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The potential of coconut oil as an anti-obesity agent: a scoping review

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Abstract

Background: The rising global prevalence of obesity and its related health issues make it crucial to explore all potential therapeutic options. Coconut oil (CNO) has been extensively studied for its health benefits, yet no scoping review has specifically assessed its potential as an anti-obesity agent, particularly among obese subjects.

Objective: This review aims to outline the characteristics and findings regarding the use of coconut oil as an anti-obesity agent in both experimental animal and human studies.

Method: The review included original studies on the potential of coconut oil as an anti-obesity agent, published in English or Indonesian between 2011 and 2022. A comprehensive search was performed across databases such as PubMed, ScienceDirect, Google Scholar, SpringerLink, and Portal Garuda. Articles were selected following the PRISMA-ScR flow diagram, with subsequent data extraction, analysis, and synthesis conducted.

Results: Eight articles met the inclusion criteria, comprising four preclinical trials (involving obese animal models) and four human studies that recruited obese people. The preclinical trials used virgin coconut oil (VCO), while the human studies utilized both VCO and coconut oil (CNO). In preclinical trials, VCO administration was associated with reductions in low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), and triglyceride (TG) levels. In clinical trials, consumption of VCO and CNO was linked to increased high-density lipoprotein cholesterol (HDL-C) levels and reductions in LDL-C, TC, TG, and anthropometric measures (body weight, body mass index, waist circumference, waist-to-hip ratio, and body fat mass). However, the effects of VCO and CNO on LDL-C, TC, and TG were inconsistent.

Conclusion: Coconut oil, particularly in the form of VCO, has shown potential as a supplement for managing obesity. However, this scoping review highlights inconsistencies in the effects of coconut oil on lipid profiles (LDL-C, TC, TG), indicating the need for further research to clarify these outcomes.

Keywords: Coconut oil, *Cocos nucifera* L., medium-chain saturated fatty acid, obesity

1. Introduction

The global prevalence of obesity has tripled between 1975 and 2016 (WHO, 2021). A cross-sectional study based on the National Basic Health Survey in 2007 reported that the prevalence of obesity and central obesity among the adult population (aged >18 years) in Indonesia was 23.1% and 28%, respectively (Harbuwono *et al*., 2018). According to data from Basic Health Research and the Statistic Center Agency, the prevalence of obesity in the adult population in Indonesia increased significantly, rising from 19.1% in 2007 to 35.4% in 2018 (Statistic Center Agency, 2021).

The World Health Organization (WHO) defines obesity as excessive and abnormal fat accumulation that negatively impacts health (Panuganti *et al*., 2021). The primary treatment for obesity involves lifestyle management, such as dietary changes, increased physical activity, and behavioral modifications (Hamdy *et al*., 2021). While pharmacological therapy and surgery are additional treatment options, they are associated with higher costs and potential side effects.

Researchers are increasingly interested in exploring natural resources that could provide effective and safe approaches to addressing obesity (Lagerros & Rössner, 2013; Pilitsi *et al*., 2019).

The coconut tree is a natural resource with potential as an anti-obesity agent (da Silva Lima & Block, 2019). It belongs to the kingdom Plantae, order Arecales, family Aracaceae, subfamily Cocoidae, genus Cocos L., and species *Cocos nucifera* L. (Schoch CL, 2020). One of the main products derived from the coconut tree is coconut oil (CNO), which exists in two forms: refined, bleached, and deodorized copra oil (RBDCO or CO) and virgin coconut oil (VCO) (Suryani *et al*., 2020). CNO is rich in saturated fatty acids (SFA), with approximately 60% being medium-chain fatty acids (MCFA), which contain 6 to 12 carbon atoms. The primary MCFA in CNO are lauric acid, myristic acid, and palmitic acid. While there has been considerable research on the potential benefits of CNO, no scoping review has specifically examined its use as an anti-obesity agent. Therefore, this scoping review aims to outline the characteristics and findings regarding the potential of CNO as an anti-obesity agent in both obese animal models and human subjects.

2. Method

The article selection followed the Preferred Reporting Items for Scoping Reviews (PRISMA-ScR) framework (Tricco *et al*., 2018), which includes steps for identification (searching databases using keyword combinations), screening (assessing titles and abstracts to exclude irrelevant articles and remove duplicates), eligibility (excluding articles that did not meet the inclusion criteria), and inclusion (selecting final articles for review).

2.1. Search strategy

A systematic search was conducted using a Boolean search strategy across multiple databases. The keyword combinations used in PubMed, Science Direct, Google Scholar, and SpringerLink were (“coconut oil” OR “Cocos nucifera”) AND (“medium chain triglycerides” OR “medium chain saturated fatty acids”) AND (obesity OR “weight loss” OR overweight). For searching Indonesian articles, we used Google Scholar and Portal Garuda; the keywords used were “minyak kelapa” AND “obesitas”. The search was filtered for articles published between 2011 and 2022.

The article selection process was based on predetermined inclusion criteria, which required articles to be written in English or Indonesian, published between 2011 and 2022, and categorized as original research with experimental study designs. Eligible studies involved either diet-induced obesity animal models or human subjects with obesity (Body Mass Index (BMI) ≥ 25 kg/m^2), regardless of age, gender, symptoms, comorbidities, or complications, and focused on investigating

the potential of coconut oil as an anti-obesity agent. Studies were excluded if they focused on populations not meeting the criteria (e.g., individuals without obesity or animal models not induced with diet-induced obesity), did not use coconut oil as the primary intervention, or were non-experimental studies such as reviews, meta-analyses, commentaries, case reports, or editorials.

2.2. Extraction and data charting

Articles that met the inclusion criteria underwent data extraction by two independent reviewers to minimize bias. The extracted data were compiled into a table in Microsoft Word, with data components including the author, year, country, study design, objective, total sample size, variables, key findings, and conclusions.

3. Result and discussion

3.1. Characteristics and study designs

A total of 656 articles were identified across all databases. After removing duplicates, 623 articles remained. Following a screening of titles and abstracts, 103 articles were considered potentially suitable. The eligibility assessment resulted in 80 full-text articles being reviewed, of which 8 met the inclusion criteria and were included in this review (Figure 1). Among these, 4 were preclinical studies conducted on obese animal models to report the effects of VCO at various doses, while the remaining 4 were clinical trials involving obese people, with 2 assessing the anti-obesity effects of VCO and 2 evaluating the effects of CNO.

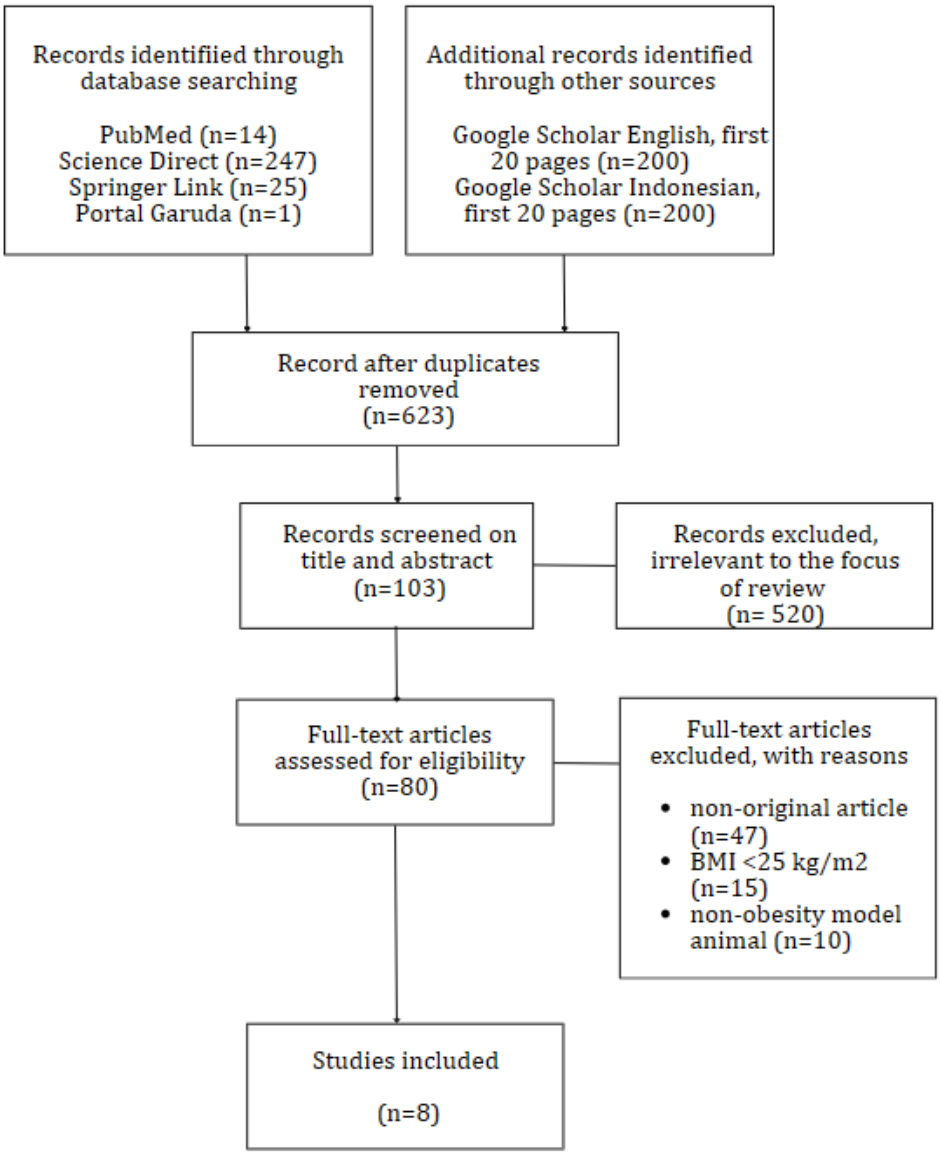

Figure 1. PRISMA-ScR flow diagram (Tricco *et al*., 2018)

Preclinical trials across four studies were conducted in Brazil and Nigeria between 2018 and 2020, involving male Wistar and BALB/c mice as experimental obese models (**Table 1**). The study designs included one multi-group pre- and post-test design (Romão-Carrascoza *et al*., 2019), two multi-group post-test-only design (Adeyemi, Olayaki, Abdussalam, Ige, et al., 2020; Zicker et al., 2018), and one of two-group post-test-only design (Ströher *et al*., 2019). The multi-group pre- and post-test study compared three groups (standard feed vs. high-carbohydrate diet (HCD) vs. HCD with added extra-VCO) (Romão-Carrascoza *et al*., 2019). Two studies employed a multi-group post-test-only design, divided the animal models into six groups (Adeyemi *et al*., 2020) and five groups (Zicker *et al*., 2018). VCO supplementation in Adeyemi's study was provided at doses of

200 mg/kg body weight (BW), 400 mg/kg BW, and 600 mg/kg BW. Zicker's study assessed high-refined carbohydrate (HC) diet with VCO at doses of 1000 mg/kg BW, 3000 mg/kg BW, and 9000 mg/kg BW. The two-group post-test-only study compared a group on an high-fat diet (HFD) with saline to a group on an HFD with VCO (Ströher *et al*., 2019).

Four human studies were conducted from 2018 to 2022 in Indonesia, Iran, Brazil, and Turkey, involving a total of 193 obese people (**Table 2**). The human trials involving VCO interventions used a quasi-experimental design with a pretest-posttest approach (Sinaga *et al*., 2021) and randomized controlled trials (RCTs) (Nikooei *et al*., 2020). The studies involving CNO interventions also employed RCT designs (Koc *et al*., 2022; Oliveira-De-Lira *et al*., 2018). Sinaga's study compared two groups of obese women: aerobic exercise alone vs. combined aerobic exercise with VCO consumption over an 8-week period (Sinaga *et al.*, 2021). The RCT conducted by Nikooei *et al.* used a stratified block randomization method to compare a group receiving a diet with ordinary daily oil and a group receiving VCO (Nikooei *et al*., 2020). Oliveira-de-Lira *et al.* performed a double-blind RCT comparing four groups: a soybean oil (placebo) group, a safflower oil group, a chia seed oil group, and a CNO group. Participants were instructed to reduce their caloric intake by approximately 500 kcal and engage in physical activity, specifically walking for at least 50 minutes, four times per week (Oliveira-De-Lira *et al.*, 2018). In contrast, Koc *et al.* used a two-phase cross-sectional RCT design. During the first phase, one group received CNO along with a hypocaloric diet, while the second group followed only a hypocaloric diet. In the second phase, the interventions were reversed across two groups (Koc *et al*., 2022).

3.2. Animal models

To establish obese mouse models, a HFD was administered for varying durations: 8 weeks (Zicker *et al*., 2018), 10 weeks (Romão-Carrascoza *et al*., 2019), 12 weeks (Ströher *et al*., 2019), and 16 weeks (Adeyemi, *et al*., 2020). Most of the animal models utilized in these studies are male Wistar rats. Female rats experience hormonal fluctuations during their estrous cycle, while male rats generally exhibit a more stable hormonal pattern (Leskanicova *et al*., 2020). The Wistar strain is commonly selected due to its calm and docile nature, as well as its low susceptibility to stress. Wistar rats also have small bodies, so they are easier to accommodate if large numbers are needed. Furthermore, Wistar rats possess a genetically homogeneous profile, thereby reducing confounding factors that could potentially influence the research outcomes (Krubaa & Yogitha, 2024).

3.3. Interventions

The VCO used in the preclinical trials varied in origin and preparation methods. One study used commercially available extra-VCO (Romão-Carrascoza *et al*., 2019). Adeyemi's study used VCO obtained from the Kwara State Ministry of Agriculture and Natural Resources in Nigeria, prepared by grinding coconut endosperm, mixing it with 400 ml of water, and allowing it to separate for one day, after which the supernatant oil was collected (Adeyemi *et al*., 2020). The VCO used by Ströher *et al.* was produced through a pressing and filtration process of coconut fruit (Ströher *et al*., 2019). In Zicker *et al.*'s study, the VCO was sourced from organic samples in Conde, Bahia, Brazil; however, no further details on its preparation were provided (Zicker *et al*., 2018). The differences in the source and preparation of this VCO pose a limitation in comparing the outcomes between studies. VCO and CO differ in several ways. VCO is obtained through the fermentation of fresh, mature coconut flesh, while CO is obtained from the extraction of dried coconut flesh. The purification process for VCO involves simple methods such as washing, settling, filtering, and centrifugation, whereas CO undergoes a refined, bleached, and deodorized (RBD) process. Unlike CO, the production of VCO does not involve heating, which allows VCO to retain a higher content of MCFA and antioxidants. In contrast, the heating process used in CO production breaks down many of the fatty acid carbon bonds and leads to the loss of antioxidants (Mela & Bintang, 2021; Suryani *et al*., 2020).

The duration of the VCO intervention was 4 weeks in three preclinical studies and only one study assessed the intervention for 30 days (Ströher *et al*., 2019). The doses of VCO varied in both quantity and measurement units. Two studies applied a single dose of VCO: 6 mg/100 g BW (Romão-Carrascoza *et al*., 2019) and 2 ml/kg BW (Ströher *et al*., 2019). The other two studies used multiple doses: 200 mg/kg BW, 400 mg/kg BW, and 600 mg/kg BW (Adeyemi *et al*., 2020), as well as 1000 mg/kg BW, 3000 mg/kg BW, and 9000 mg/kg BW (Zicker *et al*., 2018). The dosing units reported were mg/100 g BW, mg/kg BW, and ml/kg BW.

The interventions in human studies included the use of VCO (Nikooei *et al*., 2020; Sinaga *et al*., 2021) and CNO (Koc *et al*., 2022; Oliveira-De-Lira *et al*., 2018). The duration of VCO interventions ranged from 4 weeks (Nikooei *et al*., 2020) to 8 weeks (Sinaga *et al*., 2021), while CNO interventions were administered over 8 weeks (Koc *et al*., 2022; Oliveira-De-Lira *et al*., 2018). In the studies evaluating VCO, the oil was consumed directly at a dosage of 15 mL, 3 times per day (Sinaga *et al*., 2021) or used as a salad dressing or mixed into milk, tea, coffee, or other beverages

at a dosage of 30 mL/day (Nikooei *et al*., 2020). CNO was administered either directly at a dose of 20 mL/day (Koc *et al*., 2022) or in capsule form (Oliveira-De-Lira *et al*., 2018).

3.4. Anti-obesity effects of coconut oil supplementation

In studies involving obese mouse models, the primary parameters assessed were lipid profiles, including low-density lipoprotein cholesterol (LDL-C), very low-density lipoprotein cholesterol (VLDL-C), total cholesterol (TC), and triglycerides (TG). None of the studies evaluated weight loss in mice following VCO administration. Reported improvements in lipid profiles included reductions in LDL-C (Adeyemi *et al*., 2020), TC (Adeyemi *et al*., 2020; Ströher *et al*., 2019; Zicker *et al*., 2018), and TG (Adeyemi *et al*., 2020; Ströher *et al*., 2019; Zicker *et al*., 2018). However, some studies presented contradictory findings, with increases in LDL-C (Ströher *et al*., 2019) and in TG and VLDL-C (Romão-Carrascoza *et al*., 2019) following VCO administration.

A multi-group study with varied doses of VCO by Adeyemi *et al.* indicated that lower doses were more effective in improving obesity-related parameters in animal models. In contrast, high doses of VCO, which contain greater amounts of saturated fatty acids (SFA), were associated with increased cholesterol accumulation. This accumulation can damage the histological structure of the liver and vascular tissue, create an imbalance between antioxidants and prooxidants, and increase lipid peroxidation (Adeyemi *et al*., 2020; Rosqvist *et al*., 2019; Zicker *et al*., 2018). Apart from CNO, chia seed oil has also been reported to have a positive effect on lipid profiles (HDL-C, LDL-C, TC, and TG). An RCT included in this review demonstrated that chia seed oil resulted in better improvements in lipid profiles compared to CNO (Oliveira-De-Lira *et al*., 2018). Chia seeds are rich in α-linolenic acid (ALA) and linoleic acid (LA), which are known to increase HDL-C and reduce TG levels (Hrnčič *et al.*, 2020; Ullah *et al*., 2015).

In this review, the anti-obesity effects of VCO and CO are attributed to the properties of MCFA, which are absorbed more quickly and converted into energy more efficiently. MCFA can enhance thermogenesis, increase metabolic rate, boost energy expenditure, and promote satiety. VCO contains a higher concentration of MCFA than CO, contributing to its more pronounced anti-obesity effects. This is supported by research from Nevin and Rajamohan, which demonstrated that VCO was more effective than CO in reducing LDL-C, TC, and TG, while also increasing high-density lipoprotein cholesterol (HDL-C). Additionally, the high antioxidant content in VCO may help prevent LDL-C oxidation (Bueno *et al*., 2014; Deen *et al*., 2021; Nevin & Rajamohan, 2004).

The findings in this review indicate a trend of improvements in lipid profiles with the consumption of coconut oil, including increased HDL-C levels and decreased LDL-C, TC, and TG levels. The reviewed studies applied doses ranging from 30-45 mL/day for VCO and 20 mL/day for CNO for 8 weeks. However, there were inconsistent findings regarding the effects on LDL-C, TC, and TG levels. While some studies reported an increase in HDL-C levels in obese patients due to the high saturated fatty acid (SFA) content in VCO or CO, others found that the high SFA content also led to increased LDL-C and TC levels. These inconsistencies highlight the need for further research to clarify the effects of VCO and CO consumption, particularly concerning cardiovascular disease risk (Chinwong *et al*., 2017; Briggs *et al.*, 2017).

The primary parameter for assessing obesity was anthropometry, including measurements of BW, body height, BMI, waist circumference (WC), and waist-to-hip ratio (WHR). One study found that CNO consumption significantly reduced BW, BMI, WC, and WHR in obese patients (Oliveira-De-Lira *et al*., 2018). Participants consuming CNO showed the most substantial reductions in BW, BMI, WC, WHR, and the conicity index (CI) compared to those consuming safflower oil, chia seed oil, or soybean oil. This study also reported that CO consumption resulted in a weight loss of ≥5% in 94.4% of participants and a weight loss of ≥10% in 22.2% of participants, with statistically significant results ($p < 0.05$). In contrast, the studies by Koc *et al*. (2022) and Nikooei *et al*. (2020) found that VCO or CNO administration did not affect anthropometric parameters, and the study by Sinaga *et al*. (2021) did not report on these parameters. The potential effect of coconut oil on improving anthropometric parameters is attributed to the MCFA it contains, which are more rapidly absorbed and metabolized in the liver into energy, rather than being stored as fat in adipose tissue (Deen *et al*., 2021). Additionally, MCFA can enhance thermogenesis, the process of heat production from fat, leading to a reduction in body fat mass. Thermogenesis primarily occurs in brown adipose tissue, where its main regulator is uncoupling protein 1 (UCP1). Some studies have reported that MCFA can increase UCP1 expression, thereby enhancing thermogenesis (Dayrit, 2014; Ikeda & Yamada, 2020).

Lifestyle modification is the primary intervention for managing obesity. Three articles included in this scoping review reported that, in addition to interventions using VCO or CNO, subjects were also encouraged to adopt lifestyle modifications, including dietary adjustments and increased physical activity (Koc *et al*., 2022; Nikooei *et al*., 2020; Sinaga *et al*., 2021). Dietary regulation, such as calorie restriction or intermittent fasting, plays a crucial role in managing obesity. Alongside dietary changes, physical activity is another essential component of lifestyle modification. Physical

activity stimulates the release of epinephrine and norepinephrine, which promotes lipolysis, the breakdown of fat stores (Polak *et al*., 2008; Thompson *et al*., 2012).

The studies included in this scoping review present findings from both experimental animal and human research on the effects of coconut oil, particularly VCO, on obesity-related parameters. The strength of this scoping review lies in its focus on subjects with obesity, providing targeted insights into the potential anti-obesity effects of CNO and VCO. However, this review has some limitations. It only included articles published in English or Bahasa Indonesia, which may have resulted in the exclusion of relevant studies from other countries published in different languages. This restriction could potentially lead to missing valuable data and perspectives from a broader range of research.

4. Conclusion

This review highlights the potential of coconut oil, particularly in the form of VCO, as a supplement for managing obesity. VCO supplementation shows beneficial effects on lipid profiles and obesity-related parameters by leveraging its MCFA content. However, the findings also reveal inconsistencies, particularly regarding the impact of coconut oil on lipid profiles, such as LDL-C, TC, and TG, which underscore the need for further research. To optimize weight management and overall health outcomes, incorporating lifestyle modifications such as a balanced diet and regular physical activity alongside VCO supplementation is strongly recommended.

Table 1. Data extraction in preclinical trials

No.	Author, year	Country	Study design	Animal obese model	Intervention	Parameters	Key findings
1.	Romão-Carrascoza *et al*. (2019)	Brazil	Multi group pre and posttest design	Male Wistar rats (n = 35), obesity model with HCD	1. Saline 2. HCD + saline 3. HCD + extra-VCO 6 mg/100 kg BW, at 10.00 AM and 5.00 PM for 4 weeks	BW gain, adiposity index, adipocyte diameter, liver lipid contents, plasma lipid profile, glycemia, insulinemia, formation of AGEs	VCO supplementation decreases visceral adipocyte size, AGE formation, NAFLD, glycemia index, insulinemic index, liver lipid contents, and fructosamine level. VCO supplementation improves insulin levels, insulin sensitivity, VLDL-C, and TG.
2.	Adeyemi *et al*. (2020)	Nigeria	Multi group posttest only design	Male Wistar rats (n = 60), obesity model with HFD	1. Saline 2. HFD + saline 3. HFD recovery 4. HFD + VCO 200 mg/kg BW 5. HFD + VCO 400 mg/kg BW 6. HFD + VCO 600 mg/kg BW for 4 weeks	Hepatic histoarchitecture, blood glucose, insulin, insulin resistance, lipid profile (TC, TG, LDL-C, HDL-C), atherogenic index, Lee index, albumin, total protein, total bilirubin, liver enzyme (AST, ALT, ALP, GGT)	VCO, preferably at a low dose (200 mg/kg BW) improves hepatic structural alteration and biochemical deviations. VCO increases SOD and decreases LDL, TC, TG, LDL-C, atherogenic index, AST, and ALT. However, the MDA, IL-6, CRP level decreased.
3.	Ströher *et al*. (2019)	Brazil	2 group posttest only design	Male Wistar rats (n = 12), obesity model with HFD	1. HFD 2. HFD + VCO 2 ml/kg BW for 30 days	Biochemical parameters (TC, HDL-C, LDL-C, TG, glucose, ALT, AST), liver lipid contents, hepatic TC, hepatic TG, oxidative stress, histology (liver, adipose tissue, aorta)	HFD + VCO supplementation increases diet intake, LDL-C , TG, adipose inflammatory gene expression, AST and ALT levels, weight gain, hepatic fat accumulation, lipid peroxidation, and adipocyte hypertrophy. VCO reduces TC and glucose levels and increases oxidative stress parameters (SOD, CAT. GPx)
4.	Zicker *et al*. (2018)	Brazil	Multi group posttest only design	Male BALB/c mice (n = 40), obesity model with HC	1. Chow diet 2. HC 3. HC + VCO 1000 mg/kg BW 4. HC + VCO 3000 mg/kg BW 5. HC + VCO 9000 mg/kg BW	Adiposity levels, adipocytes size, VO_2, EE, RER, hematology (leukocytes, peripheral blood smear), epididymal adipose tissue, , blood glucose, TC, TG, ALT, AST, adipokine (chemerin, adiponectin, resistin, leptin), cytokine (TNF-α, IL-1β, IL-4, IL-6, IL-10, IL-13, TGF-β), hepatic and adipose tissue histology, total hepatic lipid	VCO supplementation improves metabolism abnormality (glucose homeostasis, serum lipid profile, hepatic steatosis, hepatic TC, TG, ALT), inflammatory response (leukocytes, mononuclear cell, TNF-α, IL-6, macrophage), and adiposity. VCO

No.	Author, year	Country	Study design	Animal obese model	Intervention	Parameters	Key findings
					4 weeks		supplementation has no effect on VO_2, EE, and RER.

high carbohydrate diet (HCD), virgin coconut oil (VCO), advanced glycated end-products (AGEs), non-alcoholic fatty liver disease (NAFLD), very low density lipoprotein cholesterol (VLDL-C), triglyceride (TG), total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (ALP), gamma glutamyl transferase (GGT), superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), malondialdehyde (MDA), low density lipoprotein (LDL), interleukin-6 (IL-6), C-reactive protein (CRP), high fat diet (HFD), high-refined carbohydrate (HC), oxygen consumption (VO_2), energy expenditure (EE), respiratory exchange ratio (RER), tumor necrosis factor alpha (TNF-α), interlukin-1 beta (IL-1β), interleukin-4 (IL-4), interleukin-10 (IL-10), interleukin-13 (IL-13), transforming growth factor beta (TGF-β),

Table 2. Data extraction in clinical trials

No.	Author, year	Country	Study design	Subject	Intervention and duration	Parameter	Key findings
1.	Sinaga *et al*. (2021)	Indonesia	Quasi-experimental design with pretest-posttest design	Obese women (n = 20), aged 43.55 ± 2.21, BMI 31.69 ± 1.63	1. VCO 15 ml 3x/day 8 weeks + aerobics 2. Aerobic	Triglyceride, cholesterol	Aerobic exercise and VCO supplementation can reduce TG dan TC levels.
2.	Nikooei *et al*. (2020)	Iran	Randomized controlled clinical trial	Male and female (n = 48), aged 20-50 years, metabolic syndrome	1. VCO 30 ml per day, consume it for mild cooking and salad dressing or mix with milk, coffee, tea, etc. (avoid overheating), 4 weeks 2. Placebo/control (routinely consumed oil)	Anthropometric (weight, height, BMI, WC), body composition (BFM, VFL, SMM), blood glucose, lipid profile (TC, TG, LDL-C, HDL-C, VLDL), ADMA	VCO supplementation increases HDL-C, LDL-C, ADMA, and TC levels and reduces TG and VLDL levels. VCO consumption has no effect on blood pressure, body composition, and anthropometry.
3,	Oliveira-De-Lira *et al*. (2018)	Brazil	Randomized, double-blind, placebo-controlled clinical trial	Women (n = 75), aged 20-40 years, BMI ≥30 kg/m^2 and ≤39,9 kg/m^2	1. Control = soybean oil capsule 2. Safflower oil capsule 3. Chia oil capsule 4. CNO capsule, 8 weeks	Weight, height, WC, BMI, WHR, %BF, %LM, %water, CI, TC, LDL-C, HDL-C, TG, HbA1c, TG/HDL ratio, MEG	CNO reduces abdominal fat, weight, BMI, WC, WHR, CI, %BF and improves glycemic parameters (HbA1c, MEG) and lipid profiles (TC, TG, LDL-C, HDL-C).
4.	Koc *et al*. (2022)	Turki	Randomized controlled trial, two-phase cross-sectional design	Adult (n = 44), aged19-30 years, BMI 25-29,5 kg/m^2	1. Hypocaloric diet + CNO 20 ml/day, 4 weeks in phase 1 and 4 weeks in phase 2	Weight, WC, BMI, detailed body analysis, WHC, TC, HDL-C, TG, LDL-C, insulin, irisin	CNO has no effect on anthropometric measurement (weight, BMI,

No.	Author, year	Country	Study design	Subject	Intervention and duration	Parameter	Key findings
					2. Control = hypocaloric diet		WHR). CO reduces level irisin, insulin, TC, and LDL-C.

virgin coconut oil (VCO),coconut oil (CNO) body mass index (BMI), total cholesterol (TC), triglyceride (TG), low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), very low density lipoprotein (VLDL), asymmetric dimethylarginine (ADMA), waist-to-height ratio (WHR), percentage of body fat (%BF), lean mass (%LM), conicity index (CI), hemoglobin A1c (HbA1c), mean estimated glycemia (MEG)

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