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Research Article

Characterization of Mango Seed Kernel Oil from Several Varieties

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Abstract

Mango is a fruit that is widely cultivated and very popular, but the part of the mango that is consumed is the flesh of the fruit, so the mango seeds are still waste. Mango seeds contain oil that is safe for consumption, so they are suitable as a source of vegetable oil. Mango consists of several different varieties and flavors, the difference in varieties is thought to affect the characteristics of the oil contained in the seeds. Characterization of mango seed kernel oil extracted using ethanol was carried out on the physical properties, chemical properties, and determination of the antioxidant activity of 8 (eight) mangoes cultivated in Indonesia. The study aims to provide data on the characterization of mango seed kernel oil from several mango varieties that grow in Indonesia. Therefore, the data from the characterization can be a reference for the use of the mango seed kernel oil. Physical properties include moisture (%), refractive index at 30ºC, melting point (°C), smoke point (°C), flash point (°C), density (g/ml), viscosity (MPa), pH, color, and odor. Chemical properties include acid value (mg KOH/g oil), peroxide value (mg/g oil), saponification value (mg KOH/g oil), iodine value (g I_2/100 g oil), and free fatty acid (%). Antioxidant activity includes total phenolic content (mg gallic acid equivalent/100 g) and total flavonoid content (mg catechin equivalent/100 g). The physicochemical properties of mango seed kernel oil are at values that are safe for consumption. This oil contains compounds that have the potential to act as antioxidants, as well as several other quality compounds. Mango seed kernel oil is an edible oil that is suitable for use as a food ingredient. The high levels of oleic and stearic acid make this oil suitable for spreadable products.

Keywords

Mango Seed Kernel Oil, Physical Properties, Chemical Properties, Antioxidant Capacity

1. Introduction

Mango is a popular fruit; its sweet taste and fragrant aroma make mangoes widely cultivated. The part of the mango that is consumed is the flesh, so mango seeds are still a waste. After the pulp is consumed or made into various products such as canned fruit, jam, juice, and syrup, the remaining mango seeds become waste. Mango seeds contain kernels which consist of oil and are safe for consumption [1], making them suitable for use as an edible oil source.

Mango seed kernel oil (MSKO) is often referred to as fat because it is solid at room temperature like butter, but when heated the fat immediately melts into oil. This oil is used in the cosmetic industry as an ingredient in the manufacture of soaps, shampoos, and moisturizers. In addition, MSKO is rich in phenolic compounds and minerals such as selenium, copper,

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zinc, and contains unsaturated fatty acids in the form of oleic acid, which makes mango seed oil very beneficial for health. MSKO has the potential to be used in confectionary products as a source of cocoa butter substitute [1]. MSKO has the potential to be used in the formulation of food products such as biscuits and chocolate [2]. The high quality nutritional content of MSKO makes it potentially applicable to food [3].

Increased public awareness of the importance of maintaining health has triggered this study to be directed at exploring new food sources that are safe for consumption, and rich in nutrients and natural antioxidants. Natural antioxidants are compounds that are able to protect the body from free radicals and protect it from oxidative reactions, exhibit anti-inflammatory, anti-carcinogenic activity, protect cardiovascular health, and prevent premature aging. MSKO contains high concentrations of bioactive compounds in the form of phenolic acids, flavonoids, gallotannins and ellagitannins [4, 5].

In order to extract bioactive components from agro-industrial wastes like mango seed kernel, factors that significantly affect extraction, namely the control of the extraction process, must be the focus of consideration. Currently, solvent extraction technology is still the choice in the industry because it can improve process feasibility and provide high-quality bioproducts. Regarding the application of MSKO in food, it is of course important to study solvents that are safe to use and have a high ability to extract oil components and antioxidant compounds. This study tried using ethanol as a solvent, ethanol is more widely chosen as a solvent in the process of extracting vegetable oil, because it is relatively safer for health and operational security. Another advantage is that it comes from biorenewable sources [6].

On the other hand, it is very important to know the physicochemical properties and antioxidant capacity of MSKO extracted using ethanol, so that this study provides data on the physicochemical properties, antioxidant capacity, and quality compounds of MSKO from 8 (eight) mango varieties. Quality compound of MSKO is also included. This data is really needed by the food industry, which uses MSKO as a raw material.

2. Materials and Methods

2.1. Mango Seed Sample Preparation

Ripe mango seeds of several mango varieties, including Cengkir, Chokanan, Gedong gincu, Malibu, Golek, Manalagi, Madu, and Indramayu (Figure 1), were obtained from smallholder plantations in Indonesia in October-December 2024. Mango seeds were washed with 200 ppm chlorinated water. Seed kernels were manually separated, chopped, and dried at 50 ℃ to reduce the moisture content, the thin outer layers of the kernels are separated by blowing air. The kernels were floured and packed in plastic in the freezer waiting for the extraction process.

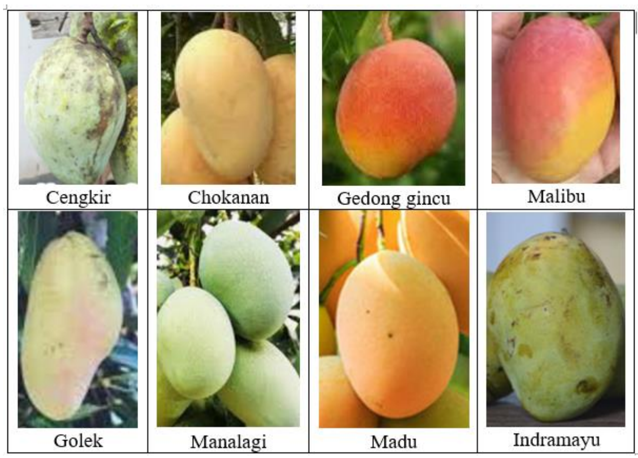

Figure 1. Mango varieties as samples.

2.2. Chemical and Solutions

Ethanol 96%, DPPH (1, 1-diphenyl-2-picrylhydrazyl), gallic acid (3, 4, 5-Trihydroxybenzoic acid), Folin-Ciocalteu reagent (Sodium 3, 4-dioxo-3, 4-dihydronaphthalene-1-sulfonate), and ABTS (2, 20-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) were from Sigma Chemical Co. (St. Louis, MO, USA). All the chemicals/reagents were used for analytical grade purposes.

2.3. Oil Extraction and Physicochemical Properties

The Soxhlet method used for the extraction of MSKO, 50 g of kernel was put into the thimble and ethanol of 350 ml was added to the neck flask 3. The heating mantle was used at the boiling temperature of ethanol for up to 3 cycles, the solvent was evaporated to obtain oil at the end of the extraction process. The oil yield was calculated and analyzed for physical properties based on AOCS (1989) [7], which included specific gravity, moisture, oil viscosity, melting point, smoke point, refractive index flash point, and pH. As well as analyzed of chemical properties which cover acid value, free fatty acid content, iodine value, peroxide value, and saponification value.

2.4. Determination of Antioxidant Capacity

2.4.1. Total Phenolic Content

The measured of the total phenolic of MSKO using 0.1 ml Folin-Ciocalteu reagent, 0.1 ml methanol extract, and 0.8 ml distilled water were reacted and incubated for 5 min at room temperature. Sodium carbonate 20% as much 0.5 ml was added than 30 min incubated at room temperature. The Ultra Violet-Visible Spectrophotometer (Orion Aquamate 8000) was used to measure the absorbance at 750 nm. The total phenolic were expressed as mg gallic acid equivalent (GAE)/100 g sample [8].

2.4.2. Total Flavonoids

The measurements of total flavonoid content of MSKO done by incubation for 6 min of 0.075 ml of 5% sodium nitrite ($NaNO_2$), 0.25 ml methanol extract, and 1.25 ml distilled water, added 0.15 ml of 10% aluminum chloride ($AlCl_3$) and saved for 5 min, 0.5 ml of 1.0 M sodium hydroxide (NaOH) and 0.275 ml of distilled water were added. At 510 nm the absorbance was measured and expressed as mg catechin equivalents (CE)/100 g sample [9].

2.4.3. DPPH Radical Scavenging Activity Assay

The DPPH method was used for the determination of the antioxidant activity of MSKO done by preparing of a solution of DPPH at 60 µM, DPPH solution of 193 µl was mixed with of MSKO 7 µl in each microplate and under dark conditions, incubated for 30 minutes. At 517 nm the absorbance was measured. The standard calibration curve from Trolox was prepared by dissolving in ethanol and diluting to the appropriate concentration, the 50% inhibitory concentration was calculated by Equation 1 [9].

$$\text{DPPH inhibition (\%)} = \frac{(Ac - As)}{Ac} \times (100) \quad (1)$$

Where, Ac is the absorbance of control, As is the absorbance of the sample.

2.5. Quality Component Analysis

Quality component analysis of MSKO according to analysis of fatty acid methyl esters (FAME). Lipids were esterified by a method adapted from Metcalfe [10], which consisted of lipid saponification with potassium hydroxide (KOH) 0.5 M in methanolic solution and a catalyzed boron trifluoride-methanol solution (BF_3-MeOH) reagent. The sample was solubilized with dichloromethane, from which 1 µl was injected for gas chromatography (GC) analyses. To separate and quantify the esterified fatty acids mixture, gas chromatography–mass spectrometry (GC-MS) QP 2010 by Shimadzu was used equipped with split/split less injector, capillary column RTX®-1 (30 mx0.25 mmIDx0.25 µm) and flame ionization detector (FID). Helium was used as the carrier gas at flows of 1.25 ml/min. The injector and detector temperatures were set to 260ºC. The chromatographic conditions for separation were the column initial temperature of 50ºC, raised to 200ºC at a flow rate of 6ºC/min, holding for 4 min. The second step consisted in increased at a heating rate of 2ºC/min to 240ºC, and held for 10 min. FAME peaks were identified by comparing their retention time and equivalent chain length with respect to standard FAME.

3. Results

Mango seeds, which are usually thrown away, can be used as a source of vegetable oil, thus providing economic value to mango seeds. In addition, this study found several positive values in mango seed oil.

3.1. Physical Properties of MSKO

Table 1 presents the physical properties of MSKO. The moisture content of MSKO was 0.16 - 0.24%. This result is acceptable for producing good quality edible oil, other studies report of 0.21% [11]. The viscosity of MSKO at 37°C was 42 MPa. This high value is thought to be caused by the high stearic fatty acid content, which causes the oil to become somewhat dense. The viscosity of crude MSKO is 42 MPas [12].

Table 1. *Physical properties of MSKO[a].*

Physical properties	Mango varieties							
	Cengkir	Chokanan	Gedong gincu	Golek	Malibu	Manalagi	Madu	Indramayu
Refractive index at 30°C	1.45 ± 0.02	1.51 ± 0.15	1.48 ± 0.05	1.45 ± 0.03	1.51 ± 0.03	150 ± 0.04	1.45 ± 0.03	1.46 ±0.04
Melting point (°C)	32.43 ± 0.2	32.35 ± 0.3	31.41 ± 0.3	31.34 ± 0.2	32.32 ± 0.2	32.89 ± 0.4	32.34 ± 0.3	32.36 ± 0.3
Smoke point (°C)	247.34 ± 0.6	249.42 ± 0.8	245.53 ± 0.6	252.23 ± 0.4	250.24 ± 0.7	249.23 ± 0.8	248.25 ± 0.8	250.22 ± 0.7
Flash point (°C)	260.27 ± 0.14	263.33 ± 0.17	261.12 ± 0.25	260.29 ± 0.4	263.42 ± 0.16	262.43 ± 0.5	262.22 ± 0.26	263.32 ± 0.6
Density (g/ml)	0.82 ± 0.06	0.82 ± 0.26	0.83 ± 0.08	0.82 ± 0.15	0.83 ± 0.26	0.83 ± 0.05	0.82 ± 0.07	0.82 ± 0.05
Viscosity value at 40ºC (MPa)	42.18 ± 0.2	42.34 ± 0.5	42.25 ± 0.13	42.18 ± 0.7	42.28 ± 0.8	42.21 ± 0.4	42.19 ± 0.25	42.18 ± 0.15
pH	4	4	4	5	4	5	5	4

Physical properties	Mango varieties							
	Cengkir	Chokanan	Gedong gincu	Golek	Malibu	Manalagi	Madu	Indramayu
Color	brown	brown	brown	brown	brown	brown	brown	brown
Odor	normal	normal	normal	normal	normal	normal	normal	normal

[a]Result is an average of duplicate determinations ±s.d

The refractive index of MSKO (30ºC) ranges from 1.456 to 1.553. The refractive index of the oil is an indication of quality assurance and signifies the stability of the oil during thermal treatment. The refractive index of MSKO (40ºC) is 1.359 to 1.559. It can be related to the unsaturation degree of oil [13]. The density (g/ml) of MSKO ranges from 0.82 to 0.83. Density is the mass per volume. Each type of oil has its own density because it depends on the fatty acid composition of the oil. The oil has a density of 0.8 g/ml [14]. The melting point of MSKO were range from 32.34 to 32.49ºC, a slightly lower value than other study [12]. MSKO has low melting point because it contains high oleic and linoleic acids as monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA). Melting points of MSKO from several studies ranged from 39 to 40ºC [15], 25 to 33ºC [16], 25 to 47ºC [17].

The flash points of MSKO range from 260.27 to 263.33°C. The flash point of oil is related to the temperature of the vapor above the liquid when ignited on exposure to an ignition source. The smoke point of MSKO range from 245.53 to 245.53. The smoke point is related to a burning point, but the smoke point value of oil can vary greatly depending on some factors such as volume of oil, the size of container, etc. The pH of MSKO was determined by pH meter, it about 4 to 5. Similar value were obtained in other studies [18]. pH of oil has an effect on the oxidative stability.

3.2. Chemical Properties of MSKO

The chemical characteristics of the MSKO is shown in Table 2. Including iodine value, peroxide value, saponification value, acid value and free fatty acid (FFA). The average acid value of mango seed kernel oil was about 4.17-4.61, as do other study reports [12]. The acid value is an indicator of the suitability of the oil for consumption, calculated as mg of KOH to neutralize FFA in 1 g oil. This value measures the glycerides in the oil that are broken down by lipase, light, and heat. The Codex recommends an acid value of 0.6 for virgin oil and 10 for non-virgin oil [19]. In general, the lower the acid value, the more acceptable it is for edible purposes. The acid value of MSKO ranges from 4.49-7.48 mg KOH/g [16].

***Table 2.** Chemical properties of MSKO[a].*

Chemical properties	Mango varieties							
	Cengkir	Chokanan	Gedong gincu	Golek	Malibu	Manalagi	Madu	Indramayu
Acid value (mg KOH.g^{-1})	4.32 ± 0.16	4.17 ± 0.21	4.52 ± 0.28	4.61 ± 0.27	4.36 ± 0.13	4.6 ± 0.15	4.48 ± 0.16	4.18 ± 0.18
Peroxide value (mg. g^{-1})	2.42 ± 0.23	2.34 ± 0.16	2.38 ± 0.21	2.34 ± 0.26	2.35 ± 0.26	2.36 ± 0.23	2.36 ± 0.26	2.34 ± 0.25
Saponification value (mg KOH. g^{-1})	194.61 ± 0.87	193.28 ± 0.68	193.48 ± 0.75	194.72 ± 0.86	193.31 ± 0.45	194.52 ± 0.56	194.73 ± 0.57	194.62 ± 0.56
Iodine value (g I_2.100g^{-1})	47.25 ± 0.42	49.25 ± 0.42	47.12 ± 0.49	47.32 ± 0.38	48.23 ± 0.36	48.72 ± 0.42	49.27 ± 0.47	48.83 ± 0.37
FFA, as oleic acid (%)	2.17 ± 0.26	2.18 ± 0.21	2.13 ± 0.22	2.19 ± 0.28	2.25 ± 0.28	2.28 ± 0.31	2.21 ± 0.35	2.17 ± 0.35

[a]The values are the average of duplicate determinations ±s.d.

Peroxide value is revered for oxidative rancidity in oil. The peroxide value of MSKO ranges from 2.32 to 2.98 mg/g. This value is close to the value of peroxide reported by other studies [12]. The peroxide number has implications for oil stability and is used as an indicator of oil damage, is the concentration of peroxides and hydroperoxides formed in the early stages of oil oxidation and is a measure of the level of oxidative rancidity of oil. Oxidative rancidity is the addition of oxygen to the double bond of unsaturated fatty acids in the presence of lipase or certain chemical compounds. A high peroxide value implies a higher level of rancidity [20]. Good rancid oil ranges from 20.00-40.00 mg/g oil [21]. Peroxide value of fresh oil should be less than 10 mg/g oil [22]. The peroxide value of MSKO is about 1.95 to 1.99 mEq/kg [15].

The saponification value of MSKO ranged from 193.28 to 194.73 mg KOH/g oil, similarly reported by other studies [13]. This could be referred to the polarity of the solvent used and the extraction method. The value of saponification is calculated as the milligrams of KOH required to saponify 1 g of oil, it has the ability to form soap from oil [22]. The value of saponification is equal to the chain length of the fatty acids in triglycerides [3]. This value is inversely proportional to the molecular weight of the glycerides making up the oil. The lower the saponification value means the triacylglycerol content has a very low molecular weight in the oil and describes the esterification of the fatty acid chains. The saponification value can also provide information about the characteristics of the fatty acids and the solubility of the soap in water.

The iodine value of MSKO is from 47.12 to 49.27g of I_2/100 g. Similarly, the value obtained by other studies [22]. The value of iodine has implications for the unsaturation of its constituent fatty acids, which is the volume of iodine to saturate 100 g of oil, reflecting the characteristics of the oil, such as a higher ability not to be degraded due to the oxidation process, so that it has a longer shelf life. The iodine values of MSKO are about 51.08-56.79 g $I_2.kg^{-1}$ oil [16], 40.90 to 56.79 g $I_2.kg^{-1}$ oil [17]. The FFA of MSKO ranged from 2.13-2.28%, almost the same as the value obtained by other studies. The value of peroxide and free fatty acid are the main parameter expressions for the quality of the oil [3]. Low percentage of FFA implies low enzymatic hydrolysis (lipase). High FFA triggers the formation of rancid oil during storage.

3.3. Chemical Properties of MSKO

The chemical properties of MSKO in this study focused on the determination of antioxidant capacity, which includes total phenolic content, total flavonoid content, and DPPH radical scavenging activity.

3.3.1. Total Phenolic Content

The total phenolic content (TPC) of MSKO was around 68.72 to 84.62 mgGAE/100 g (Table 3). The TPC is about 44.760 to 112 mg/100 g seeds were reported in other mango varieties [23-26]. The difference in TPC values is thought to be caused by mango varieties, geography, extraction methods and conditions, and differences in equivalent standards used.

The TPC of extract mango seed kernel consist of cinnamic acid, hesperidin, gallic acid, tannic acid, catachine, protocatechuic acid, p-caumaric acid, and chorogenic acid, each of these components equal to 3000, 1200, 987, 156, 21, 15, 12.5, and 8.5 mg/100 g, respectively or 55.6%, 22.2%, 18.3%, 2.9%, 0.39%, 0.23%, and 0.16%, repectively of total compounds [27]. Furthermore, it explained that the mango seed kernel extract (MSKE) contained hesperidin around 3000 ± 112 mg/100 g of seeds or 55.6% of the total polyphenols, so it is the main compound in MSKE. This is the first report of the presence of hesperidin in MSKE, cinnamic acid and tannic acid contained around 1200 ± 52 and 987 ± 44 mg/100 g of seeds or about 22.2% and 18.3% respectively of the total polyphenols. In addition, MSKE also contains small amounts of gallic, protocatechuic, p-coumaric, catachine, and cholorgenic [28].

The extract ethanol of mango seeds contained the phenolic such as valoneic acid dilactone ($C_{24}H_{22}O_{10}$), penta-galloylglucose/PPG ($C_{41}H_{32}O_{26}$), rhamnetin-3-[6′′-2-butenoil-hexoside] ($C_{26}H_{16}O_{13}$), theaflavin 3-O-gallate ($C_{36}H_{28}O_{16}$), and ethyl 2, 4-dihydroxy-3-(3, 4, 5-rihydroxybenzoyl) oxybenzoate ($C_{16}H_{14}O_9$), valoneic acid dilactone is a family of ellagitannins, PGG is a gallotannis, rhamnetin-3-[6′′-2-butenoil-hexoside] is a flavonoid, theaflavin 3-O-gallate is a flavonoid, and ethyl 2, 4-dihydroxy-3-(3, 4, 5-rihydroxybenzoyl) oxybenzoate which is a gallotannis [29]. Gallotannins are the main polyphenols of the extracted mango seeds. Valoneic acid dilactone is a compound in mango by-product [5].

Table 3. *Total phenolic, flavonoid, and antioxidant capacity of MSKO[a].*

Mango Varieties	Total Phenolic Content (mgGAE.100g-1)	Total Flavonoid Content) mg CAE. 100g-1)	DPPH (IC50) µg GAE.ml-1	Total Antioxidant Activity (µM TEAC.g-1)
Cengkir	68.72 ± 14	972 ± 0.4	36.4 ± 0.8	478 ± 12
Chokanan	76.15 ± 13	1026 ± 0.8	35.3 ± 0.8	481 ± 11
Gedong gincu	78.17 ± 13	938 ± 0.7	38.1 ± 0.3	473 ± 11
Golek	82.28 ± 18	1173 ± 0.4	35.3 ± 0.8	501 ± 15

Mango Varieties	Total Phenolic Content (mgGAE.100g-1)	Total Flavonoid Content) mg CAE. 100g-1)	DPPH (IC50) µg GAE.ml-1	Total Antioxidant Activity (µM TEAC.g-1)
Malibu	72.61 ± 14	1062 ± 0.5	33.2 ± 0.6	492 ± 11
Manalagi	84.62 ± 15	1183 ± 0.2	38.4 ± 0.5	512 ± 14
Madu	82.73 ± 12	1178 ± 0.4	32.1 ± 0.6	522 ± 12
Indramayu	76.82 ± 11	1011 ± 0.7	38.2 ± 0.3	503 ± 11

[a]The values are average of duplicate determinations ±s.d.
GAE, Gallic Acid Equivalent; CAE, Catchin Acid Equivalent; TEAC, Trolox Equivalent Antioxidant Capacity

Phenolic compounds are a group of compounds that exist in nature and act as natural antioxidants in plants. This compound has one or more (polyphenol) phenol rings, namely hydroxy groups attached to aromatic rings so that they are easily oxidized by donating their hydrogen atoms to free radicals. The antioxidant mechanism of phenolic compounds is through the ability of the phenol group to bind free radicals by donating hydrogen atoms through an electron transfer process, so that the phenols turn into phenoxyl radicals [30].

3.3.2. Total Flavonoid Content

The total flavonoid content of MSKO was around 938 to 1183 mg.100 g^{-1}. The value was in the range of that reported for MSKO of other varieties (10-1170 mg.100 g^{-1}) [5, 31]. The MSKO contains flavonoid of 3325 ± 120 mg CE.100 g^{-1} [26].

3.3.3. DPPH Radical Scavenging Activity

The DPPH radicals with IC_{50} values concentration-dependent scavenging of MSKO were about 32.1-38.4 32 µg GAE.ml^{-1}. The ethanol extracted from mango seed has an antioxidant capacity of IC_{50} 175.66 mg.l^{-1}, whereas butylated hydroxytoluene (BHT) used as the positive control has 289.17 mg.l^{-1} [32].

The MSKO's scavenging activity is related to its phenolic compound content. The total antioxidant capacity of MSKO is the reduction value of molybdenum (VI) to molybdenum (V) as measured by the half maximal effective concentration (EC_{50}) value of 4.0 ± 0.11 g.ml^{-1} [23]. Mango seeds have high amounts of antioxidants [17, 23]. The mango seed extract has antioxidant activity of about 64.04-514.50 mg TE.g^{-1} for DPPH and 297-1051.87 mg TE.g^{-1} for ABTS [33].

3.4. Quality Compound

MSKO analysis on the GCMS instrument showed several quality compounds as shown in Table 4. Several fatty acids were detected on MSKO, among others valeric acid (C5: 0), lauric acid (C12: 0), myristic acid (C14: 0), palmitic acid (C16: 0), palmitoleic acid (C16: 1), margaric acid (C17: 0), stearic acid (C18: 0), oleic acid (C18: 1), linoleic acid (C18: 2), arachidic acid (C20: 0), behenic acid (C22: 0), tricosanoic acid (C23: 0), and lignoceric acid (C24: 0). The fatty acids most commonly found in MSKO are oleic acid (9-octadecenoic acid, methyl ester) and stearic acid (octadecanoic acid, methyl ester).

The recommendations of this study are further research on storage stability and development of commercial products in the form of trials of formulations of food, cosmetic, and pharmaceutical products based on mango seed oil, especially spread products such as margarine, ointments, creams, and lotions, as well as the evaluation of consumer acceptance.

5. Conclusions

MSKO is an edible oil that is suitable for use as a food ingredient and spreadable product. The physicochemical properties of MSKO are at values that are safe for consumption. This oil contains compounds that have the potential as antioxidants, as well as several other quality compounds. The significance of the utilization of agricultural waste is that mango seeds can be used as a source of vegetable oil. The high content of antioxidant compounds and unsaturated fatty acids makes it a healthy alternative source of vegetable oil in a semi-solid form, so that it has the potential to be an alternative raw material for healthy margarine because it does not require a hydrogenation process. Relevance in the food industry can be used in margarine substitute spread products and opens up opportunities for functional food formulations. In the cosmetic and pharmaceutical industries, the bioactive content and semi-solid texture make it potentially usable in ointments, creams, and lotions. New areas of recommendation for future research on MSKO are studies on antimicrobial, anticancer, and anti-inflammatory activities.

Table 4. Quality compound of MSKO.

Quality compound	R.T. (min)	Mango varieties (%)							
		Cengkir	Chokan an	Gedong gincu	Malibu	Golek	Manalagi	Madu	Indram ayu
Dodecanoic acid, methyl ester	6.504	2.73	2.71	2.83	2.62	3.23	3.14	3.18	2.68
Tetradecanoic acid, methyl ester	13.747	0.23	0.35	0.15	0.23	1.61	1.46	1.8	0.32
Hexadecanoic acid, methyl ester	18.237	9.12	9.25	9.38	9.14	9.21	9.22	9.18	9.93
Heptadecanoic acid, methyl ester	19.954	0.22	0.26	0.28	0.24	0.22	0.24	0.24	0.23
9, 12-Octadecadienoic acid (Z, Z)-, methyl ester	20.996	7.61	7.71	7.44	7.54	7.61	7.12	7.15	7.03
9-Octadecenoic acid, methyl ester	21.167	42.3	42.2	42.18	42.48	39.1	39.65	39.4	42.14
Methyl Z-11-tetradecenoate	21.187	0	0	0	0	0.98	0.92	0.93	0
Octadecanoic acid, methyl ester	21.569	32.32	32.21	32.38	32.34	32.32	32.62	32.61	32.26
Methyl 10-methoxycarbonyl-17-oxo octadecanoate	22.935	0.25	0.26	0.25	0.25	0.38	0.34	0.23	0.33
Cyclopropaneoctanoic acid, 2-hexyl-, methyl ester	23.917	0.43	0.41	0.47	0.43	0.45	0.45	0.43	0.41
Eicosanoic acid, methyl ester	24.276	2.33	2.23	2.26	2.31	2.31	2.33	2.33	2.31
Di-n-octyl phthalate	26.842	0.15	0.14	0.15	0.15	0.15	0.14	0.15	0.15
Docosanoic acid, methyl ester	26.834	0.61	0.62	0.62	0.61	0.62	0.62	0.62	0.61
Tricosanoic acid, methyl ester	28.4	0.24	0.23	0.21	0.24	0.26	0.26	0.26	0.22
Tetracosanoic acid, methyl ester	30.356	0.93	0.87	0.85	0.87	0.99	0.95	0.95	0.83
Octadecanoic acid, 3-hydroxy-2-tetradecyl-, methyl ester, (2R, 3R)-	34.813	0.53	0.55	0.55	0.55	0.56	0.54	0.54	0.55

Abbreviations

MSKO	Mango Seed Kernel Oil
AOCS	Association of Official Analytical Chemists
DPPH	1, 1-diphenyl-2-picrylhydrazyl
ABTS	2, 20-azinobis (3-ethylbenzothiazoline-6-sulfonic Acid
GAE	Gallic Acid Equivalent
CE	Catechin Equivalents
CAE	Catchin Acid Equivalent
TEAC	Trolox Equivalent Antioxidant Capacity
FAME	Fatty Acid Methyl Ester

GC-MS	Gas Chromatography–Mass Spectrometry
MSKE	Mango Seed Kernel Extract
PPG	Penta-galloylglucose
BHT	Butylated Hydroxytoluene
EC_{50}	Half Maximal Effective Concentration

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Author Contributions

Fajriyati Mas'ud: Conceptualization, Methodology, Supervision, Formal Analysis, Writing – review and editing

Muhammad Sayuti: Data curation, Formal Analysis, Investigation, Writing – original draft

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Conflicts of Interest

The authors declare no conflicts of interest.

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