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Virgin Coconut oil” – An updated Pharmacological Review

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Abstract

Virgin coconut oil is extracted directly from fresh coconut meat without the use of high heating or chemicals. Either minimal heating is used to dry the meat before the oil is extracted by pressing, or the non-dried meat is pressed first and the mixture of oil and water which is obtained is allowed to separate to produce the virgin oil. This oil retains the characteristic scent and taste of coconut and is suitable for human consumption without any further processing. Copra and coconut oil are the traditional products based on the coconut. Their production has generally required large scale facilities with prices highly vulnerable to international supply and demand dictated by the output from countries such as the Philippines which produce a high proportion of world supply¹.

Keywords: Virgin coconut oil (VCO), Therapeutic utility

Introduction

Virgin Coconut Oil (VCO) is growing in popularity as functional food and the public awareness of it is increasing. Virgin coconut oil is the naturally processed, chemically free and additive free product from fresh coconut meat or its derivatives (coconut milk and coconut milk residue), which has not undergone any chemical processing after extraction. It is the purest form of coconut oil, water white in color, contains natural vitamin E and has not undergone hydrolytic or atmospheric oxidation as attested by its very low free fatty acid content and peroxide value. It has a mild to intense fresh coconut scent depending on the type of process used for production. Virgin Coconut Oil (VCO) is extracted from fresh coconut milk obtained from matured coconut of 12 months old. VCO can be consumed in its natural state without the need for further processing. Virgin coconut oil is known for its medium chain tryglycerides (MCTs). The most important medium chain fatty acid found in VCO is lauric acid. It constitutes 48 % of VCO². Not only the common people, but doctors and scientists are also showing a great interest in virgin coconut oil, because of its specific chemical composition and many have reported miraculous health benefits from using the virgin coconut oil. Virgin coconut oil is extracted from the meat of a fresh coconut, and it is important that it be from a fresh coconut, because the oil extracted from a dried one is much different in chemical composition. Pure virgin coconut is colorless, sediment free and has a natural coconut scent. It also tastes much lighter than the oil extracted from a dried coconut. Unlike almost other edible oils, which are loaded with cholesterol that lead to the blockage of blood vessels and the deterioration of the health but virgin coconut oil possess the opposite effect. Some of the health benefits that people have reported from consuming this oil include weight management, prevention of heart disease, and improvement of the immune system, among other things. In this review an attempt has been made to compile the therapeutic benefits of the oil

Anti-inflammatory, analgesic, and antipyretic effects

A study was conducted to investigate some pharmacological properties of virgin coconut oil. The anti-inflammatory, analgesic, and antipyretic effects of the virgin coconut oil were assessed. In acute inflammatory models, virgin coconut oil showed moderate anti-inflammatory effects on ethyl phenylpropiolate-induced ear edema in rats, and carrageenin-

and arachidonic acid-induced paw edema. Virgin coconut oil exhibited an inhibitory effect on chronic inflammation by reducing the transudative weight, granuloma formation, and serum alkaline phosphatase activity. Virgin coconut oil also showed a moderate analgesic effect on the acetic acid-induced writhing response as well as an antipyretic effect in yeast-induced hyperthermia. The study confirms the anti-inflammatory, analgesic, and antipyretic properties of virgin coconut oil³.

Antiapoptosis effect

A study was conducted for evaluating the possibility of using virgin coconut oil as new potential antiapoptosis agent to combat lung cancer was evaluated. In the present study two lung cancer cell lines were exposed to series of concentration of virgin coconut oil for 72 hrs. Upon treatment, the morphological changes of the cancer cells were observed. The apoptosis assay using Annexin V-FITC kit was also carried out. The results showed that virgin coconut oil at IC₅₀ value of 12.04% (v/v) and 8.64% (v/v) induced apoptosis in NCI-H1299 and A549 lung cancer cell lines, respectively, with 3.57% and 4.20% of the apoptotic cells following treatment. The findings reveal that virgin coconut oil can induce cell death of lung cancer cells and safe to be consumed⁴.

Oxidative stability effect

A study was designed to evaluate oxidative stability of coconut oil during 12 month of storage. The progress of lipid oxidation was assessed by measuring peroxide value, p-anisidine value and total oxidation value. The low peroxide value signifies a high oxidative stability, while p-anisidine values were in the range 0.19-0.87. Fourier transform infrared spectroscopy was used to monitor the peak changes as effect of oxidation during storage. The prominent peak change observed during storage of coconut oil was at frequency 1742 cm⁻¹ which corresponded to the ester carbonyl functional group of the triglycerides resulted from the hydroperoxide decompositions. These results suggest that coconut oil during 12 month on storage keeps its good chemical properties⁵.

Antihypercholesterolemic effect

A study has been carried out to evaluate the effect of feeding two types of virgin coconut oils. Virgin coconut oil produced by a standard drying method (A) or the oil prepared by fermentation process (B). Nine groups of New Zealand White male rabbits (n = 6/group) were used in this study. Group 1 and 2 animals were treated with 0.9% normal saline, but fed either with a normal or cholesterol-added diet (negative control), respectively. Group 3 - 5 and 6 - 8 were given orally with the different volume (0.5, 1.0 and 2.5 ml/kg/day) of virgin coconut oil A or virgin coconut oil B followed by the cholesterol-added diet. Group 9 were treated with 5 mg/kg Atorvastatin and fed a cholesterol-added diet. All groups were treated for 8 weeks and blood samples were taken from the marginal ear vein prior to treatment (day 0), weeks 4 and 8 for the analysis of plasma. The rabbits fed with different volume of virgin coconut oils showed significant (P < 0.05) reduction in plasma cholesterol and LDL cholesterol levels compared to the control group in weeks 4 and 8. The triglycerides level increased significantly (P < 0.05) on week 4 before reduced on week 8, to a level that is still significant when compared

to week 0. The HDL level also increased significantly (P < 0.05) on weeks 4 and 8 after treatment. Fatty acid analysis revealed the presence of all important fatty acids. Both virgin coconut oils showed insignificant effect on all parameters measured when compared together. From the findings we can say that the MARDI-produced virgin coconut oils possess great potentials as antihypercholesterolemic agent⁶.

Antidiabetic effect

Hot extracted virgin coconut oil has been shown to possess better antioxidant properties than cold extracted virgin coconut oil. These properties were exploited to study the antidiabetic effects of hot extracted virgin coconut oil and cold extracted virgin coconut oil in diabetic rats. Four groups 8 rats each, first group served as non-diabetic control remaining groups were made diabetic and force fed with 2 ml alcoholic extracts of commercial coconut oil, cold extracted virgin coconut oil and hot extracted virgin coconut oil for 21 days. Blood glucose once in 5 days, body weight gain, food intake once in a week and water intake and urine output daily, were monitored. Animals were sacrificed at the end of 21 days. The results indicated hot extracted virgin coconut oil reduced blood glucose and lipids like total cholesterol, tri- glycerides, Low and Very Low Density Li- poprotein and thiobarbutyric acid reactive substances increased the antioxidant status by elevating activities of anti- oxidant enzymes such as superoxide dismutase, catalase, glutathione peroxidase., glutathione concentration and decreased lipid peroxidation in liver than cold extracted virgin coconut oil. These pharmacological properties exhibited could be due to polyphenolic and other antioxidants content present in hot extracted virgin coconut oil⁷.

Oxidative stress reduction effect

A study was conducted to investigate the influence of virgin coconut oil on the malondialdehyde level in the heart tissue of rats fed with heated palm oil. Thirty two male Sprague-Dawley rats were equally assigned into four groups and fed as follows. Control-group with normal rat chow; virgin coconut oil group with rat chow and supplemented with 1.43ml/kg body weight of virgin coconut oil, Five times heated palm oil 5 times heated palm oil-group with rat chow fortified with 15% weight/weight (w/w) of 5times heated palm oil; and 5times heated palm oil + virgin coconut oil group with rat chow fortified with 15% w/w of 5HPO plus 1.43ml/kg body weight of virgin coconut oil simultaneously. The treatment has been carried out for four months. After words, the thirty two rats were sacrificed and heart tissues were harvested for biochemical analyses. There was a significant decrease in peroxide value in the virgin coconut oil. The malondialdehyde level in the virgin coconut oil and 5times heated palm oil+virgin coconut oil groups was reduced significantly compared to the 5times heated palm oil group. The results showed that supplementation of virgin coconut oil reduced the oxidative stress as depicted with decrease in peroxide value and malondialdehyde level⁸.

Anti-bacterial effect

Many strains of *Staphylococcus aureus* have exhibited antibiotic resistance and the antibiotics that are currently in the market have severe side effects. So to promote the

natural treatments, as opposed to artificial treatments, to inhibit *S. aureus* biofilm formation. This may lead to the rescuing of lives, as *S. aureus* biofilm formation is a key virulence factor of this pathogen. By examining effective dosage levels of olive and coconut oil-based soaps to inhibit biofilm formation, this investigation seeks to find natural remedies for *S. aureus* infections. A standard crystal violet assay was used to test the antibacterial activities of the agents, extra virgin olive and coconut oil based soaps. The overall trend supports the hypothesis that the agents possess antimicrobial properties that inhibit *S. aureus* biofilm formation. It is also found that the threshold value of agents for inhibition of *S. aureus* biofilm formation lies between 0.1% and 0.01%. More diluted concentrations of those agents are not as effective against *S. aureus* biofilms⁹. Another study was conducted to determine the antibacterial activity of the enzymatic hydrolyzed of virgin coconut oil and palm kernel oil, which produce a combination of lauric acid and monolaurin. Hydrolysis process was done by the enzyme lipase which was active at 1.3 position. The hydrolyzed oil then tested for antibacterial activity against *Staphylococcus aureus*, *Escherichia coli* and *Salmonella thypi* using agar diffusion method with paper disc with diameter of 6 mm. Antibacterial activity test carried out on virgin coconut oil and palm kernel oil, hydrolyzed virgin coconut oil and palm kernel oil each at 25% concentration, 50%, 75% and 100%. Antibacterial activity of the test material compared with chloramphenicol (30 µg) and tetracycline (30 µg). The results showed that the optimum hydrolysis time is 14 hours. There is low and similar antibacterial activity of virgin coconut oil and palm kernel oil. Hydrolyzed virgin coconut oil and palm kernel oil show higher antibacterial activity than virgin coconut oil and palm kernel oil. There is an increase of antibacterial activity by increased levels of hydrolyzed virgin coconut oil and palm kernel oil. Antibacterial activity against *S. aureus* was higher than *S. thypi* and *E. coli*. Antibacterial activity of the test material is lower than the standard chloramphenicol and tetracycline¹⁰.

Another study was conducted to investigate the antimicrobial activity of commercial virgin coconut oil. Agar well diffusion test and disc diffusion test were first done to test on both methanol extracted oil and pure oil samples against four types of bacteria. Both methods showed no antimicrobial activity. Broth dilution method was then done to determine the minimum inhibitory concentration of the oil samples against eight types of bacteria. Again, no antimicrobial activity was observed. In turn, gram negative bacteria like; *Coccus*, *Bacillus*, *Streptobacillus* and *Coccobacillus* were isolated from all the oil samples. The triglyceride in the oil samples have to be broken down to monoglyceride or free fatty acids by enzyme lipases in order to exert antimicrobial activity. Bacteria have the ability to produce non-specific enzymes to release free fatty acids and sn1, 3 lipase to produce sn-2 monoglyceride. In fact, the free lauric acids released by lipase only possess weak antimicrobial activity and the sn-2 monoglycerides formed may not exert any antimicrobial activity. Bacteria were isolated from the oil samples because raw and unprocessed coconut meat can support growth of bacteria and no sterilization is done to prevent microbial contamination¹¹.

Another study has been designed to evaluate the lipid components of virgin coconut oil for the control of

Clostridium difficile. Virgin coconut oil and its most active individual fatty acids were tested to evaluate their antimicrobial effect on *C. difficile* in vitro. The data indicate that exposure to lauric acid (C12) was the most inhibitory to growth ($P < 0.001$), as determined by a reduction in colony-forming units per milliliter. Capric acid (C10) and caprylic acid (C8) were inhibitory to growth, but to a lesser degree. Virgin coconut oil did not inhibit the growth of *C. difficile*; however, growth was inhibited when bacterial cells were exposed to 0.15–1.2% lipolyzed coconut oil. Transmission electron microscopy (TEM) showed the disruption of both the cell membrane and the cytoplasm of cells exposed to 2mg/mL of lauric acid. Changes in bacterial cell membrane integrity were additionally confirmed for virgin coconut oil and select fatty acids using Live/Dead staining. This study demonstrates the growth inhibition of *C. difficile* mediated by medium-chain fatty acids derived from virgin coconut oil¹².

Antioxidant effect

The antioxidant activity was determined using DPPH radical-scavenging activity and the amount of virgin coconut oil extract to decrease the DPPH radical concentration by 50% is 5.07 ± 0.19 mg/L. The study shows that the oil possess significant antioxidant effect¹³.

Antiviral effect

A study has been carried out to ascertain the antiviral activity of the virgin coconut oil. A minimum of 50 ml of coconut oil would contain 20 to 25 grams of lauric acid, which indicates that the oil is metabolized in the body to release monolaurin which is an antibiotic and an antiviral agent. Among the saturated fatty acids, lauric acid has the maximum antiviral activity. Based on this research, the first clinical trial using monolaurin as monotherapy on some of the HIV patients was conducted recently. The findings suggests that the initial trial confirmed the anecdotal reports that coconut oil does have an anti-viral effect and can beneficially reduce the viral load of HIV patients. The positive anti-viral action was seen not only with the monoglyceride of lauric acid but with coconut oil itself. This indicates that coconut oil is metabolized to monoglyceride forms of C-8, C-10, C-12 to which it must owe its anti-pathogenic activity¹⁴.

Anti-ulcerogenic effect

A study was conducted to determine the antiulcer potential of virgin coconut oil, either extracted by wet process (VCOA) or fermentation process (VCOB), and to compare their effectiveness against the copra oil (CO) using the HCl/ethanol-induced gastric ulcer model. In the antiulcer study, rats ($n = 6$) were pre-treated orally for 7 consecutive days with distilled water (vehicle), 100 mg/kg ranitidine (positive group) or the respective oils (10, 50, and 100% concentration). One hour after the last test solutions administration on Day 7th, the animals were subjected to the gastric ulcer assay. Macroscopic and microscopic analyses were performed on the collected rat's stomachs. From the results obtained, the chemical analysis revealed i) the presence of high content of lauric acid followed by myristic acid and palmitic acid in all oils and; ii) the significant ($*p < 0.05$) different in anisidine- and peroxide-value, percentage of free fatty acid, total phenolic content

and total antioxidant activity among the oils. The animal study demonstrated that all oil possess significant ($*p < 0.05$) antiulcer activity with VCOB being the most effective oil followed by VCOA and CO. The macroscopic observations were supported by the microscopic findings. Interestingly, all oils were more effective than 100 mg/kg ranitidine (reference drug). In conclusion, coconut oils exert remarkable antiulcer activity depending on their methods of extraction, possibly via the modulation of its antioxidant and anti-inflammatory activity¹⁵.

Cardioprotective effect

Emphasis on diet to improve the cardiovascular (CV) risk profile has been the focus of many studies. The chemical properties and the manufacturing process of VCO make this oil healthier than its copra-derived counterpart. The study highlights the mechanism through which saturated fatty acids contribute to CV disease (CVD), how oils and fats contribute to the risk of CVD, and the existing views on VCO and how its cardioprotective effects may make this a possible dietary intervention in isolation or in combination with exercise to help reduce the burden of CVDs. Virgin coconut oil may have a role to play in reducing the risk of CVD, thereby aiding in controlling the rising global burden of this non-communicable disease¹⁶.

Hepatoprotective effect

The present study aims to determine the hepatoprotective effect of MARDI-produced virgin coconut oils, prepared by dried- or fermented-processed methods, using the paracetamol-induced liver damage in rats. Liver injury induced by 3 g/kg paracetamol increased the liver weight per 100 g bodyweight indicating liver damage. Histological observation also confirms liver damage indicated by the presence of inflammations and necrosis on the respective liver section. Interestingly, pretreatment of the rats with 10, but not 1 and 5, mL/kg of both VCOs significantly reduced the liver damage caused by the administration of paracetamol, which is further confirmed by the histological findings. From the findings it is confirmed that VCO possessed hepatoprotective effect¹⁷.

Nephroprotective effect

A study was conducted to evaluate the remedial effect of virgin coconut oil on renal dysfunction in diabetic rats. Fifteen albino wistar rats were divided in to three groups. Fifteen albino Wistar rats were divided into 3 groups that comprise normal control group (Group I) and diabetic control group (Group II) fed with normal rat chows and a diabetic test group (Group III) fed with 10% VCO diet. Group II and Group III were made diabetic by single intra peritoneal injection of 150mg/kg of freshly prepared alloxan monohydrate. After 72 hours of alloxan injection, fasting blood glucose was tested to confirm diabetes mellitus. After 3 weeks, the animals were anaesthetized and sacrificed to collect blood samples for renal function analysis. The creatinine, urea, and blood urea nitrogen values of Group II were significantly different from those of Group I and Group III at $P < 0.001$. Also, there was significant difference ($P < 0.05$) in total protein value between Group II (4.42 ± 0.47 mg/dL) and Group I (5.78 ± 0.12 mg/dL) as well as Group III (5.86 ± 0.19 mg/dL), but there was no significant difference between that of Group I and Group III (5.78 ± 0.12 mg/dL and $5.86 \pm$

0.19 mg/dL, resp.). Thus, VCO is effective in preventing renal damage in diabetic patients¹⁸.

Antihypertensive effect

A study was performed to explore the effects of virgin coconut oil (VCO) in male rats that were fed with repeatedly heated palm oil on blood pressure, plasma nitric oxide level, and vascular reactivity. Thirty-two male Sprague-Dawley rats were divided into four groups: (i) control (basal diet), (ii) VCO (1.42 mL/kg, oral), (iii) five-times-heated palm oil (15%) (5HPO), and (iv) five-times-heated palm oil (15%) and VCO (1.42 mL/kg, oral) (5HPO + VCO). Blood pressure was significantly increased in the group that was given the 5HPO diet compared to the control group. Blood pressure in the 5HPO + VCO group was significantly lower than the 5HPO group. Plasma nitric oxide (NO) level in the 5HPO group was significantly lower compared to the control group, whereas in the 5HPO + VCO group, the plasma NO level was significantly higher compared to the 5HPO group. Aortic rings from the 5HPO group exhibited attenuated relaxation in response to acetylcholine and sodium nitroprusside as well as increased vasoconstriction to phenylephrine compared to the control group. Aortic rings from the 5HPO + VCO group showed only attenuated vasoconstriction to phenylephrine compared to the 5HPO group. In conclusion, VCO prevents blood pressure elevation and improves endothelial functions in rats fed with repeatedly heated palm oil¹⁹.

Skin protectant

Atopic dermatitis (AD) is a chronic skin disease characterized by defects in the epidermal barrier function and cutaneous inflammation, in which transepidermal water loss (TEWL) is increased and the ability of the stratum corneum to hold water is impaired, causing decreased skin capacitance and hydration. This study investigated the effects of topical virgin coconut oil (VCO) and mineral oil, respectively, on SCORAD (SCORing of Atopic Dermatitis) index values, TEWL, and skin capacitance in pediatric patients with mild to moderate AD, using a randomized controlled trial design in which participants and investigators were blinded to the treatments allocated. Patients were evaluated at baseline, and at 2, 4, and 8 weeks. A total of 117 patients were included in the analysis. Mean SCORAD indices decreased from baseline by 68.23% in the VCO group and by 38.13% in the mineral oil group ($P < 0.001$). In the VCO group, 47% (28/59) of patients achieved moderate improvement and 46% (27/59) showed an excellent response. In the mineral oil group, 34% (20/58) of patients showed moderate improvement and 19% (11/58) achieved excellent improvement. The VCO group achieved a post-treatment mean TEWL of 7.09 from a baseline mean of 26.68, whereas the mineral oil group demonstrated baseline and post-treatment TEWL values of 24.12 and 13.55, respectively. In the VCO group, post-treatment skin capacitance rose to 42.3 from a baseline mean of 32.0, whereas that in the mineral oil group increased to 37.49 from a baseline mean of 31.31. Thus, among pediatric patients with mild to moderate AD, topical application of VCO for eight weeks was superior to that of mineral oil based on clinical (SCORAD) and instrumental (TEWL, skin capacitance) assessments^{20,21}.

Anticancer (Breast Cancer) effect

Breast cancer is the most common cancer amongst Malaysian women. Both the disease and its treatment can

disrupt the lives of the woman and adversely affect all aspects of life and thus can alter a woman's quality of life. The aim of this study was to examine the effect of virgin coconut oil (VCO) on the quality of life (QOL) of patients diagnosed with breast cancer. This was a prospective study of breast cancer patients admitted into the Oncology Unit of Hospital Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia. The sample consisted of 60 patients with stage III and IV breast cancer allocated to either an intervention group (n=30) or a control group (n=30) using a simple random table. QOL was evaluated from the first cycle of chemotherapy to the sixth cycle, and data were collected using a validated *Bahasa Malaysia* version of the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Breast Cancer Module (EORTC QLQ-C30) and its breast-specific module (QLQ-BR 23). The mean age of breast cancer patients was 50.2 (SD = 13.5) years. There were significant mean score differences for functioning and global QOL between groups ($\alpha < 0.01$). The intervention group also had better scores for symptoms including fatigue, dyspnea, sleep difficulties, and loss of appetite compared to the control group. Although there are deteriorations for sexual enjoyment, the intervention group exhibited improvement in breast functioning and symptom scores for body image, sexual function, future perspective, breast symptoms, and systemic therapy side effects. VCO consumption during chemotherapy helped improve the functional status and global QOL of breast cancer patients. In addition, it reduced the symptoms related to side effects of chemotherapy²².

Antiasthmatic effect

Many studies have been done to evaluate the effect of various natural products in controlling asthma symptoms. Virgin coconut oil (VCO) is known to contain active compounds that have beneficial effects on human health and diseases. The objective of this study was to evaluate the effect of VCO inhalation on airway remodeling in a rabbit model of allergic asthma. The effects of VCO inhalation on infiltration of airway inflammatory cells, airway structures, goblet cell hyperplasia, and cell proliferation following ovalbumin induction were evaluated. Allergic asthma was induced by a combination of ovalbumin and alum injection and/or followed by ovalbumin inhalation. The effect of VCO inhalation was then evaluated via the rescue or the preventive route. Percentage of inflammatory cells infiltration, thickness of epithelium and mucosa regions, and the numbers of goblet and proliferative cells were reduced in the rescue group but not in preventive group. Analysis using a gas chromatography-mass spectrometry found that lauric acid and capric acid were among the most abundant fatty acid present in the sample. Significant improvement was observed in rescue route in alleviating the asthma symptoms, which indicates the VCO was able to relieve asthma-related symptoms more than preventing the onset of asthma²³.

Conclusion

Virgin coconut oil is considered as popular functional edible oil due to public awareness with regard to its health benefits. That's the reason, the oil with minimum pharmacotherapeutic properties is gaining popularity in the

modern society. From the existing literature, there are many health benefits including cardioprotective effects, anti-cancer, antibacterial, antifungal, and antiviral effects. However, more research is needed to provide conclusive evidence against its clinical applications.

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