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Article

Qualitative assessment of common edible oils available in Bangladesh

Md. Fahad Bin Quader[1], Mohammad Shaokat Ali[1*], Shamima Ahmed[2], A.F.M Irfan Uddin Zim[3], Susmita Roy[1] and Sumon Ahmed[1]

[1]Department of Applied Chemistry and Chemical Technology, Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4225, Bangladesh
[2]Department of Food Processing and Engineering, Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4225, Bangladesh
[3]Department of Applied Food Science and Nutrition, Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4225, Bangladesh

[*]Corresponding Author: Mohammad Shaokat Ali, Department of Applied Chemistry and Chemical Technology, Faculty of Food Science and Technology, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4225, Bangladesh. Phone: +8801672532256; E-mail: shaokat.fst@gmail.com

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Abstract: Soybean oil and palm oil are the most preferred vegetable oils in the world. The aim of the study was the correlative and qualitative appraisement of the edible vegetable oils available in Bangladesh. Five brands of soybean and one brand of palm oil were comparatively assessed to select which one was better for edible purpose. In this study the quality of the edible oils was analyzed by evaluating some physicochemical attributes such as specific gravity, color and odor, moisture content, acid value, saponification value, iodine value and peroxide value using standard methods. A significant difference ($P<0.05$) was found in all characteristic parameters of different oil samples. The study expressed the following properties as ranged values for soybean oils and single value for palm oil: Iodine value (82.34±0.633 –108.63±0.96 g I_2/100 g; 45.68±0.604 g I_2/100 g), Saponification value (182.33±2.670–197.39±1.987 mg KOH/g; 203.68±2.346 mg KOH/g), Acid value (0.33±0.06–0.57±0.03 mg KOH/g; 1.07±0.07 mg KOH/g), Peroxide value (1.13±0.01–1.96±0.006 meq O_2/kg; 1.09±0.02 meq O_2/kg), Moisture content (0.30±0.005–0.63±0.026%; 0.65±0.015%), specific gravity (0.88±0.15–0.94±0.07 g/ml; 0.91±0.03 g/ml). Taking consideration of all parameters the study concluded that Rupchanda and Fresh soybean oil had superior quality than other samples.

Keywords: soybean oil; palm oil; physicochemical properties

1. Introduction

Edible vegetable oils are actually triacylglycerol molecules, comprised of mainly unsaturated fatty acids (oleic, linoleic, and linolenic acids) and saturated fatty acids (myristic, palmitic, and stearic acids) esterified to glycerol units (Barison *et al.*, 2010). Vegetable oil, an indispensable part of human foods, is also quite essential for our health. Vegetable oils are the highest energy source and the main carrier of fat soluble vitamins (A, D, E, K) (Fasina *et al*., 2006). Essential phytochemicals such as saponin, phlobatanin, flavonoid, tanin, terpenoid, anthraquinone, etc. can also be found in different vegetable oils (Sreening, 2013).

Plant sources like soya beans, melon, groundnut, corn, oil palm, coconut, etc. are used for the production of vegetable oils. Among all edible vegetable oil sources, palm oil (*Elaesis guineensis*) and soybean oil (*Glycina maxima*) are the most common in Bangladesh. Soybean oil, a semidrying oil, is high in polyunsaturates, linoleic acid, and linolenic fatty acid. Nutritional qualities, abundance, economic value, and wide functionality of soybean oil makes it popular vegetable oil for the preparation of various types of food. In contrast, Palm oil which is extracted from pericarp of the fruit is a semisolid at room temperature. Triglycerides of palmitic and

oleic fatty acids are the main constituents of palm oil (Brien, 2004). Generally, oils containing high concentration of saturated fatty acids and fats containing trans fatty acids are less preferable for health (Tabee *et al.*, 2008). Considering the health benefits, soybean oil is better than palm oil. A study conducted by Kabagambe *et al*. (2005) reported that palm oil is associated with high risk of myocardial infarction.

The quality of oils may depend on several factors including selection of raw materials to processing, refining, bottling and storage of produced oils (Bailey, 1945). For this reason, in depth knowledge of the composition of fats and oils is very necessary. Commonly, a range of physical and chemical parameters are used to determine the compositional quality of edible oils (Ceriani *et al.*, 2008). An acceptable range of iodine value, saponification value, peroxide value, acid value etc. is important to determine the quality characteristics of edible oil (Codex, 1999).

Recently adulterated edible oils are marketed as highly purified oil in Bangladesh. That is why, determination of physicochemical properties of edible vegetable oil is important to maintain the quality of various processed foods. Therefore, the aim of this study was to explore in details about the physicochemical properties of the common edible oils in Bangladesh.

2. Materials and Methods

2.1. Sample collection

Five different brands of soybean oils and one brand of palm oil were collected from local markets of Chittagong city, Bangladesh. Different samples of this study were- Rupchanda soybean oil (RP), Pusti soybean oil (PT), Teer soybean oil (TR), Fresh soybean oil (FS), Local soybean oil (LS), Local Palm oil (PM).

2.2. Chemical analysis

The specific gravity, color, odor, moisture content, acid value, saponification value and peroxide value were analyzed by using standard methods (AOAC, 2000). Iodine value was determined by following Hanus method (Hanus, 1901). The analysis was carried out in Quality Control and Analytical Lab, Chittagong Veterinary and Animal Sciences University (CVASU). Triplicate analysis of each sample was conducted.

2.2.1. Determination of color and odor

The color of the oil samples were observed by visual parallelism while the odors were detected by using a glass stoppered conical flask rinsed with 4M HCl and distilled water. The flask was filled half with oil sample and shacked vigorously for about 2 minutes. Then the stopper was opened and the odor was assessed by the sense of smell.

2.2.2. Determination of specific gravity

Two clean and dry pre-weighed pycnometers were taken. One was filled with oil sample and the other with water. Then the pycnometers were immersed in water bath at 30 ºC. After 30 minutes pycnometers were removed from the water bath, cleaned and dried thoroughly and quickly weighed to ensure that the temperature didn't fall below 30 ºC.

Specific gravity at 30ºC = $\frac{(A-B)}{(C-B)}$

Where,

A= Weight of oil sample in gram.

B= Weight of empty pycnometers in gram.

C=Weight (g) of water.

2.2.3. Determination of moisture content

Moisture content was determined by using hot air oven method. About 10 g of oil sample was weighed into a dried crucible. Then in an oven the samples were dried at 105 ºC until a constant weight was determined.

Moisture content (%) = $\frac{(W1-W2)\times 100}{W1}$

Where,

W1= Weight (g) of sample before drying.

W2= Weight (g) of sample after drying.

2.2.4. Determination of acid value

Acid value of oil sample was determined by titrimetric method. About 20 g of oil sample was weighed into a 250 ml conical flasks, 50 ml 95% ethanol was added, shook well to dissolve the sample. The sample solution

was boiled for about 5 minutes and then 0.5 ml of 1% phenolphthalein indicator was added into it. The sample was titrated against 0.1N KOH until permanent light pink color appeared. A blank determination was carried out at the same time under the same conditions. The acid value was estimated using the following equation:

Acid value (mg KOH/g) = $\frac{(B-S) \times N \times 56.1}{W}$

Where,
B= ml of KOH required by blank titration.
S= ml of KOH required by oil sample.
N= Normality of KOH.
W= Weight (g) of oil.

2.2.5. Determination of saponification value

Two grams of oil sample was taken into 250 ml conical flask. About 25 ml alcoholic KOH was added and heated for 30 minutes with occasional shaking. When the solution was homogenous it was cooled under tap water. Then, the sample solution was titrated against 0.5N HCl with 0.5 ml phenolphthalein indicator. A blank titration was carried out without oil. Following formula was used to determine the saponification value.

Saponification value (mg KOH/g) = $\frac{(B-S) \times N \times 56.1}{W}$

Where,
B= ml of HCl required by blank.
S= ml of HCl required by oil sample.
N= Normality of HCl.
W= Weight (g) of oil.

2.2.6. Determination of peroxide value

About 5 g of was taken into a 250 ml conical flask, 30ml mixture of acetic acid and chloroform was added in it and mixed vigorously. Saturated solution of KI (0.5 ml) was added, mixed and kept in dark for few minutes and finally 30 ml of distilled water was added. Then the mixture was titrated against 0.1N $Na_2S_2O_3$ solution with starch indicator. A blank titration was also carried out without oil.

Peroxide value (meq O_2/kg) = $\frac{(S-B) \times N \times 1000}{W}$

Where,
B= Titer value of blank.
S= Titer value of sample.
W= Weight (g) of oil.

2.2.7. Determination of iodine value

At first Hanus solution was prepared by adding 13.2 g pure resublimed iodine with glacial acetic acid in a 500 ml volumetric flask by warming over water bath. When the iodine was completely dissolved, the solution was cooled and 1.5 ml pure Br_2 (sulfur free) was added in it and diluted up to 500 ml with glacial acetic acid. The whole procedure was done in a fume hood.

Then 0.3 g oil sample was taken in a well-stoppered conical flask of 500 ml and 10 ml chloroform was added in it. Then, 25 ml Hanus solution was added, mixed vigorously and kept in dark place for 30 minutes. After that, 10 ml 15% KI solution, 100 ml distilled water were added and mixed thoroughly. The solution was titrated against standard 0.1N $Na_2S_2O_3$ solution with continuous shaking until the dark color was almost disappeared. Titration was continued by adding 1 ml starch solution till the color was fully vanished. The blank determination was also conducted under same condition without oil sample.

Iodine value (g I_2/100g oil) = $\frac{(B-S) \times N \times 12.69}{W}$

Where,
B= ml of 0.1N $Na_2S_2O_3$ required for blank titration.
S= ml of 0.1N $Na_2S_2O_3$ required for sample.
N= Strength of $Na_2S_2O_3$ solution.
W= Weight (g) of oil sample.

2.3. Statistical analysis

A one-way ANOVA (analysis of variance) was performed by using the software SPSS version 25.0 (SPSS Inc., USA) to understand the significant difference of all parameters. The level of significance was set at ≤ 0.05.

3. Results and Discussion

The quality of edible oils in terms of physicochemical parameters such as color and odor, specific gravity, moisture content, acid value, saponification value, iodine value and peroxide value were analyzed. Results of physical and chemical parameters were recorded and compared with codex standards (Table 1, 2 and 3; Figure 1).

Table 1. Physical parameters of some edible oils available in Bangladesh.

Sample	Color	Odor	Specific Gravity (g/ml)
RP	Golden Yellow	Inoffensive	0.91 ± 0.0^{a}
PT	Golden Yellow	Inoffensive	0.94 ± 0.07^{b}
TR	Straw Yellow	Inoffensive	0.93 ± 0.07^{ab}
FS	Light Golden	Inoffensive	0.91 ± 0.07^{a}
LS	Light Yellow	Inoffensive	0.88 ± 0.15^{c}
PM	Amber Yellow	Inoffensive	0.91 ± 0.03^{a}

Note: Means ± SD within the column bearing different superscripts are significantly different (P< 0.05). (RP=Rupchanda soybean oil, PT=Pusti soybean oil, TR=Teer soybean oil, FS=Fresh soybean oil, LS=Local soybean oil, PM=Local Palm oil)

Table 2. Chemical parameters of some edible oils available in Bangladesh.

Sample	Moisture content (%)	Acid Value (mg KOH/g)	Saponification Value (mg KOH/g)	Iodine Value (g I_2/100g oil)	Peroxide Value (meq O_2/kg)
RP	0.60 ± 0.011^{a}	0.44 ± 0.02^{b}	184.02 ± 0.995^{ab}	108.63 ± 0.96^{a}	1.51 ± 0.006^{a}
PT	0.62 ± 0.005^{ab}	$0.57\pm0 .026^{c}$	188.80 ± 1.07^{b}	91.37 ± 1.034^{c}	1.96 ± 0.006^{b}
TR	0.30 ± 0.005^{c}	0.44 ± 0.021^{b}	186.25 ± 1.314^{ab}	94.18 ± 1.090^{b}	1.33 ± 0.01^{c}
FS	0.60 ± 0.015^{a}	0.33 ± 0.03^{a}	182.33 ± 2.670^{a}	106.60 ± 0.922^{a}	1.21 ± 0.026^{d}
OP	0.63 ± 0.026^{ab}	0.36 ± 0.046^{ab}	197.39 ± 1.987^{c}	82.34 ± 0.633^{d}	1.13 ± 0.01^{e}
PM	0.65 ± 0.015^{b}	1.07 ± 0.035^{d}	203.68 ± 2.346^{d}	45.68 ± 0.604^{e}	1.09 ± 0.02^{e}

Note: Means ± SD within the column bearing different superscripts are significantly different (P< 0.05). (RP=Rupchanda soybean oil, PT=Pusti soybean oil, TR=Teer soybean oil, FS=Fresh soybean oil, LS= Local soybean oil, PM=Local Palm oil)

Table 3. Codex standards for soybean and palm oil.

Parameter	Soybean Oil	Palm oil
Saponification value (mg KOH/g)	189-195	190-209
Acid value (mg KOH/g)	0.6	0.6
Iodine value (g I_2/100g)	124-139	50.0-55.0
Peroxide value (meq O_2/kg)	up to 10	up to 10

Source: CAC, 1999

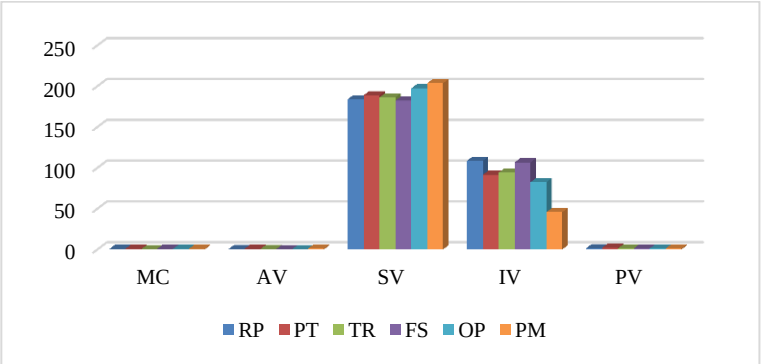

Figure 1. Schematic diagram of some physicochemical parameters of edible oils.

(RP= Rupchanda soybean oil, PT= Pusti soybean oil, TR= Teer soybean oil, FS= Fresh soybean oil, LS= Local soybean oil, PM= Local Palm oil, MC= Moisture content, AV= Acid value, SV= Saponification value, IV= Iodine value, PV= Peroxide value)

3.1. Color and odor

The color of the soybean oil was either golden yellow, light yellow, straw yellow, light golden where palm oil was amber yellow in color. The odor of all oil samples was inoffensive and receivable. Colors of the study samples were in acceptable range and the variation of color might be due to the difference in blending, storage, crushing, extraction or the refining process of oil (Kilic *et al.,* 2007). The odors were inoffensive and acceptable.

3.2. Specific gravity

Specific gravity of the samples was conducted at 30 ºC of temperature. The specific gravity of soybean oil samples was ranged between 0.88-0.94 g/ml but in case of palm oil sample the value was 0.91 g/ml. The present study findings were closely related with the study done by Hodgman and Lange, 1924. Moreover, higher unsaturation level also decreases the specific gravity (Bako *et al.,* 2017).

3.3. Moisture content

The highest moisture content was found in palm oil sample (0.65%). But the moisture content of soybean oil samples was ranged between 0.3 to 0.63% (Table 2). Generally, high moisture content can generate increased free fatty acids and off-flavours (Brien, 2004). Moreover, high moisture content is suitable for food texturing, baking and frying (Yauri and Garba, 2011).

3.4. Acid value

The amount of free fatty acids present in fat or oil is pointed out with acid value. Higher acid value implies the lower quality of oil or fat and the oil or fat is going to be rancid. In this present study PT sample had the highest value of acid (0.57 mg KOH/g) among all soybean oils and FS sample had the lowest value (0.33 mg KOH/g). Palm oil had the significantly ($P < 0.05$) higher acid value (1.07 mg KOH/g) which indicated the sample as a low quality oil (Atinafu and Bedemo, 2011).

3.5. Saponification value

Alkali-reactive groups as well as the type of glycerides of fats and oils can be measured by the saponification value. The highest saponification value was found LS sample (197.39 mg KOH/g) and lowest in FS sample (182.33 mg KOH/g). The lower saponification value indicates the presence of glycerides with the highest molecular weights (Muhammad *et al.,* 2006). On the other hand, saponification value of supplied palm oil sample was 203.68 mg KOH/g which was within the standard range of Codex Alimentarius Commission (190-209 mg KOH/g) (Table 3).

3.6. Peroxide value

Peroxide value is a useful indicator to measure the rancidity level of fats and oils. The result tabulated in Table 2 showed the range of peroxide value was between 1.13-1.96 meq O_2 /kg for soybean oils and 1.09 meq O_2/kg for palm oil. The lower value of peroxide implied that all samples are less susceptible to rancidity (Brien, 2004).

3.7. Iodine value

Degree of unsaturation in oil and fat can be measured by the iodine value. Codex standard for iodine value is 124-139 g I_2 /100 g for soybean oil and 50-55 g I_2 / 100 g for palm oil. In this study, RP sample had the highest iodine value (108.63 g I_2 / 100 g) indicating its good quality. Higher iodine value of oil also suggested that it was less stable in normal condition (Akinola *et al.,* 2010). The lowest iodine value was found in palm oil sample at 45.68 g I_2 / 100 g which pointed out that palm oil was highly saturated.

4. Conclusions

The edible oils like soybean and palm oils are the most preferred and cheap available type of vegetable oils with their respective qualities and health benefits. The results of this study concluded that soybean oil is more beneficial and good for health than that of palm oil, as it possess higher degree of unsaturation due to higher iodine value than palm oil. By considering the physicochemical properties of all samples it was also apparent that Rupchanda and Fresh soybean oil were of superior quality than other samples due to its high significantly

higher iodine and lower acid value. However, it is recommended that further studies should be performed to evaluate the nutritional value, heavy metals profile, antimicrobial activities of several branded oils.

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Conflict of interest
None to declare.

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