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Comparison of the effect of medium-chain fatty acids and long-chain fatty acids on postprandial appetite and lipemia: a randomised crossover trial

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ABSTRACT

Background Postprandial lipemia (PPL) has been recognised as a cardiovascular disease risk factor. Appetite and PPL can be influenced by the length of saturated fatty acids (FAs). Thus, this study aims to investigate if different FA chain lengths have different impacts on appetite and PPL in healthy volunteers.

Methods This is a randomised crossover single-blinded intervention study of 20 healthy adults. Coconut oil and palm oil were consumed in the form of biscuits. Blood serum samples were withdrawn after an overnight fast and 1, 2, 4 and 6 hours after eating the test meals and examined for blood lipid profile (total cholesterol (TC), high-density lipoprotein (HDL) and triglycerides (TG)), while Friedewald's equation was used to calculate low-density lipoprotein (LDL). Visual analogue scales were used by participants to rate their appetites, and an ad libitum meal was weighed to determine the energy intake.

Results The net area under the curve of TG and TC following the coconut oil were significantly lower than following the palm oil (*P* value ≤0.05). In the mean of the change in TC, LDL and HDL from the baseline, a significant difference was found after 6 hours of eating the biscuits (*P* value ≤0.05). The perceptions of hunger and fullness did not significantly differ between the two types of FAs. Also, the energy and macronutrient intakes were not significantly different after the two types of oil, neither at the ad libitum meal nor on the day following the treatments.

Conclusion The selection of FA chain length may influence PPL, and thus cardiovascular disease risk in a way that is functionally significant. However, this study detected no influence of FA chain length on appetite up to 40 hours post-treatment.

Trial registration number NCT05539742.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Several studies have found conflicting results when it comes to the effect of medium and long-chain fatty acids (FAs) on postprandial lipemia and appetite.

WHAT THIS STUDY ADDS

⇒ Consumption of medium-chain triglycerides (MCTs) rather than long-chain triglycerides resulted in decreased postprandial triglyceride and total cholesterol.

⇒ However, this study did not find any influence of MCTs on perceptions of hunger, fullness and desire to eat.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ It may aid in ameliorating one of the established risk factors for coronary heart disease.

⇒ It may open new avenues for increasing awareness of the impact of dietary FAs on the regulation of food intake and appetite.

INTRODUCTION

Over the past decades, dietary saturated fatty acids (SFAs) have repeatedly been connected to negative health impacts including dyslipidaemia and chronic illnesses;[1] however, a variety of investigations revealed diverse findings, indicating a complexity in the association between SFA and health consequences.[2–4] The contradictory findings could be linked to factors other than the saturation degree, such as the fatty acid (FA) chain length.

Postprandial lipemia (PPL), which is defined by the elevation in blood triglyceride (TG)-rich lipoproteins after consuming a meal, has been determined to be a risk factor for cardiac disorders.[5] Since the bulk of each day is spent in the postprandial condition, it is critical to understand how various dietary FAs affect the postprandial metabolic processes of lipids.[1] FAs with longer hydrocarbon chain lengths have a lower water solubility. Consequently, in terms of digestion, uptake and metabolism, medium-chain triglycerides (MCTs) differ greatly from long-chain triglycerides (LCTs). The digestion and absorption of the latter are complicated and require several steps,[6] while MCTs are readily digested and absorbed by the intestinal mucosa's villi and are delivered to the liver via the portal circulation, where oxidation occurs.[7] Therefore, it has been hypothesised that

medium-chain FAs (MCFAs) ingestion does not augment postprandial TG as much as long-chain FAs (LCFAs) as influenced by the variations in the rate of postprandial TG formation and elimination in the blood.[5]

Additionally, variations in hunger and satiety signals, which can impact appetite, may also result from changes in FA chain length or saturation degree in experimental meals or regimens.[8] The content of dietary fat controls the secretory activity of several orexigenic or anorexigenic stimulators and thus influences how much food is ingested.[9] The current evidence is conflicting regarding the effect of MCT and LCT on appetite and food intake. However, there is a potential stream indicating the ability of MCFAs to suppress appetite and urge to eat due to its impact on postprandial peptide YY hormone levels, one of the gut hormones that is associated with satiety.[10] Also, the faster absorption of MCT than LCT results in significant levels of β-oxidation and the generation of β-hydroxybutyrate, which is hypothesised to suppress the appetite.[11]

Thus, the current study is conducted to investigate if foods high in MCFA or LCFA have different impacts on appetite and postprandial blood lipid levels in healthy men and women within the framework of their regular diet. The significance of this study is established as it could help increase the awareness of the impact of dietary FAs on one of the established risk factors for coronary heart disease as well as on the regulation of food intake and appetite.

METHODS

Study design

This is a randomised crossover single-blinded postprandial intervention study with two test days. Test days were separated by a 1-week washout interval, and each test day lasted 6 hours. Using computer-generated tables, all subjects were randomly assigned to one of the experimental meals by the principal investigator. Participants were blinded to the received treatment as well as the principal investigator. This study was conducted at the University of Jordan's student clinic in Amman, Jordan, by a research coordinator.

Study population

The study population included 20 healthy adults (10 males and 10 females) aged between 18 and 35 years. Participants were excluded if they were consuming lipid-lowering drugs or any medication that might affect appetite; had regular consumption of any supplement that may affect lipid metabolism or appetite regularly for the past month; had body mass index (BMI) <18.5 or > 24.9; had regular consumption of two or more fish meals a week over the previous month; had any history of diabetes, gastrointestinal, liver disease, congestive heart failure, stroke, myocardial infarction, coronary artery bypass graft or established atherosclerotic disease; were athletes; being on a diet or lifestyle changes for the past month; had a regular consumption of coconut oil (CO) or palm oil (PO); were current smokers; or were pregnant or breastfeeding. Social media was used to announce the experiment and to recruit volunteers. Figure 1 is a flow diagram of the study participants.

Experimental protocol

This study included two types of fat: CO (source of MCTs) and PO (source of LCTs). Each test oil was given to each participant in the amount of 40 g, in the form of standard biscuits. Biscuit recipes were analysed using Food Processor Nutrition Analysis software (ESHA's Food Processor SQL, V.11.2; Salem, OR, USA). Each serving of the biscuits contains 21.30 g of fat (CO or PO), 29.72 g of carbohydrates and 4.12 g of protein. Biscuits were prepared by the research coordinator the day before the experiment in the metabolic kitchen, and all ingredients were weighed exactly using a food scale. The biscuits were then baked at 180°C. Each participant had 15 min to consume two servings of biscuits of the corresponding treatment per each experimental day with 250 mL of water. No other food was consumed during the study period (6 hours).

Participants were instructed to maintain their normal dietary intake and avoid severe physical activity on the day before each test day. Additionally, participants were instructed and reminded (via phone calls) to eat a standard evening meal before each test day. The standard evening meals were prescribed to participants as part of their habitual diet and were comparable in calories, carbohydrates, protein and fat for males (381 kcal, 50 g, 22 g and 11 g, respectively) and females (307 kcal, 40 g, 21 g and 7 g, respectively). The importance of keeping their dietary intake consistent until the completion of the trial was reinforced on several occasions. Additionally, participants were asked to complete a 24-hour food recall at each appointment, to ensure that they consumed comparable dietary intakes as well as the standard evening meals before each test day. Pictures, measuring tools and food models were used to help the participants better estimate their dietary intake. The participants were instructed to avoid food sources that contain PO or CO during the washout period. Females were not examined during their menstruation.

Appetite sensations (hunger, fullness and desire to eat) were measured using a visual analogue scale (VAS) every half hour following the consumption of the test meal.[12 13] After that, participants were allowed an ad libitum intake of standard meals. This meal was provided to assess the effects of CO versus PO on the satiety of participants by measuring the actual amount consumed from the standard meal in an ad libitum condition. The energy and macronutrient analysis of the ad libitum meals is shown in table 1. No CO or PO was used in these meals. Each meal was weighed before and after being consumed, and the amount of food ingested was calculated. The day following the experiment, participants were asked to fill

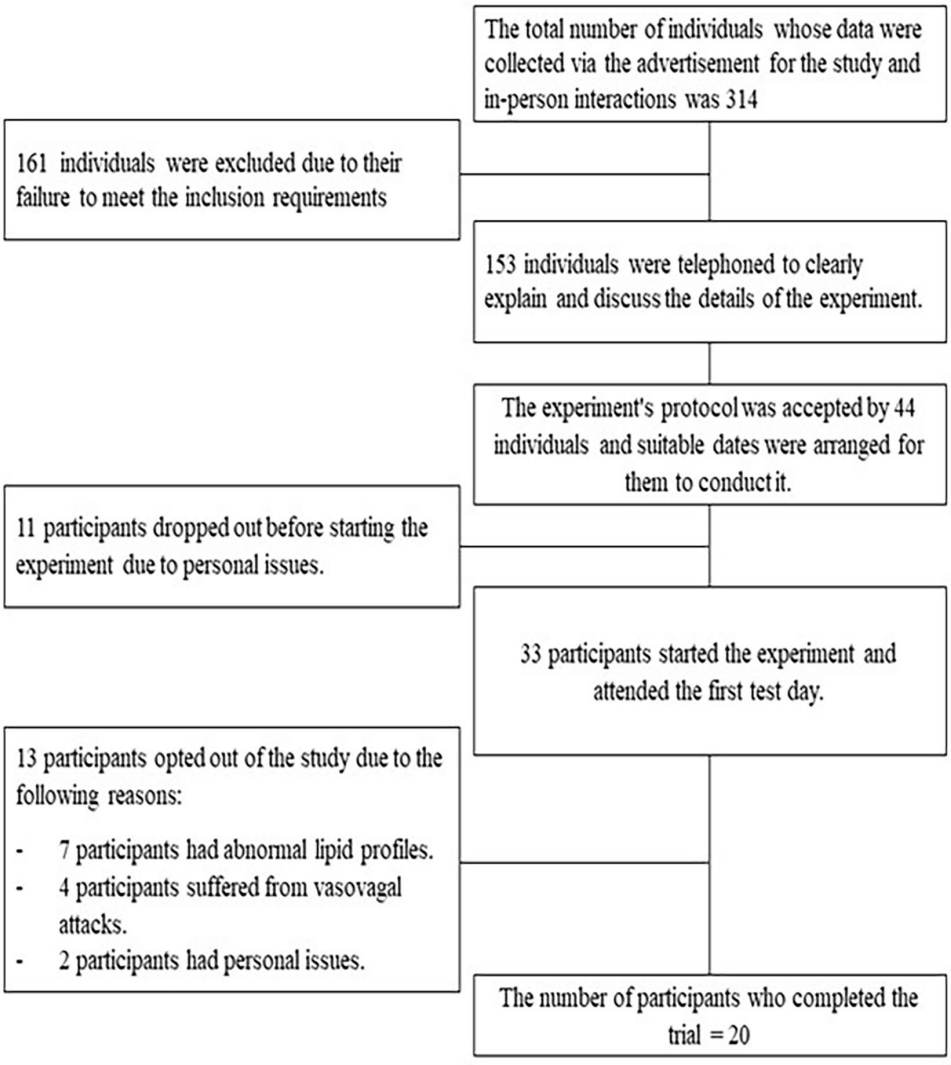

Figure 1 The total number of individuals whose data were collected and the final number of the sample.

out a food record to assess if meals high in CO or PO have a longer impact on their (intake) appetite.

The composition of treatment oils

The composition of treatment oils was tested using the gas chromatography spectrum in the laboratory of the Human Nutrition and Food Technology Department at the University of Jordan as per the previously published method.[14 15]

CO consisted of more than 90% of the SFAs. More than 50% were MCFA (C8:0, C10:0 and C12:0), while about 30% were LCFA (C14:0, C16:0 and C18:0). The percentages of monounsaturated fatty acid (MUFA) (C18:1) were 7.42%, while the percentage of polyunsaturated fatty acid (PUFA) (C18:2) was 1.74%. Around 47% of PO's FAs were LCFA (C14:0, C16:0 and C18:0), and more than 50% were unsaturated (C18:1, C18:2 and C18:3).

Table 1 The energy and macronutrient analysis for 100 g of the ad libitum meal*

Type of pizza	Energy (kcal)	Fat (g)	Carbohydrate (g)	Protein (g)
Barbecue chicken	244.82	6.12	36.72	11.37
Pepperoni	244.19	11.63	24.42	11.63
Margherita	240.00	11.00	21.50	13.50
Vegetables	218.49	10.08	25.21	8.40

*The analysis of ad libitum meal composition. The analysis was performed using Food Processor Nutrition Analysis software (ESHA's Food Processor SQL, V.11.2; Salem, OR, USA).

Sample collection and analysis

Participants visited the University of Jordan's clinic on test days after 10 hours of fasting. An expert nurse inserted the cannulas and blood serum samples (3 mL) were withdrawn after an overnight fast and at 1, 2, 4 and 6 hours after the consumption of the biscuits. Blood samples were centrifuged for 10 min at 3500 rpm to separate the serum and then stored at −40°C until further analysed. Total cholesterol (TC), high-density lipoprotein (HDL) and TG were measured using the Roche Cobas C501 analyser (enzymatic colorimetric method). Low-density lipoprotein (LDL) was calculated using Friedewald's equation (LDL=TC- HDL- (TG/5)).

Visual analogue scale (VAS)

Each participant received a detailed explanation of the VAS questions and their scale. The VAS is valid tool to assess hunger and satiety.[13] Ratings were determined by selecting a number between 1 and 7, anchored at either end by statements; 'I'm not hungry/not hungry/not appetising at all' on the left and 'I'm starving/extremely/extremely appetising' on the right.

Statistical analysis

The sample size was calculated to estimate the significance of the area under the curve (AUC) of 256 mg*h/dl and α=0.05 and power of 20% in TG level between the two treatments, taking into consideration the 35% dropout ratio.[16] All data were analysed using IBM SPSS Statistics (V.22) predictive analytics software, and results were presented as mean±SD. Statistical significance was set at $p<0.05$. The trapezoidal rule was used to determine the net AUC for postprandial levels of blood lipid and the VAS questions. The differences in study variables associated with different treatments were examined using one-way analysis of variance (ANOVA) with a crossover design. One sample t-test was used to ensure that there were no significant differences between the evening meal consumed by the participants and the standard meal. Gender and BMI were added as covariates. All missing values were labelled as missing in SPSS.

RESULTS

A total of 20 individuals participated in this study (mean age 21±2.44 years). Ten males and 10 females completed the study protocol. Demographic and clinical characteristics of participants are presented in online supplemental table 1.

Biochemical measurement

The AUC of the postprandial change in plasma lipid levels (TG, TC, LDL and HDL) over a period of 6 hours following consumption of the PO and CO is shown in figure 2. Between test days, there were no statistical differences in the TC, LDL, TG and HDL concentrations at fasting. The means AUC for TC (895.7±114.81 mg/dL and 926.90±124.75 mg/dL, respectively; p=0.024) and TG (566.20±155.89 mg/dL and 687.80±142.91 mg/dL, respectively; p=0.001) were significantly lower following CO compared with PO. No significant differences were found in the net AUC for the other lipid biomarkers.

Table 2 shows the differences in biomarkers of the lipid profile at each time point from the baseline for both types of oils. Following 6 hours of eating the biscuits, levels of TC, LDL and HDL significantly differ from baseline concentrations. Furthermore, after 2 hours of eating the biscuits, there was a significant difference in the mean of the change in TG and LDL from the baseline.

Measuring food intake and appetite

There were no significant differences between the evening meals of the study participants and the standard meal as demonstrated in table 3. After both types of oils, the means of AUC for the sensation rates as reported by the VAS were not significantly different. Figure 3 shows the AUCs of the multiple VAS scales that have been collected following the consumption of PO and CO over 6 hours.

Further, the study treatment did not affect the amount consumed at the ad libitum meals following each treatment (PO=466.60 g ±186.98; CO=468.52 g±151.73; p=0.438) (PO=1103.99±441.86; CO=1106.57±354.48; p=0.468). Regarding the long-term effect of treatment oils on appetite and hunger as measured by the food record of the day following the test days, there was no significant difference in the energy and macronutrient intakes following each treatment.

DISCUSSION

This study investigated if foods high in MCFA (CO) or LCFA (PO) have different impacts on appetite and postprandial blood lipid levels. The findings of this study revealed that, despite being categorised as SFAs, dietary MCFAs resulted in decreased postprandial TG responses compared with LCFA. In agreement with our findings, other studies found that MCFA (CO) intake resulted in reduced PPL compared with LCFA (lard and cocoa butter) in healthy adults.[1 17] Additionally, Kasai *et al*[18] found that the levels of TG, chylomicrons and very LDLs (VLDLs) after two and 3 hours following the ingestion of MCT were significantly lower than those following LCT in healthy males. Contrarily, other studies did not discover a significant difference between CO and PO in the TG response[19 20] However, in a recent study done on hypertriglyceridaemic patients and healthy controls, the test meals containing MCFA did not result in a postprandial rise in mean plasma TG, whereas test meals containing short-chain FAs (butter) or MUFA (rapeseed oil) negatively impacted postprandial TG.[16]

Our results supported the notion that the health effects of LCT and MCT are modulated by the disparate pathways of utilisation and metabolism of these dietary fats. The MCFAs are readily digested and absorbed by the intestinal mucosa's villi, and then they are delivered to the liver via the portal circulation, where oxidation occurs

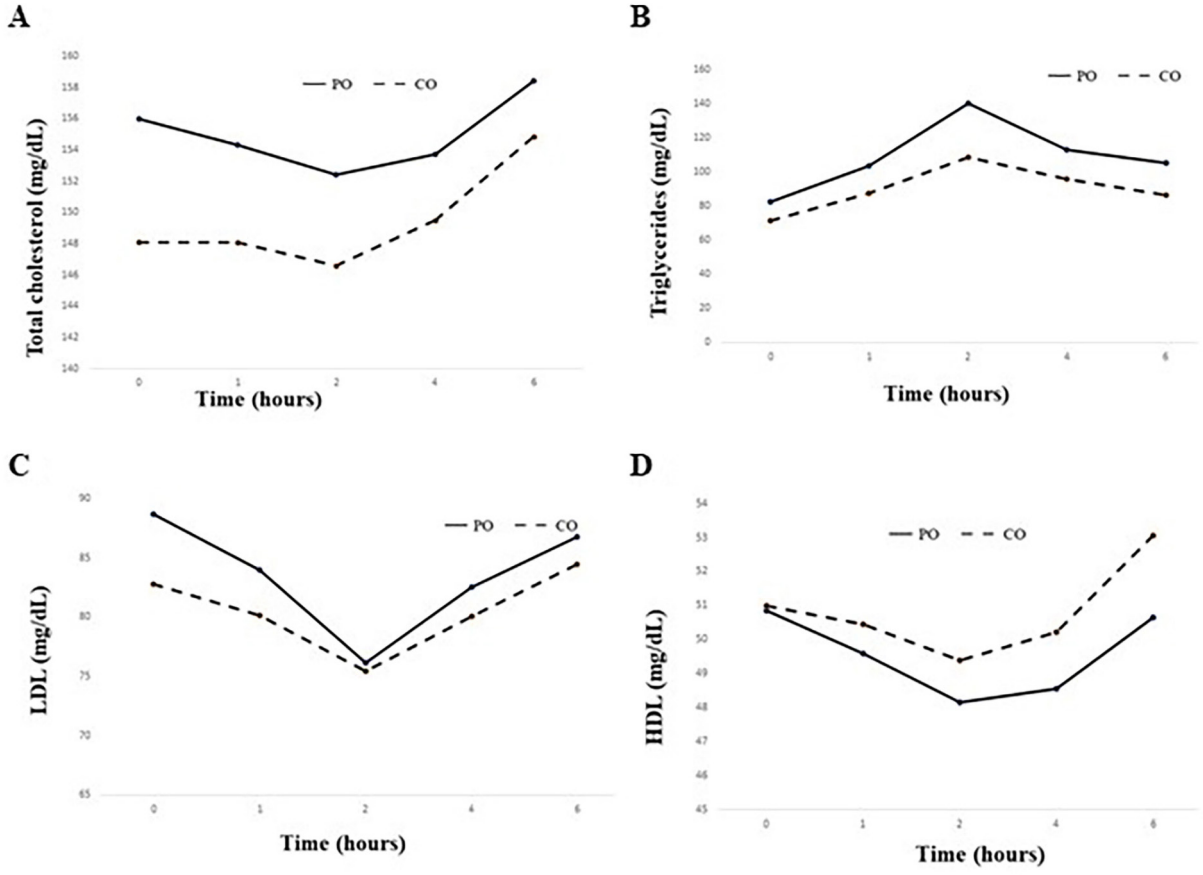

Figure 2 The area under the curve of the postprandial change in plasma levels of (**A**) total cholesterol, (**B**) triglycerides, (**C**) low-density lipoprotein (LDL), and (**D**) high-density lipoprotein (HDL) over 6 hours following consumption of the palm oil (PO) and coconut oil (CO). A one-way analysis of variance with a crossover design was used to detect the differences between the treatment oils. The statistical significance was set at p≤0.05. n=20.

with limited conversion into TG packed within chylomicrons.[7 18] On the other hand, LCFAs and monoglycerides are re-esterified TGs inside the enterocytes and are delivered by chylomicrons to the blood circulation.[6] The various health effects mediated by chain length could also be related to the levels of apolipoprotein B-48 or apolipoprotein B-100, the key transporters of cholesterol and TG throughout the body.[21] In a study on the impact of MCFA on the secretion of VLDL in chicken hepatocytes, it was suggested that MCFAs reduced the secretion of VLDL-apolipoprotein B by controlling the transcriptional expression of apolipoprotein B mRNA, resulting in a reduction in the synthesis of TG-rich chylomicron.[22] Furthermore, MCFAs are oxidised quickly, which reduces hepatic TG formation, VLDL release, and postprandial TG concentrations.[1]

There was no difference in the peak plasma TG concentrations between MCT and LCT after consuming both types of oils, as TG peaked 2 hours after consumption of each type. Comparable outcomes were shown by other studies[1 18 23] which might suggest that different chain lengths of SFAs may affect the magnitude of PPL more than the onset of TG appearance. Our findings showed that MCT and LCT peaked 2 hours after the consumption. A previous study found similar results regarding the MCT peak time following the consumption of MCFA-rich meal, but it was different for LCFA, where TG peaked 4 hours after consumption of LCFA-rich meal.[17]

In line with our study, Karupaiah *et al*[17] showed that the difference in AUC for LDL between LCFA and MCFA was not significant. However, similar to Panth *et al*,[1] our research showed that the levels of LDL dropped from the baseline after the consumption of both kinds of oils. At 2 and 6 hours after the administration of LCTs, the levels of LDL were significantly lower than MCTs. This reduction could be explained by the transport of cholesterol esters during PPL from HDL, LDL and cell membranes to the chylomicrons and then to the liver via the activities of cholesteryl ester transfer protein and lecithin cholesterol acyltransferase.[24] The drop in LDL levels was found to be accompanied by an elevation in VLDL and chylomicrons postprandially, which further supports the aforementioned explanation.[25] According to the available evidence, the higher postprandial rise in TG after LCT consumption significantly decreased LDL, while the lower increase in TG after MCT consumption slightly decreased LDL.[1]

The HDL levels decreased after ingesting both types of oil, but 2 hours later, they started to rise again; also, the AUC for HDL was not significantly different between

Table 2 The effect of palm oil versus coconut oil on the changes in lipid profile from the baseline at several time points

Biochemical markers	Time point	PO (mean±SD)	CO (mean±SD)	P value
TC (mg/dL)	After 1 hour	−1.65±5.30	0.00±5.36	0.319
	After 2 hours	−3.60±5.38	−1.50±6.83	0.328
	After 4 hours	−2.25±5.98	−6.05±31.11	0.620
	After 6 hours	2.45±6.38	6.75±6.15	**0.004**
HDL (mg/dL)	After 1 hour	−1.25±1.80	−0.55±2.08	0.163
	After 2 hours	−2.70±1.68	−1.60±2.79	0.146
	After 4 hours	−2.30±2.51	−3.30±11.01	0.700
	After 6 hours	−0.20±2.52	2.05±2.32	**0.000**
LDL (mg/dL)	After 1 hour	−4.72±5.56	−2.62±4.93	0.177
	After 2 hours	−12.54±6.51	−7.32±6.05	**0.011**
	After 4 hours	−6.12±5.45	−6.70±16.70	0.893
	After 6 hours	−1.91±6.67	1.66±4.93	**0.032**
TG (mg/dL)	After 1 hour	21.60±16.26	15.85±15.96	0.074
	After 2 hours	58.20±25.15	37.10±17.65	**0.000**
	After 4 hours	30.85±20.72	19.75±26.14	0.068
	After 6 hours	22.80±40.17	15.20±25.00	0.383

*A one-way analysis of variance with a crossover design was used to detect the differences between the treatment oils. Data are presented as mean±SD. The statistical significance was set at p≤0.05. Total n=20.
CO, coconut oil; HDL, high-density lipoprotein; LDL, low-density lipoprotein; PO, palm oil; TC, total cholesterol; TG, triglyceride.

LCTs and MCTs. These results were consistent with the findings of Karupaiah *et al*[17] and Panth *et al*,[1] respectively. Similar to LDL, this behaviour can be explained by the transfer of cholesterol ester from HDL to chylomicrons as a result of enhanced cholesteryl ester transfer protein activity, which results in a postprandial drop in HDL and an increase in chylomicrons. Furthermore, during PPL, hepatic lipase activity rises, catalysing the breakdown of both HDL and LDL into smaller, denser HDL and LDL particles,[25] particles that may contribute to an increased risk of CVD.[26]

Also, this research detected a significant increase in HDL levels after consuming the MCTs compared with the LCTs at 6 hours. The increment in HDL levels was demonstrated in long-term research and reported in a recent systematic review and meta-analysis showing that regular MCFA consumption increased HDL and apolipoprotein A-1 values relative to LCFA intake.[27] A proposed mechanism mentioned by Santos *et al*[28] is that even though lauric acid is MCFA, only 30% of it is transmitted as MCFA; the remaining 70% is delivered as LCFA. The transfer of lauric acid to the liver serves as a substrate for

Table 3 The analysis of the evening meals of the study participants before each test day

Gender	Variables	Standard meal	PO (mean±SD)	P value*	CO (mean±SD)	P value
Females	Calories (kcal)	307	265±119.81	0.304	308.80±98.60	0.955
	Carbohydrates(g)	40	33.20±18.28	0.270	40.20±11.65	0.958
	Protein (g)	21	15.50±8.86	0.081	16.30±12.91	0.280
	Fat (g)	7	7.70±6.83	0.753	9.20±5.43	0.232
Males	Calories (kcal)	381	376.75±65.06	0.859	388.75±97.68	0.829
	Carbohydrates(g)	50	50.12±10.49	0.974	53.81±10.94	0.357
	Protein (g)	22	19.50±5.52	0.242	17.87±5.95	0.091
	Fat (g)	11	11.25±3.65	0.852	11.50±5.44	0.803

*One sample t-test was used to ensure that there were no significant differences between the evening meal consumed by the participants and the standard meal. Data are presented as mean±SD. The statistical significance was set at p≤0.05. Total n=20.
CO, coconut oil; PO, palm oil.

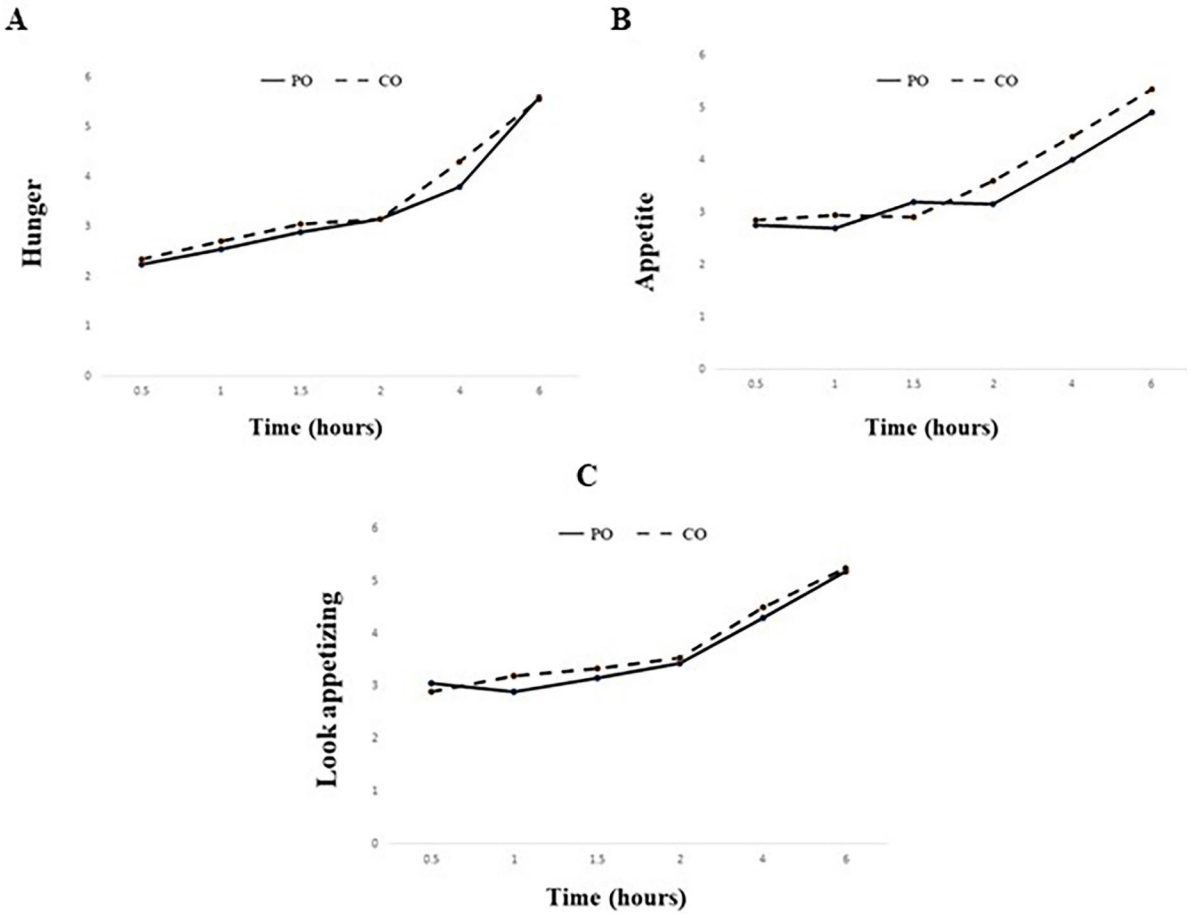

Figure 3 The area under the curve of (**A**)hunger, (**B**) appetite and (**C**) look appetising as obtained from the visual analogue scale following the consumption of palm oil (PO) and coconut oil (CO) biscuits over 6 hours. A one-way analysis of variance with a crossover design was used to detect the differences between the treatment oils. The statistical significance was set at p≤0.05. n=20.

synthesising apolipoprotein A-1 and apolipoprotein-B, which furthers the production of HDL and LDL particles. An additional explanation is that the consumption of lauric acid increases HDL concentrations by decreasing HDL and apolipoprotein A-I catabolism and increasing reverse cholesterol transfer.

Our study showed that the net AUC of TC following the MCTs was significantly lower than that following the LCTs. A similar finding was obtained in an animal study where MCT reduced serum cholesterol concentrations partially by inhibiting the expression of ileal lipid binding protein, an important protein in the transfer of bile acids via intestinal epithelial cells.[29] However, the data are not consistent.[1 17] The increase in TC observed 6 hours after consuming MCTs was proportional to the increases in LDL and HDL.

Regarding the effects of LCFA and MCFA on food intake and appetite, this study found that perceptions of hunger, fullness and desire to eat did not significantly differ between MCFA and LCFA. Also, the energy and macronutrient intakes were not significantly different after the two types of oil, neither at the ad libitum meal nor on the day following the treatments. Poppitt *et al*[19] investigated the impact of short-chain triglyceride, MCT and LCT on satiety and food intake in lean males. An ad libitum lunch meal was weighed to evaluate the energy intake 3.5 hours after consuming the test breakfasts, and VAS was used to assess the feeling of hunger. They showed that there was no difference in caloric or macronutrient consumption at lunches between test meals and that there was no significant influence of FA chain length on measures of hunger and satiety. Nguo *et al*[30] found no appetising differences between a meal high in short-chain FA/MCFA and a meal high in LCFA. A finding that disagrees with Matzinger *et al*[31] and Feltrin *et al*[32] who reported a significant decrease in calorie consumption and appetite following FAs with longer chains in healthy males. A critical stage in the suppression of appetite brought on by fat is the formation of LCFAs through fat hydrolysis with a signal being carried by cholecystokinin receptors. In a different, longer trial that lasted 4 weeks and involved overweight participants, there was no significant difference between postprandial satiety after taking MCT and LCT.[33] On the other hand, a recent randomised crossover study discovered that CO consumption compared with olive oil may have a suppressive action on appetite and urge to eat due to its impact

on postprandial peptide YY hormone levels, one of the gut hormones that is associated with satiety.[10]

Evidence is conflicting regarding the effect of MCT and LCT on appetite and food intake. However, in our study, some factors may have influenced the participants' appetite and ad libitum meal intake. One is that the volunteers may have been tired out by the prolonged trial and multiple blood draws, which may have influenced their emotions and, in turn, their appetite. Also, despite our best efforts to control them, additional environmental factors, such as the hot weather and uncomfortable long duration, may have had an impact on participants' hunger. Furthermore, a larger sample could be needed to measure appetite because the sample used in the study was calculated to detect PPL and did not consider appetite. Finally, the meal was offered 6 hours after the biscuits were consumed, which may have been long enough for the two oils to have had an equal impact as, in both situations, the participants were truly hungry. In addition to these limitations, the use of the 24-recall is mainly reliant on the participants' memory; however, measuring tools, pictures and food models were used to help the participant better estimate their portion size. Additionally, the actual trial was held after 10 hours of fasting which could have reduced the major possible effect of the previous meal on TG levels. The major strength point of this controlled trial is the crossover design which eliminated inter-individual variations because each subject served as their own control and enhanced the power of the results. However, larger controlled trials with longer durations are warranted to measure the effect of different FAs consumption on lipid profile and appetite control.

CONCLUSIONS

We found that in healthy young (aged between 18 and 35 years) population, consumption of MCTs rather than LCTs resulted in decreased postprandial TG and TC. The elevation in postprandial TG influences the risk of cardiovascular disease through several pathways, including the infiltration of TG-rich lipoproteins into the arteries, endothelial dysfunction and the lipotoxic state, which includes the stimulation of various inflammatory biomarkers.[5 21 34] As a result, the selection of FA chain length may influence CVD risk in a functionally significant way. However, this study detected no influence of MCTs on perceptions of hunger, fullness and desire to eat up to 40 hours post-treatment. Future studies are required to assess how MCFA and LCFA affect hyperlipidaemic patients and CVD-risk individuals and to detect the underlying mechanism of the effect of MCFA and LCFA on PPL.

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Contributors The authors' responsibilities were as follows: RJ was responsible for running the clinical trial and data collection and entry. RJ and SSH performed data interpretation and analysis and drafted the manuscript. SSH designed the project and supervised the study. SSH is the guarantor.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Institutional Review Board's at the University of Jordan (approval # 44-2022). Participants gave informed consent to participate in the study before taking part.

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Data availability statement Data are available upon reasonable request. Data will be available upon reasonable request from the corresponding author.

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