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Investigation of Chemical and Physical Properties of Seven Types of Edible Oils of District Mansehra with Respect to the Recommended Standards

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Abstract

This research was aimed to assess the physicochemical properties of seven edible oils, i.e., almond oil, castor oil, cooking oil, mustard oil, pumpkin oil, black seed oil and egg oil collected from local market, Mansehra. Their chemical and physical properties were also compared to the recommended levels set as a standard by WHO/FAO to find out whether they are suitable and safe to be used by human beings. Among the chemical characteristics, acid values, saponification values and peroxide values were determined while the physical properties that were studied included density, specific gravity, refractive index, moisture content and viscosity. All these assays were performed using standardized assays/protocols. From the results, it can be illustrated that most of the physicochemical parameters are in line with the standard values as evident from the results. However, some value shows deviation, for instance, the acid values of all studied oil samples except almond oil, cooking oil and pumpkin oil exceed the recommended value of 0.6. In addition, the saponification value of almond oil and black seed oil, while peroxide value of pumpkin oil are above the recommended range. So, it can be concluded that most of these oils whose studied parameters are according to permissible limits are safe for human consumption.

Keywords: Edibles oils, District Mansehra, Chemical property, Physical property, WHO/FAO standards

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1. INTRODUCTION

The significance of edible oils cannot be overlooked as they constitute a major portion of human diet. They are extracted from animals or plant sources and play a pivotal role in giving distinct taste and texture to food items[1], providing energy[2], vital fatty acids[3] and also essential fat-soluble vitamins[4]. Although many plant parts may yield oil[5] and in commercial practice, oil is extracted primarily from seeds. The larger source of oils at present is the seeds of annual plants[6]. Vegetable fats and oils include both edible and inedible varieties. For instance, processed linseed oil, tung oil, and castor oil are inedible and used in paints, lubricants, pharmaceuticals, cosmetics and other industrial applications[5]. Some of the edible vegetable oils including olive oil, palm oil, soybean oil, canola oil, pumpkin seed oil, corn oil and sunflower oil. Many other kinds of vegetable oils are also used for cooking.

Their quality and composition can be monitored by assessing various physicochemical parameters[7]. Thus, it is extremely important to monitor properly the quality of oil and hence avoid consumption of toxified oil[8]. These physicochemical properties include acid value, saponification value, peroxide value, density, specific gravity, viscosity, refractive index, moisture content and several others[9,10,11]. An oil is considered of good quality recommended for use of human consumption if all these parameters are within a standard or in recommended range of World health Organization (WHO) and Food and Agriculture Organization (FAO). Sometime most of the oil's quality is deteriorated due to various reasons which include exposure to environmental oxygen[12], light[13], storage or improper way of processing[14]. Consequently, their characteristic properties exceed their normal recommended ranges which make them unsuitable for use. For instance, higher peroxide value and acid values reflects the instability of oils[15]. Consumption of deteriorated or low functionality oil not only fail to fulfil the body requirements but is also results in different types of health issues like aging, membranes damage, cardiovascular disorders and carcinogenesis[16].

Recently, this area of research has grabbed attention from various researchers because of human's health concerns. The physicochemical properties of commercially available edible oils have been studied in different countries in order to understand their compositional quality and functionality to ensure provision of the quality oils to the consumers[17]. In the present world, people are more concerned about issues related to food safety and the associated risks to human wellbeing. Therefore, industries are also striving to provide standard quality oils for the basis of their credibility. However, all the industries are not of equal standard and some activities or processes might not be performed in a proper manner. Therefore, we carried out this research with the objectives to evaluate some physical and chemical properties of seven edible oils to understand their feasibility for humans use at district Mansehra, Khyber Pakhtunkhwa (KP), Pakistan. The current study is important to assess the quality of the edible oils used commonly for human consumption in Mansehra region.

Based on the results, most of properties meet the standard set by WHO/FAO. However, some property not meet the essential standard set by the WHO/FAO which might be due to the processing method or storing of the oils without the recommended guideline[31]. Our study will create awareness among the locals about the ill-effects of poor-quality oils and to select the oils with high nutritional value for healthy life.

2. MATERIALS AND METHODS

2.1 Samples collection

Seven oil samples were collected from different local market of district Mansehra, Pakistan. The samples included cooking oil, almond oil, pumpkin oil, castor oil, black seed oil, egg oil and mustard oil. The collected oil samples were assessed for different chemical and physical properties in Biochemistry lab, Hazara University Mansehra.

2.2 Determination of chemical properties

Chemical properties including acid value, saponification value and peroxide value of all the samples were determined by standard method[18].

2.2.1 Acid value

To estimate the acid value, we prepared three reagents including 0.1 molar alcoholic KOH, 1% Phenolphthalein solution, and Fat solvent (acetone/chloroform/butanol/amyl alcohol). 5g of oil was accurately weighed in a clean flask and added 20ml of fat solvent. Then 20ml of oil sample and 1ml of Phenolphthalein as an indicator were added and then titrated against 0.1 molar KOH solutions until pink color was appeared. The volume of KOH used was noted. This experiment was conducted three times and the average value was taken for calculation.

Acid value= (a $_x$ normality of alkali $_x$ 56.0)/W

Where a = number of ml of 0.1N alkali consumed (KOH), while W = weight of oil or fats.

2.2.2 Saponification value

For estimation of saponification value of an oil sample, a 2g of oil sample and 30ml of alcoholic KOH were taken in Pyrex flask and attached it to water condenser and reflux for 30 minutes to fully dissolve oil sample. The flask and condenser were allowed to cool at room temperature. After that 1ml of dilute Phenolphthalein indicator was added. The sample was titrated with 0.5 molar of HCl until pink colour was disappeared. The volume of HCl used against sample was noted and put into following formula to calculate saponification value.

Saponification value= (B-X) x 0.02805 x 1000/ Weight of sample

2.2.3 Peroxide value

Peroxide value reflects the peroxides present in an oil sample. It can be assessed by determining the iodine released from potassium iodide (KI). An oil samples of 5gm weight each is dissolved in acetic acid and chloroform (3:2). Then saturated solution of 1 ml KI is added to the sample. The amount of iodine liberated from KI by the oxidative action of peroxides present in the oil can be analysed using titration. Sodium thiosulphate was used as a standard while solution of starch was used as an indicator in this assay. Also, the titration was done for blanks.

PV (meq/kg oil) = (S-B) x W x N

In the above equation, B shows volume of sodium thiosulphate used for blank, W is weight of sample, S represents volume of sodium thiosulphate used by the sample oil and N represents normality of standard sodium thiosulphate[18,19].

2.3 Physical properties

Physical properties including density, viscosity, refractive index, specific gravity and moisture content were analysed following standard protocols.

2.3.1 Density

The weight of 10 ml oil was noted and density was determined according to formula (density = mass/volume).

2.3.2 Viscosity

Viscometer was first cleaned with water and 70% ethanol prior to its use. Distilled water was introduced with the help of pipette in bulb B in such a way that the bend portion of the tube and half of the bulb B were filled up with water. The viscometer was clamped vertically. Then water was sucked through the rubber tube attached with bulb A until it rose above the mark C and was allowed to flow through capillary. The time of flow of water from the mark C to D was measured with the help of stopwatch. The process was repeated 3 times to obtain accurate result with the mean value. Then water was removed from viscometer and same volume of oil was introduced into bulb B and its time of flow was noted down as before. This action was also repeated 3 times to get a mean value.

2.3.3 Specific Gravity

To get the value of specific gravity, weight of water was determined in density bottle and compared with the weight of oil

2.3.4 Refractive Index

All the samples were analyzed to determine refractive index values following the procedure used by Nawal-A-Al[19].

2.3.5 Moisture Content

Firstly, three crucibles were weighed and then 10g of the oil sample was added to each of them. The samples were oven dried at 105°C to their constant weights, then cooled in desiccators and weighed. This process was repeated three times for each sample and the average value was evaluated[20].

2.4 Quality control

All the glass wares used in our experiments were properly sterilized and autoclaved to avoid contamination or impurities input into the selected oil samples that may affect their properties as well as the results.

2.5 Statistical analysis

All the samples were run in triplicates. Their means and standard deviations were performed using MS Excel and GraphPad Prism 5. All the data has been presented in the form of figures and tables.

3. RESULTS AND DISCUSSIONS

During this study, the physicochemical properties of the seven selected edible oil samples from district Mansehra were assessed. They varied both in their physical and chemical characteristics compared to each other and with respect to the WHO/FAO standards or recommended level.

3.1 Chemical properties

Following results were obtained for chemical properties of the edible oils and their specific values represented in the figure1, table 1 and figure 2.

3.1.1 Acid value

Among the chemical characteristics, acid values of samples were found as for almond oil (0.5±0.23), castor oil (1.1±0.65), cooking oil (0.41±0.06), mustard oil (0.66±0.12), pumpkin oil (0.34±0.07), black seed oil (2.5±1.00) and egg oil (0.76±0.01). The results are presented in figure 1. Acid values of most of oil samples were found to be in the range of recommended standards except castor oil and black seed oil which possess high acid values.

3.1.2 Saponification value

Second chemical property that was studied is saponification values, which were found as for almond oil (227.205±0.58), castor oil (126.225±1.10), cooking oil (161.287±0.93), mustard oil (164.09±1.51), pumpkin oil (147.265±0.80), black seed oil (224.4±0.70) and egg oil (196.35±1.60). The lowest and highest values recorded for castor oil and almond oil respectively. The results are presented in Table 1. Saponification value of only black seed oil exceed the permissible limit while rest of samples show normal values for this parameter.

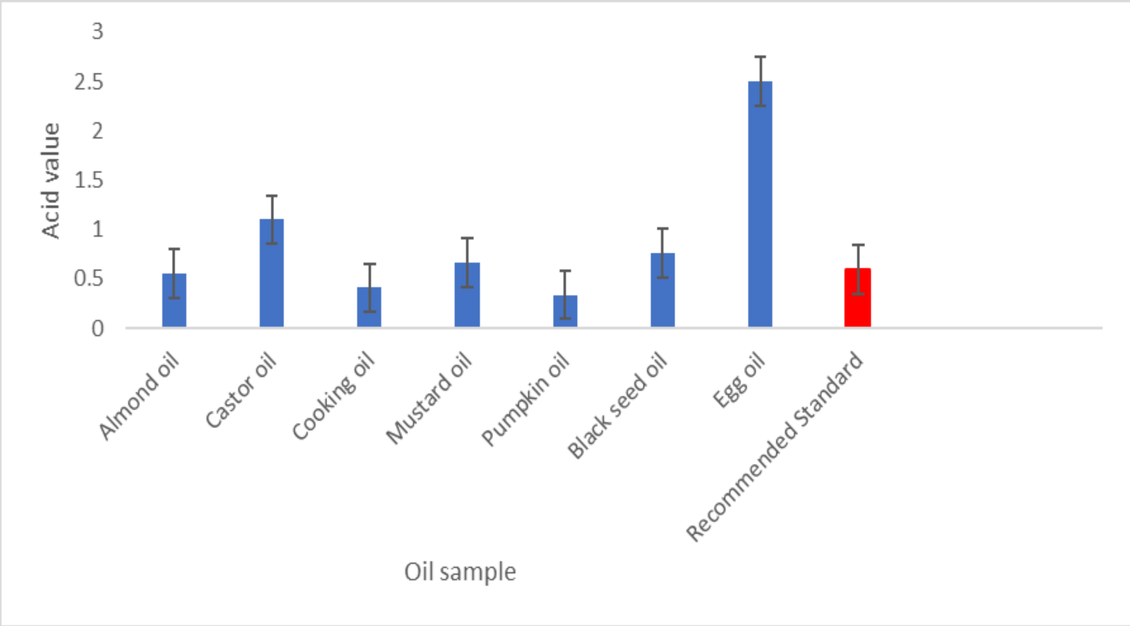

Figure 1: Acid values of the studied oil samples

Table 1. Saponification values of seven oil samples

S. No	Name of oil sample	Standard value	Saponification value
1	Almond oil	188-203	227.205±0.58
2	Castor oil	195-205	126.225±1.10
3	Cooking oil	191-207	161.287±0.93
4	Mustard oil	195-209	164.09±1.51
5	Pumpkin oil	190-200	147.265±0.80
6	Black seed oil	196-201	224.4±0.70
7	Egg oil	189-199	196.35±1.60

3.1.3 Peroxide value

From the figure 2 given below, it is clear that the peroxide value for pumpkin oil is highest followed by cooking oil while the lowest value has been recorded for almond oil. All the values range from 5.23±1.10 to 10.60±0.02 and only the peroxide value of pumpkin oil is greater than the recommended standards.

3.2 Physical properties

After analysing the oil samples for physical properties, following results were recorded.

3.2.1 Density

The density value of oil samples was for almond oil (0.868±0.20 g/ml), castor oil (1.011±0.07 g/ml), cooking oil (0.972±0.11 g/ml), mustard oil (0.902±1.02 g/ml), pumpkin oil (0.911±0.57 g/ml), black seed oil (1.062±0.15 g/ml) and egg oil (0.886±0.03 g/ml). The results are presented in Table 2.

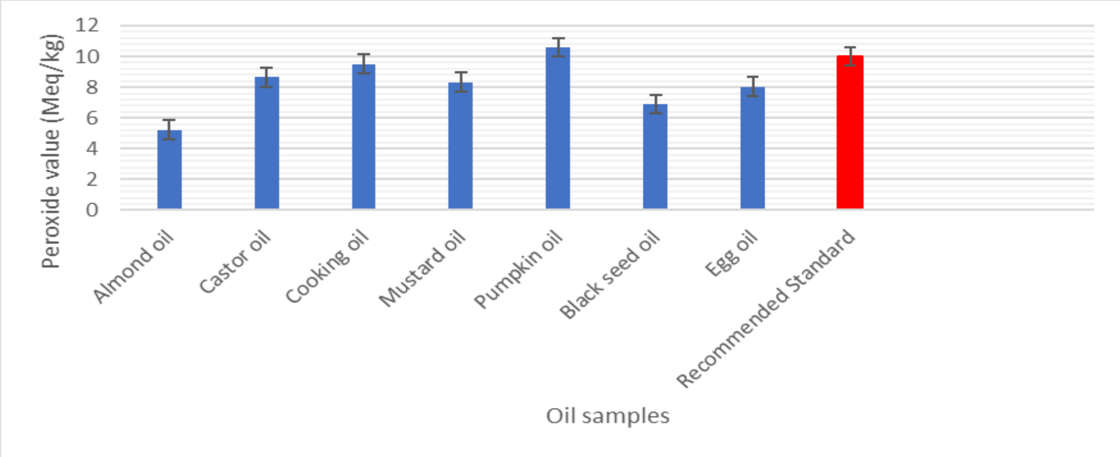

Figure 2: Peroxide values of seven oil samples

Table 2. Densities of seven edible oil samples

S. No	Name of oil sample	Standard range	Density
1	Almond oil	0.899-0.910	0.868±0.20
2	Castor oil	0.889-0.920	1.011±0.07
3	Cooking oil	0.901-0.999	0.972±0.11
4	Mustard oil	0.910-0.921	0.902±1.02
5	Pumpkin oil	0.894-0.926	0.911±0.57
6	Black seed oil	0.900-0.956	1.062±0.15
7	Egg oil	0.889-0.905	0.886±0.03

3.2.2 Specific Gravity

While evaluating the physical characteristics of these oils, the specific gravity value of oil samples for almond oil (0.93±0.00 g), castor oil (0.97±0.01 g), cooking oil (0.93±0.00 g), mustard oil (0.92± 0.02 g), pumpkin oil (0.93±0.03 g), black seed oil (0.93±0.00g) and egg oil (0.95±0.01g). The results are presented in Table 3.

Table 3. Specific gravities of each oil sample studied

S. No	Name of oil sample	Standard range	Specific gravity
1	Almond oil	0.889-0.999	0.93±0.00
2	Castor oil	0.894-0.964	0.97±0.01
3	Cooking oil	0.890-0.984	0.93±0.00
4	Mustard oil	0.889-0.939	0.92±0.02
5	Pumpkin oil	0.895-0.944	0.93±0.03
6	Black seed oil	0.890-0.993	0.93±0.00
7	Egg oil	0.899-0.996	0.95±0.01

3.2.3 Viscosity

The viscosity of oil samples was for almond oil (15.63±0.10 ctp), castor oil (254.528±0.01 ctp), cooking oil (23.77±0.20 ctp), mustard oil (18.694±0.04 ctp), pumpkin oil (19.449±0.04 ctp), black seed oil (14.072±0.02 ctp) and egg oil (14.449±0.00ctp). The results are presented in Figure 3.

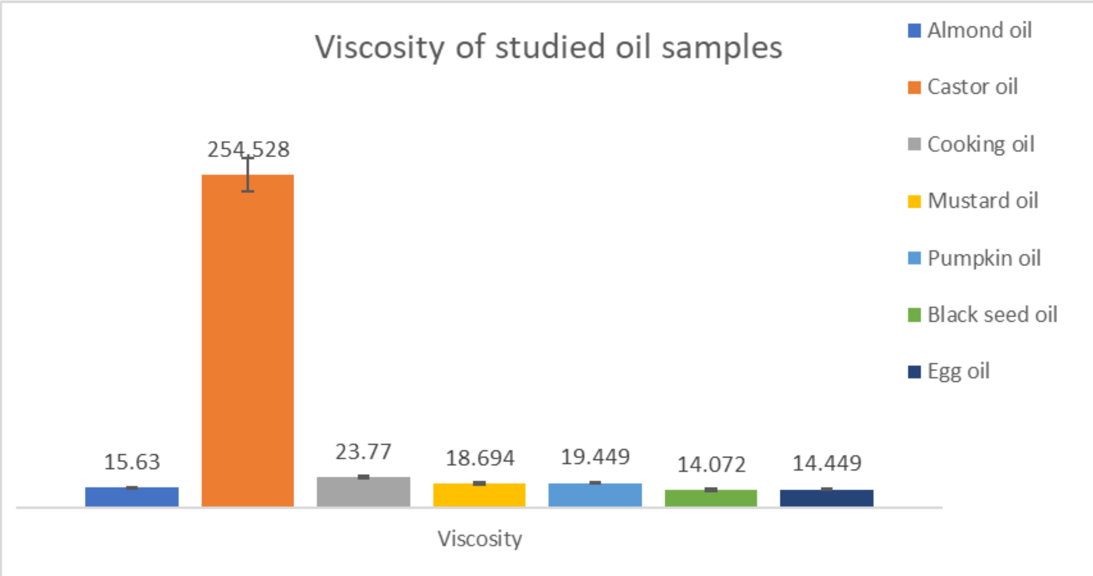

Figure 3: Viscosity of different oil samples

3.2.4 Refractive Index

The table given below illustrates the recommended and recorded values of the seven oil samples included in our study. Mustard oil has the highest refractive index value compared to the rest of the samples while pumpkin oil shows the lowest refractive index. Only almond has the refractive index beyond the standard limit. The refractive index ranged from 1.456±0.03 to 1.483±0.03. Mustard oil has the highest while pumpkin oil has lowest refractive indices.

Table 4: Refractive indices of seven oil samples

S. No	Name of oil sample	Standard range	Refractive index
1	Almond oil	1.467-1.470	1.473±0.00
2	Castor oil	1.470-1.480	1.475±0.01
3	Cooking oil	1.469-1.473	1.466±0.00
4	Mustard oil	1.474-1.490	1.483±0.03
5	Pumpkin oil	1.454-1.458	1.456±0.02
6	Black seed oil	1.467-1.469	1.466±0.00
7	Egg oil	1.460-1.480	1.471±0.00

3.2.5 Moisture content

From the following figure 4, it is obvious that moisture content of the selected oil samples varied between 0.16% and 1.00%. Most of these samples have the moisture content higher than recommended value, while some are below or in the near ranges with the standards. Moisture content of the samples was found to be in between 0.16±0.01 to 1.00±0.06. It was found greater in almond oil and low in pumpkin oil.

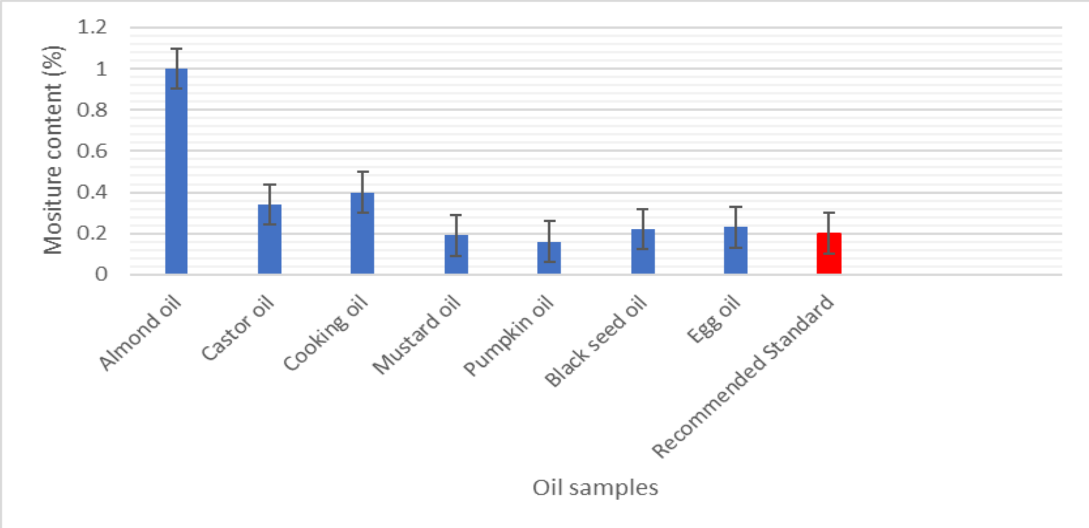

Figure 4: Moisture contents of seven edible oil samples

In this study, we determined the physiochemical properties of commercial edible oils. We compared the value of the chemical and physical properties of these oils with the standard which was recommended by WHO/FAO for the quality of the edible oils. Our analyses reveal that most of the physical and chemical properties met the standard recommended by WHO and FAO.

We analysed the collected samples of edible oils with three chemical including acidity, saponification, and peroxidation. Acid value well indicates the degradation of oil as a result of hydrolysis or enzymes[21]. Oils with higher acidity could not be favourable for edibility and further treatment is required to lower the acid value[22],[23]. Acid value of the collected samples were in range of 0.5-2.5. So, most of oil shows good quality of the oil except oil of egg which having the acidity of 2.5 and could not be consider safer for human use.

Saponification values are beneficial to provide details about the oil's quality, type of glycerides and mean weight of the acids[24,11]. The different saponification value has been suggested by WHO for different types of oils. Here, the Saponification value of the oils were in range of 126.225±1.10 to 227.205±0.58. Our analyses base on saponification shows that most of the oils do not meet the standard suggested by WHO. Therefore, certain advancement in the oils processing and at storage level might be required for the provision of the quality oils to consumers.

Peroxide value is used to assess the degree of rancidity reactions that have occurred during storage. It is a useful indicator to predict the stability and quality of oils[25]. Higher peroxide value can be due to high degree of unsaturation. It mostly increases with the temperature, storage time, light and contact with oxygen in the atmosphere[11]. Our analyses revealed except oils of pumpkin other oils having the peroxidation properties within the range recommended by WHO and this value shows the oil is of good quality for consumptions.

The physical properties that were analysed to access the quality of the oils including density, viscosity, specific gravity, refractive index, moisture content. The density of the oils is used for the determination of the quality of the oils and density of oils more than the standard recommended by WHO not recommended due its bad effect on human health[26]. Except castor oil and black seed oil, other five types of oils having the density in range of the value that was recommended by WHO. The high density of these two types of oils may be due to the pi bonds that make the bonding more rigid and rotation between CAC bonds becomes more strenuous[26].

Viscosity of the oil samples were in range of 14.072-23.77 except the castor oil which hit the highest peak of 254.53.[26] suggested that the viscosity of oils if exceeds the standards might be harmful for consumption. Higher viscosities are attributed to saturation and polymerization, however in our study, the samples show densities and viscosities considerably in WHO/FAO limits, which reflects their unsaturation and usefulness for use by human subjects[27,19].

The specific gravity of the oil varies with type of oil and temperature. It depends on various kinds of fatty acids and solid contents present in an oil[28]. When aromatic compounds are added to an oil, it causes the specific gravity values to rise, while increasing the content of saturated compounds decreases the specific gravity of an oil. In our study, the specific gravity of selected oils ranged from 0.91 to 0.97. The values of specific gravity reveal that these value in the range of recommended standards and based on it these oils are attributed to be safe for consumption.

The refractive index (RI) is the ratio of the speed of light in a vacuum to the speed of light through a given material. This value represents the purity of the oil and is used to check the quality control as this value indicate the quantity of the saturated fatty acid in the oils[29],[11]. Among the different types of oils, the RI value of almond oil was slightly greater than recommended standards set by FAO/WHO. It could be due to presence of highly unsaturated or long chain fatty acids in their triglycerides. Keeping the recommended RI values of WHO, rest of the oils are nutritionally good and safe for use[27]**.**

One of the reactions which results in the decomposition of oils is the conversion of existing triglycerides to free fatty acids. Hence, it is quite valuable to assess the water content of an oil. Higher moisture content for almond, castor and cooking oils could be the result of improper treatment during processing. Samples having low moisture contents are better in terms of withstanding microbial growth and transportation related issues. Moreover, such oils can be stored for longer periods[30],[25].

We analysed the physiochemical properties of seven edible oils to access determined its suitability for human consumption by comparing these properties with the suggested standard of WHO/FAO. Previously, data was not available about the quality of edible oils at district Mansehra. Our analyses show that most of the properties met the standard of WHO and these oils could be consider safe for human consumption. However, further care and advancement is needed in oil processing and storage for provision of quality standard oils for human consumption.

4. CONCLUSIONS

The physicochemical properties for seven different oil samples were evaluated to determine quality of these edible oils. Most of these properties suggest that the oils of commercial market met the standards of WHO/FAO. However, some of the physiochemical properties shows deviation from the recommended value of WHO/FAO. For example, acid value and saponification value of almond oil and black seed oil, and peroxide value of pumpkin oil does not fall in recommended ranges. This might be due to processing and storage of the oils without the standard protocol. Therefore, advancement in oils processing and storage of the oils in proper conditions are required to provide useful and better quality of oils for human consumption.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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