Impact of Pistachio Nuts Consumption on Human Health

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Information	Abstract
Article Type: ReviewArticle ***Article History:*** **Received:** 14.10.2019 **Accepted:** 12.11.2019 **DOI:** 10.22123/phj.2020.223473.1042 ***Keywords:*** Pistachio Nut Nutritional Elements Health ***Corresponding Author:*** ***Fatemeh Nazoori*** **Email:** F.nazoori@vru.ac.ir **Tel:** +98-3431312034	In the resent years, unique insights have been gained into the possible role of the pistachio nut in maintaining health and preventing many diseases. Many studies have been carried out to evaluate the possible effect of nut intake on body composition, metabolic, inflammatory, and oxidative stress parameters. As pistachio nuts are so very rich in fat content that can be oxidized, their skin contains many antioxidants. The in vivo experiments carried out in humans on the impact of pistachio nuts on human health are reviewed in this study.

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1. Introduction

Pistachio (Pistacia, vera) belongs to the botanical family of Anacardiaceae and is classified as a tropical stone fruit [1]. Pistachio is an extremely common nut that is highly nutritious, and is eaten raw, salted, or roasted [2]. High levels of potassium and phosphorus and different amounts of iron, calcium, and magnesium are also found in pistachio nuts [3]. Kernels are an abundant source of oil and contain linolenic and linoleic fatty acids, and are important for human health [4]. Bioactive and antioxidant compounds are essential quality parameters for human health are abundant in pistachio [5]. The regular use of pistachios in diet can be of indubitable benefit to sustain human health and defend the human body against cancer, inflammatory diseases, coronary pathologies, and more generally, pathological disorders associated with free radical overproduction [6].

2. Pistachio composition and its fatty acid profile

2.1. Carbohydrates

Carbohydrate content at nearly 29 g/100 g of pistachio is comparatively low, 2.48% of which is from naturally occurring sugars and 1.6% is from starch. Pistachios are rich in fiber relative to other nuts, with soluble fibers constituting 0.3% of their weight and insoluble fibers making 10% of their weight. Besides, pistachios have a low rate of glycemia, which leads to longer satiety and excursions being preserved [7]. Pistachios are considered as a strong dietary fiber source, offering 2.8 g of fiber per ounce, with insoluble 80 percent of the fiber [8].

2.2. Proteins

Data from the amino acid analysis indicate that P. vera kernels contain about 25% amino acids. Pistachio kernels, with a protein content of 19-31%, are a decent source of proteins. The most abundant amino acids in pistachios include glutamic acid, aspartic acid, and the essential amino acids such as lysine and leucine [9].

2.3. Fat content

Pistachio oil, like oils from other nuts, is rich in fatty acids. The main ingredient is oleic acid varies from about 52 to 81 percent. Linoleic acid is the dominant polyunsaturated fatty acid, which offers differences by variety, but with a strong reverse relationship between linoleic and oleic acid, as found in many other vegetable oils [10, 11].

Oleic, linoleic, palmitic, stearic, vaccine (Z-(7) octadecenoic acid), palmitoleic, and linolenic were found as the main fatty acids. Myristic, pentadecenoic, arachidic acid, and Z-(7)-hexadecenoic were present in trace amounts in all measurements. These minor acids are not higher than 0,5% [12,13].

2.4. Vitamins and minerals

The mineral composition in pistachio kernels includes iron, sodium, potassium, phosphorus, calcium, magnesium, copper, and selenium [14]. Pistachios are a strong source of various antioxidants that are essential vitamin A sources, such as lutein, tocopherols, flavonoids, selenium, carotenes, and phytoestrogens (alfa-carotene, cryptoxanthin, and 5,6 beta-carotene) [15,16].

2.5. Flavonoids and Phenolic compounds

The overall phenolic compound materials such as flavonoids, lignans, anthocyanins, proanthocyanidins, phenolic acids, hydrolyzable tannins, and stilbenes vary widely among nuts, with the richest sources being found in pecans, pistachios, and walnuts [17]. Therefore, pistachio nuts can be considered as a "special natural food" that has recently been listed as one of the 50 food products with the most potent antioxidants [18].

2.6. Phytosterols, carotenoids, and anthocyanin

Four key phytosterols of pistachio seed oil are β-sitosterol, Δ5-avenasterol, campesterol, and stigmasterol [12]. The main anthocyanin present in pistachio kernels is cyanidin-3-galactoside [19]. Pistachio is probably the the best nut with a high xanthophyll carotenoid content. The key pistachio carotenoid is lutein [17].

2.7. ɣ-Tocopherol

The tocopherol content is high in pistachio oils but lower than the tocopheryl concentration in walnuts and almonds. Among tocopherols, the main isomer contained in pistachio oils was γ-tocopherol. There were also some indications of substantial alpha-tocopherol content and limited δ- and β-tocopherol content [9].

3. Impact of pistachios intake on body weight management

Although nuts, such as pistachios, contain significant amounts of fat and are energy-dense ingredients, numerous studies have found that no association between nut consumption and weight gain or elevated risk of obesity [17]. There are dietary fibers, magnesium, and low sodium content in nuts, such as pistachio. Fibers build a sense of satiety, thereby preventing obesity. Pistachio can, therefore, have beneficial effects on weight [15]. Nuts contain carbohydrate, calcium, unsaturated fats and various phytochemicals; need extensive oral processing prior to swallowing; have distinct taste profiles; and are commonly thought to be energy-rich, both of which have been correlated with satiety reactions. Pistachio is a balanced snack that can be used in a weight loss regimen without concern that it will lead to weight gain in free-living people. Pistachio snacks result in lower triglyceride levels associated with

the known advantages of monounsaturated fats relative to processed carbohydrates for lipids. [20, 21].

4. Impact of pistachio on the regulation of glycemia and type 2 diabetes

Regular ingestion of nuts has been consistently shown to boost glycemic function. Diet and weight control are the fundamental concepts in the treatment of type 2 diabetes. Monounsaturated, polyunsaturated fats and magnesium, found in nuts can improve insulin sensibility, glucose metabolism, and insulin homeostasis [22]. Nuts have been shown to ameliorate certain coronary heart disease and the lipid profile of diabetic and pre-diabetics. Nonetheless, the atherogenic risk associated with pre-diabetes is not fully addressed by studies on traditional serum lipid profiles [23]. Previous studies have indicated that the inclusion of pistachios into a carbohydrate (CHO) meal reduces postprandial glucose levels to a degree comparable to other sources of fat and protein, but may have insulin-sparing properties. Pistachios alone can induce a rise in gastric inhibitory polypeptide (GIP) and glucagon-like peptide-1 (GLP-1) levels. A spike in GIP and GLP-1 levels can be stimulated by pistachios on their own. The properties that may help those with diabetes or metabolic syndrome are both insulin-sparing and elevated GLP-1 levels and a marginal effect on blood glucose [24].

5. Impact of pistachio intake on blood lipids

Accumulating evidence shows that cardiovascular disease (CVD) incidence is minimized by the consumption of nuts. Tree nuts are rich in unsaturated fats, soluble fibers, antioxidants, and phytosterols that, individually or together, may have a beneficial impact on serum lipids, blood pressure, and swelling. Previous tests have shown that the intake of nuts lowers total and LDL cholesterol [25]. Pistachio, like walnut, is a strong source of L-arginine, a precursor to endogenous vasodilator nitric oxide [26]. The unsaturated fatty acid content of pistachio and its comparatively limited SFA content seem to be the major dietary factors promoting heart-healthy blood lipids, not to mention a variety of other factors that are likely to play a minor role [17, 27]. The blood-lipid-lowering role of insoluble fiber is attributed to its capacity to raise fecal bulk and decrease intestinal transit time, interfering with cholesterol and bile absorption [28].

6. Impact of pistachio intake on the inflammatory state

Oxidation and inflammation play a major part in the pathogenesis and development of coronary heart disease (CHD) and atherosclerosis. No research on the impact of pistachio on inflammatory

parameters is available to date. No major changes in high-sensitivity C-reactive protein (hs-CRP) and tumor necrosis factor-a levels were caused by the pistachio diet. However, there has been a substantial decrease in the amount of interleukin-6, which is also an indication of inflammation [29]. Pistachios are essential sources of antioxidants that by inhibiting interleukin-1B, reduce inflammation and oxidative stress, enhancing the production and realization of degranulation. Carotenoids are primary phytochemicals in pistachios that can provide cardiovascular health with antioxidant and anti-inflammatory protection. Pistachio seems to be the only nut with a substantial xanthophyll carotenoid amount. As an antioxidant, tocopherol exclusively retrieves reactive nitrogen species and has anti-inflammatory effects regulated by cyclooxygenase repression. Antioxidant and anti-inflammatory properties can be found in phenolic compounds, which can help enhance endothelial function and minimize oxidized low-density lipoprotein (LDL) [17].

7. Impact of pistachio on oxidative stress

Oxidative stress is well known to play a significant role in the development of multiple illnesses, including cancer, atherosclerosis, rheumatoid arthritis, and aging-related chronic illnesses [4]. A diet containing pistachios has been reported to have strong antioxidant effects on the body [13]. After pistachio use, a large increase in plasma antioxidant activity (a measurement of thiobarbituric acid reactive substances (TBARS)) has been shown [30]. Phytosterols, polyphenols and other dietary antioxidants found in pistachios serve as scavengers, neutralizing reactive oxygen species (ROS) and generating endogenous antioxidant defenses [8].

8. Impact of pistachio on hypertension

Potassium is the key intracellular cation in the body for normal cellular activity and blood pressure. Pistachios have the greatest content of potassium among nuts. Clinical studies indicate that the intake of potassium by normal and hypertensive people can help regulate blood pressure [31]. In clinical research, the ingestion of nuts was linked to lower blood pressure (BP), reducing the risk of high blood pressure. Some studies indicated substantial decreases in BP when nuts are eaten, while others did not report any significant changes. There is no understanding of the mechanism(s) underlying the interaction among nut consumption and BP, and the dose-response relationship has not been studied. Following walnut research, it is believed that the relationship between nut intake

and BPP mediates lower peripheral vascular resistance [31].

9. Impact of pistachio on the coronary heart disease

Pistachio nuts have a moderate amount of arginine, a non-essential amino acid that helps to maintain artery integrity and increase blood flow by improving nitric oxide (leading to blood vessel relaxation). Due to their cardio-protective properties, pistachio nuts help to reduce the incidence of coronary heart disease [32]. Studies have shown that the risk of coronary heart disease (CHD) is reduced by repeated nut intake associated with enhancing the lipid profile of the blood by lowering the number of triacylglycerols. Nuts are rich in monounsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) that are considered to have a beneficial effect on the profile of the lipids. However, the potential advantages of nuts for CHD reduction are not restricted to their effects on lipid parameters. Dietary content, micronutrients, vitamins, fibers, antioxidants, micronutrients, and amino acids (e.g., arginine) in nuts are a good source of plant sterols as well [26].

10. Pistachio effects on multiple sclerosis (MS)

Multiple sclerosis (MS) is a demyelinating chronic nervous system disease that is the most common cause of permanent neurological impairment in clinically and socially active young adults [33]. The support of immune responses has been related to essential fatty acids (EFA). They are immunomodulatory, which means the immune responses are reinforced [34]. The nuts through specific pathomechanisms, antioxidants, and PUFAs have the potential to reduce disease symptoms. EFAs have been associated with strengthening immune responses. Pistachios are high in EFAs, which means they can induce beneficial immune responses [15].

11. Pistachio effects on cancer

Cancer is affected by external factors such as viruses, carcinogens, chemicals, and radiation and by a genetic background such as mutations in the cell line leading to malignant development, metastasis, and invasion [22]. Pistachio nut is a healthy nutrition that can prevent the disease due to its rich protein, fat and fatty acids, vitamins, minerals, and fiber content. It also contains essential phytochemicals which are capable of improving cardiovascular and autoimmune diseases with antioxidants such as gamma-tocopherol, carotenoids (β-carotene and lutein), phenolic compounds including lignans, phenolic acids, anthocyanins, flavonoids, and proanthocyanidins [35]. These may contribute to cancer chemopreventive ability, particularly because of antioxidant properties. Throughout recent decades, studies on the anticancer activity of this plant have come

to the fore. For example, phytosterols in pistachio were found to prevent prostate cancer development [36], Pistachio has also been documented to be a useful source of gamma-tocopherol and can decrease the risk of lung cancer. Research has shown that P.Vera can play a therapeutic role in the cell lines of HepG2 hepatoma, MCF-7 human breast cancer cell line, and colon carcinogenesis [36- 40].

12. Conclusions

The organoleptic properties and possible health benefits of the pistachio nut (Pistacia vera) are highly valued. Research shows that nuts, such as pistachio, have several beneficial effects on human wellbeing and can be used to control several diseases. Various experiments have been carried out to examine health and lipid profile effects of nuts including pistachio on diseases such as diabetes, metabolic syndrome, CHD, bp, cancer, inflammatory diseases, and MS. Macro- and micro-mineral nutrients in pistachio make it a perfect part of a balanced diet. In conclusion, current epidemiological evidence indicates that a healthy intake of pistachio nuts can help to reduce the risk of cardiovascular diseases, especially hypercholesterolemia. The total energy supplied by pistachio nuts is approximately 564 calories per 100 g, showing that the consumption of pistachios does not increase the normal or recommended daily caloric intake confirming its beneficial effects.

Table1- The key findings on pistachio consumption effects

Author/s (year)	Objectives	Study Results
CWC Kendall et al. (2011) [41]	Post-prandial glycemia	The effects of pistachio on post-prandial glycemia may be part of the process by which nuts decrease the risk of diabetes and CHD.
Sarah K Gebauer et al. (2020) [42]	Risk factors for coronary heart disease and possible mechanisms of action	There is a dose-dependent impact of pistachios on CVD risk factors, which may suggest effects on SCD.
Shahraki et al. (2014) [43]	Assessment of cytoprotection, ROS, lipid peroxidation, carbonylation of proteins, lysosomal, and mitochondrial membrane harm in models of cell toxicity	Cytoprotective function Pistacia vera extracts against oxidative and carbonyl stress in type 2 diabetes
Kendall et al. (2014) [24]	Impact on post-prandial levels of glucose and insulin, satiety-linked gut hormones, and endothelial effects	Pistachio decreased postprandial glycemia, improved levels of glucagon-like peptides, and and had nsulin-sparing properties.
Mandalari et al. (2012) [44]	Quantified diffusion throughout simulated human digestion of polyphenols, xanthophylls (lutein), and tocopherols from pistachios	The beneficial link between the intake of pistachio and wellness-related findings
Baer et al. (2012) [45]	Contained metabolizable energy	LDL-C reduction, no major improvement in total plasma cholesterol, HDL-C reduction,
Kay et al. (2010) [46]	Serum antioxidants and oxidative-status biomarkers	Increases in lutein serum and al-tocopherol have reduced oxidized serum-LDL
Marc Fantino et al. (2020) [47]	Body weight in healthy women	The daily intake of pistachios as a mid-morning snack increased the profile of dietary nutrients in healthy women without adversely impacting body weight regulation.

CHD: coronary heart disease, CVD: cardiovascular disease, SCD: Indexes of plasma stearoyl-CoA desaturase activity, LDL: low-density lipoprotein, HDL: Non-high-density lipoprotein,

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