International Journal of
Public Health & Safety

Research Article Open Access

Evaluation of Lipid Oxidation of Roasted Pistachio Oil in Presence of Different Additives

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Abstract

The aim of the current study was to establish whether pistachio roasting with various additives application would affect lipid oxidation. The specific objective of this study was to determine Malondialdehyde content in the roasted pistachio oil. The chemical analysis was performed on samples of roasted pistachio nuts without any additive (A), with salt (B), with salt plus 1% starch (C) and with salt plus 1% ascorbic acid (D). All samples were roasted at the temperature of 120ºC for 30 min. The level of lipid peroxidation in roasted pistachios in presence of different additives was assessed by determining Malondialdehyde (MDA) content in pistachio oil fraction with Spectrophotometric Thiobarbituric acid (TBA) test. Thiobarbituric acid values decrease for all treatments with additives in comparison to control groups. We found that using additives (salt, starch, and ascorbic acid) before roasting of pistachio nuts can reduce the oxidative reaction. The results of this study showed that using salt plus starch as an additive, prevented samples from oil deterioration being a little more efficient compared with salt and salt plus ascorbic acid, so it might be beneficial for human health

Keywords: Pistachio nut; Roasting; Oxidation; Additives

Introduction

Due to the presence of essential nutrients and especially phenolic compounds, nuts have been considered to possess various health beneficial properties including cardio-protective effects and introduced as a rich source of natural antioxidants [1,2]. Pistachio (*Pistachio vera L.*, belonging to the Anacardiaceae family) have recently been reported to be among the first 50 food products highest in phenolic compounds responsible for high antioxidant activity [3].

Pistachio nut tree is native of the west and central Asia and Mediterranean zones and is cultivated mainly in Iran, Syria, Turkey, USA, Greece, and Italy. It is one of the most popular nuts worldwide that is widely consumed as salted and roasted in confectionary, as snack foods or an ingredient of many desserts, ice cream, cake, pastry and some sausages. Pistachio nut contain about 50% oil in which oleic acid (54.4%-71.8%) is dominant fatty acid, followed by linoleic acid (16.7%-35.3%), palmitic acid (7.2%-10.5%), stearic acid (0.9%-10.5%) and less than 2% linoleic acid [3-6].

Consumption of pistachio due to unsaturated fatty acids (MUFA/PUFA) and some phytochemical compounds such as phytosterols and polyphenols contribute to the reduction in cardiovascular disease and regulate total and LDL cholesterol levels and glycemic index [7-9].

Iran is one of the leading pistachio nut producing and exporting countries in the world. The annual production of Iran was estimated at nearly 249000 tons in 2003, 304000 tons in 2005, and 472000 tons in 2011. Due to these facts and to preserve the strategic situation of Iran as the largest exporter in the world, it would be necessary to optimize qualitative properties such as oxidative stability, fatty acid profile and antioxidant activity [10-12].

Postharvest operations (including dehulling, washing, drying or roasting, packaging, and storage) are important stages to obtain the maximum yield of good quality [8]. Food processing technologies have been developed for quality improvement, food safety and aesthetics purposes [7].

Roasting (as one of the most common processes for pistachio) significantly improves the flavor, color, texture and also appearance of nuts. Compared to raw nut, the roasted nut has a palatable taste and unique organoleptic characteristics. Roasting can inactivate enzymes and also remove undesirable microorganisms and some contaminants [13]. On the other hand, the roasting process leads to changes in proteins, carbohydrates, fats, and vitamins during heat processing. Pistachio contains the large amount of lipid that may undergo deteriorative oxidation during processing and long-term storage, especially polyunsaturated fatty acids and phytosterols that make it more susceptible to oxidation. Some consequent oxidation products have a similar structure to toxic oxidized cholesterol derivatives that cause cytotoxicity and neurotoxicity. All chemical degradative reactions (especially auto-oxidation and browning reaction) result in adverse changes in the original quality properties of the roasted product and nutritional value and also shelf life [4,7,13-17].

Malondialdehyde (MDA) is a peroxidation byproduct of polyunsaturated lipids. Therefore, MDA content in the lipid fraction of pistachio is an indication of overall lipid peroxidation induced by bleaching, drying, and roasting treatments [7]. Few studies were found on the roasting process of pistachio with different additives. In this study, the magnitude of lipid peroxidation in roasted pistachios in presence of different additives was assessed by determining MDA content in pistachio oil fraction with Spectrophotometric TBA test.

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Received August 14, 2018; **Accepted** August 27, 2018; **Published** August 30, 2018

Citation: Leila PR, Behrouz TO, Parisa S (2018) Evaluation of Lipid Oxidation of Roasted Pistachio Oil in Presence of Different Additives. Int J Pub Health Safe 3: 162.

Materials and Methods

Materials

All chemicals and solvents used in this study such as Sodium chloride (NaCl), ascorbic acid, starch, and n-hexane were of analytical grade and were supplied by Merk Company (Merck KGaA, Darmstadt, Germany).

Sample preparation

A sample of raw pistachio nut, Fandoghi variety (Ohadi), was obtained from Rafsanjan province (Iran Pistachio Research Institute). After dehulling, they were grouped in 4 parts. One part was used as control (group A) and the others were formulated with additives as follows:

- **Formulation B:** Pistachio nuts were soaked in NaCl solution (15% w/w) for 5 h, and then the excess brine was sieved and removed.
- **Formulation C:** Salted pistachio nuts were soaked in starch solution (1% w/w) and then samples were sieved immediately to remove the residue solution.
- **Formulation D:** The salted pistachio nuts were soaked in ascorbic acid solution (1% w/w) and then samples were sieved immediately to remove the residue solution.

Drying

All groups of pistachio samples were dried in an electric oven at 80°C for 3 h to decrease moisture content to 4%.

Roasting

From each group, the weight of 30 g of pistachio samples was roasted in the electric oven (memmert ule500) at the temperature of 120°C for 30 min. all samples were exposed to heating operation in a pyrex Petri dish (14 cm in diameter) as a single layer. Three replications were carried out for each run. After that, roasted seeds were cooled in the desiccator and were put in plastic bags, then stored in 8°C maximum in one month before extraction.

Oil extraction

Oxidative stability of roasted pistachio oil samples was evaluated by measuring the formation of thiobarbituric acid-reactive substances (TBA-RS) as described by previous studies [19,20]. Briefly was dispensed in plastic tubes and mixed with 20% trichloroacetic acid, using a homogenizer for 1 min. the mixture was centrifuged at 3000 rpm for 3 min and filtered through Whatman No. 54 filter paper. Next, 2 M thiobarbituric acid was added to the 2 mL aliquots of the filtrate and heated in boiling water bath (100°C) for 45 min to appear the pink color. The absorbance was measured at 532 nm using a spectrophotometer (Hach, DR5000) against a blank containing 2 mL of TBA reagent and 2 mL of TCA. The values were expressed as µmoles Malondialdehyde (MDA), using a molar extinction coefficient of 1.56×105 M-1 cm^{-1}. MDA analysis in all samples was performed in triplicate.

Statistical Analysis

The evaluation of statistical differences between groups was analyzed using the student's T-test by Statistical Package for the Social Sciences (SPSS Inc., USA) version 22.0 for windows. The data values are expressed as the mean ± standard deviation and significance. According to the statistical facts, a significant difference was concluded at a level of $p \leq 0.05$ (Figure 1).

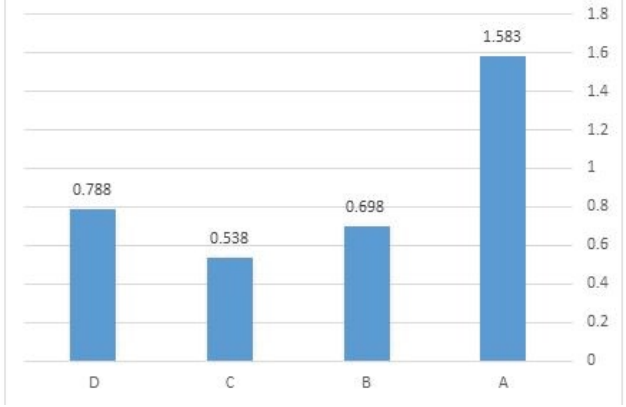

Figure 1: The effect of additives on the rate of oxidation based on TBA-RS numbers; Roasted pistachio without any additive (A), Roasted pistachio with salt (B), Roasted pistachio with salt plus starch (C) and Roasted pistachio with salt plus ascorbic acid (D).

Results and Discussions

Recently, there has been an increasing interest in the nutritional importance of nuts especially fatty acids and phenolic compounds [1,21]. Besides the positive effect of pistachio consumption on human health, recent research has been focused on potential oxidation of pistachio oil. In this research, we extracted the crude oil from pistachio kernels, roasted with different additives and investigated the effects of additives on lipid oxidation of roasted pistachio oil.

Roasting treatment influences phenolic compounds and antioxidant activity for nuts and may change fatty acid composition, resulting in the formation of hydroperoxides, aldehydes, ketones and carboxylic acids that function as catalyzer and accelerate the oxidative reaction, which cause rancidity in oil, lower the safety, organoleptic and nutritional value of product and exhibit harm potential on human health such as aging, heart disease and cancer [4,11,16,22].

Malondialdehyde (MDA) is one of the most important products of oxidation, which is a carcinogen and mutagen agent. MDA has often been used as a marker of oxidative damage in food samples. The most common method for determination of MDA is the spectrophotometric determination of the pink fluorescent MDA-TBA complex produced after reaction with the 2-thiobarbituric acid (TBA) at low pH and high temperature [23].

Racicot et al. reported the bleaching treatment had negative effects on nutritional quality and health benefits of pistachios by increasing lipid peroxidation, decreasing phytosterol content, and causing cytotoxicity compared to natural pistachios [7]. Morat ozdemir et al. indicated that roasting conditions significantly affected peroxide value and free fatty acids of hazelnuts [13]. Lin et al. showed that roasting at the higher temperature (200°C) for the longer duration (10 or 20 min) might cause the degradation of fatty acids in the oils of Almond kernels, especially for unsaturated fatty acids [22]. Nikzade and Sedaghat investigated the effects of roasting temperature, formulation, and storage on pistachio oil quality and sensory attributes. During the storage, they observed that the pistachio nuts only with salt and without any additives had more free fatty acid (%), peroxide and TBA values, and less total acceptance than other formulations [24].

The study of Nejad et al. indicated that different drying methods (sun drying, bin drying, vertical continuous drying, vertical cylindrical

TBA index	Average ± SD	Samples
1.583	0.247 ± 0.04	A
0.698	0.109 ± 0.01	B
0.538	0.084 ± 0.01	C
0.788	0.123 ± 0.01	D

Table 1: Levels of TBA index.

Paired groups	Sig. (2-tailed)
A and B	0.027
A and C	0.003
A and D	0.007
B and C	0.25
B and D	0.395

Table 2: The results of statistical analysis based on the significance.

drying, and funnel cylindrical drying) do not have any significant influence on lipid quality of pistachio nuts and no significant differences were found in thiobarbituric acid value of nuts dried with various methods [25]. Javanmard et al. suggested that wheat starch-based films can reduce the rate of oxidation and moisture uptake in pistachio nuts during the storage. They found that starch edible films were effective in minimizing the PV (Photovoltaics) value and improving the shelf life [26].

In our experimental study, we have evaluated and discussed the impact of processing (roasting) on pistachio oxidation with the presence of different additives in details. The results of statistical tests are shown in (Tables 1 and 2). It indicates that there were significant differences between the control group (A) and other groups B, C, and D ($P \leq 0.05$). The level of lipid oxidation of pistachio oil roasted without additives (control) and with salt (B), salt plus starch (C) and salt plus ascorbic acid (D) based on TBA-RS numbers was 1.58, 0.69, 0.53 and 0.78, respectively. We found that different additives may make significant alterations in the oxidation process, especially salt plus starch that was showed the most significant with the control group in comparison of other groups. The significant increase of MDA content in control groups and a significant decrease in other groups suggest that using additives (salt, starch, and ascorbic acid) before roasting of pistachio nuts can reduce the oxidative reaction. There are limited studies on the effect of additives on lipid oxidation of roasted pistachio nut. This study is intended to be the starting point for further research on the impact of additives in different roasting conditions (time and temperatures) to reduce the oxidation potential of roasted pistachio nuts.

Conclusion

In the literature, few studies have been undertaken on roasted pistachio in presence of different additives particularly regarding lipid oxidation of the pistachio oil. The present study attempted to examine whether roasting of pistachio kernels changes the lipid oxidation quality. A significant change in TBA-RS numbers and decreasing in MDA content as a positive change were observed. The results of our study suggested the helpful use of additives before roasting particularly salt plus starch to extend the shelf life and improve the safety of pistachio nuts.

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