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Estimation And Comparison Of Physical And Chemical Properties Of Different Brands Of Sunflower Oil

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ABSTRACT

Sunflower oil is the non-volatile oil expressed from sunflower (Helianthus annuus) seeds. Sunflower oil is commonly used in food as a frying oil, and in cosmetic formulations as an emollient. There are several types of sunflower oils produced, such as high linoleic, high oleic and mid oleic. High linoleic sunflower oil typically has at least 69% linoleic acid. High oleic sunflower oil has at least 82% oleic acid. Variation in fatty acid profile is strongly influenced by both genetics and climate.

In this paper we will discuss about physical-chemical properties of different brands of sunflower oil namely: Gold winner oil, Sunpure oil, Sunpower oil. In physical parameters we will be discussing about specific gravity and refractive index. In chemical parameters we will be discussing about acid value, iodine value, saponification and ester value.

Key words: Sunflower oil, specific gravity, refractive index, acid value, iodine value, saponification, ester value.

1. INTRODUCTION

Oils and fats are important parts of human diet and more than 90 percent of the world production from vegetable. Oils and fats are a rich source of dietary energy and contain more than twice the caloric value of equivalent amount of sugar. Their functional and textural characteristics contribute to the flavour and palatability of natural and prepared foods. They contain certain fatty acids which play an important role in nutrition and are also carriers of fat-soluble vitamins. Sunflower oil also contains lecithin, tocopherols, carotenoids and waxes. Sunflower oil's properties are typical of a vegetable triglyceride oil. Sunflower oil is produced from oil type sunflower seeds. Sunflower oil is light in taste and appearance and has a high Vitamin E content. It is a combination of mono-unsaturated and polyunsaturated fats with low saturated fat levels. The cultivated sunflower (Helianthus annuus L.) dicotyledonous plant is one among 67 species in the genus Helianthus. It is one of the four most essential annual crops within the global grown for edible oil. Generally, the oil content present in the sunflower seed's ranges from 16- 24%. The world's whole production of sunflower oil is nearly 16 million tonnes annually with Argentina, Ukraine, Russia and China as the largest producers.

Sunflower oil contain valuable components such as soluble vitamins (A, D, E and K), phytosterols, natural pigments and phospholipids (1 to 5%). This oil plays an essential role in the diet and provides energy. Crude oil obtained from sunflower seed needs refining before the utilization in order to eliminate unwanted compounds (free fatty acids and colour pigments). The objective of refining is to take away those impurities with the least possible impact on desirable compounds present in the crude vegetable oils in order to obtain bland, odourless antioxidative stable refined vegetable oils that are acceptable to consumers. Presence of typical compounds such as waxes, odiferous volatiles, metal traces and pigments impact negatively on the appearance, taste, smell and storage consistency of the refined oils. These compounds must be eliminated from edible oils to yield a stable product with a

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pleasant flavour. The presence of phospholipids can cause the oil discoloration, act as a precursor of off-flavours and contribute to the loss of impartial lipids in the course of neutralization. In additionally, phospholipids are naturally existing as emulsifiers, which bind oil molecules collectively leading to extended viscosity and refining. There are three main processes involved during chemical refining such as neutralization, bleaching and deodorization. During alkali neutralization process most of the free fatty acids are removed. On the other hand, during physical refining, free fatty acids are removed through deodorization process instead of alkali neutralization. Even though both physical and chemical refining processes are efficient to keep up the quality of oil, but in these processes some nutritionally valuable components are also drive out from the oil as well.

This research study is aimed to check the impact on the commercial refining of sunflower oil on some specific physicochemical attributes that are essential for good health. To the best of our expertise no any research work has been mentioned to date on the physicochemical parameters of sunflower oil during industrial processing.

2. MATERIALS AND METHODS

2.1. MATERIALS:

- THREE DIFFERENT BRANDS OF SUNFLOWER OIL.

As materials, for this experiment were used 3 different brands of refined sunflower oil (Gold winner oil, Sunpure oil, Sunpower oil) purchased from Bangalore city, Karnataka, were examined for their compositional quality. All the oil samples were characterized for specific gravity, colour, refractive index, iodine value, saponification value, acid value and ester value using established AOCS Official methods.

- **APPARATUS REQUIRED:**

➢ Specific gravity bottles (Pycnometers)
➢ Water bath
➢ Thermometer
➢ Refractometer
➢ Light source
➢ Erlenmeyer flask: 250-300 ml
➢ Glass stoppered iodine flasks: 500 ml
➢ Glass stoppered volumetric flask
➢ Pipette 20 ml
➢ Bottles, borosilicate, actinic glass, with glass stoppers: 1,000 ml
➢ Filter paper, Whatman No. 41H, or equivalent
➢ Erlenmeyer flasks: Alkali resistant, 250 or 300 mL, with T 24/40 ground glass
➢ Air condensers: minimum 65 cm long, with 3 24/40 ground glass joint to fit Erlenmeyer flasks
➢ Water bath, or a hot plate with variable heat control
➢ Distillation flask: 2 Liter, with T ground glass joint, fitted with water cooled condenser, for refluxing.
➢ Saponification flasks: 250 mL capacity, made of alkali resistant glass

- **Chemicals required:** Toluene, Ethyl alcohol, Phenolphthalein indicator solution, Standard 0.1 N KOH solution, Carbon tetrachloride solution, Wijs solution, 10% Potassium iodide solution, Starch indicator solution, 0. 1 N Sodium thiosulfate pentahydrate solution,0.5 N alcoholic KOH, 0.5 N HCl,

2.2. METHODS:

2.2.1. SPECIFIC GRAVITY PRINCIPLE:

Specific gravity is the ratio of the density (mass of a unit volume) of a substance to the density of a given reference material, often a liquid. If a substance's relative density is less than one then it is less dense than water and similarly, if greater than 1 then it is denser than water.

AOCS OFFICIAL PROCEDURE:

1) Specific Gravity at 25/25° C

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a) Melt the sample and filter through filter paper to remove impurities and the last traces of moisture. The sample must be completely dry.
b) Cool the sample to 20 to 23 C and fill the bottle to overflowing, holding the bottle on its side in such a manner as to prevent the entrapment of air bubbles.
c) Insert the stopper and immerse in a water bath at 25 C ± 0.1 C. Keep the entire bulb completely covered with water and hold at the specified temperature for 30 minutes.
d) Carefully remove any oil which has escaped from the side opening.
e) Remove the bottle from the bath and wipe completely dry, taking care not to handle the bottle excessively.
f) Weigh the bottle and contents and calculate the specific gravity as directed in calculations.

2) Specific Gravity at 60/25 C.
a) The procedure is exactly the same as noted in procedure 1, a through f, except that the melted sample is poured into the specific gravity bottle at 56 to 58 C and a water bath maintained at 60 C ± 0.1 C is used.
b) The bottle containing the sample is allowed to remain in the water bath at 60 C ± 0.1 C for 30 minutes. Clean the bottle and wipe completely dry, cool to room temperature and weigh the bottle and contents. Calculate the specific gravity as directed in calculations.

1.Specific gravity at 25/25° C = $\frac{\text{(Weight of the bottle and oil) – (Weight of bottle)}}{\text{Weight of water at 25 C}}$

2. Specific gravity at 60/25° C = $\frac{F}{W\,[1 + (0.000025 \times 35)]}$

Where, F = weight of sample at 60° C
W = weight of water at 25° C

NOTES:
1) Unless the specific bottles are protected with caps, care must be taken so that no oil or water is lost in the interval between removal from the bath and weighing. If the temperature of the room is above 25 C, this most likely will happen. Even the warmth of the hand surrounding the bottle is sufficient to cause expansion of the contents.
2) Fats not liquid at 25° C may be tested at 60/25° C.
3) Unless the specific gravity bottles are made of glass with very low coefficient of expansion of the glass. the coefficient of ordinary glass is about 0.000025.

LABORATORY PROCEDURE:
1) Clean and dry the density bottle
a) Wash the bottle with water and allow it to drain.
b) Wash it with alcohol and drain it to remove water.
c) Wash it with ether, to remove alcohol and drain ether.
2) Take accurate weight of an empty specific gravity bottle with stopper.
3) Fill the bottle completely with sample oil and weigh accurately.
4) Clean the bottle and fill completely with distilled water and weigh accurately
5) Note down the temperature of the liquid

SL .no	OBSERVATION	GOLD WINNER OIL	SUNPURE OIL	SUNPOWER OIL
1	Weight of empty gravity bottle (W1 g)	10.215 g	10.213 g	10.212 g
2	Weight of gravity bottle + sample oil (W2 g)	15.048 g	15.049 g	14.997 g
3	Weight of gravity bottle + water (W3 g)	15.488 g	15.476 g	15.480 g

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4	Specific gravity G at 25^0 C	0.91387	0.91617	0.90565

2.2.2. REFRACTIVE INDEX PRINCIPLE:

The refractive index is the measure of bending of a light ray when passing from one medium to another. It can also be defined as the ratio of the velocity of a light ray in an empty space to the velocity of light in a substance, n = c/v. The refractometer works using the principle of light refraction through liquids. As light passes from air into a liquid it slows down. This phenomenon is what gives a "bent" look to objects that are partially submerged in water.

AOCS OFFICIAL PROCEDURE:

1) Melt the sample, if it is not already liquid and filter through filter paper to remove any impurities and the last traces of moisture. The sample must be completely dry.
2) The temperature of the refractometer is adjusted to 40.0 C for ordinary fats and oils. For higher melting point samples, use a temperature of 60.0 C
3) Be sure the prisms are clean and completely dry and then place several drops of the sample on the lower prism. Close the prisms and tighten firmly with the screw-head. Allow to stand for 1 to 2 minutes or until the sample comes to the temperature of the instrument.
4) Adjust the instrument and light to obtain the most distinct reading possible and then determine the refractive index. Take at least three readings and calculate the average of all readings.

FORMULA: R = R + K (T - T)

Where, R = the reading reduced to temperature T.
R = the reading at T C.
T = the standard temperature.
T = the temperature at which the reading R is made.
K = 0.000385.

LABORATORY PROCEDURE:

1) Clean the prism face and lens cover using ethanol/acetone, taking care not to scratch the lens cover.
2) Place a few drops of the oil sample on the prism face.
3) Close and open the lens cover several times, and wait for few seconds to allow the solution to reach the refractometer's temperature,
4) Hold the refractometer up to a light source and adjust the focusing ring so that you can read the scale.
5) Note the scale position where their boundary line crosses the scale. This is the oil's refractive index.
6) Clean the prism and lens again with ethanol/acetone, taking care not to scratch the lens cover.

Refractive Index of Gold winner oil at 35°C = 1.470
Refractive Index of Sunpure oil at 35°C = 1.469
Refractive Index of Sunpower oil at 35°C = 1.458

2.2.3. ACID VALUE

PRINCIPLE:

If CMM samples contain high levels of fatty acids, they may develop rancidity when stored. Fats, aldehydes, carboxylic acids, and ketones are released during decomposition. It would then impair the quality of CMM samples since they would smell distinct. The acid value is based on the quantity of potassium hydroxide required to neutralize one gram of free acid in one gram of fats, oils, or similar substances. Additionally, sodium hydroxide may be required.

AOCS OFFICIAL PROCEDURE:

1) Determine the size of the sample from the following table:

Acid value	Approx. wt. of the sample, grams	Accuracy of weighing
0 to 5	20	± 0.05 g
5 to 15	10	± 0.05 g
15 to 30	5	± 0.05 g

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30 to 100	2.5	± 0.001 g
100 and over	1.0	± 0.001 g

2) Weigh the designated size of sample into glass stopper bottle. Add approximately 100ml of neutralized solvent and 1ml indicator and mix until sample is completely dissolved. Warming may be necessary for bodied oils.
3) Titrate with the standard alkali solution, shaking vigorously to the appearance of the first permanent pink colour of the same intensity as that of the neutralized solvent before addition. The color must persist for 1 minute.

FORMULA: The acid value, mg KOH/g of sample = $\frac{(A - B) \times N \times 56.11}{W}$

Where, A= mL of standard alkali used in the titration
B= mL of standard alkali used in titrating the blank
N= normality of standard alkali
W=grams of sample

LABORATORY PROCEDURE:
In this procedure, a known amount of 1.5 g of absolute different brands of sunflower oil [Gold winner, Sunpure, Sunpower] was weighed into saponification flask and 10ml of alcohol was added. The reaction mixture was heated for about 2 mins by shaking the flask thoroughly, in order to dissolve the free acid as completely as possible. The solution was cooled and titrated against 0.1N potassium hydroxide using phenolphthalein indicator under constant shaking until pale pink colour appears. Test was performed in triplicate for concordant value.

FORMULA:
Acid value = V × N × 56.1/ W
Where,
V = Titre value.
N = Normality of potassium hydroxide.
W = Weight of oil.

2.2.4. IODINE VALUE

PRINCIPLE:
The iodine number equals the number of mg of iodine required to saturate the fatty acids present in 100 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.

AOCS OFFICIAL PROCEDURE:
1) Melt the sample, if it is not already liquid (the temperature during melting and filtering should not exceed the melting point of the sample by more than 10 C), and filter through filter paper to remove any sloid impurities and the last traces of moisture. The sample must be absolutely clean and completely dry.
2) Weigh the sample accurately into a 500 mL flask or bottle to which has been added 20 mL of carbon tetrachloride or other solvent. The weight of sample must be such that there will be an excess of Wijs solution of 100 to 150% over the amount absorbed. Table 1 is a guide to the size of sample to weight.
3) Pipette the 25 mL of wijs solution into flask containing the sample, stopper the flask, and swirl to insure an intimate mixture.
4) Prepare and conduct at least two blank determinations with each group of samples simultaneously and similar in all respects to the samples.
5) Dispense 25 mL of wijs solution into flask containing the sample, stopper the flask, and swirl to insure an intimate mixture. Immediately set the time for 1.0 hrs or 2.0 hrs, depending on the iodine value of the sample: IV <150, 1.0 hr; IV≥150, 2.0 hrs.
6) Remove the flasks from storage and add 20 mL of KI solution, followed by 100mL of distilled water.

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7) Titration with 0.1 N $Na_2S_2O_2$ solution, adding it gradually and with constant and vigorous shaking. Continue the titration until the yellow colour has almost disappeared. Add 1 to 2 ml of starch indicator solution and continue the titration until the blue colour has just disappeared.

LABORATORY PROCEDURE:

1) The protocol for iodine value determination comprises a titration procedure, such as the wijs method. In this procedure, the content of consumed iodine was measured by titration with 0.1N sodium thiosulfate solution.

2) Iodine value was determined by weighing 0.25g of sunflower oil sample was dissolved in 10ml of carbon tetrachloride (ccl_4) solution and 25ml of wijjs solution.

3) After mixing, the reaction mixture was allowed to stand in dark for 30 mins. After standing, 15ml of 10% potassium iodide and 35ml of distilled water was added. The iodine content of the mixture was determined by titrimetric method.

4) Firstly, the reaction mixture was titrated against sodium thiosulfate, once after the solution turned lighter, starch indicator was added and titration was continued until disappearance of blue color [end point].

5) Test was performed in triplicate along with blank. Readings were noted and calculated for iodine value.


A


B


C


D

A = Initial Reaction mixture.
B = After titration- colour turned lighter.
C = Reaction mixture with starch indication.
D = End point.

FORMULA:

Iodine value = 12.69 [B - S] N/ W

Where, B = Volume in ml of standard sodium thiosulfate solution required for the blank.
S = Volume of ml of standard sodium thiosulfate solution required for the sample.
N = Normality of the standard sodium thiosulfate solution.
W = Weight in grams of the sample.

2.2.5. SAPONIFICATION VALUE

PRINCIPLE:

Saponification is the process of hydrolysing fats or triglycerides by combining them with a strong alkali in order to create glycerol and potassium salts of them. An excess of alcoholic KOH is refluxed with a known quantity of fat or oil. A titration against a standard acid determines the remaining KOH after saponification. Saponification number of fats or oils is determined by using the value obtained.

AOCS OFFICIAL PROCEDURE:

1) Melt the sample if it is not already liquid and filter through dry filter paper to remove any impurities and moisture. The sample must be complete dry.

2) Weigh a sample of such size that the back titration is 45% to 55% of the blank. This is usually requires a sample of 4 to 5g. Add 50mL of the alcoholic KOH with a pipet and allow the pipet to drain for a definite period of time.

3) Prepare and conduct blank determinations simultaneously with the sample and similar in all respects, except omitting the fat or oil.

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4) Connect the air condenser and boil gently, but steadily, until the sample is completely saponified. This usually requires about 1 hour for normal sample. Make certain that the vapour ring in the condenser does not rise to the top of the condenser, or loss may occur.
5) After the flask and condenser have cooled somewhat, but not sufficiently to form a jell, wash down the inside of the condenser with a small quantity of distilled water. Disconnect the condenser, add about 1 mL of phenolphthalein indicator and titrate with 0.5 N HCL until the pink colour just disappears. Record the volume of 0.5 N HCL required for the titration.

FORMULA:

$$\text{Saponification value} = \frac{(B - S) \times (N) \times 56.1}{W}$$

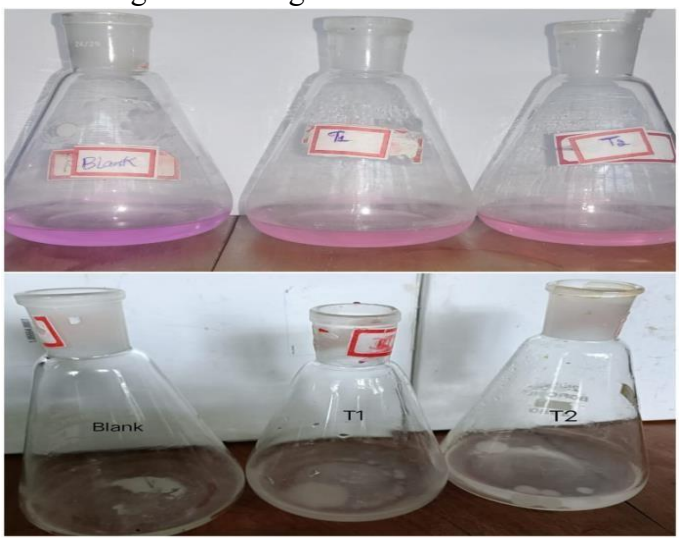
Where,
B= mL 0.5 N HCl required to titrate blank
S= mL 0.5 N HCI required to titrate sample
N= normality of HCl solution
W=weight of sample in grams

LABORATORY PROCEDURE:

1) About 2 g of oil was weighed into saponification flask.
2) The oil was dissolved in 25 ml alcoholic KOH. Then the reaction mixture was reflexed using condenser and water bath.
3) After reflex the solution was cooled to which 3-4 drops of phenolphthalein indicator was added and titrated against 0.5 N HCL until the solution turns colourless.

FORMULA:

$$\text{Saponification value} = \frac{(\text{Blank} - \text{titre value})\ 0.5 \times 56.1}{\text{Weight of oil in g}}$$



Initial and final reactions of Saponification value

2.2.6. ESTER VALUE

PRINCIPLE:

Esters are saponified with potassium hydroxide when a substance has the esters of 1 gram of potassium hydroxide. Milligrams of potassium hydroxide must be added to one gram of oil sample in order to hydrolyse the esters. Separating the acid value from the saponification value is the Ester value. Molecular weight is low in high ester values, while their ester content is high.

AOCS OFFICIAL PROCEDURE:

REAGENT BLANK

Carry Out a blank determination by boiling 5 ml of ethanol, 25.0 ml of 0.5 M ethanolic potassium hydroxide and 0.2 ml of phenolphthalein indicator solution under reflux for 1 h, cooling, adding 20

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ml of water and 0.5 ml of phenolphthalein indicator solution, and immediately titrating with 0.5 M hydrochloric acid.

DETERMINATION

Accurately weigh a suitable quantity of the oil to the saponification flask, add 5 ml of ethanol and 0.2 ml of phenolphthalein indicator solution, and titrate the free acidity with 0.1 M ethanolic potassium hydroxide. Alternatively, the contents of the flask which has been previously used forth acid value determination may be used.

To the neutralized liquid, add 25.0 ml of 0.5 M ethanolic potassium hydroxide, boil under reflex for 1 h, cool, add 20 ml of water and 0.5 ml of phenolphthalein indicator solution, and immediately titrate the excess of alkali with 0.5 M hydrochloric acid. The difference between the titration and that of the blank represents the volume of 0.5 M ethanolic potassium hydroxide required to saponify the esters.

FORMULA: The ester value EV = 28. 05 (B – V)

Where,

B = Volume, in millilitres, of 0.5 M hydrochloric acid required for the blank.

V = Volume, in millilitres, of 0.5 M hydrochloric acid required to neutralize the excess of alkali after hydrolysis.

m = mass in grams of the oil taken.

LABORATORY PROCEDURE:

1) About 1.5g of absolute oil was weighed accurately into a saponification flask to which 10 ml of neutral 95% alcohol was added and surface heated for about 2 minutes.

2) Three drops of phenolphthalein indicator was added and titrated against 0.1 A KOH, until a pale pink color appeared.

3) After adding 25 ml of 0.5 N alcoholic KOH, a reflux condenser was connected and was then heated on a boiling water bath for 2 hours.

4) At the completion of the time period, it was cooled and then excess alkali titrated with 0.5 N HCL. A blank was performed and total ester value was calculated.

FORMULA:

$$\text{Ester value} = \frac{(\text{Blank value} - \text{Titre value}) \times 56.1 \times 0.5}{\text{Weight of oil (g)}}$$

Initial and final reactions of Ester Value

3. RESULT AND DISCUSSION

PHYICAL AND CHEMICAL PROPERTIES OF DIFFERENT BRANDS OF OIL SAMPLES

Parameters	Concentration of Gold winner oil	Concentration of Sunpure oil	Concentration of Sunpower oil

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Specific gravity (SG)	0.91387 at 25°C	0.91617 at 25°C	0.90565 at 25°C
Refractive Index (RI)	1.470 at 35°C	1.469 at 35°C	1.458 at 35°C
Acid Value (AV)	0.7481 mg KOH/g	0.7481 mg KOH/g	2.0947 mg KOH/g
Iodine Value (IV)	122.33 mgI_2/100g	122.83 mgI_2/100g	86.799 mgI_2/100g
Saponification Value (SV)	194.94 mg KOH/g	196.35 mg KOH/g	193.54 mg KOH/g
Ester Value (EV)	173.94 mg KOH/g	175.81 mg KOH/g	187.03 mg KOH/g

The above table present the physicochemical properties of different brands of sunflower oil. The oil extracted from the sunflower seed is yellowish in colour. It had a specific gravity of 0.9138 for gold winner, 0.9161 for Sunpure oil and 0.9056 for Sunpower oil, which showed that it is less dense than water.

The refractive index value obtained for gold winner oil is 1.470 at 35°C, for Sunpure oil is 1.469 at 35°C and for Sunpower oil is 1.458 at 35°C.

The acid value of an oil may be used as a measure of quality. However, the acid value of the oil must not be too high, as this denotes an excessively high content of free fatty acids, which causes the oil to turn sour. Discoloration may also occur. The acid value for gold winner oil was 0.7481 mg KOH/g, for Sunpure oil was 0.7481 mg KOH/g and Sunpower oil was 2.0947 mg KOH/g. Sunflower oil should have an acid value of at most 0.9 – 1.1%.

The iodine value is 122.331mgl, /100g for gold winner, 122.839mgl /100g for Sunpure oil, and 86.799mgl_2/100g for Sunpower and these oils are classified into drying, semi drying and nondrying according to their iodine values. Since the iodine value of sunflower seed oil is higher than 100 it could be classified as semi-drying or drying oil. The high iodine value indicates that the oil has a high content of unsaturated fatty acids which is evident in the acid and free fatty acid. The IV explains the degree of unsaturation of fat and oil. It is recognized fact that least unsaturated oil shows lower iodine numbers, whereas reverse is true for highly unsaturated oil.

The saponification value of the gold winner oil was (185.163mg KOH/g), for Sunpure oil was (196.35 mg KOH/g) and for Sunpower oil was (193.54 mg KOH/g). However, this saponification value fall just below the range expected of some edible oils. The low saponification value is an indication that the oil may not be suitable for soap making, oil-based ice-cream and shampoos.

The Ester Value of gold winner oil was 173.94 mg KOH/g, for Sunpure oil was 175.81 mg KOH/g and for Sunpower oil was 187.03 mg KOH/g. The obtained data indicates that the ester value of sunflower oil had slightly higher value compared to standard ester value.

4. CONCLUSION:

Generally, oils and fats from seeds and nuts constitute an essential part of man's diet. Fats and oils, together with proteins, carbohydrates, vitamins and minerals, are the main nutrients required by the

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human body. Fats and oils are rich sources of energy, containing two and a half times the calories of carbohydrates (per unit weight). In addition to being a source of vitamins A, D, E and K, fats and oils also contain essential fatty acids. These essential fatty acids are not manufactured by the body and must be obtained from diets, with linoleic, oleic and linolenic acids as examples of unsaturated fatty acids.

The high iodine value portrays that it is rich in unsaturated fatty acid which implies that it will have short oxidative storage stability because the oxidative and chemical changes in oils during storage are characterized by increase in FFA content and a decrease in the total unsaturation of oils. Which may be attributed to the variation in variety, and climatic conditions which is evident in the iodine value. The slightly low saponification value in oil could be attributed to the low FFA content. The specific gravity shows that the oil is less dense than water

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