# Pistachios for Health

## What Do We Know About This Multifaceted Nut?

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Human beings have known about pistachio nuts since 6000 BC. Since then, pistachios have been systematically incorporated into the diet of various cultures. They are nutrient-dense nuts with a healthy nutritional profile that contains fiber, unsaturated fatty acids and antioxidant compounds. Nutr Today. 2016;51(3):133–138

## THE HISTORY OF PISTACHIOS

Pistachio (from the Greek word *pistákion* [πιστάκιον]), "the green nut," is widely cultivated in the Mediterranean region, even though it probably originated in central and southwest Asia. Evidence of its consumption has been found in archaeological excavations, which proves that it has long been associated with human activities.[1] Remains of pistachio nuts dating from the sixth millennium BC have been found in both Afghanistan and southeastern Iran, where pistachio (*Pistacia vera L*) was probably first cultivated in regions close to where it grew wild. It was widely cultivated in the ancient Persian Empire, from where it gradually expanded to the west. For example, legend has it that the Queen of Sheba (Assyria, ca 10th century BC) monopolized a limited crop of nuts for her exclusive use.[2] However, the Assyrians and the Greeks knew that pistachios could be used as medicines, aphrodisiacs, and antidotes. By the end of his reign, Emperor Tiberius, the Roman consul of the province, introduced pistachios into Italy. From Italy, they had spread into Mediterranean regions in southern Europe and North Africa. Around the 10th century, pistachios were also cultivated in China and more recently in Australia, New Mexico and California.[1]

## NUTRITIONAL VALUE OF PISTACHIOS

Compared with other nuts (Table 1), dry roasted pistachios have a lower fat content (43.4 g/100 g), which is composed mainly of saturated fatty acid (5.6 g), polyunsaturated fatty acid (13.3 g), and monounsaturated fatty acid (24.5 g)[3] (Figure 1A). Of the fatty acids, oleic and linoleic acids represent more than half of the total fat content in pistachios. Pistachios are also a good source of vegetable protein (about 21% of total weight), with an essential amino acid ratio higher than most other commonly consumed nuts (ie, almonds, walnuts, pecans, and hazelnuts), and they have a high percentage of branched chain amino acids.[4] The amount of total carbohydrates is low to moderate (about 29% by weight), but they are richer in fiber than other nuts with a 10% by weight of insoluble forms and 0.3% of soluble forms (Table 1). Pistachios also contain significant amounts of minerals (ie, potassium, phosphorus, magnesium, calcium; Figure 1B) and vitamins such as vitamin A, vitamin E (especially γ-tocopherol), vitamin C, vitamin B (except $B_{12}$), vitamin K, and folate (Table 2), with relatively high amounts of these compounds compared with other nuts.[5] Moreover, pistachios are also a rich source of lutein and zeaxanthin (xanthophyll carotenoids) and phenolic compounds, including anthocyanins, flavonoids, and proanthocyanidins, and their antioxidant capacity is considerable. Pistachios are the nuts that have

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**TABLE 1 Nutritional Composition of Nuts (Dry Roasted)**

| | Almonds | Hazelnuts | Macadamia Nuts | Peanuts | Pecans | Pistachio Nuts | Walnuts |
|---|---|---|---|---|---|---|---|
| Energy, kcal | 598 | 646 | 718 | 587 | 710 | 572 | 643 |
| SFA, g | 4.1 | 4.5 | 11.9 | 7.7 | 6.3 | 5.6 | 5.4 |
| PUFA, g | 13.0 | 8.5 | 1.5 | 9.8 | 20.6 | 13.3 | 44.2 |
| MUFA, g | 33.1 | 46.6 | 59.3 | 26.2 | 44.0 | 24.5 | 8.4 |
| Proteins, g | 21.0 | 15.0 | 7.8 | 23.6 | 9.5 | 21.0 | 14.3 |
| Carbohydrates, g | 10.1 | 8.2 | 5.4 | 12.9 | 4.2 | 28.3 | 10.8 |
| Fiber, g | 10.9 | 9.4 | 8.0 | 8.4 | 9.4 | 10.3 | 7.1 |
| Water, g | 2.4 | 2.5 | 1.6 | 1.8 | 1.1 | 1.9 | 4.4 |
| Ashes, g | 3.1 | 2.5 | 1.1 | 2.9 | 1.6 | 3.0 | 2.8 |

Data obtained from US Department of Agriculture (USDA), Nutrient Database for Standard Reference, Release 28.[3]
Abbreviations: MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid.

the highest content of phytosterols, including stigmasterol, campesterol, and β-sitosterol.[6] This complete and diverse set of micronutrients and macronutrients means that pistachio nuts are potentially one of the more health-promoting foods.

## HEALTH BENEFITS OF PISTACHIO

As their nutritional profile suggests, pistachios can play an important role in improving such metabolic conditions as overweight, type 2 diabetes mellitus (T2DM), or metabolic syndrome. This review aims to analyze current knowledge on the relationship between pistachio intake and several metabolic risk markers (Figure 2).

### Satiety Regulation and Weight Management

Because nuts are energy-dense foods with a high fat content, one of the main concerns regarding the regular consumption of nuts in a worldwide pandemic of overweight and obesity is that nuts are believed to be fattening. To date, however, epidemiological studies have failed to find any association between nut or pistachio consumption and either weight gain or an increased risk of obesity.[7–9] Likewise, controlled feeding trials confirm that adding nuts to usual diets does not induce weight gain.[10–17] Several studies that have evaluated pistachios' effect on body weight as a secondary outcome have reiterated their null effect on body weight and body mass index.[18–22] Only one recent study conducted in T2DM subjects has found a significant reduction of body mass index after pistachio consumption.[23]

These findings may be explained by the energy density of pistachios; their content in fiber, protein, and unsaturated fatty acids; and their crunchy physical structure, which may induce satiety and therefore reduce subsequent food intake.[24] It has been speculated that various signaling systems (ie, mechanical, nutrient, and sensory) are activated by mastication, which may modify appetitive sensations.[25] To date, only 2 studies have evaluated the satiating properties of pistachio nuts in humans. The conclusions are that the consumption of in-shell pistachios led to lower calorie intake than the consumption of kernels[26] and that the visual cue of empty pistachio shells helped the participants to consume fewer calories during the day.[27] In addition, the monounsaturated and polyunsaturated fatty acids that nuts contain have a greater thermic effect that will induce higher thermogenic effect[28] than saturated fatty acids, which can lead to less fat accumulation by an increase in sympathetic activity in brown adipose tissue.[29] Finally, after nut intake, fat is malabsorbed to a slight extent largely because the fat in the walls of nut cells is not completely digested in the gut,[30] suggesting that energy from nuts is poorly absorbed. Therefore, the metabolized energy contained in these types of nut is less than predicted by the Atwater general factors, which is the system used for the calculation of the available energy of foods developed from experimental studies in the early years of the 20th century.[31]

### Lipid Profile

Pistachio consumption has been widely studied in terms of its possible protective cardiovascular disease role. Significant improvements in plasma total cholesterol concentrations,[18,19,21,22,32] Total cholesterol (C)/high-density lipoprotein C (HDL-C) ratio and low-density lipoprotein C (LDL-C)/HDL-C ratio[18–22,32] have been observed in several trials in the pistachio-supplemented group compared with the control group. Some studies have shown that LDL-C concentrations also decrease significantly in the

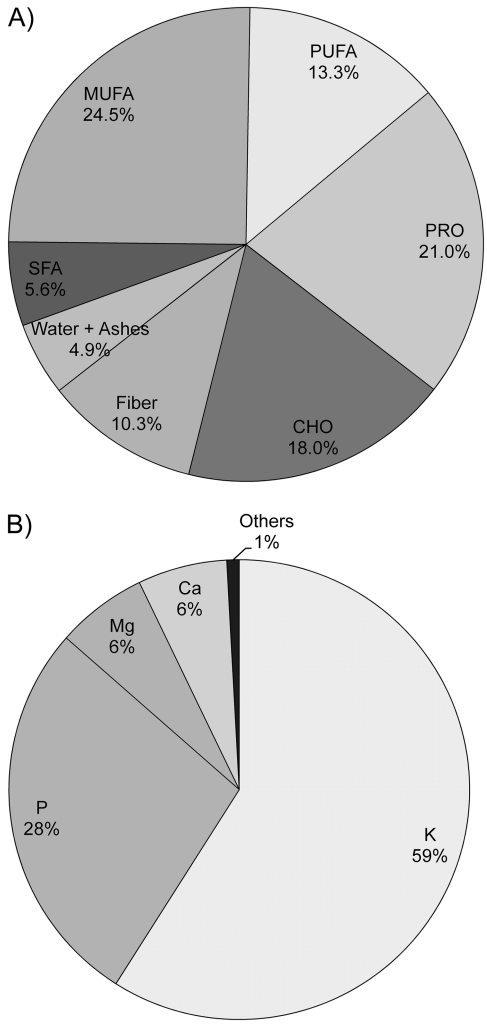


**FIGURE 1.** Macronutrient and mineral composition of pistachio nuts (dry roasted). (A) Macronutrient and (B) mineral composition of pistachios. Values are expressed as grams of macronutrient per 100 g of pistachios (A) and percentage of specific mineral from total mineral amount (B). ''Others'' includes copper, iron, manganese, selenium, sodium and zinc. Data obtained from United States Department of Agriculture, Nutrient Database for Standard Reference, Release 28.[3] MUFA indicates monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid; CHO, carbohydrates regardless of fiber; PRO, protein.

pistachio-supplemented group,[21,22,32,33] whereas others have observed a nonsignificant reduction.[18,19,34] However, Sheridan and coworkers[20] found significant increases in circulating HDL-C concentrations after pistachio intake.

It is currently considered that the conventional lipid profile cannot completely explain the atherogenic damage of cardiovascular diseases. In fact, the non-HDL-C fraction (ie, LDL-C plus very low-density lipoprotein C) has been strongly associated with an increased risk of coronary heart disease,[35] which is even greater than that attributed to LDL-C.[36] In addition, small dense LDL particles have been associated with an increased risk of ischemic heart disease in men independently of the concomitant variation in lipoprotein-lipid concentrations.[37] Therefore, novel research has taken advantage of new methodologies (ie, nuclear magnetic resonance) to evaluate the concentration and size of lipoprotein subclasses (ie, small, medium, large) rather than only the classical lipid profile. In this regard, only 3 studies have analyzed the effect of nut consumption on modulating lipoprotein subclasses. The effect of walnut consumption on lipoprotein subclasses was evaluated in 2001,[38] and the effect of pistachio on lipoprotein metabolism has been evaluated only recently.[33,39] These clinical trials found a significant antiatherogenic modulation of lipoprotein subclasses following nut interventions. In conclusion, evidence suggests that pistachios may improve well-established and novel blood lipid markers of atherosclerosis and therefore help decrease cardiovascular

**TABLE 2 Vitamin Content of Pistachios per 100 g (Dry Roasted)**

| | Pistachio Nuts |
|---|---|
| Vitamin A, IU | 266 |
| Vitamin $B_6$, mg | 1.12 |
| Vitamin $B_{12}$, mg | 0 |
| Vitamin C, mg | 3.0 |
| Vitamin D, IU | 0 |
| α-Tocopherol, mg | 2.17 |
| β-Tocopherol, mg | 0.13 |
| γ-Tocopherol, mg | 23.42 |
| δ-Tocopherol, mg | 0.55 |
| Vitamin K, μg | 13.2 |
| Folate, μg | 51 |
| Choline, mg | 71.4 |
| Betaine, mg | 0.8 |
| Thiamine, mg | 0.70 |
| Riboflavin, mg | 0.23 |
| Niacin, mg | 1.37 |
| Pantothenic acid, mg | 0.51 |
| Lutein + zeaxanthin, μg | 1160 |
| Alpha carotene, μg | 0 |
| Beta carotene, μg | 159 |

Data obtained from the US Department of Agriculture, Nutrient Database for Standard Reference, Release 28.[3]
Abbreviation: IU, international units.

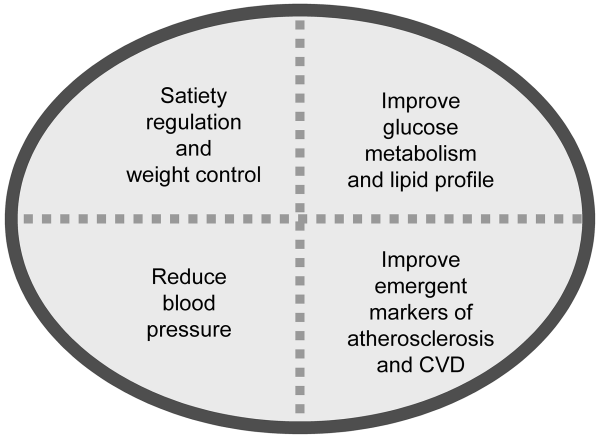


**FIGURE 2.** Possible health benefits of pistachio consumption. CVD indicates cardiovascular disease.

risk. Although they are difficult, very expensive, and time consuming, clinical trials need to be carried out in the future to fully establish the potential effects of pistachio consumption on the prevention of cardiovascular events.

### Blood Pressure and Endothelial Function

Several prospective studies have shown an inverse association between nut consumption and blood pressure or hypertension. However, the results of clinical trials are more controversial. The intake of 10% of energy in the form of pistachios for 1 month significantly reduced systolic blood pressure (SBP) and made no difference in diastolic blood pressure (DBP) compared with the control nut-free group.[40] Similarly, a recent study conducted in T2DM subjects showed a reduction in SBP after 4 weeks consuming a diet with 20% energy from pistachios.[41] Moreover, a recent systematic review and meta-analysis of more than 20 randomized controlled trials found that although DBP was reduced by the intake of mixed nuts, pistachios alone seemed to have the strongest effect on reducing both SBP and DBP.[42]

Walnut, hazelnut, and pistachio consumption also improves the circulating concentrations of endothelial markers and endothelial function.[43–45]

In conclusion, chronic pistachio consumption has proved to have a beneficial effect on blood pressure and endothelial function, which may help to improve cardiovascular risk.

### Glucose and Insulin Metabolism

Pistachios have more total carbohydrates (29% w/w) than do other nuts, but their consumption has no deleterious effect in subjects with abnormal glucose and insulin metabolism.

Data from several epidemiological studies and clinical trials suggest that the frequency of nut consumption is inversely related to an increased risk of T2DM. This may be because of the fact that nuts are relatively high in fiber, healthy fats, antioxidants, and anti-inflammatory content.[6,10,46,47] In addition, among all nuts, pistachios have a low glycemic index, suggesting that they may reduce postprandial glycemia and insulinemia and therefore contribute to reducing the T2DM risk.[48] Pistachios consumed alone had a minimal effect on postprandial glycemia, but the addition of pistachios to a meal containing foods rich in carbohydrates with a high glycemic index (eg, pasta, parboiled rice, or instant mashed potatoes)[49] or bread[48] reduces postprandial glycemia in a dose-dependent response.

Several clinical studies have investigated the effect of pistachio consumption on glucose concentrations. They observed a significant decrease in fasting plasma glucose (FPG),[22] in glucose but not in insulin blood levels,[17,23] and in both FPG and insulin levels[34] after pistachio intake. Only 1 cross-over study conducted on metabolic syndrome subjects free of type 2 diabetes has shown no significant changes in FPG or in insulin concentrations during the pistachio-enriched diet period compared with the intervention period without pistachios.[15]

Pistachio consumption has also proved to have beneficial effects on diabetes control. In a randomized controlled study, the intake of mixed nuts (including pistachios) for 3 months in T2DM subjects, as a replacement for carbohydrate-containing foods, demonstrated for the first time a significant decrease in hemoglobin $A_{1c}$ in a full-nut dose compared with a half-nut and control-muffin doses.[50] Results were similar in a recent crossover trial with 48 diabetic participants after 3 months of pistachio consumption.[23] Pistachio intake has also recently been found to significantly enhance the glucose and insulin metabolism of prediabetic patients[34] and improve insulin resistance status and other cardiovascular risk factors.

Despite the positive results observed for glucose metabolism, more studies need to be made to evaluate the long-term effects of pistachio consumption on insulin resistance and T2DM prevention and control.

## NEW TRENDS IN PISTACHIO RESEARCH

### Pistachio in the Prevention of T2DM and Other Metabolic Diseases

Research has focused widely on the beneficial effects of pistachios on such conditions as T2DM and metabolic syndrome.[17,23] However, very little information is currently available on the potential role that nuts play in preventing the development of chronic diseases such as T2DM.

### Pistachios in Cancer or Neurodegenerative Diseases

Vitamin E and other antioxidants provide some protection against certain forms of cancer. Therefore, foods such as pistachios, with a high content of γ-tocopherol (a form of vitamin E) and other antioxidants may reduce the risk of

different types of cancer.[51] Moreover, the skin of nuts contains considerable amounts of resveratrol,[52] which has been widely studied for its role in cancer, but new research is now changing this focus to other diseases such as Alzheimer's or Parkinson's.[53]

### Pistachio and Gut Microbiota

Recent findings have shown that both pistachios and almonds have a potential prebiotic effect in healthy populations, and that the effect of the former is greater.[54] Thereby, pistachios' microbiota modulation increased the number of butyrate-producing bacteria, identified as potentially beneficial, whereas bifidobacteria was not affected. However, new investigations should be performed to contrast and further explore these findings. Regulation of the phyla composition or the production of regulatory and protective molecules (eg, butyrate) by our gut microbiota could be mediators of the well-established beneficial properties of pistachios and other nuts.

## PRACTICE IMPLICATIONS

A common pistachio serving is about 28 g (1 oz) or 49 kernels of pistachio nut, in which there are almost 160 kcal. Pistachios are globally distributed and consumed as a healthy snack. Pistachios can also be added to many savory dishes such as pastas, marinades and crusts for meat entrees, salsas, and stir-fries as well as a topping for salads, yogurts, and dips. Their beneficial properties, based on pistachios' specific macronutrient, micronutrient and bioactive molecules will remain unchanged even after cooked. Moreover, other properties such as their contribution to the glycemic index and glycemic load of a particular meal would be improved by their inclusion.

To prevent fatty acids in pistachios from oxidation, store pistachios in an airtight container in the refrigerator at 40°F (4°C) for up to 1 year. At room temperature 68°F (20°C), they should be kept in a dry environment and will last several months.

Therefore, the inclusion of a handful of pistachios is a taste snack that may confer health benefits in the context of a healthy diet.

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