Comparison of Some Physico-Chemical Properties of Different Oils Available in the Local Market in Pakistan

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Abstract: The increased demands for oils both in industry and nutritional processes led the attention of the researchers to investigate and compare the physico-chemical properties of different oils. The iodine value, acid value, saponification value and viscosity are determined for different oils (Almond oil, Olive oil, Sunflower oil, Brassica oil, Palm oil, Corn oil, soya bean oil.The results show that most of the oil samples have unacceptable values as compare to the standard values. The viscosity of the oils is observed to be decreases with the increase in temperature within the given range of temperature investigated (20-70oC) which is explained in terms of the decrease in interactive forces with the increase in temperature.

***Keywords*— Physico-Chemical Properties; Oils, Local Market**

I. INTRODUCTION

Vegetable oils mainly consist of lipids with some other minor components including antioxidants, colorants, flavors, and emulsifiers [1-3]. Some of these compounds occur naturally and some are added during the manufacturing process. The presence of hydrocarbons such as n-alkenes in vegetable oils has also been reported [4]. Vegetable oils are likely to undergo auto oxidation, which produces self-heating that, in some instances, may lead to spontaneous ignition [5]. This auto oxidation phenomenon was observed by some other scientists as well [6]. The quality of Fruit or seed, oil extraction system and the refining procedures can cause variation in the content and composition of the constituents of vegetable oil [7]. Recently, Researchers are focusing on the production of bio-fuels, due to the non-uniform distribution and depletion of crude oil reserves. There are so many other reasons which lead the mankind to focus in this specialized area of research, including the periodically and rapidly changing prices of crude oil, the utilization of renewable energy sources, substitution of the polluting fossil energy sources, replacing import energy carriers, reducing the import dependence, the political potential to support rural population, moderating the agricultural overproduction crises, utilization of fallow lands, the lower lifecycle carbon-dioxide emission and the contribution to the protection of soil and water sources [8-11]. Commonly, vegetable oils are used for various purposes, such as frying, cosmetics, lotions and also used as a foods oil, which gives protection to the body from various disease (such as cancer etc.) [12-14]. Majorities of oils is produced in wild china, Japan, Korea, Taiwan and Russia, Australia and Papua New Guinea [15-17]. The determination of the content and composition of unsaponifiable material in various natural materials and food products became a very important task during the last decade [18-19]. Many studies have aimed to obtain biodiesel with properties (e.g., flash point, cetane number, viscosity, cloud point, pour point, and crystallization temperature) suitable for utilization in diesel engines [20-23]. The viscosity of a fluid plays a major role in its pumping and flow within an engine [24]. Keeping in view the importance and wide range of applications of vegetable oils; it was aimed to investigate the physic-chemical properties of almond, olive, sunflower, soybean, corn, Palm, soybean, rapeseed, and brassica and cynara oil. The main focus of the present study is to measure the acid value, iodine value, saponification value and the viscosity of the different vegetable oils used for investigation here.

II. EXPERIMANTAL

2.1 Materials

The vegetable oils used during the present study were almond, olive, sunflower, and soybean, obtained from the local market and were of high grade. The chemicals like sulfuric acid, potassium hydroxide, potassium hydrogen phthalate and phenolphthalein were obtained from E. Merck, Germany. The water used for various experiments was doubly distilled and de-ionized, while its conductance was maintained as 6-10µS.

2.2 Determination of Acid Value

1g of oil was taken in a flask and 25ml of ethanol was added to form homogeneous solution by vigorous shaking and continuous stirring. The mixture was then refluxed for about 30-40 min. The mixture was then cooled to room temperature and titrated against KOH of known concentration. The same process was carried out with the Blank (solution without oil) and the acid value was calculated using Equation (1) [25].

$$\text{Acid value} = \frac{M_{KOH}\,(V_s - V_b)}{M_{Oil}}\,100 \qquad (1)$$

M_{KOH} and M_{oil} is the molarity of KOH and mass of oil respectively. V_s and V_b is the volume of KOH used for the titration of sample and blank (solution with oil and without oil) respectively.

The above given standard procedure is repeated for all the vegetable oils used during this investigation to find their acid value.

2.3 Determination of Iodine Value

Known amount of oil was added to 20ml of chloroform to form homogeneous mixture. To the mixture, 25ml ofHun's solution(solution contain 13.2g of iodine ,1ml of acetic acid and 3ml of bromine)was added and kept in dark for 30min. The mixture was then titrated against $Na_2S_2O_3.5H_2O$.The reading for the blank was obtained in the same way as was taken in the case of acid value, and iodine value was obtained by Equation (2) [26]

$$\text{Iodine Value} = \frac{M_{equ\,(I)}(V_s - V_b)N_s\,.100}{M_{Oil}\,.1000} \qquad (2)$$

$M_{equ\,(I)}$ and M_{oil} is the gram equivalent weight of iodine and weight of oil used. V_s, V_b and N_s are the volume used of sodium thiosulphate for titration of sample, blank, and normality of sodium thiosulphate.

The above given standard procedure is repeated for all the four oils used during this investigation to find their iodine value.

2.4 Determination of Saponification Value

Small amount of oil was dissolved in 3ml of ethanol in a pre-weighted conical flask, and 25ml of 0.5N alcoholic KOH was added in to the solution. The flask was fitted with a reflux condenser and heated for 40 minutes. Similarly, all the above stated material was put in another flask except the oil and heated over water bath for 40 minutes. Then the material was allowed to cool at room temperature. After cooling, the materials in the flasks were titrated against 0.5N H_2SO_4 solution, using phenolphthalein as an indicator. The difference between the blank solution and sample gives us the amount of 0.5N KOH required to saponify the oil using Equation (3) [27].

$$\text{Saponification Value} = \frac{N_1(V_s - V_b)\,.\,M_{equ\,(KOH)}}{M_{oil}} \qquad (3)$$

The symbols N_1 and V_s, V_b stand for normality of KOH, and volume used for titration of sample, and blank; M_{oil} and $M_{equ\,(KOH)}$stands for mass of oil, and gram equitant Weight of KOH, respectively.

Once again the above given standard procedure is repeated for all the oils used during this investigation to find their saponification value.

2.5 Viscosity Measurement

For the determination of viscosity/rheology of oils, Brooke Field DV-E viscometer, Germany and Ostwald type capillary viscometers, and Advance Modular HAAK Mars 2 Rheometer, Germany, was used. All the apparatus were carefully washed with de-ionized water and dried before making their measurements. The measurements of viscosity were carried out at different temperatures in a range of 30-70°C at intervals of 10°C for a total of 5 measurements, each of which was obtained by averaging the values of three repetitions.

2.6 Measurement of Higher Calorific Value

The determination of the Higher Calorific Value (For pure oils) was carried out using an IKA C2000 isoperibolic calorimeter. Specifically; this instrument allows the HCV to be determined through bomb calorimetry in accordance with CEN/TS 14918 regulations. For HCV, two repetitions were carried out for each vegetable oil sample. Subsequently, on the basis of the values found in the elemental analysis, the LCV was calculated according to the abovementioned regulations.

III. RESULTS & DISCUSSIONS

The values obtained for different parameters of the oils are reported in Table 1 and displayed in fig. 1. The figure indicates that sunflower oil has high iodine value (115.5g) and olive oil have low iodine value (82.55g).The iodine value is actually a measure of the unsaturation of oils. So, the high iodine value for sunflower oil is indication of more unsaturation in comparison to olive oil [28]. While in Table 1, olive oil have high acid value (4.154mg) and almond oil have low value (1.1mg) indicating that olive oil is less refined as compared to almond oils and so on. High value of viscosity of oil reflects high molecular chain or existence of some unsaturation in the oils [29, 30]. The table indicates that sunflower oil have high saponification value and soybean oil low, as it depends upon extraction source and availability of low molecular mass species, hence sunflower is more dispersed as compared to others [31, 32]. Olive oil has high viscosity as compared to almond, soybean or sunflower oils. It means that olive oil is more viscous than the other oils and can be considered as more stable having high molecular mass [30].

Table. 1 Values of different physico-chemical parameters of the oils

Types of Oil	Iodine Values (g)	Acid Values (mg)	Saponification Values (mg/g)	Viscosity (Pa.s)
Almond Oil	98.42	1.1	193.2	56.8
Olive Oil	82.55	4.154	182	83.5
Soybean Oil	99.6	2.744	165.2	30.5
Sunflower oil	115.5	3.60	198.8	35.4

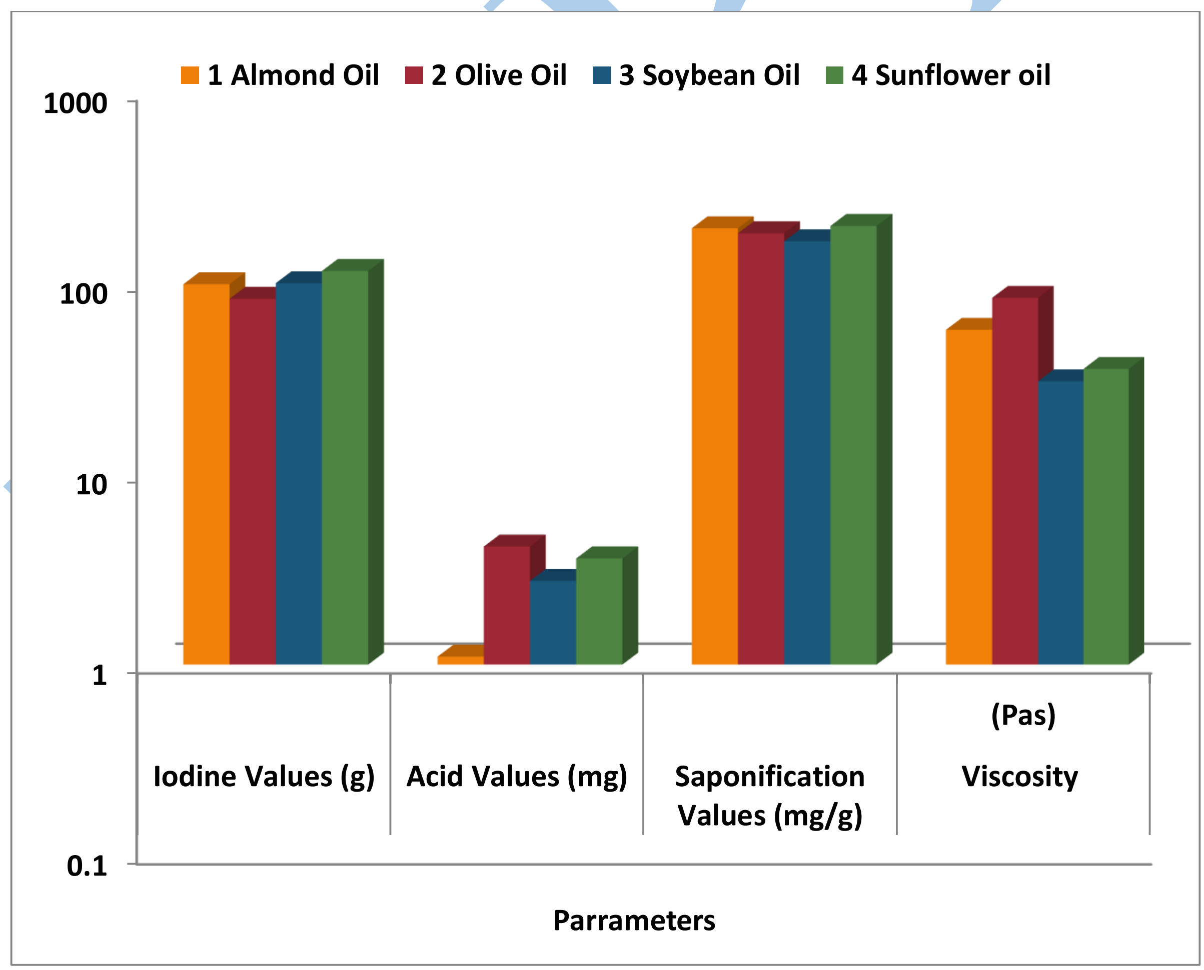

Fig. 1: Various parameters of oils investigated

The table 2 shows the viscosity and calorific values of oils under investigation at different temperatures. The data given in the table 2 is plotted in figure 2-4. Figure 2 clearly indicates that the viscosity of Palm oil and brassica oil is almost similar at all temperatures, while the rest of the oils have low viscosity in comparison to these two especially at high temperature around 70°C. The viscosity of oil is also directly proportional to the amount of unsaturation and also the length of fatty acid chain. At low temperature the difference in the viscosity of all the oils investigated here is not that much significant. The reason behind is that at high temperature the strength of the interactive forces decreases and they get weakened with the rise in temperature. Figure 3 also show the decrease in viscosity with increasing temperature for all the oils used for investigation here.

TABLE: 2 Values of viscosity at different temperatures, higher and lower calorific values of the vegetable oils studied

Viscosity and calorific values of oils at different temperatures							
Types of Oils	**30c^0**	**40c^0**	**50c^0**	**60c^0**	**70c^0**	**HCV j/g x10^3**	**LCV j/g x10^3**
Corn oil	49.1	34.95	25.81	19.79	14.68	39	36
Palm oil	61.75	42.48	29.98	21.13	16	38.7	36.3
Soybean oil	50.8	35.5	26.5	19.99	14.91	38.4	36.4
Sunflower oil	51.86	36.65	26.77	19.4	15.95	38.2	36.5
Rapeseed oil	52.67	36.93	26.84	19.43	15.97	37.9	37
Brassica oil	63.98	44.94	32.73	24.68	19.31	37.8	37.6
Cynara oil	47.67	32.54	24.98	19.2	14.5	37.8	37.9

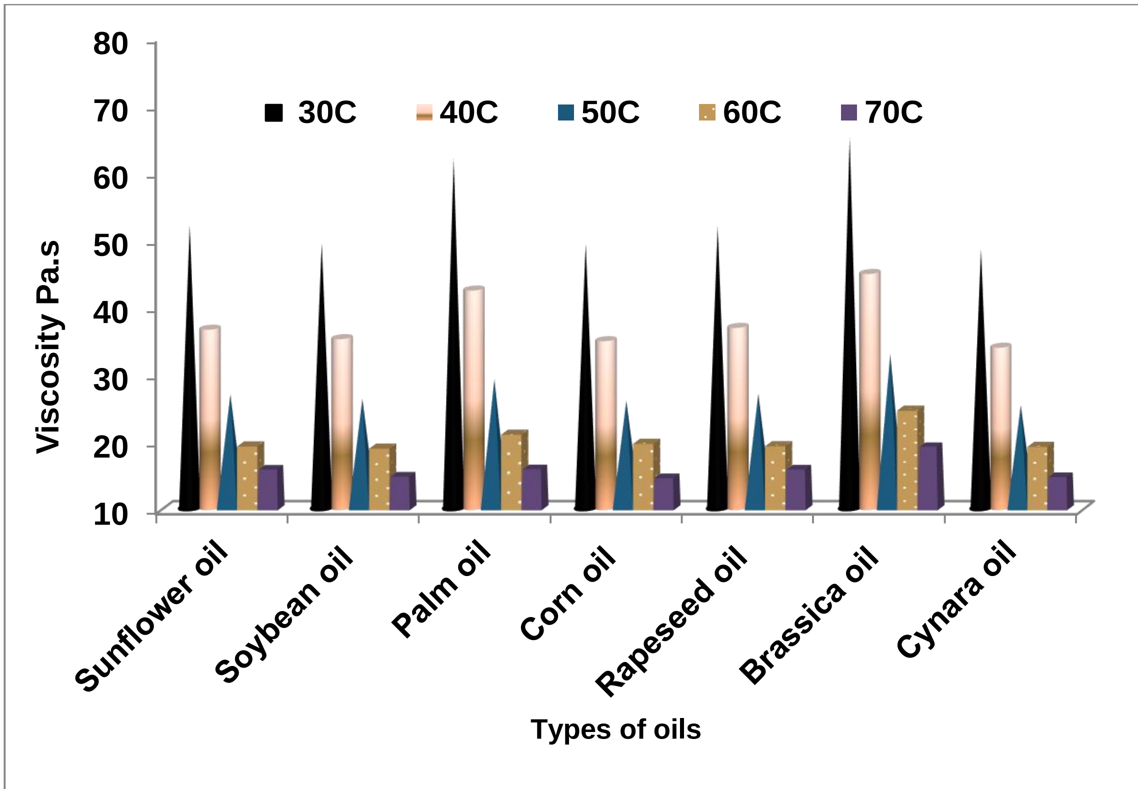

Fig: 2 Viscosity of different oils at different temperatures.

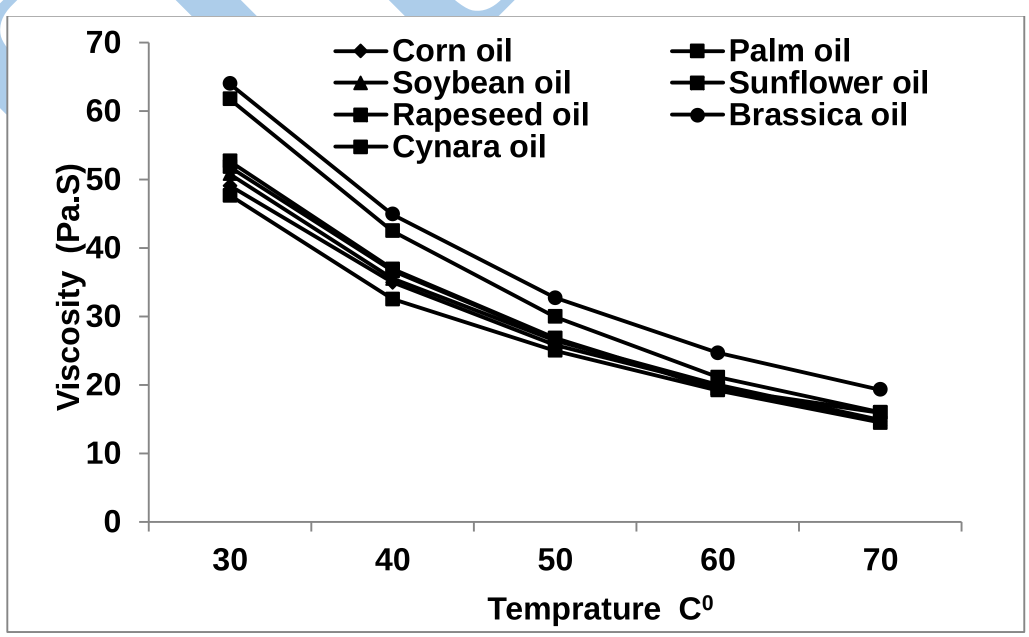

Fig: 3 Viscosity of different oils as a function of temperature.

The high calorific value (HCV) and low calorific value (LCV) given in table 2 are plotted in figure 4 for different oils. The sunflower oil has highest value of HCV while cynara oil have lowest value of HCV. The case of LCV is exactly opposite to that of HCV for the oils investigated.

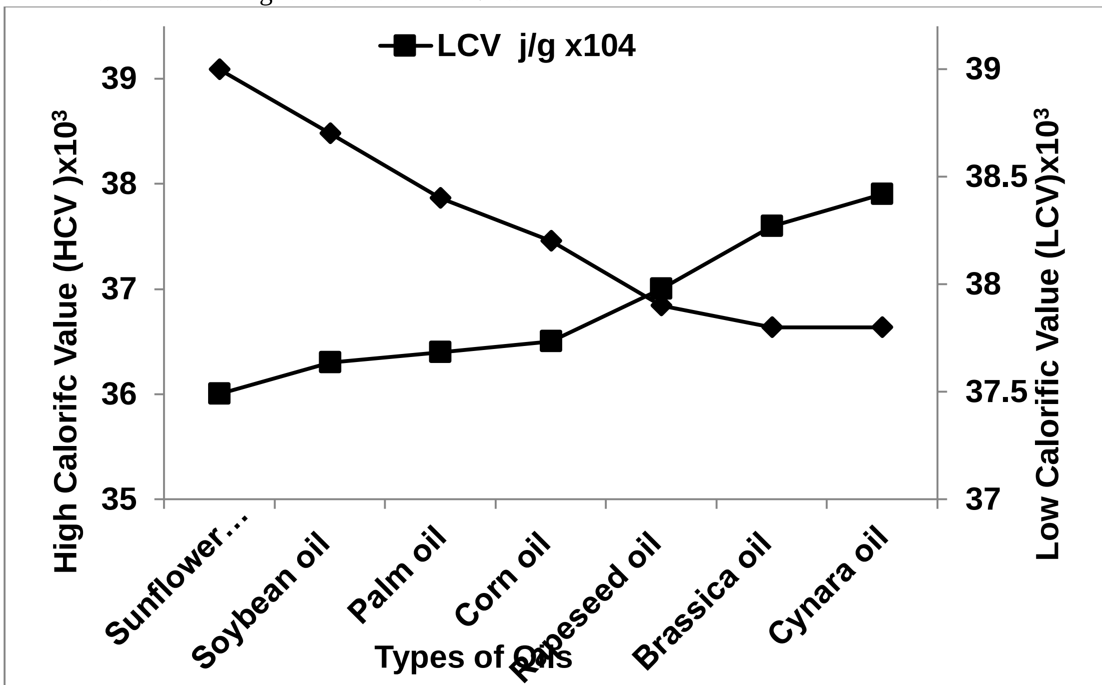

Fig: 4 plot curve Calorific Value with respect to Varity of Oils

The results show the physic-chemical properties of different oils in which considerable variation is observed among the oils but it does not mean that some oils are inferior to the others. The values obtained for different physico-chemical properties are slightly different from the standard values which are due to the difference in methodology and apparatus used. The quality and purity of the oil available in the local market is also responsible for the difference. In general, the oils used under investigation are safe for human consumption and recommended that more research should be carried out to explore their viability for nutritional and industrial use.

IV. Conclusion

In the present study various physico-chemical characteristics Iodine Value, saponification value, acid values and viscosity have been studied and may be used for quality control of the different edible oil samples (sunflower, olive, corn, coconut, castor and canola). The measurement of the mentioned physico-chemical characteristics indicated that some samples have high value of rancidity among all vegetable oil samples and this is may be attributed to the presence of higher free fatty acids, degree of unsaturation, hydrolysis of triglycerides, storage and date of expire which have adverse effect on human health.

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