

Concentration of Some Major Elements in the Kernel of *pistacia atlantica* desf., *p. Vera* Variety “sarakhs”, “badami zarand” and Cultivated Pistachio in Iran

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Abstract: Edible nuts have an increasing role in human diet. Pistachio is popular but less known kind of edible nut nevertheless it is rich in health benefiting nutrients, minerals, antioxidants and vitamins. This research focused on the concentration of nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca), all of which play a key role in the healthy human nutrition and lifestyle in the kernels of various cultivars and several samples, including “Ahmedaghahi”, “Akbari”(2 different phenotypes), “Sefid”, “Momtaz” “Kalleghuchi ” (3 different phenotype), “Ohadi (3 different phenotypes), “Garmeh” “Daneshmandi”, and “Badami zarand” which are most important commercially cultivated pistachio in Iran, also wild pistachios such as *Pistacia atlantica*, Sub sp. *mutica* Desf. (Baneh), *P. vera* variety “Sarakhs” and chance seedling as “Non-grafted trees. The amounts of the nutrient elements as well as protein content in 100 g kernel were eliminated. Protein content for examined cultivars varied from 13.75-28.13 gr/100gr, as well as N: 2.2-4.5 gr/100gr, P: 350-550 mg/100gr, K: 500-1100 mg/100gr and Ca: 40-135 mg/100gr. The results revealed wide variation in mineral content among different species and cultivars. In addition to, the results provided important data on the concentration of some major elements, emphasizing that pistachio kernel can be used as a good source of major elements as huge quantity of kernels produced and disposed in pistachio processing terminals.

Keywords: Pistachio, Edible nut, Major nutrients, Human nutrition.

INTRODUCTION

The consumption of edible nuts, especially luxury nuts, has shown an upward development in the EU in recent years. The most important trends are nuts as a healthy snack and convenience nuts products. Groundnuts (shelled as well as in shell) is by far the most popular nut in the EU, accounting for 45% of total nut consumption in 2005, followed by almonds (24%), hazelnuts (12%), walnuts (8%), cashew nuts (4%), chestnuts (3%) and pistachios (2%) [1]. Consumption of edible nuts in the EU member states, between 2001 and 2005 showed a slight increasing trend, except Hungary, Estonia, Ireland and Slovenia where the annual change is above 6% [3].

It follows from the high nutritional values of nuts and their role in healthy lifestyle. More and more consumers recognise the health value of nuts. Their high nutritious and protein level are factors which are expected to increase the demand for nuts. The beneficial effects of nuts are well known in human diet and vegetarian dietary as well.

From edible nuts, pistachio is very popular but less known than others. Nevertheless, pistachios are rich source of energy and contain many health benefiting nutrients, minerals, antioxidants and vitamins that are essential for optimum health [4]. Despite of the increasing consumption and using, there are a few reports dealing with chemical

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composition in relation to cultivar and stage of maturation [9 & 11].

Chemical composition of pistachio nuts may vary depending upon cultivar, rootstock and maturity at harvest and moisture content. The composition of pistachio kernels of various Iranian cultivars was studied by [8]. According to their results, the amount of constituent in 100 g kernel were within the following ranges, oil 55.2-60.5%, protein 15.0-21.2%, carbohydrate 14.9-17.7%, Na 4.0 mg, K 1048-1142 mg, Ca 120-150 mg, P 494-514.5 mg, Fe 5.8-11.4 mg, Cu 1.0-1.4 mg, Mg 157.5-165.0 mg [8] and 100 g pistachio has 600 calories [9]. Moreover, pistachio kernel has been recognized to have some medical properties due to antioxidant and antimicrobial actions [2].

This investigation was carried out in order to evaluate major mineral nutrient contents (nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca)) of kernels of some pistachio cultivars and compare to wild pistachio (*Pistacia atlantica* Desf.) which is the most economically important tree species as integrated genus in the west part of Iran.

MATERIALS AND METHODS

Sample collection

Pistachio samples were studied: "Ahmedaghahi", "Akbari" (2 different phenotypes), "Sefid", "Montaz" "Kallehghuchi" (3 different phenotypes), "Ohadi" (3 different phenotypes), "Garmeh" "Daneshmandi", "Badami zarand", *Pistacia atlantica* Desf. (Baneh), *P. vera* variety "Sarakhs", and 3 chance seedling ("Non-grafted 1", 2 and 3). Samples were harvested in September 2009 from different mature trees (14-year-old) randomly selected to represent the population of the plantation from a commercial pistachio orchard at Feizabad of the Khorasan-e-Razavi province, Iran (Latitude 39.295, Longitude 22.385), which covers an appropriate area for pistachio cultivation. The trees were spaced 6 and 3 m between and along the rows, respectively. The soil in this area was

classified as loam with a pH of 8.2 and contained 5.6 and 5.2 mg 100 g⁻¹ soil of plant available P and K, respectively. The soil was ploughed and treated with herbicides. The orchard was sprayed 4 times against pistachio psylla (*Agonoscyta pistaciae*): 1) just before anthesis, 2) first week of May, 3) third week of June and 4) third week of July with amitraz at 0.2%, volk 1% was used as a wetting agent. On the basis of soil analysis, the orchard was fertilized with 50 kg of N ha⁻¹ and 35 kg P ha⁻¹, before cultivation. Also 25 kg of N ha⁻¹ were supplied with irrigation (every 24 days) during the growth season.

The weather data were obtained from three stations around the experimental site. The average temperature, the amount of rainfall and relative humidity in growing season of 2009 were 28.65°C, 20 mm and 26%, respectively. The air dried pistachio nuts were used for chemical analysis in three of replication.

Chemical analysis of major elements

Approximately 50 grams of kernels was used for chemical analysis. Sample preparing was in accordance with Hungarian standard [12]. Kernels were digestion with concentrate HNO₃-H₂O₂ digester mixture. 5 g was digested at 120°C during three hours in a teflon digester. Digested samples diluted with distilled water to 100 cm³. Examined elements, except N were measured by Thermo Jarrell Ash Polyscan 61E and Thermo Electron Corporation IRIS Intrepid II XDL Inductively coupled plasma emission spectrophotometers (ICP). N content of kernels was determined by Kjeldahl method with a TECATOR 2200 automatic distillator and titrator. From N content of kernel protein was calculated by using the factor of N×6.25.

Statistical analysis

Data of plant nutrient contents were analyzed separately. Data for each element was subjected to

analysis of variance (ANOVA). The significant F-tests ($P < 0.05$) were used followed by the Least Significance Difference (LSD) test for pair wise comparison of means. Means were separated by LSD at ($P < 0.05$) Values within columns.

RESULTS AND DISCUSSION

Nitrogen

Pistachio nuts were classified as the foodstuffs that contain the high level of essential main minerals and trace elements. In the available literature data about the content of nitrogen in pistachio cultivars is scant. [8] showed that in the mature nut, arginine is a dominant amino acid and the edible kernel is rich in protein.

Nitrogen content of pistachio cultivars is presented in Figure 1. The nitrogen content varied from 2.2% to 4.5% dry weight in “Non-grafted 2” and “Kallehghuchi” cultivars, respectively. The results showed significantly higher concentrations of nitrogen were observed in the “Kallehghuchi 1”, “Kallehghuchi 2”, “Kallehghuchi 3”, than in “Ahmedaghaii”, “Non-grafted 1” and “Non-grafted 2”. Therefore, cultivar had significant effect on kernel nitrogen content.

The protein content of pistachio kernel is varied between 13.75 and 28.13 ($\text{g } 100^{-1}$ of dry weight). These values correlated with those published by [8] for various Iranian cultivars.

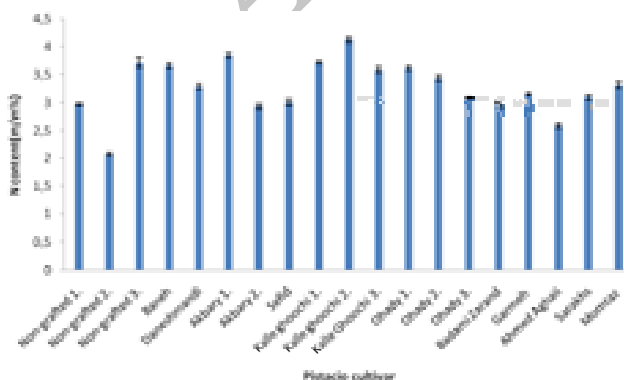


Fig. 1. Nitrogen concentration of *Pistacia atlantica* Desf., *P. vera* variety “Sarakhs”, “Badami zarand” and the most important pistachio cultivars.

Phosphorus

Phosphorus is an essential macro-element for plants growth and development required by every cell in the plant tissue. A number of enzymes, hormones and cell-signaling molecules depend on phosphorylation for their activation [10].

Phosphorus content of pistachio cultivars is presented in Figure 2. The results of this search show the phosphorus concentration of pistachio cultivars is between 0.35-0.55% dry weights “Kallehghuchi 2”, “Ohadi 2” and “Momtaz” cultivars contained significantly higher phosphorus in kernels than other examined cultivars. The lowest concentration was found at “Non-grafted 1”, “Non-grafted 2”, *Pistacia atlantica* Desf., “Daneshmandi” and “Akbari”.

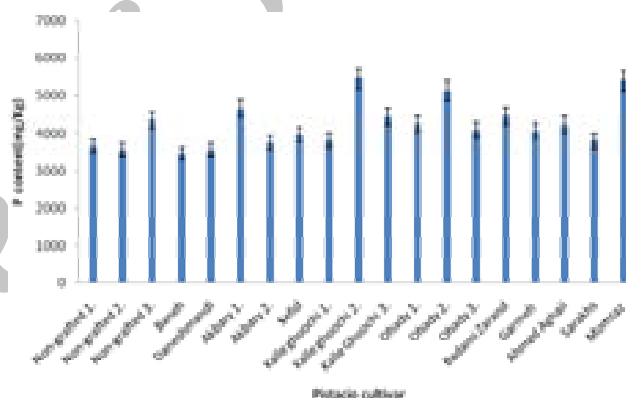


Fig. 2. Phosphorus concentration of *Pistacia atlantica* Desf., *P. vera* variety “Sarakhs”, “Badami zarand” and the most important pistachio cultivars.

Phosphorus in the examined pistachio cultivars had values in the range $350\text{-}550 \text{ mg } 100 \text{ g}^{-1}$, which are higher than the values for this element in banana ($26 \text{ mg } 100 \text{ g}^{-1}$), pineapple ($8 \text{ mg } 100 \text{ g}^{-1}$) and strawberries ($21 \text{ mg } 100 \text{ g}^{-1}$). Therefore Pistachio seems to be an excellent phosphorus source in human nutrition. Our results confirm earlier findings that pistachios are rich in phosphorus which helps the body break down meat and other proteins into amino acids. Phosphorus is necessary for hormone production and to help the body use B vitamins.

Low phosphorus can cause glucose intolerance and abnormally low serum phosphate level

(hypophosphatemia). The effects of hypophosphatemia may include loss of appetite, anemia, muscle weakness, bone pain, rickets (in children), osteomalacia (in adults), increased susceptibility to infection [10], numbness and tingling of the extremities and difficulty walking. Severe hypophosphatemia may result in death. Because phosphorus is so widespread in food, dietary phosphorus deficiency is usually seen only in cases of near-total starvation [10].

Potassium

Potassium is the most abundant mineral available in fruits. This element is mainly in combination with the various organic acids. Adequate intake of potassium for adults is 4700 (mg day⁻¹). Potassium is an essential element for nutrition. It is a cofactor for the activity of pyruvate kinase, an important enzyme in carbohydrate metabolism [13].

It is widely known that fruits and vegetables are among the richest sources of dietary potassium, and a large body of evidence supports the association of increased fruit and vegetable intakes with reduced risk of chronic disease. People who eat large amounts of fruits and vegetables have a high potassium intake (8-11 gr.day⁻¹). High dietary potassium intakes have significantly lower blood pressures than comparable groups with relatively low potassium intakes [7].

The results of this experiment showed that the average potassium content of examined cultivars is 8000 mg kg⁻¹ approximately. Significant differences in potassium content of kernel were observed. The highest amount of potassium belongs to "Non-grafted 2" by 11000 mg kg⁻¹ and the lowest amount belongs to *Pistacia atlantica* Desf., with 5000 mg.kg⁻¹ (Figure 3). "Kallehghuchi" "Ohadi" "Badami zarand", "Momtaz", "Ahmedaghaii" and "Ohadi" have medium amount of potassium which significantly differ with the other cultivars same as "Akbari", "Garmeh", *P. vera* variety "Sarakhs" "Non-grafted and "Sefid".

Calcium

Calcium has great function in human body as structural element, affected cell signaling and cofactor for enzymes and proteins. Calcium plays a role in mediating the constriction and relaxation of blood vessels (vasoconstriction and vasodilation), nerve impulse transmission, muscle contraction and the secretion of hormones like insulin [6].

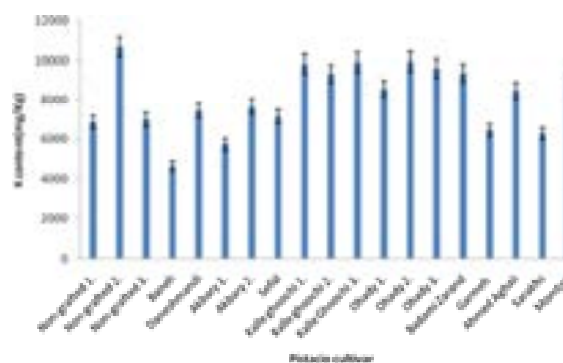


Fig. 3. Potassium concentration of *Pistacia atlantica* Desf., *P. vera* variety "Sarakhs", "Badami zarand" and the most important pistachio cultivars.

The results of this experiment showed that the maximum calcium levels in the nut of examined pistachio cultivars were about 1350 mg kg⁻¹ in "Daneshmandi" and minimum level in "Non-grafted 2" (400 mg kg⁻¹). "Kallehghuchi 3", "Ohadi 3", "Ahmedaghaii", "Akbary 1" and "Akbary 2" cultivars have medium amount of calcium which significantly differ with the other cultivars same as "Kallehghuchi 1", "Ohadi 2", "Kallehghuchi 2", "Badami zarand", "Momtaz", "Ohadi 1", "Garmeh", *P. vera* variety "Sarakhs", "Non-grafted 1", "Non-grafted 3" and "Sefid" (Figure 4). According to our results, pistachio nuts represent rich and absorbable sources of calcium, also certain vegetables and grains provide calcium. However, the bioavailability of the calcium must be taken into consideration. While the calcium rich plants in the kale family (broccoli, bokchoy, cabbage, mustard and turnip greens) contain calcium that is as bioavailable as that in milk and some food components have been found to inhibit the

absorption of calcium and are comparable to values for guava (23 mg 100 g⁻¹) and raspberries (26 mg 100 g⁻¹). *Zizyphus mauritiana* contains the highest level of calcium and magnesium with values for the latter element in fruit ranging between 16.7-227 mg 100 g⁻¹ [14].

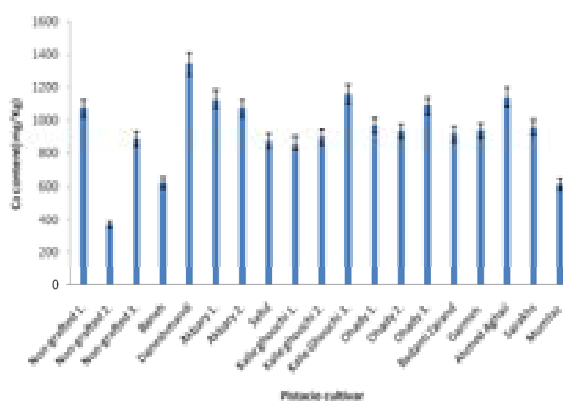


Fig. 4. Calcium concentration of *Pistacia atlantica* Desf., *P. vera* variety "Sarakhs", "Badami zarand" and the most important pistachio cultivars.

Though some fruits, such as apricots, pears, peach, plums and strawberries contain oxalic acid. The concentration of this acid is not sufficient to reduce the absorption of calcium from the fruit or from other foods eaten together with the fruit. Our results pointed out that pistachio regards as an excellent calcium source for human diet. Its role is more expressed in vegetarian diet.

Adequate intake of calcium for adults is 1000 mg day⁻¹. The combination diet represented an increase of about 800 mg of calcium day⁻¹ over the control and fruit/vegetable rich diets for a total of about 1200 mg of calcium day⁻¹.

CONCLUSIONS

The results represent that nitrogen, phosphorus, potassium and calcium content of examined pistachio cultivars which are rich sources of different essential elements and their consumption in human dietary is beneficial to human health and can provide necessary dose of elements needed by body. Although, good quality control programs must be applied for the safety of consumers

especially in processed nuts. The concentration of nitrogen ranged from 2.2% to 4.5% in "Non-grafted 2" and "Kalleghoochi 2" cultivars, respectively, where as that of phosphorus was ranged from 3500-5500 mg kg⁻¹. The potassium content of examined cultivars is 8000 mg kg⁻¹. The highest amount of potassium belongs to "Non-grafted 2" by 11000 mg kg⁻¹ and the lowest amount belongs to *Pistacia atlantica* Desf., with 5000 mg kg⁻¹. "Kalleghuchi 1", "Kalleghuchi 3", "Ohadi 2", "Ohadi 3", "Kalleghuchi 2", "Badami zarand", "Momtaz", "Ahmedaghahi" and "Ohadi 1" have medium amount of potassium which significantly differ with the other cultivars same as: "Akbary 2", "Garmeh", *P. vera* variety "Sarakhs", "Akbary 1", "Non-grafted 1", "Non-grafted 3" and "Sefid". The results of this experiment showed that the kernel calcium content varied between 1350 mg kg⁻¹ (in "Daneshmandi") and 400 mg kg⁻¹ (in "Non-grafted 2"). According to our results pistachio kernels are regarded as potential food and nutrient source for human diet.

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