International Journal of Trend in Scientific Research and Development (IJTSRD)
International Open Access Journal
ISSN No: 2456 - 6470 | www.ijtsrd.com | Volume - 1 | Issue – 6

Comparison of Physicochemical, Nutritional and Sensory Aspects of Ghee obtained from Different Species

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ABSTRACT

Ghee is a class of clarified butter that originated from the Indian subcontinent; and is commonly used in South Asian and Middle Eastern cuisines, traditional medicine, and religious rituals. Ghee is important part of human diet. It also gives longer shelf life compared to other food product. Now days, people have interested in products obtained from species other than cow and buffalo to get more health benefits. Physicochemical, nutritional and sensory aspects of ghee obtained from different species varied among each other due to the varied composition of milk. Due to difference in the milk composition of varies species; these affect physicochemical, nutritional and sensory aspects of different species. Variation of this aspects affect the consumer's preference, benefits on human health from ghee of varies species and also helps to people who wanted to check adulteration in ghee.

INTRODUCTION

Ghee is clarified butterfat, usually prepared from cow milk, buffalo milk or mixed milk (Rajorhia, 1993). Ghee is manufactured by direct heating of cream or butter churned out of fresh or ripened cream or *dahi*obtained by fermentation of milk with bacteria native to milk or selected starter cultures (Srinivasan, 1976).Ghrita (ghee) was produced in ancient India as far back as 1500 BC (Achaya, 1997). Ghee is often used as a synonym for different dairy products, e.g. clarified butter (Kumar and Singhal, 1992), butterfat (Singh and Ram, 1978), Indian butteroil, butteroil, anhydrous milkfat (Sserunjogi and Roger, 1998) and Indian ghee (Kumar and Singhal, 1992).

Some other products related to ghee are samna (Aboudonia and El-agamy, 1993), meshho (an Assyrian non-perishable milkfat) (Abdalla, 1994). Ethiopian indigenous ghee (Bekele and Kassaye, 1987), samin (Hamid, 1993), roganin Iran (Urbach and Gordon, 1994)and samuli (Sserunjogi and Roger, 1998). Most other definitions of ghee are quite ambiguous and often lack universal applicability. Various agencies viz. IDF (1977), Codex Alimentarius (1997),Agmark (1988) have defined ghee and its requirements.According to FSSAI (2011), ghee means the pure clarified fat derived solely from milk or curd or from desi (cooking) butter or from cream to which no colouring matter or preservative has been added. The standards of ghee produced in a State or Union Territory have been specified for BR reading, RM value. Ghee chemically may be defined as complex lipids of triacylglycerol, together with small quantity of free fatty acids, phospholipids, sterols, hydrocarbons, carbonyl compounds, fat soluble vitamins (A, D, E, and K), carotenoid pigments, moisture and traces of elements like copper and iron. On an average ghee contains 99.0-99.5% fat and less than 0.5% moisture.

Physicochemical Aspects

Physical properties of oils and fats are important criteria for judging their quality and have also been used to determine their purity (Hazra*et al.,* 2017). Physical and chemical constants have been derived for the characterization of the types of component fatty acids present in milk fats. Several physical methods can be used to check the purity of ghee on the basis of various physical properties such as

melting point, solidification point, BR reading, refractive index (Kumar*et al.,* 2016). The average size of fat globules in milk of camels, cows, buffaloes, sheep, and goats is presented in Table 1. The largest diameter of fat globules is found in buffalo milk, whereas the smallest is in camel milk. Generally, camel, sheep, and goat milk fat globules are smaller in size compared to those of buffalo and cow milk. Therefore, these milks have poor creaming properties (Park and Haenlein, 2006; Kumar *et al.,* 2015).

Table 1: Average Size of Milk Fat Globules of Different Species

Species	Diameter (microns)
Camel	2.00 - 3.93
Cow	3.00 - 4.50
Buffalo	4.07 - 7.50
Goat	2.57 - 3.25
Sheep	3.02 - 3.14

Parmar (2013) compared various physicochemical properties of cow, buffalo and camel ghee viz. melting point, solidification point,BR reading, refractive index, Reichert Meissl (RM) and polenskevalue (PV), saponification value, free fatty acid and iodine value. He found higher melting point, solidification point, refractive index, saponification value and iodine value whereas lower amount of free fatty acid, RM and PV value in camel milk ghee as compared to cow and buffalo milk ghee is probably because camel milk fat contains a lower amount of short chain fatty acids (C_4-C_{12}) and a higher amount of long chain fatty acids (C_{14}-C_{22}).

The compositions of fatty acids in camel, buffalo, sheep, and goat milk were reported by Park and Haenlein (2006). They reported that marked variations found among the four species. Compared to other species, camel milk fat is higher in iodine value, acid value and melting point, but lower in refractive index, Reichert Meissl, Polenske, and saponification values. This reflects its higher content of long-chain fatty acids (C_{14} –C_{18}), and lower content of short chain fatty acids (C_4 –C_{12}). Camel milk fat had higher proportions of unsaturated fatty acids compared with other species, which may be the main reason for the waxy texture of camel milk fat. An appreciable amount of the essential fatty acid linoleic is found in camel and buffalo milk fatsby Park and Haenlein (2006).

Softening point, Melting point and Iodine value of cow, buffaloand goat ghee have been reported by Ramesh and Bindal (1987). The average softening point of cow, buffalo and goat ghee were 33.4,34.0 and 29.1°C respectively. The average melting point of cow, buffalo and goat ghee were 34.1, 36.1 and 28.9°C respectively. The average iodine value of cow, buffalo and goat ghee were 35.4, 31.4 and 33.3°Crespectively.

Marked variations in physicochemical constants and fatty acid compositionamongst four species viz. cow, buffalo, goat and sheep milk fat have been reported byseveral authors (Park and Haenlein, 2006; Al-Khalifah and Al-Kahtani, 1993, Sharma, 1981).Wayua1 *et al.*(2006)determined the fatty acid compositions of ghee made from camel's, goat's milk in Mandera, north eastern Kenya and found that camel milk ghee contained nutritionally adequate proportions of medium-chain fatty acids (C_{10-14}) (19.9%). Goat milk ghee had higher proportions of short chain fatty acids (C_{8-10}) (14.5%). Compared to buffalo, goat and sheep, camel milk fat is higher in iodine value, acid value and melting point, but lower in refractive index, Reichert Meissl, Polenske, and saponification values Park and Haenlein, (2006).

Goat milk has a unique characteristic in the lauric: capric fatty acid (C_{12}:C_{10}) ratio, where it has a significantly lower ratio than cow milk (0.46 vs. 1.16) (Iverson and Sheppard, 1989).There are no significant differences in the unsaponifiable matter of milk fat and acid value between goat and cow milks. However, goat milk has higher iodine values than cow milk, indicating that goat milk fat contains higher unsaturated fatty acids than the cow counterpart.

Saponification value is higher and refractive index is slightly higher in cow milk than in goat milk. Some interesting differences are found in the Reichert Meissl value and the Polenske value between goat and cow milk. Goat milk has higher Reichert Meissl value and lower Polenske value than cow milk, suggesting that goat milk fat contains higher soluble volatile fatty acids and lower insoluble volatile fatty acids than cow milk fat(Anjaneyulu *et al.,* 1985).

Nutritional Aspects

Fat is a concentrated source of energy that provides 30–40% of dietary calories in developed countries. Fat imparts palatability to food, serves as a vehicle for fat-soluble vitamins A, D, E and K and supplies essential fatty acids. The digestion products of fats, along with endogenously synthesized lipids, provide a

diverse group of molecules that play a critical role in multiple metabolic processes.Lipids are vital components of cell membranes and take part in many inter- and intra-cellular signalling cascades. Lipids have multiple forms and functions, including vitamins and steroid hormones that are involved in many metabolic processes (Parodi, 2004).

Conjugated linoleic acid (CLA) that occurs in high concentrationsin milkfat, has been recognized as an anticarcinogen, and its anticarcinogenic effect has beendemonstrated in several animal models (Chin *et al*., 1992).Anincrease in the CLA content of mixed (cow and buffalo) milkfat from base level of5-6 mg CLA g^{-1} fat up to 1.0% was observed in the *desi*ghee due to fermentation. Also, the CLA content of gheecan be increased up to 5-fold from the base level, byincreasing the temperature of clarification from 110 to120^{0}C (Aneja and Murthi, 1991). CLA content of cow, goat and sheep milk fat were also varied (Tamine, 2009).

Ghee has been reported to contain 0.3-0.4% cholesterol (Nath*et al*., 1996). Nath*et al*. (1996) showed that mixed (cow+buffalo) ghee manufactured and stored under normal conditions did not contain COPS. The fat of goat milk is more digestible than that of the cow milk because the fat globules in goat milk are much smaller and have a greater surface area and lipases in the gut are supposedly able to attack lipids more rapidly. caproic, caprylic, capric acids and other medium chain fatty acids have been used as a treatment of malabsorption syndrome, coronary diseases, premature infant nutrition, intestinal disorders and gallstone problems (Jooyandeh and Aberoumand, 2010).

The consumption of goat milk reduces total cholesterol levels and the LDL fraction because of the higher presence of medium chain triglycerides (MCT) (36% in goat milk vs. 21% in cow milk). They could also be used in a geriatric diet (Raynal-Ljutovaca*et al.,* 2008).

Both goat and cow milk fat contain adequate amounts of essential fatty acids for human infants. Goat milk has much higher glycerol ethers than does cow milk, which appears to be important for the nutrition of the nursing newborn. Buffalo milk fat contains gangliosides which are not present in cow milk fat. The gangliosides of buffalo milk fat have anti-inflammatory activity (Ahmad *et al.,* 2013).The study carried out on 48 N-Mary male Syrian mice by Mohammadi and Azizi (2015) to compare the effect of different nutritious fats on expression ofapoB protein and showed that cow ghee increases expression of intestinal apoB48 compared to Sheep ghee. This ApoB is a component of all atherogenic or potentially atherogenic particles. Increase in the concentration of apolipoproteins B (apoB) is one of the major risk factors for coronary heart disease (CHD). Sheep ghee was proven as a protective fat against apoB48 concentration.

In ayurveda, cow ghee 'amrita'(nectar) is considered the natural oil for all internal body mechanisms. It had several health benefits such as slows the aging process,enhances the body immune system,facilitates the bowel movement, improve the health of the teeth & gums, prevent chronic cough & disorders of eyes, As a bath oil and an exquisite facial moisturizer (Mahakalkar*et al.,*2014).

Sensory Aspects

The colour of cow ghee varies from deep yellow to straw yellow while that of buffalo is white with a characteristic greenish tinge (Achaya, 1997; Bharwade*et al.,* 2017). Camel ghee's physical structure should consist of a mixture of higher softening point fats in crystalline form dispersed in the liquid lower softening point fats and this gives the ghee a somewhat granular appearance(Ruegg and Farah, 1991).Singh and Gupta (1982) reported that the majorityof ghee prepared from goat milk cream ripened withlactic starter culture was greenish white, while all cowmilk gheewas bright yellow in color.The colour and appearance score of ghee prepared from camel milk was significantly lower compared to ghee prepared from cow milk as well from buffalo milk (Parmar, 2013).

Ghee is greatly valued in our country for its characteristic flavor, which varies from region to region. It is mainly dependent on method of preparation. Goat milk is not considered suitablefor the manufacture of ghee(Arora and Singh, 1986). The average flavor score of ghee prepared from camel, cow and buffalo milk ghee was 33.73, 44.78 and 41.97 (out of 50) respectively (Parmar, 2013). Ghee prepared from cow milk and that from buffalo milk had pleasant flavor. However, ghee prepared from camel milk had an unpleasant flavor. Low flavor score in case of ghee from camel milk was attributed to its abnormal odor. The abnormal odor in ghee originated from abnormal odor associated with the camel milk itself. There are number of reports stating that camel milk has unpleasant odor and salty

taste(Parmer, 2013; Mal and Pathak (2010); Hamid, 1993, Park and Haenlein, 2006)

The granules of buffalo ghee are irregular clusters, whereas those of cow ghee are smaller and made up of fine divergent mono crystals. Camel milk fat also has higher proportions of unsaturated fatty acids compared with other species, which may be the main reason for the waxy texture of camel milk fat (Park and Haenlein, 2006).In addition, the gheeobtained from goat milkwas found to be greasy.Parmar (2013) compared the textural attributes of ghee prepared from cow, buffalo and camel milk. The ghee prepared from cow milk had small to medium size grains uniformly distributed throughout the lot. The ghee prepared from buffalo milk had large grain size,whereasfrom camel milk had hard, greasy and waxy texture. Regional preference for ghee flavor and texture in India was reported by Rajorhia (1980) and given in table 2.

Table 2: Regional preference for ghee flavour and texture in India

Region	Physical Character	Comments
Northern India	Flavor	Slightly acidic, mildly curdy
	Texture	Fine- to medium-size grains (half to three quarters solid portion)
Western India	Flavor	Mildly curdy (very curdy in Saurashtra)
	Texture	Coarse grains, i.e. size of 0.3 to 0.6 mm
Southern India	Flavor	Mild to highly cooked and aromatic, higher level of free fatty (butyric) acid, preference for special herb flavours in Tamil Nadu and Karnataka
	Texture	Medium sized grains in Tamil Nadu, coarse grains in Andhra Pradesh and Karnataka
Eastern India	Flavor	Slightly to definitely cooked flavour
	Texture	Medium grains (one quarter liquid and three quarters solid)

Aroraand Singh (1986) studied the sensory aspects of ghee prepared from goat, buffalo and two types of mixed milk by threedifferent methods, namely, *desi,* creamery butterand direct-cream methods at aclarification temperature.Pure goat ghee was quiteacceptable ranking in "good" category butwas found tohave typical "goatyflavor".Theblending of goat milk with buffalo milk in 3:1 and 1:1 ratios improved the flavor quality.

CONCLUSION

Marked variations in physicochemical constants of ghee amongst species have been reported. This could be attributed to the differences in fatty acid composition of milk fat from these species. A comparison of nutritional aspects of ghee from various species revealed that ghee prepared from different species have their own distinctive characteristics which contribute greatly to their nutritional quality. A comparison of sensory aspects of ghee reveal that ghee prepared from cow and buffalo milk has pleasant flavor, whereas camel and goat milk ghee were unacceptable. Hence, more research is required to improve the acceptability of goat and camel milk ghee.

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