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Evaluation of physicochemical parameters of edible oils at room temperature and after heating at high temperature

[1,*]Wazed, M.A., [1]Yasmin, S., [2]Basak P., [2]Hossain, A., [2]Rahman, M.M., [2,3] Hasan, M.R., [2]Khair, M.M. and [3]Khatun, M.N.

[1]*Department of Food Engineering and Technology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200, Bangladesh*
[2]*Department of Food Science and Engineering, German University Bangladesh, Gazipur-1702, Bangladesh*
[3]*Department of Food Technology, Chapainawabganj Polytechnic Institute, Chapainawabganj, Bangladesh*

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Abstract

Edible oils and fats are recognized as vital constituents of our daily diet and contribute significantly to the regulation of different body functions. Edible oil quality is largely determined by physicochemical characteristics and sensory evaluation due to its nature and processing procedure. The present study includes evaluation of different physicochemical parameters of soybean, palm, mustard and bran oil at room temperature and after heating at 180°C for 10 mins using different analytical methodologies. These properties were studied to evaluate the compositional quality of oils and also to investigate the effect of heating as it ultimately changes the physicochemical and sensory properties of the oil. Results revealed that there was a significant difference in physicochemical parameters among four types of oils before and after heating. Peroxide, free fatty acid and acid value were increased with the increase of temperature at 180°C. The iodine value was highest in soybean oil (133.17 mg/g), followed by mustard oil (110.59 mg/g) but was lowest in palm oil (46.18 mg/g). In addition, saponification value was found to be 187.1, 202.39, 191.38 and 181.6 mg/g in soybean, palm, mustard and bran oil, respectively. The study also indicated that the L*, a* and b* values of oil decreased significantly with heating temperature. However, sensory evaluation results also found that soybean oil and bran oil were more preferable to cooking than the other two oils. Taking consideration of all parameters the study concluded that soybean oil and bran oil had the superior quality to other samples.

1. Introduction

Edible oils are food substances that are derived from the seed of plants which are grown in several different parts of the world, serving as a good source of proteins, lipids and fatty acids as well as, they add flavour and colour to the foods that we consume. It also contains hydrophilic antioxidants (e.g., tocopherol, phenolic compounds, phytosterol), which aid in the metabolism of fat-soluble vitamins (Gouilleux *et al*., 2018). The two essential fatty acids, omega-3 and omega-6, which cannot be synthesized by the human body are supplied by edible oils in the diet (Ng *et al*., 2018). In addition to the two essential fatty acids, edible oils provide energy (Hou *et al*., 2019). Industrially, they play an important role in the development of different areas of chemical products, pharmaceuticals, cosmetics, paints and most importantly, food (Casoni *et al*., 2019).

Bangladesh is deficient in the production of edible oils and fats since the country can produce only about 10% of its needs and must import the remaining. In Bangladesh, there are three main edible oils; soybean oil, palm oil and mustard oil are used. Traditionally, virgin mustard oil was the most commonly consumed food oil. It contains a great amount of mono-unsaturated fatty acids and a good balance of polyunsaturated fatty acids that is good for the heart (Zahir *et al*., 2017). Later soya bean oil was introduced in the early ’60s and it is one of the principal oils used for edible purposes in Bangladesh. It contained a higher percentage of long-chain mono and polyunsaturated fatty acids (81.1±1.5%) with respect to palm oil (Chowdhury *et al*., 2007). Also, palm oil is edible oil, rich in saturated fats and free trans-fats. It was introduced in the early ’70s to meet the growing demand and is used in cooking foods and correspondingly used as an imperative component in many processed foods

*Corresponding author.
Email: *mawazed@hstu.ac.bd*

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(Lai *et al*., 2012). Besides rice bran oil now available in Bangladesh is rather tricky.

Quality represents the evaluation of excellence of a product and is indicated in terms of grade, standards and specifications. The quality of oils is very important, and the extent of the oil quality can determine its desirable use. The feature of any oil is indicated by numerous physical and chemical properties which indicate both the nutritive and physical quality of the oil (Mousavi *et al*., 2012). In quality control, the properties include moisture content, refractive index, viscosity, colour, free fatty acid, saponification value, peroxide value, acid value and iodine value which are used to determine the shelf-life quality and hence the economic value of oils (Endo, 2018). Also, the sensory concept is a multidimensional concept that acts as an indicator for determining the quality of oil (Delgado and Guinard, 2012).

Edible oils are mostly used for cooking and frying foods and snacks whereby the food is immersed in hot oil in the temperature range of 140–200^{o}C (Nduka *et al*., 2021). The temperature has been recognized as one of the factors that reduce oil quality (Jabeur *et al*., 2015). Besides, several oxidative and thermal reactions can occur during repeated frying which consequences in conversion in the physicochemical, nutritional and sensory properties of the oil. Elevated temperature is a factor that causes the increased acid value in oils (Atinafu and Bedemo, 2011). The high acid value indicates high free fatty acid, which causes oil to become rancid. It has been demonstrated that elevated free fatty acids, change of colour, low smoke point, low iodine values, elevated total polar materials, high peroxide values, high foaming properties and increased viscosity are indicators of poor oil quality (Turan and Yalcuk, 2013).

Recently, the effect of heating temperature at 185^{o}C and prolonged heating time from 1-7 hrs on the physicochemical properties of four brands of edible cooking oil was investigated by Nduka *et al*. (2021). Their results showed that there were significant differences in the physicochemical properties of the oil types but heating at different times did not have any significant effect. Results also reveal that out of the four oils based on the peroxide value, soybean oil was the most stable oil while palm kernel oil was found to be the least stable oil. Omara *et al*. (2019) investigated the effect of continuous deep-fat frying at 140^{o}C for 10-20 mins on the physicochemical properties of ten brands of edible cooking oil. Their results showed that changes in the physical and chemical parameters increase with the increase in the number of fries of the potato chips. Repeated re-use of oils for consecutive deep frying of potato chips on the same day can be done only up to a maximum of 7 times on average for hard oils and 6 times for soft oils with the oils still regarded as safe for frying potato chips for human consumption. In another study, Pardeshi (2020) examined the physicochemical properties of different brands of mustard oils at room temperature and the effect of heat treatment at 180^{o}C for 30 mins. The results displayed that, before and after frying, the physicochemical characteristics of the vegetable oils were found within the safety limit except for acid value and specific gravity and iodine values are lower than as compared with the safety limit.

In Bangladesh, the physicochemical characteristics of a large number of edible oils are not known after deep frying. It is, therefore, very important that the quality of commercially available edible oils needs to be determined to ascertain their suitability for consumption. Therefore, this study aimed to explore in detail the physicochemical properties of four selected edible oils at room temperature and after heating at high temperature in Bangladesh-which have not been compared before.

2. Materials and methods

2.1 Reagents

The chemical and reagents were used during the present research work are sodium hydroxide, starch indicator, hydrochloric acid, starch solution, alcoholic potassium hydroxide, chloroform, petroleum ether, phenolphthalein indicator, iodine monochloride, sodium thiosulfate, potassium iodide, potassium hydroxide, ethanol and glacial acetic acid. All the reagents and chemicals were of analytical grade and purchased from Paradise Scientific Company, Dhaka, Bangladesh.

2.2 Collection of samples

Due to being commonly consumed by people commercial soybean oil, palm oil, mustard oil and rice bran oil were purchased from a local market in Gazipur city, Bangladesh. All the oil samples were kept at room temperature until further analysis.

2.3 Heating process

The oil sample was first heated up to 180±1℃ for 10 mins and the analysis was carried out for the effect of heating on soybean oil, palm oil, mustard oil and rice bran oil quality.

2.4 Moisture content determination

The moisture content of oil samples before and after heating was determined by the Association of Official Analytical Chemists (AOAC, 2004) method. Firstly, the weight of the previously dried (1 hr at 100^{o}C) crucible with cover was taken and 5-15 g of sample was placed

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on it. The samples were dried to constant weights in an oven at 105°C, cooled in desiccators and weighed. Drying, cooling and weighing were repeated until the two consecutive weights were the same. From these weights the percentage of moisture was calculated as follows:

$$\text{Percent as moisture} = \frac{\text{Initial Weight (g)} - \text{Final Weight (g)}}{\text{Weight of the sample (g)}} \times 100$$

2.5 Refractive index determination

The refractive index of oil at room temperature was determined using Carl Zeiss 110849, Made in West Germany. At first, the refractometer was calibrated with freshwater. Then the oil drop was placed on the prism and directed towards a source of light. It was then observed through the lens after adjustment had been made to give a semi-circle on the glass prism in the refractometer. The reading was then taken.

2.6 Viscosity measurement

A rheometer is described by Nzikou *et al*. (2006) was used to measure the different oil viscosities. By this method, a concentric cylinder structure is immersed in the oil and the potency necessary to incredulous the resistance of the viscosity to the rotation is measured. The viscosity value (mPa.s) is automatically calculated based on the speed and the geometry of the probe. The experiment was carried out by putting 3 mL of sample in a concentric cylinder system using 100 sec^{-1} as shear rate.

2.7 Acid value measurement

The acid value was determined by the ISO 660:1996 (International Organization of Standardization, 1996) method. Approximately 2 g of oil was mixed with 10 ml ethanol, followed by two drops of phenolphthalein. The combination was boiled for about five mins and then titrated with 0.1N KOH till a pale pink colour seemed. The acid value was calculated using the following equation:

$$\text{Acid Value} = \frac{\text{Titre} \times \text{N of KOH} \times 56.1}{\text{Weight of the sample (g)}} \times 100$$

2.8 Free fatty acid determination

By titrating the alcoholic solution of the oils with an aqueous solution of sodium hydroxide using phenolphthalein indicator, the free fatty acid concentration was determined (Aletor *et al*., 1990). Approximately 10g of the oil was assessed into the conical flask. 50 ml of alcohol ether mixture in equal volume was added and it was warmed in a laboratory hotplate stirrer to obtain a homogeneous mixture. 1 mL of phenolphthalein indicator was then added and was titrated with 0.1N NaOH until a fairly pink endpoint was obtained.

$$\text{FFA as palmitic acid} = \frac{\text{Titre (mL) of NaOH} \times \text{N of NaOH} \times 28.2}{\text{Weight of the sample (g)}}$$

2.9 Iodine value measurement

The iodine value was determined by Wijs's method using the guide provided by Stancu *et al*. (2003). A modest mixture of iodine monochloride and acetic acid was added to the CPO samples. The combination was endorsed to stand for 30 mins in the dark. About 15 mL of 10% potassium iodide was added to the mixture. The solution was titrated with 0.1mL sodium thiosulphate solution using the starch indicator to a colourless endpoint (S). A study of Blank (B) was also carried out and the iodine value was calculated using the equation:

$$\text{Iodine value} = \frac{(B - S) \times N \times 12.69}{\text{Weight of the sample (g)}}$$

Where B = blank titre value; S = sample titre value; N = normality of $Na_2S_2O_3$; 12.69 is used to convert from meq thiosulphate to g iodine; molecular weight of iodine = 126.9.

2.10 Peroxide value

This was done by the AOAC method (1990). Oil sample (5.0 g) was accurately weighed into a conical flask and dissolved in a solvent mixture containing 12 mL chloroform and 18 mL glacial acetic acid. To the solution, 0.5 mL of a saturated aqueous potassium iodide solution was added. The flask was stoppered and allowed to stand for 1 min. 30 mL of water was added and the solution was titrated with 0.1 M sodium thiosulphate solution until the yellow colour had almost gone. About 0.5 mL of starch solution was introduced and titration continued with the reagent added slowly until the blue-black colour disappeared. During the titration, the flask was continuously and vigorously shaken to transfer the liberated Iodine from the chloroform layer to the aqueous layer. A blank titration was also performed, and the peroxide value was obtained from the formula:

$$\text{Peroxide value} = \frac{F \times (A - B) \times 10}{\text{Weight of the sample (g)}}$$

Where F = Factor of 0.1N $Na_2S_2O_3$, A = Sample titre value and B = Blank titre value.

2.11 Saponification value measurement

Saponification value was determined by the Association of Official Analytical Chemists (AOAC, 2005). Typically, 4 g of oil sample was taken in 250 mL conical flask and added with 50 mL alcoholic KOH and mixed thoroughly. A condenser was fitted to the conical flask and the mixture was heated between 60 and 70°C

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for an hr. The hot mixture was titrated with 0.5 N HCl using 2 drops of 1% phenolphthalein indicator until a colourless solution was obtained. A blank titration was also accompanied side by side. The saponification value was calculated using the following formula:

$$\text{Saponification value} = \frac{(B - S) \times N \times 56.1}{\text{Weight of the sample (g)}}$$

Where B = HCl (mL) for blank, S = HCl (mL) for sample and N = Normality of HCl

2.12 Colour determination

While the colour is not regarded as an imperative quality feature for the oil, it has a prodigious impact on consumer acceptance. The colour of oils was measured the surface colour in terms of L*, a* and b* (Moni *et al*., 2023) and using the CIE Hunter Lab system (Color Quest XT, Hunter Associates Laboratory Inc, USA).

2.13 Sensory evaluation of oil by frying potato chips

For sensory evaluation, potatoes were peeled and cut into pieces (approximately 5 cm). The oil sample was first heated up to 180±1°C for 10 mins. Immediately after heating, the oil samples were used to fry potato slices. Frying experiments were conducted in triplicate in each frying medium and the frying duration was five mins. The samples were evaluated for colour, flavour, taste and overall acceptability by a panel of thirty testers. The test panellists were asked to rate the different compositions presented to them on a 9-point hedonic scale (Roshid *et al*., 2016; Roni *et al*., 2021, Wazed and Islam, 2021; Wazed *et al*., 2021; Khatun *et al*., 2022).

2.14 Statistical analysis

All the experimental determinations were carried out in triplicate. The statistical analysis was performed with SPSS 16.0 software, using analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) with a 95% confidence level ($p < 0.05$).

3. Results and discussion

The quality of oil samples before heating (that is at room temperature) was analyzed by evaluating physicochemical properties such as moisture content, refractive index, viscosity, acid value, peroxide value, iodine value, free fatty acid and saponification value. Results are presented in Table 1. The effect of heating carried out at 180±1°C for 10 mins was also investigated and the results are tabulated in Table 2.

3.1 Moisture content

The moisture content is an important property that interferes with the quality of the oils during storage. The moisture content of the oils differs due to their different structural composition. Table 1 shows that the moisture contents measured for palm and mustard oils were relatively high and in bran oil the minimum amount of moisture content. High moisture content might be due to source of oil, differences in cultivar type, improper treatment during oil processing and refining process etc. Generally, high moisture content can generate increased free fatty acids and off-flavours (Brien, 2004). Moreover, the high moisture content is suitable for food texturing, baking and frying (Yauri and Garba, 2011).

In Table 2, heating of different oils at 180°C at 10 mins, the highest values of moisture content is attributed to palm oil, 0.15% followed by mustard oil with a value of 0.13%. In addition, soybean oil with a value of 0.09% while bran oil had the least moisture content of 0.05% due to the breakdown of the oil's structure following heating at high temperatures. From the results, it can be assumed that after heating the moisture contents of all the samples were wide-ranging because it was not sold or stored or packaged under appropriate conditions.

3.2 Refractive index

Table 1 shows that in bran oil, the maximum value of the refractive index is 1.478, in palm oil minimum value of the refractive index is 1.453. The refractive index of mustard and soybean oil is 1.467 and 1.469, respectively. Results show that soybean oil and mustard oil have a refractive index within the level recommended by FAO/WHO (1.466-1.470) (Nielsen, 2010). On the other hand, palm oil's refractive index is 1.453-1.456 was found by Ramachandran (2001). The refractive index of the rice bran oil was found to be 1.469 reported

Table 1. Physicochemical properties of oil at room temperature (30°C).

Properties	Soybean oil	Palm oil	Mustard oil	Bran oil
Moisture content (%)	0.14±0.021	0.30±0.011	0.21±0.021	0.09±0.02
Refractive index	1.469±0.003	1.453±0.006	1.465±0.001	1.478±0.002
Viscosity (mPa.s)	35.5±0.073	33.24±0.810	48.43±0.556	37.98±0.525
Acid Value (mg/g)	0.304±0.007	0.878±0.039	3.05±0.014	1.11±0.201
Free fatty Acid	0.313±0.008	0.502±0.014	1.54±0.034	0.581±0.024
Iodine value (mg/g)	133.17±0.589	46.18±0.633	110.59±0.731	100.27±0.940
Peroxide value (meq/kg)	0.53 ± 0.02	2.21 ± 0.05	4.33±0.02	0.98±0.10
Saponification Value (mg/g)	187.1±0.537	202.39±1.031	191.38±0.987	181.6±0.767

Values are presented as mean±SD of triplicate analyses.

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by Ramachandran (2001). The high refractive index increases the degree of unsaturation (Bello *et al*., 2012). From the refractive index of oils, the study has revealed that soybean and bran oil contain lower impurities than others. The summary of the refractive indices of the investigated oils at 180°C are depicted in Table 2 and shows that mustard and bran oils demonstrated a low RI value as compared to other oils. Therefore, mustard and bran oils will have a low boiling point relative to other oils.

3.3 Viscosity

Viscosity is related to the chemical properties of the oils such as chain length and saturation or unsaturation. Table 1 shows that at room temperature of 30°C the values of the viscosities are 35.5, 33.24, 48.43 and 37.98 mPa.s for soybean, palm, mustard and bran oils, respectively. The viscosity value is high in mustard oil and palm oil has a low value. The viscosity of soybean oil is above within the reference value that was 33 mPa.s reported by Fasina and Colley (2008). Results showed that Palm oil viscosity was below the reference value of 35 mPas at 30°C (Shahidi, 2005). On the other hand, bran oil's viscosity was below the value of 40 mPas (Kupongsak and Kansuwan, 2012).

Viscosity also depends on temperature. Results tabulated in Table 2 revealed that an increase in viscosities was observed for mustard and palm oil while a decrease was observed for soybean and bran oil at 180°C. When temperature increases kinetic energy also increases that has improved the motion of molecules and reduces intermolecular forces. The layers of the liquid pass easily over each other and thereby contribute to reducing the viscosity (Zahir *et al*., 2017). Such a phenomenon is confirmed by other researchers since the increase in viscosity may be probable due to high saturation of the triglyceride chain whereas the decrease is likely due to an increase in unsaturation (Kim *et al*., 2010; Santos *et al*., 2014).

3.4 Iodine value

The iodine values obtained for the oil samples at normal temperature are shown in Table 1. This table shows that in soybean oil, the maximum iodine value is 133.17 mg/100 g. This value indicated that the iodine value of soybean oil is within Codex standard recommended range (124-139 mg/100 g) for soybean oil (Codex Alimentarius Commission, 1999). The higher iodine value of soybean oil suggested that it was less stable in normal conditions (Akinola *et al*., 2010). On the other hand, the iodine value of bran oil is 100.27 mg/100 g which is similar to the result found by Firestone (2005). Moreover, palm oil's iodine value is 46.18 mg/100 g. The result is significant with the providing range 48-58 mg/100 g (AOCS, 2002).

From Table 2, for soybean oil, the iodine value (132.81) decreased when heated at 180°C, due to breakage and saturation of bonds. In palm oil and bran oil, the iodine value decreased steadily because of a decrease in unsaturation. In contrast, the observed highest fluctuations in the iodine values of the mustard oil, at normal temperature iodine value were 110.59 and at 180°C, it was 99.89. The lowest iodine value was found in the palm oil sample at 44.87 mg/100 g which may have contributed to its greater oxidative storage stability. The oxidative and chemical changes in oils during storage are characterized by increased levels of free fatty acid and reduction in the total unsaturation of oils (Zahir *et al*., 2017).

3.5 Saponification value

Saponification value (SV) is an index of the average molecular mass of fatty acid, and it is used in checking adulteration of the oil samples (Zahir *et al*., 2017). The SV value obtained at normal temperature for the oil samples in Table 1 showed 187.11, 202.39, 191.38, and 181.6 mg KOH/g for soybean, palm, mustard and bran oil, respectively. The saponification value of bran oil was found at 181.6 mg KOH/g which is less than 185 to 195 mg KOH/g reported by Ramachandran (2001). Similarly, the saponification value of palm oil was found 202.39 mg KOH/g which was above that sold in major markets of some states in Nigeria 192.64 – 198.03 mgKOH/g (Udensi and Iroegbu, 2007).

The SV obtained for the heated oil samples in Table

Table 2. Physicochemical properties of oil after heating at 180°C for 10 mins.

Properties	Soybean oil	Palm oil	Mustard oil	Bran oil
Moisture content (%)	0.09±0.011	0.15±0.021	0.13±0.013	0.05±0.01
Refractive index	1.491±0.001	1.483±0.003	1.467±0.002	1.481±0.001
Viscosity (mPa.s)	33.1±0.031	35.13±0.35	51.60±0.46	33.58±0.25
Acid Value (mg/g)	0.612±0.052	0.988±0.059	6.29±0.336	2.73±0.226
Free fatty Acid	0.342±0.037	0.963±0.084	2.28±0.142	1.51±0.042
Iodine value (mg/g)	132.81±0.539	44.87±0.531	99.89±0.711	99.07±0.743
Peroxide value (meq/kg)	2.90 ± 0.21	3.29 ± 0.58	6.24±0.22	2.92±0.04
Saponification Value (mg/g)	186.13±0.337	192.79±0.991	193.36±0.527	187.6±0.367

Values are presented as mean±SD of triplicate analyses.

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2 showed SV attained for palm oil and mustard oil was found higher than SV obtained for soybean oil and bran oil. All measured saponification values were below the expected range of 195–205 mg/KOH/g for edible oil as specified by 48. Standard Organization of Nigeria (SON) (2000) and Nigerian Industrial Standards (NIS) (1992). The low value of SV suggests the presence of glycerides with the highest molecular weights (Muhammad *et al.,* 2006).

3.6 Acid value and free fatty acid content

Acid value (AV) represents the mg KOH required to neutralize the free fatty acid in 1 g of oil while free fatty acid (FFA) is the percentage by weight of a specified fatty acid such as percent oleic acid in oil. Therefore, the acid value is a good indicator of oil degradation caused by hydrolysis or enzymes (Othman and Ngaasapa, 2010).

In this present study, as it is seen in Table 1, mustard oil had the highest acid value (3.05 mg KOH/g) among all sample oils and soybean oil had the lowest value (0.304 mg KOH/g). The acid value for refined rice bran oil is 0.5 mg KOH/g found by Ramachandran (2001) which was lower than the value 1.11 mg KOH/g. Higher acid value implies the lower quality of oil, and the oil is going to be rancid (Quader *et al*., 2018). The distinction of acid value in our trials could be due to variance in moisture contents as well as the alteration in the refining and deodorization technologies. The acid value trend obtained before heating (seen in Table 1) was the same after heating (seen in Table 2). That is, mustard oil showed the highest AV while soybean oil showed the least AV. After heating at 180^{o}C for 10 mins mustard oil had a higher acid value (6.29 mg KOH/g) which indicated the sample as low-quality oil (Atinafu and Bedemo, 2011).

As it is seen in Table 1 and Table 2, the FFA values for oil samples were within the range (1.0-3.0%) recommended by both FAO/WHO (Codex Alimentarius Commission, 1999; ASEAN Network of Food Data Systems, 2011). Mustard oil exhibited the highest (1.54) while soybean oil gave the lowest (0.313) FFA value compared to other oil samples at room temperature. From Table 2, the lowest FFA of 0.342 was recorded in soybean oil while the highest recorded FFA of 2.28 was found in mustard oil. High FFA value for mustard oil could be attributed to decomposition, poor extraction techniques, use of damaged seeds and incorrect or lengthy storage that can be accelerated by light and temperature.

3.7 Peroxide value

Peroxide value (PV) is a useful indicator to measure the rancidity level of fats and oils and also a good criterion for the prediction of the quality and stability of oils (Nangbes *et al*., 2013). Fresh oils have peroxide values lower than 10 meq O_2/kg and before oil becomes rancid, its peroxide value must be between 20 and 40 meq O_2/kg (Akubugwo and Ugbogu, 2007). The peroxide value was also found to increase with the temperature and contact with air of the oil samples (Zahir *et al*., 2017). The PV values tabulated in Tables 1 and 2, the range of all the oil samples indicate that they are below 10 meq O_2/kg. At normal temperature, the peroxide value of mustard oil and palm oil is slightly high compared to the other two oils.

After heating the peroxide values obtained for the oil samples are shown in Table 2. Of all the oils, only mustard oil showed an extreme peroxide value while soybean oil showed a low peroxide value. The lower value of peroxide implied that soybean oil is less susceptible to rancidity (Brien, 2004). Besides, the fluctuation in the peroxide values of soybean oil and mustard oil can be attributed to the decomposition of the peroxides that are formed during primary oxidation to secondary oxidation (Guillen and Cabo, 2002). The results further revealed that the trend in peroxide value before heating and after heating can be reported as mustard oil > palm oil > bran oil > soybean oil.

3.8 Colour determination

Refined oils have usually a clear and transparent appearance (Suzanne, 2010). The colour values for the four edible oils are shown in Figure 1. Figure 1(a) indicates that at normal temperature and 180^{o}C more lightness has been found in soybean oil and bran oil, respectively than other oils. It has also yellow and green colour and has been attributed to the decomposition of colour pigments such as chlorophylls, pheophytins, xanthophylls, and carotenes (Boskou, 2006). After heating with 10 mins at 180^{o}C, the L* values of all oil sample were decreased. Fluctuations were observed in a* (redness) and b* (yellowness) values during heating and the variation of colour might be due to the difference in blending, storage, crushing, extraction, or the refining process of oil (Kilic *et al*., 2007).

3.9 Sensory evaluation

The sensory analysis showed significant differences ($p < 0.05$) among the different experimental oils for the different attributes like colour, flavour, taste and overall acceptability (Figure 2). The colour difference of the oil is almost similar and soybean oil had the highest score and also mustard oil was best suited for colour among the other oils. In the case of flavour soybean and bran oil was the highest score followed by mustard and palm oil. However, the potato chips fried with soybean oil were

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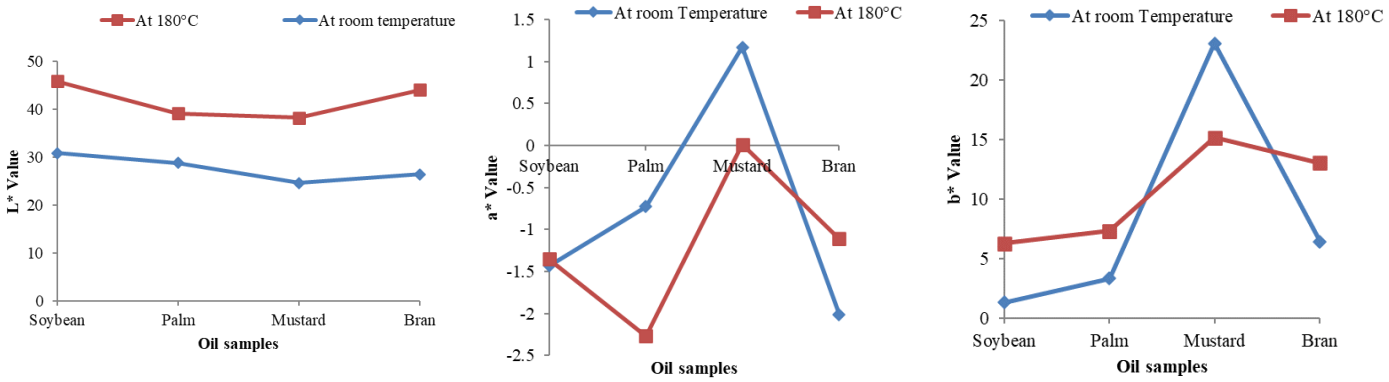

(a) L* value (b) a* value (c) b* value

Figure 1. Colour determination of commercial edible oils

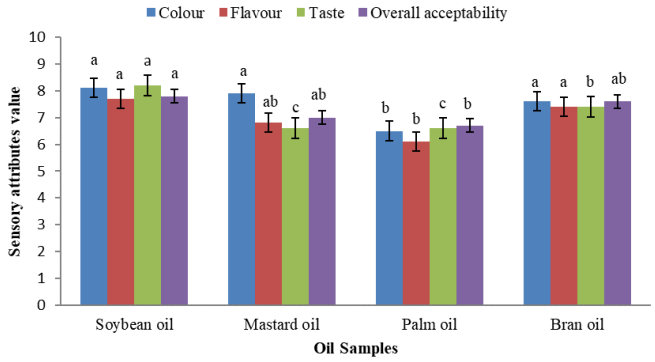

Figure 2. Sensory evaluation of the oils fried with potato chips. Bars with different notations are statistically significantly different ($p<0.05$).

considered good as the taste. With regards to the overall acceptability, the soybean fried sample was more acceptable to the panellist, while the mustard and palm oil samples were the lowest acceptable sample.

4. Conclusion

In the present study, various physicochemical parameters of local edible soybean, mustard, palm and bran oils were investigated before and after heating. Furthermore, sensory evaluation of the oil sample was also carried out. Regarding physicochemical characteristics, four samples do not exactly demonstrate all parameters in line with the recommended values, however; some of them have acceptable values. By considering the physicochemical properties of all samples it was apparent that soybean oil was of superior quality to other samples due to its higher iodine and lower acid value both at normal temperature and at 180°C. Also, the soybean oil was fair in colour. On the contrary, the mustard oil sample was characterized by extremely high acid values which make the oil to be more susceptible to oxidative rancidity, thereby affecting the quality of the oil. The results of the sensory evaluation indicate that each oil is slightly different in taste, colour, flavour and overall acceptability for different consumers. However, it is suggested that advanced studies should be accomplished to appraise the nutritional value, heavy metals profile and antimicrobial activities of several oils in Bangladesh.

Conflict of interest

The authors declare no conflict of interest.

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