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Study of the Characteristics and Oxidative Stability of a Mixture of Avocado Oil and Coconut Oil

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Abstract: This study aimed to evaluate the effect of blending avocado oil and coconut oil on the resulting physicochemical characteristics. Oil blends were prepared in six ratios of avocado oil to coconut oil (100:0; 80:20; 60:40; 40:60; 20:80; 0:100 v/v). The analyzed parameters included peroxide value, free fatty acids (FFA), iodine value, saponification value, fatty acid profile (GC-FID), and color test. The results showed that the blend in treatment C, with a ratio of avocado oil to coconut oil (60:40 v/v), yielded a peroxide value of 9.23 ± 0.32 meqO_2/kg, FFA of 0.73 ± 0.17%, iodine value of 47.33 ± 0.71 g I_2/100 g, and saponification value of 202.33 ± 0.54 mg KOH/g. The fatty acid profile was dominated by oleic acid, lauric acid, and palmitic acid. This blend produced a more diverse fatty acid profile and exhibited better oxidative stability compared to pure avocado oil. Therefore, blending avocado oil and coconut oil at a ratio of 60:40 v/v resulted in an oil product with a more varied fatty acid composition and improved oxidative stability compared to pure avocado oil.

Keywords: Avocado oil; Blended oil; Coconut oil; Fatty acid

Introduction

The avocado fruit (*Persea americana*) is one of the potential sources of vegetable oil in Indonesia. In 2018, Indonesia was recorded as the country with the highest avocado production after Mexico, Chile, and the Dominican Republic (Manaf et al., 2018). Avocado is classified as a climacteric fruit because it undergoes an increase in respiration rate and ethylene production after harvest. Avocado contains a relatively high fat content compared to other climacteric fruits such as apples, bananas, mangoes, and papayas (Bajramova & Spégel, 2022; Martial-Didier et al., 2017; Rashid et al., 2019). Therefore, avocado can serve as an alternative raw material for producing vegetable oil with good functional properties for health (Fagundes et al., 2024).

Previous studies have shown that avocado oil has a monounsaturated fatty acid (MUFA) profile similar to olive oil. However, the omega-6 and omega-3 contents of avocado oil are higher than those of olive oil. Avocado oil also contains twice the amount of sterols compared to olive oil (Berasategi et al., 2012). These characteristics make it comparable to olive oil, which is widely known in the market as a high-quality vegetable oil. Moreover, avocado oil has been proven to provide several health benefits, including reducing the risk of cardiovascular disease, acting as an anti-diabetic, exhibiting anti-inflammatory properties, and preventing oxidative stress (Lin & Li, 2024). Due to its various functional benefits, avocado oil has been applied in several cosmetic, pharmaceutical, and food products (Dewi et al., 2024; Nunes et al., 2024).

Nevertheless, avocado oil has certain drawbacks. Previous studies have reported that most commercial avocado oil samples are oxidized before reaching the expiration date stated on the bottle (Green & Wang, 2020). This is due to the high peroxide value (PV) of avocado oil, which is rich in unsaturated fatty acids, particularly oleic acid (Desiyana et al., 2020; Indriyani et al., 2016). Vegetable oils with a PV exceeding 10 meq O_2/kg are categorized as highly oxidized oils (Besbes et al., 2004; Brzezi et al., 2021).

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The physical blending of different oil sources is a simple method to address oil stability issues (Kusnandar, 2020). The process of blending vegetable oils can lead to the development of new products with improved characteristics, enhanced oxidative stability, and desirable sensory qualities for consumers (Athanasiadis et al., 2024). Controlled blending of avocado oil with coconut oil (*Cocos nucifera*) in the right proportions can enhance the value-added potential of avocado oil without reducing its quality. This approach offers a practical way to increase the added value of both avocado oil and coconut oil while providing measurable benefits.

In this study, refined, bleached, and deodorized (RBD) coconut oil was used. Coconut oil was selected due to its high saturated fatty acid content, good oxidative stability, and neutral flavor and aroma, making it more applicable in the food industry (Maurikaa et al., 2020; Mohammed et al., 2021). Coconut oil contains about 92% saturated fatty acids, primarily medium-chain fatty acids (Selvaraj et al., 2020). Previous studies have shown that coconut oil can maintain a low peroxide value during storage while exhibiting good oxidative stability (Besbes et al., 2004).

Although RBD coconut oil has lower antioxidant and polyphenol content compared to virgin coconut oil (VCO), there is no significant difference in its fatty acid profile (Mohammed et al., 2021). This suggests its potential to provide an optimal formulation when blended with avocado oil, resulting in improved characteristics and oxidative stability. Previous research reported that blending coconut oil with perilla seed oil reduced the peroxide value of perilla seed oil, with the best treatment observed at a ratio of 20% perilla seed oil and 80% coconut oil (Dhyani et al., 2022).

This study aims to examine the physicochemical characteristics of avocado oil and coconut oil blends at various ratios. The parameters analyzed include peroxide value, free fatty acids, iodine value, saponification value, fatty acid composition, and oil color evaluation. This study also offers a new contribution through an integrated approach that combines chemical aspects in a single blended oil formulation. Therefore, the results of this research are expected to serve as a scientific basis for the development of stable functional oils derived from locally sourced raw materials.

Method

Materials

The raw materials used for product preparation in this study were avocado fruit, hexane, and RBD (Refined, Bleached, and Deodorized) coconut oil. Other materials used for analysis included potassium iodide, acetic acid, 1% starch indicator, chloroform, ethanol, phenolphthalein, HCl (Smart-lab, PA), 0.1 N NaOH (Merck, PA), Wijs solution, sodium thiosulfate ($Na_2S_2O_3$), distilled water, alcohol (technical grade), hexane (PA grade), starch, and KOH.

Research Design

This study was conducted as an experimental laboratory investigation using a completely randomized design (CRD) to evaluate the physicochemical characteristics of blends of avocado oil and coconut oil at various ratios. The study consisted of six treatment levels with three replications on 100 mL oil samples with the following compositions:

A = 100% avocado oil
B = 80% avocado oil + 20% coconut oil
C = 60% avocado oil + 40% coconut oil
D = 40% avocado oil + 60% coconut oil
E = 20% avocado oil + 80% coconut oil
F = 100% coconut oil

Avocado Oil Production (Arpi et al., 2023)

Ripe fresh avocado pulp was washed, peeled, and separated from the seed. The pulp was cut into small pieces and mashed using a copper grinder. The mashed avocado pulp was then dried using a food dehydrator at 50 °C for 3 hours. Subsequently, 15 g of the dried avocado pulp was weighed and placed into filter paper for extraction using hexane solvent at a material-to-solvent ratio of 1:15 g/mL. Extraction was carried out in a 250 mL round-bottom flask using a Soxhlet apparatus at 60 °C for 5 hours, followed by evaporation of the remaining hexane solvent with a rotary vacuum evaporator.

Blending of Avocado Oil and Coconut Oil (Yi et al., 2024)

The extracted avocado oil and coconut oil were measured according to the predetermined blending ratios. The oils were combined in a closed container and vortexed for 10 minutes at a speed of 100 rpm to ensure homogeneity.

Observations

The observations consisted of analyses of the resulting oil samples. The parameters analyzed included peroxide value (SNI 7709-2012), free fatty acids (SNI 7709-2012), iodine value (SNI 2902-2011), saponification value (SNI 2902-2011), fatty acid profile (AOAC, 2012), and color evaluation (SNI 7709-2012).

Result and Discussion

Visual Characterization of Avocado–Coconut Oil Blends

The visual appearance of avocado oil and coconut oil blends clearly shows distinct color changes, which can serve as an important parameter for consumer perception and product stability (Oyeyinka et al., 2024). The visual representation of the blended oils is shown in Figure 1.

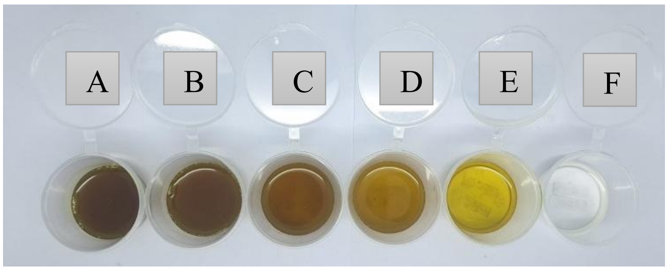

Figure 1. Oil samples from various treatments

Sample A, consisting of 100% avocado oil, exhibited a dark green-brown color, characteristic of avocado oil rich in pigments such as chlorophyll and carotenoids. These pigments naturally occur in avocado fruit and are extracted into the oil (Wang et al., 2010). As the proportion of coconut oil increased from Sample B to Sample F, the color gradually shifted toward pale yellow. This shift directly reflects the contribution of coconut oil, which is generally colorless or very pale yellow (Marina et al., 2009).

Sample E, which was predominantly coconut oil, displayed a bright yellow to almost colorless appearance, in sharp contrast to the pigment-rich green of Sample A. This visual change indicates a reduction in pigment concentration, such as chlorophyll, with increasing coconut oil content, potentially affecting the oxidative stability and functional profile of the blend.

In simple terms, this visual observation provides preliminary data on the physical attributes of the oil blends. The systematic color change serves as an indicator of blending ratios and indirectly implies changes in minor component composition. Correlating these visual changes with instrumental color measurements and pigment quantification would further enhance the understanding of the quality of these blended oils.

Peroxide Value

The peroxide value is a key indicator used to determine the degree of deterioration in oils. It measures the amount of peroxides and hydroperoxides formed during the early stages of lipid oxidation, encompassing both hydrolytic and oxidative rancidity processes (Sun-Waterhouse et al., 2011). A higher peroxide value indicates a greater extent of oxidation and a decline in oil quality. The peroxide values for the avocado oil–coconut oil blends are presented in Figure 2.

The analysis revealed a decline in peroxide values with increasing proportions of coconut oil in the blends. Pure avocado oil exhibited a peroxide value of 11.13 ± 0.51 meq O_2/kg, which is consistent with previous findings reporting values of 8.01–12.95 meq O_2/kg for avocado oil extracted via Soxhlet methods (Flores et al., 2014). Although avocado oil is rich in natural antioxidants, it also contains a high proportion of unsaturated fatty acids that are susceptible to oxidation, contributing to peroxide formation (Johnson et al., 2015).

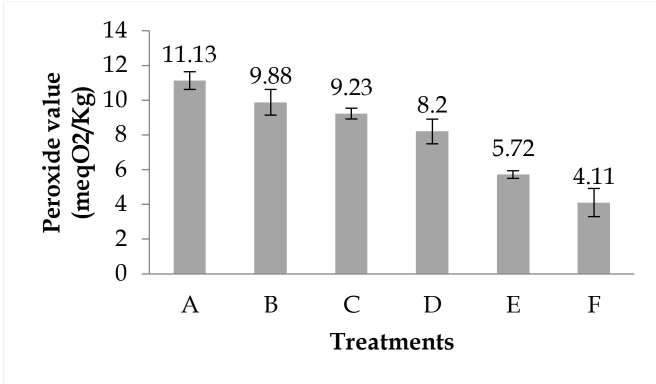

Figure 2. Peroxide value

As coconut oil concentration increased, peroxide values progressively decreased. Treatment B (80% avocado oil, 20% coconut oil) recorded a value of 9.88 ± 0.74 meq O_2/kg, which further declined to 5.72 ± 0.91 meq O_2/kg in Treatment E (20% avocado oil, 80% coconut oil). The lowest peroxide value was observed in pure coconut oil (Treatment F) at 4.11 ± 0.81 meq O_2/kg.

This reduction in peroxide values with higher coconut oil content can be attributed to the fatty acid composition of coconut oil, which is predominantly saturated—especially lauric acid—making it more resistant to oxidation compared to the unsaturated fatty acids abundant in avocado oil. The higher the degree of fatty acid unsaturation, the more prone it is to oxidation (Kaur et al., 2023). When oxidation-prone avocado oil is blended with the more stable coconut oil, the dilution effect and oxidative stability imparted by coconut oil contribute to lowering the peroxide value of the blend. Consequently, the inclusion of coconut oil can enhance the oxidative stability of the blended oil, improving its resistance to rancidity.

These findings are in agreement with earlier studies on coconut oil blended with sunflower oil, where peroxide values decreased with increasing coconut oil content. Coconut oil was also found to delay the formation of new peroxides during storage due to its high saturated fatty acid content, which reduces the proportion of highly unsaturated fatty acids in the mixture (Bhatnagar et al., 2009). Similarly, Yi et al. (2024) reported that incorporating coconut oil into other vegetable oils improves the oxidative stability of the blend.

Free Fatty Acid (FFA)

Free fatty acid (FFA) serves as an indicator of the degree of triglyceride hydrolysis and the initial deterioration of oil quality. FFA can be generated through enzymatic hydrolysis by lipase enzymes or through non-enzymatic reactions involving water and heat. A higher FFA content indicates lower oil quality (Sun-Waterhouse et al., 2011). The FFA values of the avocado oil–coconut oil blends are presented in Figure 3.

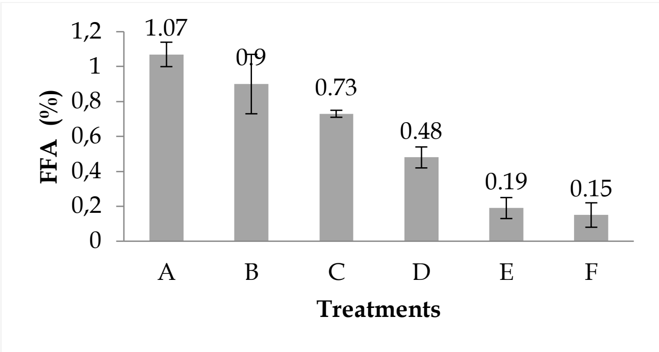

Figure 3. Free fatty acid (FFA)

Based on the results, the FFA content of the avocado oil–coconut oil blends decreased with increasing coconut oil concentration. Pure avocado oil exhibited the highest FFA content at 1.07 ± 0.07%. This value is still lower than that reported in other studies (1.78–1.89%) despite using the Soxhlet extraction method (Manaf et al., 2018). With increasing proportions of coconut oil, the FFA content progressively decreased. Treatment B (80% avocado oil and 20% coconut oil) had an FFA value of 0.90 ± 0.17%, which continued to decline to 0.19 ± 0.06% in Treatment E (20% avocado oil and 80% coconut oil). Pure coconut oil (Treatment F) recorded the lowest FFA content at 0.15 ± 0.07%.

Refined, bleached, and deodorized (RBD) coconut oil generally has very low FFA levels due to its high content of saturated fatty acids, particularly lauric acid, which is more resistant to hydrolysis, and because the refining process itself reduces FFA levels (Satriana et al., 2024). When avocado oil with a high FFA content is blended with coconut oil with a low FFA content, a dilution effect occurs, lowering the overall FFA concentration in the blend. This demonstrates that the addition of coconut oil can effectively reduce the free fatty acid content in the mixture, thereby lowering the FFA value of the resulting oil.

Iodine Value

The iodine value measures the degree of unsaturation in oils. This parameter represents the number of carbon–carbon double bonds present in fatty acid molecules, which can react with iodine or other halogens. A higher iodine value indicates a greater number of double bonds, meaning the oil contains more unsaturated fatty acids (Tan et al., 2018). The iodine values obtained in this study are presented in Figure 4.

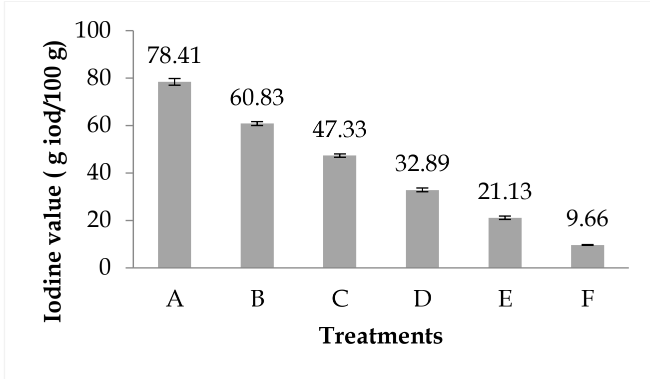

Figure 4. Iodine value

Based on the analysis, the iodine value of the avocado oil–coconut oil blends decreased with increasing proportions of coconut oil in the mixture. Pure avocado oil (Treatment A) exhibited the highest iodine value at 78.41 ± 1.41 g I_2/100 g. This value is within the Codex Alimentarius standard range of 64.38–154.41 g/100 g (Green & Wang, 2023). This is consistent with the characteristic fatty acid profile of avocado oil, which is rich in monounsaturated fatty acids (MUFA) such as oleic acid, as well as polyunsaturated fatty acids (PUFA) such as linoleic and linolenic acids (Lin & Li, 2024). The high unsaturated fatty acid content explains the relatively high iodine value of avocado oil.

As the proportion of coconut oil increased, the iodine value progressively declined. Treatment B (80% avocado oil, 20% coconut oil) showed 60.83 ± 0.82 g I_2/100 g, which further decreased to 21.13 ± 0.71 g I_2/100 g in Treatment E (20% avocado oil, 80% coconut oil). Pure coconut oil (Treatment F) recorded the lowest iodine value at 9.66 ± 0.16 g I_2/100 g. These results indicate that the blend ratio strongly influences the overall degree of unsaturation in the oil mixture.

The reduction in iodine value in blends enriched with coconut oil can be attributed to the difference in fatty acid composition between avocado oil and coconut oil. Coconut oil predominantly contains medium-chain saturated fatty acids, such as lauric and myristic acids, which have no double bonds (Maurikaa et al., 2020). The absence of double bonds results in a very low iodine value for coconut oil. Consequently, when unsaturated avocado oil is blended with saturated coconut oil, a dilution effect occurs, proportionally lowering the total number of double bonds in the mixture.

These findings demonstrate that by adjusting the blending ratio, the degree of unsaturation can be modified, which in turn affects oxidative stability and the physical properties of the final product. Blends with lower iodine values tend to be more resistant to oxidation but may exhibit higher melting points (Grover et al., 2021). This aligns with previous studies showing that blending oils with differing levels of unsaturation, even at variations as small as 10%, can significantly affect the iodine value of the resulting mixture (Purnamayati et al., 2019).

Saponification Value

The saponification value is a parameter that indicates the average molecular weight of the constituent fatty acids. It is defined as the number of milligrams of potassium hydroxide (KOH) required to saponify 1 gram of oil or fat (Ketaren, 2012). Oils composed predominantly of short-chain fatty acids have lower molecular weights and thus exhibit higher saponification values, and vice versa (Marina et al., 2009). The saponification values obtained in this study are presented in Figure 5.

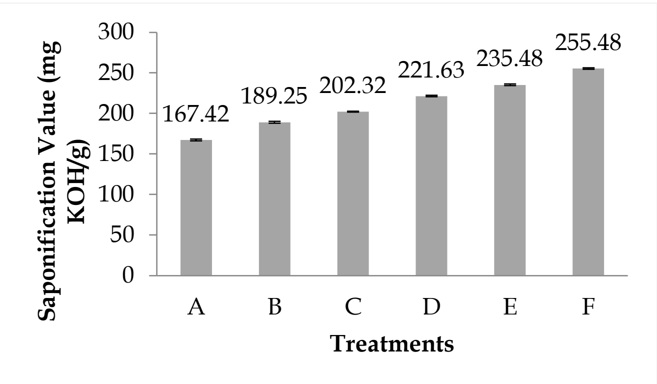

Figure 5. Saponification value

Based on the analysis of the avocado oil–coconut oil blends, an increasing trend in saponification value was observed with higher proportions of coconut oil in the mixture. Pure avocado oil (Treatment A) recorded the lowest saponification value at 167.42 ± 1.11 mg KOH/g. This result aligns with previous literature, which reports avocado oil saponification values in the range of 164.1–172.5 mg KOH/g (Ginting et al., 2020). This is consistent with the fatty acid profile of avocado oil, which is dominated by long-chain fatty acids such as oleic acid (C18:1) and linoleic acid (C18:2), both of which have higher molecular weights.

In contrast, pure coconut oil (Treatment F) exhibited the highest saponification value at 255.48 ± 0.91 mg KOH/g, consistent with values reported in previous studies and within the Codex standard and SNI 2902-2011 range of 248–256 mg KOH/g (Marina et al., 2009). Other literature reports refined, bleached, and deodorized (RBD) coconut oil with a saponification value of 252 mg KOH/g (Maurikaa et al., 2020). The high saponification value of coconut oil is attributed to its fatty acid composition, which is dominated by medium-chain fatty acids such as lauric acid (C12:0), myristic acid (C14:0), and capric acid (C10:0). Shorter-chain fatty acids have lower molecular weights, meaning that in one gram of oil there are more triglyceride molecules to be saponified.

The progressive increase in saponification value in blended treatments (B to E) reflects the effect of adding coconut oil. Treatment B (80% avocado oil, 20% coconut oil) recorded a saponification value of 189.25 ± 1.17 mg KOH/g, which continued to rise to 235.48 ± 1.00 mg KOH/g in Treatment E (20% avocado oil, 80% coconut oil). The addition of coconut oil directly influences the average molecular weight of fatty acids in the blend. The ratio between long-chain and short-chain fatty acids determines the resulting saponification value (Purnamayati et al., 2019). These results are useful for identifying adulteration or blending effects in oils, and they provide important insights into the physical properties and potential applications of blended oils.

Fatty Acid Composition

The fatty acid composition of each oil sample was analyzed using gas chromatography–flame ionization detection (GC-FID). This method was selected for its ability to accurately separate, identify, and quantify the percentage of each fatty acid present in the oil. The fatty acid composition is presented in the form of a heatmap, which provides a visual representation of variations in fatty acid content among samples, facilitating the identification of patterns and differences. In general, warmer colors indicate a higher concentration of a given fatty acid compared to the mean, whereas cooler colors represent lower concentrations (Mika et al., 2021). The heatmap of fatty acids for avocado oil–coconut oil blends is shown in Figure 6.

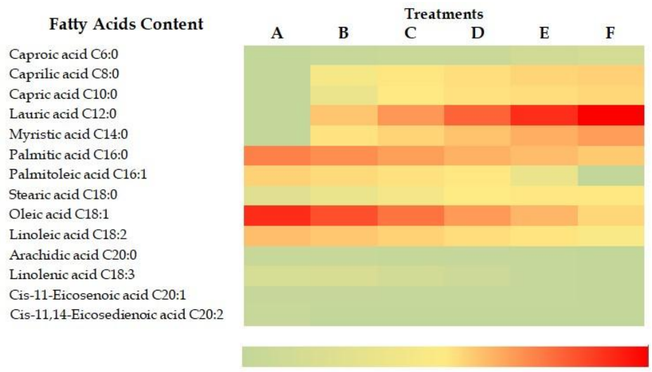

Figure 6. Heatmap of fatty acid content

The heatmap analysis illustrates changes in the fatty acid profile across various avocado oil–coconut oil blends, providing insights into their potential applications and nutritional implications. Based on the fatty acid profile data from treatments A to F, there were notable differences in the proportions of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) as the concentration ratio of the two oils varied. In the 100% avocado oil sample (Treatment A), the composition was dominated by MUFA and PUFA, with oleic acid (C18:1) as the major component, followed by palmitic acid (C16:0) and linoleic acid (C18:2). This profile is consistent with literature describing avocado oil as rich in unsaturated fatty acids, contributing to its high functional value. Recent studies have confirmed the cardioprotective role of oleic acid, which has been shown to lower LDL cholesterol and triglyceride levels while reducing the risk of cardiovascular disease (Lopez-Huertas, 2010).

In contrast, the 100% coconut oil sample (Treatment F) exhibited a markedly different profile, dominated by SFA—particularly lauric acid (C12:0) and myristic acid (C14:0). This characteristic aligns with coconut oil's highly saturated nature, conferring high oxidative stability. Additionally, the SFA components in coconut oil possess unique metabolic properties. Monolaurin, a natural metabolite of lauric acid, exhibits antiviral activity and is readily digested, transported directly to the liver via the portal vein for energy production, and can be converted into ketone bodies through various metabolic pathways (Silalahi, 2020).

The gradual transition from Sample A to F revealed a decrease in oleic acid content alongside an increase in medium-chain fatty acids with higher coconut oil proportions. In blended treatments (B–E), the progressive addition of coconut oil increased SFA while decreasing MUFA and PUFA levels. This phenomenon aligns with literature reporting that a 10% change in the concentration ratio of vegetable oils can significantly alter the fatty acid profile, thereby affecting the physicochemical properties of the blend (Jin et al., 2022).

The nutritional and functional implications of these changes are evident. Blends with higher avocado oil content, such as Samples B and C, retained substantial levels of oleic acid and PUFA such as linoleic acid, which are associated with cardiovascular benefits (Jackson et al., 2024). Conversely, coconut oil–rich blends, such as Samples D and E, were higher in medium-chain triglycerides (MCTs), which are rapidly absorbed and metabolized, making them suitable for sports nutrition, weight management, or as an easily digestible energy source (Chapman-Lopez & Koh, 2022).

These compositional changes also influence oxidative stability. The high PUFA content in avocado oil increases susceptibility to oxidation due to the presence of multiple double bonds, meaning blends with higher avocado proportions tend to have higher peroxide values. In contrast, coconut oil–rich blends (Treatments E and F) exhibited greater oxidative stability due to SFA dominance. The heatmap provides a clear visual representation of the compositional dynamics in these oil blends, enhancing the understanding of how blending ratios affect the final fatty acid profile. Such comprehensive characterization is essential for the development of food products, functional ingredients, and cosmetic formulations with tailored properties.

Color Analysis

Color evaluation is an important parameter in determining the quality of oils, particularly vegetable oils, as it can indicate purity, stability, and consumer acceptance. The Lovibond color measurement system is a widely used standard for determining the color of vegetable oils. Its principle involves comparing light transmission through a cuvette using color filters (Estiasiih et al., 2018). The results of the color analysis for the produced oils are presented in Table 1.

Table 1. Color Value

Treatments	Color (R+Y+B)
A	18.2 + 66 + 11.7
B	15.2 + 59.2 + 9.8
C	13 + 59 + 9.7
D	10 + 58 + 7.9
E	4.4 + 65.8 +2.9
F	0.9 + 5.9 + 0.3

Note: R = Red; Y = Yellow; B = Blue

Based on the Lovibond color measurements (R+Y+B) for mixtures of avocado oil and coconut oil, it is evident that concentration ratios influence color values. Pure avocado oil (Treatment A) exhibited a high color value (18.2 + 66 + 11.7), reflecting the naturally intense color characteristic of avocado oil. In contrast, pure coconut oil (Treatment F) displayed a very low color value (0.9 + 5.9 + 0.3), indicating a nearly colorless or very pale appearance. Mixed treatments (B, C, D, and E) showed a decreasing trend in color value with increasing proportions of coconut oil. For example, Treatment B (80% avocado oil + 20% coconut oil) recorded a color value of 15.2 + 59.2 + 9.8, whereas Treatment E (20% avocado oil + 80% coconut oil) had a value of 4.4 + 65.8 + 2.9. This trend is consistent with the intrinsic characteristics of coconut oil, which is typically colorless or significantly lighter in tone compared to avocado oil. The observed color change can be attributed to the dilution of avocado oil pigments by the clearer coconut oil.

Color changes in vegetable oils, including mixtures of avocado and coconut oils, are strongly influenced by the presence of natural pigments in each oil. Avocado oil is known to be rich in carotenoids and chlorophyll, which are responsible for its greenish-yellow to deep green coloration (Cervantes-Paz et al., 2021). Carotenoids, such as lutein and β-carotene, impart yellow to orange hues, while chlorophyll contributes to the green tones. The concentration of these pigments varies depending on the avocado variety, fruit maturity, and oil extraction method. Higher pigment concentrations result in a more intense avocado oil color, as demonstrated by Treatment A (100% avocado oil), which recorded the highest Lovibond color values.

On the other hand, pure coconut oil—particularly when derived from high-quality copra or processed through efficient refining—tends to be very light in color or nearly colorless. This is due to its significantly lower pigment content compared to avocado oil. Although trace amounts of carotenoids may still be present in coconut oil (Marina et al., 2009), their levels are insufficient to produce a pronounced color. A stronger yellowish tone in coconut oil is often associated with oxidation, contamination, or suboptimal processing.

Consequently, when avocado oil is blended with coconut oil, the color value of the mixture correlates directly with the proportion of avocado oil. As more coconut oil is added, the concentrations of carotenoids and chlorophyll from avocado oil become progressively diluted, resulting in an overall decrease in color intensity, as reflected in the trend from Treatments B to E. This decline represents the dilution effect of active pigments by the clearer coconut oil matrix.

Conclusion

The results of this study indicate that mixing avocado oil with coconut oil in various proportions significantly affects the physicochemical characteristics of the resulting oil. Differences in peroxide values, free fatty acid content, iodine values, saponification values, fatty acid profiles, and color were observed across various treatments, indicating that oil composition directly influences oxidative stability and nutritional properties. Among the formulations analyzed, treatment C (60% avocado oil + 40% coconut oil) was the optimal treatment because it provided a varied and balanced fatty acid profile with a low peroxide value.

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Author Contributions
The contributions of each author in this study are as follows: conceptualization, Aisman; methodology, Daimon Syukri; data curation, Aisman and Daimon Syukri; writing—drafting, Lucia Saraswati; writing—revision and editing, Aisman and Daimon Syukri. All authors have read and approved the published version of this manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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