# Synthesis and characterization of medium-chain triglyceride (MCT) from virgin coconut oil (VCO)

Cite as: AIP Conference Proceedings **2243**, 020007 (2020); https://doi.org/10.1063/5.0001449
Published Online: 04 June 2020

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# Synthesis And Characterization Of Medium-Chain Triglyceride (MCT) From Virgin Coconut Oil (VCO)

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**Abstract.** Medium-chain Triglyceride (MCT) consists of medium length fatty acids with much potential application, from becoming cancer treatment patient to dietary supplements. It found as a major constituent of coconut oil. This study prepared isolated Medium-chain fatty acids (MCFAs) from virgin coconut oil (VCO) using low pressure fractionated distillation with a temperature of 130-140$^{o}$C. This process produced 81.74% (w/w) of MCFAs and synthesis with glycerol to produce MCT, performed at 170$^{o}$C/40kPa. The highest glycerol conversion and MCT yield has been obtained on esterification reaction in reaction time of 8 hours, gave a value of 99,17% (w/w).

## INTRODUCTION

Medium-chain fatty acids (MCFAs) are the primary constituent fatty acids in virgin coconut oil (VCO) for about 50% of the total fatty acids [2,4,9]. MCFAs are unique fatty acids that have saturated carbon chains with lengths from 6 – 12 [12,8]. MCFAs can be reacted with glycerol to produce a Medium-chain triglyceride (MCT) [10]. MCT become a public interest as a provider of energy sources for sports nutrition product because MCT can be a source of energy (concentrate) and available quickly [3,11]. MCT has characteristics that odorless, tasteless, and almost colorless [1,5]. Therefore various kind of MCT based products has been developed. MCT has different properties from conventional fats and oil in two crucial respects [6]. MCT metabolized through burning like fat and oil, but just as carbohydrates metabolized in the liver. Therefore MCT is not stored as reserve fat but is burned as energy. MCT produces twice the energy greater than the amount of energy produced by glucose. So that MCT is suitable to be used as fat-lowering formulas and calorie decomposers [12]. VCO extracted by wet method directly from coconut milk with maintained temperature has several advantages compared to the process of refined, bleached, and deodorized (RBD) [12,7]. Compared with the RBD method, the VCO produced has a smaller number of unsaturated chain bonds, lower peroxide value, and a higher number of phenolic compounds. Previous research reported that based on the nature of the data, it shows that the production of MCT from VCO would be more effective than coconut oil from the RBD process [5, 7]. Therefore in this study, fractionated distillation was using low pressure for the isolation and synthesis of MCT and characterizing the result.

## METHODOLOGY

To get the objective result, the stages of this research method adopted by Nitbani et al., 2016. Neutralization of VCO, neutral VCO transesterification, fatty acid isolation, and synthesis of MCT method adopted by Hartman et al., 1989 and Babayan, 1968. Then it was characterized using gas chromatography using FID as a detector.

*The 8th International Conference of the Indonesian Chemical Society (ICICS) 2019*
AIP Conf. Proc. 2243, 020007-1–020007-5; https://doi.org/10.1063/5.0001449
Published by AIP Publishing. 978-0-7354-2002-1/$30.00

## Neutralization of VCO

In the separating funnels, dissolve 50 grams of VCO with 50 mL of hexane, added 30 mL $Na_2CO_3$ 30% (w/w), and match it slowly. Aquadest adds until it reaches a neutral pH. Dried the yellow fraction by adding $Na_2SO_4$.

## Transesterification of Neutral VCO

Add $K_2CO_3$ as 0.25% (w/w) much of the total weight of the yellow fraction, the added 0.21 moles of methanol. This process is carried out in a three-neck flask equipped with a thermometer and condenser. Neutral VCO of 0.1 moles is added to the mixture and heated at 55 $^{O}$C for 3 hours. The mixture is slowly cooled and left overnight in a funnel, then dissolve in hexane, and washed with aquadest until pH neutral reached.

## Isolation of MCFAs

The MCFAs are then isolated from the mixture of methyl esters obtained from the transesterification step. Isolation using distillation technique with fractional distillation. Distillation fraction takes from ranges 130-140 $^{o}$C. Fraction then analyzed by 2010 Shimadzu Gas Chromatography (FID Detector; Cyanopropil methyl sil Column; Nitrogen flow 30mL/min) using AOAC (2012);969.33 standard methods.

## Synthesis of MCT

Dissolve 120 gram of MCFAs and 20.25 gram of glycerol into a three-neck flask, then stirred at a temperature of 170$^{o}$C/40 kPa for 8 hours in vacuum. Each fraction was then analysis for acid number, saponification rate, iodine number, peroxide number, water content, and specific gravity (at 20$^{o}$C) to determine the quality of the MCT.

# RESULT AND DISCUSSION

According to Nitbani 2016, the neutralization process is carried out to obtain neutral VCO, because VCO which still contains large amounts of free fatty acids, can react with base catalyst used in the transesterification of VCO, and will lead to lowering the quality of the product.

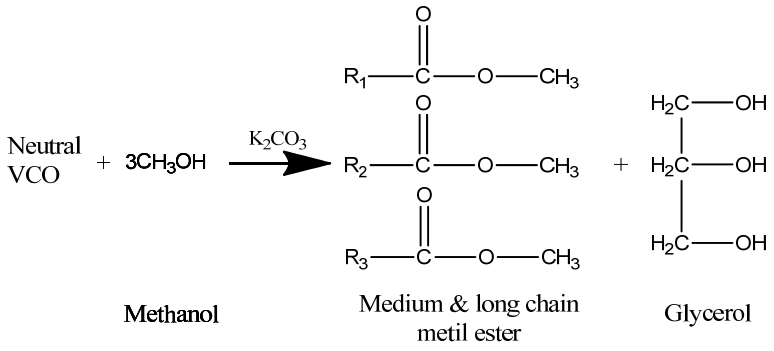


**FIGURE 1.** Transesterification reaction

The result of the transesterification reaction is a mixture of methyl esters that have medium and long chains of methyl ester. So the distillation technique with fractional distillation is carried out at 130-140$^{o}$C to isolate only medium-chain methyl ester.

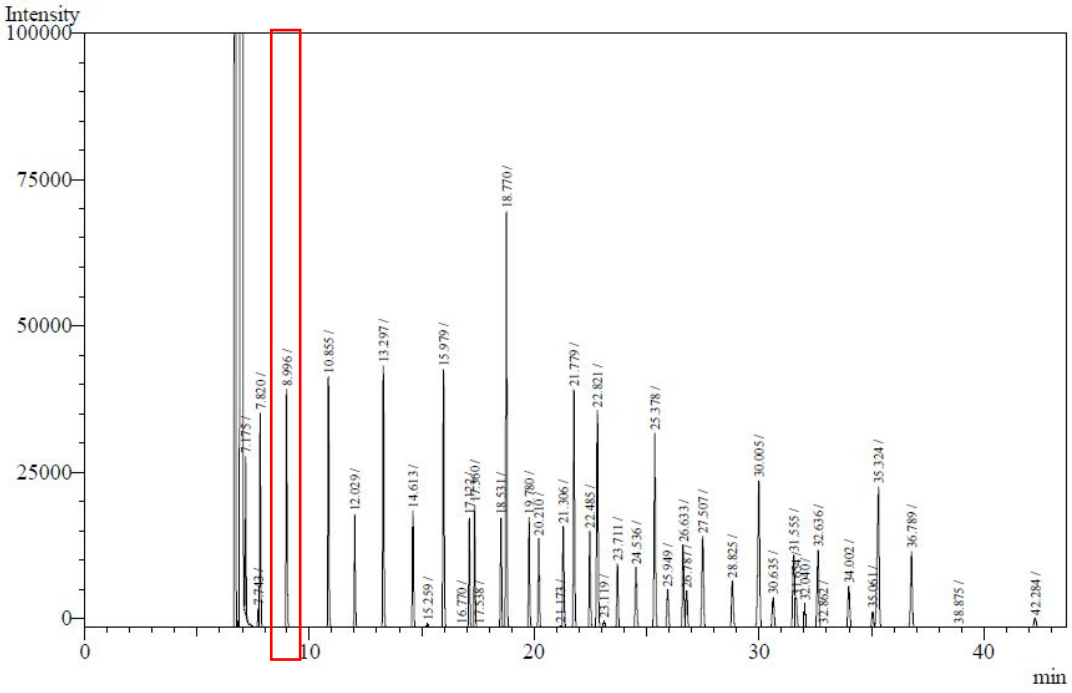


**FIGURE 2.** Gas chromatogram of a mixture of methyl ester (Standard)

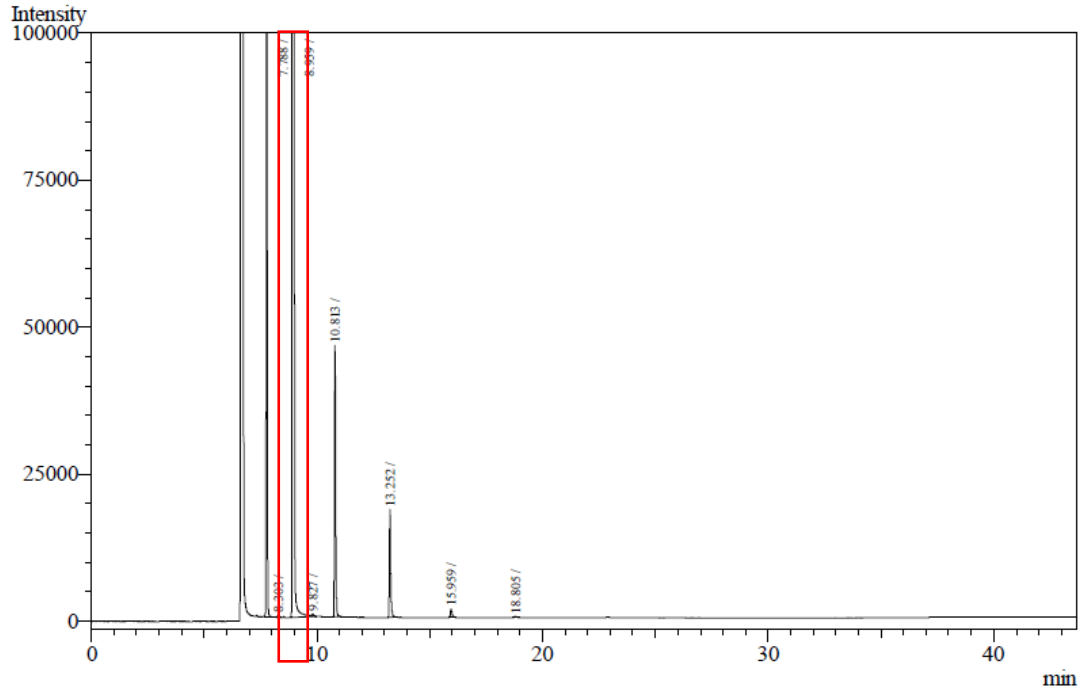


**FIGURE 3.** Gas chromatogram of product distillate of fraction 130-140$^{O}$C.

Furthermore, the product of the transesterification was analyzed using a Gas chromatography technique using AOAC (2012);969.33 standard methods, analyzed by 2010 Shimadzu (FID Detector; Cyanopropil methyl sil Column; Nitrogen flow 30mL/min). Figure 3 shows the chromatogram of seven peaks with retention time ranging from 7.78 to 18.80 minutes' presence of MCFAs. The highest peak in Fig. 3 is at the retention time 8,96 minutes with a relative percent number reaching 81.74% (w/w), which is methyl caprylate after compared to its retention time with a standard containing a mixture of medium and long methyl ester (Fig. 2). With a high percentage of

methyl caprylate, the isolation of MCFAs was successful. MCFAs can be used as a raw material for the synthesis of MCT by the transesterification reaction of MCFAs with glycerol. The following is a transesterification reaction of MCFAs with glycerol, which is reversible (Fig. 4)

**TABLE 1.** Relative composition of methyl ester

| Parameter | Standard (% w/w) | MCFAs (% w/w) |
|---|---|---|
| Caproic Acid | 0.61 | 7.67 |
| Caprylic Acid | 8.25 | 81.74 |
| Capric Acid | 6.00 | 2.84 |
| Undecanoic Acid | 0.02 | - |
| Lauric Acid | 48.63 | 1.27 |
| Myristic Acid | 17.34 | 0.13 |
| Palmitic Acid | 7.70 | 0.03 |
| Stearic Acid | 1.92 | - |
| Oleic | 5.08 | - |
| Linoleic | 1.11 | - |
| Arachidic | 0.02 | - |
| Fatty Acid Total | 96.70 | 93.68 |

During the esterification reaction takes place in a vacuum to expel oxygen. Glycerol conversion value obtained in the vacuum condition reached 97.10% (w/w). The result shown in Fig. 4 shows that the longer the reaction time, the higher the glyceride conversion value. During the initial reaction time, glycerol bar reacts with one fatty acid group so that the amount of monoglyceride formed will be significant. Because the longer the reaction time, the more glycerol converted into monoglyceride, further converts to diglyceride, and triglyceride (MCT). Table 2 shows the value of quality of MCT produced compared to the standard of AOAC, with a satisfactory result, because all test parameters enter the specified standard range.

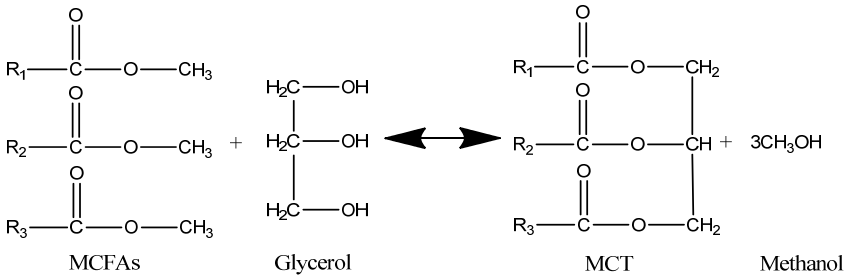


**FIGURE 4.** Transesterification reaction

**TABLE 2. Specification of MCT**

| Parameter | Value |
|---|---|
| Viscosity ($20^{O}C$) | 25-33 mPa.s |
| Specific Gravity ($20^{O}C$) | 0.93-0.96 |
| Acid Value | <0.1 |
| Saponification value | 325 – 345 mg NaOH/g Oil |
| Iodine value | <1 |
| Peroxide value | <1 meq/kg |
| Hydroxyl value | <0.2% |

## CONCLUSION

A neutral VCO transesterification reaction process that produced a mixture of MCFAs with a fractionated distillation process, the highest optimal temperature of the MCFAs obtained at 130-140$^{o}$C, which reached a value of

81.74% (w/w), was confirmed using methyl caprylate using chromatography technique. Then added glycerol to produce MCT with the result of the conversion value reaching 99.71 % (w/w), and the quality of the MCT built is very good according to the AOAC standard.

## ACKNOWLEDGEMENTS

We want to thank Kementrian Ristek Dikti for funding this research through the "Skim Hibah Penelitian Dosen Pemula."

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