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Research article

Assessment of the quality of different brands of ghee available in Bangladesh

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ABSTRACT

The present experiment was conducted to assess the quality of Ghee from six different brands available in Bangladesh namely Brand1 (B1),Brand2 (B2), Brand3 (B3), Brand4 (B4), Brand5 (B5) and Brand6 (B6).The study was aimed to investigate the quality of ghee by comparing with the standard of Bangladesh Standard and Testing Institution(BSTI). The Ghee samples were collected and analyzed to know the moisture (%), fat (%), acid value, free fatty acid (FFA), melting point, iodine value, saponification value, peroxide value, and identify types of adulterants added such as vanaspati, sweet potato, mashed potato or other starches, old and rancid ghee, synthetic coloring matter, coal tardyes, animal fat - tallow or lard and waxes. The data revealed that allthe chemically analyzed values differed significantly ($P<0.05$) from each other of the brands. The moisture content was within the BSTI standard. Significant variations ($P<0.05$) in fat, acid value, FFA, melting point, iodine value, saponification value, and peroxide value among different ghee brands were also found. The iodine value was high in all other 5 brands, and low saponification values were detected between the samples. No starch, synthetic coloring matter, coal tar dyes, animal fat, or waxes were detected except for some rancidity in B2,which indicated that good sanitary measures were adopted during the manufacture of the supplied ghee samples. The results indicated that the supplied ghee samples were not satisfactory in terms of BSTI standards, as B1 brand ghee contains a high melting point and peroxide value with a low iodine value. Therefore, all the brands should ensure their quality properly for the consumer.

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1.INTRODUCTION

Livestock production in Bangladesh are tremendously important to the direct economic output of milk, meat, eggs, and hides and the indirect benefits of draught power (transportation, land cultivation, etc.) and manure for fuel and fertilizer (Saadullah, 2001). Dairy products help people to get enough protein in their food, which support the

country's economic growth and reduces poverty in both rural and urban areas of the country (Hamid and Hossain, 2014). People of all ages like dairy products particularly ghee (Hossain et al., 2016). Dairy products in our diet supply nutrients like proteins, fat, carbohydrates, vitamins, and minerals in significant amounts than any other single foods (Afzal et al., 2011).

Daily milk consumption went up to from 22gm in 1983 to 32gm in 2005, while meat and egg consumption roses up from 10gm to 18gm (Jabbar et al., 2010). Among different dairy products available in Bangladesh, ghee is also a top-rated dairy product and is rich in milk fat. Many people consume it regularly. Ghee can be prepared from butter or cream (Lamsal et al., 2020; Sudhakaran and Minj, 2020). Ghee is a clarified fat that is obtained from buffalo or cow milk in Asia (PFA, 2001), having incomparable organoleptic properties, which make it an important ingredient in a wide variety of food applications (Pawar et al., 2012). Cow ghee because of its regenerative properties and promoting ability of growth of healthy cells is generally prescribed for topical application for the treatment of wounds caused by heat or fire, painful ulcers, insect bites, herpes, and leprosy (Tonniand Wali, 2013).

Ghee is the most widely used milk product in the Indian sub-continent. Ghee making involves the application of heat at atmospheric pressure, which results in the almost total removal of moisture and solids-not-fat and which gives the product a characteristic flavor, physical structure and texture (Illingworth et al., 2009).

According to Ayurveda, ghee promotes longevity and protects the body from various diseases. It increases the digestion, improves absorption and assimilation. It nourishes the energy production the subtle essence of all the body tissues. It improves memory and strengthens the brain and nervous system. It lubricates the connective tissues thereby rendering the body more flexible (Agnivesh, 2011). Ghee also known as clarified butter, is an ancient dairy product prepared by heating milk, cream, or butter over 100 ℃ to evaporate water and precipitate the nonfat solids (Antony et al., 2018; Andrewes, 2012; Sharma et al., 2010; Sieber, 2005).In Bangladesh, the total production of ghee per year is 33.2 thousand metric tons (FAO, 2022). The detection of adulterants and their estimation is a key concern for many years. Therefore, it is highly prone to adulteration with cheaper materials such as vegetable oils, animal depot fats, hydrogenated fats, potato mass, inedible mineral oils, synthetic coloring matter, waxes, coal tar dyes, etc. has economic advantages when the product is not labeled accordingly. It is reported that ghee from ten brands available in markets were found adulterated in 2008 (BSTI).However, data of recent works are limited, so it necessitates to explore the quality of different branded ghee and their adulteration available in the different markets. The study was, therefore, conducted to assess the quality of ghee from different brands available in Bangladesh and compare it with the current BSTI standards.

2.MATERIALS AND METHODS

Location of the study

The study was conducted at the Dairy Science Laboratory, Faculty of Veterinary Medicine, and Chemistry Laboratory, Faculty of Food Science and Technology of Chattogram Veterinary and Animal Sciences University (CVASU), and Chemistry Laboratory of Bangladesh Council of Scientific and Industrial Research (BCSIR), Chattogram.

Study period

The study was conducted during the period from January to June 2018. All the procedures like sample collection and chemical analysis of samples were performed within this period.

Collection of samples

A total of 18 samples of 6 brands as Brand1 (B1), Brand2 (B2), Brand3 (B3), Brand4 (B4), Brand5 (B5) and Brand6 (B6)and 3 samples of each brand belonging to different batches of production were collected from different super shops of Chattogram for this study.

Preparation of samples

The samples were prepared according to the method described by Reaffirmed (1997). Methods of sampling and laboratory tests for determining the quality of Ghee were done

according to the guidelines of the Bureau of Indian Standards, New Delhi.

Various chemical parameters like melting point, moisture content, total acidity, iodine value, and saponification value were determined using methods reported in the literature (Sathe, 1999; IUPAC, 1979). The peroxide value was determined using methods reported in AOAC (2000).

Detection of food value of ghee

Determination of moisture content of ghee

The moisture in ghee was determined by using an automatic moisture analyzer (PMB 202, Germany, Max 200g d=0.01). (Ref: IS 3508-1966 (Reaffirmed 1997). Methods of sampling and test for Ghee were done according to Bureau of Indian Standards, New Delhi.

Determination of fat content of ghee

Fat in ghee was determined by using a butyro-refractometer(Ref: IS 3508-1966, Reaffirmed 1997, Methods of sampling and test for Ghee (Butterfat), Bureau of Indian Standards, New Delhi).

Determination of acidity of ghee

Acidity was determined using methods reported in the literature (Sathe,1999; IUPAC, 1979).The acidity of ghee can be expressed in different ways including free fatty acids (FFA)and Acid value.

Determination of melting point of ghee

The iodine value was determined using methods reported in the literature (Sathe, 1999; IUPAC, 1979). 3ml of ghee with 3ml glacial acetic acid was taken into a test tube and warm the contents in a test tube. It was agitated frequently and a melting point was noted.

Determination of iodine value of ghee

The iodine value was determined using methods reported in the literature (Sathe,1999; IUPAC, 1979).

Determination of saponification value of ghee

Saponification value was determined using methods reported in the literature (Sathe,1999; IUPAC, 1979).

Determination of peroxide value of ghee

Peroxide value was determined using methods reported in AOAC, 2000. Briefly, 0.5 gm sample was taken into a conical flask, 10 ml chloroform and 15 ml acetic acid were added. Then, 1 ml potassium iodide was mixed with the solution, and kept in dark place for 5 minutes. Later 30 ml of distilled water was added, 1 ml warm starch solution was added. The solution was then titrated with 0.1N sodium thiosulphate and the blue color was discarded. Finally, the per oxide value was calculated using the titrated value.

Bodouine test

A melted sample of ghee was shaken with cane sugar solution in hydrochloric acid. In the presence of sesame oil in ghee, it showed red color (FSSAI Rules, 2010).

Determination of adulteration in ghee

The adulterants of ghee were detected according to the method as described by Reaffirmed (1997).

Test for adulteration in ghee with vegetable oil or Vanaspathi

One teaspoonful of melted ghee with an equal quantity of concentrated hydrochloric acid was taken in a test tube. A pinch of sugar was added. The test tube was closed and shaken to mix. The test tube was kept in standing condition for five minutes. After five minutes, a crimson red color was appeared on the bottom of the ghee.

Test for adulteration in ghee with sweet potato, mashed potato, and other starches

A small quantity of ghee was melted in a test tube and a few drops of the iodine solution were added to the melted ghee. The iodine solution, which is brown in colour, was turned purple, indicating the presence of starches in ghee.

Test for adulteration in ghee with old and rancid ghee

One teaspoonful of the ghee sample was melted in the test tube. Five ml of hydrochloric acid and 5ml of 0.1% ether solution of phloroglucinol were added to the test tube. The test tube was closed and shaken well to mix all the substances. After some time, the bottom layer

was shown pink or red colour, indicating the sample was adulterated with rancid ghee.

Test for adulteration in ghee with synthetic coloring matter

Two gm of ghee was dissolved in ether. The whole portion was divided into two test tubes. One ml of HCl was added in one test tube and 1 ml of 10% NaOH solution added in another test tube. The test tubes were shaken well and allowed to stand. The presence of pink color in the acidic solution and/or yellow color in the alkaline solution indicated the added coloring materials.

Test for adulteration in ghee with coal tar dyes

Five ml of dilute hydrochloric acid or concentrated Sulphuric acid and 5 ml of melted ghee sample were taken in a test tube and shaken well. The pink color in the case of Sulphuric acid addition and crimson red color in the case of dilute hydrochloric acid indicated the presence of coal tar dyes. If the addition of HCl does not give crimson red color, add some water. The development of color indicates the presence of coal tar dyes.

Test for adulteration in ghee with animal fat (tallow or lard)

Three ml of ghee + 3 ml glacial acetic acid was taken into a test tube and warmed the contents. Agitated it frequently and a melting point were noted. When the melting temperature was above 39^0c it indicated the presence of animal fat.

Test for adulteration in ghee with waxes

Three ml of ghee sample was taken into a test tube and melted. Three drops of concentrated colorless nitric acid were added and kept in a hot water bath. The appearance of reddish or yellow color indicated the presence of wax.

Statistical analysis

Data were incorporated in a microsoft excel sheet (2007). Data were then analyzed using one-way ANOVA of SPSS v.16 for windows and least square means were compared by Duncan's Multiple Range Test (DMRT).All statements of differences were measured on significance ($P \leq 0.05$).

3. RESULTS

Chemical analysis of ghee

The data of chemical parameters of different brands of ghee were shown below (Table 1).The result revealed that the moisture content was detected highest ($P<0.01$) in B_3 (0.93 ±0.01%) and the lowest being in B_5(0.30±0.01%)(Table 1). The highest (P<0.05) fat (%) was detected in B_4 (99.0±0.29%) and lowest in B_5(97.3±0.17%). The highest acid value was detected in B_2, and B_3 (0.81±0.01%) and the lowest in B_4, (0.54±0.01%). The highest FFA percentage was detected in B_1, B_2, B_3(0.40±0.01%) and the lowest in B_4 (0.27±0.01%)(Table 1). The highest melting point was detected in B_2, (46.0±0.58^0 C) and the lowest inB_5 (41.0±0.58^0 C).The highest Iodine value was detected in B_3, (82.09±0.1) and the lowest inB_1 (22.38±0.1) (Table 1). The highest saponification value was detected in B_5(65.07±1.15) and the lowest in B_1, (2.6±0.67)(Table 1). Table 1 shows that the highest peroxide value (59.67±0.89) was detected in case of B_5 and the lowest in B_2, (1.4±0.58)(Table 1). Besides, all Ghee brands were negative in the Bodouine test (Table 2).

Table 2.Bodouine test of different brands of ghee

Brands of Ghee	Bodouine Test
*B_1	Negative
B_2	Negative
B_3	Negative
B_4	Negative
B_5	Negative
B_6	Negative

*B_1 = Brand 1, B_2 = Brand 2, B_3 = Brand 3, B_4 = Brand 4, B_5 = Brand 5, B_6 = Brand 6.

Detection of adulteration in different brands of ghee

A total of 18 samples of Ghee from 6 brands (3 samples from each brand) were analyzed. Ghee from B_2, B_3, B_4, B_5 and B_6were adulterated with Vanaspati. Ghee from B_2 was slightly rancid. All ghee brands were adulterated with synthetic coloring matter. B_3,B_5 and B_6 brands were adulterated with animal fat, tallow or lards (Table 3).

Table 1. Chemical parameters of different brands of ghee

Parameters	***B_1 Mean±SE**	**B_2 Mean±SE**	**B_3 Mean±SE**	**B_4 Mean±SE**	**B_5 Mean±SE**	**B_6 Mean±SE**	**BDS Value**	**P – value**
Moisture (%)	0.63 ± 0.01^{c}	0.64 ± 0.01^{c}	0.93 ± 0.01^{d}	0.59 ± 0.01^{b}	0.30 ± 0.01^{a}	0.59 ± 0.01^{b}	0.1	0.001
Fat (%)	98.5 ± 0.29^{bc}	98.16 ± 0.17^{bc}	98.0 ± 0.29^{ab}	99.0 ± 0.29^{c}	97.3 ± 0.17^{a}	98.5 ± 0.29^{bc}	99.8	0.011
Acid value (%)	0.80 ± 0.01^{d}	0.81 ± 0.01^{d}	0.81 ± 0.01^{d}	0.54 ± 0.01^{a}	0.67 ± 0.01^{c}	0.62 ± 0.01^{b}	1.9	0.001
Free fatty acid (FFA) (%)	0.40 ± 0.01^{d}	0.40 ± 0.01^{d}	0.40 ± 0.01^{d}	0.27 ± 0.01^{a}	0.35 ± 0.02^{c}	0.31 ± 0.01^{b}	-	0.001
Melting point (^{0} C)	44.7 ± 0.89^{bc}	46.0 ± 0.58^{c}	42.0 ± 1.15^{ab}	43.0 ± 1.73^{abc}	41.0 ± 0.58^{a}	44.0 ± 0.58^{abc}	33-35	0.043
Iodine value	22.38 ± 0.1^{a}	64.25 ± 2.08^{d}	82.09 ± 0.1^{e}	57.0 ± 0.1^{c}	34.8 ± 1.15^{b}	34.22 ± 2.31^{b}	26-35	0.001
Saponification value	2.6 ± 0.67^{e}	22.3 ± 0.65^{a}	45.22 ± 3.5^{b}	43.36 ± 0.57^{b}	65.07 ± 1.15^{c}	2.23 ± 0.58^{d}	281.0	0.001
Peroxide value	30.0 ± 1.15^{c}	20.0 ± 1.15^{b}	1.4 ± 0.58^{f}	40.67 ± 0.67^{d}	59.67 ± 0.89^{e}	13.33 ± 0.89^{a}	0.2	0.001

Means with different superscript letters (a–f) in the same row differ significantly at $p < 0.05$; *B_1 = Brand 1, B_2 = Brand 2, B_3 = Brand 3, B_4 = Brand 4, B_5 = Brand 5, B_6 = Brand 6.

Table 3.Detection of Vanaspati, Sweet potato or mashed potato and other starches, Old and rancid ghee, Synthetic coloring matter, Coal tar dyes, Animal fat; tallow or lard, and Waxes.

Parameters	**B_1**	**B_2**	**B_3**	**B_4**	**B_5**	**B_6**
Vanaspati	Absent	Present	Present	Present	Present	Present
[1]Starches	Absent	Absent	Absent	Absent	Absent	Absent
Old and rancid Ghee	Absent	Present	Absent	Absent	Absent	Absent
Synthetic coloring matter	Present	Present	Present	Present	Present	Present
Coal tar dyes	Absent	Absent	Absent	Absent	Absent	Absent
[2]Animal fat	Absent	Absent	Present	Absent	Present	Present
Waxes (Nitric acid test)	Absent	Absent	Absent	Absent	Absent	Absent

[1]Starches = sweet potato, mashed potato and other starches; [2]Animal fat = Animal fat, tallow or lard (Valenta test); *B_1 = Brand 1, B_2 = Brand 2, B_3 = Brand 3, B_4 = Brand 4, B_5 = Brand 5, B_6 = Brand 6.

4. DISCUSSION

Assessment of the quality of ghee is important for both economics and health management. Weassessed the important quality parameters branded ghee and compared with BSTI standard. It is obvious from the data that different branded ghee showed significant differences for moisture, fat percentage, acid value, FFA, melting point, iodine value, saponification value, and peroxide value, respectively. All the parameters of chemical analyses showed significant variation between treatment. BSTI standard for moisture content(%) is 0.1-1. The moisture content (%) of B1, B2, B3, B4, B5 and B6 were within the limit as suggested by BSTI. Though, it was highest in B3, and lowest in B5. This variable was statistically significant ($P \leq 0.05$). Sathe (1999) stated that the moisture content of the ghee playsan important role and affects the shelf life of the product. It should be as low as 0.2% by weight. She also found that the moisture content of all the brands was within the normal limit of around 0.2%.

BSTI standard for fat content(%) of ghee is 99.0 - 99.9. The fat percentage of B4 only was matched with BSTI standards but brands were below the standards. The highest fat percentage was detected in B4, and the lowest in B5. This variable was statistically significant ($P \leq 0.05$). Ghee is a dairy product that contain highest amount of fat than all other dairy products. It acts as the best source of fat and energy. Ghee (heat clarified milk fat) is reported to be the richest natural source of CLA (Serunjogi et al., 1998). We can use ghee in the formulation of desserts such as cakes cookies and melted chocolate, pudding (PIFC, 2011). BSTI standard for acid value for the ghee sample is 1.9. The acid value of all the tested brands was below the BSTI standard which indicated that the ghee of all brands possessed outstanding shelf life quality. The abnormal acidity may affect the shelf life of the ghee adversely (Sathe, 1999). This variable was statistically significant ($P \leq 0.05$).

In this study, the Free Fatty acid(FFA) value of B1, B2 and B3, brands were the highest and lowest in B4. This variable was statistically significant ($P \leq 0.05$). 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 structure of the triglycerides 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 a variety of fatty acids and its composition will vary as per the source of milk (Parmar et al., 2018). Despite the steady and significant ($P < 0.05$) increase in FFA during storage, none of the samples had rancid flavor indicating that the level of FFA production was not to an extent that would cause the off flavor. An increase in FFA in a 'low-calorie dairy product during storage due to the continuous lipolytic breakdown as a result of the growth of yeasts and moulds has been reported in a previous study (Ibrahim et al., 1994). Patel and Gupta (1989) also reported that the increase in the FFA content of low-fat soya spread with progressive storage. Similar trends of rising in the FFA content of stored spreads were also observed by other workers (Devdhara et al., 1991; Deshmukh et al., 2003; John and Tyagi, 2003).

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 33^0 C -35^0 C according to BSTI standards. In the present study, the melting point of B1, B2, B3, B4, B5 and B6 were not matched with BSTI standards which was several times higher than the normal value of 35^0 C. It may be suspected that ghee is adulterated with animal fat tallow or lard which is likely to higher the melting point of ghee by above 39^0 C. Adulteration with vegetable oil up to 20% does not make any significant change in the melting point of ghee (Sharma and Singhal, 1996).

BSTI standard for Iodine value is 26-35. B5 and B6were matched with BSTI standard. In B1, Iodine value was lower than BSTI standard and thanB2,B3,and B4brands. This value was higher than the BSTI standard. This variable was statistically significant ($P \leq 0.05$).The iodine value for ghee was found in the range of26-28 except for the loose variety. The lower value is due to the presence of saturated fatty acid and

the 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 of 70-79 and can be increased by adding cottonseed to the ghee.

Saponification value gives an indication of the average molecular weight of fatty acids present in fat. This value is 281.0 according to BSTI standards. All the brands of ghee contain the lowest saponification value than BSTI standards. This variable was statistically significant ($P \leq 0.05$). Feeding of cotton seeds to milch animals lowers this value by 7 units (Rangappa and Achaya, 1974). Lea (1939) reported that autoxidation caused partial hydrolysis of fats into fatty acids and glycerol, oxidation of glycerides to fatty acids of low molecular weight, and oxidation of unsaturated fatty acids to hydroxy acids and peroxides, which lead to increase in potash absorption of fats.

BSTI standard for peroxide value 0.2. The peroxide value below 1.5 is very good. Peroxide value above 3.5 is not acceptable. In this present study, the peroxide value was too much higher than the acceptable level. This variable was statistically significant ($P \leq 0.05$). Frying of food at 185–200°C in ghee increased peroxide values. Paul et al. (1949) reported that the peroxide value of ghee prepared from raw cow and buffalo milk increased from 0.5 to 3.5 and 0.3 to 3.2 respectively after 24 weeks of storage at 37º C in tin containers. Kehagias and Radema (1973) also reported a continuous increase in peroxide value (0.31 to 3.22) of butter oil stored at 30º C for 11 months. Similar results were also observed by Reddy (1998) for both samples prepared from H2O2 treated and untreated milk and the value increased gradually on storage.

The current study revealed that Vanaspati or vegetable oil was present in all brands of ghee except B1 brand. Mostly palm oil and cotton seed oil are used in the manufacturing of Vanaspati ghee (Tahir et al., 2013).Sweet potato, mashed potato and other starches was absent in all brands of ghee. Ghee from B1, B3, B4, B5 and B6was not old or rancid except B2was slightly rancid. In every ghee brand, synthetic coloring matter was added. Coal tar dyes were absent in all brands of ghee. Animal fat, tallow or lard was present in B3, B5 and B6but absent in B1, B2and B4. In all brands of ghee, waxes were absent. From this study, we can say that all brands of ghee were adulterated with vegetable oil, synthetic coloring matter and animal fat. Other adulterants were not added to these supplied samples. Roday (2002) tested food samples examined at various Public Health Laboratories in the state of Maharashtra. They stated that in small cities like Jalgoan, Nanded and Jalna the percentage of adulteration is very high compared to bigger cities including Nagpur, Pune, Amaravati and Solapur in India.

5. CONCLUSION

In conclusion, the moisture and fat content of ghee were within the BSTI value but other chemical parameters were not within this reference value. So, ghee samples from some brands were unsatisfactory regarded in meeting standard quality. The current study revealed that the common adulterants used in supplied ghee were vanaspati, synthetic coloring matter, and animal fat; which were commonly used in almost all of the ghee brands whereas starches, old or rancid ghee, coal tar dyes, and waxes were not used at any brands of ghee. This study recommends further study regarding the quality of ghee considering a wide range of parameters and with a large number of samples.

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