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Research Article
Exploring the Potential of Sago Caterpillars as Cooking Oils: Extraction, Purifying and Characterization

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Abstract

Background and Objective: The dual demand for palm oil, both as a cooking oil and as a raw material for biodiesel, gives rise to concerns regarding potential shortages. Hence, it is crucial to explore alternative sources of cooking oil, with one such alternative being the oil extracted from sago caterpillars. This study aims to extract and determine the characteristics of sago caterpillar oil and its potential as cooking oil. **Materials and Methods:** Sago caterpillar oil extraction was done using pressing, Soxhlet extraction and Folch's lipid extraction. The yield of sago caterpillar oil obtained by pressing, Soxhlet and Folch's lipid extraction were 20, 16 and 2.2%, respectively. Oil purifying was done using degumming, neutralization and bleaching. Furthermore, the resulting sago caterpillar oil was characterized physically, chemically and organoleptic. **Results:** The sago caterpillar oil met the requirements as cooking oil based on the Indonesian National Standard for cooking oil and other chemical parameters. The results of the analysis of sago caterpillar oil with gas chromatography-mass spectrometer showed that the sago caterpillar oil contained 0.15% lauric acid, 2.06% myristic acid, 5.92% palmitoleic acid, 55.05% palmitic acid, 0.84% linoleic acid, 34.00% oleic acid and 1.43% stearic acid. The main peak positions from the fourier transform infrared spectrophotometer are at 725, 1118, 1165, 1234, 1373, 1458, 1743, 2854 and 2924 cm^{-1}. The results of the analysis of sago caterpillar oil showed that the lipid profile of sago caterpillar oil was similar to commercial palm oil. **Conclusion:** Based on the results of extraction, purifying and characterization, it was concluded that sago caterpillar oil has the potential to be used as cooking oil.

Key words: Sago caterpillar oil, palmitic acid, oleic acid, palmitoleic acid, gas chromatography-mass spectrometer, fourier transform infrared spectrophotometer

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Since 2006, Indonesia has held the position of the world's leading palm oil producer. Nevertheless, the growing number of derivative palm oil processing industries has triggered an increasing demand for palm oil. The export market share for palm oil also exhibits great promise, thanks to substantial annual demand growth. An outcome of this trend is the emergence of cooking oil shortages. Hence, it becomes crucial to explore alternative sources for cooking oil production, with animal oils derived from insects showing potential as a viable solution.

Edible insects have always been a part of the human diet, but some societies have distaste for them. According to Chen *et al.*[1], in most countries, people do not like to eat insects because of their "dirty" and "scary" image. However, according to van Huis *et al.*[2], more than 1,900 species have been utilized as a source of food. Globally, the insects with the highest consumption rates are beetles (Coleoptera) at 31%, followed by caterpillars (Lepidoptera) at 18% and bees, wasps and ants (Hymenoptera) at 14%. Grasshoppers and crickets (Orthoptera) account for 13%, while crickets, leafhoppers, scale insects and true insects (Hemiptera) make up 10%. Termites (Isoptera) contribute 3%, dragonflies (Odonata) 3%, flies (Diptera) 2% and other orders represent 5% of the total consumption.

According to Govorushko[3], in Africa, numerous insect species are consumed as food, offering high nutritional value with protein, fat, minerals and vitamins akin to meat and fish. Among the edible caterpillars of Africa, the mopane caterpillar, better known as the phane, is the larval stage of the emperor moth, *Imbrasia belina* (Westwood) (Lepidoptera: Saturniidae). The lipid composition of the oil of the mopane caterpillar, *Imbrasia belina*, based on GC-MS analysis, is as follows: 18:3 (29.98%), 16:0 (25.64%), 18:1 (17.97%), 18:0 (12.49%) and 18:2 (11.81%)[4].

The potential of sago in Indonesia in terms of its breadth is tremendous. About 60% of the world's sago area is in Indonesia. One of the areas where sago plants spread in Indonesia is North Sulawesi. The use of sago plants in North Sulawesi is still minimal and sago plants are only used as raw material for sago flour. Sago processing is still done traditionally and many farmers are reluctant to take advantage of this plant. Beetles will infect sago trees that have rotted and beetle larvae that settle on sago trees will breed into sago caterpillars (*Rhynchophorus ferrugineus*)[5].

As of now, despite their nutritional benefits, sago caterpillars have not been commercially utilized. Although some people in Papua and Maluku use sago caterpillars as food, not all people can consume them and some use them as animal feed[6]. Sago caterpillars are also reported to be used as an alternative local food that can prevent malnutrition in children[7]. Nirmala and Pramono[8] showed an increase in protein levels in the group of children who were given sago caterpillars compared to those without sago caterpillars.

The prominent nutritional value of the sago caterpillar is its protein and oil content. According to Edrus and Sjahrul Bustaman[9], the sago caterpillar is good to use as a source of protein because it contains 13.8% protein and 18.04% fat. In contrast, according to Leatemia *et al.*[10], sago caterpillars' fat and protein content is 27.97 and 59.71%. Therefore, according to Tzompa-Sosa *et al.*[11], several types of caterpillar oil and insects have characteristics that are suitable for use as table oil.

Until now, there has been no research report on how to process/extract sago caterpillar oil as cooking oil, especially those that can be applied in the industrial world. To get cooking oil with minimal risk and that meets the Indonesian National Standard (Standard Nasional Indonesia) for cooking oil, SNI 3741: 2013[12]. In this study, the characteristics and potential of sago caterpillar oil were measured.

MATERIALS AND METHODS

Study area: This research was conducted from April to October, 2022. Extraction and purification took place at the Chemistry Laboratory of Universitas Sam Ratulangi, North Sulawesi, Indonesia and spectroscopy analyses were carried out at the Chemistry Laboratory of Universitas Gadjah Mada, Yogyakarta, Indonesia.

Study material: The main materials used are sago caterpillars which were taken from plantations in North Sulawesi, sodium hydroxide (ACS reagent, $\geq$97.0%, pellets), bentonite, phosphoric acid (ACS reagent, $\geq$85 wt. % in H_2O), ethanol and methanol (Pro analysis EMSURE" ACS, ISO, Reag. Ph Eur), dichloromethane (for analysis EMSURE® ACS, ISO, Reag. Ph Eur) and other chemicals were purchased from Sigma-Aldrich Singapore. The main tools used are hydraulic press machine, centrifuge (Clements GS 150) and chroma meter (CR-400 Konica Minolta, Inc.) from the Chemistry Laboratory of Universitas Sam Ratulangi. Gas Chromatography-Mass Spectrometer (GC-MS) GCMS-QP2010S Shimadzu and Fourier Transform Infrared Spectrophotometer (FTIR) IRPrestige-21 Shimadzu were recorded at the Chemistry Laboratory of Universitas Gadjah Mada.

Sago caterpillars (1500 g) were fasted and weighed. Afterwards, they were washed and extracted. Oil extraction was optimized using Tzompa-Sosa *et al.*[11] methods. In the pressing method, the sago caterpillars are roasted, baked in the oven and extracted using a hydraulic press. In the Soxhlet extraction method, oil is extracted using petroleum ether. In Folch's lipid extraction, sago caterpillars were ground and mixed with dichloromethane/methanol (2:1). In aqueous lipid extraction, frozen sago caterpillars were mixed with 600 mL of demineralized water and then centrifuged. The lipid profile of sago caterpillar oil was also compared with commercial palm oil. The extraction was done in three replicates.

Purifying sago caterpillar oil was carried out to produce refined, deodorizing, bleached sago caterpillar oil. Degumming was carried out using the Zufarov *et al.*[13] method by adding phosphoric acid. Neutralization was carried out using the Gomes *et al.*[14] method by adding NaOH solution. Bleaching and deodorizing were carried out using the Nuansa *et al.*[15] method by adding commercial bleaching earth.

Processed oil is tested for its quality with SNI parameters (3741: 2013)[12]: Aroma, color, moisture content and volatile matter, peroxide value, arsenic, tin and lead metal contaminants, as well as other parameters including viscosity, the content of iron, zinc, copper and yod number[16] and saponification number[17].

Functional groups of the oil samples were analyzed by FTIR. The oil samples were trans-esterified by refluxing in dry methanol that contained methyl chloride to produce fatty acid methyl esters (FAME) so the fatty acid composition could be determined[18]. Subsequently, the fatty acid profile of the sago caterpillar oil was analyzed by GC-MS using an internal standard of margaric acid. The capillary gas chromatograph is fitted with a fused DB-5MS capillary column (30×0.25 m ID) with helium as carrier gas.

RESULTS

Sago caterpillar oil extraction: Oil extraction is carried out by pressing method, Soxhlet extraction method and Folch's lipid extraction. The results of sago caterpillar oil extraction can be seen in Table 1.

Table 1 shows that the highest oil extraction yield is obtained by pressing, compared to Soxhlet and Folch lipid extraction. Using the pressing method, the oil yield was 100 g or 20% yield, while using the Soxhlet method, the oil yield was 16% or 80 g and Folch lipid extraction only obtained the oil yield of 2.2% or 11 g.

Purifying of sago caterpillar oil: Degumming is a stage of the purification process that aims to separate gum, sap and mucus (phospholipids, proteins, residues and carbohydrates) in oil without reducing the amount of free fatty acids in the oil. Neutralization aims to reduce impurities that affect the aroma and taste of the oil. The primary purpose of oil bleaching is to remove pigments and color compounds present in the oil. These pigments can make the oil appear dark or cloudy, which is undesirable for many culinary and food processing applications. Bleaching helps to achieve clear and light-colored oil, which is more aesthetically pleasing.

The results of degumming sago caterpillar oil with a yield of 97%, the result of neutralization sago caterpillar oil was 93% and the result of bleaching sago caterpillar oil was 83%. From the results of purifying sago caterpillar oil, the oil is clearer and the aroma is better. Photos of extracted and refined sago caterpillar oil were shown in Fig. 1.

Quality of purifying sago caterpillar oil: The quality of sago caterpillar oil is measured from the SNI 3741: 2013 (Standard Nasional Indonesia) parameters regarding cooking oil such as odor, color, water and volatile content, peroxide number, free fatty acid, arsenic, tin and lead content. Furthermore, other parameters of oil quality such as viscosity, iron, zinc, copper content, yod and saponification number. The quality of sago caterpillar oil before and after purifying can be seen in Table 2.

Based on Table 2, purifying can improve the quality of sago caterpillar oil. The oil quality meets the requirements of SNI 3741: 2013.

Table 1: Yield of sago caterpillar oil extraction

		Solvent		
Extraction method	Weight of sago caterpillar (g)	Petroleum ether (mL)	Dichloromethane: Methanol (mL)	Yield (%)
Pressing	500 g	-	-	20
Soxhlet	500 g	350	-	16
Folch-lipid	500 g	-	200	2.2

Fig. 1: Extracted and purified sago caterpillar oil

Table 2: Quality of sago caterpillar oil before and after purifying

Parameter	Sago caterpillar oils		SNI
	Before purifying	After purifying	
Parameter of SNI (3741: 2013)			
Odor	Sting	No smell (normal)	Normal
Color	Rather dark yellow	Yellow (normal)	Normal
Water and volatile content (%)	0.05	0.01	Max. 0.15
Peroxide number (meq kg^{-1})	6.04	1.93	Max. 10
Free fatty acid (mg KOH g^{-1})	1.0	0.3	Max. 0.6
Arsenic (As) (mg kg^{-1})	<0.0009	<0.006	Max. 0.1
Tin (Sn) (mg kg^{-1})	<0.006	<0.006	Max. 40.0/250.0
Lead (Pb) (mg kg^{-1})	<0.0013	<0.0007	Max. 0.1
Other parameter			
Viscosity (NS m^{-2})	0.060	0.045	-
Iron (Fe) (mg kg^{-1})	0.1142	0.2782	-
Zinc (Zn) (mg kg^{-1})	0.0509	0.0349	-
Copper (Cu) (mg kg^{-1})	0.1006	<0.01	-
Yod number (g I/100 g sample)	44.1	47.26	-
Saponification number (mg KOH g^{-1} sample)	191.62	142.87	-

Table 3: Fatty acid composition of sago caterpillar oil

Peak No	RT	Percentage of fatty acid (%)	Type fatty acid
1	26.26	0.15	Lauric acid (C12:0)
2	31.22	2.06	Myristic acid (C14:0)
3	35.27	5.92	Palmitoleic acid (C16:1)
4	35.80	55.05	Palmitic acid (C16:0)
5	39.15	0.84	Linoleic acid (C18:2)
6	39.35	34.00	Oleic acid (C18:1)
7	39.76	1.43	Stearic acid (18:0)

Fourier Transform Infrared (FTIR) analysis: The Fourier Transform Infrared (FTIR) spectrophotometer was analyzed to determine the functional groups in the sago caterpillar oil. This analysis is based on the wavelength of the peaks that appear in a sample. Each functional group has a specific peak, so the peak's wavelength indicates certain functional groups in sago caterpillar oil. The FTIR spectrum of sago caterpillar oil shown in Fig. 2.

Gas Chromatography-Mass Spectroscopy (GC-MS) analysis: The purpose of GC-MS analysis is to see the fatty acid composition of sago caterpillar oil and then compare it with the fatty acid composition of palm oil. Fatty acid composition of sago caterpillar oil can be seen in Table 3.

The GC-chromatogram of sago caterpillar oil was presented in Fig. 3. Meanwhile, the methyl palmitate fragment's peak and fragmentation pattern were shown in Fig. 4 and 5, respectively.

In this study, the lipid profile of sago caterpillar oil was also compared with the lipid profile of palm oil. The palm oil chromatogram was presented in Fig. 6.

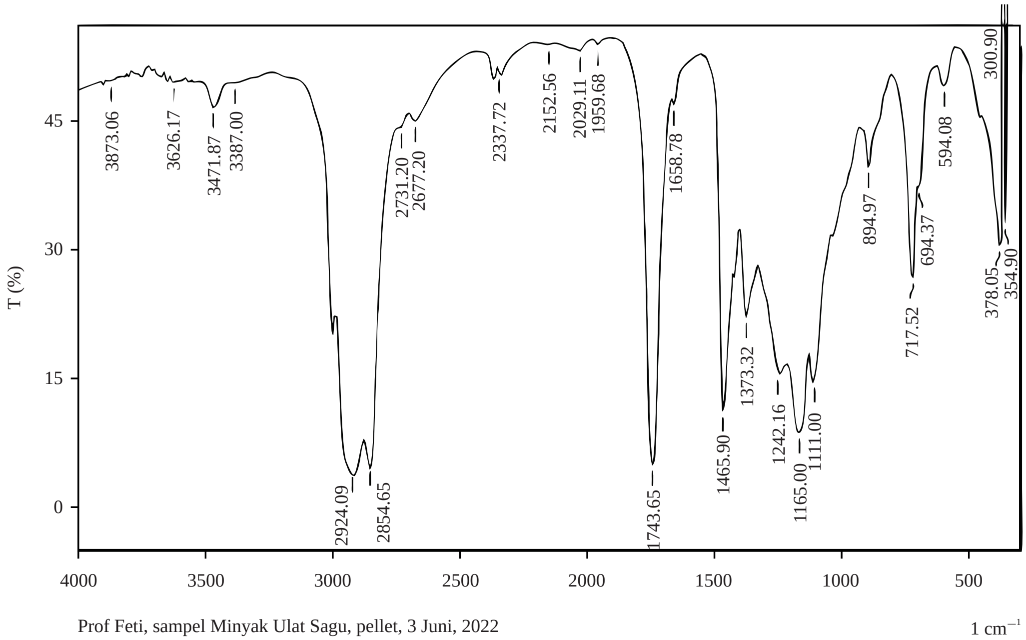
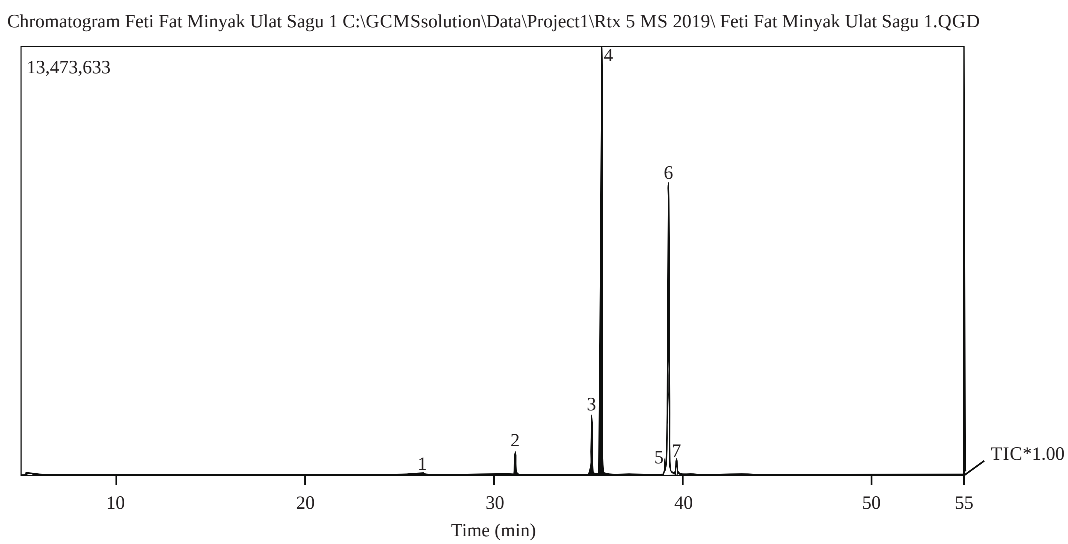


Fig. 2: FTIR spectra of sago caterpillar oil

ν (cm^{-1}) absorption, 2924.09, 2854.65 C-H (Alkyl group), 1743.65 -C=O (ester), 1458.18-CH_2^- (methylene group), 1373.32-CH_3 (methyl group), 1234.44, 1165.00, 1118.71 C-O-C (ester) and 725.23=C-H (alkene)



Peak report TIC						
Peak No.	R. Time	I. Time	F. Time	Area	Area (%)	Height
1	26.261	26.200	26.367	209673	0.15	51787
2	31.228	35.117	31.333	2901050	2.06	723243
3	35.274	35.100	35.400	8318080	5.92	1880476
4	35.803	35.592	36.050	78170238	55.60	13419532
5	39.159	39.067	39.200	1178790	0.84	280017
6	39.353	39.200	39.858	47802652	34.00	9168235
7	39.767	39.617	39.858	2006357	1.43	477790
				140586840	100.00	26001080

Fig. 3: GC Chromatogram of sago caterpillar oil

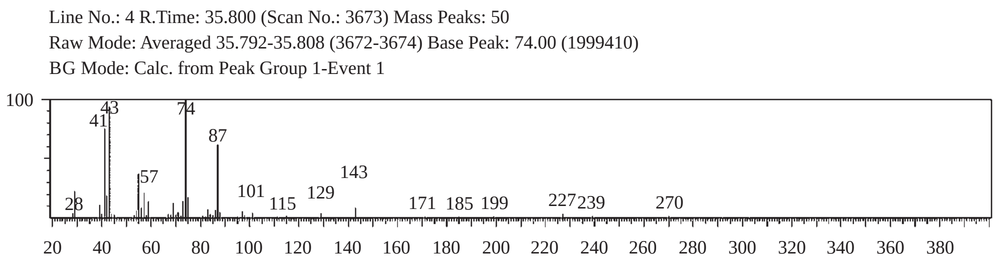


Fig. 4: Mass spectrum of peak 4, retention time 35.8 (methyl palmitate)

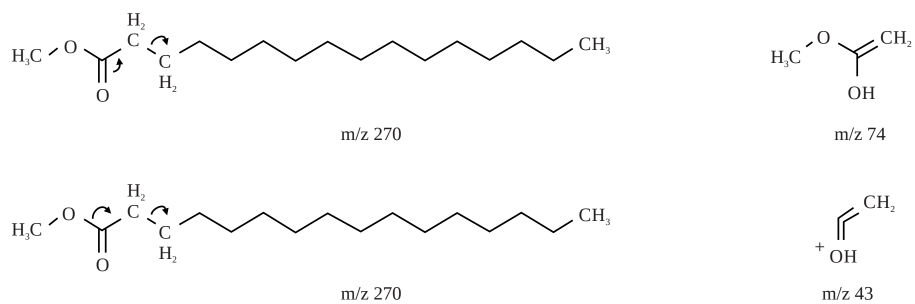
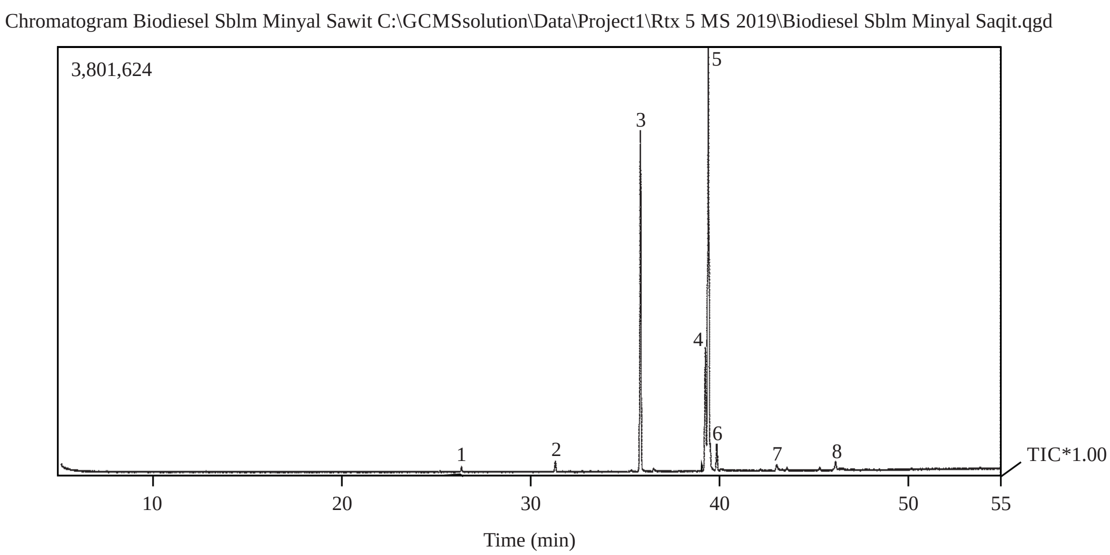


Fig. 5: Fragmentation pattern of methyl palmitate fragment



Peak report TIC

Peak No.	R. Time	I. Time	F. Time	Area	Area (%)	Height
1	26.425	26.358	26.525	192287	0.50	50490
2	31.407	31.300	31.483	366531	0.95	95067
3	35.923	35.792	36.058	12962797	33.77	3011836
4	39.356	39.225	39.417	4919125	12.81	1096840
5	39.514	39.417	39.700	18411857	74.96	3747072
6	39.964	39.858	40.067	1036796	2.70	238211
7	43.129	43.025	43.208	200335	0.52	44630
8	46.256	46.167	46.358	299632	0.78	65791
				38389360	100.00	8349937

Fig. 6: GC chromatogram of palm oil

Table 4: Comparison of the fatty acid composition of sago caterpillar oil compared to palm oil

RT of sago caterpillar oil (peak)	Percentage of fatty acid (%)	RT of palm oil (peak)	Percentage of fatty acid (%)	Type fatty acid
26.26 (1)	0.15	26.42 (1)	0.50	Lauric acid (C12:0)
31.22 (2)	2.06	31.40 (2)	0.95	Myristic acid (C14:0)
35.27 (3)	5.92	-	-	Palmitoleic acid (C16:1)
35.80 (4)	55.05	35.92 (3)	33.77	Palmitic acid (C16:0)
39.15 (5)	0.84	39.35 (4)	12.81	Linoleic acid (C18:2)
39.35 (6)	34.00	39.51 (5)	47.96	Oleic acid (C18:1)
39.76 (7)	1.43	39.96 (6)	2.70	Stearic acid (18:0)
-	-	43.12 (7)	0.52	(C20:1)
-	-	46.25 (8)	0.78	(C20:0)

A comparison of the fatty acid composition of sago caterpillar oil and palm oil results of GC-MS analysis was presented in Table 4.

Table 4 showed that sago caterpillar oil's fatty acid composition is similar to palm oil. Sago caterpillar oil consists of seven fatty acids, while palm oil consists of eight fatty acids. Lauric acid, myristic acid, palmitic acid, linoleic acid, oleic acid and stearic acid are constituents of the fatty acid in both oils.

DISCUSSION

Sago caterpillar oil extraction: In sago caterpillar extraction, the highest yield is found in pressing extraction (Table 1). The yield of the pressing method extraction showed 20% and 200% more yield than the Soxhlet method and Folch lipid method, respectively. Using the pressing method, the resulting oil still contains impurities so the yield obtained is higher. The yield of sago caterpillar oil extraction has a value similar to the yield of dirty oil from the palm. According to Chew *et al.*[19], the average yield content of crude palm oil (CPO) is 21 %. The results of Edrus and Sjahrul Bustaman[9] research show that the yield of sago caterpillar oil is 18.04%, whereas according to Leatemia *et al.*[10] is 27.97%.

The principal difference between the three extraction techniques is the use of solvents. A solvent is not used in pressing extraction, while the solvent is used in Soxhlet and Folch lipid extraction. According to Tzompa-Sosa *et al.*[11], lipids from insects can be extracted by two industrial extraction processes (aqueous and Soxhlet) and one laboratory method (Folch extraction). Furthermore, it is said that aqueous extraction gives the lowest lipid yield compared to Soxhlet and Folch lipid extraction.

The effectiveness of lipid extraction varies and is strongly influenced by the material to be extracted. According to Nurfadilah[20], aqueous extraction of selar fish oil (also known as the wet rendering method) and extraction using n-hexane solvents produce low-quality oil. Eka *et al.*[21] compared the wet rendering and dry extraction methods to physical characteristics, namely viscosity and chemical characteristics of catfish oil and concluded that wet rendering provides extraction results with better characteristics. Meanwhile, according to Santoso and Astuti[22], the quantity of German caterpillar yield using the Soxhlet extraction method is more than the maceration extraction method.

Purifying of sago caterpillar oil: The crude oil from the press method still has impurities, so further purification is undertaken to obtain oil with improved characteristics and quality. The purifying of sago caterpillar oil results showed a reduction in the amount of oil to 83% and meets the requirements of SNI 3741: 2013. Oil purifying can be done in two ways, namely physically by using adsorbents and chemicals. Physical purifying of cooking oil that has been carried out includes magnesol xl[23], Zeolite and Bleaching Earth[24] and Corn Cob Charcoal[25]. Meanwhile, the chemical purifying method used for cooking oil is done by mixing the oil with an alkaline solution. Purifying of used cooking oil can also be done by adding NaOH[26].

The purifying of sago caterpillar oil causes a reduction in the quantity of oil caused by the loss of impurities. According to Feryana *et al.*[27], bleaching also occurs in the neutralization process, resulting in oil with better characteristics. In contrast, according to Akbar *et al.*[24], natural zeolite adsorbents and bleaching earth can produce relatively clear cooking oil and still meet SNI health standards, especially the acid number and peroxide value.

Quality of refined sago caterpillar oil: Based on the extraction results of sago caterpillar oil processing, the quality of sago caterpillar oil was tested based on SNI 3741: 2013. According to Silalahi *et al.*[28], quality control of cooking oil can be found in standards of cooking oil that are safe for consumption. The basis for quality standardization can use the SNI, the measure used to determine the quality of a product commonly used in Indonesia. In addition, the quality standard for cooking oil can also be seen in the PORAM (Palm Oil Regional Association of Malaysia) standard, namely the quality standard used by foreign cooking oil companies, especially Malaysia and Singapore. The quality of sago caterpillar oil before and after purifying was presented in Table 2.

Based on Table 2, purifying can improve the quality of sago caterpillar oil. The oil quality meets the requirements of SNI 3741:2013. According to Aladedunye and Przybylski[29], the decline in the quality of cooking oil can be seen from the color of the oil becoming darker and less clear, the oily odor being unpleasant, the oil's consistency being thicker and the high content of free fatty acids (FFA) and peroxide.

The quality of cooking oil can also be seen from several other parameters such as viscosity, yod number and saponification number. According to Sutiah *et al.*[30], packaged cooking oil is good quality if the viscosity value is $3.91 \times 10\text{-}3$ Ns m^{-2}. The yod number for packaged and bulk oil is 54.734 and 50.722 g I_2/100 g, respectively, while the yod number of used oil for frying chicken is 3.255-3.55 g I_2/100 g oil[16]. Meanwhile, according to SNI 3741:2013, the saponification rate for cooking oil is 180-265 mg KOH g^{-1} [17]. Based on this, the quality of refined sago caterpillar oil is good and follows the parameters of commercial cooking oil.

Fourier Transform Infrared (FTIR) analysis: Gugule *et al.*[31] stated the peak indicates the absorption of an alkyl group (C-H) at 2893-2978 cm^{-1}, which is confirmed by the absorption of the methylene group ($-CH_2^-$) at 1450 cm^{-1} and of the methyl group ($-CH_3$) at 1327 cm^{-1}.

Stating the absorption peak in the 2923 cm^{-1} wave number region indicates the presence of C-H groups. It is reinforced by absorption in 2854 cm^{-1}, which indicates $-CH_2^-$ and $-CH_3$ absorption. The absorption peak at 1157 cm^{-1} indicates the presence of C-O and 871 cm^{-1} indicates the presence of C-C ester. Strong absorption at 1743.65 cm^{-1} indicates the presence of a C=O bond from the ester compound and medium absorption at 1234.44, 1165.00 and 1118.71 cm^{-1} strengthens the presence of ester groups in sago caterpillar oil.

Chromatography Gas-Mass Spectroscopy (GC-MS) analysis: Table 3 shows that sago caterpillar oil comprises seven fatty acids, which are dominated by palmitic acid and oleic acid, with the ratio of saturated and unsaturated fatty acids being almost the same. This is in line with the results of Motshegwe *et al.*[32]. The oil extracted from the edible mopane caterpillar, known as "phane" or Imbrasia belina, boasts a nearly equal ratio of saturated to unsaturated fatty acids, with a composition of approximately 48.2% saturated and 48.8% unsaturated fatty acids. The predominant fatty acids in this oil include 16:0 (comprising 31.9%), 18:0 (making up 15.2%), 18:1 (constituting 20.4%), 18:2 (accounting for 9.9%) and 18:3 (comprising 19%).

However, not all types of caterpillars have almost the same composition. The fatty acid profile of the caterpillar of *Cirina forda*, a pallid emperor moth known for its popularity as a food insect in Nigeria, is rich in fatty acids such as Linolenic acid (33.84%), Linoleic acid (7.81%) and Oleic acid (12.93%)[33].

Table 3 shows seven components of sago caterpillar oil: Ethyl lauric, ethyl myristic, ethyl palmitoleic, ethyl palmitic, ethyl linoleic, ethyl oleic and ethyl stearic. Given that the ethyl ester fragmentation pattern matches that of other fatty acids, it can be inferred that the fragmentation pattern of the primary and most abundant component in sago caterpillar oil is methyl palmitate (Fig. 3), which accounts for a substantial 55.05% of the composition (identified as peak 4 with a retention time of 35.80). The confirmation of methyl palmitate appeared in the mass spectrum of peak 4 (Fig. 4). The spectrum showed fragment m/z 270 $[M]^+$ and identified as $C_{17}H_{34}O_2$. Another high fragment present in m/z 74 and m/z 43 were identified as two most stable fragment from methyl palmitate (Fig. 5).

Table 4 showed that sago caterpillar oil's fatty acid composition is similar to palm oil, where the dominant constituent fatty acids are palmitic and oleic acids in both oils. Sago caterpillar oil has a total saturated fatty acid of 58.69% and a total unsaturated fatty acid of 40.76%, while palm oil has a total saturated fatty acid of 38.70% and a total unsaturated fatty acid of 61.29%. Thus, sago caterpillar oil has the potential to be used as cooking oil.

CONCLUSION

Sago caterpillar oil was extracted with pressing, Soxhlet and Folch's lipid method with yield of 20, 16 and 2.2%, respectively. The crude oil is then further purified and analyzed. The characteristic of purifying sago caterpillar oil showed improvement in quality and meets the requirements of SNI 3741: 2013. The lipid profile of sago caterpillar oil was dominated by palmitic (55.05%) and oleic fatty acids (34.0%), which resembled palm oil. The results showed the potential of sago caterpillar oil to be used as cooking oil. To be able to utilize sago caterpillar oil, further studies on its safety as cooking oil can be carried out.

SIGNIFICANCE STATEMENT

This is new research that has never been studied before, which aims to extract, purify and characterize oil from sago caterpillars and to determine the potential of sago caterpillar oil as cooking oil. The characteristics of sago caterpillar oil are compared with palm oil for cooking oil. Based on the results, sago caterpillar oil has the potential to be used as cooking oil. This research produced important findings, as we know the availability of cooking oil, one of the main food ingredients that humans need, is currently a serious concern because it is competing with the need for oil as fuel (biodiesel). The follow-up science needed in this research is the need to carry out the evaluation of the application of sago caterpillar oil as cooking oil consumed by the wider community and the continuity of its cultivation.

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