

# Assessment on quality of some edible cooking oils sold in local market using AV, PV, smoke point, flash point and fire point

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**Abstract:** Chemical reactions like oxidation and hydrolysis occur when oil is heated repeatedly due to thermal decomposition. During frying, oil or fat is exposed to heat. Therefore, thermal, oxidative, and hydrolytic decomposition of the oil may occur. Fats and oils are oxidized to form hydroperoxides, the primary oxidation products. These peroxides are extremely unstable and decompose and formation of chemical products, such as alcohols, aldehydes, ketones, acids, dimers, trimers, polymers, and cyclic compounds. In this research, the assessment of qualitative quality of different widely used sixteen cooking oils used in kitchen for the study of smoke point and peroxide value, acid value, flash point and fire point were investigated using standard procedures. Acid values were ranged between 0.33-4.48 mg KOH/g ( $\pm 0.05$ ), PV were ranged from 0.6-6.8 Meq/kg ( $\pm 0.18$ ), In case of Smoke point, it is in the between 191-265<sup>o</sup>C (0.43). Flash and Fire point values were ranged between 278-329<sup>o</sup>C ( $\pm 0.31$ ) and 313-378<sup>o</sup>C ( $\pm 0.22$ ) respectively. Furthermore, AV and PV are higher in some oil samples which implies that the quality of these samples are slightly poor. The vegetable oils that do not undergo rancidity should be well below 10 meq/kg. The standard deviation for AV, PV, Smoke, Flash and Fire point are in the range of 0.05-0.43 while in case of standard mean error it is in the range of 0.03-0.25. The present study concludes with the observation that the majority of edible vegetable cooking oils available in the local market of Jalgaon city of Maharashtra are pure in nature and also conforms to the safety standards.

**Keywords:** Cooking oil, acid value, peroxide value, smoke point, flash point and fire point

## 1. Introduction:

Lipids and triacylglycerol naturally occur in oils and fats. Their chemical composition contains saturated and unsaturated fatty acids and glycerides. Different physical and chemical parameters of edible oil were used to monitor the compositional quality of oils [1-2]. These physico-chemical parameters include iodine value (IV), saponification value (SV), viscosity, density and peroxide value (PV). flash point, smoke point, fire point and fatty acid composition. Edible oils are one of the main constituents of the diet used for cooking purposes. Several researchers studied the impact of temperature on the stability; viscosity, peroxide value, and iodine value to assess the quality and functionality of the oil [3-5].

Heating oil changes its characteristics. Oils that are healthy at room temperature can become unhealthy when heated above certain temperatures; this is due to the changes occurring in their chemical composition during the process of heating. When choosing cooking oil, it is important to match the oil's heat tolerance with the cooking methods used. The smoke point of any oil depends primarily on its free fatty acid content (FFA) and molecular weight. Through repeated use, as in deep frying, the oil accumulates food residues or by-products of the cooking process that lower its smoke point further [6].

## 1.2. Related work

Several chemical reactions during frying such as hydrolysis, oxidation, polymerization, fission and isomerization take place. The presence of oxygen, moisture, trace elements and free radicals at the high temperatures used in frying accelerate the breakdown process. These reactions change the oil from a medium that is almost pure triacylglycerol when fresh to one that contains literally thousands of different degradation

compounds. These can compromise the texture, taste, flavor, and the overall perception of the fried product. Additionally, potential risk to human health and nutrition may arise [7]. Oils with higher amounts of PUFA are not stable to oxidation and the products fried using such oils have shorter shelf-life. PUFA oils quickly break down at frying temperatures to form gums. Some physical changes such as increased viscosity and foaming, color changes and decreased smoke-point, also occur. Also, a vast number of volatile compounds are formed during the frying process, depending on the nature of the oil used and the frying conditions employed. The volatiles cover different classes of compounds, like alkanes, alkenes, alcohols, saturated and unsaturated aldehydes/ ketones, and short chain fatty acids. These compounds are responsible for the distinctive pleasant odor and the unpleasant flavor of abused frying oil and can be used as markers of frying oil quality [8-10].

Acid value (AV) are measure of hydrolytic rancidity of fats and oils. Presence of excess acid value (more than 0.5) or free fatty acid (more than 0.25%, expressed as oleic acid) in edible oil is not desirable. If FFAs are present in excess quantity in the oil samples they may cause few health hazards and decrease the smoke point of the oil. Increased level of free fatty acid may occur due to poor neutralization process or hydrolysis of triglycerides by the exposure of oil to moisture, light, lipase enzyme and high temperature which commonly exists in Indian climate. Peroxide value (PV) is used as a measure of the extent to which rancidity reactions have occurred during storage due to formation of primary oxidation products and thus can be used as an indicator of the quality and stability of fats and oils [11].

It is the amount of peroxide oxygen present in 1 kilogram of oil. It is expressed in units of mill equivalents. In general fresh oils have a peroxide value of less than 10 mEq/Kg while peroxide values in the 30-40 mEq/Kg range are generally associated with a rancid taste. Rancid oil forms harmful free radicals in the body which increase the risk of cancer, heart disease, cellular damage and have been associated with diabetes, Peroxides accelerates ageing, raised cholesterol levels, obesity etc. smoke point refers to a temperature at which oil burns or give out smoke [12].

Vegetable oils played an important role in our diet. The high temperature during cooking would lead to the production of smoke containing the degradation products of oils, which were uncomfortable and harmful to health. To satisfy consumers' requirement, the refining technology of vegetable oils need to ensure the thermal stability of vegetable oils. The requirement of less smoke, vegetable oils should possess certain thermal stability, which was evaluated by smoke point and dependent on the content of the minor compounds[13].

Acc. to literature, smoking point and flash properties of edible oil at high temperature using point temperatures of edible oil should be found near to 250°C and 300°C respectively and its drop down due to heating. The temperature limit up to which oil can be used is given by smoke point. Heating oil until it gives smoke produces harmful free radicals. An attempt was made to suggest that selection of particular oil for different types of cooking is important to match oils heat tolerance with cooking method[14].

Most vegetable cooking oils have smoke points between 165°C and 260°C [15-16]. The smoke point of any oil is the temperature at which that particular oil begins to burn and produce smoke. This is the temperature the oil begins to break down to glycerol and free fatty acids. The glycerol is then further broken down to acrolein which is a component of the smoke. It is the presence of the acrolein that causes the smoke to be extremely irritating to the eyes and throat. The smoke point also marks the beginning of both flavour and nutritional degradation [16-17].

Smoke point was used to evaluate the thermal stability of vegetable oils, which corresponded to the lowest temperature when the thermal decomposer or impurities volatilize continuously. There are several nontriglyceride components in crude oils with a boiling point lower than that of triglycerides, such as free fatty acid, peroxide, phosphorus, solvent, water and other volatile matters[18].

Refinement processes include bleaching, filtering, and high-temperature heating to extract and eliminate those extraneous compounds. Refined oils are neutral-flavored with a longer shelf life and a higher smoke point. Over heating an oil with low smoke point produces harmful free radicals which initiate cellular damage and other

harmful diseases. Comparatively unrefined oils will have high smoke point than refined oils because they contain impurities and free fatty acids. Oils with high smoke point are better suited for cooking at high temperatures. According to the opinion of the Experts, the smoke point of a cooking oil must be at least 170 °C and must not differ from the temperature of the fresh fat by more than 50 °C so that the fat can still be classified as usable. Smoke point of an oil increases as free fatty acid content decreases. Heating an oil produces free fatty acid and as heating time increases, more free fatty acids are produced, thereby decreasing smoke point [19].

Refining process of vegetable oils could remove non-triglyceride components, increasing the smoke point and the stability significantly [20]. The removal of the minor compounds to extend the shelf-life and thermal stability of vegetable oils, loss of the micronutrients such as tocopherols and sterols, formation of the harmful trans fatty acids, polymeric triacylglycerols, and oxidized triacylglycerols. It was necessary to clarify the effects of the changes of minor compound contents on smoke point [21-23].

Considerably above the temperature of the smoke point is the “flash point”, the point at which the vapors from the oil can first ignite when mixed with air. Even if smoking point is not reached even high heating can cause harm with some oils. The fire point is the higher temperature at which the oil vapours will continue to burn when ignited. In general, flash point is 50-70 °F less than the fire point [24].

The aim of present study was to evaluate the chemical properties such as Acid value (AV), Peroxide value (PV), Smoke point (SP), Flash point (FP) and fire point (fp) of some edible cooking oils were measured and to assess the quality of oil and which oil is better for frying and cooking.

## 2. Materials and Methods

All the chemicals reagents and glassware used in this analytical work are analytical grade. Sixteen different widely used cooking edible oil samples coded as Groundnut oil (Gn), Palm (Pm), Cottonseed (Ct), Sesame (Ss), Buffalo ghee (Bg), Cow ghee (Cg), Safflower (Saf), Soyabean (Sb), Coconut (Cn), Mustard (Mu), Ricebran (Rb), Olive (Ol), Hydrogenated vegetable (Hv), Sunflower I (Sf (I)), Sunflower (Sf), Filtered groundnut (Fgn), Almond (Am), Canola (Cn), Corn (Cr), and Palmolein (Pmn) were purchased from some food supply markets in Jalgaon city of Maharashtra, India and home kitchen uses and summarized in table 1. In this study, cooking oil samples of different brands having different manufacturing date and were subjected to analysed in the laboratory for acid value, peroxide value, smoke, flash and fire point of different edible cooking oil were measured according to the AOCS and AOAC [25-29].

**2.1 Determination of Acid value :** Acid value was measured by titration with sodium hydroxide according to the American Oil Chemists' Society (AOCS) method Cd 8-53 (AOCS, 1989b) [40-44].

### 2.2 Method for Determination of smoke point [25-29]

Each oil has its own smoke point. Heating oils beyond their smoke point, the temperature at which the oil begins to smoke, generating toxic fumes and harmful free radicals. Always discard oil that's reached its smoke point, along with any food with which it had contact. The smoke point of each oil was carried out using YD-1 Full automatic Oil Smoke Point instrument based on AOCS Official Method Cc 9a-48. A test portion of each oil was filled into a cup, and heated until a continuous bluish smoke appeared. Each measurement was made by duplicate.

**2.3 Method for Determination of Peroxide value:** The acetic acid-chloroform method of the AOCS (Method Ca 5a-40) was used for determination of the peroxide value (PV) (AOCS, 1989c) [25-29]

### 2.4 Method for the determination of flash point and fire point [25-29]

The method determines the temperature at which the sample will flash when a test flame is applied under the conditions specified for the test using Pensky-Martens closed cup apparatus with thermometer apparatus which consist of oil cup, air path, shutter, pilot burner and flash test burner. Thoroughly clean and dry all parts of the cup and its accessories before starting the test, being sure to remove any solvent which had been used to clean

the apparatus. Support the tester on a level steady table. Fill the cup with the oil to be tested up to the level indicated by the filling mark. Place the lid on the cup and properly engage the heating devices. Insert the thermometer, light the test flame and adjust its diameter. Heat the sample so that the temperature increase is about 5 to 6°C per min with stirring. Apply the test flame, At every 5°C rise in temperature, discontinue stirring and by opening the device which controls the shutter and lowers the test flame into the shutter opening. Lower the test flame in for 0.5 second and quickly return to the raised position. Do not stir the sample while applying the test flame. As soon as the test flame has been returned to the raised position, resume stirring. The flash point is the temperature indicated by the thermometer at the time of the flame application that causes a distinct flash in the interior of the cup. **The heating is continued after every 10°C rise in temperature, the oil vapors are tested for fire points. The temperature at which the experimenting oil catches fire at least 5 sec. is recorded as its fire point[25-29].**

The oil sample is filled up to the mark in the cup. It is heated with constant stirring at the rate of about 50C per minute. At every 10C rise in temp, test flame is introduced for a moment with the help of a shutter door. When test flame produces a distance flash in the oil cup, the temperature noted and recorded as flash point. The heating is continued after every 10C rise in temp, the oil vapors are tested for fire points. The temperature at which the experimenting oil catches fire at least 5 sec. is recorded as its fire point.

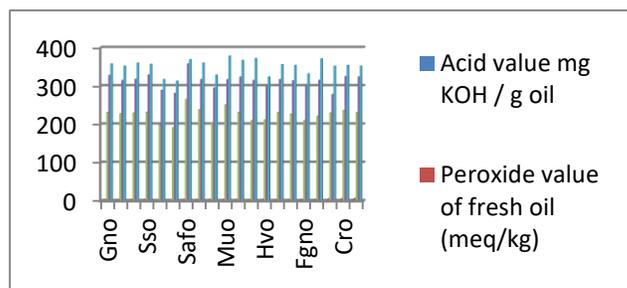
#### 4.0 Experimental results of different edible vegetable oils

**Table 1.** Chemical characteristics of different brand of cooking oils

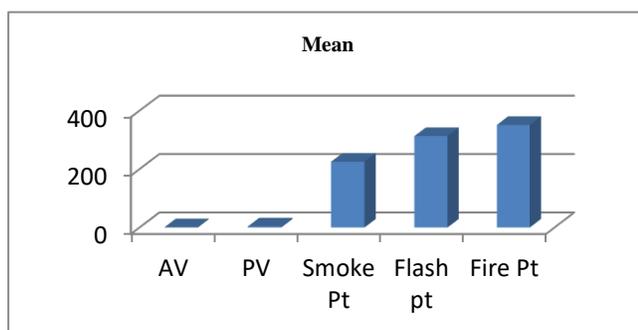
S.No	Oil Code	AVmg KOH / g oil	PV (meq/kg)	Smoke point (°c)	Flash point (°c)	Fire point (°c)
1	Gn	0.44	3.6	231	328	358
2	Pm	2.33	4.2	228	315	352
3	Ct	0.33	3.88	230	318	360
4	Ss	1.34	3.34	232	329	357
5	Bg	0.66	0.6	198	289	317
6	Cg	0.88	0.7	191	281	313
7	Saf	0.55	4.2	265	358	369
8	Sb	0.52	3.6	238	317	360
9	Cc	1.35	4.2	205	295	329
10	Mu	1.34	3.8	251	317	378
11	Rb	0.52	3.7	231	324	367
12	Ol	0.56	2.5	210	315	372
13	Hv	1.34	4.5	212	302	324
14	Sf(I)	0.50	2.90	231	317	356
15	Sf	0.52	2.90	227	314	354
16	Fgn	2.34	3.67	210	302	332
17	Alm	2.05	4.1	221	315	371
18	Cn	0.56	5.6	230	278	352
19	Cr	0.44	5.8	236	325	354
20	Pmn	4.48	6.8	231	324	352
21	Total	23.05	74.59	4508	6263	7027
22	Mean	1.15	3.73	225.4	313.15	351.35
23	SD	0.05	0.18	0.43	0.31	0.22
24	CV	4.35	4.89	0.19	0.09	0.06
25	SEM	0.03	0.1	0.25	0.18	0.13

#### 5. 0 Statistical Analysis:

The data obtained from the experimental measurements and accuracy of different parameters for different varieties of oils have been analysed. The Statistical parameter like standard deviation, coefficient of variance and standard mean error were calculated for AV,IV,SV and EV for different brands of oils before and after frying. All the experiment was carried out in triplicate and the results are presented as the mean  $\pm$  SD, CV,  $\pm$  SEM. Accuracy and descriptive Statistics of different oils from different parts of India as shown in figure1to2.



**Figure 1.**Plot of different characteristics of different edible vegetable against the obtained experimental data



**Figure 2.** Accuracy and descriptive Statistics of different edible vegetable oils from different parts of India as shown in figure 2.

## 6. Results and Discussion

Some Physicochemical characteristics of different brands of sixteen edible vegetable cooking oils available in local market of Jalgaon city have been extensively investigated for AV, PV, Smoke, Flash and Fire point. The experimental obtained results of above physicochemical characteristics of cooking oils are illustrated with codex and FSSAI food safety standards in Tables 1 and accuracy and descriptive statistical are shown in figures 1-2. **In the view of the results shown in Table 1, all the samples have acceptable AV was found in between 0.33-4.48 except samples 2,4,9,13,16,17 and 20 which have slightly higher values, which are however not in significant level and so have minimal adverse effect on health. As per codex and FSSAI food safety standards, the oil with PV less than 10 is safe for human consumption. The PV of different vegetable oils marketed in Jalgaon was found to be between 0.6-6.8 meq/kg oil. Samples 2,4,9,13,16 and 17 had the peroxide value below 5 (Table 1). The other three samples coded as Cn(5.6,Cr(5.8) and Pmn(6.8) had PV greater than 5. Possible reasons for higher peroxide values are poor packaging and storage conditions. Flash, Smoke and Fire point of all these oil samples conforms as per the prescribed limit of safety standards. The results will help us for selecting a good quality edible oil. The observation results concluded that we should consider the physicochemical properties for selecting good type edible oil. The standard deviation for AV, PV, Smoke, Flash and Fire point are in the range of 0.05-0.43 while in case of standard mean error it is in the range of 0.03-0.25.**

## 7. Conclusion

The present study concludes with the observation that the majority of edible vegetable cooking oils available in the local market of Jalgaon city of Maharashtra in pouch or bottle are pure in nature and also conforms to the safety standards. All the physico-chemical characteristics (AV, PV, Smoke point, Flash point and Fire point) have been studied and used for quality ascertain of vegetable cooking oil samples available. Almost all the physicochemical properties of the product were analysed and it has been seen that samples 2,4,9,13,16,17 and

20 have slightly higher AV levels which implies that the quality of these samples are slightly poor. The same samples of higher AV has a slightly higher PV value which signifies which indicates the oxidation or rancidity of oil sample, indicating a long or improper storage of oil. Flash, Smoke and Fire point of all these oil samples conforms as per the prescribed limit of safety standards. **The study shows that when the PV and AV are high which are slightly poor qualities edible oils.**

The vegetable oils that do not undergo rancidity should be well below 10 meq/kg.

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