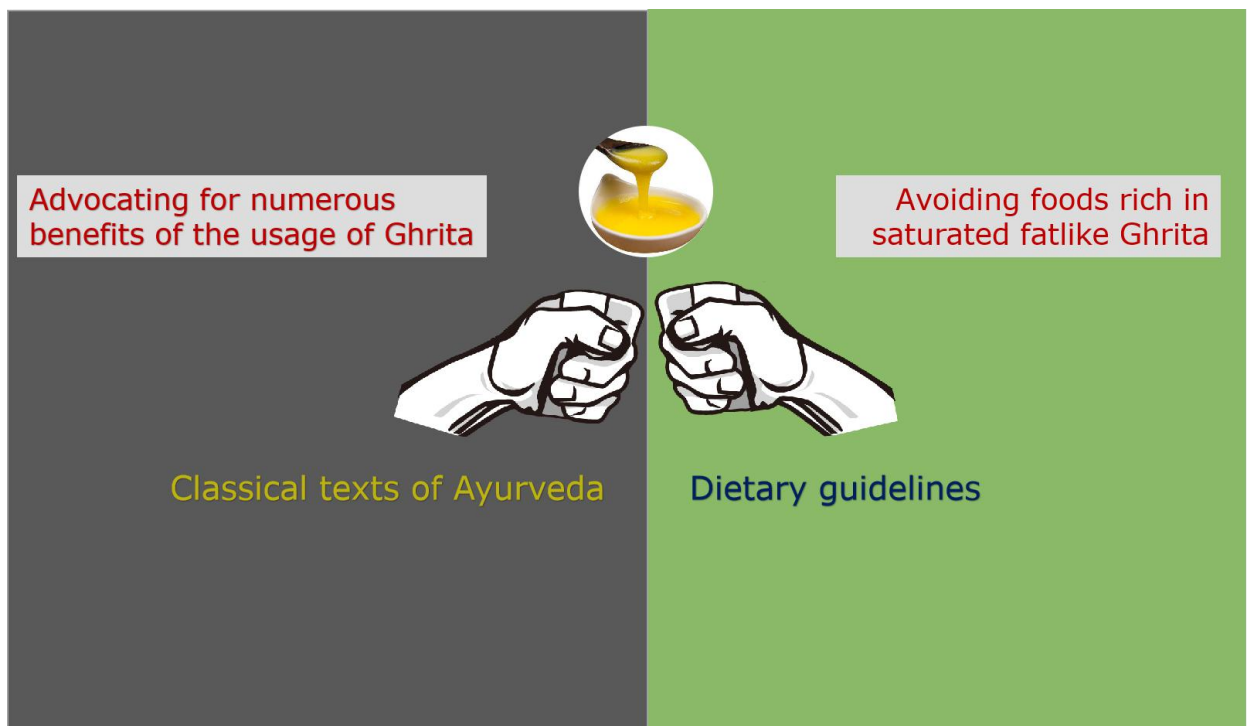
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Highlights

Ghrita (clarified butter), treated as the culprit of a number of diseases, has been depicted incorrectly for a long time. This review presents the complete picture in view of Ayurvedic perspective and recent researches on *Ghrita* to let the readers contemplate again on *Ghrita*.

Traditionality

Ghrita, also called as clarified butter in Sanskrita, has been used for more than 5,000 years throughout the Indian subcontinent and has been an inevitable part of diet in the Indian cuisine. It has also been traditionally associated with a number of health benefits recorded in *Charaka* (the most ancient written text of Ayurveda dating to [second century B.C.](#)), such as promoting strength and longevity, promoting appetite and digestion, increasing cognition, etc.



Abstract

Background: For long dietary guidelines, it is recommended to avoid foods rich in saturated fatlike *Ghrita*, also named clarified butter or ghee, which is considered as the culprit of cardiovascular diseases, diabetes, stroke, etc. Contradictory to the modern medical science, Ayurveda advocated for numerous benefits of the usage of *Ghrita* in the judicious manner. This paper systematically reviews and analyses the scientific researches that carried out on the benefits and harms associated with the usage of *Ghrita*. **Methods and Findings:** A search over the various search engines like Pubmed, Google was made. The relevant articles and chapters from books retrieved in English language were saved to a folder and analysed for their utility relevant to the topic and the matter was presented in a systematic manner. **Results:** *Ghrita* consisted various fats (saturated, monosaturated and polyunsaturated), fatty acids, minerals, vitamins etc. And the composition of *Ghrita* varies along with the method of preparation. Scientific researches carried out on *Ghrita* plain as well as medicated have reported about the depressant effects of medicated *Ghrita* in gross behavioural tests, potentiated phentobarbitone sleeping time, analgesic effect and stimulatory effect on cognition. Further, studies conducted to evaluate the effect of *Ghrita* on the serum lipid levels showed a dose dependant decrease in the total cholesterol, low density lipoproteins, and very low density lipoproteins. *Ghrita* was also reported to have wound healing activity. **Conclusion:** The results of the study suggest the beneficial effects of plain as well as medicated *Ghrita* on the various components of health and break the myth associated to the exclusion of *Ghrita* in diet. These researches also substantiate the claims made by the classical texts of Ayurveda. **Keywords:** Ayurveda, *Ghrita*, Clarified butter, Ghee, Cardiovascular diseases, Diabetes

Concepts:

Oja: The vital essence of all tissue crucial for life and immunity; *Vata, Pitta and Kapha*: Vata, Pitta and Kapha are three bodily humors that make up one's constitution according to Ayurveda and working in coherence and equilibrium are responsible for all the functions of the body; *Sanskrohigunantaradhanam*: It adopts on the properties of herbs and substances with which it is processed and also retains its own qualities.

Abbreviations:

CVDs, Cardiovascular diseases; CNS, Central nervous system; FAs, Fatty acids; SFAs, Saturated fatty acids; UFAs, Unsaturated fatty acids; MUFA, Monounsaturated unsaturated fatty acids; PUFAs, Polyunsaturated unsaturated fatty acids; LDL, Low density lipoprotein; HDL, High density lipoproteins; DHA, Docosahexaenoic acid; CADs, Coronary artery diseases; TG, Triglyceride; VLDL, Very low density lipoproteins; SOD, Superoxide dismutase; HMG CoA, 3-hydroxy-3-methylglutaryl coenzyme A; COPS, Cholesterol oxidation products; CHD, Coronary heart disease; TC, Total cholesterol; CLA, Conjugated linoleic acid; BG, *BrahmyadiGhrita*; PFA, Polyunsaturated fatty acid.

Competing interests:

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Background

Ghrita in Sanskrita, also called as clarified butter or ghee, has been used for more than 5,000 years throughout the Indian subcontinent and has been an inevitable part of diet in the Indian cuisine. Apart from the incredible taste it delivers to the food items, it has been traditionally associated with a number of health benefits in *Charaka*, the most ancient written text of Ayurveda dating to [second century B.C.](#), as promoting strength and longevity, providing protection from various diseases, promoting appetite and digestion, increasing cognition, providing lubrication to the various parts of the body, etc.

On the other hand, the researches of modern medical science have associated *Ghrita* to a number of diseases such as cardiovascular diseases (CVDs), ischemic heart disease, obesity, type 2 diabetes mellitus, stroke, overall increase in mortality etc. The growing confusion over the potential benefits or the harmful implications prompts the researchers to conduct this review.

Methodology

The review of literature was carried out in two phases of Ayurvedic and contemporary review. The classical compendium of Ayurveda was explored to find the relevant matter regarding the descriptions about the usage of *Ghrita*.

The contemporary literature review was done using Pubmed, Google and hand search. All the articles available on the topic till the year 2018 were included in the search based on inclusion criteria. Hand search refers to searching the articles from cross-references of the articles selected for review and is meant to purposefully select articles as per their content and suitability. This process was undertaken at the stage of eligibility and inclusion and helps in recognizing articles that didn't typically undergo the method of identification and screening.

The searching strategy for Pubmed was as follows: (*Ghrita* OR ghee OR clarified butter OR butter oil) and (composition OR benefits OR harm OR side effects OR diseases OR usage) and (researches OR concepts OR Ayurveda OR scientific aspects OR studies). Similar but adapted search terms were used for other databases. This study adopted a narrative review approach instead of a quantitative approach as used in meta-analysis. Hence, statistical analysis was not required for this review.

Inclusion and exclusion criteria

The review included articles published in English language only. Furthermore, original researches including clinical trials, observational studies,

experimental studies, review articles, chapters from books were recruited for the purpose of review. Single case reports and studies not falling in the above mentioned categories were excluded from the review.

Data extraction and analysis

In the first phase, the articles were identified based on the objectives of the study. In the second phase, the identified articles were pooled together for the purpose of screening by reading the titles and thereafter the abstracts. Articles which were not satisfying the inclusion criteria were excluded at this stage. After this, the eligible articles were further vetted and assessed by reading the complete texts and those not meeting the inclusion criteria were excluded. By the end of this process, 50 eligible full-text articles meeting the inclusion criteria were included along with other relevant matter from chapters of books.

Observation

Ghrita is almost anhydrous milk fat prominent in the hierarchy of Indian diet and is given great importance in diet. *Ghrita* is not only used as a food but also is a main ingredient for many Ayurveda medicines and is an excellent vehicle for administration of drugs [1].

Results

Benefits of *Ghrita* as described in Ayurveda

Charaka, the most ancient written text of Ayurveda dating to [second century B.C.](#) [2], has inscribed the benefits and indications of *Ghrita* as the best amongst all unctuous substances or fats. It promotes memory, intellect, digestive capacity, reproductive capacity, fatty tissue, and *Oja* (the vital essence of all tissue crucial for life and immunity) [3]. *Ghrita* has been described to alleviate *Vata and Pitta* [4] and increase *Kapha* (*Vata*, *Pitta* and *Kapha* are three bodily humors that make up one's constitution according to Ayurveda and working in coherence and equilibrium are responsible for all the functions of the body) [3]. *Ghrita* is also described to alleviate poisons, insanity, phthisis, fevers, epilepsies, syncope) and chronic pains occurring in the genital tracts, ears and head [4]. Vagabhatta, the author of the classical text *Ashtanga Hridaya and Ashtanga Sangraha*, has additionally described *Ghrita* to be also beneficial for patients suffering from tumors, sinuses, ulcers and worms diseases [5].

Ghrita is described to have unctuous, penetrating property along with being light in digestion as well as have sweet taste, cold potency and sweet post digestion effect [6, 7]. All these properties make it an excellent vehicle for lubrication, both for internal consumption as well as for external application. *Ghrita* has been described as the most unique substance in the fact that it possesses the effect of *Sanskarohigunantaradhanam*

(It adopts on the properties of herbs and substances with which it is processed and also retains its own qualities) [1]. This quality of *Ghrita* makes it an excellent vehicle for drug administration and its spreading nature facilitates the dispersion of all medicinal properties to the deepest tissues. In this context it is also referred to as catalytic agent [8].

Ayurveda has traditionally considered *Ghrita* to be the healthiest source of edible fat with many beneficial properties like improving voice and complexion, promoting memory, intelligence and power of digestion, boosting up immunity, helping in absorption of vital nutrients, lubricating the connective tissues there by rendering the body more flexible. Ayurveda described for the regular consumption of *Ghrita* as it boosted the mental as well as physical strength of the individual and also warded off diseases [9].

Medicated *Ghrita*

Ghrita was given foremost importance for internal usage in diet and as an adjuvant medicine in Ayurveda. It is used in different doses for different purposes at different timings in Ayurvedic treatment. There are many therapeutic forms of drugs described in Ayurvedic classics like tablet, powder, self-generated alcohol, processed medicated oil and skimmed milk fat. There are about more than 55-60 medicated *Ghrita* described in the Ayurvedic classics [10]. Medicated *Ghrita* are mainly used to alleviate and manage vitiated *Vata*, *Pitta* and *Kapha*. It is prepared by boiling *Ghrita* with decoction of herbs integrated with paste of herbs. Drug given in the form of *Ghrita* would not only be digested and absorbed fast but also be able to reach some of the most distant areas of body like the central nervous system (CNS). There are several medicated *Ghrita* used in Ayurveda for better treatment modality. It is stated that *Ghrita* promoted remembrance intellect and power of absorption. According to Ayurveda classical texts, various types of *Ghritas* were recommended for treatment of CNS disorders. Further *Ghrita* preparations are also described in the treatment in other diseases like anaemia, which demonstrating the probable role of *Ghrita* on membrane stability.

Composition of *Ghrita*

Ghrita made from cow milk is considered as superior to all other *Ghrita* [11]. Like many dairy products, *Ghrita* is composed almost entirely of fat, 62% of which consists of saturated fats. Composition of *Ghritas* was given in the Table 1 [12]. *Ghrita* is a valuable source of fat soluble vitamins A, E, and K. It is a rapid source of energy compared to other vegetable oils because it contains short-chain fatty acids (FAs), which are readily absorbed and metabolized.

However, researches have proved that the composition of *Ghrita* varies with the method of preparation. There are several methods of preparation

of *Ghrita*, like preparation of *Ghrita* by indigenous method also called as traditional or homemade method, direct cream method, creamery butter method, pre stratification method, continuous method etc. All these procedures to produce *Ghrita* rely upon heating at temperatures from 105 °C to 118 °C to remove the water. Indigenous method is the traditional method which basically involves two kinds of methods [13]. In the first method, raw or heated milk is covered at room temperature for around 12 hours and a bit of yoghurt is added to it and left undisturbed overnight. This makes more yoghurt by the process of lactic acid fermentation which is churned with water to obtain cultured butter used to simmer into *Ghrita* on low flame. The second method involves the separation of the clotted cream of boiled and cooled milk which is then converted into yoghurt and is churned to take out butter which is then simmered on low flame into *Ghrita*. Direct cream method involves the separation of cream from milk by centrifugation and omits the need for production of butter because cream is directly converted into *Ghrita*. This method is mostly adopted commercially for producing *Ghrita* in large amounts. Other methods are used in industries to prepare *Ghrita* in bulk amount. The difference in the preparation of *Ghrita* by different methods is presented below in Table 2 and 3 [14, 15].

Ghrita: an important but controversial lipid

Ghritas belong to an important category of bio-organic compounds called as lipids, which are essential for living organisms, besides carbohydrates, proteins and nucleic acids. Lipids, a type of carbon containing organic compounds, are classified into saturated fatty acids (SFAs), that have no carbon-carbon double bonds in the carbon chain, and unsaturated fatty acids (UFAs), that have one or more than one carbon-carbon double bond in the carbon chain, based on their saturation levels. UFAs is further categorized as monounsaturated UFAs (MUFAs) and polyunsaturated UFAs (PUFAs). SFAs with the same number of carbons in the chain will have a higher melting point as compared to UFAs as the presence of double bonds lowers the melting point [16, 17].

Plant based oils are generally rich in UFAs, while the products derived from animals are rich in SFAs. These SFAs in animal products are produced by the hydrogenation of plant based UFAs with gaseous methane (produced as a waste product during the anaerobic process of fermentation going on in their lumen during the process of breakdown and digestion of plants consumed as foods). This is the reason why animal products as meat, milk, cheese and butter are rich in volatile short chain SFAs like acetic acid, propionic acid, butyric acid [18].

SFAs produced as a result of ruminant biochemical hydrogenation produces mostly the cis configuration of SFAs and differs quite extensively from the FAs produced by industrial hydrogenation which converts

some cis FAs to trans FAs through the process of cis-tran isomerization. The trans configuration of SFAs are not recognized by the enzymes presented in the biological systems of humans and other animals and tend to collect in the body thus being associated with higher CVDs risk [19, 20]. Researches and publications have linked cerebro-vascular diseases, atherosclerosis [21, 22], CVDs [23] with the consumption of SFAs, predominantly due to increased levels of low density lipoprotein (LDL) [24].

However, different behavior is observed with some SFAs as caproic acid, caprylic acid, decanoic acid and stearic acid, which have been found to exhibit no effect on LDL cholesterol [25] and butyric acid (found 2-5% by weight in *Ghrita*) has a role in improving insulin sensitivity, increasing energy expenditure, exhibiting anti-inflammatory action and modulating immune response and inflammation as well as act as an anti-tumor agent [25, 26].

Table 1 Fat, fatty acids and non-fat nutrients contents in 100 g of *Ghrita*

Components	Values & units	Components	Values & units
Fats and fatty acids		Mineral content	
Total fats or lipids	99.48 g	Calcium	4 mg
Saturated fat	61.924 g	Iron	0 mg
Monounsaturated fat	28.732 g	Magnesium	0 mg
Polyunsaturated fat	3.694 g	Phosphorus	3.0 mg
Total omega-3 fatty acids	2966 mg	Potassium	5 mg
Total omega-6 fatty acids	4606 mg	Sodium	2 mg
Cholesterol	256 mg	Zinc	0 mg
Vitamin content		Copper	0 mg
Vitamin A	3069 IU	Manganese	0 mg
Retinol	824 mcg	Selenium	0 mcg
Carotene, beta	193 mcg	Sterols	
Carotene, alpha	0 mcg	Cholesterol	525 mg
Vitamin C	0 mg	Amino acids	
Vitamin D	0 IU	Tryptophan	0.004 g
Vitamin E	2.80 mg	Threonine	0.013 g
Vitamin K	8.6 mcg	Isoleucine	0.017 g
Thiamin	0.001 mg	Leucine	0.027 g
Riboflavin	0.005 mg	Lysine	0.022 g
Niacin	0.003 mg	Methionine	0.007 g
Vitamin B-6	0.001 mg	Cystine	0.003 g
Vitamin B12	0.01 mg	Phenylalanine	0.014 g
Folate total	0 mg	Tyrosine	0.014 g
Folic acid	0 mg	Valine	0.019 g
Choline total	22.3 mg	Arginine	0.010 g
Folate	0 mcg	Histidine	0.008 g
Pantothenic acid	0 mg	Alanine	0.010 g
Choline	45.7mg	Aspartic acid	0.021 g
Lycopene	0 mcg	Glutamic acid	0.059 g
Lutein + zeaxanthin	0 mcg	Glycine	0.006 g
Other contents		Proline	0.027 g
Water	0.24 g	Serine	0.015 g

Table 2 Composition of selected Omega-3 and Omega-6 fatty acids in homemade *Ghrita* as compared to commercially produced *Ghrita*

Fatty acid distribution (%)	Traditional <i>Ghrita</i>	Commercial <i>Ghrita</i>
Linoleic acid	5.1 ± 0.544	6.2 ± 1.29
Arachidonic acid	0.157 ± 0.061	0.132 ± 0.037
α-Linolenic acid	3.66 ± 0.88	3.0 ± 0.7
Docosasahecanoic acid	0.083 ± 0.003	0.062 ± 0.002

Table 3 Composition of fatty acids in homemade *Ghrita* as compared to commercially produced *Ghrita*

Fatty acid distribution (%)	Traditional <i>Ghrita</i>	Commercial <i>Ghrita</i>
Saturated fatty acid	72.4	73.2
Mono unsaturated fatty acid	18.6	17.5
n-6	5.38	6.3
n-3	3.7	3.1
n-3 : n-6	0.69	0.5

n-6: Omega 6 fatty acid; n- 3: Omega 3 fatty acid.

Lipids are structurally very important components of the human body, which serve many important functions as components of membrane (phospholipids, sphingoglycolipids and cholesterol), emulsification (bile acids), messengers (steroid hormones, cholesterol, eicosanoids) and energy storage (triacylglycerol). Cholesterol is an integral component of cell membranes and a precursor for other steroid based lipids [16, 17, 27].

Cholesterol, body physiology and the pathogenic role

Cholesterol is a component of cell membranes, nerve tissue, brain tissue and nearly all bodily fluids; hence it is the most abundant steroid in the human body. Majority of cholesterol is synthesized in the liver and to some degree in other organs [16, 17, 27, 21] and from the ingested food in the intestine. Ingested cholesterol decreases the amount of cholesterol produced by the body via a negative feed-back system. Cholesterol is packaged with FAs and protein into lipoproteins to facilitate circulation since it is water insoluble [16, 17]. Cholesterol is carried from the liver to the tissues in the form of LDL and back to the liver in the form of high density lipoproteins (HDL).

Cholesterol has been extensively researched due to its abundance in the body in both healthy and pathological conditions and was initially found as a crystalline component in atherosclerotic plaques and gallstones [28]. Anitschkow's landmark study which gave birth to the "Lipid Hypothesis" was a result of this finding where he showed that feeding pure cholesterol dissolved in oil to rabbits led to the development of atherosclerotic lesions. However, this study disregarded the fact that the humans and the rabbits differ in their processing and metabolism of

as their diet patterns are entirely different. Rabbits are obligate herbivores in which the cholesterol component is negligible [28].

Medical science pursues LDL as a therapeutic agent in the treatment of atherosclerotic diseases, which gained solid acceptance with the advent of statins for normalizing dyslipidemia and reducing the primary and secondary risk for CVDs [29, 30]. Still, abundant research data suggests that cholesterol alone is not the causative agent in CVDs [21, 24, 25, 26, 30]. In fact, the usage of statins and the inhibition of cholesterol biosynthesis has been associated with a number of negative health impacts like impairing insulin secretion and other cholesterol mediated membrane processes involving secretion of bioactive molecules such as insulin, neurotransmitters and hormones, leading to a number of medical syndromes ranging from diabetes, rhabdomyolysis to death [30, 31, 32].

Jacobson pointed out that *Ghrita* contained high concentrations of oxidized cholesterol, also known as oxysterols, up to 12.3% [33]. More recent studies clearly demonstrated this value likely was incorrect [34]. However, fresh *Ghrita* and cream samples contain barely detectable concentrations of oxidized cholesterol, whereas *Ghrita* manufactured at temperatures below 120°C only contains 1.3% oxidized cholesterol. Whether regular consumption of oxidized cholesterol at low concentration still induce atherosclerosis in humans is currently unknown.

An interesting fact was revealed by the enhance study which detect regression of fatty plaques in the arteries due to combination therapy of simvastatin, a kind of statin, and ezetimibe, a cholesterol uptake inhibitor. These patients achieved tremendous reductions in LDL cholesterol and but still experienced growth of fatty plaques in their arteries [35]. The study

was stopped at early stage because of this [36]. Other studies where LDL and total cholesterol (TC) levels were lowered severely while great health benefits to the patient were not achieved, leaving scientists and researchers a puzzle about the growth of atherosclerotic plaque [30, 37]. It is now established that lowering too much of cholesterol can result in unhealthy outcomes in some patients.

***Ghrita*: the changing perspective**

More attention is now turning towards the role of fat in the diet and more specifically to omega-3 and omega-6 FAs because of their importance not only for cardiovascular health but also for overall general health. Omega-3 FAs have been associated with the anti-inflammatory pathways in the body while omega-6 FAs is highly correlated with the inflammatory pathways. The ancient diet of India till 100 years ago favored omega-3 FAs because the ratio of omega-3 and omega-6 has been changed from 9:1 to 20-30 : 1 as a result of change from forage and grass based feeding to corn based feeding in cattle [23]. These FAs are present in *Ghrita* in the form of triglyceride (TG) which constitute the bulk of *Ghrita* approximating to about 98%. Butyric acid, one of the volatile FAs found in *Ghrita*, is associated with decreasing inflammation and normalizing some pathological processes, especially gastrointestinal inflammation [26].

A number of studies have proved that *Ghrita* prepared by traditional methods contains higher amount of docosahexaenoic acid (DHA) [38] and omega-3 long chain polyunsaturated fatty acid (PFA). DHA contributes to reduce risk of diseases like heart attack, cancer, insulin resistance and arthritis [39]. Omega-3 long chain PFA is a major component of retinal and brain tissue and has been associated with anti-inflammatory pathways. Butyric acid is one of the volatile FAs found in highest quantity in butter and *Ghrita* and has been associated to decrease inflammation and normalize gastrointestinal inflammation [25, 26, 40, 41]. *Ghrita* is fairly shelf-stable largely because of its low moisture content and possible anti-oxidative properties. Most of the activities described for *Ghrita* in the classics are known to be imparted by anti-oxidants and essential FAs such as DHA.

A low fat and cholesterol diet as advised by the doctors comprises of daily intake of less than 300 mg of cholesterol a day from a 1000 kcal/day diet in which only 30% of the calories come from fat, as outlined in the step I diet [42]. 100 g of *Ghrita* contains 178.2 mg cholesterol and it have been reported to contain 900 kcal of total energy. On this basis an intake of about 15 g of *Ghrita* daily, amounting to about 1 tablespoon, will provide about 27 mg cholesterol and 135 kcal of total energy. So it is very reasonable to include one tablespoon of *Ghrita* a day as a part of a low fat/low

cholesterol step I diet, without putting the patient at risk of intake too much cholesterol.

For years, *Ghrita* has been considered as fattening and unhealthy and has been associated to the occurrence of a number of diseases and overall increased mortality. A number of researches have explored that *Ghrita* has been implicated in the increased prevalence of coronary artery diseases (CADs) in Asian Indians due to its content of SFAs and cholesterol and in heated *Ghrita* cholesterol oxidation products (COPS) [23]. There has been concern about increased risk of CVDs due to its high percentage of SFAs in *Ghrita* [43]. A study of evaluating the effect of cow *Ghrita* and butter on memory and lipid profile of Wistar rats revealed no significant effect on cognition and memory in Elevated plus Maze and Morris Water Maze model, but showed reduction in weight of animals in cow *Ghrita* group and increase in weight in butter group. However, there was a significant increase in TG and very low density lipoproteins (VLDL) levels of rats in butter groups and increase in TG and VLDL of rats with cow *Ghrita* [44]. Study on usage of *Ghrita* in Fischer inbred rats, which serve as a model for genetic predisposition to diseases, showed an increase in serum TC and TG levels after feeding a 10% *Ghrita*-supplemented diet [10].

A previous research on Sprague-Dawley outbred rats, which serve as a model for the general population, showed no effect of 5 and 10% *Ghrita* supplemented diets on the levels of serum cholesterol and TG [45]. Research performed on male Wistar rats found that *Ghrita* from prolonged heating decreased the cholesterol levels and increased the COPS levels in *Ghrita*. However, animals fed with *Ghrita* or heated *Ghrita* with significant levels of COPS, both demonstrated an overall decrease in serum lipids of 2.5% - 10% [46]. Researches suggest that such a kind of reduction in the levels of serum cholesterol may be due to increased secretion of biliary lipids [46]. Researches have even documented that *Ghrita* raised the HDL, that is called as the good cholesterol, and thus slightly raise TC levels [47]. A survey study conducted on 200 people in north India revealed that people who consumed more *Ghrita* and less mustard oil in their daily routine documented lower LDL levels and higher HDL levels [48].

Saturated fats, in which *Ghrita* is also considered, have been in the line of fire for more than three decades. The major drawback in understanding of fats was to equate all SFAs as one. The oversimplification of the relationship of saturated fats with CVDs led to unwarranted removal of some valuable fats from our diets. Recently, the relationship of dietary saturated fats and that of individual SFAs to CVDs risk has been reevaluated. All saturated fats are not equal and they are not as bad as they are made out to be. Thus, not all SFAs in natural fats are atherogenic. Butter, clarified butter, coconut oil, and palm oil as a part of a healthy

diet are not contraindicated [49]. *Ghrita* by nature is lipolytic, which breaks down fat and this is due to its short chain fatty acid structure. It reduces cholesterol by increasing contribution of lipids towards metabolism. Studies showed that the consumption of up to 10% *Ghrita* in the diet had a positive effect on serum lipid profile [45]. There was a dose-dependent decrease in TC, LDL, VLDL and TG when *Ghrita* was given at levels greater than 2.5% in the diet. Liver cholesterol and TG were also decreased [10]. Another study on effect of dietary *Ghrita* at levels ranging from 0.25 to 10% was included in a nutritionally balanced AIN-76 diet, a type of standard purified diet for rats reported by the American Institute of Nutrition, fed to Wistar rats for a period of 8 weeks. The serum lipid profiles of these animals showed a dose dependent decrease in TC, LDL and VLDL. This study revealed that the consumption of *Ghrita* up to a 10% level in the diet altered blood lipid profiles and then not elevated the risk factors for CVDs [45]. In another study during 5-23 years of follow-up of 347,747 subjects, 11,006 developed coronary heart disease (CHD) or stroke. Intake of saturated fat was not associated with an increased risk of CHD, stroke, or CVDs. A meta-analysis of prospective epidemiologic studies showed that there was no significant evidence for concluding that dietary saturated fat is associated with an increased risk of CHD or CVDs. More data are needed to elucidate whether cardiovascular disease risks are likely to be influenced by the specific nutrients used to replace saturated fat [50]. When *Ghrita* was used as the sole source of fat at a 10% level, there was a large increase in oleic acid levels and a large decrease in arachidonic acid levels in serum lipids [46].

A study on a rural population in India showed a significantly lower prevalence of CHD in men who consumed higher amounts of *Ghrita* [51]. High doses of medicated *Ghrita* decreased serum cholesterol, TG, phospholipids, and cholesterol esters in psoriasis patients. Another study conducted by Kumar MV, *et al.* to study the effect of medicated *Ghrita* on serum lipid levels in psoriasis patients reported significant improvements in the patients' symptoms as well as the decrease in serum lipid levels [44]. A study published in September 2012 in "The Indian Journal of Medical Research" reported that *Ghrita*, when compared to soybean oil, decreased enzyme activity, which was responsible for activating carcinogens in the liver. The study also showed that *Ghrita* helped to increase carcinogen detoxification-the expulsion of carcinogens from the body. This animal study indicated significant potential health benefits in terms of protecting and defending against cancer [52]. In another study for 44 weeks rats fed with 10% of calories from *Ghrita* had lower levels of several breast cancer markers as compared to rats fed with the same percentage of soybean oil [53].

A randomized clinical trial conducted with 129 healthy participants aged 20-60 years in 3 groups with a diet containing cooking and frying liquid, *Ghrita*, or hydrogenated fats for 40 days, demonstrated that TC, TG and Apo B had a significant reduction in the liquid oil group compared to the hydrogenated oil group. The *Ghrita* group demonstrated decrease in TG and a raise in HDL and Apo A [54]. Similar findings were revealed by a study on female Wistar rats fed with soybean diet (Control diet), low conjugated linoleic acid (CLA) diet and high CLA *Ghrita* diet (treatments) for thirty five days for studying antioxidative enzymes and sixteen weeks in case of antiatherogenic studies, revealed an increase in catalase and superoxide dismutase (SOD) enzyme activities in blood and increased catalase, SOD and glutathione transferase enzymes activities in liver by 27, 130 and 168 percent, respectively. Feeding of high CLA *Ghrita* resulted in lower plasma cholesterol and TG level, and higher HDL than feeding of soybean oil (control group), manifesting a decrease datherogenic index. Lesser cholesterol and TG levels were observed in the liver and aorta of high CLA fed rats than those in the other groups. Histopathological studies also revealed normal hepatic cords with portal triad in the high CLA *Ghrita* fed rats as compared to fatty degeneration of hepatocytes in other groups [55].

Researches in Ayurveda on *Ghrita*

Some researches have also been conducted on Ayurvedic medicated *Ghrita* to explore their effect in various conditions. A study conducted on *Saraswata Ghrita* (a polyherbal formulation containing *Bacopa monnieri* as the main content with *Curcuma longa*, *Phyllanthus emblica*, *Operculina turpethum*, *Terminalia chebula*, *Piper longum* *Embelia ribes*. *Cow's Ghrita* etc. from Ayurveda, an ancient medicinal system of India) demonstrated that *Ghrita* had its exquisite potential for management of disorders like Alzheimers diseases and dementia [56]. A study done to evaluate the effect of *Bramhi Ghrita* (a polyherbal formulation containing *Bacopa monnieri*, *Evolvulus alsinoids*, *Acorus calamus*, *Saussurea lappa* and cow's *Ghrita*) on CNS activity in mice like motor coordination, behaviour, sleep, convulsions, locomotion and analgesia showed significant CNS depressant actions such as reduced alertness and locomotion, and diminished response to touch and noise in a dose-dependent manner [57]. Anticonvulsant activities have also been reported in medicated *Unmadnashak Ghrita* (a Ayurvedic formulation containing *Ferula narthex* (6g), *Gardenia gummifera* (6g), *Ellataria cardamom* (6g), *Bacopa monnieri* (6g), and cow's *Ghrita* (76 g), which showed CNS-depressant activity in gross behavioural test, potentiated pentobarbitone sleeping time and there was significant decrease in spontaneous locomotor count in mice. The formulation also antagonized the

behavioural effects of CNS-stimulant drug amphetamine, and showed analgesic effect in mice [58]. A scientific study used *Brahmyadi Ghrita* (BG), a formulation recommended for usage in children in the classical Ayurvedic text of Ashtang Hridaya that including *Bacopa monneri*, *Operculina turpethum*, *Baliospermum Montenum*, *Convolvulus pluricaulis*, as study group, cow *Ghrita* as control group and no intervention as plain group. Administration with single doses of BG and cow ghee in the dosage of 10 g per day to participants showed that learning and memory was significantly ($P < 0.005$) increased in children after 30 days of BG treatment group as compared to control group and plain group [59]. Other medicated *Ghritas* as *Hinguadi Ghrita* (a unique lipophilic formulation from Ayurveda claimed to pacify both psychosis and epilepsy) displayed potent anti-depressant activity comparable to standard drug imipramine hydrochloride [60]. So *Ghrita* is the drug of choice prescribed to normalize vitiated entities and to nourish, to regain the strength of brain. Similarly, a study performed by Oza, *et al.* about *Bhringarajadi Ghrita Rasayana* (a formulation mentioned in the classical text of Bhaishajya Ratnavali as an anti-ageing drug with ingredients: *Eclipta alba Hassk*, *Sesamum orientale Linn*, *Embelica officinalis Gaertn*, Sugar, Cow milk, Cow's *Ghrita*) on premature aging demonstrated an improvement in muscle weakness and mental acuity, showing the reversal of several Ayurvedic parameters of aging [61]. A study on the consumption of *Ghrita* for internal oleation revealed that oral ingestion of lipids facilitates brought the serum lipids levels to normal, though a transient rise in the lipid levels was seen immediately after oral ingestion of oil which returns to normal after body processing [62].

Discussion

Ghrita is the elixir for daily life in human beings. In routine dietetics, *Ghrita* is advised either in pure form or medicated or mixed with food articles. However, being animal fat, it is the most averted substance by the physicians of modern medicine due to its property of increasing serum cholesterol. On the contrary, according to Ayurveda, *Ghrita* was a most favoured substance, not only as an important medicine in the management of disease but also as an important food ingredient in daily diet as it also promoted the function of intellect and mind when it crossed the blood brain barrier. *Charak* mentioned the intake of *Ghrita* in various *Pitta* and *Vata Dosha* dominant conditions, allergy, respiratory diseases, skin diseases, etc [63].

These properties attributed to the various composition of *Ghrita* including saturated fats, cholesterol, omega-3 FAs, omega-6 FAs, omega-9 FAs, phospholipids, many fat soluble vitamins like Vitamin A, E and K, DHA, etc. Because the short-chain fatty

acid of *Ghrita* is readily absorbed and metabolized, it is a very rapid source of energy. Other components of *Ghrita*, such as DHA and omega-3 long chain PUFAs, are a major component of retinal and brain tissue and have been associated with the anti-inflammatory pathways to further protect against various diseases. DHA contributes to reduce risk of diseases like heart attack, cancer, insulin resistance and arthritis [39]. Butyric acid is one of the volatile FAs found in highest quantity in butter and *Ghrita* and has been associated to decrease inflammation and normalize gastrointestinal inflammation [25, 26], demonstrating anti-tumor activity to colon carcinoma cell line [40, 41]. *Ghrita* is fairly shelf-stable largely because of its low moisture content and possible anti-oxidative properties. Most of the activities described for *Ghrita* in the classics were known to be imparted by anti-oxidants and essential FAs such as DHA.

Ayurvedic classical texts described eight kinds of *Ghrita* from eight different animal milk and *Ghrita* made by cow milk was said to be superior whereas *Ghrita* of ewe milk is said to be inferior [64]. *Charaka* has mentioned *Ghrita* from ewe milk to be unhealthy to the heart [65]. In the present era, due to less production and high-price, defilement of *Ghrita* is very common. To overcome this problem, dairy industry is expanding its area for products made from the milk from other animals other than cow and buffalo. Milk of ewe is one of them which is planned to use for production of *Ghrita*. There is clear reference regarding the harmful effect of *Ghrita* of ewe milk on heart in almost all the classical texts of Ayurveda. A scientific experimental study with compared the effects of *Ghrita* made by ewe milk to that by cow milk and normal controls on heart of Wistar strain albino rats. This study showed that chronic administration of ewe *Ghrita* and cow *Ghrita* had no marked differences except the QTc prolongation in ewe *Ghrita* as compared to normal controls. This may be the basis for the classics to categorize ewe *Ghrita* as *Ahritya* (detrimental to heart) [66].

The usage of medicated *Ghrita* described in Ayurveda, is prepared by cooking herbs with it. The lipophilic nature of *Ghrita* disseminates the therapeutic properties of the drugs into cells including the brain, as it is able to cross the blood brain barrier. This is also the reason *Ghrita* has been described to act as an excellent vehicle for transporting herbs to the deepest tissues of the body [67]. The lipophilic property of *Ghrita* along with appropriate digestion, absorption and delivery to the site required are crucial for obtaining the maximum benefit from any therapeutic formulation as the cell membrane also contains lipid [68]. A study has reported increased efficacy of herbs and herb extracts on usage with *Ghrita* as compared to usage in powder or tablet form [69]. This is probably due to the composition of cells membrane consisting of the phospholipids through which metabolic waste is

exchanged across the membrane and removed through the intestine. Studies suggest oleation saturates the body's cells with lipids, which then replace the original cell lipids and remove metabolic wastes and decreases cholesterol at the same time. In a follow-up study conducted to determine the mechanism of action for the hypocholesterolemic effect of *Ghrita*, Wistar rats were fed with diets supplemented with 2.5 and 5% *Ghrita*, both native and "oxidized" (heated) made iso-caloric with groundnut oil [46]. The level of 3-hydroxy-3-methylglutaryl coenzyme A (HMG CoA) reductase activity in liver microsomes was not affected by dietary *Ghrita*, indicating that cholesterol biosynthesis was not affected by it, but instead the excretion of bile constituents was increased by 18-30%, lowering the serum cholesterol levels. Biosynthesis of cholesterol occurs primarily in the liver and is regulated by HMG CoA reductase. Oxysterols and cholesterol levels in the diet down regulated this enzyme. It also documented a decrease in TC levels by 10-25% in the serum, and by 7-14% in the intestinal mucosal cells as compared to groundnut oil fed controls, proving the hypocholesterolemic effects of *Ghrita*. Usage of *Ghrita* as the sole energy source at 10% level in animals resulted in significant decrease in the levels of cholesterol esters in the liver, which is implicated in the process of atherogenesis, increase in oleic acid by 36-40% in serum lipids, which enables LDL to resist oxidation and 65% decrease in arachidonic acid levels as compared to controls, which is a key inflammatory intermediate in the process of atherosclerosis [10].

The description of *Ghrita* to be useful for promoting intelligence, memory and wisdom may be attributed to its high content of fatty acid precursors for DHA, the deficiency of which has been described in several diseases like Alzheimer's [70]. The researches on medicated *Ghritas* also provide substantial evidence to the positive attributes of *Ghrita* in diseases mentioned above. A study on administration of high doses of medicated *Ghrita* in psoriasis patients reported decreased serum cholesterol, TG, phospholipids, and cholesterol esters along with significant improvements in the patients' psoriasis symptoms [25]. Studies on *Ghrita* with other mixtures have demonstrated hepatoprotective effects [71], anticonvulsant activity [58], effects on enhancement of memory, and enhancement of wound healing [72].

Conclusion

Ghrita, an important component of Ayurvedic food and medicine, has been in circumspect for decades by the medicinal community the world over due to its anticipated role in atherosclerosis. In the last several decades, *Ghrita* has been implicated in the increasing prevalence of CADs in Asian Indians, but previous researches and data do not support the harmful effects

of the moderate consumption of *Ghrita* in the general population. Many research studies report the beneficial properties of *Ghrita* and herbal mixtures containing *Ghrita* as the medicated *Ghritas* for normal health maintenance, decreasing the LDL cholesterol, increasing HDL, aiding in weight loss, improving the nutrition and metabolism of the body, improving immunity and eyesight, benefits for skin and membranes, improving memory, protective effects on insomnia, dementia, alzheimer's, epilepsy, insanity etc. Because corn based products can shift the ratio of omega 3 and omega 6 and then result in pro-inflammatory processes, the benefits of *Ghrita* described in Ayurveda will be further demonstrated as long as the *Ghrita* is made from the milk of animals fed with grass based products instead of those with corn based products. Further, the amount of cholesterol in 1 tablespoon of *Ghrita* is in consonance with the recommendations of National Heart, Lung, and Blood Institutes for a low fat/low cholesterol diet and can be safely used in daily practice for health maintenance, which will validate the Ayurvedic medicinal claims for *Ghrita*.

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