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Evaluation of the Organoleptic Properties and Free Fatty Acid (FFA) of Cooking Oil in the Selected Stores of Poblacion Malita, Davao Occidental, Philippines

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

The study aimed to evaluate the organoleptic properties and percent (%) free fatty acid (FFA) content of cooking oil, namely Coconut oil, palm oil, and Canola oil, in the selected stores of Poblacion Malita, Davao Occidental Philippines. The study compared the organoleptic properties and % FFA of the cooking oil to the Codex standard of Food and Agriculture Organization (FAO). The study was conducted from August to December 2021. The post-product organoleptic evaluation of organoleptic properties and % FFA content in cooking oils can aid in determining the FFA safety level of cooking oil. A total of 15 samples (10 mL each) of Coconut, Palm and Canola oil were randomly collected from five selected stores. The organoleptic properties of collected oil samples were evaluated by direct inspection following the protocol by Dentali (2013). Free Fatty Acids (FFA) were analyzed using a titration method approved by the American Oil Chemist Society (AOCS). Results revealed that the color of coconut oil samples from the selected stores was very light yellow; canola oils were light yellow, and palm oils from the same stores had a golden yellow color.

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The taste and odor of coconut, palm, and canola oil samples were neutral, as well as the odor. The organoleptic characteristics of the oil samples were within the Codex Standard of FAO; thus, the products were compliant to the Codex standard. The percentage of FFA content showed that Coconut oil and Canola oil had lower FFA content compared to Palm oil. The average FFA values for each oil group were all compliant to the 2% limit set by industry standards.

Keywords: Cooking oil; organoleptic; % FFA; quality control; food safety.

1. INTRODUCTION

The continuous increase for cooking oil across the world demonstrates its importance in the food industry [1]. Vegetable oil is composed of main dietary components on the daily basis of food consumption and is used in every type of food preparation, which includes frying, baking, sauteing, dressing, marination, and extrusion cooking [2]. The consumption of fats and oils in industry is closely regulated and monitored [3]. Monitoring and maintaining cooking oil quality are of paramount importance to ensure safety of the product for consumption [3]. Vegetable oils are mainly triacylglycerols, polar lipids, monoacylglycerols, and diacylglycerols. Its components comprise free fatty acids (FFAs), fat soluble vitamins, pigments, phospholipids, waxes, sterols, and fatty alcohols [4]. Determination of free fatty acid content in cooking oil is essential because Free Fatty Acid (FFA) value is an important parameter in assessing the cooking oil quality due to its sensitivity to environmental fluctuations which trigger spoilage and product integrity degradation [5]. Free fatty acids are produced as a result of hydrolysis and oxidation reactions [5].

The production of free fatty acids is caused by both thermal degradation and hydrolysis of fatty acids [6]. It is proven that FFA's affect the quality of foods; for example, physical characteristics considerably can affect and be detrimental to human health [7]. According to Mahesar et al. (2014), the level of FFA depends on time, temperature, and moisture content because fats and oils are exposed to different environmental factors such as heating, frying, storage, or processing [8]. FFA are less stable than neutral oil; they are more susceptible to oxidation and to rancidity. Due to this, free fatty acids are an important factor in determining the quality and commercial value of oils and fats [8].

To assess the quality of cooking oils, free fatty acids (FFA) are often used [5]. Free fatty acid (FFA %) content is the most widely used criterion for determining the quality of cooking oil [9]. Triacylglycerol hydrolysis occurs when water from the fried food is released; resulting in high free fatty acid (percent FFA) values [10]. The American Oil Chemist's Society (AOCS) and the European Commission (EC) Regulations have established almost the same standard method of titration in assessing FFA. Simple titration, a process commonly used to calculate the concentration of FFA in oils and fats, is used to determine free fatty acids in oils and fats, to an endpoint of pH 8.3 with sodium hydroxide, and the results are expressed as %FFA [11].

Previously reported studies on the determination of free fatty acids in cooking oil products were widely carried out in different countries using different methods of FFA assessment. This study used the titration technique in quantifying the % Free Fatty Acid (FFA) content of the cooking oil because of its simplicity and convenience of testing [12].

Currently, there had been no reported or published report on the % FFA of cooking oil from various grocery stores in the Province of Davao Occidental, Philippines. Some regulating bodies in the locality have little information on oil quality assessment of FFA content in commercial cooking oil marketed in Malita, Davao Occidental. Due to the limited or lack of monitoring on the quality assurance of cooking oils in Malita, Davao Occidental, the study would like to provide a preliminary post-product analysis of the % free fatty acid content of the commercial cooking oils sold in the selected stores. The findings of the study provide an informed decision on the consumer in considering the type of cooking oil to be purchased in the market and grocery stores. The main objectives of the study were to determine the organoleptic properties and % free fatty acid content of cooking oil sold in the selected stores of Malita, Davao Occidental Philippines.

2. MATERIALS AND METHODS

2.1 Research Locale

The study was conducted at the selected stores of Poblacion, Malita, Davao Occidental, Philippines. Poblacion, Malita is a barangay in the municipality of Malita, Davao Occidental. It is situated at approximately 6°24′39″North, 125°36′52″East on the island of Mindanao. Elevation of its coordinates is estimated at 11.4 meters or 37.4 feet above mean sea level. The samples were collected from five major stores in the Barangay Poblacion. Malita Davao Occidental Philippines. For confidentiality concerns, the names of the stores will not be mentioned but instead coded as store A, Store B, Store C, Store D, and Store E.

2.2 Study Design

An experimental research design was employed in the study. The different types of cooking oil were designated as treatments. Three (3) samples per type of cooking oil were collected in every store. Three types of cooking oils were collected from the identified stores, namely Coconut oil, Palm oil, and Canola oil. The collected cooking oil was analyzed for organoleptic and Percent (%) Free Fatty acid content in triplicates. The types of cooking oil represent the independent variable and the cooking oil quality represents the dependent variables. The selected stores where samples were collected were labeled as stores A, B, C, D, and E. Analysis of each sample was carried out in triplicates. The researchers purchased 3 bottles of cooking oils per type from five selected stores in Poblacion Malita, Davao Occidental. Moreover, the researcher interviewed the store owner as to where they purchased the product and the type of cooking oil (coconut, palm, or canola).

2.3 Evaluation of Organoleptic properties of the cooking oil

The collected cooking oil samples were transferred to clean, transparent and sterile bottle and were labeled accordingly. Sensory evaluation of the collected cooking oil samples was conducted by the researchers as a pre-assessment of the raw products. Color, aroma, and taste were the organoleptic attributes that were evaluated in cooking oil. In analyzing the color of the sample, the researcher inspected the color and clarity through direct visual inspection [13]. In evaluating the aroma of the sample, the researcher sniffed the cooking oil sample from the bottle cap. To test the flavor, the researcher gets minute sample and quickly tastes it.

2.4 Percent (%) Free Fatty Acid Content of the Cooking Oil Sample

In laboratory analysis, the following materials were used burette, pipettes, conical flask, beakers, stirring rod, Erlenmeyer flask, test tubes, balance machine, and a hot plate was used. Chemical reagents such as 50 ml of ethanol, 0.1 Normality of NaOH and phenolphthalein were utilized in the titration of samples. The American Oil Chemist Society (AOCS) official method Ca. 5a-40 was adapted in the FFA determination. The FFA content of the cooking oil was determined by titration with a standard alkali, either 0.1 Normality of NaOH [14]. For the American Oil Chemist Society official method Ca 5a-40 (1), the recommended oil sample size, volume of alcohol, and NaOH strength are 1-10g of oil, 50-100 ml, and 0.1 N respectively [14]. FFA concentrations in fats and oils were calculated as a percentage of oleic acid. Oleic acid (Fisher Scientific, Fairlawn, NJ) of National Formulary (NF) and Food Chemicals Codex (FCC) grades were used to determine known FFA concentrations in coconut and palm oil samples [15]. About 2.0 g of oil samples each in duplicates were transferred into the Erlenmeyer flask. Then, 50 ml of ethanol was added and heated on a hot plate with stirring. The oil containing the heated ethanol was titrated with 0.1 N NaOH by the addition of 2-3 drops of phenolphthalein as an indicator. Weighing of the oil samples and titrations were carried out in triplicates. Solutions were stirred for 3 to 5 min with magnetic stirrers. All standard oil solutions were stored at 2 to 5°C in stoppered flasks. The % FFA as Lauric acid was computed for of Coconut oil and Palm oil were computed using the formula below, while % FFA as Oleic acid was computed for Canola oil. The obtained FFA was recorded in the data notebook.

The expression as given in AOCS official method Ca-40 (I) is,

$$\% \text{ FFA}=(v-b) \times N \times 28.2/W$$

where v is the volume of the titrant, b is the blank volume, N is the Normality of NaOH (0.1 N), W is the weight of sample.

3. RESULTS AND DISCUSSION

There are three (3) types of cooking oil collected from Five (5) identified stores namely Coconut oil, Palm oil, and Canola oil. Table 1 shows the results of the organoleptic evaluation; the general organoleptic properties were evaluated by direct visual inspection following the protocol of Dentali (2013). The coconut oil samples collected from stores A, B, C, D, and E had light yellow colors, conforming to the color yellow standards for coconut oil in the Codex Standard [16]. The oils had no odor and no taste, indicating a bland odor and taste for each of the oils. The standard odor and taste of coconut oil must be neutral (Codex Alimentarius Commission, 1999); hence they are within the Codex standard [17]. The color, odor, and taste of coconut oil samples from different sampling sites were within the Codex standards of the Food and Agriculture Organization (FAO, 1999) since they were free from foreign and rancid color, odor, and taste [16].

Secondly, palm oil samples collected from stores A, B, C, and D, and E had golden yellow colors, conforming to the color golden yellow standards for coconut oil in the Codex Standard [16]. However, samples from stores A and E were observed to have small numbers of foreign particles embedded. The clarity difference was due to different factors such as longer storage, sun exposure, and re-packaging of the product being sold in minute quantities [8]. The oils had no odor and no taste, indicating a bland odor and taste for each of the oils. The standard odor and taste of palm oil must be neutral [17]; hence they are within the Codex standard [16]. The color, odor, and taste of palm oil samples from different sampling sites were within the Codex standards of the Food and Agriculture Organization (FAO, 1999) since they were free from foreign and rancid color, odor, and taste [16].

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Moreover, the canola oil samples had very light-yellow colors, conforming to the color standards for coconut oil in the Codex Standard [16]. The very light-yellow color was due to carotenoids and other pigments, which are color materials occurring naturally in oils. The oils had no odor and no taste, indicating a bland odor and taste for each of the oils. The standard odor and taste of canola oil must be neutral [17]; hence they are within the Codex standard [16]. The color, odor, and taste of canola oil samples from different sampling sites were within the Codex standards of the Food and Agriculture Organization (FAO, 1999) since they were free from foreign and rancid color, odor, and taste [16].

Table 1. Organoleptic Properties of the cooking oil in selected stores of Poblacion, Malita Davao Occidental Philippines

Stores	Types of Cooking Oil								
	Coconut Oil			Palm Oil			Canola Oil		
	Color	Odour	Taste	Color	Odour	Taste	Color	Odour	Taste
A	Light yellow	Neutral	Neutral	Golden yellow	Neutral	Neutral	Very light yellow	Neutral	Neutral
B	Light yellow	Neutral	Neutral	Golden yellow with observed foreign particles observed	Neutral	Neutral	Very light yellow	Neutral	Neutral
C	Light yellow	Neutral	Neutral	Golden yellow	Neutral	Neutral	Very light yellow	Neutral	Neutral
D	Light yellow	Neutral	Neutral	Golden yellow	Neutral	Neutral	Very light yellow	Neutral	Neutral
E	Light yellow	Neutral	Neutral	Golden yellow with foreign particles observed	Neutral	Neutral	Very light yellow	Neutral	Neutral
Codex Standard	Light yellow	Neutral	Neutral	Golden yellow	Neutral	Neutral	Very light yellow	Neutral	Neutral

The determination of free fatty acids of oil through the amount of free fatty acids formed in the hydrolysis and oxidation processes. Table 2 presents the results of the percent (%) Free Fatty Acid Analysis (FFA) of Canola cooking oil samples from identified major stores coded as A, B, C, D, and E. The mean amount of canola oil ranges from 0.12 to 0.20 %. Store A has 0.15 %, Store B has 0.12 % and Store C, D and E has 0.20%. Moreover, the % FFA of Palm oil range from 0.16% to 0.69 %. Specifically Store A has 0.65 %, Store B has 0.63 %, Store C has 0.16 % while Store D has 0.69 % and Store E has 0.61 % FFA.

So far there have been no other reported study on the Percent (%) FFA of Canola oil and Palm oil in the Philippines. Furthermore, the % FFA Coconut oil range from 0.24 % to 0.31%. Specifically, Store A has 0.31 %, Store B and C has 0.24% and Store D and E has 0.28%. Previously, Percent (%) Free fatty acid as Lauric acid of coconut oil was reported to be ranging from 0.037 % to 0.337 % with an average of 0.131 % [18]. Moreover, the % FFA of coconut oil and palm oil was reported to be 0.281 % and 0.510 % [19]. Furthermore, the % FFA of canola oil ranges from 0.04-0.06 % [20]. Meanwhile, a study from Canadian grain commission reported the % FFA of canola oil to be 0.15 to 0.24 % [21]. According to the Industry Standards for % FFA, cooking oil must not exceed the 2 % threshold limit [22]. Based on the results, all the collected cooking oil samples from five (5) major stores in Poblacion Malita, Davao Occidental are compliant to existing Free Fatty Acid industry standards.

Table 2. Percent (%) Free Fatty Acid (FFA) of cooking oil

Stores	Mean of Percent (%) Free Fatty Acid of Cooking Oil		
	Coconut oil	**Palm Oil**	**Canola Oil**
A	0.31	0.65	0.15
B	0.24	0.63	0.12
C	0.24	0.16	0.20
D	0.28	0.69	0.20
E	0.28	0.61	0.20
Industry Standard	Percent (%) FFA: <2 %		

Moreover, the free fatty acid (FFA) content of cooking oil could be one of the good quality indicators. Free Fatty acid (FFA) can act as pro-oxidants in oils by speeding up the rate of hydroperoxide decomposition. Thus, high FFA concentrations in the cooking oil may cause further oxidation and might lead to the formation of offensive taste and flavor in the oil. FFA is often used to indicate the oil quality and its suitability for edibles [23]. The findings of the study can be useful guide for the bulk buyer to check the % FFA in the product specifications and do random checking of the cooking oil in terms of organoleptic properties prior to product purchased.

4. CONCLUSION

The organoleptic properties in terms of color, odor and taste of canola, coconut, and palm oils were within the Codex standards of the Food and Agriculture Organization. Secondly, the average Percent (%) Free Fatty Acid (FFA values of canola oil, coconut oil, and palm oil in the selected stores were 0.17%, 0.29%, and 0.55%, respectively. The % FFA content of the collected cooking oil was within the standard limit set by the FDA. Moreover, the % FFA levels of the three types of cooking oils were also within the 2% limits of the industry standard set by the FDA. The findings generated in this study can be utilized as reference by the cooking oil manufacturer in monitoring the product quality in the market. Moreover, the consumer can also use this finding in selecting the type of cooking oil depending on the level of Percent (%) Free Fatty Acid.

5. RECOMMENDATION

The researchers highly recommend conducting assessments of other physico-chemical parameters, such as viscosity tests and turbidity. To further substantiate the safety threshold of the cooking oil, follow-up studies on evaluating the antioxidants and contaminants will be beneficial. A sample collection based on the military standard would further improve in assessing the statistical significance of the % FFA results of cooking oil. Moreover, it is highly desirable also to evaluate the % FFA of unlabeled cooking oil mostly displayed in the public market.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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