International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Assessment of Physicochemical Quality of Edible Oils in Hyderabad Urban Retail Markets

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Abstract
In the present study the quality of commercial edible oils was evaluated. The percentages of acid value, iodine value, refractive index (Butyro-Refractometer Reading-BRR), saponification value, and unsaponifiable were estimated to evaluate the quality of commercial edible oils- like sunflower oil, groundnut oil, rice bran oil, palm oil and palmolein oil sold in Hyderabad city markets to assess freshness, degree of unsaturation, identity and possible adulteration. The acid value results of all tested oils were found to be very low and well within permissible limits, indicating minimal free fatty acid content and good stability. Iodine value analysis confirmed that the degree of unsaturation of sunflower, groundnut, rice bran and palm oil samples were found to be in the standard ranges, suggesting their purity and safety. Refractive index values of olive oil and rice bran oil were also found within the standard specific ranges confirming their safety and suitability for cooking. Further qualitative parameters such as saponification value, unsaponifiable matter and BRR were also within acceptable limits for all oils, confirming purity. All oils analysed were well within the permissible acid value limits, indicating they are safe for culinary use; oils exceeding these limits would be considered unfit for consumption.

Keywords: Food Adulteration, edible oils, iodine value, saponification value, BRR

1. Introduction

Food adulteration has now a common issue that affects the quality, safety of food products, consumer trust, consumer health and well-being of public health by introducing less standard, unauthorized, or harmful substances into food products (Pririti et al., 2024; Sharma, 2017). As per the rules of Food Safety and Standards Authority of India (FSSAI) and the World Health Organization (WHO) food adulteration is the intentional or incidental addition, substitution, or removal of substances that negatively affect the nature, quality, or safety of food components that undermines food safety and consumer health (FSSAI, 2025) (Meghwal et al., 2022).

The consumption of adulterated food product exposes consumers to acute and chronic health risks, including gastrointestinal disorders, toxicity, and long-term conditions such as cancer (Sharma, 2017; Pririti et al., 2024). Mostly adulterants are substances or inferior-quality materials that are intentionally or unintentionally added to food products for economic gain or technical purposes, such as improving appearance, extending shelf life, or facilitating. Food adulteration results in degrades the nutritional value of foods introduce chemical or biological contaminants, rendering the food unsafe and unfit for human consumption. It also undermines trust in the food industry, compromise food security, and have significant economic implications. (Meghwal et al., 2022; Kumar et al., 2023).

Food adulterants can be present in a wide range of food products consumed routinely such as dairy products, cereals, pulses, grains, meat, vegetables, fruits, edible oils, and beverages causing a serious threat to food safety and public health (FAO & WHO, 2023). Certain food products such as Oils and fats, Cereals and cereal products, Spices and condiments are particularly susceptible to adulteration due to their high demand, economic value, and ease of manipulation.

Often, Oils and Fats are frequently adulterated by blending them with inferior edible or non-edible oils, incorporating synthetic colours, flavours, or preservatives, to increase their volume and profits, which can affect lipid content and quality leading to health hazards (MDPI review, 2024). For example, Olive oil is adulterated with cheaper oils like sunflower or soybean oil, Mustard oil is adulterated with argemone oil or other oils. Coconut oil is adulterated with palm kernel oil or other oils (Hu Lizhi 2019).

The most common adulterants observed are adding excessive amounts of preservatives to extend shelf life, using artificial colours to enhance appearance or mask inferior quality, Presence of foreign particles like stones to increase the weight, artificially increasing moisture content to increase weight, Mixing expensive grains with cheaper alternatives, Presence of excessive pesticide residues due to improper farming practices. All these reducing their nutritional quality and food safety (S.R. Delwiche 2016). Spices and condiments are highly valued as ingredients for their flavouring and colouring properties, aroma, and bioactive properties, make so vulnerable for adulteration. They are frequently intentionally adulterated by adding synthetic colours to enhance appearance, by adding inferior materials like starch, chalk, or brick powder to increase weight, mixing with similar-looking plants or herbs, applying coatings like talc or starch to improve appearance. All these practices introduces toxic compounds and degrades quality (Velázquez et al., 2023) (Tomas & Others, 2023). This type of adulteration with non-permitted components is most difficult to detect.

Physico-chemical evaluation is usually used for assessing the quality, safety and authenticity of edible oils. Broadly used parameters such as acid value provide information about free fatty acid content and hydrolytic rancidity, whereas iodine value indicates the degree of unsaturation (AOAC International, 2019). The refractive index/ butyro - refractometer reading (BRR) is another important physical property used to identify adulterants in oils. Moreover, saponification value gives insight into the average molecular weight of fatty acids, and unsaponifiable matter reflects the presence of non-glyceride compounds such as sterols, tocopherols and pigments (AOCS, 2017; AOAC International, 2019).

In the present study, we aim to evaluate the quality of commonly consumed commercial edible oils sold in Hyderabad city markets by comparing standard permissible limits using acid value, iodine value, refractive index, saponification value, and unsaponifiable matter of different oil samples and analysing their safety, stability and authenticity.

2. Materials and Methods

Samples of different Brands of edible oils sunflower oil, ground nut oil, Rice bran oil, palm oil and palmolein oil were taken for the analysis of food adulterants.

Sample-1 collected from Mehdipatnam market

Sample-2 collected from LB Nagar market

Sample-3 collected from Secunderabad market

Sample-4 collected from Old city market
Sodium hydroxide, Distilled Alcohol, Phenolphthalein indicator, Chloroform, Wij's solution, Potassium iodide, Distilled water, Hypo, Starch solution, Potassium Hydroxide, Alcohol, Phenolphthalein indicator, 0.5 Hydrochloric Acid, Petroleum ether.

3. Tests To Detect the Adulteration in Oils

3.1 Analysis of oils using Acid Value Test

The acid value was determined following the standard procedure described by the American Oil Chemists' Society (AOCS Cd 3d-63). Acid value is defined as number of milligrams of potassium hydroxide or sodium hydroxide required to neutralize the free fatty acids present in 1 gram of fat. The acid value (AV) is measure of the breakdown of the triacylglycerols into free fatty acids. On account of oxidation oils quality decreases, oxidation of any substance increases the acid value. For a good oil, the acid value should be very low (< 0.1). The increase in acid value should be taken as an indicator of oxidation of oil which may lead to gum and sludge formation besides corrosion.

Procedure: A known quantity of oil sample (5gms) was dissolved in a 50 ml of neutralized alcohol (to alcohol 1 drop of NaOH and 1 drop of phenolphthalein), and heat it on hot plate until bubbles are observed. The solution was titrated against 0.05N NaOH solution using phenolphthalein as an indicator until a faint pink colour persisted for at least 30 seconds. All analyses were carried out in triplicate to ensure accuracy and reproducibility. It is relative measure of rancidity as free fatty acids are normally formed during the decomposition of triglycerides.

$$\text{Acid Value} = \frac{\text{Titre value x 56.1x Normality of NaOH}}{\text{Weight of the oil taken in gm}}$$

Figure 1: Analysis of oils using Acid Value Test

3.2 Analysis of oils Iodine Value

Iodine Value (IV) of an oil or fat is the number of grams of iodine absorbed by 100g of oil/fat when determined by using Wij's solution (iodine monochloride). The iodine value is measure of amount of unsaturation (number of double bonds) in a fats or oils. The excess iodine is treated with potassium iodide, liberating iodine, which is titrated with sodium thiosulphate.

Procedure: Oil or fat sample is filtered using filter paper and dried in oven for 1hr, after cooling dissolved in 25ml of chloroform. To this, 25 ml of Wijs solution (iodine monochloride in glacial acetic acid) was added. The flask was stoppered, mixed gently, and kept in the dark at room temperature for 30 min to allow complete halogenation of unsaturated bonds.

After the reaction period, 15 ml of 10% potassium iodide solution and 50 ml of distilled water were added to liberate iodine. The liberated iodine was titrated against 0.1 N sodium thiosulphate solution with constant shaking until the solution turned pale yellow. Subsequently, 1–2 ml of starch indicator was added, upon adding of starch it turns to blue colour and titration was continued until the disappearance of the blue colour, indicating the endpoint. A blank determination was carried out under identical conditions without the sample.

Iodine Value = (Titre value x 12.69 x Normality of hypo) ÷ (Weight of oil sample in gm)

Titre Value = Blank value - Titre value

Normality of hypo = 0.0963

Weight of oil sample in gm = 20

Figure 2: Analysis of oils Iodine Value

3.3 Determination of Saponification Value (SV) of Oil/Fat

The saponification value is an important chemical index used to determine the average molecular weight of fatty acids present in oils and fats. It is defined as the number of milligrams of potassium hydroxide required to saponify 1 gram of fat/oil. Oils containing short-chain fatty acids require more KOH and therefore show a higher saponification value, whereas oils with long-chain fatty acids show a lower saponification value (AOCS, 2017; FSSAI, 2016).

Procedure: Approximately 1.5–2.0g of the prepared oil sample was accurately weighed into a 250 ml conical flask. To this, 25 ml of alcoholic KOH was added. A blank was carried out simultaneously. Both sample and blank flasks were connected to an air condenser and heated on a water bath and saponification was carried out under reflux for 1.5–2 h. A clear solution confirms the completion of saponification. The flasks were cooled, and 10 ml of hot ethyl alcohol was added. The excess KOH was then titrated against 0.5 N HCl using phenolphthalein as indicator. The endpoint was recorded as the disappearance of pink colour (pink to colourless) (FSSAI, 2016; AOCS, 2017).

Calculation

The saponification value was calculated using the equation:

SV= [(B-S) x N x 56.1] ÷ W

Where:

SV = Saponification value (mg KOH/g); B = volume of HCl used for blank (ml); S = volume of HCl used for sample (ml); N = normality of HCl; W = weight of sample (g); 56.1 = molecular weight of KOH.

3.4 Determination Of Unsaponifiable Matter:

Unsaponifiable matter includes lipides of natural origin such as sterols, higher aliphatic alcohols, pigments, vitamins & hydrocarbons.

Procedure: Approximately 1.5–2.0 g of the prepared oil sample was accurately weighed into a 250 ml conical flask. To this, 50 ml of alcoholic KOH was added. Flask is connected to an air condenser and heated on a water bath and saponification was carried out under reflux for 1 h. Then the condenser is washed with 10ml of alcohol. Saponified mixture while still warm is transferred into a separating funnel then washed the saponification flask with alcohol and then with cold water. Added 50 ml of petroleum ether and shaken vigorously. The soap layer is taken into another separating funnel and extraction is repeated 3 times using 50ml portion of petroleum ether. Combined all ether extracts then washed by 23ml aqueous alcohol and followed by 25ml of distilled water. Ether is evaporated from the ether extracts then placed the residue dish in oven for 30min for drying. Dissolved the residue with 50ml of warm alcohol and titrated with 0.02N sodium hydroxide using phenolphthalein indicator until end point colourless to pink reaches.

Formula: Unsaponifiable (A-B) ÷ Weight of sample x 100

Where, A= Weight of Residue, B = FFA of Residue

3.5 Determination of Refractive Index using Butyro Refractometer Reading (BRR)

The refractive index of given oil or fat sample is done by using a suitable Butyro refractometer., The ratio of velocity of light in vacuum to velocity of lights in the oil or fat, more generally, expresses the ratio between the sine of angle of incidence to the sine of angle of refraction when a ray of light of known wave length passes from air into the oil or fat. Refractive index varies with temperature and wavelength.

Procedure: The lens of the butyro refractometer is cleaned with alcohol using tissue paper. A drop of oil / or melted fat sample is placed on the lens. After the temperature reached at 40^0C note the reading. For all the oils temperature maintained is at 40^0C and for palm oil at 50^0C.

4. Results and Discussion

The acid value indicates the amount of free fatty acids present in oils and reflects the extent of oxidation of oils. A higher acid value suggests deterioration or adulteration of oils. The acid values obtained for different oils are presented in Table 1. All oil samples analysed here showed very low acid values, indicating good quality and safety of oils. The observed acid values were far below the maximum permissible limit for sunflower oil, groundnut oil, palmolein oil, and rice bran oil, confirming that these oils were not adulterated and safe for cooking. Among all samples analysed palm oil (0.16) and olive oil (0.176–0.18) showed the lowest acid values that shows their superior stability. Overall, acid value analysis suggests that the oils available in Hyderabad markets during the study period were of satisfactory quality and fit for consumption.

Table 1: Acid Value of Different Oils

S.No.	Oil Used	Acid value
1	Sunflower Oil, Sample1	0.19
2	Sunflower Oil, Sample2	0.19
3	Ground Nut Oil, Sample 1	0.39
4	Ground Nut Oil, Sample 2	0.50
5	Ground Nut Oil, Sample3	0.54
6	Ground Nut Oil, Sample 4	0.25
7	Palm Oil, Sample 1	0.16
8	Palmolein Oil, Sample 1	0.25
9	Palmolein Oil, Sample 2	0.25
10	Rice bran Oil, Sample 1	0.56
11	Rice bran Oil, Sample 2	0.56
12	Rice bran Oil, Sample 3	0.26
13	Olive Oil, Sample 1	0.18
14	Olive Oil, Sample 2	0.176

The iodine value (IV) measures the degree of unsaturation in oils. Oils with higher unsaturation absorb more iodine and thus have higher iodine values. This parameter is useful for identifying oil type and detecting adulteration, especially mixing with oils of different unsaturation levels.
The iodine values obtained for each oil were compared with standard limits: Sunflower oil: 100–145, Groundnut oil: 85–99, Rice bran oil: 90–105, Palm oil: 45–56.
The iodine values of different oils studied are presented in Table 2. The results clearly show that Sunflower oil samples (117.88–123.28%) fall within the standard range, confirming authenticity and high unsaturation. Groundnut oil samples (88.71–89.70%) are within the permissible range, indicating no evidence of adulteration with highly saturated or highly unsaturated oils. Rice bran oil samples (92.22%) also match the standard range, confirming purity. Palm oil sample (53.38%) falls within the expected range (45–56), confirming it is not adulterated. Thus, iodine value results indicates that the tested oils were within acceptable limits and confirming that they are not adultereted.

Table 2: Iodine Value of Different Oils

S.No.	Oil Used	Iodine value
1	Refined Sunflower Oil, Sample1	123.28%
2	Refined Sunflower Oil, Sample2	117.88%
3	Ground Nut Oil, Sample 1	88.71%
4	Ground Nut Oil, Sample 2	89.7%
5	Palm Oil, Sample 1	53.38%
6	Ricebran Oil, Sample 1	92.22%
7	Ricebran Oil, Sample 2	92.22%

The refractive index is a characteristic physical property of oils and is commonly used to detect adulteration. Each edible oil has a specific refractive index range depending on fatty acid composition and temperature. The refractive index for olive oil samples and rice bran oil samples were analysed and the results are shown in Table 3. All refractive index readings were consistent and within the permissible ranges. This indicates that the refractive index of olive oil sample and rice bran sample matched the standard refractive index range, confirming it is not adulterated, confirming purity. Therefore, refractive index analysis further supports the conclusion that the oils tested in this study were authentic and not adulterated.

Table 3: Refractive Index using Butyro Refractometer

S. No	Oil Used	Refractive Index	Adulteration
1	Olive Oil	Refractive index at 20^0 Reading-1(R1) = 1.4689 Reading–2(R2) = 1.4690 Reading–3(R3) = 1.4697	These 3 readings indicate the olive oil sample is not Adulterated. [NOTE: Olive oil range is in between 1.4680 to 1.4707]
2	Rice bran Oil	Refractive index at 40^0 Reading -1 (R1) = 60.36 Reading – 2(R2) = 60.36 Reading – 3(R3) = 60.36	These 3 readings indicate the olive oil sample is not Adulterated. [NOTE: Rice bran oil range is in between 51.0 to 66.4]

4.1 Saponification, Unsaponifiable Matter & BRR

The qualitative testing edible oils was carried out using saponification value, unsaponifiable matter, and butyro-refractometer reading (BRR) as shown in Table 4. These parameters are useful for assessing the purity, identity, and possible adulteration of edible oils.

The saponification value reflects the average molecular weight of fatty acids present in the oil, oils containing shorter-chain fatty acids generally show higher saponification values. The saponification values for sunflower oil (188–194), rice bran oil (180–195), palm oil (195–205), palmolein oil (195–205), groundnut oil (188–196) and olive oil (184–196) were found to match the standard ranges prescribed for these oils. This confirms that the fatty acid composition of these oils is consistent with their identity and these oils were found to be free from adulteration.

Unsaponifiable matter includes non-fatty components compounds such as sterols, tocopherols, pigments, hydrocarbons that do not form soap with alkali. Higher levels may indicate poor adulteration. The unsaponifiable matter was found to be in permissible limits for all oils sunflower oil (**NMT 1.5%**), rice bran oil (**NMT 3.5%**), palm oil (**NMT 1.2%**), palmolein oil (**NMT 1.2%**), groundnut oil (**NMT 1.0%**) and olive oil (**NMT 1.5%**). These findings suggest that the oils are free from excessive non-glyceride impurities.

Butyro-refractometer reading value is related to the refractive index of the oil and is commonly used as a quick quality and identity check. Most oils showed a BRR of **40°**, which is typical for these edible oils. **Palmolein oil** showed a lower BRR value (**20°**), which can be attributed to its characteristic composition and physical properties compared to other oils. Since the value aligns with the expected range for palmolein, it does not indicate adulteration.

Therefore, it can be concluded that the oils available during the study period were safe for cooking and consumption.

Table 4: Qualitative Parameters of Different Edible Oils - Saponification, Unsaponifiable Matter & BRR

Oil Sample	Saponification Value (Standard Range)	Unsaponifiable Matter (NMT %)	BRR (°)	Remarks
Sunflower oil	188–194	NMT 1.5%	40	Within standard limits
Rice bran oil	180–195	NMT 3.5%	40	Within standard limits
Palm oil	195–205	NMT 1.2%	40	Within standard limits
Palmolein oil	195–205	NMT 1.2%	20	Within standard limits
Groundnut oil	188–196	NMT 1.0%	40	Within standard limits
Olive oil	184–196	NMT 1.5%	40	Within standard limits

5. CONCLUSION

The present study of food adulteration in commercial edible oils analysed from Hyderabad markets were found to be good in quality and were falling in the standard permissible limits. All oil samples showed low acid values, confirming low free fatty acid content and indicating safety, freshness and stability. Iodine value results confirmed that the degree of unsaturation of the commercial edible oils are in the expected standard ranges, showing no evidence of adulteration. Refractive index, saponification value, unsaponifiable matter and BRR results further supported the purity and safety of the tested oils. Overall, the observed values for most oil samples were found to be within the permissible limits, indicating that the oils were of acceptable quality for consumption. Regular monitoring of edible oils using such physico-chemical parameters is recommended to ensure consumer safety and prevent adulteration in the market.

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