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Influence of Different Roasting Conditions in the Phenolic Compounds and Antioxidant Capacity of the Pistachio Nuts

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Abstract

Pistachio is a functional food rich in varied antioxidants that a large percentage of it is used as roasted. In this study the effect of different roasting conditions, including temperature-time of 120 °C -30 min and various additives such as NaCl, ascorbic acid and sodium metabisulphite, was investigated on the phenolic compounds and antioxidant capacity of the pistachio nuts. For this purpose, cupric ion reducing, carotenoids, flavonoids, vitamin E, chlorophyll a and chlorophyll b of raw and roasted pistachios was measured. The combination of time-temperature decreased the amount of chlorophylls, carotenoids and antioxidant capacity in roasted pistachios, but had no effect on the flavonoids and vitamin E content. The additives did not influence flavonoids and antioxidant capacity of roasted pistachio. Sodium metabisulphite had been lowering effect on chlorophylls, carotenoids and vitamin E content of roasted pistachios. NaCl and ascorbic acid only had a depressing effect on the amount of vitamin E and a positive effect on chlorophyll b content.

Key words: antioxidant capacity; phenolic compounds; roasting; pistachio nut

1. INTRODUCTION

Pistachio is an edible seed of a pistachio tree (Pistacia Vera L.), a plant of the Anacardiaceae family(Hsu, Mannapperuma et al. 1991, Saitta, Giuffrida et al. 2009). Pistachio tree can be cultured on hot, dry areas and under saline conditions. Iran, United States of America, Turkey, Syria, Italy and Greece are the main manufacturers of pistachio, and world production is constantly increasing(Pumilia, Cichon et al. 2014).

Pistachio is from popular nuts in the world and known as green gold due to its high economic value(Kahyaoglu 2008). Pistachio has considered due to the large amounts of certain nutrients and health promoting compounds, such as unsaturated fatty acids, carotenoids, vitamins, minerals, sterols and polyphenols. And most recently, as a functional food has ranked among fifty first food products with the highest antioxidant potential (Hojjati, Calín-Sánchez et al. 2013, Pumilia, Cichon et al. 2014) Several antioxidants of pistachio are such as γ-tocopherol , β-carotene, lutein, selenium, flavonoids, and phytoestrogens(Gebauer, West et al. 2008). Dietary compounds, including polyphenols, carotenoids and vitamins C and E are considered as effective antioxidants in preventing oxidative stress and related diseases(Locatelli, Travaglia et al. 2010).

Compared to other nuts used commonly, pistachios are the richest source of phytosterols (279 mg total phytosterols/100 g; 210 mg β-sitosterol/100 g, as the predominant phytosterol), potassium (1042 mg / 100 g), vitamin B-6 (1/3 mg /100 g), β-carotene (157µg/100g), and lutein + zeaxanthin (1205 µg/100 g), and are one of the excellent sources of protein (21.4 g /100 g), fiber (10.3 g/100 g), selenium (9.3 mcg/100 g), and γ-tocopherol (22.5 mg/100 g)(Gebauer, West et al. 2008).

One of the most common forms of pistachio nut processing is roasting. This process leads to be sensory, texture, chemical and physical changes to the product(Kahyaoglu 2008, Nikzadeh and Sedaghat 2008). Moreover, the roasting process affects the phenolic contents and antioxidant activities of nuts such as cashew nut, hazelnuts and peanuts. It has been shown that the Maillard reaction compounds generated during thermal treatments may enhance the antioxidant effects of processed foods(Lin, Liu et al. 2016). However, little information is available regarding the effects of roasting process on antioxidant activity and phenolic compounds of pistachio.

Based on the above, this study was performed to investigate the effect of the temperature - time of 120 °C - 30 min and different additives (NaCl, ascorbic acid and sodium metabisulphite) on the antioxidant capacity, carotenoids, flavonoids, vitamin E, chlorophyll a and chlorophyll b of pistachio during roasting process.

2. MATERIALS AND METHODS

2.1. Materials

Sodium chloride (NaCl), ascorbic acid (Vc) and sodium metabisulphite ($Na_2S_2O_5$) obtained from Merck company.

2.2. Roasting

Raw pistachio, Fandoghi variety (Ohadi), was prepared from Rafsanjan Pistachio Research Center. And were divided into four parts. One part was used as control and the other three parts were formulated as follows:

Salting: Pistachio nuts were immersed in 15% NaCl in water (w / w) for five hours, and then were sieved to remove the excess salt water.

Immersion in sodium metabisulphite or ascorbic acid solution: The salted nuts were immersed in 1% sodium

metabisulphite or 1% ascorbic acid in water (w / w), and taken out immediately.
Drying: pistachio's samples were dried in an electric oven (Memmert ule500) at 80 °C for three hours (until 4% moisture).
Roasting: 30 g of pistachio's samples was placed in a petri dish with a diameter of 14 cm as one layer and roasted in the electric oven (Memmert ule500) in temperature of 120 °C in time of 30 minute
Cooling: roasted pistachios were cooled to room temperature and placed in plastic bags, then stored in a temperature of 8 °C.

2. 3. Extracting
Pistachio samples, including raw and roasted pistachios were powdered and extracted with 100 mL of ethanol-water mixture at 70:30 (v/v). The mixtures were stirred continuously for 24 h at 4 °C.

2. 4. Determination of chlorophylls
The levels of chlorophyll were determined according to method of Misyura et al. (Misyura, Colasanti et al. 2012). The extracts absorbance was read in a UV-260 spectrophotometer at 663 nm and 645 nm. The amounts of Chlorophyll a and Chlorophyll b was calculated according to following formulas:
Chlorophyll a = (19.3 ×A663 - 0.86 × A645) V/100W
Chlorophyll b = (19.3 ×A645 - 3.6 ×A663) V/100W

2.5. Determination of carotenoids
The extracts absorbance was read in the spectrophotometer at 470 nm. Carotenoids content was calculated upon the basis of the standard curve of B carotene.

2.6. Determination of vitamin E
Vitamin E content was measured according to a published method by Shah et al. Samples were exposed to Fe^3 solution, TPTZ and acetate buffer (pH 4). Then, the standard curve was prepared with appropriate vitamin E concentrations. The absorbance of samples was read at 595 nm wavelength(Shah, Khand et al. 2015).

2.7. Determination of cupric ion reducing assay (cupric)
The cupric ion reducing capacity assay measures the cupric reducing capacity. The samples were mixed with solutions of $CuCl_2$, neocuproine reagent in an ammonium acetate buffer. The resulting absorbance at 450 nm is recorded either directly after incubation at 50 °C for 20 min(Apak, Güclü et al. 2008).

2.8. Determination of Flavonoid
Total flavonoid content was assayed according to previous methods (Qiu–Lin et al., 2006). Diluted extracts were mixed with reagent; ALCl3.6H2O 2% in methanol flavonoids could make complex with trivalent aluminum ion. Then, the samples were incubated in room condition for 10 minute. The absorbance of the samples was measured at 430 nm.

2.9. Statistical analysis
Data were analyzed for differences between means using SPSS version 16, with statistical significance when $P < 0.05$.

3. RESULTS AND DISCUSSION

After roasting of pistachio samples at 120 ° C for 30 minutes, content of the total carotenoids, flavonoids, chlorophylls, vitamin E and antioxidant activity of raw and roasted pistachio samples was measured. The results are shown in Tables 1 and 2. The data values were expressed as mean ±SD. The concentration of carotenoid pigments in the extracts was calculated using the standard curve obtained by a commercial β-carotene reagent. The formula used in the calculation was as follows:
$y = 517.42x - 0.0049$; $R^2 = 0.99$
The total flavonoids content was also calculated using the standard curve obtained by a rutin reagent. The formula used in the calculation was as follows:
$y = 4.973x - 0.0017$; $R^2 = 1$

3.1. Chlorophylls
Temperature - time conditions of 120 °C - 30 min significantly (p-value <.05) reduced the amount of chlorophyll a and b in the roasted pistachio sample. Chlorophyll a and b measured by Pumilia et al. (2014) in pistachio kernels roasted at 138 ° C for 5 and 10 minutes has been more than raw pistachio kernels(Pumilia, Cichon et al. 2014).

Table 1. Levels of total carotenoids, total flavonoids and Chlorophylls

Preparation condition	Chlorophylls (mg /g)		Total flavonoids (mg/g)	Total carotenoids (mg /g)
	Chlorophyll a	Chlorophyll b		
Raw pistachio	0.33± 0.011	0.14± 0.005	2.6± 1.35	0.007± 0.002
Control	0.073± 0.01	0.06± 0.015	1.8± 0.83	0.005± 0.002
NaCl (15%)	0.089± 0.001	0.108± 0.018	1.6± 0.27	0.005± 0.002
Ascorbic acid (1%)	0.034± 0.001	0.08± 0.017	1.7± 0.25	0.005± 0.002
Sodium metabisulphite (1%)	0.02± 0.006	0.014± 0.001	1.7± 0.23	0.004± 0.002

Table 2. Level of antioxidant activity and vitamin E

Preparation condition	cupric assay (nm)	Vitamin E (mg/g(
Raw pistachio	0.56± 0.03	1.16± 0.07
Control	0.42± 0.06	1.18± 0.27
NaCl (15%)	0.41± 0.02	0.4± 0.18
Ascorbic acid (1%)	0.4± 0.02	0.6± 0.13
Sodium metabisulphite (1%)	0.36± 0.03	0.08± 0.007

NaCl and ascorbic acid had no effect on chlorophyll a content of roasted pistachio sample (p-value> .05). But sodium metabisulphite had a depressing effect on chlorophyll a content of roasted pistachio sample (p-value <.05), which means, a greater reduction in chlorophyll a was observed in the presence of sodium metabisulphite.
In the presence of NaCl and ascorbic acid, less decline in chlorophyll b content was observed (p-value <.05), but sodium metabisulphite had lowering effect on chlorophyll b content of roasted pistachio sample (p-value <.05).

3.2. Carotenoids

Temperature - time of 120 ^{o}C - 30 min reduced the amount of carotenoids in roasted pistachio, significantly (p-value <.05).
NaCl and ascorbic acid had no effect on the carotenoids content of roasted pistachio sample (p-value> .05). But sodium metabisulphite had a reducing effect on the amount of roasted pistachio carotenoids.

3.3. Vitamin E

Temperature - time of 120 ^{o}C - 30 min had no significant effect on the vitamin E content of roasted pistachio sample (p-value> .05). NaCl, ascorbic acid and sodium metabisulphite reduced the amount of vitamin E in the roasted pistachio sample (p-value <.05). Vitamin E is one of the best scavenging agent for free radicals agents (Goudarzi et al, 2016).

3.4. Flavonoids

Temperature - time of 120 ^{o}C - 30 min and additives used in the roasting process had no significant effect on the flavonoids content of roasted pistachio samples (p-value> .05).
In the study of Lin et al. (2016), in the initial stage of roasting (5 minutes), flavonoids substantially lost in defatted almonds kernels roasted at 150, 180 or 200 ° C(Lin, Liu et al. 2016).

3.5. Antioxidant capacity

Temperature-time of 120 ^{o}C - 30 min significantly decreased antioxidant capacity of roasted pistachio samples (p-value <.05).Also, Schlormann et al. (2015) found that Pistachio lipophilic antioxidant capacity reduced as a result of roasting(Schlörmann, Birringer et al. 2015). Lemos et al. (2012) showed that the roasting process significantly reduces antioxidant capacity in the baru nut with peel(Lemos, de Almeida Siqueira et al. 2012). As well as decreased antioxidant activity of Roasted almonds and other nuts have been reported By Acar (2009)(Açar, Gökmen et al. 2009). In the study of lin et al (2016), the antioxidant activity of roasted almonds in 180 or 200 ° C for 20 minutes was significantly higher than the raw almonds(Lin, Liu et al. 2016).
None of the additives had any effect on the antioxidant capacity of roasted pistachios (p-value > .05).

4. CONCLUSION

In general, sodium metabisulphite, NaCl and ascorbic acid respectively had the highest and lowest negative effect on phenolic compounds and antioxidant capacity of roasted pistachios.

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