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Comparison of Physicochemical Properties of Malaysian Avocado (*Persea americana*) Fat and Olive Oil

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ABSTRACT

This study examines the physicochemical properties of crude fat extracted from a Malaysian avocado (*Persea americana*) cultivar, comparing its characteristics with those of commercial olive oil. The primary objective was to explore the unique characteristics of the lipid extracted from Malaysian avocado, particularly its solid state at room temperature (25 °C), a property not typically observed in commercial oils like olive oil, which remains liquid under similar conditions. The avocado fat was extracted using the mechanical press method, yielding 20.71% fat. A comprehensive analysis was conducted on both avocado fat and olive oil to evaluate various parameters, including colour, slip melting point, iodine value, refractive index, free fatty acid content, peroxide value, and p-anisidine value. The results revealed that while the local avocado fat remains solid at room temperature, olive oil is liquid, making avocado fat potentially more suitable for applications requiring stability at ambient temperatures. The major fatty acids identified in the avocado fat were oleic, linoleic, and linolenic acids, whereas olive oil predominantly contained oleic and palmitoleic acids. In terms of triacylglycerol composition, avocado fat was primarily composed of POL, PLL, POO, and PPL, while olive oil predominantly featured OOO, POO, and OOL. These findings not only provide valuable insights into the properties of Malaysian avocado fat but also highlight its potential as a viable alternative to olive oil in food and cosmetic formulations, where a solid fat at room temperature can be beneficial for enhanced stability, texture, and shelf life.

INTRODUCTION

Avocado, scientifically known as *Persea americana* Mill., is a tropical and subtropical fruit, categorised under the Lauraceae family. The pulp of this fruit is recognized for its high lipid content, which is mainly composed of monounsaturated fatty acids, especially oleic acid [1]. In addition to its favourable fatty acid profile, the lipid substance of this fruit is rich in essential nutrients, including a variety of vitamins and minerals. It also contains a substantial amount of bioactive components such as phenolic compounds, carotenoids, tocopherols, and phytosterols [2]. In recent years, the demand for healthy, plant-based fats and oils has increased, with avocado oil emerging as a strong alternative to olive oil due to its comparable nutritional benefits and versatility. Often regarded as a heart-healthy oil, avocado oil offers numerous health benefits, in addition to its desirable taste and aroma. It has been associated with improved cardiovascular health [3], enhanced skin health [4], and strengthened immune

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function [5]. Malaysia's equatorial climate, fertile soil, and consistent year-round growing conditions provide a distinct environment that may influence the biochemical composition of avocado oil, potentially enhancing its functional and nutritional properties. Moreover, local avocado cultivars, which have adapted to the country's tropical agroecological conditions, are likely to produce oil with characteristics distinct from widely studied international varieties. Despite this potential, research on the physicochemical properties of Malaysian avocado oil remains limited, particularly when it is extracted using mechanical pressing. This method, which involves minimal heat and no chemical solvents, is considered one of the most effective techniques for obtaining high-quality oil while preserving its valuable bioactive compounds [6].

This study, therefore, sought to determine the physicochemical characteristics of a Malaysian avocado fat extracted from the pulp using mechanical press extraction. Due to numerous studies highlighting the similarities between avocado oil and olive oil, this study also aims to compare these oils in terms of their chemical composition and functional attributes. By examining these properties, the article seeks to provide a comprehensive understanding of the potential of Malaysian avocado oil as a viable alternative to olive oil in both culinary and industrial applications.

MATERIALS AND METHODS

Materials

The avocado fruits used in this study were obtained from a local wet market located in Kota Kinabalu, Sabah, Malaysia. The extra virgin olive oil was purchased from a local supermarket in Kota Kinabalu, Sabah. All chemicals used in this experiment were of analytical or HPLC grades.

Sample preparation

The mature fruits were round with a smooth and green peel. The fruits were kept until fully ripe, and they were carefully selected based on the darkening of the peel (purple colour) and softening of the flesh. The fruits were first washed to remove any dirt and impurities, then cut open to remove the seeds. The pulp was collected, mashed into a smooth paste, and oven-dried for 24 h at 60 °C. The dried pulp paste was then reduced to powder form with a grinder. Fat extraction from the avocado pulp powder was conducted using the mechanical press method, following the procedure outlined by Amin *et al.* [1]. The dried powder was pressed at a pressure of 15 MPa at room temperature (25 °C). The extracted fat was then filtered through standard laboratory filter paper and stored in a freezer at -20 °C prior to analysis.

Determination of physicochemical properties

The colour (L*, a*, b*), slip melting point (SMP), and refractive index (RI) of fat and oil samples were determined for the physical properties of fat and oil samples while the chemical properties of fat and oil samples were determined for iodine value (IV), free fatty acid (FFA) content, peroxide value (PV), and p-anisidine value (AnV), according to the AOAC [7] standard analytical methods.

Determination of fatty acid composition

Fatty acid methyl esters (FAME) of fat and oil samples were first prepared based on the PORIM [8] method. The FAMEs were then analysed using a gas chromatographic system (7890A, Agilent Technologies, California, USA) equipped with a flame ionization detector (FID) and a non-polar column (J&W Scientific DB-5; 30 m, ID 0.25 mm, film thickness 0.25µm), with reference to the method of Amin et al. [21]. The FAMEs were identified by comparing their retention time with FAME standards (Sigma St. Louis, MO). The relative percentage of individual fatty acids was reported as the relative proportion of the total fatty acids.

Determination of triacylglycerol (TAG) profile

The fat and oil samples were analysed for TAG composition by non-aqueous reverse-phase HPLC, referring to the method of Yanty *et al.* [9]. The HPLC used (G1213B, Agilent Technologies, California, USA) was fitted with a refractive index detector (Model RID-6A). The temperature of the column (250 mm × 4.6 mm, Kromasil 100-5-C18) was maintained at 30 °C. A mixture of acetone: acetonitrile (63.5:36.5, v/v) was used as the mobile phase, and the flow rate was set at 1 mL/min. Auto-injection was set at 10 µL of 5% (w/w) oil in chloroform, and the total run time was set to 40 min. The individual peaks were identified by comparing their retention time TAG standards, and the relative percentage of individual TAGs was reported as the relative proportion of the TAGs.

Statistical analysis

All analyses were conducted in triplicate, and the results were expressed as mean values ± standard deviations. Analysis of variance (ANOVA) accompanied with Tukey's test was conducted using the Statistical Package for Social Sciences (SPSS) version 29.0.0.0 to determine the significant differences at a 0.05 probability level ($p \leq 0.05$).

RESULTS AND DISCUSSION

Physicochemical properties

The fat obtained in this study had a brownish-green colour, aligning with colorimeter measurements that indicate the presence of green and yellow pigments. Chlorophyll and carotene, the primary pigments found in avocado oils, are responsible for these hues in the oil [10]. On the other hand, olive oil in this study was yellowish-green in colour. The avocado fat obtained through mechanical press extraction yielded approximately 20.71% of the dried pulp powder. The yield of avocado oils using mechanical pressing methods typically varies between 29% to 80%, depending on factors such as fruit variety, ripeness, and pre-treatment processes [11].

The physicochemical properties of avocado fat and avocado oil are shown in **Table 1**. The fat extracted from the local avocado cultivar in this study had a high solid fat melting point (SMP) of 29.67 °C, resulting in a solid fat at room temperature. This differs from the findings of Amin *et al.* [1], who reported that their local avocado cultivar, extracted using similar extraction, produced liquid oil at room temperature (25°C). These variations could be attributed to the differences in the fatty acid and triacylglycerol compositions of the avocado cultivars [9,12]. In comparison, the SMP of olive oil was not determined because it was liquid at room temperature.

Iodine value (IV) is a measure of the degree of unsaturation in fat, with a higher IV indicating a greater number of double bonds, making the fat more prone to oxidation. The IV of the avocado fat obtained in this study was 69.86 g I_2/100g, which closely aligns with the 70.6 g I_2/100 g reported for avocados grown in Dhankuta, Nepal [13]. In contrast, higher IVs have been reported for the oils of avocados from Malaysia (79.48 g I_2/100 g) [1] and Brazil (90.1-91.4 g I_2/100 g) [14]. The IV of the avocado fat in this study was lower than that of olive oil (82.92 g I_2/100 g), which was within the range of 75 to 94 g I_2/100 g [15]. This may indicate that olive oils generally have a higher degree of unsaturation compared to avocado oils, and thus could be more

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susceptible to oxidation under certain conditions. Given its relatively lower IV and greater stability, avocado oil is well-suited for high-heat cooking applications, such as frying and sautéing, where oxidative stability is essential.

Table 1. Physicochemical properties of avocado fat and olive oil. L* – indicates dark-to-light; **a*** – indicates green-to-red; **b*** – indicates blue-to-yellow. ND – Not Determined. Each value in the table represents the mean ± standard deviation of three replicates (n = 3). Superscripts with different letters are significantly different at p≤0.05 in the same row.

Analysis	Avocado fat	Olive oil
L*	29.83 ± 0.01^b	76.10 ± 0.02^a
a*	2.21 ± 0.02^a	-4.21 ± 0.02^b
b*	0.95 ± 0.01^b	20.18 ± 0.02^a
Slip melting point (°C)	29.67 ± 0.58	ND
Iodine value (g I_2/100 g)	69.86 ± 1.14^b	82.95 ± 0.05^a
Refractive index	1.48 ± 0.00^a	1.49 ± 0.00^a
Free fatty acid (as % oleic acid)	1.82 ± 0.13^a	0.66 ± 0.04^b
Peroxide value (meq O_2/kg)	3.03 ± 0.11^b	4.17 ± 0.12^a
p-Anisidine value	13.90 ± 0.07^a	6.50 ± 0.05^b

Free fatty acid (FFA) content, peroxide value (PV), and p-anisidine value (p-AV) are common indices used to assess the extent of oxidation and, consequently, the quality of edible oils. Lower values for these indices are generally more desirable, as they indicate a lower state of oxidation. In this study, the FFA, PV, and p-AV of the avocado fat were 1.82%, 3.43 meq O_2/kg, and 13.9, respectively. In contrast, Chimsook and Assawarachan [16] reported a much lower value of FFA content for Thai avocado oil, ranging from 0.43% to 0.63%. The FFA content of the avocado fat in this study was higher than that of olive oil (0.66%). This higher FFA content of avocado fat compared to that of olive oil is because the avocado fat exists in crude form, but it is expected that this value could be reduced through the refining process. Nevertheless, the FFA value observed in this study remains within the Codex Alimentarius [17] limit of 5% for crude avocado oil, indicating that the fat meets the standard for acceptable quality.

In the literature, the PV of mechanically pressed avocado oil was reported to range from 3.1 to 7.4 meq O_2/kg [14,16]. The PV of the avocado fat analysed in this study falls within this range, aligning with previous reports but higher than olive oil. Sara *et al.* [18] reported a higher PV of 17.17 meq O_2/kg in olive oil. There was limited data on the p-AV of avocado oil obtained through mechanical pressing; therefore, direct comparison using a similar extraction method has not yet been determined. In comparison to olive oil, Özcan & Uslu [19] found a lower p-AV, which ranged from 6.62 to 8.15. While the PV of the avocado fat studied remains relatively low, indicating minimal primary oxidation products.

The high p-AV suggests the presence of secondary oxidation products. PV typically peaks in the early stages of oxidation and decreases as the peroxides break down into secondary oxidation products, while the p-AV increases as secondary oxidation products form [20]. These findings suggest that the avocado fat in this study may be at a more advanced stage of oxidation compared to olive oil. Nevertheless, the values for both PV and p-AV still fall within the acceptable limits set by Codex Alimentarius [15], with maximum values of 10 meq O_2/kg and 20 for PV and p-AV, respectively.

Fatty acid methyl ester (FAME) compositional analysis

The fatty acid compositions of the studied avocado fat compared to olive oil are shown in **Table 2**. The main fatty acids of avocado fat were composed of oleic (50.32%), linoleic (22.29%), palmitic (14.76%), and linolenic (6.98%), with palmitoleic and stearic acids present in smaller percentages (2.69% and 2.96%, respectively). On the other hand, olive contained a high percentage of oleic acid (75.98%), followed by palmitic acid (11.61%) and a low percentage of other fatty acids.

Table 2. Fatty acid composition of avocado fat and olive oil. Each value in the table represents the mean ± standard deviation of three replicates (n = 3). Superscripts with different letters are significantly different at p≤0.05 in the same row.

Fatty acid	Avocado fat	Olive oil
Palmitic acid	14.76 ± 0.30^a	11.61 ± 0.02^b
Palmitoleic acid	2.69 ± 0.16^a	0.64 ± 0.05^b
Stearic acid	2.96 ± 0.10^a	2.20 ± 0.02^b
Oleic acid	50.32 ± 0.99^b	75.89 ± 0.31^a
Linoleic acid	22.29 ± 0.68^a	6.98 ± 0.24^b
Linolenic acid	6.98 ± 0.03^a	2.68 ± 0.10^b
Unsaturated fatty acid	82.28	88.39
Saturated fatty acid	17.72	13.81

The major fatty acid in avocado fat distribution in this study differs from the findings of previous studies [1,12,21], where oleic acid was the most abundant, followed by palmitic, linoleic, and then palmitoleic acids. These differences can be attributed to the variations in avocado variety and geographical origins [22]. The significant presence of linoleic and linolenic acids suggests that the avocado cultivar in this study could serve as a notable source of omega-6 and omega-3 fatty acids, contributing to the daily intake of these essential nutrients. As shown in **Table 2**, there was a noticeable difference between the fatty acid composition in this study and that reported by Amin *et al.* [1], particularly in terms of having a higher content of unsaturated fatty acids (USFA) and a lower content of saturated fatty acids (SFA). The total USFA of the avocado fat in this study was lower compared to that of olive oil due to the high percentages of monounsaturated fatty acids in olive oil, thus making this oil remain liquid at room temperature. However, the olive oil shared a similar fatty acid distribution with the avocado oil from the previous study, with oleic acid as the predominant fatty acid, followed by palmitic acid, linoleic acid, and palmitoleic acid.

Triacylglycerol (TAG) analysis

The TAG composition of avocado fat and olive oil is shown in **Table 3**. Fourteen TAG components were identified in the extracted avocado fat, with the most abundant being POL (20.77%), PLL (16.73%), POO (12.65%), and PPL (11.02%). The fat was predominantly composed of di-unsaturated TAGs (51.43%) and tri-unsaturated TAGs (25.73%). While there are minor differences between the major TAG profiles in this study and those reported in the literature, POL was consistently identified as the most predominant TAG species across both avocado cultivars. Amin *et al.* [1] found POO, PLL, and PPO to be the next most abundant TAG species in their study of avocado oil. Meanwhile, Yanty *et al.* [9] reported POO, POL, and OOO as the major TAGs in Malaysian avocado oil obtained through solvent extraction. In comparison to olive oil, the major TAGs were OOO (42.33%) POO (22.8%), and OOL (12.43%) with a total of nine TAG components.

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Typically, olive oil had OOO as the predominant TAG, as reported by several researchers [23,24]. These TAG molecules resembled the fatty acid that olive oil contained a high percentage of oleic acid (**Table 2**). Due to its high percentage of tri-unsaturated (56.24%) TAG molecules and richness in unsaturated fatty acids, olive oil remained liquid at room temperature with a low melting point. The oil rich in OOO is commonly used as an emulsifier, emulsion stabilizer, and wetting agent in food and cosmetic products [25]. The previous study also stated that the differences in their TAG composition play a key role in determining the melting point and overall physical state of the oil [20].

Table 3: Triacylglycerol composition of avocado fat and olive oil. O – Oleic; P – Palmitic; L – Linoleic; Ln – Linolenic; S – Stearic; U – Unsaturated; St – Saturated. UUU – tri-unsaturated; UUSt – di-unsaturated; StStU – monounsaturated; StStSt – tri-saturated. Each value in the table represents the mean ± standard deviation of three replicates (n = 3). Superscripts with different letters are significantly different at p≤0.05 in the same row.

Triacylglycerol	Avocado fat	Olive oil
LLLn	4.75 ± 0.15	-
LLL	2.60 ± 0.20	-
OLL	7.21 ± 0.32	1.48± 0.04
PLL	16.73 ± 0.11	1.48± 0.30
OOL	6.57 ± 0.17	12.43± 0.20
POL	20.77 ± 0.24	5.52± 0.15
PPL	11.02 ± 0.21	-
OOO	4.60 ± 0.19	42.33± 0.23
POO	12.65 ± 0.07	22.80± 0.10
PPO	8.89 ± 0.04	5.00± 0.03
PPP	1.93 ± 0.04	-
OOS	1.23 ± 0.09	6.50± 0.03
SPO	0.79 ± 0.04	2.46± 0.02
PPS	0.27 ± 0.07	-
UUU	25.73	56.24
UUSt	51.43	36.30
StStU	20.70	7.46
StStSt	2.2	-

CONCLUSION

This study demonstrated that the fat extracted from a local Malaysian avocado pulp via mechanical press extraction remained solid at room temperature, offering unique properties not typically associated with avocado oil. While avocado oil is typically a liquid, the solid form of avocado fat opens up new possibilities for food and cosmeceutical applications where solid fat is desired. The fatty acid profile revealed that this avocado fat possessed a high content of monounsaturated fatty acids, particularly oleic acid, similar to olive oil. However, notable differences were observed in other chemical properties, such as oxidative stability and TAG components. While the profile of Malaysian avocado fat suggests it could serve as an alternative to other vegetable fats, further studies are required to evaluate its functional properties, including oxidative stability, shelf life, and performance in applications like frying, emulsification, and cosmetics, in order to confirm its practical equivalence to olive oil fully. Additionally, the avocado fat may be fractionated into olein and stearin components to broaden its application.

CONFLICT OF INTEREST

The authors have declared that no conflict of interest exists.

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