# Quality Evaluation and Safety Assessment of Different Cooking Oils Available in Pakistan

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**Summary:** The present study was conducted to evaluate the quality of cooking oils available in Pakistani market. The physicochemical qualities of 35 commercially available cooking oil brands were investigated for free fatty acid, peroxide value, smell, weight, color, rancidity, foreign matter, appearance and cold point. Analysis showed that free fatty acid, peroxide, smell, weight and rancidity value significantly deviate from standards set by Pakistan standard quality control authority (PSQCA). However, color, foreign matter, appearance and cloud point values were in limits set by PSQCA. In terms of vitamin only 71.43±2.32% brands contain vitamins. These results confirm the presence of adulteration and deviation of product development from quality limits sets by Pakistan standard quality control authority.

Keywords: Cooking oil, quality evaluation, Pakistan, brands, free fatty acid, color

## Introduction

Oil and fat are important constituents of our diet and contribute significantly for development and regulation of different functions of our body. There are three main sources of oil and fat i.e. plants, marine and animal source. These are necessary for a healthy life and one third of total calories must come from oil and fat. Major edible oil is extracted from soybean, sunflower, cottonseed, canola and olive.

Fats consist of a wide group of compounds that are soluble in organic solvents and insoluble in water. They have lower densities than water at normal room temperature and they have consistency from liquids to solids, depending on their structure and composition. Chemically, fats are generally triesters of glycerol and fatty acids. Although the words “oils”, “fats” and “lipids” are all used to refer to fats, “oils” is usually used to refer fats that are liquids at normal room temperature, while “fats” is usually used to refer fats that are solids at normal room temperature. “Lipids” is used to refer to both liquid and solid fats [1].

Triacylglycerols are the predominant components of most food fats and oils. The minor components include mono and diacylglycerols, free fatty acids, phosphatides, sterols, fatty alcohols, fat-soluble vitamins, and other substances [2].

Pakistan is deficient in cooking oil and a large share of foreign exchange is spent on its import. During 2009-10 Pakistan spent 77.78 billion rupees on import of 1.246 million tons of edible oil. While oil consumed from local market is estimated to be 0.680 million tons during 2009-10 [3]. Pakistan mostly imports edible oil in form of seed and crude oil and refining is done in Pakistan. In recent year there is a rapid increase in edible oil refining industries but at the same time decline in quality of finished product was also observed. Nowadays, a large number of cooking oil industries is marketing edible oil in Pakistani market but their oil quality does not meet with the standards set by Pakistan Standard Quality Authority (PSQCA).

Quality of cooking oil can be judged by testing different parameter of cooking oil. Free fatty acid (FFA) value indicates quality of raw material, processing, degree of purity and storage condition [4]. Per oxide value (POV) is also an indicator of quality of oil and fats. To measure oxidative rancidity POV is used [5]. Colors values give information about quality of bleaching. Hydrolysis of ester by moisture or enzyme is called hydrolytic rancidity. By enzymatic action it produces free fatty acids (FFA). At higher temperature it may cause non-enzymatic ally by producing FFAs [4]. By oxidative and hydrolytic degradation commercial shelf life of oils decreases which results in low quality of product.

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Lipid oxidation effects negatively on taste, aroma and nutrition. It also causes health hazard, like biological damage of living tissues and increase in the risk of cardiovascular diseases [6]. Oxidized oil, effects the taste of food negatively in which it is added and also causes some health problem such as diarrhea and poor growth rate [7].

The main objective of this study was to determine the quality of edible oil produced by different industries in Pakistan and to draw the attention of consumers and concerned authorities towards the consequences of its poor quality.

## Results and Discussion

### *Free Fatty Acids*

FFA values obtained from cooking oil samples ranged from 0.03±0.004 to 0.80±0.03% in different brands (Fig. 1). Free fatty acid analysis showed that the free fatty acid values significantly deviate ($P<0.05$) from standard value (≤0.2%). Out of 35 samples which are evaluated for quality of cooking oil, only 24 samples (68.57%) were according to standards of PSQCA (≤0.2%) and 11 samples (31.43%) were not fulfilling the PSQCA standard (Table-1). The free fatty acid analysis revealed that 17% sample have excellent quality (<0.068), 23% sample lie in good quality range (0.068-0.13), 29% sample have acceptable quality (0.14-0.20),14% sample have low quality (0.21-0.27) and 17% samples were lie in very low quality range (0.27%). If Free Fatty Acids are in excess in quantity they may cause several health hazards. The increase in the level of FFA in plasma may cause obesity and type 2 diabetes mellitus [8].

Increased level of free fatty acid may be due to poor neutralization process. Hydrolysis of triglycerides [9] and deterioration of oil also increase free fatty acid. Other factors which increase fatty acid level in cooking oils are exposure to light [10], lipase enzyme [11] and high temperature [4] which commonly exists in Pakistani climate.

### *Per oxide Value*

The value of peroxide is a measure of active oxygen bound by cooking oils. The mean per oxide values of different cooking oil brands, are presented in Table-1. Values of peroxide deviate significantly ($P<0.05$) from standard value (10 meq of $O_2$/Kg). Per oxide values obtained from analysis of different cooking oils showed that their values ranged from 0.7±0.1 to 84±1.25. Analysis results showed that POV of 28 samples (Fig. 2) lies within the range prescribed by PSQCA and Codex Alimentarious Commission (10 meq of $O_2$/Kg) and 7 samples were not falling in the range prescribe by PSQCA and Codex Alimentarious Commission. Per oxide values obtained from analysis of different cooking oil brands revealed that 52% sample was of excellent quality (<3.33), 17% samples have good quality (3.33-6.67), 11% samples were of acceptable quality (6.68-10), 9% were of low quality and remaining 11% samples lie in very low quality range (>13.33).

Possible reasons for higher peroxide values are poor packaging and storage conditions. Cooking oils are rich in unsaturated fatty acids especially linoleic and linolenic acid which have 25 time higher oxidation rate than oleic acid [12, 13]. Antioxidants can suppress oxidation of cooking oils. Sometimes polyphenolic compounds act as anti-oxidant which is present naturally in food or added intentionally in cooking oils to lowers theperoxide value [14].

### *Rancidity*

The rancid cooking oil have undesirable color and flavor. Rancidity values of different brands deviate significantly ($P<0.05$) from standard value (≤10). Rancidity in cooking oil brands ranges from zero to 15. Mean rancidity values of different cooking oil brands are given in Fig. 3. Out of 35 samples 27 lies within the range of PSQCA standards. Values of 8 samples were out of range. Analysis results showed that 52% samples have excellent quality (<1.1), 11% were of good quality (1.1-2), 14% lies in acceptable quality range (2.1-3), 3% were of low quality and remaining 20% were of very low quality with respect to rancidity values. Some sample values were very higher than standards which indicate poor processing and storage condition. Many health risk are associated with it because the compounds which are produce in rancid cooking oils have harmful effects in experimental animals [15].

The present results are in relation with findings of Mendez and Falque [16] that oil which are pack in tin pack resist rancidity because of blockage of light. Out of 7 samples which were rancid only one is pack in tin pack. Cooking oil pack in poly pouches is more susceptible to rancidity.

### *Color*

Color of the cooking oil is due to carotenoids and some other pigments [17]. As it is given in Table-1 that range of cooking oils colors is from Y:80-R:8 to Y:3.4-R:0.9. Color values did not deviate significantly ($P>0.05$) from standard values (Fig. 4 and 5). Color of most of the samples was satisfactory. In 91.43% samples color value is according to PSQCA standards (Y: 50 – R: 5) and 54% samples lie in excellent quality range with respect to color value (Y<16.67 and (R<1.67) .Only 8.57% samples deviate from this value. More color value may be due to poor bleaching procedure or the product is exposing to higher temperature for a long time.

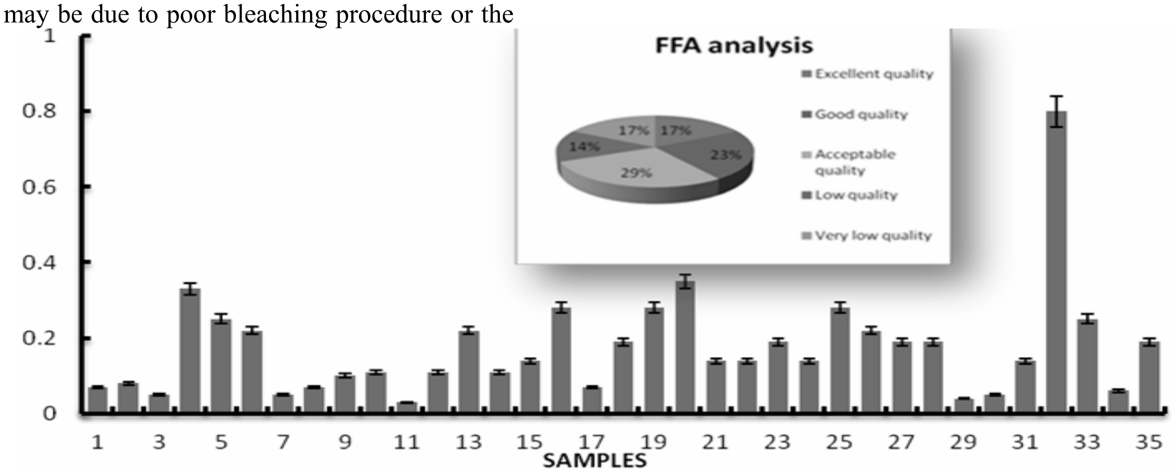


Fig. 1: Free fatty acid (FFAs) variation in 35 cooking oil samples.

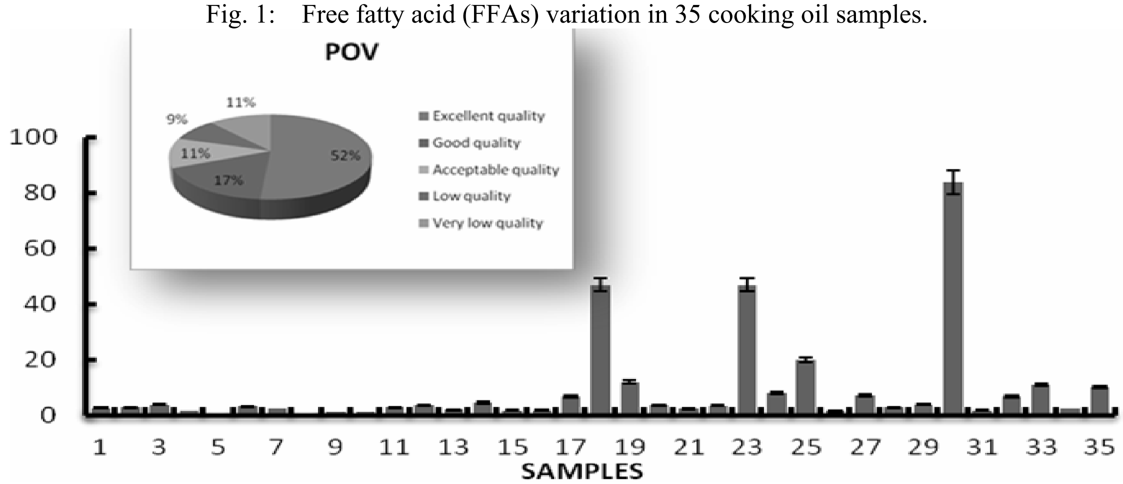


Fig. 2: Peroxide value (POV) variation in cooking oil samples.

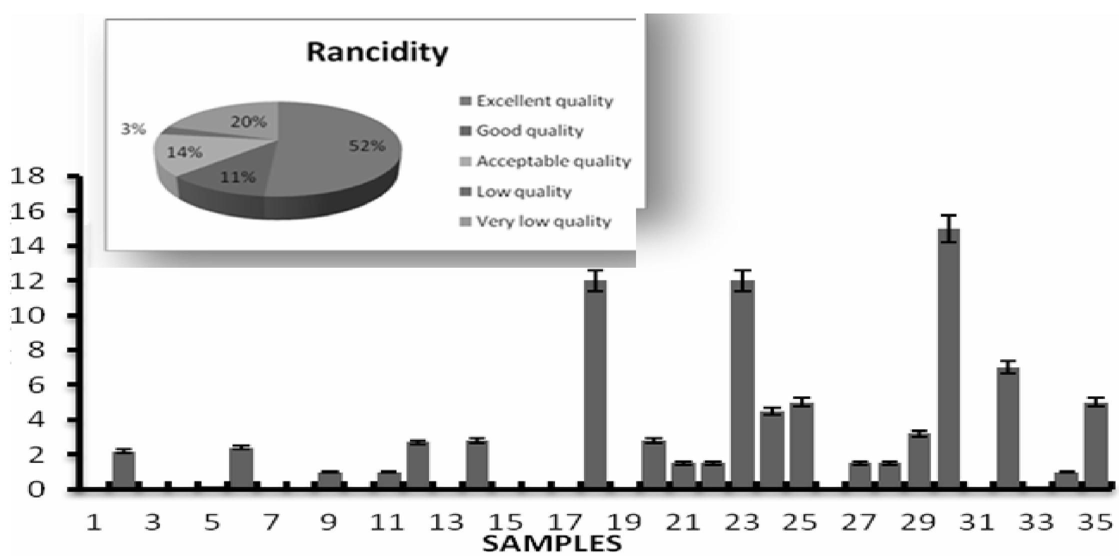


Fig. 3: Rancidity variation in 35 cooking oil samples.

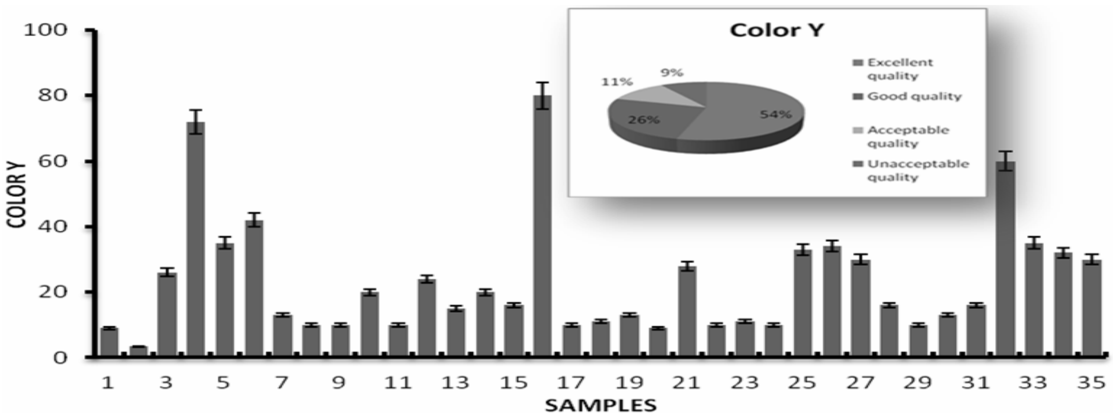


Fig. 4: Color Y variations in cooking oil samples of different brands in Pakistan.

Table-1: Frequencies distribution of 35 cooking oils in terms of FFA, POA, Rancidity, Color and Cloud point.

Frequency distribution of free fatty acid values

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 0.068 | 6 |
| 2 | 0.068 – 0.13 | 8 |
| 3 | 0.14 – 0.20 | 10 |
| 4 | 0.21 – 0.27 | 5 |
| 5 | > 0.27 | 6 |

Frequency distribution of per oxide value

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 3.33 | 18 |
| 2 | 3.33 – 6.67 | 6 |
| 3 | 6.68 – 10 | 4 |
| 4 | 10.1 – 13.33 | 3 |
| 5 | > 13.33 | 4 |

Frequency distribution of rancidity

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 1.1 | 18 |
| 2 | 1.1 – 2 | 4 |
| 3 | 2.1 – 3 | 5 |
| 4 | 3.1 – 4 | 1 |
| 5 | > 4 | 7 |

Frequency distribution of color Y

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | > 16.67 | 19 |
| 2 | 16.67 – 33.33 | 9 |
| 3 | 33.34 – 50 | 4 |
| 4 | > 50 | 3 |

Frequency distribution of color R

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 1.67 | 20 |
| 2 | 1.67 – 3.33 | 8 |
| 3 | 3.33 – 5 | 4 |
| 4 | > 5 | 3 |

Frequency distribution of cloud point

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 3.33 | 11 |
| 2 | 3.34 – 6.67 | 4 |
| 3 | 6.68 – 10 | 10 |
| 4 | 10.1 – 13.33 | 8 |
| 5 | > 13.33 | 2 |

Redness of cooking oils is due to formation of polymers [18] and yellow color is due to combined peroxide and aldehydes in cooking oils [17]. Another factor is lipase enzyme which effect taste, color and aroma by breaking ester bond [4, 11]. Apart from these processing techniques are also play role in variation of color polyphenols which are present in cooking oils affected by processing techniques [19].

*Vitamin addition*

There is a deficiency of vitamin A in Pakistani population and this vitamin is a fat soluble. Keeping of above fact PSQCA recommend addition of vitamin A in cooking oil to a range of 33,000 IU ±10%. But practically no addition of vitamin is in practice. More than half samples have no Vitamin A addition. Out of 35 samples only 10 samples contain vitamin A which is 28.57% of total samples. 71.43% samples do not contain any vitamin A addition (**Fig. 6**).

*Cloud point*

Mean values of cloud point are given in Fig. 7. Cloud point ranges from 1°C to 14°C for different cooking oil brands and did not deviate significantly from standard value (10°C). Analysis results indicate that 10 samples do not fulfill this criterion and appear as cloudy on this temperature. 25 samples were according to standard. Cloud point analysis revealed that 31% samples have excellent quality (<3.33°C), 11% samples are of good quality (3.34-6.67), 29% samples were lie in acceptable quality range (6.68-10°C), 23% have low quality (10.1-13.33°C) and 6% were of very low quality ( >13.33°C).

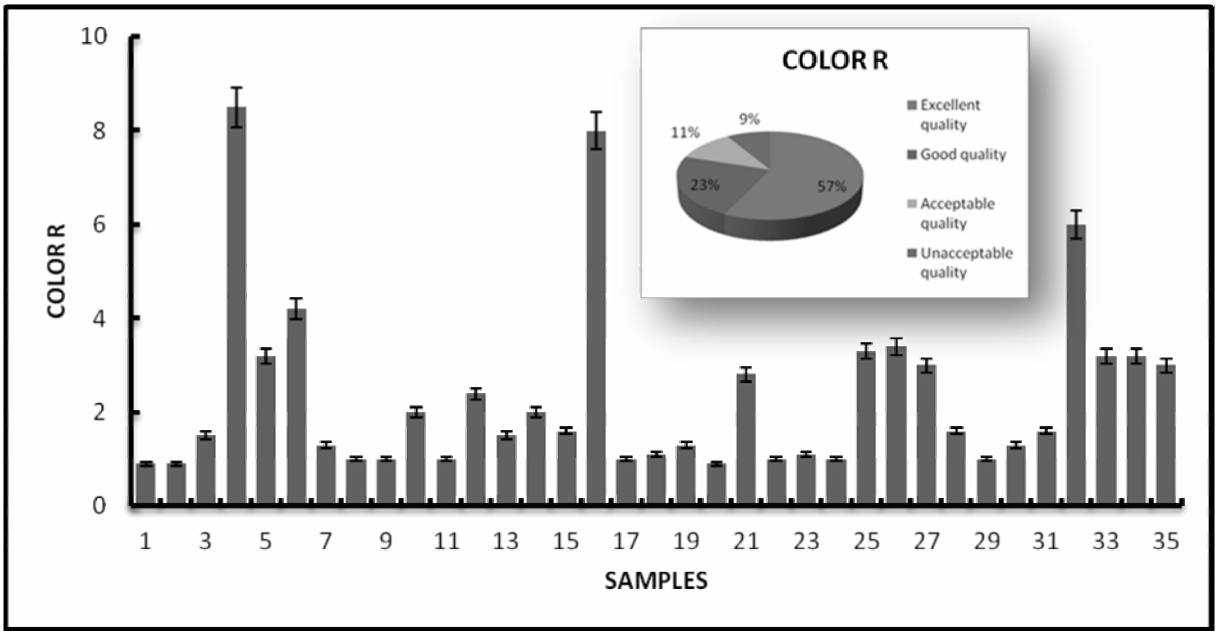


Fig. 5: Color R variations in cooking oil samples of different brands in Pakistan

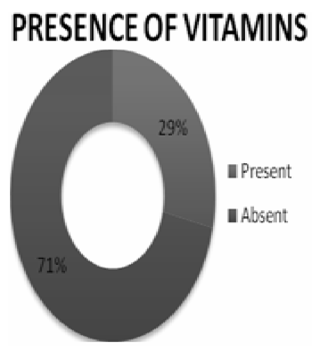


Fig. 6: Presence of vitamins in cooking oil samples

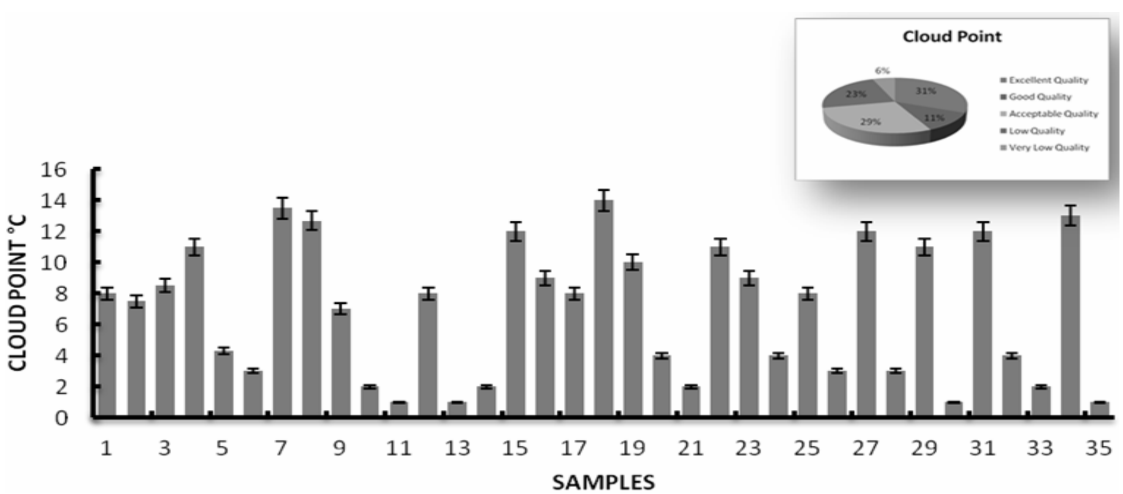


Fig. 7: Cloud point variations in cooking oil samples of different brands in Pakistan

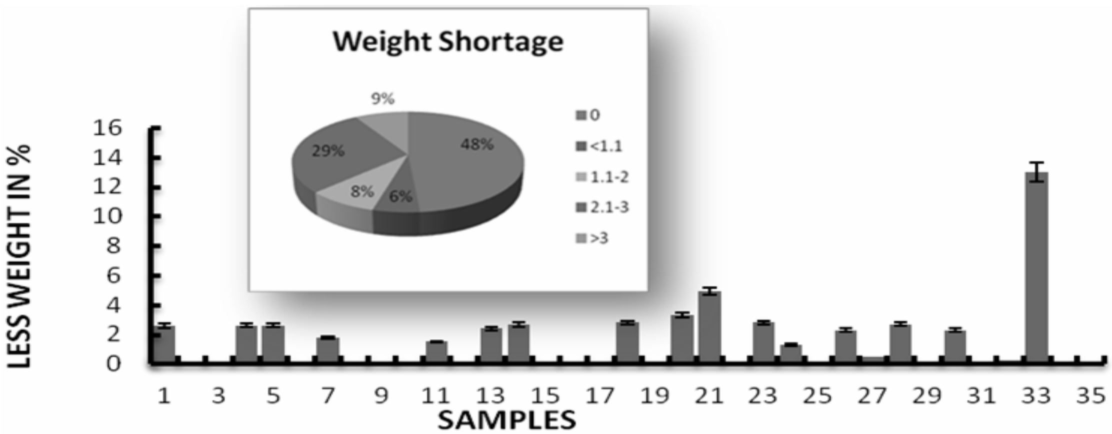


Fig. 8: Weight difference in cooking oil samples in different brands in Pakistan.

Table-2: Frequencies distribution of 35 cooking oil in terms of weight, smell, foreign matter and appearance

Frequency distribution of weight shortage

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 3.4 | 7 |
| 2 | 3.4 – 4.9 | 5 |
| 3 | 5 – 6.5 | 10 |
| 4 | 6.6 – 8.1 | 10 |
| 5 | > 8.1 | 3 |

Frequency distribution of smell

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | 0 | 17 |
| 2 | < 1.1 | 2 |
| 3 | 1.1 – 2 | 3 |
| 4 | 2.1 – 3 | 10 |
| 5 | > 3 | 3 |

Frequency distribution of foreign matter

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 3.4 | 2 |
| 2 | 3.4 – 4.9 | 0 |
| 3 | 5 – 6.5 | 0 |
| 4 | 6.6 – 8.1 | 12 |
| 5 | > 8.1 | 21 |

Frequency distribution of appearance

| No | Ranges of values | No of samples |
|---|---|---|
| 1 | < 3.4 | 2 |
| 2 | 3.4 – 4.9 | 3 |
| 3 | 5 – 6.5 | 15 |
| 4 | 6.6 – 8.1 | 11 |
| 5 | > 8.1 | 4 |

*Weight*

Weight is determined by using electronic balance. Results are quite surprising that only 17 samples are according to weight which is mention on their label (Fig. 8). 18 samples in finished product, weight is less than that mentioning on their label. In 48% samples, weight was according to standards. But 6% sample have <1.1% weight show shortage, 8% have weight shortage in range of 1.1-2%, 29% have weight shortage in the range of 2.1-3% and remaining 9% have weight shortage more than 3% (Table-2).

*Smell/Odor*

The sensation perceived by the sense of smell is called aroma. Smell score of different cooking oil brands are given in Fig. 9. Smell score range from 1 to 8.5 and significantly deviate from standard value i.e. 5. As it is clear from table that about 12 samples give smell which is not acceptable. According to smell score 8% samples are of excellent quality (>8.1), 29% samples have good quality(6.6-8.1), 29% samples lie in acceptable quality range (5-6.5), 14% samples were of low quality (3.4-4.9) and 20% samples (Table 2) are of very low quality (<3.4). Mostly flavors are added in those cooking oils in which deodorization process was not carried out properly. So, it is a way to cheat consumer because if flavors are not added in cooking oils then poor deodorized oils give bad smell.16 samples have blend odor which is desirable in cooking oils (Fig. 9).

Lipase enzyme break down ester bond between glycerol and fatty acid and form compounds which affects it taste, aroma and color [4, 11]. From flavor and odor point of view linolenic and lenoleic acids are very important [20] because these form hydro peroxide readily which later on produce compounds having bad smell.

*Foreign Matter and Appearance*

Score for foreign matter is given in Fig. 10 .It ranges from 1 to 9. In only 2 samples filter particles were present. It means that foreign matter problem was present in 5.71% samples. All other samples i.e. 33 out of 35 found satisfactory on this criteria.

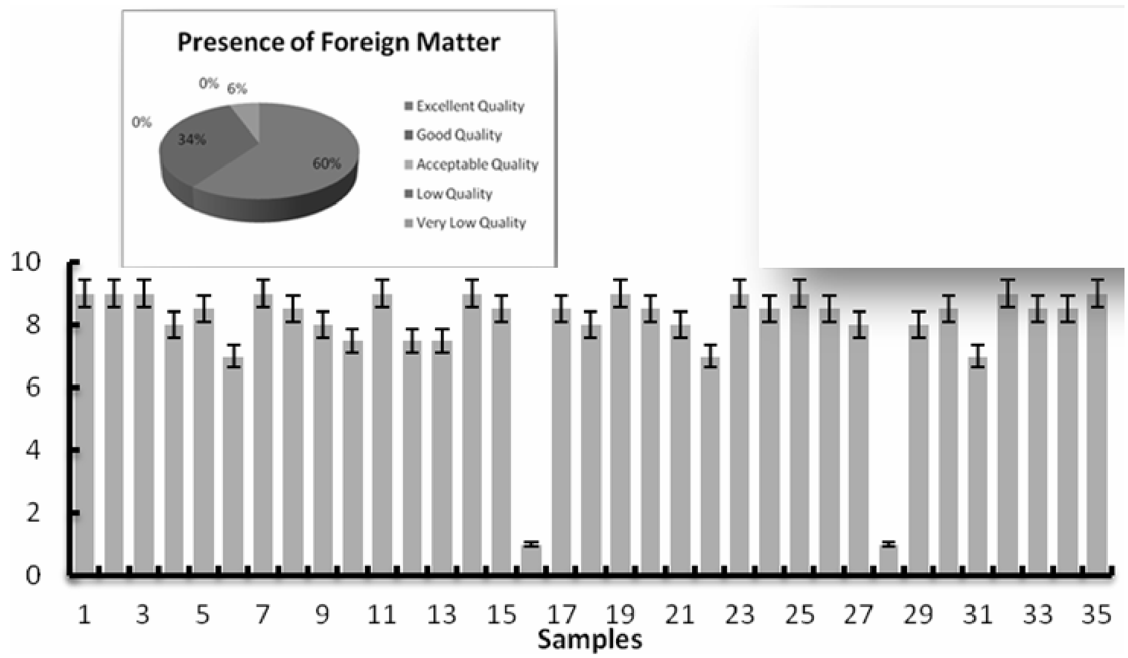


Fig. 10: Foreign matter present in different cooking oil samples

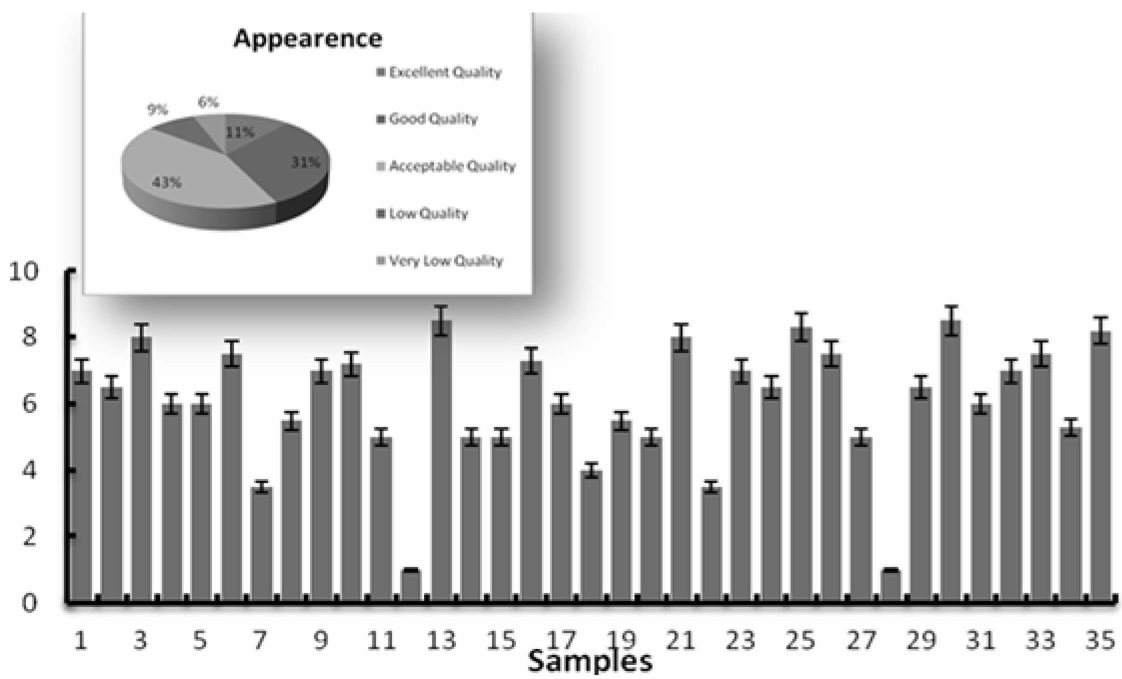


Fig. 11: Physical appearance of 35 cooking samples.

Appearance score for different cooking oil brands is given in fig. 11. It ranges from 1 to 8.5. Mostly brands appearance was according to standard. Cooking oils should appear liquid but 2 samples have grainy appearance and three samples have substandard appearance. On the basis of appearance score 4 brands were of excellent quality, 11 have good quality, 15 brands quality was satisfactory, 3 was of low quality and 2 have very low quality.

## Experimental

Cooking oil samples was collected from local markets of Pakistan. A total of 35 brands of different edible oil industries were kept under study.

Samples were brought in industrial packaging to laboratory and stored them at room temperature for five hours before analysis.

*Physico-chemical analysis*

FFA in cooking oil samples was analyzing by using AOAC method No. 41.1.21 [21]. To analyze the per-oxide value of cooking oil this is expressed in mill equivalent of active oxygen per Kilogram (meq/Kg) of cooking oil by AOAC method No. 41. 1. 16 [21].

Color, rancidity, cloud point and vitamin presence was tested by using PSQCA method No. PS-2858-2003 (R) [22].

*Sensory Evaluation*

A panel of six judges evaluated the samples of different cooking oils organolaptically by using the method of Larmond [23].

*Statistical Analysis*

Frequency distribution with standard deviation, and Z-test was carried out in this article. Each sample was analyzed in triplicate and mean value was calculated. The significance was established at a level of $P<0.05$ [24, 25].

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