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ORGANOLEPTIC AND PHYSICAL CHANGES IN FRESH AND REPEATED USAGE OF COOKING OILS IN INDIAN HOUSES

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ABSTRACT: Frying is one of the oldest food processing methods. Its popularity is related to the ease and speed of food preparation and sensory characteristics, such as unique flavor and taste. Nowadays, the consumption of deep-fried food has gained popularity which causes an increase risk of different disease conditions such as obesity, cardiovascular disease, diabetes, hypertension, *etc*. So, the validation and standardization of fried foods commonly used in the household were more important. In this study, the Physiochemical and Organoleptic changes in repeatedly heated different types of oil such as sesame oil, coconut oil, groundnut oil, and refined Sunflower oil for preparing homemade popular South Indian snacks (Muruku) were studied. Density was found to increase gradually in peanut oil and refined sunflower oil. Viscosity was found to be stable in sesame oil. While the viscosity reduces in coconut oil, it increases in refined sunflower oil. The refractive index of the fresh and fried oil was found to be close enough to all the oils except refined sunflower oil, which had more deviations. Thus, the results conclude homemade snacks are always safer for consumption.

INTRODUCTION: Edible oil is a fatty liquid that is extracted physically from several vegetables and animal tissues, the most appreciated to enhance taste and improve health properties [1]. The Indian vegetable oil economy is the world's fourth largest after the US, China and Brazil, harvesting about 25 million tons of oilseeds against the world. Since 1995, the Indian share in the world production of oilseeds has been around 10 percent. India imports half of its edible oil requirement, making it the world's third-largest importer of edible oil. India accounts for 11.2 percent of vegetable oil imports and 9.3 percent of edible oil consumption [2].

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The major edible oilseed crops grown in this state are peanut, sesame oil, sunflower oil, *etc*. The total area under oilseed crops in the state is 0.659 million, with total production of 1.15 million tons [3]. Deep-fried foods are one of the most popular and longstanding culinary techniques in the world [4]. Deep frying consists of submerging foods in a high-temperature fatty medium, normally oil, until cooked to the desired taste and texture.

Through this process, foods absorb a notable amount of fat and accumulate a certain proportion of degraded products from the fatty medium [5]. Frying occurs at high temperatures and in the presence of air, moisture, and food. These conditions mean that the fats/oils used for frying are subject to various alterations, such as hydrolysis and thermo oxidation. The process of frying also results in the degradation of numerous compounds, including free fatty acids, hydroperoxides,

monoacyl glycerides, diacyl glycerides, cyclic/geometric isomers of unsaturated fatty acids and of oxidized triacylglycerides monomers, dimers and oligomers [6].

During the cooking process, the rich chemical composition of the food is subjected to many chemical and physical transformations promoted by the high temperature and exposure to air. Since an oxidation process is involved in producing volatile organic compounds (VOCs), oxygen concentration is directly related to their production [7].

Viscosity is strongly affected when exposed to higher temperatures, air, and an increase in the number of frying cycles. It enhances the formation of oxidative and polymeric compounds and increases the tendency to foam during frying [8].

It depends upon density, molecular weight, melting point, degree of unsaturation, and temperature [9]. Viscosity increases during hydrogenation as the chain length of tri-glycoside fatty acid increases and decreases during unsaturation of fatty acids [10].

Nor *et al.,* (2008) also reported that the darkening of oil samples was due to the oxidation of phenolic antioxidants present in the oil while heating. The refractive index increases with the amount of conjugated fatty acids, while peroxide values vary with the concentration of primary oxidation products [11]. But both are ultimately used to detect deterioration in terms of rancidity. Rancidity is usually seen as a foul smell in food and the oil. Refractive index increases with an increase in oxidation, the same as peroxide value [12].

Repeated use of oils and fats for frying food changes their physical and chemical properties. Due to the increasing health concerns, the assessment of the quality of reused oils has received much attention; since such assessment is useful in determining the discarding point of the oils, the parameters such as viscosity, density and colour change [13]. The oil is reused repeatedly and it is discarded and replaced with fresh oil, only when it becomes foamy, highly viscous, emits bad odour and becomes dark coloured [14] and many at times it is never replaced at all, instead, fresh oil is added to already heated, thick and highly viscous oil [15]. It is determining and comparing various physiochemical properties of oil before and after frying gives relevant information on the change in cooking oil quality which can be used to determine its rate and range of degradation. That way possible health complications related to such degradation can be stressed out [12]. Hence, this research study focuses on the analysis of Physiochemical and Organoleptic changes in repeatedly heated different types of oil used to prepare homemade popular south Indian snack (muruku).

EXPERIMENTAL:

Physical Parameters and Sensory Evaluation of Different Types of Oils and Snack Fried Oils:

Physical Parameters and Sensory Evaluation of Different Types of Oils: The physical characteristics and sensory evaluation of purchased oil such as Sesame oil, Peanut oil, coconut oil, and Refined Sunflower oil were evaluated and recorded.

Sample Presentation: Samples were presented to judges in a random, sequential monadic order. At panel evaluation time, a sample was taken in plain glass and served immediately to the panelists. Panelists requested the next sample by sequential timing. This procedure was followed until all samples were served.

Recruitment of Panelists: The panel consisted of six members recruited by analyzing their former experience in quality control. The panelists selected were post-graduates in Nutrition and specialists in quality control of foods and processed food. Panelists were informed that they would evaluate different types of oil. Those with aversions to oil were not included in the panel. Qualifications for selection were availability, willingness to participate, year of birth (must be after 1970), purchase of vegetable oil (at least once every 2 months), and consumption of fried food and salad dressing (at least once a week).

Questionnaire: Validated standardized questionnaires were written in English and translated verbally in Tamil the survey was carried out within 2 weeks in November 2019.

Relevant data was collected from the respondents by individual face-to-face interviews, adhering strictly to the standardized, validated questionnaire questions. The questions were divided into three parts.

The respondents were required to provide demographic data such as age, sex, and educational level in the first part of the questionnaire. The knowledge of the usage of repeatedly heated cooking oil was evaluated in the second part of the questionnaire. In this part, the respondents were asked whether the usage of repeatedly heated cooking oil is a good practice, whether the quality of oil used for frying remains the same regardless of how many times the oil is reheated, whether there is loss of nutrients in the repeatedly heated cooking oil, whether the different types of cooking oil produce different by-products if repeatedly heated, whether consumption of food that was fried with repeatedly heated cooking oil is healthy and the health complication that can arise through consumption of such food. The attitude and practice of usage of repeatedly heated cooking oil were evaluated in the third part of the questionnaire. In this part, we mostly assumed that the cooking mothers' attitude towards repeatedly heated cooking oil was reflected in their practice of using it.

The respondents were asked if they used cooking oil repeatedly when they deep fry food such as potato chips (French fries), chips made from yam varieties, vadai, pappad, muruku or fried sweets like athirasam. If they did not reuse the oil for subsequent sessions of deep frying, they were again asked for their reasons. If the respondents replied that they had used cooking oil repeatedly for subsequent deep-frying sessions, they were again asked how many times the oil was used before being discarded. The respondent's attitude in seeking information about the usage of repeatedly heated cooking oil was also tested by asking them if they had ever heard that reusing and reheating cooking oil repeatedly is not a good practice, either through the newspapers, magazines, and other mass media such television, radio and the internet. All data collected was made anonymous, stored, and controlled by soft copy.

Training of Panelists: The panelists were explained completely about the research study. A brief background to sensory evaluation was discussed with the panelists. Discussion included the definition, importance, and application of sensory evaluation. The capability of the trainees to recognize and distinguish the four basic tastes was assessed by conducting taste exercises until all trainees successfully identified the basic tastes. This was done to determine their abilities to identify the odor of familiar substances and describe the odor of unfamiliar substances in terms of other substances whose odor is known to them.

Physical Parameters of Different Types of Oil: Commercially available branded oil such as Sesame oil, Peanut oil, Coconut oil, and Refined Sunflower oil were freshly purchased from the supermarket. These oils are relatively cheap, and it's in the regular usage of preparing dishes in household kitchen.

As most of the south Indian snacks were fried in different types of oil, the commonly used oil for frying was Sesame oil, Peanut oil, Coconut oil, and Refined Sunflower oil. According to Ramana and Viswanath (2005) the commonly used variety of cooking oil in rural India are Refined sunflower oil, Palm oil, Ground nut oil, Sesame oil, Coconut oil and others [16].

After purchase of branded oil, the preliminary steps involved were its assessment of physical, chemical and sensory assessment of oils and its evaluation will give a clear picture on the quality of oils. Panelists, conducted evaluations in two steps for the purchased oil with different manufacturer and brand. Panelists were instructed on the definition, technique, and evaluation of the different types of oils and a reference sample were provided during training [17].

Panelists were then instructed to evaluate the standard references' colour and texture intensity using a 9-point scale. After the panelists conducted two practice evaluations to review the whole process of the testing procedures, the actual testing in two sessions was performed in individual booths under a red lighting system to minimize the color effect across the samples. A warm-up sample was provided for each panelist in each session prior to the start of the test. Test samples were presented one by one to the panelists in duplicate. Order of the sample presentation followed a completely randomized block design. Panelists rated the samples' intensity of colour and texture using a Hedonic 9- point scale. Monetary compensation was provided after the final evaluations.

The Physical parameters, such as colour and texture of different types of oil, were assessed by six selected panel members.

Hedonic Scale: Hedonic scales are well tried and tested in consumer research for capturing liking data [18]. **Table 1** shows a typical example of a nine-point hedonic scale, a version regularly used with consumers in preference mapping studies to capture liking scores.

TABLE 1: NINE-POINT HEDONIC SCALE WITH VERBAL ANCHORS

Dislike Extremely	**Dislike** Very Much	**Dislike** Moderately	**Dislike** Slightly	**Neither Like** nor Dislike	**Like** Slightly	**Like** Moderately	**Like** Very Much	**Like** Extremely

Colour of Purchased Oils: The colour of the purchased oils, such as Sesame oil, Peanut oil, Coconut oil, and Refined Sunflower oil, were evaluated by six qualified panel members according to the rating of hedonic scale and recorded respectively.

Texture of Purchased Oils: The texture of the purchased oils, such as Sesame oil, Peanut oil, Coconut oil and Refined Sunflower oil, were evaluated by six qualified panel members according to the rating of hedonic scale and recorded respectively.

Packaging of Oil: The packaging quality of oil, such as the pack type, date of manufacturing, date of expiry and nutritional facts were verified and recorded.

Sensory Evaluation of Different Types of Oil: The most important parameter for assessing edible oils is the sensory evaluation because the product has to fit the consumer's likes; otherwise, the product has no chance on the market. The primary aim of sensory evaluation is to get reproducible and reliable results and not to detect some minimal differences between samples that taste more or less the same. The attribute woody is associated with some sensations that are not pleasant for all people but do not indicate any fault in the production process. On the other hand, the sensory evaluation of edible oils is possible by a trained group of panelists familiar with the product and possible perceptions resulting from sound or defective products. In the case of this analytical sensory evaluation, the available methods range from simple triangle testing via recognizing differences between two samples to the more complex descriptive analyses of edible oils.

Flavour of Purchased Oil: Panelists were then presented with a sample of oil and instructed on how to evaluate the odor of the oil. Panelists were asked to pick up the glass containing the oil (hold the glass as close to the base as possible), swirl the covered glass, lift to nose, remove the cover, and sniff above the oil using short, "bunny" sniffs. Before testing other samples and in between samples, to help equilibrate ("zero") their nose to prevent adaptation and fatigue to oil odors, panelists were instructed to replace the cap quickly and smell the back to their hand.

Taste of Purchased Oil: The panelists had to rinse their mouths with warm, filtered water before starting the evaluation. To evaluate the oil flavor, they placed the entire sample of warm oil into their mouths, swished the oil thoroughly, cupped their mouth, drew air in through the mouth, exhaled through the nose to enhance perceptions of aromatics, and expectorated the sample. They rinsed their mouths well with warm filtered water between samples for 10-s to clear the mouth of residual flavors and waited at least 5 min to prevent taste fatigue before being given the next sample.

Thickness of the Purchased Oil: The thickness of the purchased oils such as Sesame oil, Peanut oil, Coconut oil and Refined Sunflower oil were assessed by six trained panel members according to the rating of hedonic scale and recorded respectively.

Functional Properties of Purchased Oil:

Solubility of the Purchased Oil: Solubility is an important parameter for checking the quality of essential oil. Generally, solubility is checked in dilute solutions of absolute alcohol.

The solubility test gives an idea about the nature of components present in a material. The solubility of different types of purchased oils was assessed to know the purity of the oils [19].

Physical and Sensory Parameters of Different Types of Fried/Cooked Oils:

Physical Parameters of Different Types of Fried/Cooked Oil: Different physical and chemical parameters of edible oil were used to monitor the compositional quality of oils [20]. Therefore, it is essential to monitor the quality of oil to avoid the use of abused oil. Good edible oil that can be used for cooking purposes must be considered with a proven range of physicochemical parameters. Understanding the properties allows us to evaluate the oil for human health considerations, industrial application, *etc*. Low-density oils are highly appreciable to consumers [21].

Repeated use of oils and fats for frying food changes their physical and chemical properties. Due to the increasing health concerns, the assessment of the quality of reused oils has received much attention since such an assessment is useful in determining the discarding point of the oils. The parameters such as viscosity, density, and colour change [13].

Changes in oils that occur during heating and frying include increased viscosity, darkening in colour, and increased foaming as frying time continues. The physical parameters of different types of fried/cooked oils such as refractive index, viscosity of oil, the density of oil and colour of the oils were assessed [22].

Estimation of Density of Oil: The density of the oil is measured by the weighing balance. The empty weight of the measuring glass is weighed without the sample, and the value is noted. After that the sample is filled into the measuring tube and weighed then the value is noted and calculated using the following formula [23].

$$\text{Density} = \text{Mass} / \text{Volume}$$

Estimation of Viscosity: A viscometer is an instrument used to measure the viscosity of a fluid. Viscometers only measure under one flow condition. The viscometer also measures the measure of oil's resistance to flow. Fill the viscometer, previously washed and completely dried, with the liquid under examination through tube L to slightly above mark G using a long pipette to minimize wetting the tube above the mark. Place the tube vertically in a water bath maintained at the temperature indicated in the monograph and allow standing for less than 30 minutes to allow the temperature to reach equilibrium. Adjust the volume of the liquid so that the bottom of the meniscus settles at the mark G. Suck or blow the liquid to a point about 5mm above the mark E. After releasing pressure or suction, measure the time taken for the bottom of the meniscus to fall from the top edge of mark E to the top of the edge of mark F.

$$n1 / n2 = d1t1 / d2t2$$

Where d1 is the density of oil, d2 is the density of water. T1 is the time of flow for oil, t2 the time flow for water, n1 is the viscosity of oil, and n2 is the viscosity of water.

$$N1 /0.89 = 0.9100 \times 5576/0.9982 \times 51$$

N1/0.894 = 99.67, n1 = 99.67 x 0.89, n1 = 88.71 cps

Estimation of Colour: The Lovibond Tintometer is a visual colorimeter designed to optimize the use of Lovibond glass filters. It is arranged with two adjacent fields of view, seen through the viewing tube, so that the product in the sample field and a white reflective surface in the comparison field are observed side by side, suitably illuminated. The sample is placed in the tube, and the Lovibond glasses are introduced into the comparison field by a simple system of sliding racks, allowing the user to compare the color of light either transmitted through or reflected from the sample with that transmitted through the glasses. A series of neutral glasses in racks is also supplied; these can be introduced into the sample file to dull the color of products that are too bright to obtain a good color match using Lovibond Red, Yellow or Blue glasses. The racks are varied until a visual color match is found for the light from the sample, and its color can then be expressed in Lovibond units [24].

Estimation of Refractive Index: Refractive Index (Index of Refraction) is a value calculated from the ratio of the speed of light in a vacuum to that in a second medium of greater density. A refractometer instrument was used as described by the AOAC Method [25]. A refractometer measures the degree to which the light changes direction, called the angle of refraction. A refractometer takes the refraction

angles and correlates them to refractive index values that have been established. Using these values, you can determine the concentrations of solutions. Wipe the prism clean, apply 2-3 drops of distilled water, and press the start button. The measurement and the prism temperature are displayed. Press the zero buttons while the water is on the prism. Zero setting is complete when 000 blinks twice and then stop. Wipe the prism clean, apply about 0.03ml of the sample, and press start. The refractive index of the sample is displayed on the screen. Wipe the prism clean, and switch off the unit by pressing the start button for 2 seconds. The refractive index is directly taken from the screen.

RESULTS AND DISCUSSION:

Physical Parameters and Sensory Evaluation of Different Types of Oils and Snacks Cooked Oil: The physical characteristics and sensory evaluation of purchased oil such as Sesame oil, Peanut oil, Coconut oil, and Refined Sunflower oil were evaluated by six panelists according to hedonic scale and recorded. Panelists evaluated each sample under white incandescent light in sensory partitions equipped with computer terminals. Samples were coded with three-digit random numbers obtained using a computerized random number generator program. The sample order of presentation was randomized at every session to minimize bias. References for intensity were provided to all panelists. This consisted of different concentrations of basic taste solutions to represent [26]. In addition, each judge was provided with all standard references for self-calibration before rating the samples and in between samples as necessary but not in the middle of evaluating a sample. If a panelist was unable to rate all flavor attributes using one 10-mL sample, they could obtain additional 10-mL portions of the warmed sample in a test tube. Warm, filtered water and unsalted crackers were provided to clear the palate between evaluations of each sample.

Physical Parameters of Different Types of Oil: The Physical parameters, such as colour and texture of different types of oil were assessed.

Colour of Purchased Oils: The colour of the purchased oils, such as Sesame oil, Peanut oil, Coconut oil, and refined sunflower oil were evaluated by six-panel members and recorded in **Table 2.**

TABLE 2: COLOUR OF PURCHASED OIL ACCORDING TO HEDONIC SCALE

Types of Oil	Characteristic colour	Std (H.V)	P1	P2	P3	P4	P5
Sesame oil	Golden	8.8	8.5	8.5	8.5	8.5	8.5
Peanut oil	Deep yellow	9	8.8	8.8*	8.8	8.8	8.8
Coconut oil	White	8.6	8.6	8.4	8.6	8.6	8.6
Refined Sunflower oil	Slightly yellow	8.8*	.8	8.8	8.8	8.6	8.6

*Represents significant difference by t-test (*p<0.05, **p<0.01).

H.V-Hedonic Value, P1, P2, P3, P4, P5- Panelist: Hedonic scales are well tried and tested in consumer research for capturing liking data [18]. A mean liking score of 7 or higher on a nine-point scale is usually indicative of highly acceptable sensory quality; hence, a product achieving this score could be used confidently as a good illustration of 'target' quality. On this basis, products from a research set can then be selected to provide physical references to illustrate the sensory quality that realistically represents the consumer's acceptance. Here according to hedonic scale, the colour of the oil was evaluated by the trained panelist **Table 3**; the colour of the sesame oil has a characteristic standard golden colour according to the hedonic scale, which has a hedonic value 8.8, and almost all the panelists ranked the colour according to hedonic scale. The mean value of the sesame oil was 8.5, which denotes yellow. The characteristic colour of peanut oil is deep yellow and in the hedonic scale the value 9 is denoted the standard. According to all the panelists, the mean range of the colour of the peanut oil was [8]. Next the characteristic colour of coconut oil is white sox; according to hedonic scale the standard coconut oil hedonic value 8.6. So, the panelists ranked the values according to the standard colour as 8.6, P2 panelists alone ranked the colour of the coconut oil is slightly differ from the standard and their mean value is 8.4. Finally, the characteristic colour of refined sunflower oil is slight yellow so the hedonic value of the refined sunflower oil is 8.8 and according to the hedonic scale the panelists range the mean score of the colour of the oil as 8.8.

TABLE 3: DESCRIPTIVE EVALUATION OF COLOUR OF DIFFERENT TYPES OF OIL

Types of Oils	Characteristic Colour	P1	P2	P3	P4	P5
Sesame oil	Golden	Light golden	Light Golden	Slight golden	Light golden	Light golden
Peanut oil	Deep yellow	Deep yellow	Deep yellow	Deep yellow	Deep yellow	Deep yellow
Coconut oil	White	White	Translucent white	White	White	White
Refined Sunflower Oil	Slightly yellow	Slight yellow	Slight yellow	Slight yellow	Slight yellow	Slight yellow

P1, P2, P3, P4, P5-Panelist.

The colour of the different types of oil, such as Sesame oil, Peanut oil, Coconut oil, and Refined Sunflower oil were evaluated by panel members at a different times with the controlled environment. Sesame oil is golden in colour and most of the panelist reported as Light golden colour. Sesame oil is extracted with cheaper and physically demanding techniques.

The colour of the oil varies depending upon the method of extraction. Cold pressed oil is pale yellow in colour, Indian sesame oil is golden, and East Asian oil is brown in colour. If the seeds are roasted you tend to get a dark brown colour. Sesame oil is a polyunsaturated (PUFA) semi-drying oil. Commercial sesame oil varies in colour from light to deep reddish-yellow depending on the colour of the seed processed and the method of milling. Provided the oil is milled from well-cleaned seed, it can be refined and bleached easily to yield light-coloured limpid oil [27].

Most of the panel judges recorded the coconut oil is translucent white in colour. Virgin coconut oil is light yellow or slightly yellowish oil, sometimes ivory white. With the method of processing pure coconut oil manually, the color of the virgin coconut oil depends on the cooking temperature and the type of coconut selected, maybe light yellow or slightly yellowish or white in colour.

During extraction, very high heat is used (typically 90C / 194F) and the oil that's produced in brown in colour so needs to be chemically bleached to make it whiter. The refining is done with a weak caustic soda solution to remove the 3+% of Free Fatty Acids (FFA) and make the oil edible [28]. The panelist of judges recorded the refined sunflower oil is slight yellow in colour. The sunflower oil rapidly changes from a light yellow to an orange-brown colour. This combined result of oxidation, polymerization and other chemical changes also increases the viscosity of the frying oil. The changes in colour and viscosity of frying oil are signs of oil deterioration. Its yellow color is due to the sedimentation of pollutants that have not been emptied or thermal effects during processing.

Here according to hedonic scale, the colour of the oil which is the colour of sesame oil has a characteristic golden colour which has a hedonic value 8.8; the panelist ranges the colour according to hedonic scale as 8.5, which denote slight yellow. The characteristic colour of peanut oil is the deep yellow sun; according to the hedonic scale the exact colour of the peanut oil ranged.

Texture of Purchased Oils: According to hedonic scale the texture of the oils was ranked and judged by the panelist members **Table 4**. Sesame oil the standard characteristic texture was very thick which is ranged as 8.9 according to the hedonic scale, similarly by comparing the standard texture the panelist gave the ranges according to the hedonic scales and the mean Hedonic values (H.V) were 8.6, 8.6, 8.7, 8.6, 8.7 respectively.

For peanut oil, the characteristic texture was tender and hedonic value was 8.6; by panelist evaluation, the mean hedonic value (HV) was 8.6, 8.6, 8.5, 8.6, and 8.5 respectively. The characteristic texture of coconut oil was Firm and rated in hedonic scale as 8.8, the five panelists ranged the value according to the hedonic value and the mean hedonic value (HV) texture were 8.6, 8.8, 8.6, 8.6 and 8.8 respectively. Finally, the refined sunflower oil characteristic texture was thickness which has a hedonic value (HV) for standard as 9; the panelists assessed the texture of refined sunflower oil and rated the texture with the hedonic value (HV) as 8, 7.6, 7.7, 7.8, 8 respectively.

TABLE 4: TEXTURE OF PURCHASED OIL ACCORDING TO HEDONIC SCALE

Types of Oil	Characteristic colour	Std (H.V)	P1	P2	P3	P4	P5
Sesame oil	Very thick	8.9	8.6	8.6	8.7	8.6	8.7
Peanut oil	Tender	8.6	8.6	8.6	8.5	8.6	8.5
Coconut oil	Firm	8.8	8.6	8.8*****	8.6	8.6	8.8
Refined sunflower oil	Thickness	9*****	8	7.6	7.7	7.8	8

*Represents significant difference by t-test (*p<0.05, **p<0.01).

H.V- Hedonic Value, P1, P2, P3, P4, P5-Panelist: All the five panelists of judges declared that the texture of the Sesame oil in **Table 5** is thick inconsistency. Also, they declared the thickness of sunflower oil is slightly thicker and also, they confirm the thickness of the peanut oil is tender in consistency. There is a slight change in the thickness of the coconut, the characteristic feature of coconut oil is firm in consistency; two panelists of judges declare the texture as slight firm and the other three panelists confirm the consistency firm inconsistency. The second set of attributes to be considered are those perceived by sensors in the mouth other than taste and chemical feelings. Food's texture and mouth feel could be considered critical attributes in consumer choice and acceptability. Therefore, the food industry and food science have a joint attempt to understand and improve the perception of fat-related sensations of products. Sensory perception of fat is related to taste, orally perceived in-mouth consistency and also friction [29].

TABLE 5: DESCRIPTIVE EVALUATION OF TEXTURE OF DIFFERENT TYPES OF OIL

Types of Oils	Characteristic Texture	Panelist1	Panelist 2	Panelist 3	Panelist 4	Panelist 5
Sesame oil	Very thick	Thick	Thick	Thick	Thick	Thick
Peanut oil	Tender	Tender	Tender	Tender	Tender	Tender
Coconut oil	Firm	Slight firm	Firm	Slight firm	Slight firm	Firm
Refined Sunflower Oil	Thickness	Slightly thicker	Slightly thicker	Slightly thicker	Slightly thicker	Slightly thicker

Sensory Evaluation of Purchased Oil:

The flavor of purchased oil: The flavor of purchased oil such as Sesame oil, Peanut oil, coconut oil and refined sunflower oil were evaluated by panel members **Table 6.** The Flavour of the oils was ranked according to the hedonic scale and its characteristic flavor by the trained panelist. The sesame oil has a characteristic grainy-like flavor and the standard sesame oil was rated by hedonic value (HV) as 8.9; the panelists ranged the mean flavour values as 8.7, 8.8, 8.8, 8.7, 8.8, respectively. The characteristic flavor of peanut oil was nutty flavour and its hedonic value (HV) is 9. The panelists ranged the mean hedonic value (HV) as 8.6, 8.6, 7.4, 8.8 and 8.6, respectively. The coconut oil characteristic flavour was coconut flavour and the hedonic value is rated as 8.8, the panelists analyzed the flavor of the coconut oil and recorded the mean hedonic value (HV) as 7.8, 8.8, 7.8, 8.6 and 8.6 respectively. Finally, the refined sunflower oil characteristic flavor was fatty flavour with a hedonic value (HV) as 9, the panelists analyzed there fined sunflower oil and valued the flavour by Hedonic scale as 8.2, 8.9, 8.2, 8.9 and 8.8, respectively.

TABLE 6: FLAVOUR OF PURCHASED OIL ACCORDING TO HEDONIC SCALE

Types of Oil	Characteristic Flavour	Std (H.V)	P1	P2	P3	P4	P5
Sesame oil	Grain like Flavor	8.9*****	8.7	8.8	8.8	8.7	8.8
Peanut oil	Nutty Flavour	9	8.6	8.6	7.4	8.8*****	8.6
Coconut oil	Coconut Flavor	8.8*****	7.8	8.8	7.8	8.6	8.6
Refined sunflower oil	Fatty Flavour	9	8.2	8.9*****	8.2	8.9	8.8

*Represents significant difference by t-test (*p<0.05, **p<0.01)

H.V- Hedonic Value, P1, P2, P3, P4, P5-Panelist: The flavor of the purchased oil as shown in **Table 7** was assessed by the panelists of judges, all the five panelists of judges declare the characteristics flavor of coconut oil has neutral coconut flavour and similarly, for sesame oil all panelists gave similar declaration as it has its characteristic grainy flavour and for peanut oil three panelist assessed it has slight nutty flavour and other panelist assessed it has neutral nutty flavour and followed by nutty flavour.

TABLE 7: DESCRIPTIVE EVALUATION OF FLAVOUR OF PURCHASED OIL

Types of Oils	Characteristic flavour	Panelist 1	Panelist 2	Panelist 3	Panelist 4	Panelist 5
Sesame oil	Grain like flavour	Flavour similar to grain	Grain like flavour	Grainy flavour	Grainy flavour	Grainy flavour
Peanut oil	Nutty flavour	Slightly nutty flavour	Slight nutty flavour	Neutral nutty flavour	Nutty flavour	Slightly nutty flavour
Coconut oil	Coconut flavour	Neutral coconut flavour	Coconut flavour	Neutral coconut flavour	Coconut flavour	Coconut flavour
Sunflower Oil	Fatty flavour	Slightly fatty flavour	Fatty flavour	Slightly fatty flavour	Fatty flavour	Fatty flavour

Food sensory analysis is gaining importance for testing the quality of products but, above all, for evaluating new healthy foods for consumers. The evaluation of the sensory properties and determination of the importance of these properties in consumer product acceptance represents a major accomplishment in sensory analysis.

Sensory evaluation involves measurement in two main areas, difference testing and descriptive analysis. Sensory difference test are procedures used to determine whether judges can distinguish between two stimuli. In terms of food, the two stimuli are two very similar food samples. These evaluations are used to determine whether slight changes occur due to either product formulation or change in technological processing [30].

The Taste of Purchased Oil: The Taste of purchased oil such as Sesame oil, Peanut oil, coconut oil and refined sunflower oil were evaluated by panel members **Table 8.**

TABLE 8: TASTE OF PURCHASED OIL ACCORDING TO HEDONIC SCALE

Oils	Characteristic Taste	Std (H.V)	P1	P2	P3	P4	P5
Sesame oil	Nutty taste	8.8	8.8	8.8	8.8*	8.8	8.8
Peanut oil	Neutral taste	9	9*	9	9	9	9
Coconut oil	Sweet taste	8.8*	8.8	8.8*	8.8	8.8	8.8
Refined sunflower oil	Mild taste	8.5	8.5	8.5	8.5	8.5	8.5

*Represents significant difference by t-test (*p<0.05, **p<0.01).

H.V-Hedonic Value, P1, P2, P3, P4, P5-Panelist:
The Thickness of Purchased Oil: Sesame oil, Peanut oil, Coconut oil and Refined Sunflower oil were evaluated by hedonic scale. Their descriptions of thickness were also recorded by trained pane list **Table 9.**

TABLE 9: THICKNESS OF PURCHASED OIL ACCORDING TO HEDONIC SCALE

Types of Oil	Characteristic thickness	Std (H.V)	P1	P2	P3	P4	P5
Sesame oil	Higher thickness	8.9*	8.7	8.8	8.7	8.6	8.6
Peanut oil	Slight thickness	8.6	8.5	8.6	8.5	8.4	8.5
Coconut oil	Cloudy and easy to pour	8.8	8.8	8.6	8.7	8.6	8.6
Refined sunflower oil	Varies in thickness	9*	8.2	8	7.9	8.2	7.9

*Represents significant difference by t-test (*p<0.05, **p<0.01)

H.V- Hedonic Value, P1, P2, P3, P4, P5-Panelist: The characteristic thickness of sesame oil **Table 10** is the higher thickness and the standard hedonic value (HV) were 8.9, the panelist ranged the thickness of the sesame oil compared with the standard thickness and ranged the value as 8.7, 8.8, 8.7, 8.6, 8.6 respectively. The characteristic thickness of peanut oil was slight thickness and its standard hedonic value were 8.6, the panelist analyzed the thickness between their fingers and rated it with the help of hedonic scale; the ranges of mean hedonic value (HV) varied as 8.5, 8.6, 8.5, 8.4, 8.5 respectively. The coconut oil has a characteristic thickness that is Cloudy and easy to pour, and the standard coconut oil hedonic value (HV) was 8.8. The panelist ranged the values of coconut oil, which will be be used frying snacks and reported with hedonic value (HV) and; mean HV value was 8.8, 8.6, 8.7, 8.6 and 8.6, respectively. Finally, the refined sunflower oil characteristic thickness varies and its standard hedonic value 9. The panelist analyzed the thickness of the refined sunflower oil and ranged the values as 8.2, 8.7.9, 8.2, 7.9, respectively.

TABLE 10: DESCRIPTIVE EVALUATION OF THICKNESS OF PURCHASED OIL

Types of Oils	Characteristic thickness	Panelist 1	Panelist 2	Panelist 3	Panelist 4	Panelist 5
Sesame oil	Higher thickness	Thicker	Thicker	Thicker	Thicker	Thicker
Peanut oil	Slight thickness	Slightly thicker	Slight thicker	Thicker	Slightly thicker in consistency	Thicker in consistency
Coconut oil	Cloudy and easy to pour	Cloudy and easy to pour	Slight cloudy and easytopour	Cloudy in appearance and easy to pour	Slightly cloudy and easy to pour	Easy to pour and slightly cloudy
Refined Oil	Varies in thickness	Transparent and slightly thicker	Less thicker	Slightly thicker	Less thicker	Slightly thicker

The characteristic thickness of Sesame oil, which the panelists judged, was similar in **Table 9**. The thickness of Sesame oil is thicker. For coconut oil also, similar results were recorded. The three panelists confirmed the thickness of the peanut oil was slightly thicker, and the other two confirmed it is thicker in consistency. For refined sunflower oil, two panelists confirm the oil is slightly thicker and three panelists confirm the oil is less thick in consistency. While some manufacturers will further refine sesame oil through solvent extraction, neutralization and bleaching in order to improve its phytochemical aspects, sesame oil derived from quality seeds already possesses a pleasant taste and does not require further purification before it can be consumed. Many consumers prefer unrefined sesame oil due to their belief that the refining process removes important nutrients. So, there by the texture of the sesame oil remains similar. Because of its highly saturated, it is used to make shortening and frying oil [30].

Functional Properties of Purchased Oil:

Solubility of the Purchased Oil: The solubility of vegetable oils in aqueous ethanol depends on the concentration of alcohol and the temperature of the system. At ordinary temperatures, even absolute alcohol is not a good solvent for vegetable oils since the solubility is even less than 10 g. of oil per 100 g. of alcohol. Mow rah, safflower, peanut and cottonseed oils are soluble in absolute alcohol at 70°C. All the oils investigated are found to be miscible above the boiling point of alcohol even if the concentration is 98%. In 95% ethanol they are miscible between 90° and 100°C. The addition of a good solvent, like n-hexane, increases the solubility of oils, and the solubility temperatures are lowered.

TABLE 11: SOLUBILITY OF DIFFERENT TYPES OF OIL

Types of oil	Soluble in alcohol	Soluble
Sesame oil	Sesame oil is soluble in alcohol	Soluble in isopropyl esters and mineral oil and in soluble in water
Peanut oil	Peanut oil dissolves in isopropyl alcohol	Soluble nether, ligroins, carbon disulfide, chloroform. Slightly soluble in ethanol. In soluble in water
Coconut oil	Coconut oil is soluble in isopropyl alcohol	It is highly soluble in petroleum ether
Refined Sunflower oil	Refined oil is soluble inalcoholatabsolute70℃	It is also soluble in absolute ethanol at 95℃

From the results in **Table 11** obtained by various methods of solubility determination, it is found that the apparatus employed in the present work yields more reliable results by eliminating the visual observation of turbidity temperatures, ensuring vigorous stirring and allowing a sufficient amount of time to attain equilibrium conditions in determining the solubilities of vegetable oils. The solubility shows the nature of the oil and gives an idea about the frying capacity and its degradation [19].

Physical and Sensory Parameters of Different Types of Fried/ Cooked Oils: Quality control in the production of fried food, whether the analyst is a quality control inspector or a member of the health food inspection service, demands a simple, easy procedure, using no chemicals. The results should correspond to official methods such as polar compounds. When the snacks are prepared at home, analyzing the cooked oil and its snacks is not possible. So, the research on the physical and sensory changes in the oil fried with the snacks will

be helpful to know about the characteristic of the fried oil and the capacity of the oil to fry for the respectively repeated time. Also, the quality of the snacks fried in oils and the quality of the snacks fried in the repeatedly heated oil. Atmospheric oxygen reacts instantly with lipid and other organic compounds of the oil to cause structural degradation in the oil which leads to loss of quality of food and is harmful to human health [31].

Physical Parameters of Different Types of Cooked Oil: Physiochemical parameters like density, refractive index, colour of the cooking oil such as sesame oil, peanut oil, coconut oil, and refined sunflower oil were studied to evaluate the compositional quality of oils and also to investigate the effect on the use of same oil for repeated frying it ultimately changes the physicochemical, nutritional and sensory properties of the oil.

Density of Cooked Oil: Density is an important property affecting heat transfer by natural convection and buoyant movement of gas bubbles in a liquid. The density of different types of oil is dissimilar due to differences in their composition. The density of the different types of cooked oils were presented in **Table 12.**

TABLE 12: DENSITY OF COOKED OILS

Sample	Fresh Oils(g)	Fried Oils (used1st time)	Fried oils (used 2nd time)
Sesame oil	25.0610g	25.0524g	25.1337g*
Peanut oil	25.1512g	25.1929g	25.2123g
Coconut oil	25.1446g	25.2165g	25.1847g
Refined sunflower oil	25.1798g*	25.1927g	25.2200g

*Represents significant difference by t-test (*p<0.05, **p<0.01).

The density of the fresh Sesame oil, coconut oil, peanut oil, and refined sunflower oil was 25.06g, 25.15g, 25.14g and 25.18g, respectively. The different types of cooking oil fried first time to prepare snacks (South Indian Popular Homemade snacks -Muruku) density is 25.05g, 25.19, 25.22g, 25.19g, respectively.

The second time repeatedly heated cooking oil such as Sesame oil, coconut oil, peanut oil and refined sunflower oil had density of 25.13g, 25.21g, 25.18gand 25.22g, respectively. The density was found to increase gradually in peanut oil and refined sunflower oil.

Sesame oil and coconut oil showed slight variations after usage. Density is an important factor influencing oil absorption as it affects the drainage rate after frying and the mass transfer rate during the cooling stage of frying [32].

The density of Sesame oil, Peanut oil, coconut oil, and refined sunflower oil was estimated by Analytical weighing balance. The density profile of heated Sesame oil with homemade snacks showed the oil becomes denser when it is fried second time compared to the first time. When compared to other oils, the density rate of sesame oil is lower. For other types of oils such as Peanut oil, coconut oil and refined sunflower oil, the density rate is higher. Also, when compared to first-time oils fried with homemade snacks (Muruku), the density is higher when the oil is reused and repeatedly cooked for the second time.

In comparison with other types of oils, the beneficial effect of Sesame oil is due to low saturated fatty acid, and the non-volatile compounds in the oil will not allow changes in the physical and chemical properties of oil and fried foods. Because of the volatile compounds present in the sesame oil, the tendency to retain the density of the oil increases.

Also, the properties of fresh Sesame oil contains antioxidants such as Sesamol and Sesamolin; the oil can be stored for more than one year; sesame oil contains low saturated fatty acids so, so sesame oil provides many benefits, both health and the potential to maintain fitness [33]. Overall, the other oils, such as Peanut oil, Coconut oil, and Refined Sunflower oil, showed more density when fried a second time when compared to the first time [32].

Viscosity Oil: Viscosity is one of the indicators used to evaluate the physical changes in edible oil. It depends upon density, molecular weight, melting point, degree of unsaturation, and temperature [9]. The viscosity of the different cooked oil types were presented in **Table 13.**

TABLE 13: VISCOSITY OF COOKED OILS

Sample	Fresh Oils	1st time used oils	2nd time used oils
Sesame oil	27.623g	27.943g	28.663g
Peanut oil	33.695g	33.953g	35.275g
Coconut oil	35.270g	28.265g	23.057g*
Refined sunflower oil	27.058g	29.174g	32.238g

*Represents significant difference by t-test (*p<0.05, **p<0.01).

The viscosity of Sesame oil, Peanut oil, Coconut oil and refined sunflower oil was measured by viscometer. Under the room temperature, there was a linear increase in the viscosity of oils with temperature of different types of oils are same. The viscosity of the fresh Sesame oil, Peanut oil, coconut oil and refined sunflower oil is 27.62g, 33.69g, 35.27g, and 27.05g, respectively. The different types of homemade snack murukufried oils were compared, and the finding denotes that the second-time fried oils viscosity is higher compared to first-time snack fried oils such as fresh Sesame oil, Peanut oil, Coconut oil, and refined sunflower oil. There is a slight difference in viscosity for the first-time snack fried oils and second-time snack fried oils to prepare snacks viscosity is 28.66g, 35.27g, 23.05g, 32.23g, respectively. The viscosity was found to be quite stable in sesame oil. While the viscosity value went down in coconut oil, it was found to increase in refined sunflower oil. The viscosity profile of different types of homemade snack muruku fried oils such as Sesame oil, Peanut oil, Coconut oil and refined sunflower oil showed greater viscosity than its initial volume when it was purchased fresh. The viscosity of oils increases due to repeated frying of oil with an increase in the temperature. The viscosity of oil increased as the number of frying cycles increased, whereas the viscosity decreased with increased temperature. It has been well-established that temperature strongly influences the viscosity of oil with increased temperature. When there is a repeated cycle of frying there is a gradual rise in the viscosity of the oil fried a second time [34].

Colour of Cooked Oils: Coloris a prejudiced indicator used by the food industry for rapid monitoring of frying oil quality. Darkening of oil color occurs due to the development of pigments (non-volatile decomposition products [NVDPs] and α-, β-unsaturated carbonyl compounds) during oxidation and thermal decomposition of fatty acids which diffuses into the oil during frying, although due to traces of carotenoids available in oil [35]. Maskan, (2003) has also explained that oil darkening maybe caused by caramelized scorched product, which accelerates the reduction of lightness value (L-value) in oil when assessed by the Hunter colorimeter [36]. The colors of the different types of cooked oils were presented in **Table 14.**

TABLE 14: COLOUR OF COOKED OILS

Sample	Fresh oil		Fried oil (1st time used oils)		Fried oil (2nd time used oils)	
	Red	Yellow	Red	Yellow	Red	Yellow
Sesame oil	12.8	28.9	11.9*	12.9	11.9*	14.9
Peanut oil	11.9*	15.1	11.9*	19.9	11.8	12.2
Coconut oil	11.9*	13.9	11.9*	13.1	12.9	20
Refined sunflower oil	10.9	13.4	11.9*	14.2	11.9*	12.2

*Represents significant difference by t-test (*p<0.05, **p<0.01).

The colour of fresh sesame oil, peanut oil, coconut oil, refined sunflower oil was measured by Lovibond tintometer visual colorimeter. The colour values of fresh oils were differentiated with two colours red and yellow. The red colour values were 12.8, 11.9, 11.9 and 10.9, respectively and the yellow 28.9, 15.1, 13.9, and 13.4 respectively. Three things are necessary to perceive colour: (i) a light source, (ii) an object and (iii) an observer/processor. However, colour is a perceptual property in human beings and is broadly described by descriptive words such as red, yellow, light, dull and the like. However, each person describes and therefore defines an object's colour differently. With this in mind, various methods have been developed to measure the colour of edible oils and fats. Colour can be measured visually by comparing glass colour standards in a

colorimeter such as the Tintometer Model F, using a series of gradient red-, yellow-, blue- and neutral-colored glasses. Any variation in colours can be measured and expressed in an easily understood and communicative way [37].

The colour values of different types of homemade snack muruku first time fried oils were graded and the variety of oils such as Sesame oil, Peanut oil, Coconut oil and refined sunflower oil showed in Red colour graded values as 11.9, 11.9, 11.9 and 11.9 respectively whereas yellow colour graded values were 12.9,19.9, 13.1 and 14.2 respectively.

The colour values of different types of homemade snack muruku second-time fried oils were graded with visual calorimeter. The colour grading of Sesame oil, Peanut oil, Coconut oil, refined sunflower oil the different types of snacks fried oil were is graded for Red as 11.9, 11.8, 12.9 and 11.9 respectively and for yellow is 14.9, 12.2, 20 and 12.2 respectively.

By the estimation of colour in Sesame oil, Peanut oil, coconut oil and refined sunflower oil the colour changes occurs on the effect of deep fat frying. The parameters of colour include the redness, yellowness and lightness were used to estimate colour changes during frying as a function of the main process variables. The results show that the oil's temperature and thickness of the snacks fried in the oil significantly affect the colour parameters of the oils. The colour change occurs in the continuous reuse of the fried oils again. The color of the oils increased with frying time and being initially near colorless, the red color index changed for Voltage-Controlled Oscillator. The effect of frying conditions on the colour changes during deep fat frying of French fries has been investigated. The Hunter colour scale parameters redness, yellowness and lightness were used to estimate colour changes during frying as function of the main process variables (oil temperature, oil type and sample thickness) [37].

Refractive Index of Oils: Refractive index increases with the increase in the amount of conjugated fatty acids whilst peroxide values vary with the concentration of primary oxidation products. But both ultimately are used to detect deterioration in terms of rancidity. Rancidity is usually noticeable as a foul smell in food and also within the oil itself. Refractive index increases with increase in oxidation same as peroxide value. Rancid oil will bear a PV between 30mEq/kg and 40mEq/kg [12]. The Refractive index of cooked oils were presented in the **Table 15.**

TABLE 15: REFRACTIVE INDEX OF COOKED OILS

Sample	Fresh Oil	Fried oil (1st time used oil)	Fried oil (2nd time used oil)
Sesame oil	1.4696	1.4618	1.4665
Peanut oil	1.4668	1.4618	1.4665
Coconut oil	1.4517	1.4525	1.4533
Refined sunflower oil	1.4706	1.4701	1.4962*

*Represent significant difference by t-test (*p<0.05, **p<0.01).

The refractive index of Sesame oil, Peanut oil, Coconut oil and refined sunflower oils were measured under 29°C. The refractive index of fresh Sesame oil, Peanut oil, Coconut oil and refined sunflower oil were 1.4696, 1.4668, 1.4517 and 1.4706 respectively. The refractive index of first-time homemade snacks fried oil was 1.4618, 1.4618, 1.4525 and 1.4701. The different types of oils fried second time to prepare snacks shows refractive index as 1.4665, 1.4665, 1.4533 and 1.4962 respectively. The refractive index of the unused oil and fried oil was found to be close enough all the oils except refined sunflower oil, which had more deviations. The refractive index of Sesame oil, Peanut oil, Coconut oil, and refined sunflower oil was estimated by refractometer. The Refractive index of fried peanut oil changes slightly in Peanut oil, Sesame oil, and coconut oil.
In contrast, the refractive index of refined sunflower oil produces a slight increase when compared with a fresh refractive index value and second-time fried refractive index values. There is a general increase in the index of refraction of these oils which may be due to the increase in the level of conjugated fatty acid sasa resul to thermal degradationduring the frying process. The increase in the number of conjugated acids also conveys an increase in the level of autoxidation. The refractive index during the heating of oil increases as more conjugated acids is formed [38]. In optics, the

refractive index or index of refraction of an optical medium is a dimensionless number that describes how light, or any other radiation, propagates through that medium. The Refractive index is an important topical parameter to analyze the light rays traversing through materials medium [39]. It is the ratio of velocity of light in vacuum to the velocity of light in the oil or fat; more generally, it expresses the ratio between the sine of angle of incidence to the sine of angle of refraction when a ray of light of known wavelength passes from air into the oil or fat. Refractive index varies with temperature and wavelength [12]. The refractive index values get changed with the change in temperature and based on the density of oil it varies. Refractive Index can be used as an objective method for evaluating rancidity in edible oils and fats. Continuous increase in the RI of the oil due to repeated frying batches indicates that deep frying increases rancidity of the oil [40]. Refractive Index can be used as an objective method for evaluating rancidity in edible Oils and fats (Arya *et al.*, 1969). Continuous increase in the RI of the oil due to repeated frying batch indicates that deep frying increases rancidity of the oil. This means that repeated Frying using same vegetable oil should be discounted.

CONCLUSION: Physical parameters and organoleptic parameters of different types of cooking oils were assessed using hedonic scales. The colour of purchased oils, texture of purchased oils, were assessed, and Functional properties like solubility of purchased oils were assessed. The cooking oil's quality were also assessed. All five panelists of judges stated their reports which guided the present study. The flavor, thickness of oils, density, viscosity, colour change, refractive index, and rancidity were analyzed for fresh oils and cooking oils. There were notable changes when using the oils for the first and second time. Repeated heating of oils and their usage affects the quality of the oil.

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