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Avocado and Cardiovascular Health

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Abstract

Avocado is a fruit which had a caloric density of 1.7 kcal per gram and a half unit (~70 g) is composed by 114 kcal, 4.6 g of fibers, 345 mg of potassium, 19.5 mg of magnesium, 1.3 mg of vitamin E and 57 mg of phytosterols. Approximately 75% of fiber's avocado contents are considered insoluble and 25% are soluble. The avocado contains lipids that consist of 71% from monounsaturated fatty acids (MUFA), 13% from polyunsaturated (PUFA) and 16% from saturated fatty acids (SFA). Recent researches have shown that avocado may improve hypercholesterolemia and may be useful in the treatment of hypertension and type 2 diabetes mellitus (T2DM). This way, avocado plays an important role in the cardiovascular health. This review summarizes the potential benefits of avocado consumption in the prevention of cardiovascular risk factors and metabolic diseases.

Keywords

Persea, Diabetes Mellitus, Type 2, Dyslipidemias, Nutritional Status, Blood Pressure

1. Introduction

The tree of the avocado is originally from Mexico and Central America, and belongs to the *Lauraceae* family, genus *Perseal* [1]-[3]. This genus is divided into two subgenuses: *Persea* and *Eriodaphne* [3]. However, there are two important species in horticulture: *Persea americana Mill* and *Persea drymifolia cham*.; this last comprising Mexican race avocados, which currently is considered as the botanical variety of *Persea Americana* [3] [4].

The avocado is a fruit which had a caloric density of 1.7 kcal per gram and a half unit (~70g) is composed by 114 kcal, 4.6 g of fibers, 345 mg of potassium, 19.5 mg of magnesium, 1.3 mg of vitamin E and 57 mg of phy-

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tosterols (**Table 1**) [5]. Approximately 75% of fiber's avocado contents are considered insoluble and 25% are soluble [6]. The avocado contains lipids that consist of 71% from monounsaturated fatty acids (MUFA), 13% from polyunsaturated (PUFA) and 16% from saturated fatty acids (SFA) [7]. Its high MUFA content in a water-based matrix appears to enhance the bioavailability of nutrients and phytochemical compounds of the avocado [8].

The avocado consumption has been related to benefits on some cardiovascular risk factors [5] [9], as well as to the improvement of the dietary quality and nutrient intake by increasing the consumption of MUFA, dietary fiber, magnesium, potassium, vitamins E and K [10]. Recent researches have shown that avocado can improve hypercholesterolemia and be useful in the treatment of hypertension (HTN) and type 2 diabetes mellitus (T2DM). This way, avocado can play an important role in the cardiovascular health.

This review aims to summarize the potential benefits of avocado consumption in the prevention of cardiovascular risk factors and metabolic diseases.

1.1. Avocado and Type 2 Diabetes Mellitus

The World Health Organization (WHO) have update the prevalence of T2DM in the United States (estimated about 30.3 million people by 2025) and worldwide, which is estimated around 380 million people diagnosed until the same year [11]. T2DM is associated with obesity, unhealthy diet, sedentary lifestyle and aging population

Table 1. Nutritional composition of the Hass avocado (*Persea americana*)[5].

Nutrient/Phytochemical	Value per 100 g
Proximates	
Water (g)	72.3
Energy (Kcal)	167
Protein (g)	1.96
Fat (g)	15.4
Carbohydrate (g)	8.64
Fiber, total dietary (g)	6.8
Sugars, total (g)	0.3
Minerals	
Magnesium (mg)	29
Phosphorus (mg)	54
Potassium (mg)	507
Sodium (mg)	8
Zinc (mg)	0.68
Selenium (ug)	0.4
Vitamins/Phytochemicals	
Vitamin C (mg)	8.8
Folate, food (µg)	89
Lutein + zeaxanthin (µg)	271
Vitamin E (alpha-tocopherol) (mg)	1.97
Lipids	
Fatty acids, total saturated (g)	2.13
Fatty acids, total monounsaturated (g)	9.8
Fatty acids, total polyunsaturated (g)	1.82
Cholesterol (mg)	0

Adapted from Dreher ML *et al.*[5].

[12]. Patients with fasting plasma glucose ≥126 mg/dL, oral glucose tolerance test (75 g glucose load) ≥200 mg/dL or glycated hemoglobin ≥ 6.5% [13] are diagnosed with T2DM. Patients with diabetes are at high risk for microvascular (*e.g.*, nephropathy, retinopathy and neuropathy) and macrovascular complications (*e.g.*, peripheral vascular disease, stroke and cardiovascular disease) [12].

Avocado has low sugar content (0.2 g in a half unity). D-mannoheptulose is the main kind of sugar found in the fruit but is seems do not have nutritional properties, appearing to be one more phytochemical component of the avocado [9]. The aqueous extract from the avocad's seeds has hypoglycemic agents, which act protecting against toxicity and oxidative stress [14]-[16]. In rats, phenolic extracts of avocado (from leaves and fruits) inhibited the activity of enzymes related to the development of T2DM (α-amilase and α-glucosidase), as well as the malondialdehyde production (MDA), a marker of oxidative stress and responsible for increasing the lipid peroxidation [17]. The hypoglycemic effect of the avocado was also related to its ability to stimulate the remaining pancreatic β-cells in animal models, making them able to secrete more insulin [18].

Diets rich in MUFA are considered alternatives for the dietary treatment of T2DM [19] and since avocado have a substantial amount of MUFA it could be used as an option for glycemic control in diabetic patients. However, few studies had evaluated the use of avocado in individuals with T2DM. Among overweight and moderately obese individuals, adding half avocado (70 g) in the lunch increased the satiety in a period of 3 to 5 subsequent hours, followed by a reduction of the insulin secretion in a 3-hour postprandial period [20]. Patients with hypercholesterolemia and T2DM supplemented with 300g/day of avocado for 7 days had their total cholesterol (TC) and LDL-cholesterol decreased by 17% and 22% respectively, and their triglycerides (TG) levels reduced by 22%; there was also a slightly increase in HDL-cholesterol when compared to the control group (isocaloric diet, 50% of total calories from fats and without avocado) [21].

The avocado paste can be obtained by the fruit oil and its effects were evaluated in rats, who consumed a hypercholesterolemic diet added of glucose solution and also the paste of avocado. Authors concluded that the animals had lower levels of blood sugar, lower values of the Homeostasis Model Assessment-Insulin Resistance Index (HOMA-IR Index) and less accumulation of fat in their liver. In this study, the improvement of the HOMA-IR Index and of the hepatic steatosis was attributed to the phytochemicals components and dietary fibers of the avocado [22].

1.2. Avocado and Dyslipidemia

Dyslipidemia is defined as lipid metabolic changes resulting from disturbances in any phase of the lipid metabolism, which impact on serum lipoproteins levels. It is an important cardiovascular risk factor: about a third of ischemic heart diseases are attributable to increased levels of TC. Globally, higher levels of cholesterol are responsible for 2.6 million deaths annually, and the treatment of dyslipidemia may reduce the cardiovascular risk by 30% over a period of 5 years [23] [24].

Nutritional therapy and changes in lifestyle are part of the non-pharmacological treatment for dyslipidemia. The American Heart Association/American College of Cardiology (AHA/ACC) recommends a healthy eating pattern, with 5% to 6% of total daily calories from SFA to reduce the levels of LDL-cholesterol [25]; SFA should be replaced by MUFA and PUFA intake [26] [27]. MUFA have benefic effect on hypercholesterolemia without increasing the lipid oxidation, in contrast with excessive intake of PUFA; MUFA ingestion also does not reduce serum HDL-cholesterol levels [28]. Recently, the PREDIMED study (*Prevención con Dieta Mediterránea*) showed that the Mediterranean diet supplemented with foods rich in MUFA (olive oil and nuts) reduced the incidence of major cardiovascular events by 30% after a follow-up of 4.8 years, in subjects at high risk for cardiovascular disease [29].

The lipid-lowering effect of avocado (also rich in MUFA) occurs mainly due its phytosterol β-sitosterol [30]. Among 17,567 participants of the *National Health and Nutrition Examination Survey* (NHANES: 2001-2008) who had their avocado intake evaluated, the average daily intake was about a half of unit (70.1 ± 5.4g/day), and the avocado consumers had higher levels of HDL-cholesterol when compared to those who did not consume [10].

The first clinical trial evaluating the influence of the avocado on serum TC was carried out by C. Grant Wilson in 1960 [31]. At that time, 16 men aged between 27 and 71 years (with and without hypercholesterolemia) were advised to consume 0.5 to 1.5 units of avocado a day. After 4 weeks, 8 participants had their TC reduced by 8.7% to 42.8%, without changing other lipid parameters. Subsequently, Carranza *et al.* [32] evaluated the effect of two diets in 16 individuals with dyslipidemia: 1) a diet rich in avocado (75% of total fat); or 2) a low sa-

turated fat/low dietary cholesterol diet. After 4 weeks, results showed that individuals allocated to the avocado diet had lower levels of TC and LDL-cholesterol and increased serum HDL-cholesterol.

Avocado may modify the structure of the HDL lipoprotein by increasing paraoxonase1 (PON1) enzyme activity. The cardioprotector effect of HDL-cholesterol is in part due of PON1 activity, which is responsible for the hydrolysis of lipid hydroperoxides (products of the lipid oxidation) [33] [34]. About LDL-cholesterol particles, a randomized controlled trial was conducted among 45 overweight/obese participants submitted to a 2-week run-in diet (Average American Diet, AAD) and later allocated to three distinct diets: 1) LF—low fat diet (24% of daily total calories from fats); 2) MF—moderate fat diet (34% of daily total calories from fats); or 3) AV—avocado diet (~140 g of Hass avocado a day 13 g of MUFA). The AV diet group showed higher reduction of LDL and non-HDL cholesterol when compared to the other diets, and had reduced values of total LDL-cholesterol particles (LDL-P −80.1 nmol/l, $p = 0.0001$), subclasses of LDL-cholesterol (LDL_{3+4}-4.1 mg/dl, $p = 0.04$) and LDL/HDL ratio (−6.6%, $p < 0.0001$). AV and MF diets reduced apolipoprotein B-100 (ApoB) levels and the relationship between ApoB/ApoA-I decreased in AV diet group, without weight changes [35].

1.3. Avocado and Nutritional Status

The pathophysiological processes linking obesity to atherosclerosis and cardiovascular disease clearly involve a chronic inflammatory state [36], which interact with other factors such as ectopic fat, insulin resistance and HTN. For weight management and prevention of cardiovascular disease, international dietary recommendations regarding MUFA ingestion vary from 12% to 25% of total daily calories [37].

Popularly, avocado is known by its high caloric value being "a fruit whose consumption should be contraindicated in diets for weight loss." In fact, few studies have evaluated the avocado in the weight loss setting.

Pieterse *et al.* conducted a clinical trial among 61 overweight/obese subjects, who were randomly assigned in two groups (an isocaloric diet with or without 200 g/day of avocado). After 6 weeks individuals in both groups reduced their weight, Body Mass Index (BMI) and body fat percentage, without significant differences according to group. In other study for weight maintenance, 131 subjects were allocated for three diets: 1) a moderate fat diet (34% to 45% of total daily calories from fats, including 100 g/day of avocado); 2) a low fat diet (20% to 30% of total daily calories from fats); or 3) a control diet (35% of total calories from fats). After 6 months all groups showed significant increase body weight, without differences between them [38]. In general, avocado consumers had a higher daily consumption of fruits and vegetables, essential foods included in a healthy diet for reduction or maintenance of the body weight [39] [40].

1.4. Avocado and Blood Pressure

Hypertension is the leading cause of worldwide mortality and is responsible for approximately 40% of deaths from cardiovascular disease, chronicle kidney disease (CKD) and type 2 diabetes mellitus (T2DM) [41]. Beyond weight reduction, the adoption of a DASH diet is a part of the non-pharmacological treatment for higher levels of blood pressure (BP) (systolic and diastolic BP > 140/90 mmHg) [42].

The high content of potassium and lutein in the avocado may improve the BP values by controlling oxidative stress and inflammation[5]. In addition, diets rich in MUFA may improve systolic and diastolic BP levels when compared to diets with low content of MUFA [43].

Experimental studies have evaluated the potential hypotensive effect attributed to the aqueous extract of the avocado leaves [44]-[46]. Ojewola *et al.* [44] showed that the vascular dilation in consequence to the aqueous extract intake was the responsible for an anti-hypertensive effect of the avocado in rats. Authors suggest that different phytochemical components in the avocado's extract caused this effect. In other study, the aqueous extract from avocado seeds used as treatment for HTN in rats reduced BP levels and also improved the lipid profile [47]. In humans, subjects with overweight and moderate obesity who received a restricted caloric diet supplemented with 200 g of avocado a day do not had their BP levels reduced after the intervention [38].

2. Conclusions

The consumption of avocado seems to be related to cardiometabolic health by preventing traditional risk factors such as dyslipidemia, glycemic control and hypertension (**Table 2**). Despite all beneficial effects of avocado,

Table 2. Summary of clinical trials regarding avocado consumption and cardiovascular risk factors.

Author	Year	No. Participants	Trial Design	Consumption /follow-up	Intervention	Outcome (s)
Grant *et al.* [31]	1960	16	Crossover	Daily, 4 weeks/phase	Avocado addition of 0.5 - 1.5 units	↓ total cholesterol
Colquhoun *et al.* [21]	1992	15	Crossover	Daily, 1 week/phase	Diet rich in MUFAs supplemented with 300 g avocado *vs.* diet rich in complex carbohydrates	↓ total cholesterol, LDL and triglycerides, ↑ HDL concentration
Carranza *et al.* [32]	1995	16	Crossover	Daily, 4 week/phase	Diet rich in avocados (75% of total fat), *vs.* diet low in saturated fat	↓ total cholesterol and LDL, ↑increased HDL concentration
Pieterse *et al.* [38]	2005	61	Parallel	Daily, 6 weeks	Hypocaloric diet with inclusion of 200 g of avocado or hypocaloric diet	No difference regarding weight reduction and blood pressure
Sloth *et al.* [39]	2009	131	Parallel	Daily, 6 months	Moderate fat diet with 100 g avocado or low-fat diet or control diet	No difference regarding weight reduction
Wien *et al.* [20]	2013	26	Crossover	1 meal, postmeal measurement	Adding avocado 68g at lunch	↑ satiety and ↓ of fasting insulin in postprandial period of 3 h
Wang *et al.* [35]	2015	45	Crossover	Daily, 5 weeks/phase	Low-fat diet, moderate fat diet or moderate fat diet with addition of 136 g of avocado per day	↓ LDL and weight maintenance

many studies were made in animal models and there results should be interpreted with caution. It is suggested that further studies must be designed among humans, in order to evaluate and to confirm the benefits of avocado.

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