ASSESSMENT OF QUALITY PARAMETERS OF LOCAL EDIBLE OILS AVAILABLE IN DINAJPUR

A THESIS

BY

NAZMEEN AKHTER

Roll No. 1305177

Session: 2013-2014

Semester: July- December, 2014

MASTER OF SCIENCE (MS)

IN

FOOD PROCESSING AND PRESERVATION

DEPARTMENT OF FOOD PROCESSING AND PRESERVATION

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

DECEMBER, 2014

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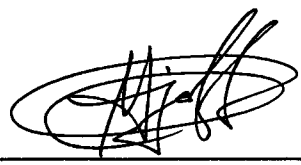

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DEDICATED
TO MY
BELOVED PARENTS

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The Author

ABSTRACT

In this work, physicochemical parameters (moisture, refractive index, viscosity, color, free fatty acid, iodine value, peroxide value, and saponification value) of palm, mustard, soybean and bran oil were studied at room temperature and after heating at 180°C for various periods (10 min, 15 min and 20 min). There were slightly variation in physical parameters in moisture content, refractive index color, viscosity, iodine value and saponification value among four types of oils. Peroxide and acid value were increased in palm oil and mustard oil with the increase of frying time. Result showed that there was no significant difference between soybean oil and bran oil during frying time on free fatty acid value, acid value and peroxide value at 180°C. In sensory evaluation results also found that soybean oil and bran oil were more preferable to cooking than other two oils. These results indicated that palm oil and mustard oil were oxidized rapidly than other oil samples upon heating and become risk for human consumption.

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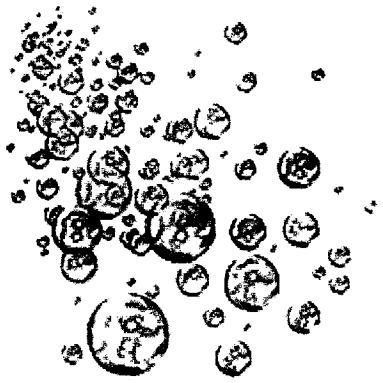

CHAPTER I
INTRODUCTION

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INTRODUCTION

Fats and oils are an essential part of our diet, supplying nutrients, improving flavor, aiding in the absorption of vitamins, and providing concentrated sources of energy for our body. Oils are derived from oilseed and animal sources. There is a universal demand for vegetable oil due to its use in domestic cooking, as an ingredient for other food production (in baked goods and fried snack foods). Edible vegetable oils are "foodstuffs which are composed primarily of glycerides of fatty acids phospholipids, sterols, hydrocarbons, pigments, waxes, and vitamins being obtained only from vegetable sources. Oils and Fats can also have very negative effects on health (Robert *et al.,* 2003).

The quality of vegetable oil is a measure of identity and edibility. This is also related to the method of obtaining the oils from the vegetable source (i.e. whether it is virgin oil or cold pressed oil) both obtained without altering the nature of the oil, by mechanical procedures (e.g. expelling or pressing), and the application of heat only. The quality of the oil is determined by its composition, FFA (Free Fatty Acid) content, iodine value, peroxide value, melting point, etc (Agimark, 2002).

Worldwide, natural vegetable oil and fats are increasingly becoming important in nutrition and commerce because they are sources of dietary energy, antioxidants, biofuels and raw material for the manufacture of industrial products. They are use in food, cosmetic, pharmaceutical and chemical industries (Fasin and Colley, 2008). Vegetable oils account for 80% of the world's natural oils and fat supply (FAO, 2007).

Bangladesh is deficit in edible oils and fat production as the country is able to produce only about 10% of its requirements and has to import the remaining. In Bangladesh, three major edible oils namely, palm oil soybean oil and rape/mustard oil is consumed (Shatabdi Goon, 2014). Soybean oil is also good for health and these are more or less "Cheap" (though the price is rather high at present in Bangladesh). Rice Bran oil now available in Bangladesh is rather tricky. Mustard seed is the major oil seed crop produced in the country and traditionally, mustard oil in virgin form was the most consumed edible oil. Later soya bean oil was introduced in early '60s and was the dominating cooking oil of the country till 2002. Palm oil was introduced in early '70s to meet the growing demand but due to lack of refining facility of crude palm oil, only refined palm olein, locally

known as palm oil, was used to be imported which continued till early '90s. Bangladesh Market Scenario by MPOC.

With an annual global production equating to about 39% of world production of vegetable oils (Oil world, 2011), palm oil has outclassed soybean during the last decade to become the most important oil crop in the world.

Vegetable oils are mostly used for cooking and frying of foods and snacks. The oils are heated in the temperature range of 35°C to 180°C during frying. Oils are degraded from thermal oxidation to form volatile and non-volatile decomposition products (Melton *et al.*, 1994). The fatty acid composition and oxidized products are important factors affecting its quality; therefore, it should be low level of polyunsaturated fatty acid such as linoleic or linolenic acids and high level of oleic acid with moderate amounts of saturated fatty acid (Kiatsrichart *et al.*, 2003; Mehta and Swinbum, 2001). Physical changes are mainly increased viscosity and foaming, color changes and decreased smoke-point.

Quality denotes the degree of excellence of a product. It is indicated in terms of grade, standards and specifications. These are laid down by a competent authority in the country. Consumers have concern about the safety, nutritional quality, aesthetic value, convenience of use and also cost of foods which they buy. They have a right to know what is in a processed product and that is safe to consumer (Kayser, 2012).

The consumers are unaware of deleterious effects of damages in a food article which can easily be masked by modern methods of processing. The legal view point demands that the quality of products conforms to national and international standards.
Hence the study was undertaken with edible oil with following specific objectives

1. To assess quality parameters of local palm, mustard, soybean and bran oil available in Dinajpur district
2. To find out best edible oil based on physicochemical qualities of fried oils

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

World vegetable oil production has increased over the past decades, especially production of palm oil, soybean oil, rapeseed oil (canola) and sunflower oil. Edible oils are from vegetable origin obtained by extraction of oilseeds (soybeans, rapeseed, sunflower, argan, peanuts, etc) or oleaginous fruits like coconut, olive and palm, or from animal fat like the pork fat (lard) or cattle (tallow), but essentially from some products deep sea fishing (cod, whale). Since the turn of century, vegetable oils have gradually replaced animal oils as main source of food fat (Said Gharby *et al.,* 2014). Vegetable oils consist of triglycerides between 95 and 99% (Argenson and Morin, 2007). They can also contain soluble vitamins (A, D, E and K), phytosterols, natural pigments and phospholipids from 1 to 5% (Argenson and Morin. *et al.,* (2007). The constituent fatty acid (FA) of triglycerides differs from each other by the length of their carbon chain and the number of double bonds (Cuvelier and Maillard, 2012). They contribute to the energy supply, oils are essential sources of fatty acid. These fatty acids are considered essential because they cannot be synthesized by humans, and are essential for the proper functioning of the human body, growth and physiological functions, on the other hand they contribute to the prevention of certain diseases related to eating habits (cardiovascular diseases, diabetes, obesity, cancer) (Vingering *et al.* 2010).

However, these unsaturated fatty acids are susceptible to oxidation (Gharby, *et al.,* 2013). Lipid oxidation has a negative impact on the functionality of raw materials, sensory and nutritional quality of food, and causes economic losses (Matthäus, *et al.,* 2010). The most noticeable result of lipid oxidation is the appearance of an unpleasant flavor often referred to rancid, which modifies the sensory characteristics of the food, so its assessment by the consumer (Gharby, *et al.,* 2012).

Soybean is the dominant oilseed produced in the world, due to its favorable agronomic characteristics, its high-quality protein, and its valuable edible oil. It contributes over a half of all oilseeds produced worldwide. The production of soybeans and soybean oil is driven by the need for soy protein meal. Oxidative instability limits the use of soybean oil in certain applications, but hydrogenation and other means of composition modification have made soybean oils the most widely used of all vegetable oils. Partial hydrogenation

is used to increase the melting temperature and, at the same time, to improve the oxidative stability of soybean oil (Frankel 1998).

Palm oil is a common cooking ingredients and originate in western Africa, it has spread to most part of the tropical and subtropical zones of the, but particularly to Malaysia and Indonesia (Richard D. O'Brien, 2009). Palm oil has a balanced fatty acid composition in which the level of saturated fatty acids is almost equal to that of the unsaturated fatty acids. Palmitic acid (44–45%) and oleic acid (39–40%) are the major component acids along with linoleic acid (10–11%) and only a trace amount of linolenic acid. The low level of linoleic acid and virtual absence of linolenic acid make the oil relatively stable to oxidative deterioration. Palm oil, a semi-solid at ambient temperature (25–30°C), may be fractionated into a liquid fraction (olein) and a more solid fraction (stearin). The olein contains higher levels of oleic (39–45%) and linoleic acids (10–13%) compared to the oil. (Tan *et al.,* 1990).

Agbaire (2012) studied on quality assessment of palm oil is mostly determined by measuring the following parameters: free fatty acid (FFA) content, iodine value (IV), peroxide value (PV), moisture content, saponification value (SV) and impurity content. The results obtained showed that the moisture content ranged from 0.14- 0.17%, specific gravity from 0.859-0.889, smoke value from 114.12-116.40°C, melting point from 34.5-35.6°C, FFA from 2.73-2.83mg KOH/g, IV from 52.55-53.66 Wij's, PV from 7.80-8.40meq/kg, SV from 195.76-198.75mg KOH/g, impurity 0.11-0.14, carotene from 1376.73-1568.59mg/kg.

Udensi and Iroegbu (2012) studied about the quality of palm oil samples obtained from different locations in terms of their physicochemical properties. The results obtained showed that the saponification value (SV) ranged from 129.04 – 198.03KOH/g of oil. The free fatty acid (FFA) of the palm oil samples ranged from 2.73 – 2.89mgKOH/g of oil, peroxide value (PV) 7.90 – 8.80meq/kg and the iodine value (IV) 52.61 – 53.48 Wiji's. The values of the oil samples were non-significantly ($p > 0.05$) similar, with crude coconut oil giving the highest value of 247.21 ± 0.40 mg KOH/g.

Rice bran oil is nutritionally superior oil compared to other common vegetable oils and India is the second largest producer of crude rice bran oil in the world (Usha and Premi, 2011). Rice bran oil has high levels of phytosterols, gamma-oryzanol, tocotrienols as well as tocopherols and it extends the shelf - life of snack foods. The high oxidative stability of rice bran oil makes it preferred oil for frying and baking applications (Gopal, *et al.,* 2005). The saturated, mono saturated and poly saturated fatty acids in RBO are in the ratio of approximately 1:2.2:1.5 and the major fatty acid compositions are not influenced by storage temperature, although linolenic acid level decrease by approximately 50 percent during storage. Rice bran oil is called the "heart oil" because being used for cooking food, it is found to be very delicious and has a high hypo-cholesterolemic effect (Yin and Wen, 2011).

Rice Bran oil is generally considered to be one of the highest quality vegetable oil in terms of its cooking quality, shelf life and fatty acid composition (Sayre and Sunders, 1990). Rice bran oil is miracle product obtained from the outer brown layer of rice. Generally rice bran contains 15 % to 20 % oil (Marshall and Wadsworth, 1994). It is extensively used in Japan, Korea, China, Taiwan and Thailand as a "Premium Edible Oil". In Japan, Rice Bran Oil is more popularly known as a "Heart Oil'. In Western countries Rice Bran Oil has acquired the status of a "Health Food". The oryzanol present in rice bran is reported to have functions similar to vitamin E in promoting growth, facilitating capillary growth in the skin, and improving blood circulation along with stimulating hormonal secretion (Luh *et al.,* 1991).

Mustard oil is extracted from the seeds of mustard plant (*Brassica campestris L.).* It grows easily in many parts of the world. It has a characteristically pungent flavor and aroma. Though this oil is nutty tasting it is good for heart and also has many other benefits. Mustard oil contains a high amount of selenium and magnesium, which gives it anti-inflammatory properties. It also helps stimulating sweat glands and helps lowering body temperature (Sood *et al.,* 2010). Oil high in oleic acid has demand in commercial food-service applications due to a long shelf-life and cholesterol-reducing properties. Both linoleic and linolenic acids are essential fatty acids; however, less than 3% linolenic acid is preferred for oil stability. High erucic acid content is beneficial for the polymer industry, whereas low erucic acid is recommended for food purposes (Kaushik and Agnihotri, 2000).

During the frying process, oil will experience degradation reactions caused by heat, air, and water, resulting in oxidation, hydrolysis and polymerization. Degradation reaction products contained in this oil will reduce the quality of the oil and adverse effects for humans (Bhattacharya, *et al.,* 2008). Recycling used cooking oil cause using adsorbents, such as silica gel, magnesium oxide, aluminum hydroxide gel and activated clay, has been studied (Lin and Reynolds, 1998; Miyagi & Nakajima, 2003) for improving the quality parameter of used cooking oil. The indicators of poor oil quality include elevated Free Fatty Acids (FFA), change of color, low smoke point, low iodine value, total polar material, peroxide value, high foaming properties and increased viscosity (Loh Soh Kheang, *et al.,* 2006). Peroxide value is measure of oxidation or rancidity and the color darker is also effect from oxidation. (Pandey and Careney, 2008).

Zeb and Ahmed (2004) studied that quality of oil is determined in terms of its quality constants/parameters. The change in this parameter would change the quality of the oil. There are some factors that affect by decreasing or increasing the level of quality parameters from the control and consequently change the market acceptable level such as color, refractive index, free fatty acid, peroxide value, iodine value, anisidine value and β-carotene.

Buckle (2003) studied that the quality of essential oils can vary widely. As a consumer (and even as an aromatherapies), it is difficult to assess quality. The quality of essential oils can be negatively impacted by the use of pesticides and other chemicals, the variability in altitude, soil conditions and rainfall, and the difficulty of differentiating plant species and varieties, processing practice, packaging, handling and storage condition.

Aboki *et al.* (2012) studied on physicochemical properties of sunflower seed oil and results obtained showed that it has a specific gravity of 0.825, iodine value was 119.921mgI2 /100g, acid value was 0.953mgKOH/g, peroxide value was 6.322mgO2/kg, saponification value was (182.233mgKOH/g). Saponification value was lower than the values for some common oils like palm oil (196-205mgKOH/g), coconut oil (253mgKOH/g) and palm kernel oil (247mgKOH/g). They stated that, low saponification value is an indication that the oil may not be suitable for soap making, oil-based ice-cream and shampoos.

Abayeh *et al.* (2013) studied on quality characteristics of Luffa aegyptiaca seed oil and results obtained showed that saponification value is 168mg KOH/g of oil, iodine value is 130g iodine/100g of oil, peroxide value is 280 meq peroxide/kg of oil, free fatty acid is 10.36% of oil and acid value is 20.62%, density of the oil was 0.91g/cm3 and the specific gravity was 0.92g/ml oil. The oil quality parameters suggest that the oil may find use as feedstock for biodiesel production. Owing to its iodine value, the oil may also be used in surface coating applications.

Onwuliri *et al.* (2011) studied on physicochemical properties of some fresh locally produced (crude) and industrially refined edible vegetables oils available in northern Nigeria, using standard methods. Results obtained showed that the crude and refined palm oil samples as well as palm kernel oil gave significantly ($p < 0.05$) higher values for percentage free fatty acid, acid value, unsaponifiable matters and soap content, in comparison to the other oil samples studied. The crude and refined forms of cotton seed oil and soybean oil had significantly ($p < 0.05$) higher iodine values than other oil samples, with the palm oil brands having significantly ($p < 0.05$) lowest iodine values. Saponification values of the oil samples were non-significantly ($p > 0.05$) similar, with crude coconut oil giving the highest value of 247.21 ± 0.40 mg KOH/g.

Orhevba *et al.* (2013) studied the effect of moisture content on some quality parameters of mechanically expressed neem seed kernel oil. The quality parameters include saponification value, iodine value, fatty acid, acid value and color. Matured neem seed kernels were obtained and the initial moisture content was determined. The neem seed kernels are then preconditioned to the following moisture content values: 6.3, 8.1, 13.2 and 16.6 % (wet basis).

Farhoosh and Moosavi (2009) studied performance of Peroxide value in monitoring quality of used frying oils. Result showed an increase in Peroxide Value (PV) at the initial stages of the frying process followed by a decrease. All the frying oils have Peroxide values lower than 4.42 meq O_2 kg-1 oil during the frying process and, consequently, none of them was above the limit of 10 meq O_2 kg-1 oil for edible oils.

Rose *et al.* (2001) studied that lead and arsenic have harmful effects on health. Lead affect the brain and intellectual development in young children, while long-term exposure in both children and adults can cause damage to the kidneys, reproductive and immune

systems in addition to effects on the nervous system. Exposure to inorganic arsenic is primarily of concern because of its cancer causing properties.

Kulichenko and Shevchenko (2001) studied that acid number is the key parameter that characterizes the quality of essential oil and fats. The amount of free fatty acid in fat and oil varies depending on the quality of raw materials, the method of oil production and the duration and condition of storage.

Bosco *et al.* (2012) studied that, rapid identification and quality control of edible oil is possible by measuring emulsion stability of nitromethane/vegetable oil. Flasification of sesame oil with 10% corn oil or any cheaper vegetable oil decreases significantly the stability of nitromethane/sesame oil emulsion. Among sesame oil, groundnut oil, soy bean oil, palm oil and maize oil, sesame oil form more stable emulsion with nitromethane as emulsifier in all emulsion /oil ratios.

Popa *et al.* (2012) studied on fatty acids composition and oil characteristics of linseed. Results obtained showed that linseed oil contain high levels of linolenic (53.21%) followed by oleic (18.51%), and linoleic (17.25%), while the dominant saturated acids are palmitic (6.58 %) and stearic (4.43%).And refractive index, iodine value (g I/ 100g oil), saponification value (mg KOH/ g oil) acid value (mg KOH/ g oil)and peroxide value (meqO2/ kg oil) were 1.469, 177, 190, 0.80 and 0.95 respectively; where ASTM standards were 0.4-4.0, 175-187, 82-88, 0.957-0.968, 6.3-8.8 respectively.

Manaf *et al.* (2007) carried out to assess the effectiveness of Fourier transform infrared (FTIR) spectroscopy in detecting adulteration of virgin coconut oil with palm kernel olein as a potential adulterant. Moisture content was in the range of 0.14-0.16%. The results obtained after the analysis of variance (ANOVA) showed that there were no significant differences ($P>0.05$) in the smoke, moisture content, saponification value, peroxide value and free fatty acid values of the palm oil samples. However, there were significant differences ($P<0.05$) in the melting point and carotene content of the palm oil samples respectively.

During frying, oils are degraded from thermal oxidation to form volatile and non-volatile decomposition products (Melton *et al.,* 1994). The chemical changes in frying oil also result in changes in the quality of fried food. The fatty acid composition of the frying oil is an important factor affecting fried food flavor and its stability; therefore, it should be low

level of polyunsaturated fatty acid such as linoleic or linolenic acids and high level of oleic acid with moderate amounts of saturated fatty acid (Kiatsrichart *et al.,* 2003; Mehta and Swinbum, 2001). As a result, the quality of frying oil is important because of absorbed oil of fried products during deep frying. Soybean oil has a good nutritional profile due to high level of unsaturated fatty acid but less oxidative stability (Steenson and Min, 2000).

Various method to improve oxidative stability of soybean oil has been developed and studied, for example, partial hydrogenation, fatty acid modification and blending with more saturated or monosaturated oils to reduce the amount of polyunsaturated fatty acids (Cuesta *et al.,* 1993; Hunter and Apple white, 1991; Su and White, 2004). Partial hydrogenation decreases polyunsaturated fatty acid but increases saturated fatty acid and trans-fatty acid to produce more stable frying oil. However, trans fatty acid may have adverse effects on cardiac health (Ascherio *et al.*, 1994). Palm oil is considered value domestic oil in many countries of Africa and Asia. Nowadays, palm oil becomes useful for cooking because of very low cost. It is also an excellent source vitamins A and E for Africa and Asia population (Zagre and Tarini, 2001). This work is to undertake a comparative study on the deterioration and the thermal stability of the two oils (soybean oil and refined palm oil) sold on the markets during cracklings of fritters.

Deep-fat frying is one of the most popular procedures for food processing since it is rapid and develops desirable flavors and textures (Sanibal and Mancini-Filho, 2004). During the frying not only water vapor but also other compounds moved from the food into the fat, which were combined high frying temperature leading to degradation of the frying oil (Mellema, 2003). The frying oil degradation produced volatile and non-volatile compounds. Most of volatile compounds evaporate in the atmosphere with steam and the remaining non-volatile compounds in oil undergo further chemical reactions or absorbed in fried foods. The non-volatile compounds in the oil affected the physical and chemical properties fried foods, i.e. flavor stability, taste and texture during storage. Deep-fat frying also decreased the unsaturated fatty acids of oil and increased foaming, color, viscosity, density, specific heat, and contents of free fatty acids, polar materials and polymeric compounds (Choe and Min, 2007). Therefore, repeated deep-fat frying can produce constituents that not only influence food quality but also can induce the formation of

compounds with adverse nutritional implications and potential hazards to human health (Sanibal and Mancini, Filho, 2004).

Repeated frying more batches/day exhibited lower in L^*, a^* and b^* than repeated frying less batches/day for few days. The viscosity of all the oils increased with number of frying. Similar results were described by Sanchez- Gimeno *et al.* (2008) that viscosity of olive oil and high oleic sunflower oil using for frying potato at 180°C had increased with frying cycle. The comparison between two repeated frying processes indicated that the continued frying for more batches within 1 day gave darkened and viscosity of oil greater than continuous frying for less batches a day for few consecutive days. This could be explained by the effect of filtration helping to polish the fat by removal of charred batter. This can ruin the appearance of a fried product, contribute bitter flavor and darken the frying oil (Jacobson, 1991)

The changes of PV and FFA in repeated frying oil during frying chicken drumsticks for 30 batched within 1 day were presented. The results showed that PV was significantly increased ($p<0.05$) with number of frying until 10 batches. The maximum of PV was 5.93±0.17 mg O_2/kg fat at 10 batched of frying, then PV in the oil sample started to decrease. FFA increased significantly ($p<0.05$) with increasing the number of repeated frying. The PV was rapidly increased by the end of the first day frying. There were decreased after the maximum of 6.85 ± 0.40 mg O_2/kg fat in the second day of frying as a result of unstable compound as mentioned above. FFA increased with number of frying this is due to water, steam, and oxygen initiated the chemical reactions in the frying oil and food. Water, a weak nucleophile, attacks the ester linkage of triacylglycerols and produces di- and monoacylglycerols, glycerol, and free fatty acids (Chung *et al.*, 2004).

Cooking oil used for frying are sunflower oil, palm oil, coconut oil etc. as they are easily available. As oils are heated for an extended time (abuse), they undergo oxidation (degradation) and give rise to oxides. Many of these such as hydroperoxides, epoxides and polymeric substances have shown adverse health/biological effects such as growth retardation, increase in liver and kidney size as well as cellular damage to different organs when fed to laboratory animals (Potgieter *et al.*, 2004 and Riera *et al.*, 2000).

Viscosity and acid value of the oil increase after frying (Knothe *et al.*, 2009). Thus, the identification of these parameters is a prerequisite for determining the viability of the

vegetable oil for trans esterification process and is essential to identify the right processes that can be performed to achieve best results (Canakci, 2007).

For economic reasons, normally the same oil is used during continuous and repeated frying. Frying is performed in one batch of oil for several days, may be several weeks. UFOs from restaurants and food industries have a wide variety of qualities. During the frying process, oil may undergo changes due to hydrolytic, oxidative and thermal reactions. Changes in the main fat constituents are known, although it is not easy to foresee the rate of oil degradation due to the high number of variables involved in the frying process (Issariyakul *et al.*, 2007). A chemical change during the frying process makes the oil to increase the free fatty acids content and the viscosity of the oil, change its colour to dark brown or even red and increase the tendency of fat to foam (Nawar, 1994).

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The present study was conducted in the laboratories during the period of March to April, 2015 of the department of Food Processing and Preservation, and Food Engineering and Technology under the Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200.

3.1 Materials

3.1.1 Chemicals:

The chemical and reagents were used during the present research work were 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.

3.1.2 Apparatus and equipment used:

The apparatus and equipments were used throughout the experimental period were Air oven, Beaker, Burette , Conical flask , Desiccators , Electric balance, Measuring cylinder, Pipette, Refractometer, Volumetric flask ,Viscosity analyzer, Colorimeter and magnetic stirrer with hot plate.

3.2 Collection of sample

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

3.3 Methods

3.3.1. Analysis of commercial oils

Selected commercial oil sample were analyzed for their moisture and volatile matter content (%m/m); refractive index; acid value as KOH(mg/g); iodine value as KOH (mg/g); peroxide value (as milliequivalents of oxygen per kg of oil) color, viscosity and

sensory evaluation determination. These tests were conducted in the laboratory of the Department of Food processing and preservation and Food Engineering and Technology, Hajee Mohammad Danesh Science and Technology University, Dinajpur-5200.

3.3.2. Moisture content determination

Moisture content was determined by the Association of Official Analytical Chemists (AOAC, 2004) method. First of all, weight of empty previously dried (1hr at 100°C) crucible with cover was taken and 5-15 g of sample was placed on it. Then the crucible was placed in an air oven and dried at a temperature of 100 to 105 ° C for 24 hrs. After drying, the crucible was removed from the oven and cooled in desiccators. It was then weighed and the crucible was again placed in the oven, dried for 30 minutes, took out of the dryer, cooled in a desiccators' and weighed. Drying, cooling and weighing were repeated until the two consecutive weights were the same. From these weights the percentage of moisture in food sample was calculated as follows:

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

3.3.3. Refractive index determination

The refractive index of oil at room temperature was determined using refractometer (model no. Carl Zeiss 110849, Made in West Germany). At first the refractometer was calibrated by fresh water. 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.

3.3.4. Viscosity determination and Color determination:

A rheometer as described by Nzikou *et al.* (2006) was used to measure the different oil viscosities. By this procedure, a concentric cylinder system was submerged in the oil and the force necessary to overcome the resistance of the viscosity to the rotation was measured. The viscosity value (mPas) was automatically calculated on the basis of the speed and the geometry of the probe (digital viscometer, VR 3000 with L-1 probe at 25^0 C and a speed of 200 rpm). The experiment was carried out by putting 150 ml of sample in a 250 ml beaker. The color of oils were measured the surface color in term L*, a* and b*. The color of the oil was measured by colorimeter (model no. CM-2500d, Minolta, Japan).

3.3.5. Acid value determination:

Acid value of samples was determined by the Association of Official Analytical Chemists (AOAC, 2005). Acid value was determined by directly titrating the oil in an alcoholic medium against standard potassium hydroxide solution. 10g sample was taken in a conical flask and shaken vigorously during the titration. Acid value was calculated using following formula: 50ml of freshly neutralized hot ethyl alcohol and about 1ml of phenolphthalein indicator solution. Boiled the mixture for about five minutes and titrated while hot against standard alkali solution and calculating by the following formula:

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

3.3.6. Free fatty acid determination:

This method was done by Aletor *et al.* (1990). The free fatty acid concentration was determined by titrating method with the alcoholic solution of the oils with an aqueous solution of sodium hydroxide using phenolphthalein indicator about 10g of the oil was weighed into the conical flask. Fifty (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. 1ml of phenolphthalein indicator was then added and was titrated with 0.1N NaOH until a fairly pink end point was obtained.

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

3.3.7. Iodine value determination:

The iodine value was determined by the Wijs' method using the guide provided by Pike (2003). A moderate mixture of iodine monochloride and acetic acid were added to the samples. The mixture was allowed to stand for 30 minutes in dark. About 15ml of 10% potassium iodide was added to the mixture. The solution was titrated with 0.1ml sodium thiosulphate solution using starch indicator to a colorless end point (S). Analysis of Blank (B) was also carried out. Therefore;

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

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.

3.3.8. Peroxide value (PV):

The procedure was done by the AOAC method (1990). Oil sample (5.0 g) was accurately weighed into a conical flask, and dissolved in 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 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 color had almost gone. About 0.5 ml of starch solution was introduced and titration continued with the reagent added slowly until the blue black color 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.

3.3.9. Saponification value determination:

Saponification value of samples was determined by the Association of Official Analytical Chemists (AOAC, 2005). 4 g of sample was taken in 250 ml conical flask and added with 50 ml alcoholic KOH. Then the flask was connected with a condenser. Then it was boiled in a condenser until the solution becomes clear homogenized, i.e. complete saponification. The solution was then cooled and titrated with o.5N HCL in presence of phenolphthalein indicator. A blank titration was also conducted side by side. Saponification value was calculated using following formula:

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

Where B= Blank titre, S= sample titre, N = normality of KOH

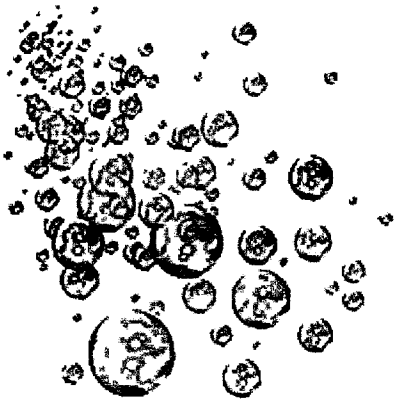
3.3.10. Subjective (sensory) evaluation of oil by frying flour chips:

For statistical analysis of sensory data four different samples were evaluated for color, flavor, taste and overall acceptability by a panel of 10 testers. Four reconstituted samples were presented to 10 panelist and randomly coded sample. The test panelists were asked to rate the different composition presented to them on a 9 point hedonic scale with the

ratings of: 1=dislike extremely; 2=dislike very much; 3 dislike moderately; 4=dislike slightly; 5= neither like nor dislike; 6=like slightly; 7= like moderately; 8= like very much; 9=like extremely.

3.4 Statistical analysis:

All measurements were carried out in triplicate for each of the sample. Results were expressed as mean values standard deviation. The sensory evaluation results were evaluated by Analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) procedures of the Statistical Analysis system (SAS, 1985). Differences were considered statistically significant at $P < 0.05$.



CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

There are a number of edible oils available in Bangladesh market. With so many brands and so many different oil products, such as soybean oil, palm oil, canola, rapeseed oil, mustard oil, bran oil and so on. The results of the study on oil in terms of the different types of oil and its physical and chemical qualities are presented in this chapter. The quality of the oil is determined by its composition, FFA (Free Fatty Acid) content, iodine value, peroxide value, saponification value refractive index, viscosity and sensory evaluation etc.

4.1 Proximate composition of selected oils:

The physical and chemical properties were analyzed in the laboratory. The results are showed in Table 4.1.

Table 4.1 Physico-chemical properties of the commercial oils:

Properties	Soybean oil	Palm oil	Mustard oil	Bran oil
Moisture content (%m/m)	0.14±0.021	0.30±0.011	0.21±0.021	0.09±0.02
Refractive index	1.4694±0.0031	1.4539±0.0068	1.4658±0.0011	1.4708±0.0021
Iodine value as (KOH) mg/g	133.17±0.589	46.18±0.633	110.59±0.731	100.27±0.940
Saponification Value(asKOH) mg/g	187.11±0.537	202.39±1.031	191.38±0.9874	181.6±0.7673
Viscosity at 28°C (mPas)	35.5±0.073	33.247±0.8103	48.43±0.556	37.98±0.525

Mean values are triplicate ± standard deviation

4.1.1 Moisture content

Moisture content is one of the important parameters which interfere in the quality of the oils during the storage. Table 4.1 showed that in palm oil maximum amount of moisture content and in bran oil minimum amount of moisture content present. The moisture content of bran oil, mustard oil, palm oil and soybean oil were 0.09%, 0.21%, 0.30% and 0.14% respectively. In soybean oil the optimum moisture content is 0.06-0.10% (Max.0.20% in Mahfujur Rahman, 2013). The moisture content found in soybean oil is reasonable and suitable that compared with the reference. On the other hand comparing within the literature (Agbaire2012) the moisture content of palm oil ranged from 0.14-0.17%. Ngando *et al.* (2011) reported that the moisture content of crude palm oil (CPO) produced in Cameroun are 0.22%, 0.23 – 0.32% and 0.08% for traditional, semi-mechanical and mechanized method of processing respectively. Zu *et al.* (2012) also reported the moisture content of crude palm oil (CPO) produced in Ghana as 0.79 – 1.59%. The founding for palm oil moisture content is reasonable with references.

According to Mahfujur Rahman, (2013) the moisture content of mustard oil ranges from 0.12-0.27% (max.0.10%, Mahfujur Rahman, 2013). On the other hand Yi-Hsu Ju and Shaik Ramjan Vali, (2005) also reported that the moisture content of bran oil range from 0.03 to 0.09. The comparable value with the literature that the moisture content of bran oil is suitable and also reasonable. Low moisture in oil implies that the oil cannot easily be subjected to rancidity and high moisture content is an indication of ease of spoilage and rancidity as well as short shelf-life (Aboki *et al.*, 2012).

4.1.2 Refractive index of commercial oils:

Table 4.1 showed that in bran oil, maximum value of refractive index is 1.4693, in palm oil minimum value of refractive index is 1.456. The refractive index of mustard and soybean oil are 1.4652 and 1.4663 respectively. Results showed that soybean oil and mustard oil has refractive index within BSTI reference value (1.466 - 1.470 for soybean oil and 1.4650 - 1.4670 for mustard oil). On the other hand palm oil's refractive index is 1.4530-1.4560 was found by Ghavami, *et al.* (2008). The refractive index of the rice bran oil was found to be 1.469 reported by (Patel and Naik, 2004). The high refractive index increases the degree of unsaturation (Bello *et al.*, 2011). From the refractive index of oils the study has revealed that soybean and bran oil contents low impurities than other.

4.1.3 Iodine value of commercial oils:

The iodine number equals the number of mg of iodine required to saturate the fatty acids present in100 mg of the oil or fat. Oils rich in saturated fatty acids have low iodine numbers, while oils rich in unsaturated fatty acids have high iodine numbers. Table 4.1 showed that in soybean oil, maximum iodine value is 133.17 g/100g. This value indicated that iodine value of soybean oil is within BSTI recommended range (120 -143) g/100g (Mahfujur Rahman, 2013) and the another oil, mustard oil's iodine value is 110.59 g/100g and it also indicated that iodine value of mustard oil is similar the BSTI recommended range (110–129) g/100g (Mahfujur Rahman, 2013). On the other hand the iodine value of bran oil is 100.27 g/100gwhich is similar to the result found by Firestone D., (2005). Moreover palm oil's iodine value is 46.18g/100g. The result is significant with the providing ranged 48-58g/100g (AOCS, 2002).

The lower the iodine value the lower the degree of unsaturation and hence the lower the tendency of the oil to undergo oxidative rancidity. High iodine values show some level of rancidity and deterioration and suggest high level of unsaturation and susceptible to oxidative rancidity. Low iodine values indicate oil may be adulterated with other low quality oil (Orhevba *et al.*, 2013). The finding values have revealed that soybean oil has high unsaturated fatty acid and good for health other than mustard, bran and palm oils.

4.1.4 Saponification value of commercial oils:

Table 4.1 shows that the saponification values were 187.11, 202.39, 191.38, and 181.6 for soybean oil, palm oil, mustard oil, and bran oil respectively. The saponification value of soybean oil was 187.11 which below the recommended value of BSTI range (189-195 mg KOH/g). On the other hand the saponification value of mustard oil was found 191.38 mg KOH/g within the BSTI recommended reference range 188-193mg KOH/g.

Saponification value measured the total acid and it is used in checking adulteration (Akinola *et al.*, 2010). The saponification value of bran oil was found 181.6 mg KOH/g which is less than 185 to 195 mg KOH/g reported by Gharby *et al.* (2012). Similarly the saponification value of palm oil was found 202.39 mg KOH/g which was above that sold in major market of some states in Nigeeiria 192.64 – 198.03mgKOH/g (Abia, Udensi and Iroegbu, 2007).

High saponification value indicates high proportion of low fatty acids since saponification value is inversely proportional to the average molecular weight or length of fatty acids (Muhammad *et al.,* 2011). High saponification value recorded for the oil is weight indicative that they can be used for soap production and in making other cosmetic products such as shampoo and the low saponification value is an indication that the oil may not be suitable for soap making, oil based ice-cream and shampoos (Nwabanne, 2012).

4.1.5 Viscosity of commercial oils:

The viscosity of the different oil at room temperaturemeasured by visco-analyzerare shown in Table 4.1. These values were 35 mPas, 48 mPas, 38 mPas and 32 mPas for soybean oil , mustard oil, bran oil and palm oil respectively. Viscosity of soybean oil is above within the reference value thatwas 33 mPa s reported by Fasina And Colley, (2013). Result showed that Palm oil viscosity wasbelow within the reference value 35 mPa s at 30^{0} C (Bailey's Industrial And Fat Products, 2005). On the other hand Mustard oil's viscosity was also below within the value 52 mPa s by Roger Muncaster(2004). And also bran oil's viscosity was below within the value 40 mPa s (Sasikan Kupongsak *et al.*, 2012).

The viscosity of all the oils increased due to the formation of high molecular weight polymers. The more the viscous, the higher the degree of deterioration was described by Sanchez-Gimeno *et al.* (2008). Viscosity of oils is physical indicators of oil deterioration caused by oxidation and polymerization. Low viscosity of oil allows less oil uptake during frying (Knothe *et al.*, 2009). It is considerable to be good frying/cooking oil due to its high smoke point and delicate flavor (Ghosh 2007).

4.2. Change in quality indices during heating at 180 ° C

4.2.1 Acid value of oils:

The acid values showed in appendix 1.2. From the data it was found that the acid value of the fresh oils was low but varied from oil to oil. The values increased gradually after heating for various periods (10 min, 15 min and 20 min). The acid value of fresh uncooked oil was high in palm oil and low in soybean oil before heating. Changes of acid value of oil showed in Fig. (4.1). From the results, the acid value of soybean oil increased

slowly and remained constant. On the other hand palm oil and mustard oil increased rapidly at first 10 min, it reached (from 3.698 to 7.23) comparing to the beginning time (from 3.051 to 6.291). And then slightly decreased from first time heating but gradually increased with time. The highest acid value was recorded for fresh unheated and heated palm oil and lowest value was soybean oil. Acid value increased significantly with increasing the heating temperature (Bhattacharya, *et al.,* 2008). Soybean oil acid value was found in table 4.2 as low within the BSTI (0.6 max.) (Mahfujur Rahman, 2013). On the other hand mustard oil acid value was high within the BSTI reference (0.6 max.). Again palm oil acid value was found above the value 0.54 that reported by Sambanthamurthi, *et al.* (2005). Acid values are used as an indicator for edibility or otherwise of oils and suitability for use in industries (Akubugwo and Ugbogu, 2007).

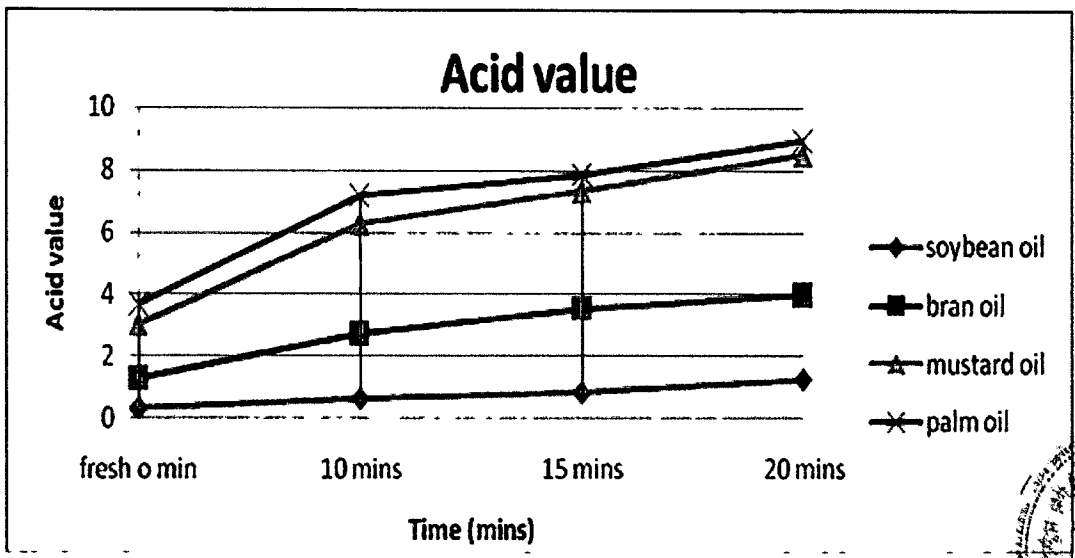


Fig. 4.1: Evolution of acid content depending on the time of heating at 180 °C

4.2.2 Free fatty acid of oils:

The free fatty acid values showed in appendix 1.1 marked increasing on 10 min, 15 min and 20 min of heating over that of fresh oils. Changes of free fatty acids (FFA) were shown in the Fig. (4.2). Results showed that FFA increased significantly to reach high levels at the end of induction time respectively for palm oil (vary from 0.96 to 2.64% and mustard oil (vary from 0.653 to 2.48%), while it didn't note any variation in FFA for soybean oil which remains constant during heating time. On the other hand bran oil increased slightly at 10 min but 15 min and 20 min it gradually increased on heating time.

Free fatty acid (FFA) percent of fresh rice bran oil was 0.45% which gradually increased during heating to reach 0.73% 180°C for 10 min reported by Yi-Hsu Ju and Shaik Ramjan Vali, (2005). Slow rate of increase in FFA and may be attributed due to the protective effect of oryzanol present in rice bran oil (Rubalya Valantinal *et al.*, 2010).

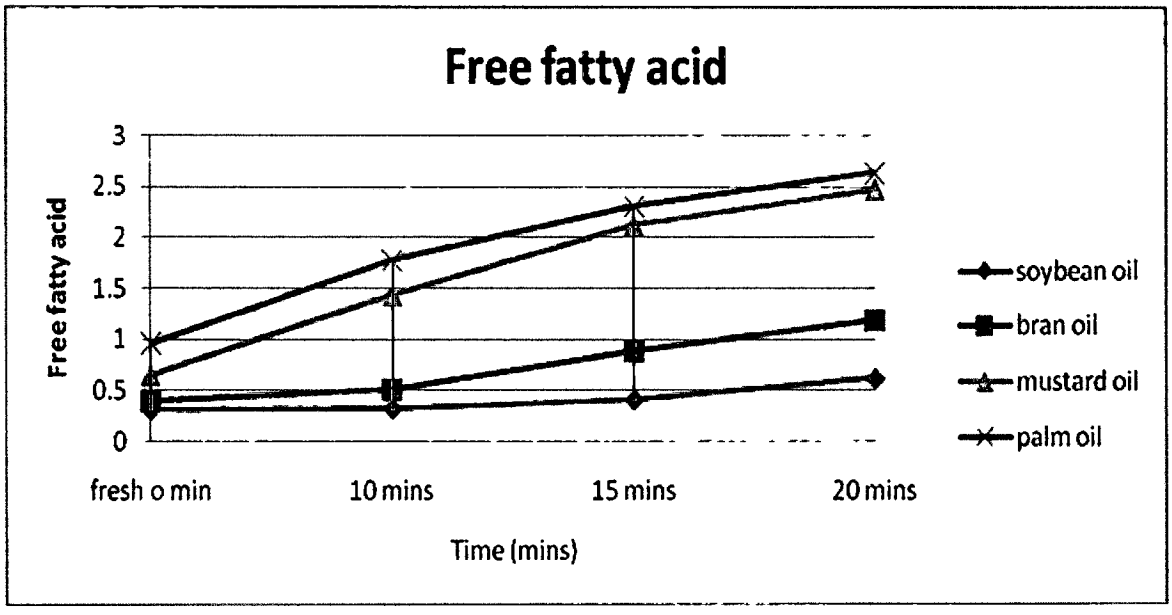


Fig. 4.2: Evolution of free fatty acid content depending on the time of heating at 180°C.

The presence and increase of FFA has been shown to catalyze both oxidation and hydrolysis of triacylglycerols and consequently they contribute to the decrease of the smoke point due to their partial volatilization (Richardson and Finley, 1985). The invariability of FFA for soybean oil might due to its high thermal stability confirmed by some studies (Dobarganes and Velasco2002), normally the bran oil should display same results as soybean in point of its high stability. its seems that each oil perform a specific behavior towards heating treatment, which might explain the observed data and should be confirmed by establishing many correlation between different parameters such as Rancimat index, FFA levels, oxidative stability and fatty acid composition (Gharby *et al.*, 2012). In soybean oil include: low saturated fatty acids, high-palmitic acid, high-stearic acid, low-linolenic acid, and high-oleic according to Chung, *et al.*, (2004) this type of oil has significantly improved oxidative stability. This oil has an optimum composition and is predicted to be the soybean variety of the future. It will have improved shelf life and flavor quality.

4.3.3 Peroxide value of oils:

From data presented in appendix (1.3), it was found that the peroxide value of the fresh uncooked oils was low varied from oil to oil. The value increased gradually after heating various periods (10 min, 15 min and 20 min). The peroxide value (PV) of different oils was shown in the Fig. 4.3. The PV of soybean oil and bran oil increased slowly during the first 10 min, but it reached comparing to the beginning time, this value remains relatively constant in the following time.

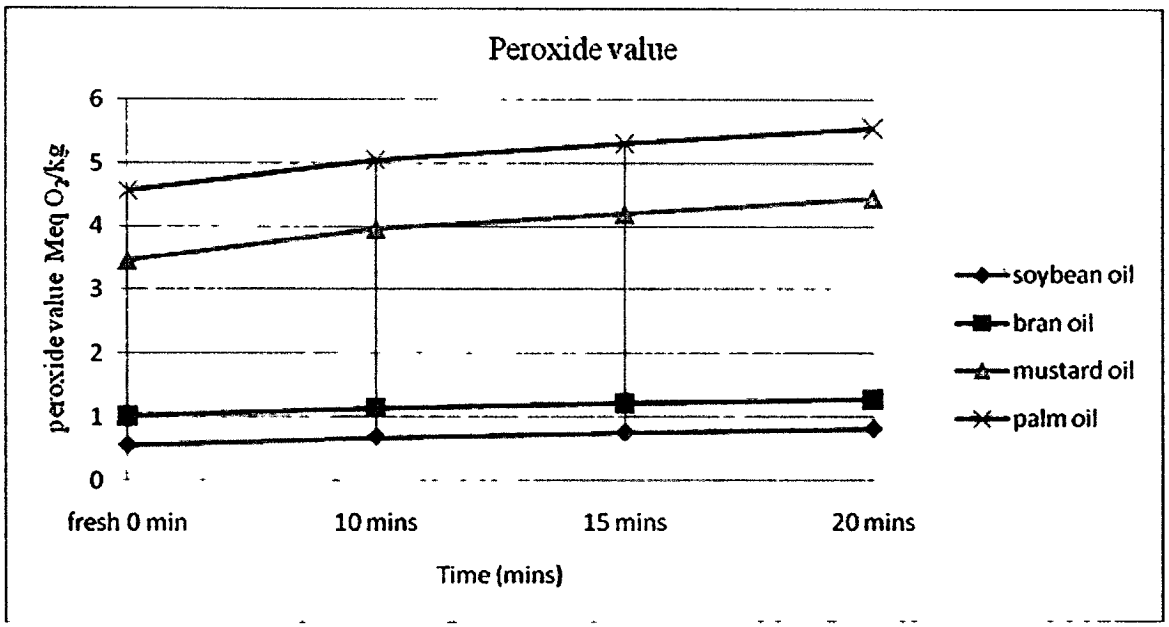


Fig. 4.3: Evolution of peroxide content depending on the time of heating at 180 °C.

In contrast, the palm oil and mustard oil showed a slight variation after 10 min comparing to the soybean and bran oil. However, they increased significantly at the end of the induction time (20 min). In our study, we showed that PV of soybean oil and bran oil did not vary after 20 min depending on the heating time which normally should increases intensively due to the oxidative activation. Consequently, in this case we cannot consider this index as an appropriate indicator to evaluate the hydroperoxides degradation at high temperature; in fact it can be used as an index of instability (Marmesat, *et al.*, 2009). For mustard oil and palm oils, the peroxide value were increased successively this might be due to high amounts of polyunsaturated fatty acids compared to the soybean oil. Indeed, the observed results are in accordance with many recent studies investigating the production peroxide of oils using heat treatment by Che Man, *et al.* (2005).

Low peroxide value attest to the oxidative stability of the oil and high peroxide value of oil indicates a poor resistance of the oil to peroxidation during storage. Peroxide value is a measure of oxidation during storage and the freshness of the lipid matrix Ijeh *et al.* (2011). The peroxide value of the oil heated at 170°C and 180°C were significantly increased ($p<0.05$) with time increased, whereas frying at 190°C, the peroxide value increased in the first period of frying until reached the peak and started to decrease, (Agbaire 2012). However, peroxides are unstable compounds particularly under high temperature conditions.

4.4 Color determination of commercial oil:

The features and physical specifications of color are also related with objects based on their physical properties such as light absorption, reflection, or emission spectra. Colors vary in different ways such as red, orange, yellow, green, blue, and violet, saturation, brightness, and gloss etc. The oils were examined without dilution to avoid color variation. The oil color was expressed as L* (luminosity), a* (greenness) and b* (yellowness).

Table 4.2 Effect of color during heating of the oils

parameter		Soybean oil	Palm oil	Mustard oil	Bran oil
At room temperature	L	30.86±2.95	28.775±0.9033	24.58±8.58	26.4±6.4
	a	-1.43±0.14	-0.73±0.0	1.17±0.68	-2.01±0.27
	b	1.335±0.3033	3.365±0.05	23.085±3.915	6.475±0.445
At 180°C	L	14.995±1.165	10.315±0.385	13.63±0.24	17.605±0.1588
	a	-1.35±0.04	-2.275±0.005	0.015±0.01443	-1.11±0.04
	b	6.3±0.08	7.35±0.17	15.16±0.34	13.05±0.35

Mean values are triplicate ± standard deviation

Table 4.2 indicates that soybean oil more lightness than other oils. It has also yellow and green color. After frying with 10 minutes at 180°C the color of oils gradually changed. All

oils have owned color. The color value of rice bran oil L*, a* and b* values were 26.4, -2.01 and 6.475 respectively. From this experiment, it was found that the lightness (L^*), redness (a^*) and yellowness (b^*) of the color of oil that decreased significantly with frying temperature. Mustard oil has less lightness and high redness and yellowness than other oils. After heating these color were decreased with the frying temperature. On the other hand palm color was also L*, a* (redness) decreased and b* increased than others oils. This may be attributed to the fact that food when fried at a high temperature can introduce various components into the oil. Many of these components contribute to color formation along with other changes of color intensity is due to the accumulation of nonvolatile decomposition products such as oxidized triacylglycerols and FFA, (Abdulkarim *et al.*, 2007). A decrease in L^* with time may be attributed to Maillard browning reaction and caramelization at the high frying temperature as affected of sugar in seasoning. As well known a rate of the Maillard reaction depends on its chemical environment such as water activity, pH, chemical composition of the food and the reaction temperature (Carabasa and Ibarz, 2000). Color of frying oil after frying at various temperatures and times were indicated that increasing frying time resulted slightly decrease of oil lightness (L^*) and greenness ($-a^*$) but slightly increase in yellowness(b^*). Color of frying oils is physical indicators of oil deterioration caused by oxidation and polymerization, (Ghosh, 2007).

4.4 Sensory Evaluation

Sensory evaluation of the formulated oil was carried out on the color, flavor, taste and overall acceptability by a panel of ten members from the faculty of engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The flour chips were evaluated by the panel members in ascending order of 9 point hedonic scale with the ratings of: 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much and 1 = Dislike extremely. The panel members scored showing their degree of preference of the different oils.

The results were evaluated with Analysis of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) procedures of the Statistical Analysis System. The responses were tabulated in tables (Appendix). The mean scores for color, flavor, taste and overall

acceptability of four types of oils are shown in table 4.3. The mean score for color, flavor, taste and acceptability of the oil are presented details in appendix.

Table 4.3: Mean score of sensory attributes of selected oils after frying

Sample	Sensory attributes			
	Color	Flavor	Taste	Overall acceptability
Soybean oil	8.1^{a}	7.7^{a}	8.2^{a}	7.8^{a}
Bran oil	7.6^{a}	7.4^{a}	7.4^{b}	7.6^{ab}
Mustard oil	7.9^{a}	6.8^{ab}	6.6^{c}	7.0^{ab}
Palm oil	6.5^{b}	6.1^{b}	6.6^{c}	6.7^{b}
LSD	0.20	0.30	0.80	0.20

4.4.1 Color

For color preference a one way of analysis of variance ANOVA (Appendix 2.1 and 2.2) was carried out and there was no significant difference in color ratings among the soybean, bran and mustard oils by the panelists are shown in table 4.3. On the other hand palm has significant difference from others oils that rated by the panelists. However scores for all this oils were within quite acceptable. Factors may have affected the color by frying temperature and time. Low color ratings of oils food can decrease the acceptability as color is important organoleptic attribute which enhanced product acceptability. The DMRT result (Appendix 3.3) showed that color difference of the oil are almost similar and palm oil gained score 6.5 and soybean oil gained score 8.1 which can be high ranked. From this results soybean oil and also bran oil were best suited for color among the other oils.

4.4.2 Flavor

In case of flavor preference of analysis of variance ANOVA (Appendix 3.1 and 3.2) showed that there was a significant difference ($P<0.005$) in flavor acceptability among the oils. But there was no significant difference between soybean oil and bran oil. On the other hand palm oil has significance difference among others oils that shown in table 4.3. Palm oil gained score 6.1 that lower than other oils which may be affected by heating or

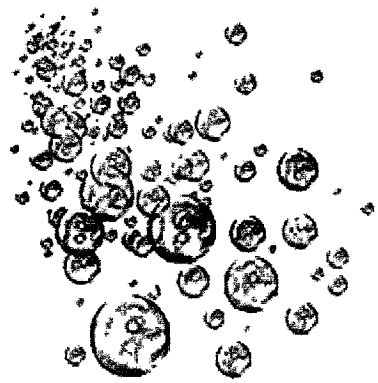
air polluted because this oil is not well packaged and oxidized by its composition. Similarly mustard oil has high pungency and acidity that is why panelists like less than soybean and bran oil. Flavor is important attribute in case of frying products for consumer acceptability otherwise the acceptability of frying product is refused if it is odor.

4.4.3 Taste

The taste acceptability of the difference oil ranged from (6.6 – 8.2). There was a significant difference among the oils that showed in table 4.3. From table 4.3 showed that taste of soybean oil was highest score 8.2 and bran oil score 7.4 and significantly different from each other while mustard oil and palm has no significant difference between them. The high score rating soybean oil would be as a result of good composite oil that increases the taste after heating. On the other hand the taste ratings of the sample palm oil and mustard oil gained least score 6.6. Soybean oil has the highest score and also bran oil was suited for taste among the other oils.

4.4.4 Overall acceptability

It was apparent from the results of analysis of variance ANOVA (Appendix 5.1 and 5.2) showed that there was significant ($P<0.05$) difference in overall acceptability among the oils as the F-value (2.944). From table 4.3 showed that overall acceptance of soybean oil was highest score 7.8 and followed by bran oil and mustard oil score 7.4 and 7.0 while palm oil gained score 6.7. Soybean oil compared favorably with other oils in case of overall acceptability. The result of the present study based on commonly consumed frying food which fried by different oil was found to be comparable among the oils in terms of color, flavor, taste and overall acceptability. The commercial oil was found to be rated best while palm oil was less acceptable. Therefore, soybean oil is more acceptable than other oils.



CHAPTER V

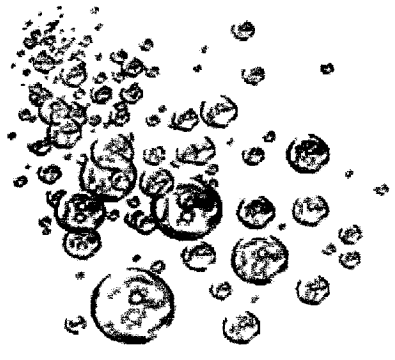
SUMMARY AND CONCLUSION

SUMMERY AND CONCLUSION

Maintaining the quality of oil is of great importance. Different kind of oil such as soybean oil, mustard oil, palm oil and bran oil play a major role in determining the taste, texture, nutrient profile, and shelf life of food products and are used for cooking of various kinds of food and manufacture of various kinds of food products.

The study was conducted on four different fresh edible oils to observe the quality effect in oils before and after heating. The results obtained that moisture content of the mustard oil and palm oil samples were high. Saponification value was the highest in palm oil and viscosity of most of the mustard oil. It represents that these samples may be adulterated with other oils. On the other hand the highest chemical properties (peroxide value, acid value and free fatty acid) were found in palm oil and lowest in soybean oil during heating on various periods. In conclusions, being summary of this research, indicate that physical and chemical parameters of oil are increased during heating period and more susceptible to oxidative rancidity. Here it is recommended that cooking food in oils that have to be heated for long time should be avoided.

Referring to the study of the thermal stability of vegetable oils, our results indicated that the soybean oil has an excellent profile in terms of stability at high temperature. Hence, further investigations will be necessary in order to draw conclusions about how long oils can be heated before the deterioration increases to such a level that it is no longer acceptable for human consumption.



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APPENDICS

Appendix- 1: Change in Quality indices heating at 180 °C

Table 1.1 Free fatty acid values of oils during frying in different times at 180°c

Oils	Free fatty acid value			
	Fresh	Heated		
		10 min	15 min	20 min
Soybean oil	0.3134±0.007	0.3226±0.037	0.4112±0.004	0.6241±0.001
Bran oil	0.393±0.024	0.503±0.042	0.884±0.034	1.185±0.021
Mustard oil	1.542±0.0.034	2.282±0.042	2.573±0.021	2.878±0.012
Palm oil	0.502±0.014	0.963±0.084	1.142±0.045	1.242±0.032

Table 1.2 Acid values of oils during frying in different times at 180°c

Oils	Acid value			
	Fresh	Heated		
		10 min	15 min	20 min
Soybean oil	0.3045±0.007	0.6123±0.01	0.8132±0.32	1.245±0.01
Bran oil	1.271±0.201	2.734±0.00	3.573±0.02	4.013±0.12
Mustard oil	3.051±0.014	6.291±0.07	7.342±0.01	8.514±0.21
Palm oil	3.698±0.039	7.23±0.21	7.896±0.34	8.983±0.23

Table 1.3 Peroxide value of commercial oil:

Oils	Peroxide value			
	Fresh	Heated		
		10 min	15 min	20 min
soybean oil	0.56±0.001	0.69±0.00	0.76±0.00	0.82±0.002
bran oil	1.01±0.012	1.14±0.01	1.21±0.001	1.27±0.013
mustard oil	3.46±0.07	3.96±0.03	4.2±0.01	4.45±0.001
palm oil	4.56±0.07	5.05±0.05	5.3±0.00	5.55±0.007

Mean value ± standard deviation

Appendix- 2: Statistical analysis of sensory evaluation for color

Table 2.1. Rating score for color of different oils

Judges	Samples			
	Soybean oil	Bran oil	Mustard oil	Palm oil
1	9	8	7	7
2	8	9	9	6
3	8	8	9	7
4	7	7	6	6
5	8	8	7	7
6	9	8	8	7
7	9	7	8	7
8	7	7	8	6
9	9	7	9	6
10	7	7	8	6
Total	81	76	79	65
Mean	8.1	7.6	7.9	6.5

Table 2.2. Analysis of variance (ANOVA) for color of different oils

ANOVA
Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.275	3	5.092	8.075	.000
Within Groups	22.700	36	.631		
Total	37.975	39			

Table 2.3. Duncan's Multiple Range Test (DMRT) value for color

Sample	Original Rank	Sample	Arrange rank
Soybean oil	8.1^{a}	Soybean oil	8.1^{a}
Bran oil	7.6^{a}	Mustard oil	7.9^{a}
Mustard oil	7.9^{a}	Bran oil	7.6^{a}
Palm oil	6.5^{b}	Palm oil	6.5^{b}

Mean within same superscripts within a column are not significant at $p<0.05$

Appendix- 3: Statistical analysis of sensory evaluation for flavor

Table 3.1. Rating score for flavor of different oils

Jugdes	Samples			
	Soybean oil	Bran oil	Mustard oil	Palm oil
1	7	8	6	7
2	6	9	7	8
3	7	8	7	6
4	8	5	6	5
5	8	7	7	6
6	8	8	8	6
7	9	7	7	6
8	8	9	6	7
9	9	7	7	5
10	7	6	7	5
Total	77	74	68	61
Mean	7.7	7.4	6.8	6.1

Table 3.2. Analysis of variance (ANOVA) for flavor of different oils

ANOVA
Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.000	3	5.000	5.143	.005
Within Groups	35.000	36	.972		
Total	50.000	39			

Table 3.3. Duncan's Multiple Range Test (DMRT) value for flavor

Sample	Original Rank	Sample	Arrange rank
Soybean oil	7.7^{a}	Soybean oil	7.7^{a}
Bran oil	7.4^{a}	Bran oil	7.4^{a}
Mustard oil	6.8^{ab}	Mustard oil	6.8^{ab}
Palm oil	6.1^{b}	Palm oil	6.1^{b}

Mean within same superscripts within a column are not significant at $p<0.005$

Appendix- 4: Statistical analysis of sensory evaluation for taste

Table 4.1. Rating score for taste of different oils

Judges	Samples			
	Soybean oil	Bran oil	Mustard oil	Palm oil
1	8	6	7	6
2	8	7	8	7
3	9	7	7	6
4	8	8	6	6
5	8	8	6	7
6	9	8	7	6
7	8	6	6	7
8	9	9	6	8
9	8	7	6	6
10	7	8	7	7
Total	82	74	66	66
Mean	8.2	7.4	6.6	6.6

Table 4.2. Analysis of variance (ANOVA) for taste of different oils

ANOVA
Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	17.600	3	5.867	10.154	.000
Within Groups	20.800	36	.578		
Total	38.400	39			

Table 4.3. Duncan's Multiple Range Test (DMRT) value for taste

Sample	Original Rank	Sample	Arrange rank
Soybean oil	8.2^{a}	Soybean oil	8.2^{a}
Bran oil	7.4^{b}	Bran oil	7.4^{b}
Mustard oil	6.6^{c}	Mustard oil	6.6^{c}
Palm oil	6.6^{c}	Palm oil	6.6^{c}

Mean within same superscripts within a column are not significant at $p<0.0001$

Appendix- 5: Statistical analysis of sensory evaluation for overall acceptability

Table 5.1. Rating score for overall acceptability of different oils

Jugde	Samples			
	Soybean oil	Bran oil	Mustard oil	Palm oil
1	9	8	7	6
2	7	9	7	5
3	8	7	8	8
4	8	8	6	7
5	9	6	8	6
6	7	7	6	7
7	6	9	8	7
8	8	7	7	6
9	7	7	6	8
10	9	8	7	7
Total	78	76	70	67
Mean	7.8	7.6	7.0	6.7

Table 5.2. Analysis of variance (ANOVA) for overall acceptability of different oils

ANOVA
Score

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.875	3	2.625	2.944	.046
Within Groups	32.100	36	.892		
Total	39.975	39			

Table 5.3. Duncan's Multiple Range Test (DMRT) value for overall acceptability

Sample	Original Rank	Sample	Arrange rank
Soybean oil	7.8^{a}	Soybean oil	7.8^{a}
Bran oil	7.6^{ab}	Bran oil	7.6^{ab}
Mustard oil	7.0^{ab}	Mustard oil	7.0^{ab}
Palm oil	6.7^{b}	Palm oil	6.7^{b}

Mean within same superscripts within a column are not significant at $p<0.05$

Appendix 6: Hedonic rating test of oil fried with flour chips

Name of the tester..... Date:.....

Please taste these samples and check how much you like or dislike each one on four sensory attributes such as Color, Flavor, Taste, and Overall Acceptability. Use the appropriate scale to show your attitude by checking at the point that best describe your feeling about the sample.

Sample	Sensory attributes			
	Color	Flavor	Taste	Overall Acceptability
T1(soybean)				
T2(palm)				
T3(mustard)				
T4(bran)				

Extra comments on each sample if any:

N.B. Overall Evaluation:

Hedonic scale used: 9=Like extremely; 8=Like very much; 7= Like moderately; 6=Like slightly; 5= Neither like nor dislike; 4=Dislike slightly; 3= Dislike moderately; 2= Dislike very much; 1=Dislike extremely.