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Studies on physico-chemical properties of crude oil and refined oil

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Abstract

The present investigation was undertaken to physico-chemical properties of crude oil and refined oil under different storage condition. The effect of storage conditions on the quality of mustard, soybean, sunflower, groundnut oil and their refined oils were analyzed under storage up to 210 days in Room temperature, BOD incubator and Refrigerated condition. An average oil seeds contain 40-50% oil and 20-25% good quality protein with exception 40-45% protein and 18-20% oil in soybean. Fats and oils are one of the five essential ingredients of human diet and the others are protein, carbohydrates, minerals and vitamins. Oils and fat form an important constituent of human food. Lipid metabolism generates many bioactive lipid molecules, which are fundamental mediators of multiple signaling pathways and they are also indispensable compounds of cell membranes. Many people in developing countries, especially children under five years of age suffer from acute or chronic protein and energy shortages. There is definitely a need for food production to keep pace with the increase in the number of the world's population. Sunflower oil is high-quality edible oil. It is used in cooking, frying, and in the manufacture of margarine and shortening and considered by some as desirable as olive oil.

***Keyword**: Crude oil, iodine value, peroxide value, refined oil, room temperature*

Introduction

Fats and oils are one of the five essential ingredients of human diet and the others are protein, carbohydrates, minerals and vitamins (Shukla *et al.,* 1992). The oil seeds are major source of edible in world. There is also good source (20-25%) of protein. Unfortunately due to like of processing technologies and equipment, these cakes are not utilized for human consumption as protein source. Un an average oil seeds contain 40-50% oil and 20-25% good quality protein with exception 40-45% protein and 18-20% oil in soybean. India occupies a prominent place in global oil seeds scenario with 12-15% of area 6-7% vegetable oil production and 9-10% of the total edible oil consumption and 13.6% of vegetable oil imports. Edible oil seeds indie yield about 8.7 million tonnes of edible oil and 17 million of cake/meal containing 30-35% protein. Rapeseed *(Brassica napus L.)* is now the second most important source of vegetable oil in the world. Canola oil is also considered healthy for human nutrition due to its lowest content of saturated fatty acids among vegetable oils and moderate content of polyunsaturated fatty acids (Stamer *et al*., 1999). Rapeseed-mustard oil quality is determined by the constituent fatty acids including palmitic, stearic, oleic, linoleic, linolenic, eicosenoic and erucic acids. Linoleic and linolenic acids are essential fatty acids not synthesized by our body. Soybean consumption is associated with reduced risk of cancer of the breast and prostate and may enhance survival (Zhu *et al.,* 2011; Kang *et al.,* 2012; Zhang *et al.,* 2012; Sugiyama *et al.,* 2013). Soybean is a major source of high quality protein and Oil, and soybean seed quality is often determined by seed protein, oil, fatty acid, and mineral content. Sunflower *(Helianthus annuus L.)* is cultivated for its seeds' high oil content. Oil represents up to 80% of its economic value. Sunflower seeds are very rich in protein and in essential fatty acids. These nutrients are essential for the good health of the nerves, brain and eyes and for the general health. More than half a sunflower seed is made up of the valuable and highly nutritive Sunflower oil. The industrial processes for oil production consist of four successive stages: trituration, pressing, extraction of the residual oil using hexane and refining (Isobe *et al.,* 1992; Rosenthal *et al.,* 1996). Groundnut (*Arachis hypogeal L.*) is an important oilseed crop as it contains 44-56% oil and 22-30% protein on a dry seed basis (Reddy *et al.,* 2003). Groundnut is grown on 19.3 million ha of land in about 82 countries. More than half of the production area is in arid and semi-arid regions. Groundnut otherwise called peanut, monkey nut, gobber pea and arachide belongs to the family leguminosea. In addition, they are a good source of minerals (phosphorus, calcium, magnesium and potassium) and vitamins (E, K and B groups), (Hassan and Ahmed, 2012). Bukola *et al.,* (2015) determined physicochemical properties of oils every two weeks interval by standard method of AOCS. The results obtained from this work showed that as time

increased from week 0 to 6 weeks, the Acidity and Peroxide value, Saponification values increased while iodine values decreased in all the oils studied. The samples stored on the shelf exhibited the highest Acid values, Peroxide values, Saponification values throughout the period of storage followed by those stored inside the cupboard, the lowest Iodine values recorded were for those stored on the shelf. Based on the Acid value, Peroxide values and Iodine values, the samples stored in the refrigerator provided the best protection to the oil.

Materials and Methods

All oils (Mustard oil, soybean oil, sun flower oil and Groundnut oil) were purchases from Shive Sales Corporation, 252, Kotla, Mayur Vihar Phase-1 Delhi-110091, Refined oil of Soybean, Ground nut and Sun flower and packaging materials (PET Bottles) were purchases from local market of Meerut-250110. Experiments were carried out to assessment of crude oil and refined oil in process and Food Engineering Laboratory of the Department of Agricultural Engineering, Sardar Vallabhbhai Patel university of Agriculture and Technology, Modipuram, Meerut. Studies were also carried out to evaluate the physico-chemical property of crude and refined oil filled in PET bottle under different storage condition. The physico-chemical and sensory attributes were analysed just after preparation and during storage of 0 and 210 days under ambient condition packaging in pet bottle.

Density: The density of edible and refined oil was calculated by mass of the sample per unit volume.

$$\text{Density} = \frac{\text{mass of the oil (g)}}{\text{volume of the oil } (cm^3)}$$

Specific gravity: Specific gravity of oil is determined as the ratio of the density of oil in to the density of water at same temperature.

$$\text{Specific gravity} = \frac{\text{Density of oil}}{\text{Density of water}}$$

Peroxide value: Weight 2 g of the oil sample a 25-ml test tube. Add 2 g of potassium iodide and 20 ml of solvent mixture ($CH_3COOH : CHCl_3$: : 2 : 1). Loosely stopper test tube. Boil the contents of the tube within 30 seconds by placing the test tube in a boiling water bath. Boil for another 30 seconds. Cool the test tube immediately under tap water and transfer the contents of the tube into a conical flask. Add 20 ml of 5% potassium iodide and 50 ml of distilled water to the flask and titrate against 0.002 N sodium thiosulphate using starch indicator towards the end (Meyer, 2000).

Peroxide value = $\frac{V}{W}$ (ml of 0.002 N. Sodium thiosulphate per gm)

Where,

V = ml of 0.002N. $Na_2S_2O_3$ used.

W = weight of the sample taken in gms.

Free Fatty Acid (Acid Value): Weigh 10 g of oil or melted fat. Dissolve the sample in hot 100 ml of neutralized ethanol and titrate using 0.01 or 0.1 N alkali using phenolphthalein as indicator. Shake vigorously during titration and keep the solution warm. When testing oils and fats which give dark coloured solution, use the indicators as stated under determination of saponification value (Ranganna, 2005).

$$\text{Acid value as oleic acid} = \frac{\text{ml of alkali} \times \text{N of alkali} \times 56.1}{\text{wt of sample (g)}}$$

Iodine Value: The weight of to the sample required is 2.5 - 3.0g in the case of coconut oil and 0.15 to 0.6 g in the case of other oils depending upon the iodine value. Weigh accurately by difference, an appropriate quantity of the oil or fat (previously melted) into a clean dry 250-ml glass-stoppered conical flask, and add 10 ml of carbon tetrachloride. Add 25 ml of Wijs solution, replace the stopper after moistening with potassium iodide solution, mix, and store in a dark cupboard for 30 min in the case of non-drying and semi-drying oils and 60 min in the case of drying oils. Add 15 ml of 10% potassium iodide solution and 100 ml of distilled water. Titrate with 0.1 N $Na_2S_2O_3$ solution using starch as an indicator near the end point (Ranganna, 2005).

Carry out a blank determination alongside without the fat.

$$\text{Iodine Value} = \frac{(\text{Blank titre} - \text{Sample titre}) \times \text{N of Na2S2O3}}{\text{Wt of sample (g)}} \times 12.69$$

Refractive Index: Refractive Index was determined using a mathematical expression derived by Perkins.

RI = 1.45765 + 0.0001164 IV

Where,

RI is the Refractive Index and IV is the Iodine Value

Moisture content: Moisture content of oils and fats is the loss in mass of the sample on heating at 105±1°C under operating conditions specified.

Weigh in a previously dried and tarred dish about 5-10g of oil or fat which has been thoroughly mixed by stirring. Loosen the lid of the dish and heat, in an oven at 105±1°C for 1 hour. Remove the dish from the oven and close the lid. Cool in a desiccator containing phosphorus pentoxide or equivalent dessicant and weigh. Heat in the oven for a further period of 1 hour, cool and weigh. Repeat this process until change in weight between two successive observations does not exceed 1 mg. Carry out the determination in duplicate.

$$\text{Moisture and volatile matter} = \frac{\text{W1 x 100}}{\text{Percent by weight W}}$$

Where,
W1 = Loss in gm of the material on drying
W = Weight in gm of the material taken for test.

pH value: The digital pH meter is kept at stand by position firstly then calibrating the pH 7 and pH 4 standard buffer solutions. The electrode of pH meter is dipped in test solution and the temperature knob is placed at 0°C control to the temperature of test solution. The function selector switch is set to pH and reading of digital display is allowed to stabilize, before it sample is mix or grind with 100 ml water and filtered through what man filter paper No. 1. The filtered sample is used for pH measurement.

Sensory attributes: Sensory attributes including color, taste and smell of edible oil and refined oil were evaluated by Hedonic rating test as recommended by Ranganna (1994). This test is used to measure the acceptability of consumer for the product. The effect of various oils such as mustard, soybean, sunflower, groundnut oil and refined oil. Taste value of oil is determined by frying the potato chips and serve to panelist for analyzing the taste properties. Colour of oils were determined by eyes and smells were by nose.

Results and discussion

Effects on pH: From the data it was found that pH ranged from 4.3 to 5.4 among the oils under 0 day storage. The pH data recorded for refrigerator storage after 210 days were ranged from 5.5 to 6.4 for BOD storage after 210 days were ranged from 5.1 to 5.9 and for room storage after 210 days ranged were from 4.6 to 6.7 among the samples (Table 1).

Table 1: Effect of storage condition on pH of crude oil and refined oils

Samples	Fresh (o day)	Refrigerator 210 Days	BOD (35 °C) 210 Days	Room 210 Days
Crude oils				
MS	4.3	5.6	5.1	4.6
SB	5.4	6.4	5.8	6.2
SF	4.5	5.8	5.1	6.2
GN	4.3	5.8	5.1	6.7
Refined oils				
SBR	4.4	5.5	5.7	5.2
GNR	4.6	5.6	5.9	5.2
SFR	5.4	6.4	5.5	5.1

Description - MS: Mustard oil, SB: Soybean oil, SF: Sunflower oil, GN: Groundnut oil, SBR: Soybean refined oil, GNR: Groundnut refined oil and SFR: Sunflower refined oil.

Density: The density data ranged from 0.889 to 0.900 among the oils under 0 day storage. The density data evaluated for refrigerator storage after 210 days were ranged from 0.890 to 0.915 among the crude oil and refined oil samples (Table 2). The density data evaluated for BOD storage after 210 days were ranged from 0.891 to 0.902 and for room storage after 210 days were ranged from 0.885 to 0.929 among the samples.

Specific gravity: From the data it was found that specific gravity ranged from 0.8329 to 0.8432 among the oils under 0 day storage. The specific gravity data recorded for refrigerator storage after 210 days were ranged from 0.8341 to 0.8579 among the crude oil and refined oil samples. The specific gravity data evaluated for BOD storage after 210 days were ranged from 0.8347 to 0.8457 and for room storage after 210 days were ranged from 0.8294 to 0.8707 among the samples (Table 3).

Refractive index: From the data it is clear that their ware no difference in refractive index content at 0 day among all oil samples. After 210 days minor increment was observed in refractive index but value remains same for all samples (Table 4).

Table 2: Effect of storage condition on density of crude oil and refined oils

Samples	0 Day	Refrigerator 210 Days	BOD (35 °C) 210 Days	Room 210 Days
Crude oils				
MS	0.892	0.894	0.898	0.909
SB	0.900	0.915	0.902	0.929
SF	0.900	0.904	0.898	0.921
GN	0.895	0.900	0.891	0.922
Refined oils				
SBR	0.897	0.905	0.902	0.890
GNR	0.889	0.890	0.893	0.885
SFR	0.897	0.897	0.896	0.895

Table 3: Effect of storage condition on specific gravity of crude oil and refined oils

Samples	0 Day	Refrigerator 210 Days	BOD (35°C) 210 Days	Room 210 Days
Crude oils				
MS	0.8363	0.8379	0.8413	0.8519
SB	0.8432	0.8579	0.8457	0.8707
SF	0.8432	0.8469	0.8416	0.8635
GN	0.8391	0.8435	0.8347	0.8638
Refined oils				
SBR	0.8407	0.8479	0.8450	0.8338
GNR	0.8329	0.8341	0.8372	0.8294
SFR	0.8407	0.8404	0.8397	0.8385

Table 4: Effect of storage condition on refractive index (RI) of crude oil and refined oils

Samples	0 Day	Refrigerator 210 Days	BOD (35 °C) 210 Days	Room 210 Days
Crude oils				
MS	1.4579	1.4578	1.4578	1.4578
SB	1.4579	1.4578	1.4578	1.4578
SF	1.4579	1.4578	1.4578	1.4578
GN	1.4579	1.4578	1.4578	1.4578
Refined oils				
SBR	1.4579	1.4578	1.4578	1.4578
GNR	1.4579	1.4578	1.4578	1.4578
SFR	1.4579	1.4578	1.4578	1.4578

Free fatty acid: From the data it was found that free fatty acid ranged from 00.18 to 0.19 among the oils under 0 day storage. The free fatty acid data recorded for refrigerator storage after 210 days were ranged from 0.69 to 0.79 among the crude oil and refined oil samples (Table 5). The free fatty acid data evaluated for BOD storage after 210 days were ranged 0.69 to 0.79 and for room storage after 210 days were ranged from 0.69 to 1.03 among the samples.

Iodine value: The iodine value data ranged from 2.19 to 2.22 among the oils under 0 day storage. The iodine value data evaluated for refrigerator storage after 210 days were ranged from 1.27 to 1.36 among the crude oil and refined oil samples. The iodine value data evaluated for BOD storage after 210 days were ranged from 1.08 to 1.44 and for room storage after 210 days were ranged from 1.25 to 1.44among the samples (Table 6).

Peroxide value: From the data it was found that peroxide value ranged from 0.16 to 0.34 among the oils under 0 day storage. The peroxide value data recorded for refrigerator storage after 210 days were ranged from 0.30 to 0.70 among

Table 7: Effect of storage condition on peroxide value of crude oil and refined oils

Samples	0 Day	Refrigerator 210 Days	BOD (35 °C) 210 Days	Room 210 Days
Crude oils				
MS	0.34	0.70	1.03	1.37
SB	0.22	0.30	0.61	0.48
SF	0.16	0.42	0.43	0.60
GN	0.23	0.47	0.62	0.68
Refined oils				
SBR	0.21	0.31	0.60	0.48
GNR	0.19	0.46	0.59	0.67
SFR	0.16	0.40	0.43	0.58

Table 6: Effect of storage condition on Iodine value of crude oil and refined oils

Samples	0 Day	Refrigerator 210 Days	BOD (35°C) 210 Days	Room 210 Days
Crude oils				
MS	2.22	1.35	1.44	1.44
SB	2.21	1.27	1.08	1.27
SF	2.21	1.27	1.19	1.27
GN	2.20	1.35	1.36	1.27
Refined oils				
SBR	2.19	1.27	1.35	1.25
GNR	2.19	1.36	1.27	1.35
SFR	2.19	1.27	1.36	1.27

the crude oil and refined oil samples. The peroxide value data evaluated for BOD storage after 210 days were ranged from 0.43 to 1.03 and for room storage after 210 days were ranged from 0.48 to 1.37 among the samples (Table 7).

Conclusions

As per result of the study, the pH of the entire oils was increased under different storage condition i.e. under room storage, BOD (at 35°C) and refrigerator storage. Highest pH was observed under room while lowest was observed in refrigerated storage. The pH of the crude oil was also affected by the addition of other oils with specific proportion. In the case of density it was found highest in soybean oil then others. The density was decreased during storage and highest was observed at room temperature. Since specific gravity depends upon density; it was found highest in soybean oil. Refractive index of oils was found same for all samples under different storage period and conditions; minor decrement was observed in RI during storage. The free fatty acid of oils was found highest in ground nut oil then other after 210 days of storage at different conditions. The iodine value was decreased during storage. The peroxide value of oils was found highest in mustard oil then other. In the case of iodine value it was found highest in mustard oil then others.

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