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Avocados (monounsaturated fatty acids), weight loss and serum lipids

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ABSTRACT

The consumption of diets enriched with monounsaturated fatty acids have been related to a lower rate of coronary heart disease, mainly due to their positive effects on serum lipids. The avocado is a fruit rich in monounsaturated fatty acids and other nutrients, offering protection against coronary heart disease. This article will review the scientific evidence on avocados, and their impact on weight loss and serum lipids.

INTRODUCTION

There is epidemiological evidence that increasing dietary monounsaturated fatty acids (MUFA) may decrease the risk of coronary heart disease (CHD). Moreover, evidence from controlled clinical studies has shown that a diet high in MUFA favourably affects a number of risk factors for CHD, including plasma lipids and lipoproteins, factors related to thrombogenesis, *in vitro* low density lipoprotein (LDL) oxidative susceptibility (compared to polyunsaturated fatty acids), and insulin sensitivity.[1] This article will focus on the effects of MUFA on plasma lipids.

Elevated blood concentrations of total cholesterol or LDL cholesterol (LDL-C) increase the risk of cardiovascular disease (CVD), whereas higher concentrations of high density lipoprotein cholesterol (HDL-C) decrease risk. Elevated concentrations of circulating triglycerides (TG) have also been shown to be an independent risk factor for CVD.[2] In comparison with a diet high in saturated fatty acids (SFA), a high MUFA diet decreases LDL-C and TG levels and increases HDL-C levels.[1,3]

Avocados are a rich food source of MUFA, with a MUFA content of 15.63 g per 100 g of avocado.[4] The MUFA, oleic acid (C18:1), is the most prevalent MUFA in the diet, and contributes to 58.6% of the total fatty acids content found in avocados.[5] The high concentration of MUFA (oleic acid) in avocado suggests that a diet rich in avocado may have beneficial effects on blood lipids, and could play a significant role in protecting against the development of CHD.[6]

The first study concerning the health benefits of avocados was published in 1960, investigating the cholesterol-lowering effect of avocados.[7] This study stimulated new research on avocados, resulting in the publication of six other studies on the lipid-lowering effect of avocados.[6,8-12]

Health profile of the avocado

Avocados meet the definition of a functional food as outlined by the American Dietetic Association (ADA) Position Statement in that they provide health benefits beyond basic nutrition.[13] The avocado is a nutrient dense, cholesterol-free fruit, which is low in sodium and can be considered to be a source of fibre. The nutritional information of avocados is given in Table 1. New research from the University of California, Los Angeles, indicates that California avocados have nearly twice as much vitamin E as previously reported, making avocados the highest fruit source of this powerful antioxidant.[14] Love and Sayed have also identified avocados as a food that may protect against disease, due to its vitamin E content.[15]

According to the vegetable and fruit composition tables of South African food, avocados are the forth-highest fruit source of lutein among fruit.[4] Lutein is a carotenoid which improves visual performance in patients with age-related cataracts as demonstrated by Olmedilla *et al* in a two year double-blind, placebo-controlled pilot study, where patients consumed 15 mg of lutein three times a week. Similar results were also previously reported by other authors.[18]

The avocado provides more beta-sitosterol than any other fruit with known value.[19] Beta-sitosterol is the most abundant phytosterol found in avocados and function as an anticholesterolemic agent.[17] On a gram-per-gram basis, avocados contain more than four times the beta-sitosterol of oranges, which have previously been reported as the richest known fruit source of beta-sitosterol.[19]

Avocados and weight loss

Obesity is considered a risk factor for the development chronic diseases. A 20% increase in body weight substantially increases the risk for hypertension, coronary artery disease, lipid disorders, and non-insulin-dependent diabetes mellitus.[20] The prevalence of obesity is common among South African

Table 1. Nutritional information of avocados (per 100 g edible portion)

	Amount	
	South African[4,5]	USDA[16]
Energy (kJ)	1021	741
Protein (g)	1.7	2.11
Carbohydrates (g)	1.9	6.91
Fibre (g)	5.3	4.9
Fat (g)	23.5	17.33
Monounsaturated fatty acids (g)	15.63	11.21
Polyunsaturated fatty acids (g)	3.04	2.041
Saturated fatty acids (g)	4.82	2.59
Cholesterol (g)	0	0
Vitamin A (RE) (μg)	61	61
Vitamin C (mg)	14	7.9
Vitamin E (mg)	1	1.34
Thiamine (mg)	0.04	0.108
Riboflavin (mg)	0.03	0.122
Niacin (mg)	1.6	1.921
Folate (μg)	29	66
Magnesium (mg)	31	41
Iron (mg)	0.4	1.18
Potassium (mg)	583	634
Lutein (μg)	169	-
Beta-Sitosterol (mg)[17]	76	

USDA: United States Department of Agriculture
SA: Figures from MRC Food Composition Tables

Table 2. Comparison of high-fat dietary sources. [4,5]

	Avocado		**Margarine** (Brick / Hard)		**Margarine** (Med fat, spread)		**Mayonnaise**		**Cream** (Canned)		**Cream cheese**		**Cheese** (Cheddar)	
	Per 100g serving	Per 30g serving	Per 100g serving	Per 5g serving	Per 100g serving	Per 5g serving	Per 100g serving	Per 5g serving	Per 100g serving	Per 15g serving	Per 100g serving	Per 20g serving	Per 100g serving	Per 30g serving
Kilojoules (kJ)	**1021**	**309**	2975	149	1882	94	2165	108	905	135	1466	293	1646	499
Fat (g)	**23.5**	**7.1**	80	4	50.5	2.53	54	2.7	21	3.1	34.9	6.98	32.3	9.8
SFA (g)	**4.82**	**1.46**	14.3	0.72	9.87	0.49	6.84	0.34	13.1	1.96	22.0	4.4	18.4	5.6
MUFA (g)	**15.6**	**4.7**	35.7	1.79	12.1	0.61	10.0	0.5	6.05	0.9	9.84	1.97	8.1	2.5
PUFA (g)	**3.04**	**0.92**	26.2	1.31	26.3	1.32	34.6	14.6	0.78	0.12	1.27	0.25	0.75	0.23
Cholesterol (g)	**0**	**0**	0	0	0	0	28	1.4	44	6.6	110	22	115	34.8

SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids

women, ranging from 23.8% to 59.4%, with the highest prevalence among black women.[21]

In the public's mind, the word "dietary fat" has become synonymous with obesity and heart disease, whereas the words "low fat" and "fat-free" have become synonymous with heart health. Compelling evidence, however, indicates the greater importance of types of fat, rather than total amount of fat with respect to risk of CHD.[22] A very low-fat diet (10%E), high in carbohydrates, will, however, not necessarily prevent the development of obesity and may even have other negative effects, such as decreased HDL-C and increased TG, as well as insulin resistance (glucose intolerance). A moderate-fat diet (30%E) with a low SFA (<10%E) and high MUFA has the most beneficial effect on lipid profiles and is also associated with a lower body mass.[21]

Avocados are, when compared to other fruit, high in fat (17.33 – 23.5 g/100g)[4,16] and are seen by many consumers to be fattening, and therefore excluded in energy restricted diets.

In a recent study conducted by the Potchefstroom Institute of Nutrition at the Potchefstroom University, the effects of avocado within an energy restricted diet on weight loss and serum lipids were investigated in overweight and obese subjects, using a controlled parallel intervention study. Intervention studies are experimental studies in which an exposure (avocado intake) is given to a group of people over a certain time period, and the effect / outcome (e.g. weight loss, serum lipids) compared to a control group, which did not receive the treatment. In this study fifty-five free-living volunteers (11 men, 44 women), with a body mass index of between 27 and 44 kg/m^2, were paired and randomly assigned to one of two groups. The experimental group consumed 200 g of avocado (1 avocado) per day, substituting 30 g of other dietary fats, and the control group excluded avocado from their energy restricted diet for six weeks. Seven-day isocaloric menu plans were given according to energy requirements of both groups to provide 30% fat, 55% carbohydrates and 15% protein of total energy.[23]

There were significant reductions in body weight in both groups during the study. The weight lost by the experimental and control group was similar and was accompanied by significant reductions in body mass index and percentage body fat. The study concluded that the consumption of 200 g avocado per day, within an energy restricted diet, did not compromise weight loss when substituted for 30 g of dietary fat.[23]

The study thus proves that avocados are not more fattening than other fat sources. The inclusion of avocados in energy restricted diets will probably also increase the palatability of the diet and promote dietary compliance. The total amount of fat in avocados is lower when compared to other dietary sources (Table 2). Avocados can therefore be a healthy substitute for butter / margarine, cheese, cream cheese – on bread, toast, crackers – as well as a healthy substitute for commonly used ingredients in dips.[24]

Avocados, MUFA and serum lipids

A fatty acid is an organic acid – a chain of carbon atoms with hydrogen atoms attached – that has an acid group (-COOH) at one end and a methyl group (-CH3) at the other end. Unsaturated fatty acids lack hydrogen atoms and have at least one double bond between carbon atoms. MUFA lacks two hydrogen atoms and has one double bond between carbon atoms.[24] The richest sources of MUFA in the diet are vegetable oils, especially olives and olive oil, canola oil, avocados and nuts (Table 3).

Studies investigating the lipid-lowering effects of avocados as MUFA source are limited. The primary food source of MUFA that has been used in studies is olive oil, with only seven studies published where avocados were used as main MUFA.[6-12] Five of the seven studies published are, however, poorly designed because of a lack of an appropriate control group, and will therefore not be discussed.[5,7,8,11]

In a well-designed randomised parallel controlled study, Lopez-Ledesma *et al*, investigated the effects of a MUFA (avocado) rich diet in 37 adult patients with mild hypercholesterolemia (15 of them with hypertriglyceridemia), and 30 healthy patients. Patients were randomly assigned to receive either a high MUFA diet or an isocaloric control diet

Table 3. Dietary sources high in MUFA (100 g portion). [4,5]

Dietary source	Kilojoules (kJ)	Total fat (g)	MUFA (g)
Vegetable oil			
Canola	3700	100	58.9
Olive	3699	100	73.7
Sunflower	3699	100	18.57
Avocado[16]	884	100	70.55
Peanut	3700	100	40.84
Nuts and seeds			
Almonds	2451	52.5	34.11
Cashews	2402	46.4	27.32
Hazel	2643	62.6	49.09
Macadamia	2936	73.7	58.17
Pecans	2792	67.6	42.16
Peanuts	2431	49.3	24.46
Fruit			
Avocado	1021	23.5	15.63
Olives	517	10.7	7.89

for a period of seven days, while being hospitalised. They found a significant decline in total cholesterol and LDL-C concentration with no change in HDL-C in healthy and hypercholesterolemic subjects, as well as a significant decline in TG levels in moderately hypercholesterolemic patients, either with hypertriglyceridemia (combined hyperlipidemia) or with normal serum TG levels.[10] The short intervention period of only seven days is, however, a limitation of the study. The controlled feeding on the other hand provides strength to the study.

Carranza *et al* showed improvement in lipid levels, when investigating the effects of avocado on the level of blood lipids in 8 patients with phenotype II and 8 patients with phenotype IV dyslipidemias. Patients were assigned to either a diet rich in MUFA using avocado as their major source, or a low-saturated fat diet without avocado. Diets were of 4 weeks duration and they were assigned in a crossover design, with their three daily meals eaten at their clinical unit. Total cholesterol and LDL-C decreased significantly in patients with phenotype II dyslipidemia. A significant increase was also seen in HDL-C in both phenotype II and IV dyslipidemia patients. Carranza *et al* concluded that avocados are an excellent source of MUFA in diets designed to treat hypercholesterolemia with some advantages over low-fat diets with a greater amount of carbohydrates.[9] This study also used controlled feeding, which strengthens the study, but the small sample size used is, however, a limitation.

The study by Pieterse *et al*, however, found no significant changes in plasma lipid levels when investigating the effects of avocado within an energy restricted diet on weight loss and serum lipids in overweight and obese subjects.[23] This could be due to the normal to borderline high serum lipid levels of the subjects, in contrast to the dyslipidemic patients used in the previous studies. The good initial MUFA intake (10% of total energy intake) of the subjects recorded at baseline, could also be a possible explanation for the lack of effect.

There is thus scientific evidence suggesting a lipid-lowering effect when consuming high MUFA diets enriched with avocados, especially in hypercholesterolemic patients.

Lipid-lowering mechanisms of avocados

Interest in the lipid-lowering effect of avocados has primarily been stimulated by the high MUFA content of avocados. Data also suggest that the phytosterols found in avocados could contribute to their lipid-lowering affect.

• Effect of MUFA

Kinetic studies have previously demonstrated that plasma LDL concentrations are dependent on the production rate of small, very low-density lipoproteins (VLDL). This suggests that the hypocholesterolaemic effect of MUFA may be due to an alternation of $VLDL_2$ particle production rates, but not the larger triacylglycerol-rich $VLDL_1$ particles, as plasma triacylglycerol levels were found to be unaffected by MUFA. A study by Sanderson and co-workers suggested that the LDL-lowering effect of increasing dietary MUFA is mediated either by an upregulation of LDL clearance or by reduced conversion of intermediate-density lipoprotein into LDL. Thus, MUFA did not change triacylglycerol, but decreased LDL-cholesterol.[25]

In addition to the lowering of LDL-C by high MUFA diets, studies also found decreases in plasma TG levels with a high MUFA diet, suggesting a triacylglycerol-lowering effect by MUFA. The underlying mechanism for the hypotriacylglycerolemic effect of MUFA is not clear.[26] However, McNamara proposed two complementary mechanisms that may be involved: (1) changes in the composition of VLDL, (2) changes in the expressed activities of the enzymes and proteins involved in intravascular processing and catabolism of VLDL, both of which would decrease plasma triacylglycerol concentrations.[27] Additional studies are, however, needed to clarify the mechanism or mechanisms by which MUFA elicit a triacylglycerol-lowering effect.[26]

- **Effect of phytosterols**

Recently, analysis of avocados has provided new information showing that this fruit is a significant source of dietary phytosterols.[17] Plant sterols (phytosterols) are found in vegetable oils, seeds, nuts and some vegetables and fruit. Phytosterols are the plant analogues of cholesterol and are effective in reducing serum cholesterol levels without causing serious side effects.[28] On average, a 13% reduction in LDL and a 10% reduction in total cholesterol concentrations were found by Moghadasian & Frohlich in a review of 16 published studies, using various phytosterol mixtures (1 – 6 g/day). Neither HDL cholesterol or triglyseride levels are found to be significantly affected by dietary phytosterols.[28] The mechanism for the serum cholesterol-lowering effect of phytosterols involves inhibition of intestinal cholesterol absorption and decreased hepatic cholesterol synthesis.[17] In the light of the fairly high doses phytosterols necessary to significantly reduce cholesterol it is unclear what the overall impact of the phytosterols in avocados might be.

CONCLUSION

CHD is one of the leading causes of mortality and morbidity in South Africa.[29] It is accepted that diet, *inter alia,* through its effects on lipid metabolism and antioxidant properties, plays an important role in the primary and secondary prevention of CVD.[30]

There is consistent evidence showing a lipid-lowering effect of diets high in MUFA. A MUFA-enriched diet also does not compromise weight loss. Although the existing scientific evidence on avocados is limited, the high MUFA content and nutrient density of the avocado, suggests a beneficial effect on the lipid and nutrient profile, and should be considered as part of a dietary strategy to protect against the development of CHD.

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