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Review Article

INVESTIGATION OF QUALITY, ADVANTAGES AND DISADVANTAGES, PROCESSING AND CHARACTERISTICS OF GHEE: A REVIEW PAPER

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ABSTRACT
Ghee is a product that is made by indigenous methods in many countries around the world, largely in Asia, the Middle East and Africa. It is known by various other names such as maslee in the Middle East where ghee is derived from goat, sheep or camel milk and roghan in Iran. Ghee is used in cooking, as a condiment and for religious purposes. Ghee is a class of clarified butter, although the traditional ghee-making processes (originating in India, where ghee is very commonly used in cooking) place emphasis on the exact steps and specific qualities of the clarified butter. Ghee is fairly shelf-stable largely because of its low moisture content and possible antioxidative properties. In this study, manufacture process, physical and chemical characteristics, nutrition, advantages and disadvantages, quality and shelf life of ghee were studied.

Keywords: *Ghee, Quality, Disadvantages, Manufacture Process, Nutrition*

INTRODUCTION
Ghee is important part of human diet. It is the most important ingredient in food and it is rich source of dietary energy and contains high calorific value. The Ghee contains certain acids which are very important and essential for the human beings. They are vehicle for the fat soluble vitamins (Jariwala, 2014). From a nutritional point of view, is both butter and ghee is mainly made of fat from whole milk. Even butter in the U.S. are almost always made from cow's milk, the ghee used for cooking in India are often made from buffalo milk. Both ghee and butter are usually 80% fat or more in terms of their composition, and around two thirds of that fat is saturated fat. Ghee, the most famous traditional dairy product in India and many countries in Middle East. It is made from milk, cream, or butter of several animal species (Rajorhia, 2003; Suwarat and Tungjaroenchai, 2013). Vanaspati ghee is a cheaper substitute of animal fat. It is manufactured by fully or partially hydrogenation of cooking oils of plant source by applying low medium pressure and in the presence of nickel catalyst. Mostly palm oil and cotton seed oil are used in the manufacturing of Vanaspati ghee (Tahir *et al.,* 2013).
Ghee is widely considered as the Indian name for clarified butter fat, usually prepared from cow milk, buffalo milk or mixed milk.
In the Middle East, ghee is commonly made from goat, sheep or camel milk and it is known as maslee or by some variant of the Arabic term samn. In Iran, it is called roghan (Urbach and Gordon, 1994; Mohammed *et al.,* 1998).
Ghee is a source of lipid nutrients, fat-soluble vitamins and essential fatty acids (Chand *et al.,* 1986). Table 1 showed chemical composition of ghee. About 70% of the fatty acids in milk are saturated, of which about 60% are long-chain fatty acids (Mohammed *et al.,* 1998; Havel, 1997). The monoenes, mainly 18: 1, constitute most of the remainder, with the dienes and trienes together only accounting for about 3%. Although medical criticism has been directed at milk fat on the basis of its saturated nature, it is more accurate to consider it as lacking in poly unsaturates because of its high 18: 1 content (Mohammed *et al.,* 1998; Banks, 1991). Ghee is complex lipids of glycerides, free fatty acids, phospholipids, sterols, sterol esters, fat soluble vitamins, carbonyls, hydrocarbons and carotenoids (cow ghee). Ghee also contains traces of iron and calcium. It contains moisture. The major constituent of ghee

is glycerides which constitutes 98% of total material in ghee and rest 2% consist of sterols most commonly cholesterol occur to the extent of about 0.5% (Jariwala *et al.*, 2014).

Table 1: Chemical Composition of Ghee (Source: Aneja *et al.*, (1990)

Constituents	Cow milk ghee	Buffalo milk ghee
Fat (%)	99 – 99.5	99 – 99.5
Moisture (%)	<0.5	<0.5
Carotene(mg/g)	3.2-7.4	-
Vitamin A(IU/g)	19-34	17-38
Cholesterol (mg/100g)	302 – 362	209 – 312
Tocopherol(mg/g)	26 – 48	18 – 31
Free fatty acid (%)	2.8	2.8

Ghee can be used in formulation of snacks and appetizers for example into fresh popped popcorn. Ghee can mix with good quality coarse sea salt. Furthermore, it can be mixed with nut butters such as almond, peanut, cashew and others for an amazing dip for apples and other fruits. Stir-fry minced fresh garlic in ghee and pour over fresh hot bread. It can be spreaded over whole grain crackers; top with cheese. Moreover we can use ghee for vegetable, potato, and grain dishes (try it on hot rice, drizzle over fresh steamed veggies, brush a layer over corn-on-the-cob, Makes great flour and corn tortillas, mash into hot baked potato, or stir into hot mashed potatoes. We can use gee in formulation of desserts such as cakes and cookies, melt chocolate, pudding (Pure Indian Foods Corporation, 2011).

The most common types of adulterants used are Vegetable oils and Animal body fats. The detection of animal body fat in ghee is difficult as the mixture has more or less the same physical and chemical characteristics. The adulterants like Starch (Potato), Sesamolin, Dyes, Synthetic colours, Vegetable fat, lard and wax. Sometimes the rancid ghee is also mixed with the fresh ghee and sold in the market. Any type of adulteration in ghee samples bring about the changes in the physical and chemical properties of ghee. The ghee samples collected from the different place for assessment of its quality and determination of adulteration is sent to Forensic Science Laboratory. The Ghee samples are tested to check whether it meets the specifications or not and the samples are analyzed for the presence of adulteration. The properties of ghee are determined by the physical and chemical methods in the laboratory (Jariwala *et al.*, 2014). The characteristic flavour of ghee is its major criterion for acceptance. Flavour is greatly influenced by the fermentation of the cream or butter and the heating processes. Carbonyls, lactones and free fatty acids are reported to be the key ghee flavouring compounds (Mohammed *et al.*, 1998).

Ghee Processing

Ghee processing was made either with or without fermenting and rendering oil from milk, cream or butter by direct heating. Consequences were milk protein precipitation, dehydration and clarification of oil. Generally, about 95% of milk fat melted almost completely at body temperature, leading to a clean mouth feels without waxy sensation (Rachana *et al.*, 2012; Suwarat and Tungjaroenchai, 2012). Following are the step taken during ghee making process (Jariwala, 2014). During pasteurization process milk cream is separated in the cream separator with 50 – 70 % fat content. This cream is then churned in butter churn. This makes butter of 84 % fat. The whey is drained in whey tank, which is used as by product. Butter from the butter churn is taken in the butter trolley. This butter either can be stored in the cold room, till sufficient butter is available for further processing. Once sufficient butter is available, it is taken in the Ghee Kettle. Open the condensate drain valve and remove all the condensate from the steam jacket.

Steam valve in the ghee kettle is opened slowly and start supplying steam (1.5 bar G.). This is to heat the butter and melt it. Close the drain valve and open steam trap and let condensate pass through it. Once enough butter is melted, start the agitator of the ghee kettle. Continue supplying steam to the kettle. The butter oil will start boiling and water from the butter will evaporate. Let all the water evaporate. Close slowly the steam supply valve and open vent valve on the jacket. Let all condensate from the steam jacket get drained. Let ghee to cool down. Continue agitating ghee with the help of agitator. After ghee temperature has come down to around 70 Deg C, drain this in the ghee filter tank. With the help of SS strainer, most of burned protein from the butter is filtered out. Once all ghee is filtered, start the ghee pump. The ghee should be fed to ghee clarifier, where ghee will be clarified. The clarified ghee is collected in the balance tank. Ghee from the balance tank, with the help of another ghee pump is transferred to jacketed ghee storage tank. This storage tank has water jacket with electric heater. In case of very cold weather, switch on the electric heater. This is to keep ghee in free flowing condition. This is final product. Pack ghee in consumer packing. (These equipments are not in our scope of supply.) Clean the complete plant from inside and outside with warm detergent followed with water and wipe out all traces of butter / ghee. Clean all pipes / valves (Jariwala, 2014).

Four methods of making ghee were known (figure 1): pre-stratification method (PS), creamery butter method (CB), direct cream method (DC), desi method or milk butter method (MB) (Serunjogi, 1998; Suwarat and Tungjaroenchai, 2013). Direct heating has been selected to render or separate oil or ghee from milk cream. Keeping quality of butter oil was governed by several factors as the ripening of cream, method of manufacture, clarification temperature, and permeability of packaging materials to air and moisture, and type of animal feed (Suwarat and Tungjaroenchai, 2013).

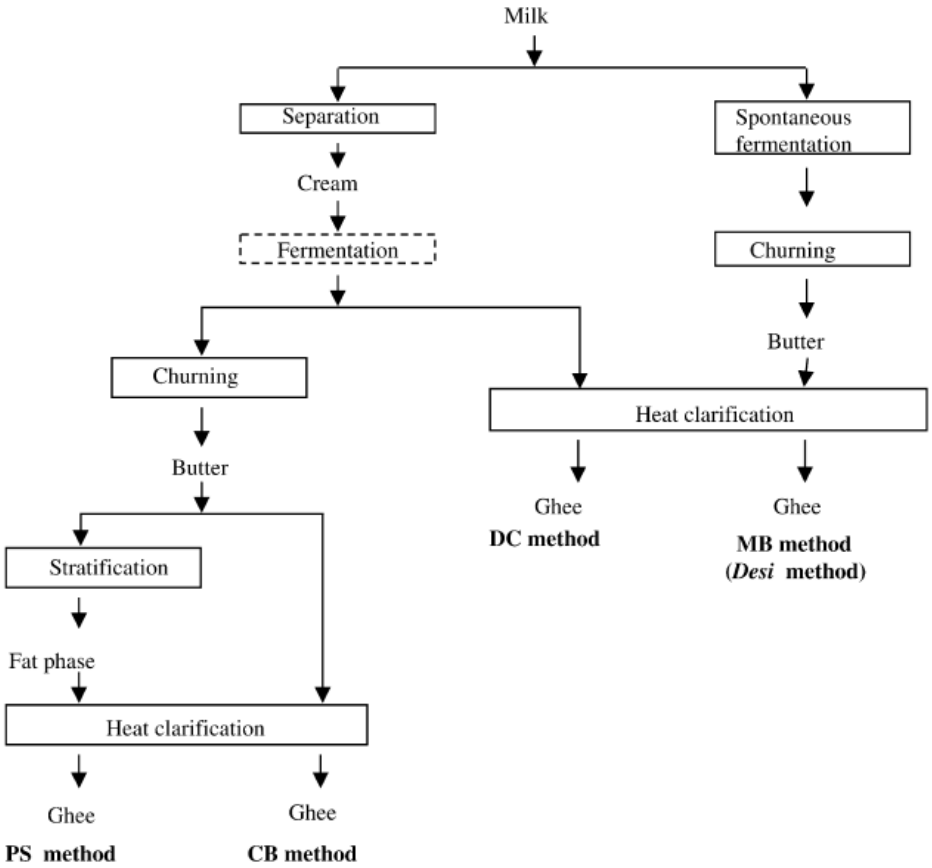

Figure 1: Flow Diagram Illustrating Four Methods of Ghee Manufacture: Milk Butter (MB) (*desi*); Cream Butter (CB); Direct Cream (DC); Pre-Stratification (PS) (Source: Mohammed *et al.*, 1998)

Advantages and Disadvantages of Ghee

Debate on the role of milk fat in human health is still continuing. It suffices to highlight here some of the alleged positive and negative aspects relevant to ghee (Tahir *et al.,* 2013)**.** Research in ghee and health is limited but fairly consistent. When ghee is consumed at a level above 10% of total calories may increase the risk of cardiovascular disease. (For a person consuming 1800 calories per day, would 10% of calories be 180 calories or about 20 grams of fat, equivalent to about 2 tablespoons of ghee.) At a level below 10% of total calories, however, ghee appears to help lower cardiovascular risk, especially when other fats that are consumed during the day, is entirely of plant or vegetable oils. Butter ghee, can increase the risk for cardiovascular diseases, if consumed in large quantities. The benefits of butter at moderate levels that do not yet have the same level of research support as ghee. But there is growing interest in research into butter, which has some unique advantages of its own, especially in relation to its vitamin K and vitamin D content. This content can vary, depending on diet and living conditions in the dairy cow.

Previous researches record of ghee versus butter may be the increased volume of medium and short chain fatty acids in ghee. Butter contains about 12-15% of those between-chains and short chain fat, ghee contains about 25%. (Our bodies metabolize medium-chain and short chain fatty differently than long-chain them, and medium and short chain them are not associated with cardiovascular problems like the long-chain them there are. Ghee tends to have a higher smoke point than butter. For butter, smoke point is typically reached between 325-375 ^{0}F (163-191 ^{0}C). Some clarification Butters also falls within this general framework, but ghee usually has a higher smoke point, between 400-500 ^{0}F (204-260 ^{0}C). This higher smoke point can be an advantage when cooking at high heat, then smoke point is that when the heat damage to some components of a grease or oil is insufficient to be visible in the form of smoke. When it comes to our health, heating the smoke point is not a good idea with an oil or fat (http://freenaturalbeautytips.blogspot.in/2009/12/what-are-advantages-and-disadvantages.html).

During the manufacturing of Vanaspati ghee Tran's fats are produced which are dangerous for human health and cause numerous diseases in human such as cardiovascular diseases, cancer and obesity (Tahir *et al.,* 2013; Gebauer, 2011). Recently, Conjugated linoleic acid (CLA) that occurs in high concentrations in milk fat, has been recognized as an anticarcinogen, and its anticarcinogenic effect has been demonstrated in several animal models (Mohammed *et al.,* 1998; Chin *et al.,* 1992).

Cholesterol oxidation compounds (COPS) has been reported that oxysterols may initiate atherosclerosis and have mutagenic effects; current recommendations restrict their levels in foods (Mohammed *et al.,* 1998; Nielsen *et al.,* 1996). The tendency for cholesterol to autoxidize spontaneously in air and to peroxidize in vivo, and the presence of COPS in foods, has recently evoked much interest. Ghee has been reported to contain 0.3-0.4% cholesterol (Nath *et al.,* 1996). Ghee, dried milk products (such as milk powder) and grated cheeses were reported to contain the highest cholesterol levels (on a per lipid basis) among dairy products. Exposure to heat, as in the preparation of ghee, caused marked increases in levels of COPS. However, COPS were absent in commercial ghee although the epoxides could be detected in the home-made ghee. Kumar and Singhal (1992) studied the effect of processing conditions on the oxidation of cholesterol in ghee. COPS were formed in both cow and buffalo ghee which was clarified at 12 ^{0}C. The concentration of COPS was 0.7-0-9% of the total cholesterol.

Ghee Quality

Ghee may deteriorate as a result of development of oxidized and/or rancid flavours (Van Den Berg, 1988). The heat treatment involved in the manufacture of ghee should destroy most bacteria and the moisture content is too low to allow normal growth of most microorganisms. However, certain Bacillus species such as B. subtilis and B. megatherium were reported to occur in ghee (Mohammed, 1998). These isolates were detected almost certainly as spores; they were most probably not growing. It was therefore suggested that rancidity may develop as a result of the activity of microbial lipases provided the ghee contains sufficient moisture. Buffalo ghee has been reported to be more resistant to lipolysis than cow ghee (Van Den Berg, 1988). The keeping quality of ghee is governed by such factors as the ripening of cream, method of manufacture, clarification temperature and the permeability of the packaging material to air and moisture (Singh and Ram, 1978; Mohammed, 1998).

The quality of Vanaspati ghee can be judged by performing different physicochemical tests. Free fatty acid analysis provides useful information about the raw cooking oil quality, effectiveness of neutralization process and storage condition (Tahir *et al.,* 2013; Mehmood *et al.,* 2012). Increased level of free fatty acid may cause many metabolic defects in humans including insulin resistance and other health defects (Tahir *et al.,* 2013; Karpe *et al.,* 2011). Peroxide value is also an important indicator of quality of oils and fats. Peroxide value is also used to measure the oxidative rancidity (Tahir *et al.,* 2013).

Rancidity is a process which is accompanied by the formation of the unpleasant odour, taste and as a result of action of moisture, oxygen of air and enzymes. The rancidity in ghee is of two types: Hydrolytic Rancidity, Oxidative Rancidity. The hydrolytic rancidity takes place when the triglycerides are broken down to free fatty acids and simple glycerides. The action is accomplished by enzyme called Lipase. The oxidative rancidity also known as ketonic rancidity occurs in three steps where fatty acids are converted in to ketones. The enzymes responsible are Lipoxidase Enzymes, Dehydrogenase Enzymes and Decarboxylase Enzymes (Jariwala *et al.,* 2014).

Oxidation of oils and fats is one of the important quality parameter commonly used to evaluate their quality. During oxidation processes many the odorous compounds are produced. Their presence is able to decrease the nutritional quality of product and produce such compounds which are dangerous for health (Tahir *et al.,* 2013). Color indicate whether the product is proper bleached or not and presence of coloring pigments. Sunlight play very important pole in development of rancidity. To avoid such type of rancidity protection of oils and fats against light is needed. Fluorescent light also can affect the stability of oils and fats (Tahir *et al.,* 2013; Ahmed, 2011).

Ghee Shelf Life

A shelf life of 6-8 months, even at ambient temperatures, has been reported. Longer storage periods of up to two years were reported by Bekele and Kassaye (1987). However, such variations in shelf life could be due to regional preferences in taste. The storage stability of ghee is attributed to the low moisture content (ca. 0.2%) and the high content of phospholipids (ca. 400 mg kg^{-1}) and perhaps the free amino acids, which are liberated from the phospholipid-protein complex into the fat phase (Mohammed *et al.,* 1998). The low acidity of the ghee and the presence of natural antioxidants are also believed to contribute to the extension of its shelf life (Van Den Berg, 1988).

Cow ghee is apparently more shelf stable than buffalo ghee due to the higher content of natural antioxidants in the former (Van Den Berg, 1988). Because of their unsaturated nature, phospholipids are more prone to oxidation than neutral fat. In the autooxidation of milk fat, the free radical process is assumed to originate in the phospholipid (Banks, 1991).

Various attempts have been made to elucidate the influence of high temperature of clarification on the shelf life of ghee. It has been suggested that during heating, especially after most of the moisture has been evaporated, antioxidants are produced from phospholipids. The heat-modified phospholipids are believed to be absorbed by the fat and hence contribute to the keeping quality of the ghee. Consequently, the ghee produced by the DC method is said to be more stable than that produced by the CB method because of the longer heat treatment and the higher phospholipid content (Mohammed *et al.,* 1998; Van Den Berg, 1988).

In spite of its intrinsic shelf life stabilizing properties, ghee does eventually spoil due to the oxidation of fatty acids during storage at ambient temperature. Rao *et al.,* (1987) showed that the method of manufacture had a significant effect on the flavour of ghee. Textural changes may also occur in ghee during storage. The fat in ghee crystallizes with the formation of solid, semisolid and liquid layers (Mohammed, 1998).

Conclusion

Ghee is an important constituent of Indian meal. It is prepared using different methods. The highest quality ghee is obtained when the long-simmered butter is allowed to cool, and only the top most layer is skimmed off. (This layer is ghee, which are considered top-quality, and used in cooking). By definition, ghee is ‘a product exclusively obtained from milk, cream or butter by means of processes which result in almost total removal of water and non-fat solids, with an especially developed flavour and physical

structure. The health aspect of ghee is subject to further debate. More research is needed to elucidate the net health effect of ghee due to the presence of both COPS and CLA which allegedly have negative and positive effects, respectively. The shelf stability of ghee, one of its major quality characteristics, is mainly dependent on the low moisture content and the presence of reducing compounds produced during heat processing. The role of phospholipids in extending the shelf life of ghee needs further investigation considering that they are also known to initiate lipid oxidation.

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