Pistachios for Health

What Do We Know About This Multifaceted Nut?

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THE HISTORY OF PISTACHIOS

Pistachio (from the Greek word pistaikon [πιστάκιον]), “the green nut,” is widely cultivated in the Mediterranean region, even though it probably originated in central and southwestern Asia. Evidence of its consumption has been found in archaeological excavations, which proves that it has long been associated with human activities. 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. 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.

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. 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 B12), and folate (Table 2), with relatively high amounts of these compounds compared with other nuts. 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...
the highest content of phytosterols, including stigmasterol, campesterol, and β-sitosterol. 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. 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 and that the visual cue of empty pistachio shells helped the participants to consume fewer calories during the day. 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. Only one recent study conducted in T2DM subjects has found a significant reduction of body mass index after pistachio consumption. 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. It has been speculated that various signaling systems (ie, mechanical, nutrient, and sensory) are activated by mastication, which may modify appetitive sensations. 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 and that the visual cue of empty pistachio shells helped the participants to consume fewer calories during the day.

Lipid Profile

Pistachio consumption has been widely studied in terms of its possible protective cardiovascular disease role. Significant improvements in plasma total cholesterol concentrations, total cholesterol (C)/high-density lipoprotein C (HDL-C) ratio and low-density lipoprotein C (LDL-C)/HDL-C ratio 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

| TABLE 1 Nutritional Composition of Nuts (Dry Roasted) |
|---------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 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. Abbreviations: MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid.

134 Nutrition Today® Volume 51, Number 3, May/June 2016
pistachio-supplemented group,\textsuperscript{21,22,32,33} whereas others have observed a nonsignificant reduction.\textsuperscript{18,19,34} However, Sheridan and coworkers\textsuperscript{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,\textsuperscript{35} which is even greater than that attributed to LDL-C.\textsuperscript{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.\textsuperscript{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,\textsuperscript{38} and the effect of pistachio on lipoprotein metabolism has been evaluated only recently.\textsuperscript{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

![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.\textsuperscript{3} MUF indicates monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid; CHO, carbohydrates regardless of fiber; PRO, protein.]

| Vitamin Content of Pistachios per 100 g (Dry Roasted) | Pistachio Nuts |
|------------------------------------------------------|---------------|
| Vitamin A, IU                                        | 266           |
| Vitamin B\textsubscript{6}, mg                        | 1.12          |
| Vitamin B\textsubscript{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.\textsuperscript{3}

Abbreviation: IU, international units.
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.
different types of cancer. Moreover, the skin of nuts contains considerable amounts of resveratrol, 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.

**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. 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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