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Synthesis of Methyl Esters from Banda Nutmeg and Papua Nutmeg Oil Production Wastes Using the Ultrasonication Method

Sintesis Metil Ester dari Limbah Produksi Minyak Pala Banda dan Pala Papua Menggunakan Metode Ultrasonikasi

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ABSTRACT

Methysters from oil production waste from Banda nutmeg (*Myristicafragrans* Houtt) and Papuan nutmeg (Myristica Argentea Ware) go through several process stages, namely isolation of trimyristin and synthesis of methyl ester. The process of isolating trimyristin from nutmeg essential oil production waste by maceration using chloroform solvent. The transesterification process with methanol uses a CaO catalyst and ultrasonication method for 20 minutes; the results are analyzed using GCMS. The results of isolating trimyristin from nutmeg oil waste for Papuan nutmeg yielded 55.6 g of trimyristin (22.24%), which was greater than Banda nutmeg which was 49.7 g of trimyristin (19.88%). Transesterification results for Banda nutmeg oil waste obtained 28.57% soakage with a composition of 5 known major methyl ester compounds, namely methyl laurate (3.22%), myristicin (13.48%), metal myristate (53.39%), methyl Palmitate (5.24%), and Methyl Oleate (9.33%). In Papuan nutmeg oil waste, a 3.93% soakage was obtained with a composition of 5 known methyl ester compounds, namely metal myristate (19.80%), methyl arachidate (18.04%), methyl linoleate (1.42%), methyl oleate (48.37%), and methyl stearate (3.18%). The sonication method can synthesize methyl esters from nutmeg oil waste and gives different results for the two types of nutmeg. The results of the trimyristin transesterification of Banda nutmeg seeds and Papuan nutmeg seeds using a CaO catalyst using the sonication method resulted in a methyl ester soak of Banda nutmeg waste 28.57% and Papuan nutmeg 3.93%.

Keywords: Banda nutmeg; Papuan nutmeg; Methyl ester; Trimyristin; Ultrasonication.

ABSTRAK

Metilester dari limbah produksi minyak pala banda Banda (Myristicafragrans Houtt) Dan Pala Papua (Myristica Argentea Ware) melalui beberapa tahapan proses yaitu isolasi trimiristin dan sintesis metilester. Proses isolasi trimiristin dari limbah produksi minyak *atsiri biji pala dengan cara maserasi menggunakan pelarut kloroform. Proses transesterifikasi dengan metanol menggunakan katalis CaO dan metode ultrasonikasi selama 20 menit, hasilnya dianalisis menggunakan GCMS. Hasil isolasi trimiristin pada limbah minyak pala untuk biji pala Papua menghasilkan 55,6 g trimiristin (22,24%) lebih besar dari biji pala Banda sebesar 49,7 g trimiristin (19,88%). Hasil Transesterifikasi untuk limbah minyak pala Banda diperoleh rendemen 28,57% dengan komposisi 5 senyawa metil ester mayor yang diketahui yaitu metil Laurat (3,22%), miristisin (13,48%), metal miristat (53,39%), metil Palmitat (5,24%), dan metil Oleat (9,33%). Pada limbah minyak pala Papua diperoleh rendemen 3,93% dengan komposisi 5 senyawa metil ester yang diketahui yaitu metal miristat (19,80%), metil Arakidat (18,04%), metil Linoleat (1,42%), metil Oleat (48,37%), dan metil Stearat (3,18%). Metode sonikasi mampu mensintesis metil ester dari limbah minyak pala dan memberikan hasil yang berbeda untuk kedua jenis pala. Hasil transesterifikasi trimiristin biji pala banda dan biji pala papua menggunakan katalis CaO dengan menggunakan metode sonikasi diperoleh rendemen metil ester limbah biji pala banda 28,57% dan pala papua 3,93%.*

***Kata Kunci**: Pala Banda; Pala Papua; Metil ester; Trimiristin; Ultrasonikasi.*

INTRODUCTION

Indonesia is a country that has natural wealth, both on land and at sea. One of the biodiversity in Maluku province is the nutmeg plant, which produces essential oil. Banda nutmeg (*Myristica fragrans Houtt*) is one of Indonesia's primary export commodities. The export volume of nutmeg in 2018 was around 20 thousand tons, with a value of US$111.68 million and a growth rate of 0.63% per year in 2014-2018 (Ditjenbun, 2019). The most nutmeg import in 2019 was from China, which reached 3,748.40 thousand tons (16.11 million US$), followed by Vietnam, which was 3,740.05 tons (17.83 million US$), India reached 2,257,46 thousand tons (29.78 million US $) and the Netherlands which is 1 536.73 tonnes (13.94 million US$) (Ditjenbun, 2020). Maluku is one of the largest producers of nutmeg in Indonesia in terms of area of mature plantations and production for smallholder plantations. Indonesia's nutmeg production of 43.97 thousand tonnes is concentrated in five provinces: Aceh, Maluku, North Maluku, North Sulawesi, and West Papua (Pusdatin, 2020).

Nutmeg is a plant with good economic, ecological, and social values; therefore, nutmeg is one of the plants in great demand in the development of social forestry (Parliansyah,

2019). Nutmeg, with its main products in the form of seeds and mace, is an indigenous spice plant from the Maluku Islands, to be precise, Banda Island (Ruth et al., 2019). The nutmeg plant produces two important economic value products, nutmeg and mace or mace, which cover the seeds. These two products produce nutmeg, essential oils, spices, and medicinal ingredients (Ojechi et al., 1998). In Fakfak Regency, Papua, nutmeg has developed different types and characteristics from banda nutmeg. This type of nutmeg has a larger and longer fruit size than the banda nutmeg. The mace is also thicker with a redder color. According to Guenther (1987) and Lawless (2002), this type of nutmeg belongs to Myristica argentea Ware and is called Fakfak nutmeg or Papuan nutmeg.

In nutmeg, especially the old seeds, besides the essential oil, there is a non-volatile component called fixed oil or nutmeg butter. *Nutmeg oil* is an essential oil produced through distillation using steam from ripe and dry seeds and mace. Nutmeg oil is one of the largest export commodities in Indonesia and has advantages in the world market because it has a distinctive aroma and high oil content (Kapelle & Laratmase, 2014). Besides being a spice, the nutmeg oil produced is a raw material for the beverage, medicine, and cosmetic industries (Bustaman, 2008). Nutmeg oil is divided into 2, namely fatty oils and essential oils. A buttery orange fatty oil obtained from hydraulically pressing nutmeg seeds. This oil contains much trimyristin, which is not used in food. Meanwhile, essential oils are obtained by steam distillation as a pale yellow liquid with a distinctive aroma of spices (Kapelle & Laratmase, 2014).

The process of isolating nutmeg oil from nutmeg seeds using the steam distillation method yields oil and residue in the form of waste or unused production waste. The production waste is known to contain trimyristin compounds. Trimyristin is a raw material for soaps, detergents, and oleochemicals. Trimyristin is a derivative of an ester compound commonly known as myristicin fat. Another name for trimyristin is glycerol trimyristate or glycerol tritetradecanoate. This fat is soluble in alcohol, benzene, chloroform, and diethyl ether and is insoluble in water (Kapelle & Laratmase, 2014).

Asgarpanah and Kayemiyas (2012) reported that trimyristin, together with myristic acid, myristicin, and elemicin, has antioxidant, anticonvulsant, analgesic, anti-inflammatory, anti-diabetic, anti-bacterial, and antifungal activities. Trimyristin can also be processed into its derivatives, namely myristic acid and myristyl alcohol. These materials are widely used to manufacture soaps, detergents, and other cosmetic ingredients, such as shampoos, lipsticks, and lotions (Idrus et al., 2014). This study aimed to isolate trimyristin from waste products of essential oil production of banda nutmeg (Myristica Fragrans Houtt) and Papuan nutmeg (Myristica Argentea Ware) seeds and synthesize methyl ester using sonication method.

METHODOLOGY

Trimyristin Isolation

The trimyristin isolation method uses the procedure carried out by Kapelle & Laratmase (2014). 250 g of nutmeg oil production waste (banda nutmeg waste) and 500 mL of chloroform were added to a 1 L Erlenmeyer. Then, the isolation process was carried out using the maceration method for 8 hours. The results were then filtered, and the maceration filtrate was evaporated using an evaporator. Then, the recrystallization process was continued by adding 250 mL of 95% methanol. The results are then filtered. The same procedure was carried out for samples of nutmeg oil waste from Papuan nutmeg seeds.

Synthesis of methyl ester using CaO catalyst

The methyl ester synthesis method uses a modification of the procedure of Kapelle & Laratmase (2014) and Puspawati et al. (2018). As much as 10 g of trimyristin isolated from banda nutmeg waste and 400 mL of methanol were put into a beaker and stirred until dissolved, then 10 g of CaO and sonicated with a frequency of 47 kHz for 20 minutes. The sonication results were cooled and put into a separatory funnel, washed with 200 mL of distilled water, and extracted with 200 mL of n-hexane. Then, the top layer is taken, washed with distilled water until the pH is neutral, dried with anhydrous Na2SO4, filtered, and then the solvent is evaporated using an evaporator. The product results obtained were carried out structural analysis using GC-MS. The same procedure was done for trimyristin samples from Papuan nutmeg seed oil waste.

RESULTS AND DISCUSSION

Isolation of trimyristin was carried out using the maceration method. The waste from nutmeg production is nutmeg seeds whose oil has been distilled, so they are free of essential oils. Trimyristin was obtained with a yellowish-white color from 250 g of nutmeg waste powder. Trimyristin recrystallization process with 95% methanol and filtered in cold conditions. Filtration is carried out in cold conditions because the solubility of trimyristin in methanol is very low, so trimyristin can be obtained with a high yield. Recrystallization was used to separate trimyristin from impurities in the form of dyes involved in the isolation process. From the results of trimyristin extraction, trimyristin from Papua nutmeg was obtained at 55.6 g with a higher yield (22.24%) compared to trimyristin from banda nutmeg at 49.7 g (19.88%).

The results of trimyristin transesterification of banda nutmeg and Papua nutmeg using a CaO catalyst using the sonication method obtained 28.57% methyl ester from banda nutmeg waste and 3.93% papua nutmeg. Sonication has been widely used in synthesizing ester-derived compounds. Ultrasonic waves in sonication accelerate material dissolution by breaking the intermolecular bonds in the frequency range of 20 kHz – 50 mHz to produce hollow balls or trapped gas bubbles (cavity effect) (Yasui, 2002., Candani et al., 2018). The sonication method using ultrasonic waves is considered more energy efficient, which results in more efficiency, and the reaction process requires a relatively shorter time. Applying ultrasonic waves to a solution will cause the molecules to oscillate about their average position. The solution experiences tension and density. When the ultrasonic wave energy applied is large enough, the wave strain can break the molecular bonds between solutions, and the gases dissolved in the solution will be trapped due to the solution molecules whose bonds are broken. The sonication method can increase reactivity, which effectively improves the catalytic properties of the CaO catalyst to further reactivate the atoms and molecules in the system (Candani et al., 2018).

In reactions that use solid materials, sonication functions to break up solids from the energy generated due to the collapse of the cavity. The impact is that the surface area of the solid is larger, which increases the reaction rate. The longer the sonication time, the more homogeneous and smaller the particle size, eventually reaching a stable non-particle size and less clumping. This is because the shock waves in the sonication method can separate clumping

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particles, and perfect dispersion occurs with the addition of surfactant as a stabilizer. Suppose a sonication wave is emitted into a mixture of trimyristin and methanol. In that case, you can see that a white color appears like tiny bubbles from inside the mixture, which becomes more evenly distributed. Bubbles in a liquid arise due to the emission of a sonication wave, which causes the pressure of the liquid to increase due to the influence of the wave's amplitude. The bubble expands and deflates unstable with a greater expansion rate on deflation, so the longer the bubble gets bigger, the more it bursts due to vibration and high frequency (Kuldiloke, 2002).

This reaction causes an increase in the temperature of the mixture during the transesterification process. Heterogeneous base catalysts (CaO) have a slightly lower catalytic ability than homogeneous base catalysts (NaOH, KOH). Heterogeneous base catalysts can be easily separated from the reaction mixture so they can be reused, reducing the cost of procuring and operating expensive separation equipment and minimizing waste problems that can harm the environment. To obtain good process performance, the use of an alkaline catalyst in the transesterification reaction has several essential requirements, including the alcohol used must be in an anhydrous state with a water content <0.1-0.5% by weight and the oil used must have a free fatty acid content < 0.5% (Lotero et al., 2005). The presence of water in the transesterification reaction is significant to note because, in the presence of water, the alkyl esters that are formed will hydrolyze into free fatty acids. The presence of free fatty acids in the reaction system can cause a saponification reaction, which is very disturbing in its manufacture.

A gas chromatography method was used to identify the methyl ester compound formed from the transesterification product. The results of the GCMS analysis for methyl ester compounds from banda nutmeg waste are shown in Figure 1, and the resulting methyl ester composition is presented in Table 1. The methyl myristate component has the most extensive composition, 53.39%, compared to the other seven components.

The first peak with a retention time of 12.628 resulted in a methyl laurate compound with an area percentage of 3.22%. The mass spectra of methyl laurate compounds have fragmentation patterns with m/z 74, 87, 101, 115, 129, 143, 157, 171, 183, and 214. The peak of the molecular ion is at m/z = 214, which comes from $C_{13}H_{26}O_2$, while the m/ z: 183 peak is obtained by releasing a methoxy radical (OCH_3). Meanwhile, the peak with m/z = 171 was produced by releasing radicals (C_3H_7) from the molecular ion, then followed by releasing the methylene group successively to produce fragments with peaks m/z = 157, 143, 129, 115, 101, and 87 while for the base peak with m/z = 74 resulting from β splitting followed by rearrangement. The second peak, with a retention time of 12.741, yielded myristicin with a percentage area of 13.48%. The mass spectra of myristicin have a fragmentation pattern with m/z 91, 103, 119, 131, 147, 161, 177, and 192. The molecular ion peak is found at m/z = 192, which comes from $C_{11}H_{12}O_3$.

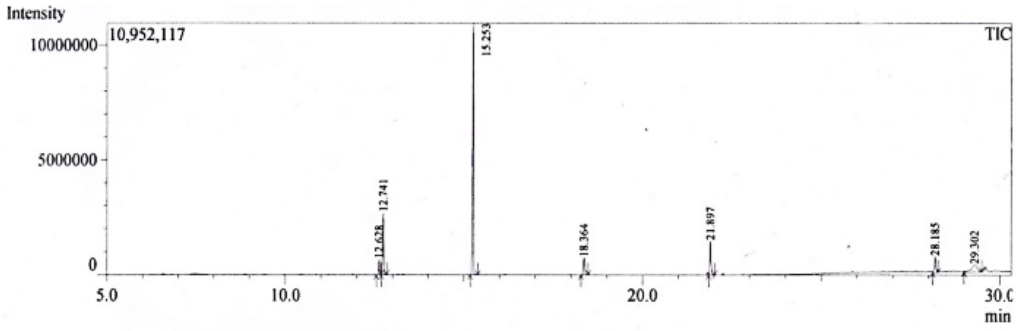

Figure 1. GC-MS chromatogram of methyl ester from nutmeg banda waste

Table 1. Composition of metal esters resulting from the transesterification of banda nutmeg waste

No	Retention Time (Rt)	Component Name	% Area
1	12,626	Metil Laurat	3,22
2	12,741	Miristisin	13,48
3	15,253	Metil Miristat	53,39
4	18,364	Metil Palmitat	5,24
5	21,897	Metil Oleat	9,33
6	28,185	-	5,65
7	29,302	-	9,68

Table 2. Composition of metal esters resulting from the transesterification of papua nutmeg seed waste

No	Retention Time (Rt)	Component Name	% Area
1	15,268	Metil Miristat	19,80
2	18,405	Metil Arakidonat	18,04
3	21,830	Metil Linoleat	1,42
4	21,959	Metil Oleat	48,37
5	22,258	Metil Stearat	3,18
6	24,966	-	2,68
7	26,980	-	1,21
8	27,837	-	5,30

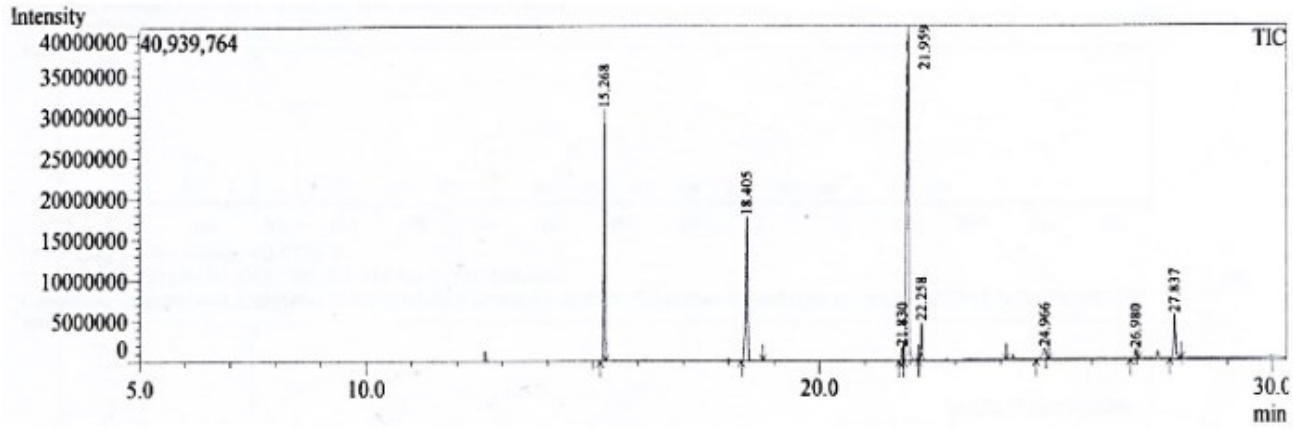

Figure 2. GC-MS chromatogram of methyl ester from Papua nutmeg seed waste

The third peak, with a retention time of 15.253, yielded methyl myristate with an area percentage of 53.39%. The mass spectra of methyl myristate have fragmentation patterns with m/z 74, 87, 101, 115, 129, 143, 157, 171, 185, 199, 211 and 242. The molecular ion peak is at m/z = 242, which comes from $C_{15}H_{30}O_2$, While the peak m/z: 211 was obtained by releasing a methoxy radical (OCH_3). Meanwhile, the peak with m/z = 199 was produced through the release of radicals (C_3H_7) from molecular ions, followed by the release of methylene groups (CH_2) to produce fragments with peaks m/z = 185, 171, 157,143, 129, 115, 101, and 87 while for the base peak with m/z = 74 obtained through the release of tetradecane ($-C_{12}H_{26}$) from the molecular peak ion—the base peak ion results from β splitting followed by rearrangement.

The fourth peak, with a retention time of 18.364, yielded methyl palmitate with an area percentage of 5.24%. The mass spectra of methyl palmitate have fragmentation patterns with m/z 74, 87, 101, 115, 129, 143, 157, 171, 185, 199, 213, 227,239 and 270. The molecular ion peak is at m/z = 270, which comes from $C_{17}H_{34}O_2$, While the peak m/z: 239 was obtained by releasing a methoxy radical (OCH_3). Meanwhile, the peak with m/z = 227 was produced by releasing radicals (C_3H_7) from the molecular ion, then followed by releasing the methylene group successively to produce fragments with peaks m/z = 213, 199, 185, 171, 157, 143, 129, 115, 101, and 87 while for the base peak with m/z = 74 which was obtained by releasing the tetradecane molecule ($-C_{14}H_{28}$) from the ion-molecular peak—the base peak ion results from β cleavage followed by rearrangement.

The fifth peak, with a retention time of 21.897, yielded a methyl oleate compound with an area percentage of 9.33%. The mass spectra of the methyl oleate compound have a fragmentation pattern with m/z 41, 55, 56, 82, 96, 110, 139, 153, 167, 181, 209, 223, 237, 265 and 296. The peak of the molecular ion is at m/z = 296, which comes from $C_{19}H_{36}O_2$, while the peak m/z: 265 is obtained by releasing a methoxy radical ($-OCH_3$). Meanwhile, the peak with m/z = 237 was obtained by removing the group (-CO) from the peak m/z = 265 and then continuing with the release of the methylene group (CH_2) to produce peaks with m/z = 223, 209, 181, 167, 153, 139. The m/z = 124 peak was obtained through the release of CH from the m/z = 139 peaks, followed by the release of methylene radicals to produce peaks with m/z = 110, 96, 82, while for the base peak with m/z = 41 was obtained by releasing ethyne molecules ($-C_2H_2$) from the peak m/z: 82. Meanwhile, the peak with m/z: 41 was obtained by releasing hydrogen radicals (H) from the peak m/z:56. The peak with m/z = 41 is the basic peak of the methyl most minor compound which is relatively stable due to resonance.

The sixth peak with a retention time of 28.185 resulted in an area percentage undetectable compound of 5.65%. The mass spectra of these compounds have fragmentation patterns with m/z 40, 41, 51, 65, 77, 91, 103, 115, 135, 149, 165, 174, 189, 207, 221, 233, 251, 265, 281, 295, 309, 324, 341, 405 and the molecular ion peak is at m/z = 405. The seventh peak, with a retention time of 29.302, produces an undetectable compound with an area percentage of 9.86%. The mass spectra of these compounds have fragmentation patterns with m/z 41, 51, 63, 77, 91, 102, 118, 138, 151, 163, 178, 191, 207, 216, 251, 279, 295, 311, 323, 339, 353, 405 and the molecular ion peak is at m/z = 405.

The results of the GCMS analysis for methyl ester compounds from Papua's nutmeg waste are shown in Figure 2, and the composition of the resulting methyl esters is presented in Table 2. The transesterification results for Papua's nutmeg waste yielded a metal oleate product with a composition of 48.37%.

The first peak with a retention time of 15.268 resulted in a methyl myristate compound with an area percentage of 19.80%. The mass spectra of methyl myristate have fragmentation patterns with m/z 74, 87, 101, 115, 129, 143, 157, 171, 185, 199, 211 and 242. The molecular ion peak is at m/z = 242, which comes from $C_{15}H_{30}O_2$, While the peak m/z: 211 was obtained by releasing a methoxy radical (OCH_3). Meanwhile, the peak with m/z = 199 was produced through the release of radicals (C_3H_7) from molecular ions, followed by the release of methylene groups (CH_2) to produce fragments with peaks m/z = 185, 171, 157, 143, 129, 115, 101, and 87 while for the base peak with m/z = 74 obtained by releasing tetradecane ($-C_{12}H_{26}$) from the molecular peak into—the base peak ion results from β splitting followed by rearrangement.

The second peak, with a retention time of 18.405, resulted in a methyl arachidate compound with an area percentage of 18.04%. The mass spectra of methyl arachidate compounds have fragmentation patterns with m/z 74, 87, 101, 115, 129, 143, 157, 171, 185, 199, 213, 227,239, and 270. The peak of the molecular ion is at m/z = 270, which comes from $C_{20}H_{40}O_2$, While the peak m/z: 239 is obtained by releasing a methoxy radical (OCH_3). Meanwhile, the peak with m/z = 227 was produced by releasing radicals (CH) from molecular ions, then followed by releasing methylene groups successively to produce fragments with peaks m/z = 213, 199, 185, 171, 157, 143, 129, 115, 101, and 87 while for the base peak with m/z = 74 which was obtained by releasing the tetradecane molecule ($-C_{14}H_{28}$) from the molecular ion peak—the base peak ion results from β cleavage followed by rearrangement.

The third peak, with a retention time of 21.830, resulted in a methyl linoleic compound with an area percentage of 1.42%. The mass spectra of methyl linoleic compounds have fragmentation patterns with m/z 55, 67, 81, 95, 109, 123, 135, 150, 164, 178, 191, 263 and 294). The molecular ion peak is found at m/z = 294, which comes from $C_{19}H_{34}O_2$, while the peak m/z: 263 is obtained by releasing a methoxy radical (-OCH_3). Meanwhile, the peak with m/z = 235 was obtained by releasing the group (-CH) from the peak m/z = 263 and then releasing the methylene group to produce peaks with m/z = 191, 178, 164. The peak m/z = 150 was obtained through the release of CH from the peak m/z = 164, then followed by the release of the methylene radical to produce peaks with m/z = 135, 123, 109, 95 while for the basic peak with m/z = 68 obtained through the release of ethyne (C_2H_2) from the m/z = 95 peak. In comparison, the m/z = 67 peak was obtained by releasing hydrogen radicals from the m/z = 68 peak.

The fourth peak, with a retention time of 21.959, produces an oleic compound with an area percentage of 48.37%. The mass spectra of the methyl oleate compound have a fragmentation pattern with m/z 55, 69, 74, 97, 123, 137, 152, 166, 180, 193, 207, 222, 235, 246, and 292. The peak of the molecular ion is found at m/ z = 292, which comes from $C_{19}H_{32}O_2$, While the peak m/z: 261 is obtained by releasing a methoxy radical (-OCH_3). Meanwhile, the peak with m/z = 235 was obtained by removing the (-CH) group from the peak m/z = 264 and then continuing with the release of the methylene group to produce peaks with m/z = 222, 207, 193, 166, 152, 137. The m/z = 123 peak was obtained through the release of CH from the m/z = 137 peaks, then followed by the release of methylene radicals to produce peaks with m/z = 123, 97, 74, while the peaks with m/z = 55 were obtained through the release of hydrogen radicals from the peak m/z =56.

The fifth peak, with a retention time of 21.258, yielded methyl stearate with an area percentage of 3.18%. The mass spectra of methyl stearate have fragmentation patterns with m/z 74, 87, 101, 115, 129, 143, 157, 171, 185, 199, 213, 227, 241,255,267 and 298. The molecular ion peak is at m/z = 298, which comes from $C_{19}H_{38}O_2$, While the peak m/z: 267 is obtained by releasing a methoxy radical (OCH_3). Meanwhile, the peak with m/z = 255 was produced by releasing radicals (CH) from molecular ions, then followed by releasing methylene groups successively to produce fragments with peaks m/z = 241, 241, 227, 213, 199, 185, 171, 157, 143, 129, 115, 101 and 87 while for the base peak with m/z = 74 which was obtained by releasing the tetradecane molecule ($C_{14}H_{28}$) from the molecular ion peak—the peak ion results from β splitting followed by rearrangement.

The sixth peak, with a retention time of 24.966, yielded an area percentage of 2.68% that was not detected. The mass spectra of these compounds have fragmentation patterns with m/z 41, 51, 63, 77, 89, 103, 121, 123, 133, 143, 161, 178, 168, 208, 220, 235, 251, 263, 279, 293, 294, 327 and the molecular ion peak is at m/z = 327. The seventh peak, with a retention time of 26.980, produces an undetectable compound with an area percent of 1.21%. The mass spectra of these compounds have fragmentation patterns with m/z 40, 51, 65, 77, 91, 105, 115, 135, 149, 163, 175, 190, 209, 251, 265, 283, 326, 343, 405 and peaks the molecular ion is present at m/z = 405. The eighth peak, with a retention time of 27.837, produces an undetectable compound with an area percent of 5.30%. The mass spectra of these compounds have fragmentation patterns with m/z 40, 51, 65, 77, 94, 105, 122, 137, 149, 161, 175, 192, 207, 225, 239, 253, 267, 281, 295, 328, 346, 355, 405 and the molecular ion peak is at m/z = 405.

The sonication method can synthesize methyl esters from nutmeg oil waste and gives different results for the two types of nutmeg. The methyl meristate compound in Banda nutmeg seeds is higher than that of Papuan nutmeg. This differs from the methyl oleate compound in Banda nutmeg which is lower than Papuan nutmeg. The sonication method can increase the yield of methyl ester obtained; this can be seen in the research results of Kapelle and Laratmase (2014), who used conventional methods to obtain a yield of 1.78%. Compared with conventional methods, such sonication allows the reaction to be completed in 20–60 min with low molar ratios. (Yasui, 2002)

CONCLUSION

Isolation of trimyristin using the maceration method on essential oil production waste from Papuan nutmeg seeds obtained 22.24% yield and 19.88% yield from Banda nutmeg seeds. The sonication method can synthesize methyl esters from nutmeg oil waste and gives different results for the two types of nutmeg. The transesterification reaction of trimyristin from nutmeg seed waste with a CaO catalyst using the sonication method produces 7 known methyl ester compounds, namely methyl laurate (3.22%); myristicin (13.48%); metal myristate (53.39%); Methyl Palmitate (5.24%); Methyl Oleate (9.33%) and 2 other compounds were not identified. Transesterification results of trimyristin from Papuan nutmeg waste produced 8 known methyl ester compounds, namely methyl myristate (19.80%), Methyl Arachidate (18.04%), Methyl Linoleate (1.42%), Methyl Oleate (48.37%); Methyl Stearate (3.18%); and 3 other unidentified compounds.

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