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Quality assessment based on physico-chemical properties of fried soybean oils available in Tangail region, Bangladesh

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Abstract

The study was conducted on the physicochemical characteristics of six brands of edible soybean oils including Non-brand (Open) soybean oil, Muskan, Pusti, Teer, Fresh and Rupchanda soybean oils. A significant difference in the moisture content ($P< 0.05$) was observed in the different brands of soybean oil. Rupchanda soybean oil possesses maximum saponification value (230) whereas open soybean oil showed minimum value (200). The iodine value of investigated oils also differed significantly. Highest iodine value (110.2) found in the Rupchanda soybean oil though it has not embraced the standard value (124-139) sated by Codex Alimentarius. All the soybean oil revealed preferred level of acid value except Muskan brand. The Pusti and Teer brands of soybean oil indicated maximum Reichert-Meissl value which means that they contain maximum volatile fatty acids compared to others. Although the highest per-oxide value 7.5 milliequivalents of active oxygen/kg oil found in the open soybean oil but it does not exceed the standard level. The unsaponifiable matter of the - Open oil, Muskan, Pusti, Teer, Fresh and Rupchanda soybean oils were 0.08, 0.06, 0.07, 0.04, 0.05 and 0.05 percent respectively. Considering the significance of above parameters Rupchanda is better than others soybean oil for human health.

Keywords: Soybean oil, acid value, Saponification value, Reichert–Meissl value and Unsaponifiable matter

Introduction

Vegetable oil plays a vital role to supply fat in the daily diet. Among all the vegetable oils, Soybean oil gains maximum popularity for containing Omega 3 and Omega 6 fatty acids which regulate lipid and cholesterol metabolism and help to prevent plaque formation in the artery (Yesim et al., 2011; Brien, 2004). About 80% of the total edible oil usually consume in the US consists soybean oil because of its availability, desirable characteristics, and functional properties (Hammond et al., 2005). Due to having high antioxidant potential, soybean oil is utilized worldwide in the food industry. The antioxidants have a ventured role to minimize the oxidative damage caused by reactive oxygen species (Kumar et al., 2009; Lee et al., 2005). It is obtained from soybeans (Glycine max), a species of

legume native to East Asia. Soybeans are rich in protein and fat compared to other beans and it contains relatively lowest carbohydrate (Cheftel and Cuq, 1985). Beyond oil and fats, soybean possesses neutraceutical components, such as isoflavones, tocopherols, and vitamin C, which quench reactive oxygen species by donating a hydrogen atom or an electron (Tripathi et al., 2005; Lee et al., 2005).

Soybean oil is using not only in consumer cooking, it is a primary ingredient of many processed foods i.e. salad dressings, sandwich spreads, margarine, bread, mayonnaise, non-dairy coffee creamers and snack foods. Besides, it's a rich source of vitamin B which helps in preventing chronic digestion (Yesim et al., 2011). The physico-chemical properties of fried soybean oil are directly related to their glyceride, fatty acid composition and chemical constitution. The fatty acids composition of soybean oil reveals as lauric acid 0.2%, myristic acid 0.1%, palmitic acid 9.8%, stearic acid 2.4%, arachidic acid 0.9%, oleic acid 28.9%, linoleic acid 50.7%, linolenic acid 6.5% and hexadecenoic acid 0.4% (Jokić et al., 2013; Bailey, 1967). The variation of fatty acids and content of poly unsaturated fatty acids are appreciable, these polyunsaturated fatty acids have beneficial physiological effects towards prevention of coronary heart disease and cancer (Yehuda et al., 2005). However, the fatty acids composition depends on refining process. During refining, some extraneous stuff such as trans fatty acids, fishy odor, dust, dirt etc. can enter in to the oil as a contaminants (Farhoosh et al., 2009). During frying oils with much higher heat, oxidation occurs that causes the production of hydroperoxides and volatile compounds such as aldehydes, ketones and other chemicals are undesirable for human health (Choe and Min, 2009). Therefore, knowledge of these compositional factors, their importance and uses drawback is necessary in connection with research aimed at improvement of fat and fat products. Several research works have been carried out on the identification and characterization of different vegetables oil but till now no comparative studies have been made between soybean oil. Hence the present investigations were carried out to find out the better soybean oil from different brands available in the market.

Materials and methods

1. Sample collection

Open soybean oil (without brand), Muskan, Pusti, Teer, Fresh and Rupchanda soybean oils were collected from retail market available in different places of Bangladesh. All samples were preserved in dry and brown bottles. To prevent photo oxidation, the bottles were covered with carbon papers. All reagents used were of analytical grade unless otherwise specified and the results were depicted as the mean value of three replicates. All the samples were analyzed according to methods described in Codex alimentarius, 2001, volume-8 and AOAC (1984).

2. Moisture content of soybean oils

About 5 g of oil sample was taken in a pre-weighted tight fitting metal dishes and heated at 105 ± 5^0 C for 1 hour. During heating the lead was loosen. Then the sample was cooled in a desiccator containing phosphorus pentoxide or equivalent desiccant and weighted. The process was repeated until change in weight between two successive observations was not exceeding 1 mg.

3. Determination of Saponification value

A 5gm of sample oil was weighted accurately into 250ml conical flask and 50ml of 0.5N alcoholic KOH solution was added in the flask. The solution was constantly stirring during addition. Then the flask was connected to air condensers and then reflux the change by boiling at least for

half an hour or more to saponify the sample completely. After refluxing was over, the change were cooled and titrated with 0.5 N HCl using phenolphthalein as an indicator. A blank sample was titrated in the same way.

$$\text{Saponification value} = \frac{(\text{Titration of blank in ml}) - (\text{Titration of sample in ml}) \times 28.05}{\text{Weight of sample}}$$

4. Determination of Acid value

About 20 g of oil sample was weighted into a 250 ml conical flask and 50 ml of 95% alcohol was added. After then solution was neutralized with 0.1 N alkali solution using phenolphthalein indicator. Then the free fatty acids were dissolving completely by boiling the solution. The solution was cooled and then titrated against 0.1 N alcoholic KOH (using phenolphthalein as indicator) until the pink color persisted after vigorous shaking.

$$\text{Acid value} = \text{Ml of 0.1 N alkali} \times \frac{5.61}{\text{Weight of sample}}$$

5. Determination of Iodine value

Wijs reagent was first prepared by dissolving 8.5g of iodine and 7.5g of iodine monocholoride in worm glacial acetic acid. After dissolving the solution was made up to 1000 ml by adding cold glacial acetic acid. Then accurately 0.1 g of the sample was taken in a 250-300 ml glass stopper flask. The sample was then dissolved in 10 ml of chloroform or carbon tetrachloride, wormed slightly. Then the solution was cooled well, and added similar volume of CHCl3 or CCl4 to a similar flask containing no sample (blank). About 25 ml of the wijs solution was added into the flask containing the sample and an equal volume (25 ml) into the blank. By shaking each flask were diluted with 50-100 ml of water. A 15ml of 10% KOH solution was added to the solution in each flask. Then the solution was titrated with standard 0.1 N sodium thiosulphatesolutions (standardized with standard $K_2Cr_2O_7$ solution). Starch solution was added when yellow color nearly disappeared by the addition of the sulphate. Finally the solution was titrated up to end point, when blue color formed by the addition of starch was suddenly discharged.

IV= (Ml of thiosulphate required by blank) – (Ml of thiosulphate required by sample) × Normality of thiosulphate × 12.692 / Weight of sample.

6. Determination of Reichert–Meissl value

About 5 g of the sample was weighted in a 300 ml conical flask and added 10 ml of 95% ethyl alcohol and 2 ml of 50 % caustic soda solution. The mixture was boiled for about one hour and reflux to saponify the material. After saponification alcohol was removed by heating the solution on a water bath and the dry soap thus formed was dissolved in 100 ml of distilled water. The soap was then acidified with 50 ml of 0.1N H2SO4 as a result of which the soap was converted into sodium sulphate and the fatty acids. The aqueous mixture was then distilled and the distillate was collected (110 ml.) and filtered. The filtered distillate was titrated against 0.1N NaOH, using phenolphthalein as an indicator.

R.M. value = V × 1.1

7. Determination of per-oxide value

A 5 g of sample into a 250 ml glass stoppered Erlenmeyer flask. Then 30 ml of the acetic acid -chloroform solution was added to the flask and dissolved in worming hot plate. Then 0.5 ml of saturated potassium iodide solution was added. After then 30 ml of either distilled or deionized water was added to liberate the iodine from the chloroform layer. The solution was titrated with 0.1N sodium thiosulfate after adding 1 ml of starch solution as an indicator. The process was repeated for a blank solution.

$$\text{Peroxide Value} = \frac{(S - B) \times N \text{ thiosulfate} \times 1000}{\text{Weight of sample}}$$

8. Determination of unsaponifiable Matter

Accurately 5 g of well mixed oil sample was taken into a 250ml conical flask. Then 50ml of alcoholic potassium hydroxide solution was added. The content was boiled under reflux air condenser for one hour .The condenser was vasted with about 10 ml of ethyl alcohol. The mixture was transferred and the saponification flask was washed. 50 ml of petroleum ether was added, shaken vigorously, and allow the layers to separate. Then the lower soap layer was transferred into another separating funnel and repeated the ether extraction for another 3 times using 50 ml portions of petroleum ether. Washed the combined ether extract three times with 25 ml portions of aqueous alcohol followed by washing with 25 ml portions of distilled water to ensure ether extract is free of alkali. Then ether solution was transferred to 50 ml beaker, rinse separator with ether, rinsing was added to main solution. The solution was evaporated to about 5ml and transferred quantitatively using several portions of ether to 50 ml Erlenmeyer flask previously dried and weighed. When all ether had been removed, 2-3 ml of acetone was added. Last traces of ether were removed by drying at 100'C for 30 minutes. Residue was dissolved in 50 ml of warm ethanol which had been neutralized by phenolpthahen and was titrated with 0.02N NaOH.

$$\text{Unsaponifiable Matter} = \frac{100 (A-B)}{\text{Weight in g of the sample}}$$

A = Weight in g of the residue

B = Weight in g of the free fatty acids in the extract = 0.282 VN, Where,

V = Volume standard sodium hydroxide solution

N = Normality of standard sodium hydroxide solution

Results and discussion

The results obtained from the study are represented by Figure 1-7. The samples of soybean oils collected for this study were manufactured in the same month. To avoid any change due to storage time and transport, the samples were collected from the same region. The moisture content of all the samples was between 0.8 to 1.4% (figure 1).The familiar brand Pusti soybean oil contains maximum 1.4% of moisture and the fresh brand contains only 0.8%. The cooking oil is not supposed to be contained any moisture. However, up to 0.08% moisture could be present in the solvent extracted soybean oil (Hammond, 2005). Even the codex alimentarius (2001) reveled that soybean oil could contain 0.8% volatile matter. Due to present of water, the oil could be oxidized and rancid immediately. Water may be contributed to the hydrolysis of oil during various handling and processing steps, which generates free fatty acids and glycerol products. Thus, it is desirable to have low moisture content in oils.

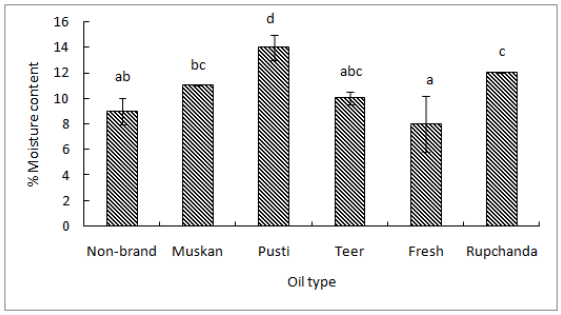

Figure 1: percentage of moisture content in different brands of soybean oil.

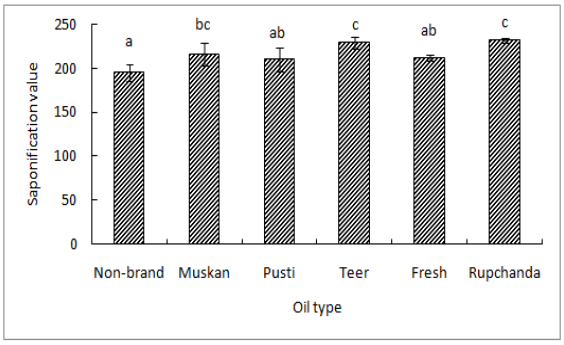

Figure 2: Saponification value observed in different brands of soybean oil.

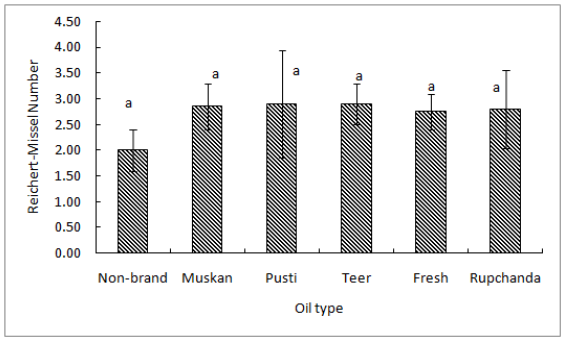

Figure 5: Reichert-Missel number in different brands of soybean oil.

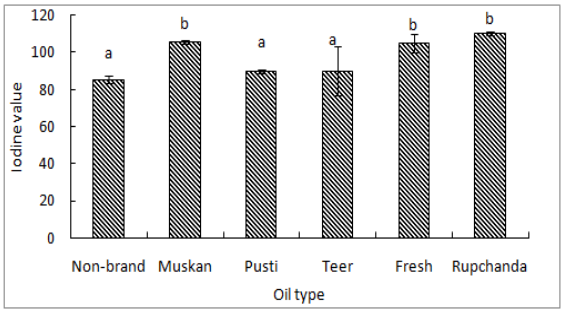

Figure 3: Iodine value present in different brands of soybean oil.

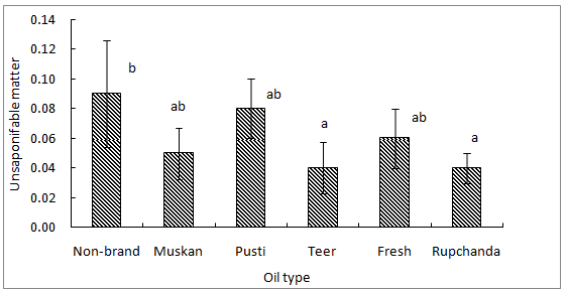

Figure 6: Unsafonifiable matter (g/kg)present in different brands of soybean oil.

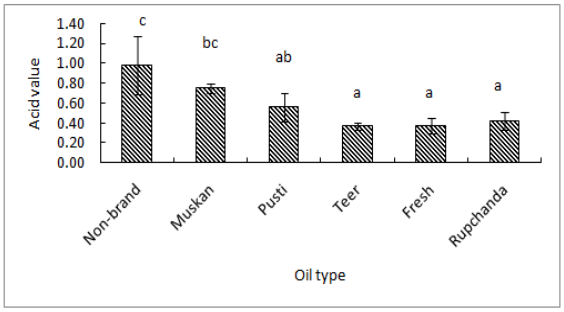

Figure 4: Acid value (mg KOH/g Oil) in different brands of soybean oil.

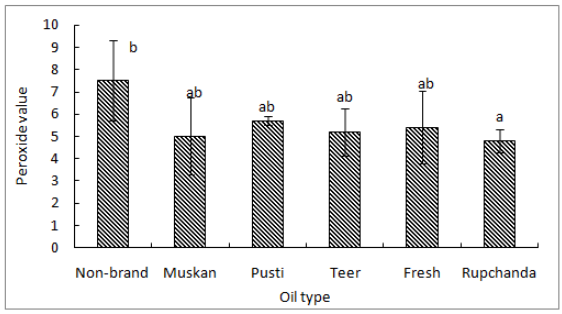

Figure 7: Peroxide value (milli equivalents of active oxygen/kg oil) of different brands of soybean oil with standard.

Table 1: Standard value of different parameters in soybean oil.

Standard value[1] of different parameters in soybean oil	Saponification Value	Acid value	Iodine value	Reichert-Miessl Number	Unsafonifiable matter
	189-195	<0.6	124-139	3-6	<15

[1] Standard value stated by Codex Alimentarius, 2001. Volume-8

Saponification value of all the brands exceeded the standard value (189 -195) (table 1) recommended by Codex Alimentarius (2011). It also satisfies the standard value recommended by Bangladesh Standard & Testing Institute (BSTI). Rupchanda possessed the highest saponification value (230) among the entire oils investigated (figure 2) whereas non brand open soybean oil revealed lowest

value (200). Saponification value is an index of average molecular mass of fatty acid in oil sample. It also indicates the extent of triglycerides present in the soybean oil. Except non brand open soybean oil, all the branded soybean oil embraced the expected range of saponification value (195-205) stated by SON (2000) and NIS (1992). The worse saponification value of edible vegetable oil put forward that the molecular weight of fatty acids is poorer or that the number of ester bonds is less. This might imply that the fat molecules were not intact with each other (Denniston et al., 2004).

Acid values of Non brand, Muskan, Pusti, Teer, Fresh and Rupchandasoyabean oils were 0.98, 0.75, 0.56, 0.37, 0.37 and 0.42 respectively (figure 3). Codex Alimentarius (2001) and BSTI standard for acid value is maximum 0.6 mg/g. The Non brand and Muskan possessed the highest acid values among all the oils investigated. They exceeded the maximum standard value also. Basically hydrolytic rancidity occurs in the soybean oil when glycerol further converts into fatty acids (Freeman, 2005). Free fatty acids can be increased in the soybean oil due to faulty refining also (Choe and Min, 2009).

Iodine value usually measures the degree of unsaturation in a fat or vegetable oil. BSTI standard for iodine value is 120-143 and the international codex alimentarius standard (2001) for iodine value in soybean oil is 124 – 139. In this study, maximum iodine value (110.20) possessed by Rupchanda brand among the entire oils investigated (figure 4). Therefore, the expected value has not expressed by any soybean oil investigated. Iodine value determines the stability of oils to oxidation, and allows the overall unsaturation of the vegetable oils (AOCS, 1993; Asuquo et al., 2012). Low iodine values may have contributed to its greater oxidative storage stability. The oxidative and chemical changes in oils during storage are characterized by increase in free fatty acid contents and a decrease in the total unsaturation of oils (Perkin, 1992).

Maximum Reichert-Meissl value (2.9) was observed in Teer and Pusti Brand of soybean oil whereas the lowest value observed in non-brand open soybean oil (figure 5). This value represents the amount of volatile and water soluble acid components in vegetable oil or fat. Usually it is a good indicator to determine the non- fat compounds in the fats or oil (Murthy, 1995). The Reichert-Meissl value or R.M. value of lard is zero, of coconut oil about 8 and that of butter is 17-35. The standard Reichert-Meissl value recommended by Codex is 3-6 for vegetable oils like palm, soybean etc. Figure 6 showed that the highest unsaponifiable matter (0.09%) was present in non-brand soybean oil whilst Rupchanda and Teer were found to be contained lowest unsaffoniable matter (0.04%). The unsaffoniable matters present in the studied soyean oil were negligible compared to the standard value (1.5%) for refined soybean oil (Codex Alimentarius, 2001; Hammond et al., 2005). It includes lipids of natural origin such as sterols, higher aliphatic alcohols, pigments, vitamins and hydrocarbons as well as any foreign organic matter (Choo et al., 2007;Stauffer, 1996). According to the Australia New Zealand Food Authority (2000), edible oils may contain incidental amounts of free fatty acids, unsaponifiable constituents and other lipids.

Lipid oxidation is the main process leading to the deterioration of edible oils, e.g. during production, transportation and mainly storage (Hrncirik and Fritsche, 2005). Peroxide values (PVs), a measure of primary lipid oxidation products. It is usually used as a measure of the extent to which rancidity reactions have occurred in the vegetable oils (Ekwu and Nwagu, 2004). The peroxide value can be increased with the storage time, temperature and contact with air of the oil samples and also determine whether the oil has undergone rancid (Zahir et al., 2014).

The significantly highest peroxide value (7.5) was observed in the non-brand open soybean oil and the lowest value (4.8) was in the Rupchand brand (figure 7). Which means the lipid oxidation occurred in the non-brand soybean oil, though the value did not cross the standard limit (10) for refined oil set by the BSTI, Codex Alimentarius (2001) and (SON 2000).

Vegetable oils are of great importance in human life. Particularly, soybean oils act as important sources of essential fatty acids. There is strong scientific evidence, that n−3 fatty acids significantly reduce blood triglyceride levels (Harris, 1997) and regular intake reduces the risk of secondary and primary heart attack (Bucher et al., 2002). Some benefits have been reported in conditions such as rheumatoid arthritis (Kremer et al., 1985) and cardiac arrhythmias. Soybean oil may reduce risk of heart disease (Burr et al., 1994). Frying could change the degree of unsaturation of fatty acids along with other chemical values. Therefore, this research can further be advanced to know the change in the fatty acids level during traditional cooking and frying.

Conclusion

After completing this study it has been concluded that among all the studied samples, the Rupchanda brand was better compared to others. Because the Rupchanda soybean oil possessed maximum saponification and iodine value, thus the molecular weight and degree of unsaturation was high which indicates health fatty acids. Although the other brands of soybean oil were qualitatively lower than Rupchanda but depending on the significance of all physical parameter of oil, the values were between standards range provided by BSTI and Codex Alimentarius. The result of this study will be able to create awareness among people to choose a soybean oil from different brands whether it will be good for health or not. As the frying temperatures could change the formation of triglycerides and structure of fatty acids, it is essential to undertake future study to analysis the modification of fatty acids during heat treatment

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