Prāgyik Prabāha Vol. 11, No. 1: 62-74, April 2023 Tribhuvan University Teachers' Association, Tribhuvan Multiple Campus, Tribhuvan University, Nepal

Comparison on the Physicochemical Parameters of Five Commercially Available Branded Oils in Tansen Bazar

Madhab Gautam and Varsha Bhandari

madhab.gautam@tmc.tu.edu.np

Department of Chemistry

Tribhuvan Multiple Campus, Tribhuvan University, Nepal

Article History: *Received 12August 2022; Reviewed 25 October 2022; Revised 22 December 2022; Accepted 27 January 2023*

Abstract

Oils are unsaturated triglycerides or lipids which are liquid at room temperature. The physicochemical parameters of oils should be analyzed to assess the quality and functionality of the oil. The parameters like saponification value, acid value, iodine value, and insoluble impurities can identify characteristics of edible vegetable oils available in Nepali market whose characteristics remain indistinct and for this, the quality of individual edible oil also remains unknown. Objective of this research work is to get idea about other applicability of vegetable oils instead of commonly used mustard oils. Five different branded and certified samples of oils: coconut oil, olive oil, castor oil, soybean oil and sunflower oil were collected from different shops of Tansen bazaar for quality analysis. The saponification values, acid values, iodine values and percentage insoluble impurities of the selected oil samples were recorded in the range (178.54-284.70) mg KOH/gm, (0.48-4.48) mg KOH/gm, (8.75-141.2) mg KOH/gm and (0.004-0.078) % respectively. This study showed that all the selected five samples of oils are very good for soap making process or studied coconut oil was observed to produce the best quality soap. Analyzed olive oil was not consumable or good as skin care product either. This study had recommended public not to use pre-heated oil more than one time and also, analyzed sunflower oil had been recommended as the best suitable for all purposes among all samples of oils under study from Tansen.

Keywords: *Acid value, saponification value, iodine value, insoluble impurities, lipids, soap.*

Introduction

Edible oils are vital constituents of our daily diet which provide energy, essential fatty acids and serve as a carrier of fat-soluble vitamins (Hasan et al., 2016). Vegetable oils or edible oils are derived from the seeds of plants grows in many different parts in world. Nutritionally, vegetable oils are usually preferred to animal fat because of the unsaturated fatty acids they contain and their molecular weight. Vegetable oils obtained from various sources thrives and are sold under different certified brand names in the society (Otunola et al., 2009). According to USDA standards, oils are unsaturated fats that are in liquid state at room temperature. Oils come from fruit seeds or other part of fruit or plant and also from some fishes. Oils are not a food group, but they provide essential nutrients, therefore, oils are included in USDA food patterns. There are numerous sources of oils and fats that go into the production of food products. They can be of vegetable or animal origin. Some commonly consumed oils include: canola oil, corn oil, castor oil, cottonseed oil, olive oil, safflower oil, coconut oil, mustard oil, soybean oil, sunflower oil etc. Some oils are used mainly as flavorings, such as walnut oil and sesame oil (Alberts et al., 2002). Soaps are made of lipids and different lipids bring different properties to soaps. Lipids are responsible for both physical and chemical properties of soap (Morrison & Boyd, 2002). Conditioning, moisturizing, hardness or softness of soap, lather formation, cleansing property, anti-bacterial, anti-inflammatory, anti-oxidant and vitamin contents are some major and essential properties of oil that enhance the quality of soaps (Christie, 2002).

The physicochemical parameters include density, saponification value, iodine value, acid value, peroxide value, Insoluble Impurities etc. In 21st century it is very necessary to understand the importance of evaluation of these quality parameters of oil because of the amount of impurities added in oils, and other food products by the manufacturers for their own profit which can lead to many serious health related problems. Repeated frying has been reported to cause several oxidative and thermal reactions which results in change in the physicochemical, nutritional and sensory properties of oils (Alajtal et al., 2018). Atmospheric oxygen reacts instantly with oils and other organic compounds of the oil to cause structural degradation which leads to the loss of quality of food and harmful to human health. Therefore, it is essential to monitor the quality of oils to avoid the use of abused oil due to the health consequences of consuming foods fried in degraded oil, and to maintain the quality of fried foods (Badmos et al., 2019). If saponification values of oils are high, then the average chain length of the fatty acids in oils are shorter and the average molecular weight of the fatty acids will be low (Birnin-Yauri & Garba, 2011). The cooking oils or edible must have lower acid value otherwise the oil can damage human health since higher acid value of oils indicates that triglycerides of oil are converted into fatty acids and glycerol which cause rancidity of the oil. Oxidized oils are harmful for skin and its consumption may cause cardiovascular diseases (Nancy et al., 2016). Iodine value measures the degree of unsaturation in a vegetable oil and greater would be the possibility of the oils to go to rancid if they contain higher unsaturation. Low level of insoluble impurities is a desirable character of oil as the impurities may contain substances which may be harmful to humans (Chebet et al., 2016). Oxidation of fats, generally known as rancidity, is caused by a biochemical reaction between fats and oxygen. In this process the long-chain fatty acids are degraded and short-chain compounds are formed. One of the reaction products is butyric acid, which causes the typical rancid taste. Rancidity can be prevented by adding antioxidants (substances which prevent oxidation) to food, storing food in airtight containers to slow the process of rancidification. Refrigerating food also helps to slow down rancidification and replacing oxygen in the containers with another gas (Chowdhury et al., 2015). This study is mainly aimed to find out the saponification value, acid value, iodine value and insoluble impurities of the different oil samples collected from Tansen, Palpa for the quality parameterization and to determine and compare of quality parameters of selected samples oils samples with the international standard values for edible oils and suitability for soap making processes or not.

Methods and Materials

Collection of Sample

Five samples of branded and certified oils (Coconut oil, Olive oil, Castor oil, Sunflower oil and Soyabean oil) that are commonly used, had been collected from Tansen bazaar and the quality parameters of each oil had been determined within one day of breaking the seal of the packaging in the laboratory.

Determination of Physical Parameters:

The samples have been physically analyzed under following parameters: color, odor, taste and state at room temperature by sensory method.

Determination of saponification value

AOCS method cd 3-25 was used to determine saponification value of oil samples (AOCS, 1993). For this, 2 g of oil samples dissolved in 25 mL of 1 N alcoholic KOH was boiled gently in a flask with condenser system for 45 minutes for complete saponification but 5.611 gm KOH in 2 ml water and 98 ml of 95% ethanol, KOH solution was prepared, followed with standardization with 0.5N oxalic acid using phenolphthalein as an indicator to obtain standard KOH solution. The flask with condenser was cooled but not sufficiently to form a gel, the inside of the condenser was washed down with about 1 mL of distilled water and the condenser was disconnected. 1 ml of phenolphthalein indicator was added to the flask and was titrated with 0.5N HCl until the pink colour just disappeared. A blank determination was conducted simultaneously with the sample. The saponification value was calculated using the formula;

$$\text{Saponification value} = \frac{56 \times N\,(V_1 - V_2)}{W}$$

where, N is normality of HCl, V_1 is volume of HCl used in ml, V_2 = volume of HCl used in the blank in mL and W is weight of sample in gm.

Determination of acid value

The acid value was determined by AOCS method Cd 3a-63(AOCS, 1993). 1 g of oil was dissolved in 20 mL of absolute ethanol in 250 ml and few drops of phenolphthalein indicator were added. The prepared solution was then titrated with 0.2 N standard KOH until pink colour appeared at the end point. Acid value of oils was calculated as;

$$\text{Acid value} = \frac{V \times N \times 56 \times 1000}{W}$$

$$\text{FFA (as oleic acid)} = \frac{V \times N \times 28.2}{W \times 1000} \text{ \%by weight.}$$

Thus, Acid value = Percent Fatty acid (as oleic acid) x 1.99 or

Where, V is volume of KOH, N is normality of KOH and W is weight of the sample in gm.

Determination of iodine value

The iodine value was determined by AOCS method Cd 1-25 (AOCS, 1993). 15 ml of carbon tetrachloride was added to 1 g of oil sample and swirled to ensure that the sample is completely dissolved. 25 ml of Wij's solution (2.8 g of iodine was dissolved in 250 mL glacial acetic acid and Cl_2 gas was passed until permanent orange color appeared) was then dispensed into the flask containing the sample using a pipette. The flask was stoppered and swirled to ensure complete mixing. The sample was then placed in the dark for 30 minutes at room temperature and 20 ml of 10 % potassium iodide (KI) solution was added, followed by 150 mL of distilled water.

The mixture was titrated with 0.1N thiosulphate solution, adding gradually and with constant and vigorous shaking until the yellow color had almost disappeared. 1.5 mL of starch indicator solution was added and the titration was continued until the blue color disappeared. A blank determination was conducted simultaneously. The iodine value was calculated as;

$$\text{Iodine value} = \frac{12.69 \times (V_2 - V_1) \times N}{W}$$

Where, N is normality of thiosulphate solution, V_1 is volume of thiosulphate solution used in test, V_2 is volume of thiosulphate solution used in blank and W is weight of sample.

Determination of insoluble impurities

The percentage insoluble impurities were determined according to the method of food analysis: Theory and Practice (Pomeranz and Meloan, 1987). 2 g of the oil sample was dissolved in 20 mL of 1:1 solvent mixture (petroleum ether + diethyl ether) with vigorous shaking and allowed to stand for 30 minutes at 30˚C. The liquid was then filtered through a dried and weighed Whatmann number 1 filter paper. The filter paper was carefully washed with 10 mL of the solvent mixture. The filter paper was then dried to a constant weight in an oven at 103˚C. The increase in weight represented the weight of insoluble impurities was calculated as;

$$\text{Impurity (\%)} = \frac{a}{W} \times 100\%$$

Where, a is increase in the weight of filter paper and W is weight of oil sample.

Determination of Free Caustic Alkali

Free Caustic Alkali content (as NaOH) in soap is determined by titration method (Vivian et al. 2014). The titration mixture was prepared by heating 1 g of soap sample with 5 ml of 20 % aqueous Barium chloride solution in water bath until it was completely dissolved. The titration mixture was titrated against 0.05 M H_2SO_4 solution using Phenolphthalein till the disappearance of pink color. Free Caustic Alkali was calculated as;

$$\text{Free caustic alkali (as NaOH)} = \frac{0.31 \times V_A}{W}$$

where, V_A is volume of acid consumed and W is weight of soap sample.

Results and Discussion

Analysis of Physical Parameters

Physical parameterization of oils gave idea about different color, odor, taste and different state at room temperature for collected oil samples in Tansen. The samples selected had been mostly pale yellow except for coconut oil which was white in color. All the oils had specified smell and taste except for sunflower oil and soybean oil as in Table 1. Coconut oil was white solid at room temperature while the rest were liquid. The different color of the oil depends upon the part of plant it was extracted from like the white colour of coconut oil is because the colour of the kernel of the coconut is white.

Table 1: Physical parameters of different oils selected for the study.

Oil samples	Color	Odour	Taste	State (Room temp.)
Coconut oil (O1)	White	Specific coconut like smell (strong)	Specific	Solid
Olive oil (O2)	Greenish yellow	Specific smell (mild)	Specific taste	Liquid

Castor oil (O3)	Pale yellow	Specific smell (mild)	Specific taste	Liquid
Soyabean oil (O4)	Pale yellow	No specific smell	No specific taste	Liquid
Sunflower oil (O5)	Light yellow	No specific smell	No specific taste	Liquid

Analysis of Chemical Parameters

The four chemical parameters (saponification value, acid value, iodine value and insoluble impurities) of collected five oil samples in this study were determined as tabulated in table 2.

Table 2: *Values of chemical parameters of the selected samples of oils in Tansen bazaar.*

Oil samples	Saponification Value (mg. KOH/g)	Acid Value (mg. KOH/g)	Iodine Value (mg. KOH/g)	Insoluble impurities (mg. KOH/g)
Coconut oil (O1)	253.85	1.48	8.75	0.004
Olive oil (O2)	191.72	4.48	84.23	0.051
Castor oil (O3)	178.54	1.006	89.43	0.072
Soyabean oil (O4)	197.3	0.87	118.9	0.064
Sunflower oil (O5)	181.94	0.48	141.2	0.078

The saponification number is the number of milligrams of potassium hydroxide required to neutralize the fatty acids resulting from the complete hydrolysis of 1gram of fat. It is also considered as a measure of the average molecular weight (or chain length) of all the fatty acids present or the long chain fatty acids found in fats have low saponification value because they have a relatively fewer number of carboxylic functional groups per unit mass of the fat and therefore high molecular weight. The standard recommended saponification values for edible coconut, olive, castor, sunflower and soyabean oils are 258, 190,181, 192, and 192 mg KOH/gm respectively (Odoom et al., 2002).

The results were obtained in the range (178.54 - 284.7) mg KOH/g as shown in Figure 1. It was observed that the saponification value of soybean oil slightly increased by +1.3 mg KOH/g from its standard value to be edible oils while, the saponification value of sunflower oil decreased by -4.055 mg KOH/g from its standard range to be edible oil but all others are in accordance with recommended standard values for edible oils. On comparing, coconut oil had the highest saponification value which means it has the smaller chains of fatty acids and lower molecular weight and hence will form good quality soap or is best for soap making out of all samples. On the other hand, castor oil had the lowest which means that it had longer chain of fatty acids and thus higher molecular weight and hence to soap formed will be of low quality.

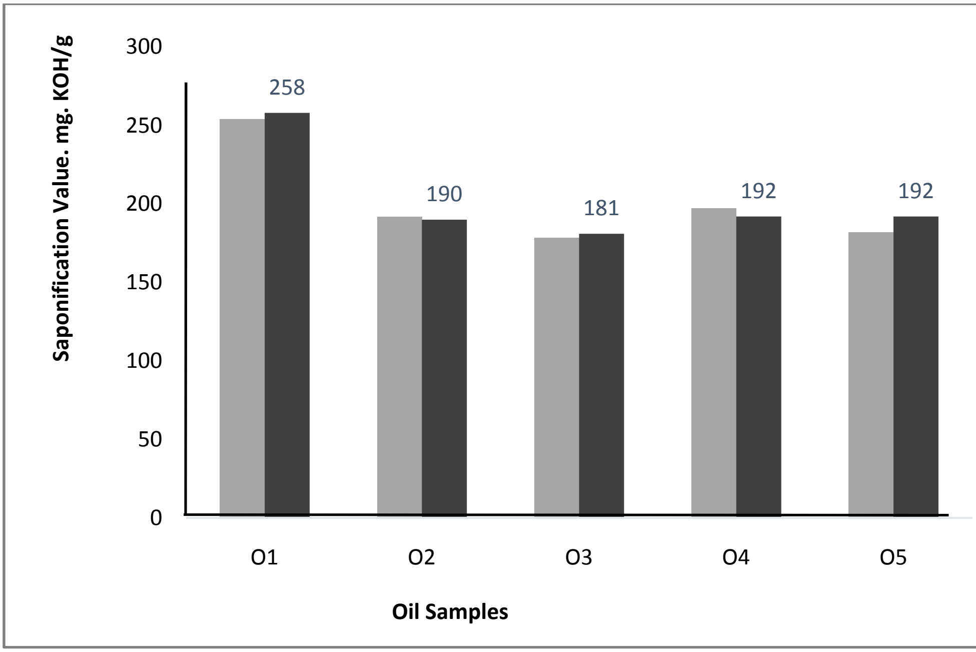

Figure 1: *Bar graph showing Saponification value of selected samples of oils.*

The acid value is a common quality parameter of oils which is taken as an important indicator of oxidation of oil or the acid value is the number of milligrams of potassium hydroxide required to neutralize the free fatty acid in 1 gm of the substance. Higher acid values of oils indicate oxidation of oil and rancidity (Omari et al., 2015). As the oils rancidify, triglycerides are converted into fatty acids and glycerol. Oxidized oils are harmful for skin and its consumption may cause cardiovascular diseases. Low acid value indicates better cleansing action of the lipids. The standard acid values of any edible oils should be within 0.3 to 0.6 mg (Sharma & Jain, 2015).

It was determined that the acid value of soybean oil is in accordance to its recommended standard value for edible oil while the acid values of coconut oil, olive oil, castor oil and soybean oil were increased by +0.88, +3.38, +0.42 and +0.27 mg KOH/g respectively. The deviation of calculated acid value from standard value indicates easy rancidity and oxidation of oil. It had been observed that olive oil had the highest acid value which means it was highly oxidized and highly rancid, hence inconsumable and may be harmful for skin but sunflower oil had the lowest acid value and it was the only sample in accordance to standard range for edible oils which means it was less oxidized or rancid than others, hence was consumable.

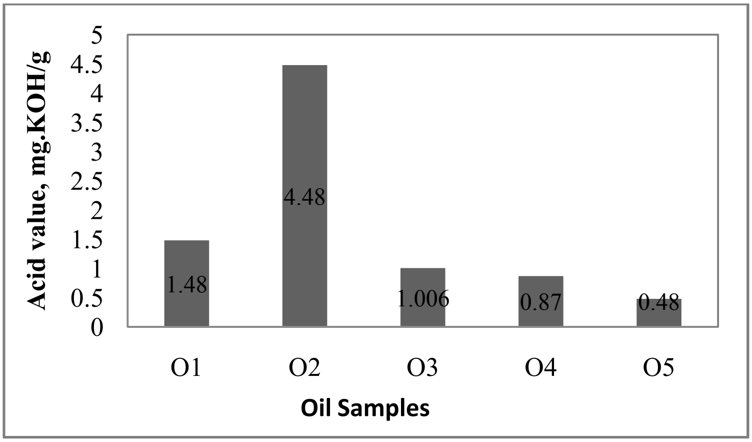

***Figure 2**: Bar graph showing Acid value of the selected samples of oils.*

An increment in the amount of FFA in a sample of oil indicates hydrolysis of triglycerides. Such reaction occurs by the action of lipase enzyme and it is an indicator of inadequate processing and storage conditions (i.e., high temperature and relative humidity, tissue damage). Besides FFA, hydrolysis of triglycerides produces glycerol (Scrimgeour, 2005). Free fatty acid values of the selected samples oils were also determined using acid values of oils. FFAs are neutralized during refining processes so low or negligible value of FFA value is desirable in refined oils, as high value of FFA indicates rancidity and oxidation of the oil (Pal et al., 2015).

The results were obtained in the range (0.0002-0.007) as shown in figure 3. The FFA values of the selected samples of oils were compared. It was observed that olive oil had the highest amount of FFA value and soybean oil had the lowest.

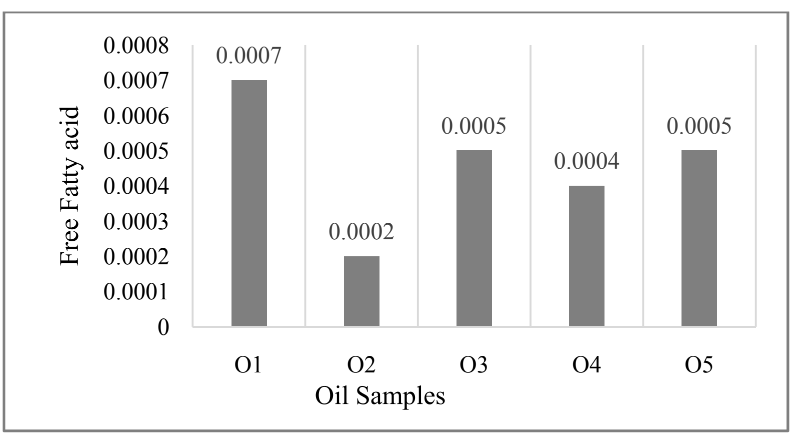

***Figure 3:** Bar graph showing free fatty acid of selected samples of oils.*

Iodine value indicates the degree of unsaturation of constituent fatty acids in an oil and is thus a relative measure of the unsaturated bonds present in the oil. Iodine value is expressed in grams of iodine absorbed by the oil or fat. Unsaturated compounds absorb iodine and form saturated compounds. The higher the amount of unsaturation, the more iodine value is absorbed (Neilson, 1994). No oil has zero iodine value. The higher the iodine value, the more unsaturated fatty acid bonds are present in a fat (Yusuf et al., 2015). According to dietitian association of Australia, unsaturated fats are considered the 'healthy' fats and they're important to include as part of a healthy diet. Higher the iodine value, better the oil or fat. Unsaturated lipids are also ideal for producing dry oils and are well suited for paint production. Whereas lower iodine value not only indicated the saturation of the lipids it also indicated its better cleansing action, that means, lipids with lower iodine value are best suited for soap production (Kyari, 2007). The standard iodine values for edible coconut oil, olive oil, castor oil, olive oil, sunflower oil and soyabean oil are 8.45, 84.5, 85, 131.5 and 142 respectively.

The results were obtained in the range (8.45-131.5) mg KOH/g. It was observed that the iodine values of castor oil and soybean oil increased by +1.4309 and +2.2379 mg KOH/g respectively from their recommended standard iodine values for edible oils while, iodine values of coconut oil, olive oil and soybean oil were almost in accordance to their standard iodine values. The deviation of the calculated iodine value from the standard iodine value indicated amount of the unsaturated fatty acid bonds present in fats and oils. On comparing, it was observed that sunflower oil has the highest iodine value whereas coconut oil has the lowest. Higher the iodine value, better the oil. The high iodine value also indicates the better dry oil and paint producing quality of oils. The low iodine value not only indicates the saturation of the oils it also indicates the good cleansing action of soap.

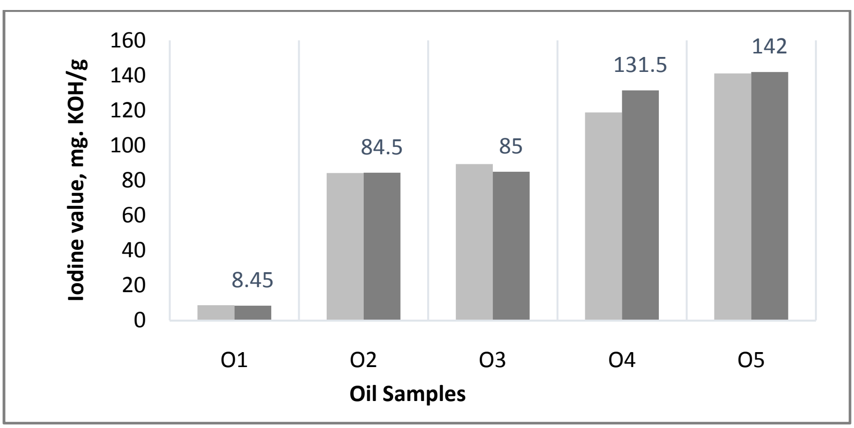

***Figure 4**: Bar graph showing Iodine Value of selected samples of oils.*

Insoluble impurities in oils refers to those materials such as dirt, minerals, resins, oxidized fatty acids, saturated or unsaturated fatty acids, proteins, etc. which remain insoluble and can be filtered off, by dissolving some oil in petroleum ether and filtering out the impurities and are expressed as a percentage (%) of the total (Celik & Bakirci, 2000). The nature of the impurities in vegetable oil foods renders them resistant to treatment by acids as in normal acidulation. Strong caustic soda solution was found to attack the gums and make them at least partially soluble in a 5 to 10 % aqueous caustic solution (Frederick et al., 1954). Low level of insoluble impurities is a desirable character of oil as the impurities may contain substances which may be harmful to humans like lead and mercury which makes the determination and knowledge of % insoluble impurities of oils and fats important. The standard % insoluble impurities for any oil or fat should not be more than 0.08 %.

The results were obtained in the range (0.004-0.078) % are shown in figure 5 2. Thus, all oil samples are in accordance to their standard range that is < 0.08 %. On comparing the insoluble impurities, castor oil had the highest and coconut oil had the lowest insoluble impurity. This indicates that coconut oil is safer in terms of impurities than castor oil since lower value of insoluble impurity is a desirable character of oils.

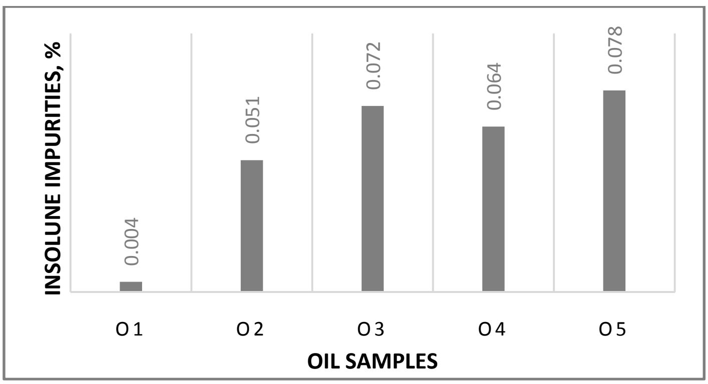

Figure 5*: Bar graph showing insoluble impurities in selected samples of oils and fats.*

Conclusion

Five different branded and certified oil samples of coconut, olive, castor, soyabean and sunflower were collected from Tansen bazaar for quality analysis under physical parameters and four chemical parameters: saponification value, acid value, iodine value and insoluble impurities to have better knowledge and understanding about the quality of oils. Following conclusions are drawn based on the result and discussion:

- Coconut oil used in this study has the highest value of saponification value among analyzed oils and hence can be used for soap making. Coconut oil has low iodine value and low insoluble impurities but the acid value showed major deviation from the standard value hence might not be the best option for consumption or as skin care product.
- Olive oil used in this study has a fair saponification value and hence good for soap making. It has low Iodine value and Insoluble impurities but has very high acid value and high percentage of free fatty acids which means the olive oil used for the study was highly oxidized and could be harmful if consumed or used as skin care product.

- Castor oil used for the study has high saponification value and thus is good for soap making. It has low iodine, free fatty acids and insoluble impurities but has slightly high acid value so it might not be good for consumption but can be used as skin care product or hair growth supplement.
- Soybean oil used in this study has good Saponification value and is moderately good for soap making. The Iodine value, Free Fatty acid value and the insoluble impurity percentage has been low and in accordance to the standard range. The acid value has been slightly out of the standard range but can be compromised. Hence, the soybean oil used for this study is fairly fit consumption.
- Sunflower oil used for the study has good saponification value and thus can be used for soap making. It has low Iodine value, acid value, free fatty acid value. The insoluble impurity percentage is slightly higher than the standard value but this deviation in the value can be compromised and hence the sunflower oil used in the study is fit for consumption.

Acknowledgements

Authors would like to acknowledge to Tribhuvan Multiple Campus, Palpa for supporting and providing available research facilities to conduct this research work at the Department of Chemistry.

Author Contributors

MG and VB designed experiments; sample collection, data analysis, and results summarization by VB and MG. The first draft of the manuscript was written by VB, and both authors read and approved the final manuscript.

References

Ackelsberg, O.J. (1958). Fat splitting. *Journal of the American Oil Chemists Society*, **35**, 635-640. DOI: https://doi.org/10.1007/BF02633824).

Alajtal, A.I., Sherami, F.E., & Elbagermi, M.A. (2018). Acid, Peroxide, Ester and Saponification Values for Some Vegetable Oils Before and After Frying. *American Association for Science and Technology Journal of Materials*, ***4**(2)*, 43-47.

Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). P. Molecular biology of the cell (4th ed.), *Garland Science*, ***91**(3)*, 401.

AOCS. (1993). *Official Methods and Recommended Practices of the American Oil Chemists Society((AOCS)*, Washington, DC.

Badmos, F.O., Usman, N.A., Onagun, Q., Arogbokun, O.A., Ezikanyi, G.K., & Kinta, M.Jr. (2019). Determination of some Physico-chemical parameters of three vegetable oils sold in Bosso market, minna, Nigeria. *Journal of Science, Technology, Mathematics and Education*, ***15**(1)*, 1-7.

Birnin-Yauri, U.A., & Garba, S. (2011). Comparative studies on some physicochemical properties of Baobab, Vegetable, Peanut and Palm oils. *Nigerian Journal of Basic and Applied Science, **19**(1)*, 64-67. (DOI: https://doi.org/10.4314/njbas.v19i1.69345).

Celik, S., & Bakirci, I. (2000). A Study on the Physical and Chemical Properties of Cookery-Type Butter, *Pakistan Journal of Biological Sciences, **3**(4),* 596-598. (DOI: https://dx.doi.org/10.3923/pjbs.2000.596.598).

Chebet, J., Kinyanjui, T., & Cheplogo, P.K. (2016). Impact of frying on iodine value of vegetable oils before and after deep frying in different types of food in Kenya. *Journal of Scientific and Innovative Research, **5**(5),* 193-196.

Chowdhury, K., Obaid, M., Lisa, S.A., & Karim, R. (2015). Evaluation on Edible Oil Quality Parameters as well as Nutritional Value of Flaxseed (Linseed) Oil in Bangladesh. *Journal of Chemical, Biological and Physical Sciences, **5**(1), 401-412.*

Christie, W.W. (2003). *Lipid analysis: isolation, separation, identification and structural analysis of lipids (3rd ed.)*. The Oily Press.

Frederick, W.K. Jr., Fred, E. B., & Fred, S.S. (1954). Impurities in Vegetable oil refining soap stock. *Journal of the American Oil Chemists' Society, **31**(7*), 298-302. (DOI: https://doi.org/10.1007/BF02639162).

Hasan, S., Jahan, R., Alam, A., Khatun, K., & AI-Reza, S.M. (2016). Study on Physicochemical Properties of Edible Oils Available in Bangladeshi Local Market.

*Archives of Research Journal International, **6**(1)*, 1-6. (DOI:

ISO 660, (1996). *Methods of sampling and tests for oils and fats: Determination of acid value and acidity*, Switzerland.

Kyari, M.Z. (2008). Extraction and Characterization of Seed Oils. *International Agro physics,* **22**, 139-142.

Morrison, R.T., & Boyd, R.N. (2002). *Organic chemistry (**6**th ed.).* Prentice Hall.

Nancy, I.A., George, Y.O., & Ebenezer, M. (2016). Repetitive Use of Vegetable Cooking Oil and Effects on Physico-Chemical Properties-Case of Frying with Redfish (Lutjanus fulgens). *Science and Technology, **6**(1)*: 8-14. (DOI: 10.5923/j.scit.20160601.02).

Nielson, S.S. (1994). Introduction to the chemical analysis of foods. New York, Chapman and Hall.

Odoom, W., & Vida, E.O. (2015). Evaluation of Saponification value, Iodine value and Insoluble impurities in Coconut Oils from Jomoro District in the Western Region of Ghana. Asian J*ournal of Agriculture and Food Sciences,* ***3**(5)*, 494-499. Retrieved from https://www.ajouronline.com/index.php/AJAFS/article/view/2938.

Omari, A., Mgani, Q.A., & Mubofu, E.B. (2015). Fatty Acid Profile and Physico-Chemical Parameters of Castor Oils in Tanzania. *Green and Sustainable Chemistry,* **5**, 154-163. (DOI: http://dx.doi.org/10.4236/gsc.2015.54019).

Otunola, G.A., Adebayo, G.B., & Olufemi, O.G. (2009). Evaluation of some physicochemical parameters of selected brands of vegetable oils sold in Ilorin metropolis. *International Journal of Physical Sciences, **4**(5)*, 327-329.

Pal, U.S., Patra, R.K., Sahoo, N. R., Bakhara, C.K., & Panda, M.K. (2015). Effect of refining on quality and composition of sunflower oil. *Journal of Food Science and Technology*, **52**(7), 4613-4618. (DOI: http://doi.org/10.1007/s13197-014-1461-0).

Pomeranz, Y., & Meloan, C.E. (1987). Food analysis: Theory and Practice (2nd edition), 81-765. (DOI: https://doi.org/10.1002/food.19720160715).

Scrimgeour, C. (2005). Chemistry of fatty acid, in Bailey of Industrial Oil and Fat Products, F. *Shahidi, Ed., **5**(6),* 1-43. (DOI:)

Sharma, S., & Jain, V.K. (2015). Acid Value of Various Domestic Uses Oil.*Research Journal of Science and Technology, **7**(2)*. (DOI: https://doi.org/10.5958/2349-2988.2015.00012.1).

Vivian, O. P., Nathan, O., Osano, A., Mesopirr, L., & Omwoyo, W. N. (2014). Assessment of the Physicochemical Properties of Selected Commercial Soaps Manufactured and Sold in Kenya. *Open Journal of Applied Sciences, 4, 433*-440 (DOI: 10.4236/ojapps.2014.48040).

Yusuf, A.K., Mamza, P.A.P., Ahmed, A.S., & Agunwa, U. (2015). Extraction and characterization of castor seed oil from wild ricinus communis linn. *International Journal of Science, Environment and Technology, **4**(05),* 1392 – 1404.