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Variation of nutrients and antioxidant activity in seed and exocarp layer of some Persian pistachio genotypes

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ABSTRACT

Pistachio nuts are rich sources of nutrients which are essential for human wellbeing. In the present study we investigate the variation of oil, protein, total phenol, mineral contents, and antioxidant activity of twenty rare Persian pistachio nuts and exocarp layer. Among the 20 pistachio genotypes, in seeds Mn concentration was varied from 5.73 to 17.33 mg/kg; Fe ranged from 17 to 62.4 mg/kg; Zn varied from 6.76 to 30.3 mg/kg; Na ranged from 0.06 to 0.126%; K varied from 0.68 to 1.35%; P varied from 0.42 to 0.73%; N ranged from 2.6 to 4.29%; Mg varied from 0.11 to 0.17%, Ca varied from 0.23 to 0.47%, oil ranged from 47.94 to 57.29% and protein ranged from 16.26 to 25.5%. The G3 genotype had the highest total phenol content (35.64 mg GAEs/g) and antioxidant activity (90.55%) in exocarp layer and oil content in seeds (57.29%). The highest phosphorus (0.73%) in exocarp layer and phenol (4.2 mg GAEs/g) contents in seeds were observed in G19. According to the correlation analysis, there were a correlation between total phenol (in exocarp layer) and oil contents gain with some values; these two values had a significant correlation with PC1. Cluster analysis separated the genotypes into three groups considering all measured Values.

Introduction

Pistachio nuts are rich sources of nutrients such as proteins, phenol compounds, vitamins, antioxidants and minerals which are essential for human wellbeing (Ghrab et al., 2012; Venkatachalam and Sathe, 2006; Miraliakbari and Shahidi, 2008; Tomaino et al., 2010). Moreover, pistachio contains unsaturated lipids and is useful in lowering blood cholesterol and in reducing cardiovascular morbidity and mortality (West et al., 2012; Kris-Etherton et al., 2001). Pistachio-rich diet has been demonstrated as a lucrative nutritional strategy for the prediabetic state and effective glucose and insulin lowering agent (Hernández-Alonso et al., 2014). Nowadays, synthetic antioxidants such as BHT, BHA, and tBHQ are used to delay the oxidation of lipid; however, due to the toxic effects of these synthetic antioxidants, and because of their carcinogenicity, particular attention has been given to dietary consumption of phenolic compounds of plant origin (Tomaino et al., 2010; Branen, 1975; Gharavi et al., 2007; van Esch, 1986; Arcan and Yemenicioğlu, 2009). Iran is one of the two main centers of diversity and the leading pistachio producer country in the world, with total production of 415,531 tons in 2014 (FAO, 2014; Pazouki et al., 2010; Tayefeh Aliakbarkhani et al., 2015; Talebi et al., 2016). Goli et al. (2005) expressed that the green pistachio testa, contains considerable amounts of phenolic compounds comparing other sources of these compounds. Since the exterior green testa of the pistachio nut comprises about 40 percentage of its weight, Iran has great potential to produce phenolic compounds from the pistachio exocarp layer. Nevertheless, there exist some variations among different pistachio genotypes in terms of protein, oil and fatty acid contents, particularly under various climatic conditions (Küçüköner and Yurt, 2003; Arena et al., 2007; Tsantili et al., 2010). Tsantili et al. (2010) expressed that physical, compositional and sensory traits of pistachio nuts are considerably affected by the variation. Due to the wide range of pistachio diversity in Iran, investigating competent genotypes containing more phenolic compounds, antioxidant, protein, oil and micronutrient

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contents, would be of great interest and could introduce the extend pistachio gene pool for breeding or nutritional purposes. Overall, the present investigation tries to investigate the variation of food properties among 20 rare Persian pistachio genotypes.

Materials and methods

Preparation of plant material

Twenty pistachio genotypes from different pistachio production areas of Iran were gathered and used in the present investigation (Table 1). At harvest time, 15 fruit bunches were taken randomly from different parts of each tree. Samples preparation was as follows: Initially the exocarp layers and seeds were slowly dried in the shade at room temperature over the course of a week, then the dried exocarp layer and nuts were milled and subsequently sifted using a 1-mm mesh sieve. The sifted samples were kept in a freezer at −20 °C until examination. Measured values are presented in Table 2.

Oil analysis

The oil percentage was determined using the soxhlet method. One gram of the milled sample was sifted using a 1-mm mesh sieve, and then the oil was extracted using an automatic Soxhlet extractor for six hours (Soxtec system 1043, Foss Tecator, Sweden).

Protein content analysis

Protein content was determined by the micro-Kjeldahl method using a conversion factor of 6.25 suggested by Hosseini-Shokraii (1977). In this method, the main aim is to find the total nitrogen content of the samples (Chemists AoOA and Horwitz, 1980).

Determination of macro- and micro-nutrients

Nutrients content such as nitrogen (N), phosphorous (P), potassium (K), sodium (Na), calcium (Ca) magnesium (Mg), manganese (Mn), zinc (Zn) and iron (Fe), were measured.

For this purpose, plant materials were mineralized by the ashing method as follows: one gram of the powdered plant was heated for six hours in an oven (Model 28, Precision Scientific, Chicago, IL) at 550 °C to convert it into ash. Then, 10 ml of 2 N hydrochloric acid were added to it and the mixture was placed in a hot bath for half an hour. After that, distilled water was added to raise the volume of this extract to 100 ml; and the contents of P, K, Na, Mn, Zn and Fe were determined. To determine nutrients, the Kjeldahl method (for N), the method of Eible and Lands (for P), the flame photometry method (for K and Na) and a complex ometric titration method (for Ca and Mg) were applied; and an atomic absorption spectrophotometer (Model: AA-670, Shimadzu Co., Kyoto, Japan) was employed to measure the Mn, Zn, and Fe contents (Eibl and Lands, 1969).

Determination of total phenol content

The total phenolic content was determined using the Folin–Ciocalteu method (Singh et al., 2002). Twenty milliliters of methanol were added to one gram of the milled samples and kept for four hours at room temperature and subsequently filtered using a filter paper (Whatman No. 1) and kept at −20 °C until examination. At examination time, 40 Âμl of samples plus different standard concentrations of gallic acid were added to 3160 Âμl distilled water and 200 Âμl of the Folin indicator and 600 Âμl of saturated sodium carbonate were added. After keeping the mixtures in the dark for three hours, the absorption at the wavelength of 765 nm were measured. The total phenolic content was expressed in mg of gallic acid equivalents (GAE)/g of the dried sample.

Antioxidant activity

The antioxidant capacity of the extracts (radical scavenging activity RSA) was accessed by stable DPPH radicals and following the method introduced by Oliveira et al. (2008). 0.2 ml of the extract at different concentrations was added to 4 ml of a 6×10^{-5} M methanol solution of the free radical DPPH and the mixtures were kept at room temperature for four hours. Then the absorption was read at the wavelength of 517 nm using a spectrophotometer. A sample containing 0.2 ml of methanol plus 4 ml of the DPPH solution was applied as control sample; and the solvent methanol was employed to set the spectrometer at zero. The experiment was conducted in three replications. The radical scavenging activity of the extract was determined using the following formula:

$$\% \text{ RSA} = [1 - (A_{\text{control}} - A_{\text{sample}})/A_{\text{contol}}] \times 100$$

Table 1
Persian pistachio genotypes with their collection area (region) included in the study.

Genotype	Collection area	Latitude (N)	Longitude (E)	Altitude (M)
G1	Feyzabad	35°00′51″	58°46′48″	928
G2	Feyzabad	35°00′51″	58°46′48″	928
G3	Feyzabad	35°00′51″	58°46′48″	928
G4	Bardaskan	35°15′38″	57°58′10″	984
G5	Bardaskan	35°15′38″	57°58′10″	984
G6	Rafsanjan	30°24′24″	55°59′38″	1514
G7	Feyzabad	35°00′51″	58°46′48″	928
G8	Feyzabad	35°00′51″	58°46′48″	928
G9	Feyzabad	35°00′51″	58°46′48″	928
G10	Kerman	30°16′59″	57°04′43″	1760
G11	Gonabad	34°21′10″	58°41′01″	1095
G12	Torbat-e Jam	35°14′38″	60°37′21″	908
G13	Torbat-e Jam	35°14′38″	60°37′21″	908
G14	Birjand	32°51′58″	59°13′16″	1459
G15	Birjand	32°51′58″	59°13′16″	1459
G16	Gonabad	34°21′10″	58°41′01″	1095
G17	Gonabad	34°21′10″	58°41′01″	1095
G18	Feyzabad	35°00′51″	58°46′48″	928
G19	Rafsanjan	30°24′24″	55°59′38″	1514
G 20	Kerman	30°16′59″	57°04′43″	1760