RESEARCH ARTICLE — FOOD SCIENCE RESEARCH JOURNAL — Volume 4 | Issue 2 | October, 2013 | 116-120

Consumption pattern and fatty acid composition of ghee

MEENA MEHTA

Ghee is a common fat consumed by many families in their daily diet as a rich source of energy. With ever increasing demand of ghee and nutritional awareness amongst the consumer, various food industries have started producing and marketing ghee with different brands. It becomes worth investigating the nutritional status with respect various analytical parameters and fatty acid composition of these differently branded ghee. A survey was conducted regarding consumption pattern of different brands of ghee using pre-designed questionnaire. Eight most popular brands of ghee were collected from the local market and characterized for various analytical parameters. Each sample of ghee was characterized for fatty acid composition using GC on C_{18} column. The results were summarized and interpreted with respect to importance of different fatty acids which suggest that all the brands have characteristics as prescribed by the PFA.

Key Words : Composition of ghee, Physical characteristics, Fatty acid

How to cite this article : Mehta, Meena (2013). Consumption pattern and fatty acid composition of ghee. *Food Sci. Res. J.,* **4**(2): 116-120.

INTRODUCTION

Health and nutrition are the most important contributory factors for human resource development in India. Diet is a vital determinant of health and nutritional status of people (Gopalan, 1989). The dietary habit of individual/families/ communities varies according to socio-economic factors and regional as well as traditional customs. Precise information on variety of food consumption pattern of population through application of appropriate methodology is often needed not only for assessing the nutritional status of people, but also for elucidating the relationship of nutrient intake with specific deficiency of certain nutrients. A well balanced diet is essential from early stages of life for proper growth, development and healthy active life (Kachondham *et al.*, 1992). Common people believe that ghee is the rich source of all the nutritive aspects. Also, it has good flavor with pleasant aroma besides being a source of certain essential fatty acids (Ali and Tremazi, 1966). Hence, ghee becomes the important component in their daily diet. Ayurveda describes ghee as a cool agent, which is capable of increasing mental power and physical strength. The medicine system has proposed its applications in many health disorders (Reddy, 1998). However, ignorance about the high fat consumption and its harmful effects may invite health problem.

AUTHOR FOR CORRESPONDENCE

MEENA MEHTA, Department of Food Science and Nutrition, Dr. B.M. Nanavati College of Home Science, Matunga, MUMBAI (M.S.) INDIA

According to PFA (2001). ghee is a pure clarified fat derived from milk and milk products. It is an anhydrous butter fat containing various fatty acids. The nutritive status of ghee mainly depends on the different milk sources and physical parameters applied during the manufacturing processes. In order to maintain and upgrade the nutritive status along with acceptance by the people, various manufacturers started blending ghee with different fatty acids and marketed with different brands. It is important to study on quantification of variation in dietary pattern and adequacies in consumption of ghee in daily diet. The consumption of ghee in diet varies from state to state, region wise, community wise and individual-to-individual (Simopoulos *et al.,* 1999). Also, the socio-economic factor plays important role in the consumption of different brands of ghee. Hence, it is worth investigating the quality of each brands of ghee with special reference to its physical, chemical and fatty acid composition. A research problem was designed to study the goal with following objectives.

- To study the consumption pattern and popularity of different brands of ghee by pre-designed questionnaire.
- To characterize each brand of ghee with respect to their physical and chemical parameters.
- To evaluate fatty acid composition of each branded ghee.
- To compare and correlate the effects of fatty acid composition on the human health.

- To suggest and recommend the acceptability of particular brand of ghee.

METHODOLOGY

A pre-planned and pre-tested questionnaire was used to collect data on consumption of differently branded ghee. The personal interview with the selected family data were collected for evaluation. The salient features of the questionnaire consisted of four major titles as below.

- General information about the race, religion, size of family and socio-economic factor.
- Dietary information by recall method using detail on quantity of ghee consumed by them per day.
- Reasons for choice of particular brand of ghee.
- Status of their health.

The 100 cooperative families and respondent from Mumbai were randomly selected for the study. Most of the families provided good support and cooperated while conducting the diet survey. The quantities of ghee used in various preparations were estimated by using household measurement like cup, spoon and bowl.

The different brands of ghee were collected from the local market and analyzed for various parameters. The physical parameters like flavor, texture, color and suspended impurities if any were recorded for branded ghee. Various chemical parameters like melting point, moisture content, total acidity, Butyro refractometer reading (B.R.), Reichert-Meisal value (R.M. value), iodine value and saponification value were determined using methods reported in the literature (Sathe, 1999; IUPAC, (1979). Each experiment was repeated three times and only averaged results are reported in the discussion.

The fatty acid composition was determined by using gas chromatography method (Boniforti, 1962). The fatty acid component of the ghee was converted to its methyl esters by trans esterifying with methonalic solution of diazomethane in presence of dilute hydrochloric acid. The esters were dissolved in hexane and 2ml was injected in GC for separation on C_{18} column at room temperature. The retention time for each individual fatty acid ester was determined by running the pure ester of the corresponding fatty acid at the same attenuation conditions. The flame ionization detector (FID) was used for proper resolution and detection purpose. The chromatogram was run for 10 minutes and each peak was identified with respect to different fatty acid ester. The area under the peak was used calculate the approximate concentration of each fatty acid. The results of all the above experimental findings are summarized and discussed.

OBSERVATIONS AND ASSESSMENT

Milk and milk products have traditionally formed an important part of average Indian diet. The consumption of milk is 46% of the total production of milk while remaining milk is consumed as milk products. Amongst the milk products ghee predominates to almost 28%. Ghee is prepared by heating butter till moisture content is reducing to zero level (Patel *et al.,* 1949). It is highly placed for its aroma and is used as a cooling media. The survey was conducted between the 100 selected families of different race and religion from Mumbai city. The consumer survey reveals that eight different brands of ghee were popularly consumed in their daily diet. The variance in the consumption of different brands of ghee has shown definite relation between the costs of ghee. This classification provides the broad ghee consumption practices amongst different families of socio-economic status. Eight different brands were identified and investigated for their physical and chemical parameters along with fatty acid composition. The experimental findings are summarized in the Table 1,2 and 3.

The ghee sample of all the brands has color index near to either yellow or off white as expected for the animal fat. The smooth texture with pleasant fatty aroma makes the ghee more acceptable. However, the homemade desi ghee and loose brand ghee is granular due to different fat additives. Melting point of ghee varies over a wide range and this property has been employed for checking the adulteration in the sample. Melting point of ghee is in the range of 20-30°C, which is little subnormal value as compared with the normal value of 35°C. It may be suspected that ghee is adulterated with vegetable oil, which is likely to lower the melting point of ghee by at least 5-10°C.

Table 1. Physical characteristics of differently branded ghee

Brand	Color	Flavor	Texture	M.P.°C	Refractive Index
Aarey Dairy	Yellow	Good	Smooth	20	1.4524
Gokul Dairy	Off white	Good	Smooth	30	1.4522
Nakoda Dairy Taza	Yellow	Good	Smooth	20	1.4525
Nakoda Dairy special	Off white	Good	Smooth	25	1.4528
Gits	Yellow	Good	Smooth	22	1.4523
Nova ghee	Off white	Good	Smooth	24	1.4529
Dynamix ghee	Yellow	Good	Smooth	20	1.4523
Home made Desi	White	Pleasant	Granular	29	1.4530
Loose Desi	Creamish	Rancid	Granular	34	1.4529

Table 2. Chemical characteristics of differently branded ghee

Brand	% moisture	% acidity	B.R.reading (40°C)	R.M.value	I_2 value	Sap. value
Aarey Dairy	0.2	5.2	41.3	31.0	26.5	220
Gokul Dairy	0.3	2.0	42.0	33.6	27.0	225
Nakoda Dairy Taza	0.5	3.9	41.6	29.9	26.5	215
Nakoda Dairy special	0.5	3.5	44.6	32.8	28.0	220
Gits	0.4	4.5	40.9	31.7	27.5	215
Nova ghee	0.2	4.0	43.9	33.1	26.5	222
Dynamix ghee	0.3	4.0	42.1	29.8	28.0	218
Home made Desi	0.4	3.0	45.0	32.7	26.5	230
Loose Desi	0.4	2.5	53.1	15.9	40.0	105

However, adulteration with vegetable oil up to 20% does not make any significant change in the melting point of ghee (Sharma and Singhal, 1996). The refractive index of ghee was minimum at 1.4522 for Gokul brand while it was maximum for at 1.4530 for homemade desi ghee.

The moisture content of the ghee plays important role and affects the shelf life of the sample. It should be as low as 0.2% by weight. The moisture content of all the brands was within the normal limit around 0.2%. Although, Nakoda dairy brand ghee have little higher value of moisture (Sathe, 1999). Similarly, the total titrable acidity should not exceed 3% for the good quality of ghee. All the samples found to have acidity about 4%, which is little higher than the normal value. The abnormal acidity may affect the shelf life of the ghee adversely (Sathe, 1999). The value of BR readings of ghee was centered in the range 45 to 40 and showed significant variation. Gunstone *et al.* (1994) has reported that this index can be used to identify the adulteration level in the ghee. The addition of vegetable oil increases the BR index value by at least 10 to 15 units. It can be seen that loose sample of ghee had highest BR value indicating the higher per cent of mixing of vegetable oil. Recently, Arora *et al.* (1996) and Lal *et al.* (1998) have confirmed the adulteration of ghee with vegetable oil due to increased value of BR value. The Reichert-Meissl value of ghee is a specific test for the presence of butyric and caproic acid. The RM value of ghee was expected in the range

Table 3. Fatty acid composition of differently branded ghee (% weight)

Fatty acid	Reten.time (Sec.)	Aarey Dairy	Gokul Dairy	Nakoda Dairy	Gits	Nova	Dynamix	Home Desi	Loose Desi
Small chain saturated fatty acid (SFA)									
Butyric acid (C_4)	3.602	5.95	10.01	8.99	31.35	7.51	10.21	9.72	5.95
Caproic acid (C_6)	5.444	2.34	2.87	3.64	11.18	3.75	5.23	2.86	2.34
Caprylic acid (C_8)	7.577	1.22	1.15	1.61	4.07	1.56	2.19	-	1.22
Total		9.51	14.03	14.24	46.50	12.82	17.63	12.58	9.51
Medium chain saturated fatty acid (SFA)									
Capric acid (C_{10})	10.232	2.48	2.98	2.66	5.84	2.51	12.96	7.72	2.48
Myristic acid (C_{14})	16.903	8.84	11.54	12.18	7.78	11.30	12.33	12.45	0.09
Total		11.32	9.43	14.84	13.62	13.81	25.29	20.17	2.48
Long chain saturated fatty acid (SFA)									
Pentadecanoic acid (C_{15})	18.370	2.19	1.87	2.80	-	2.83	1.49	-	0.23
Hexadecanoic acid (C_{16})	20.665	23.70	22.84	27.16	14.78	28.77	29.79	38.70	43.56
Stearic acid (C_{18})	26.219	9.67	11.37	10.45	1.44	11.17	-	2.32	-
Arachidic acid (C_{20})	23.036	0.69	0.72	0.95	-	0.79	-	-	0.18
Total		36.23	36.80	41.36	16.22	43.56	31.28	41.02	43.97
Total SFA		57.06	60.26	70.44	76.34	70.19	74.10	73.77	55.96
Monounsaturated fatty acid (MUFA)									
Cis Palmitoleic acid ($C_{16:1}$)	20.226	2.15	2.75	2.09	0.74	2.46	2.12	2.09	-
Trans Oleic acid ($C_{18:1}$)	25.481	19.20	22.54	20.65	3.15	18.38	16.22	17.82	47.69
Cis Oleic acid ($C_{18:1}$)	16.745	0.79	0.93	0.82	0.66	0.76	1.48	-	2.05
Total		22.14	26.22	23.56	4.55	21.50	19.82	19.91	49.74

17 to 35 any lowering in the value is attributed to presence of vegetable oil. The RM value for each brand of the ghee ranged between 15-33, being highest for Gokul brand ghee. The linear relation between these fatty acid and RM value can also be seen amongst the other brands of ghee. Rangappa and Achaya (1974) have reported the lowering in the RM value due to adulteration. Iodine value is a measure of unsaturated linkages present in the fat. The iodine value for ghee was found in the range 26-28 except for loose variety. The lower value is due to presence of saturated fatty acid and absence of polyunsaturated fatty acid (PUFA). The very high iodine value of loose ghee indicated presence of more vegetable oil. In the literature (Rangappa and Achaya, 1974) it is reported that for hydrogenated fats, the iodine value should lie in the range 70-79 and can be increased by adding cottonseed in the ghee. Saponification value gives an indication of average molecular weight of fatty acids present in a fat. This value should range between 190-200. All the brands of ghee indicated the value between 215-226 except loose variety, which was pointed at 105.

The nutritional and health effects of dietary lipids are determined by the nature of their constituent fatty acids, their chain length, degree of unsaturation, the orientation of double bonds, the distribution of fatty acids in the triglycerides structure and the composition of the non-glyceride fraction (Ghafoorunissa, 1999). All fatty acids generate energy and when in excess they are stored in adipose tissue. Ghee prepared from cow and buffalo milk fat contains variety of fatty acid and its composition will vary as per the source of milk (Rammurthy and Narayanan, 1971). Fatty acid composition can be described in terms of number of carbon atom chain, which is a main skeleton of different fatty acids. Most of the fatty acid will have carbon atom between 14-22. The fatty acid with C atom less than 8 are termed as short chain fatty acid while those having between C_8 and C_{12} are known as medium chain fatty acid. Fatty acid with C atom more than 12 are classified as long chain fatty acid.

Butyric acid (C_4) is found only in milk fat. Any decrease in butyric acid content below 9.6% would indicate the adulteration with other fat bodies (Eckizen and Deki). The butyric acid content of different brands of ghee indicate that Aarey ghee has minimum content of 5.95% while Gits brand has maximum of 31.35% by weight of butyric acid. Also, the other contributor to short chain fatty acids (SCFA) like caproic (C_6) and caprylic acids (C_8) were in varying concentration. The total SCFA of Gits brand was maximum value, while that of Aarey brand ghee made from cow milk has minimum amount.

Capric (C_{10}) and myristic acid (C_{14}) are the major component of the medium chain fatty acid (MCFA). The total MCFA of Dynamix brand had maximum value averaged at 25.29% but it was lowest for the loose ghee. The MCFA value increases due to adulteration by margarine in the ghee during preparation. In loose brand ghee margarine adulteration is probably minimum and did not add to MCFA. However, Aarey brand ghee had equally lower content of MCFA can be regarded as better quality ghee. Also, the ratio of C_{14}/C_{10} fatty acid was more than 1.6 in almost all the brands of ghee suggesting some degree of adulteration by foreign fat bodies. Boniforti (1962) reported that the milk fat with a ratio of C_{12}/C_{10} fatty acid more than1.6, are considered to be adulterated with margarine tallow.

Long chain fatty acid (LCFA) components are classified as hexadecanoic (C_{16}), stearic (C_{18}) and arachandic acid (C_{20}). The composition of ghee with respect to LCFA shows similarities in the content of their different components. All the brands had LCFA in the close proximity of 35% except for Gits brand, which has a lowest value of 16.22%. The overall SFA content of Aarey dairy ghee is averaged at 54.93%, which was lowest as compared to other brands. The loose ghee also had similar low value but certain important fatty acids were found to be absent. It is essential for a better quality ghee to have minimum content of total SFA, which leads to CAD. Saturated fatty acids especially myristic acid and palmitic acid accelerates atherosclerostic processes, which helps to accumulate cholesterol. It probably depends on the fact that lipoprotein lipase and the enzymes, which esterifies the cholesterol and act slightly more efficiently on certain fatty acids.

The major constituents of mono unsaturated fatty acid (MUFA) are oleic and other long chain branched fatty acids. Oleic acid is the most prevalent monounsaturated fatty acid in the diet (Mahan and Sylvia, 2000). Also, oleic acid is a preferred substrate for sterol-o-acyl transferase activity. Any free cholesterol in the liver is esterifies to form inert cholesterol. It increases the hepatic receptor activity and whereby reduces the LDL-C production (Daumerie *et al.,* 1989). Similarly, linoleic acid and a-linoleic acid cannot be synthesized by the body and are essential dietary components. Studies on EFA nutritional status in Indians showed that the requirements of linoleic acid were fully met due to many vegetable oil but a-linoleic acid intake needs to be increased (Ghafoorunissa, 1999). Linoleic acid and oleic acid may substitute for SFA in macrophesogs membrane, which decreases the number of receptors for low-density lipoproteins. Also, the linoleic acid will reduce the averaged size of very low-density lipoproteins and inhibit fat synthesis in the liver. Thus, replacement of SFA by MUFA helps in lowering the serum cholesterol and triglycerides level. However, the effect of MUFA on LDL cholesterol depends on the total fat content of the diet. The Aarey brand ghee had maximum of oleic acid while other branded ghee had lower value of oleic acid and palmitoleic acid. Both these acid exhibits cis-trans isomeric form and show different retention time on C_{18} column. It was observed that total MUFA content of the Gokul brand ghee had maximum value up to 22.56% while Gits brand had minimum amount of 4.55%. The nutritional importance of ghee can be related to its

MUFA content. Coronary heart diseases (CHD) arises due to deficiency of MUFA and poly unsaturated fatty acid (PUFA) rather than excess of SFA or cholesterol. Thus, MUFA is the friendly fatty acid and higher value of its ratio with the total SFA will decrease the CHD risk. More recently, Enas (1949) have shown that 5% reduction in the SFA calories and its substitution by PUFA or MUFA can result in a 42% lowering in the risk of coronary artery diseases.

Conclusively, it appears that Aarey brand ghee made from cow's milk has better fatty acid composition as compared with other brands. The physico-chemical parameters also indicate the good acceptability of Aarey brand ghee. However, the consumer survey, suggest that Gokul dairy ghee is better for health and have good market. Many families consume loose ghee due to low cost but unaware about the risk from poor fatty acid consumption.

Conclusion :

After interpreting the experimental observations on the objectives of the research problem on different brands of ghee, following conclusion may be drawn.

- Gokul brand ghee is most popular brand due to low cost and good aroma.
- The physical parameters of each brands of ghee are in agreement with the reported standard values.
- Loose ghee has a poor quality.
- Fatty acid composition indicates the higher content of SFA in all the brands.
- MUFA value of Aarey is better and can be recommended for consumption.
- The excess consumption of any brand of ghee will increase the risk of CHD.

Acknowledgement :

Author wants to thank Ms. Darshana Chheda, who was the student of FSQC, a helping hand during the progress of work. The technical support in recording GLC by Mr. Prajapati of Worli Dairy products is gratefully acknowledged.

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Received : *07.06.2013;* **Revised:** *02.07.2013;* **Accepted :** *30.07.2013*