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Mini-Review

Virgin coconut oil and tuberculosis: A mini-review

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ABSTRACT

Virgin coconut oil is widely promoted and used as healthy and beneficial oil. One of them is caused by antimicrobials. Caprylic, caproic acid, capric acid, lauric acid and tau glyceryl monolaurate are other VCO compositions. Furthermore, due to the non-heating manufacturing process, the content in VCO can reduce cholesterol levels of triglycerides, LDL, phospholipids, VLDL and increase HDL in blood serum. VCO consumption lowers the number of *Mycobacterium tuberculosis* colonies while increasing the conversion of BTA sputum. Until now, the prevalence of tuberculosis (TB) disease was extremely high. VCO can be used as a supplement to help TB patients recover faster.

Key words: Virgin coconut oil, *Mycobacterium tuberculosis,* Tuberculosis.

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INTRODUCTION

Virgin coconut oil is widely promoted and used as healthy and beneficial oil. Some of the benefits of using coconut oil support overcoming various health problems.[1] Coconut oil is a vegetable oil staple for the food industry. Another term for coconut oil is tropical oil or lauric oil.[2] However, there are differences in the coconut oil used for cooking (coconut cooking oil) with VCO. The distinction is found in the extraction process. RBD or coconut oil is typically extracted using dried, ground, and chemically mixed parts of the coconut skin.

Meanwhile, VCO is produced from fresh, pure coconut milk, which undergoes a fermentation process by adding microbes such as lactobacillus fermentum and/or lactobacillus plantarum, separating coconut milk from oil (churning), and then adding an enzyme to separate oil and water. VCO is called virgin oil because no heating process is known as cold extraction.[3] RBD or ordinary oil will produce a large amount of saturated fatty acids due to this process, whereas VCO produces no precipitate.[4] In addition, without the heating process, the content in VCO can reduce cholesterol levels of triglycerides, LDL, phospholipids, VLDL and increase HDL in blood serum compared to coconut oil. Furthermore, VCO contains antioxidant enzymes and has antithrombotic effect.[5] According to other research, to obtain the antimicrobial effect of coconut, triglycerides must first be broken down into monoglycerides also known as free fatty acids. Lipase-released free fatty acids, on the other hand, contain only weak antimicrobials.[6]

Some of the compositions of VCO have a positive impact on health. VCO can be antifungal, antibacterial, antioxidant, antiviral, prevent cardiovascular and liver disease, increase the immune system, anti-diabetic, and treat metabolic syndrome.[7] Several scientific studies have shown that VCO can be used as an antibacterial agent to treat tuberculosis. Tuberculosis (TB) is a fatal airborne disease that frequently becomes a significant problem in low and middle-income countries' health, economic, and social sectors.[8] World case reports show around 10-20 million TB cases. 90% of cases are found in adults and 9% in people living with HIV. Ethiopians occupy the highest burden of TB disease globally, and Africa ranks third.[9] The average TB incidence rate is 164 per 100,000 populations. 23% of them are latent TB.[10]

Tuberculosis is caused by a bacterium called *Mycobacterium tuberculosis*. Several species of these bacteria include MTBC (*mycobacterium tuberculosis* complex), which consists of *Mycobacterium tuberculosis* (Mtb), a common cause of TB in humans, and M. *africanum*, a type of TB, especially in the African region. Meanwhile, M. *caprae*, M. *bovis* and M. *pinnipedi* I are TB in mammals and M. *Microti* specific to mice.[11] The high number of sufferers and TB transmission rates and some literature show an increase in sputum conversion and nutritional status of TB patients after consuming VCO,[12] or other benefits. It is necessary to discuss the benefits of VCO for people with tuberculosis comprehensively.

Search strategies

The search for research literature was carried out through database journals such as Pubmed, ScienceDirect, Willey Online Library, and Google Scholar by using a combination of keywords MeSH (Medical Subject Headings) of "virgin", "coconut oil", "oil", tuberculosis, and infectious disease. Other additional references are also searched manually.

Virgin coconut oil (VCO)

Coconut oil is a necessary ingredient in food processing as well as the most important and primary dietary fat. In the food processing industry, the presence of coconut oil is vital. There are two types of coconut oil: RBD coconut oil or copra oil and VCO.[13] RBD or copra is oil that is refined or purified using various chemical compounds (refined) and then purified (bleaching), and finally removing the unpleasant odour that appears (deodorised).[14] Making RBD is to first dry the coconut either by using smoke, the sun, or both. Then after cleaning,

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the grated coconut is pressed to get coconut oil. However, the three processes must still be carried out in the extraction process to get healthy coconut oil, such as refined, bleaching and deodorised.[15]

The other type is VCO. Unlike RBD, which is extracted using a dry process, VCO is extracted using a wet technique under carefully controlled temperature conditions, allowing better components of coconut oil to be preserved. Small components, such as vitamins A and E and polyphenols, can be preserved by avoiding UV radiation.

VCO composition

Currently, VCO has been widely used as a food supplement and moisturizer. Other VCO compositions are caprylic, caproic acid, capric acid and lauric acid.[13] Based on other studies, it shows that the biological properties of VCO are much better than coconut oil. VCO contains chain fatty acids containing 45-50% lauric acid, a powerful antimicrobial and anti-inflammatory agent. With integrated or wet, the physicochemical structure showed the free fatty acid content (FFA) in the range of 0.13% ± 0.06%. The phenol content ranges from 16.02 ± 0.44 mg GAE in every 100 g VCO.[16]

VCO extraction

VCO is the result of coconut extraction, which has high economic value. In order to get the best VCO composition, there are several extraction techniques used, namely the fresh-wet technique (fermentation then centrifugation) and the fresh-dry technique (fresh-dry). These two techniques can maintain the antioxidant components in coconut oil, such as polyphenols, tocotrienols and tocopherols.[17]

VCO extracted by fermentation technique showed that the addition of yeast greatly affected the volume of VCO produced in water content, free fatty acid composition, and viscosity. The types of yeast used are Saccharomyces cerevisiae, baker's yeast, Rhizopus sp or tempeh yeast, and yeast tape.[18] Meanwhile, other literature shows four ways to get good quality VCO: centrifugation, cooling, direct micro expelling-oven dried that does not use high temperatures, and direct micro expelling sun-dried.[19] However, from other sources, it is described that the physicochemical properties of coconut oil's fatty acids with the best quality are obtained from processing methods by centrifugation or suspended solid-liquid separation.[20]

Benefits of VCO

Fresh VCO contains a very beneficial component in lowering blood pressure, helping to lose excess weight, and is a biomarker in the inflammatory process. On the other hand, VCO that has been heated repeatedly, such as palm oil, can increase blood pressure. Therefore, VCO should be consumed fresh to obtain health benefits.[17]

In addition, other studies have shown that VCO treated with a new wet system has a good role as an endogenous antioxidant and paraoxonase one because it can prevent the oxidation of lipids and proteins.[17] Another benefit is that VCO can be hepatoprotective with dry or fermentation techniques. The experimental results using paracetamol-induced liver damage showed that VCO significantly reduced liver damage or was hepatoprotective.[22] Furthermore, consuming 30 mL of VCO daily can raise high-density lipoprotein cholesterol levels for healthy young adults. No problems or complications were discovered after eight weeks of daily VCO consumption.[23] Other research indicates that, while still in early stages, VCO's use effectively reduce the incidence of atopic dermatitis, and prevents dental caries and hair damage caused by UV exposure and treatment that results in protein loss.[24] VCO, a diet rich in unsaturated fatty acids, can reduce the incidence of cardiovascular disease and have local effects (CVD). However, some trials are still limited to animal trials, so further studies are needed in humans.[25] Others show that coconut oil contains a better concentration of palm oil. Coconut oil does not affect body weight, body fat percentage, waist circumference, and plasma glucose. However, vegetable oil (coconut oil) cannot be said to reduce the risk of CHD.[26]

The effect of VCO on TB patients

TB disease has been an epidemic for hundreds of years, with 5000 TB deaths per day. MTB, caused by Mycobacterium tuberculosis, is a parasitic disease in humans that can adapt and survive by transmitting it between humans. Therefore, a host maintaining systemic immunity is needed to control infection transmission.[27] Other literature states that TB is a disease that can induce the body's immunity, either as a protective immunity or by damaging tissues. Primary TB plays a role in mediating protective immunity to spread infection.

In contrast to primary TB, post-primary TB plays a role in forming tissue damage that results in the formation of cavities. Both components are indispensable for mycobacterium tuberculosis or MTB bacteria.[28] The process of MTB in multiplying is by making MTB-infected macrophages isolated into hypoxic tissues and then differentiation containing lipids containing triacylglycerol.[29] Other literature states that the MTB replication process is carried out by converting fatty acids into acyl-adenylate so that the inhibitor will be disrupted by the presence of various pathways.[30] The MTB structure plays a vital role in determining the survival of MTB bacteria, namely the plasma membrane, cell wall, mycomembranes and capsules.[31]

Based on the study results, giving VCO with different concentrations reduced the number of Mycobacterium tuberculosis colonies. When given VCO with different concentrations, 1:10 with a given concentration of 1:10,000 was able to reduce colonies from 46% to 100%. This is because different VCO preparations contain varying amounts of lauric acid.[32] In addition, giving VCO combined with the administration of catfish albumin impacts the cure rate and shortens the length of treatment due to conversion of the sputum smear and interferon-gamma composition in the third month.[33] The positive impact of the use of VCO can be caused by the content of saturated fatty acid chains or glycerol monolaurate or also called monolaurin, which has chemical and biological effects or has strong antimicrobials in killing pulmonary tuberculosis bacteria by penetrating membranes and synthesizing, making efforts to inhibit the reproduction and replication of tuberculosis germs.[34]

Other studies also show the results or benefits of VCO on TB. Pulmonary TB patients who were given MDT DOTS then combined with VCO tablets could accelerate the time needed to convert the sputum components of AFB. Accelerated conversion is caused by the content of long-chain saturated fat or also called glyceryl monolaurate, which functions as a potent bactericide for pulmonary TB, thereby inhibiting the replication and reproduction of mycobacterium TB.[35] In addition, from the results of the analysis of the VCO content, of the 84% composition of saturated fatty acids, 46.67% of them are lauric acid. Furthermore, when absorbed into the body, lauric acid will be converted or changed to glycerol monolaurate or monolaurin. In the study of detecting the resistance level to OAT or mycobacterial tuberculosis using the REMA (resazurin microtiter assay plate) technique, the results showed that VCO could be effective against mycobacterium tuberculosis. Monolaurin counteracts MTB at 313 mg/mL while rifampin at 0.0025 mg/mL.[36] While related to the dose of VCO, which can provide a good therapeutic effect, VCO should be given at a low dose first in order to improve hepatic structural, biochemical deviation or modify diet. The therapeutic effect of VCO will be more significant on LDH, SOD, MDH and total bilirubin.[37]

The therapeutic effect of VCO begins with lipolysis in the mouth, continues to the stomach, and ends in the small intestine. Monolaurin and monocaprin are the two forms of VCO metabolites.[38] VCO fights

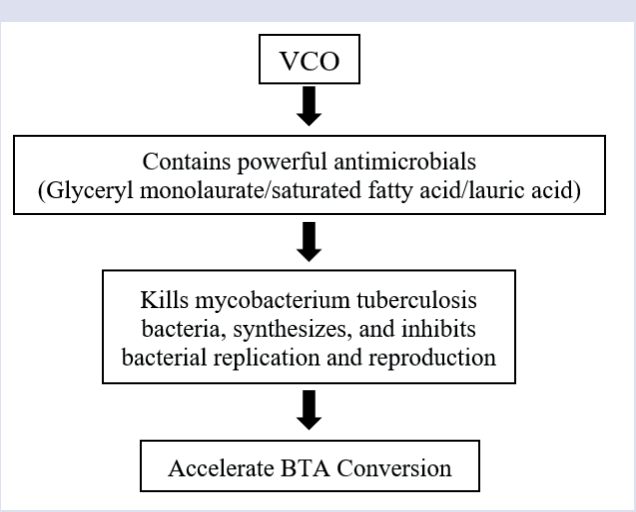

Figure 1: The mechanism of VCO in overcoming TB.

Table 1: Summary of the study.

Study	Outcome	Result
Dalmacion et al.[32]	The effect of VCO in reducing Mycobacterium tuberculosis	2 brands of VCO can reduce the number of mycobacterium tuberculosis colonies, 46-100% on Middle brook 7H10 media.
Montolalu et al.[33]	Effects of albumin and VCO supplementation with sputum and interferon conversion	There was a difference in the level of gamma interference in the intervention group given VCO and albumin and the control group at 3 months (mean SE 38.53-13.64). Meanwhile, in the 1st and 6th months, no difference was found. At 6 months there was no difference because the body no longer produced IFN-X cytokines after 6 months of treatment.
Arifin et al.[35]	Accelerated conversion of BTA sputum	The combination of VCO nutrition with albumin extracted from catfish showed significant results in increasing body immunity, accelerating the conversion of BTA VCO sputum with a P value <0.00 while the conversion of sputum with catfish extract showed a P value of 0.004. As for the combination of the two, VCO and albumin with P value <0.00.
Delia.[36]	Clinical trials of VCO as an antimycobacterial	The results of clinical trials using the REMA (Resazurin microtiter assay) method, showed that VCO was active against MTB H 37 Rv at 625ug/ml and against clinical isolates from 78 to 625. While Monolaurin was active at 313 ug/mL against MTB H 37 Rv, and Rifampicin, at 0.0025 g/mL. These data indicate the high potential of VCO as an antimycobacterial tuberculosis.
Kasman.[12]	Increased conversion of BTA sputum and nutritional status of pulmonary TB patients with VCO	The results of this study showed that the sputum smear conversion rate that received VCO and DOTS interventions had a mean = 4 weeks, 2 weeks faster than those who were only given DOTS with a mean = 6 weeks.

microbial growth through three basic mechanisms: 1) disintegration of the lipid membrane, 2) inhibition of pathogenic organism maturation and 3) Preventing pathogens from entering the host cell membrane. Furthermore, the lipid breakdown process is the foundation for monolaurin activity.[39]

From the table 1, we know that VCO can be an excellent supplement recommendation for TB sufferers. If described further, the mechanism or effect of VCO in overcoming TB is shown in Figure 1.

Based on the mechanism (Figure 1), it can be seen that the main antimicrobial content in VCO is glyceryl monolaurate/lauric acid/saturated fatty acids. Glyceryl monolaurate is a glycerol ester of lauric acid, often used in the food industry as a cosmetic, preservative, or emulsifier, and has been declared safe by the food and drug administration for topical use at a dose of 100 mg/ml.[40] However, glyceryl monolaurate is also known as a very potent antimicrobial against gram-positive bacteria. GML is also known as a topical microbicide used in a broad spectrum. Despite GML's superiority as an antimicrobial, other research indicates that its use is declining. This is because its water-soluble properties are still low, and its melting point is too high. However, the most recent nanoparticle formulation can effectively reduce the toxic effect against BTA germs.[41]

Apart from being an antimicrobial pathogen, Glyceryl monolaurate or monolaurin is an antiviral that can fight various viruses and improve the body's immune system. The mechanism of the role of glyceryl guacholate related to its function as an antiviral includes controlling the pro-inflammatory cytokine system, activating leukocytes, disintegrating membranes, and inhibiting the process of maturation and replication of the virus.[42]

The antibacterial component of VCO that can increase sputum conversion is lauric acid. Lauric acid is a bioactive compound that can be an inhibitory factor for Mycobacterium tuberculosis. The lauric acid inhibitory concentration level was 22.2 -66.7 g/mL.[43] The way lauric acid works in inhibiting the performance of bacteria is by forming reactive oxygen species (ROS) and causing damage to the membrane, and inhibiting the formation of biofilms, thereby inhibiting pro-inflammatory cytokines.[44]

As for getting the maximum antibacterial or antiviral effect from VCO, the thing that must be considered is the hydrolysis process of VCO. The higher the amount of NaOH used in the hydrolysis process, the antibacterial activity can increase. In addition, VCO, which is hydrolyzed with enzymes, is more effective than that which undergoes hydrolysis with sodium hydroxide [46].[45] Based on an antibacterial activity test of hydrolyzed VCO also known as VCOH, the hydraulic VCO process outperformed VCO without hydrolysis.[46] Furthermore, the length of fermentation and whether or not induction oil is used impact VCO quality.[47]

A positive impact of giving VCO is an increase in sputum conversion BTA. Sputum conversion is the strongest predictor in determining the effectiveness of TB therapy. Mycobacteria characterize sputum conversion in the sputum culture of TB cases formed in the second month of the treatment process. The first month's conversion ranged from 60-80%, while in the second month, it reached 95%. Some of the supporting factors in increasing sputum conversion are the level of compliance in consuming drugs, smoking habits, nutritional status (BMI), and habits in consuming alcohol.[48]

According to the previous reference, VCO, due to its glyceryl monolaurate content, can increase sputum conversion by inhibiting the replication and reproduction of mycobacterium bacteria. Another study found that glyceryl monolaurate inhibited the growth of Streptococcus aureus and Streptococcus epidermidis bacteria by inhibiting the production of lipase enzymes. Lipase deficiency can inhibit bacterial growth.[49] VCO

also has antibacterial properties and can be used as a skin protection material to protect against UV rays and radiation exposure. The test results of VCO creams show that they increase spreadability but have no effect on pH or adhesion.[50]

Future direction

From the literature review described previously, we get an overview of the antibacterial benefits of VCO in increasing the conversion of BTA sputum. However, further scientific studies are needed to determine the best type of VCO, dosage and the effect of VCO consumption time.

CONCLUSION

TB is an infectious disease that is still becoming an epidemic with a high prevalence every year. Apart from medical drugs, nutrition or complementary supplements are needed to reduce the prevalence of events and accelerate and make the TB treatment process more effective. According to the literature, virgin coconut oil is one companion supplement that can increase the conversion of BTA sputum. Antimicrobials containing glyceryl monolaurate/saturated fatty acid/lauric acid are found in VCO. The use of VCO as an additional supplement for TB therapy is recommended.

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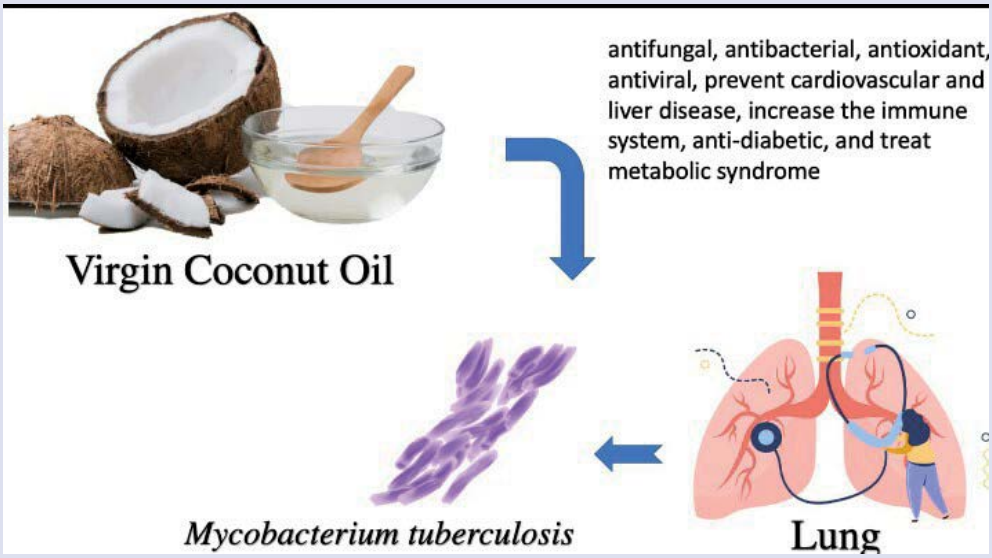
GRAPHICAL ABSTRACT



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