INFLUENCE OF MODIFIED ATMOSPHERIC CONDITIONS AND DIFFERENT PACKAGING MATERIALS ON PISTACHIO (Pistacia vera L.) OIL QUALITY

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Abstract—Pistachio as a strategic product has a particular position among Iranian productions and is one of the most important non-oil exports after carpet. In this study, after primary processing such as dehulling, washing, drying and roasting, pistachio nuts were packed in four different atmospheres including N$_2$, CO$_2$, vacuum and ambient air. Storage temperatures were 20°C and 40°C for a 12 month period. The evaluated packaging materials were a plastic compound five layers film, a modified polypropylene pouch, and a metalized plastic pouch (polypropylene with a layer of aluminum). After extracting pistachio oil with hexane, thiobarbituric acid (TBA) index, free fatty acids (FFA), and induction time (IT) were measured at three-month intervals. Statistical analysis of our data revealed that stored samples under N$_2$, CO$_2$ and vacuum had a lower TBA index compared with air-packed ones, and the IT of pistachio oil was longer at 20°C than at 40°C.

Keywords—Packaging, pistachio oil, free fatty acids, oxidation, shelf life.

1. INTRODUCTION
Pistachio is a rich source of nutritional substances, especially fat, since it has high amounts of unsaturated fatty acids, which are essential in human diets for health reasons. Iran is one of the most important countries regarding producing and exporting pistachio in the world. Among non-oil exports of Iran, pistachio is in the second ranking after carpet. Annual production of pistachio at 2010 in Iran was 162,000 Mt which constitutes 55% of the world pistachio production (Iran Pistachio Association, 2011) followed by U.S.A and Turkey. Pistachio nut is mainly consumed as salted, roasted or added in confectionery and snack foods (Amirteimoori and Chizari, 2008). It is also used as the main ingredient of desserts, such as baklava and nut paste in Turkey.

Pistachio contains around 23% protein, 19% carbohydrate and 5% moisture. It also contains high amounts of K and P, and various amounts of Ca, Mg and Fe (Kucukoner and Yurt, 2003; Pala et al., 1994). In a research carried out on 8 varieties of pistachio in Greece, the fatty acid composition of kernel oil averaged 61.88 % oleic, 17.52 % linoleic, 9.26 % palmitic and 0.4 % linolenic acid (Tsantili et al., 2010). Great differences in fat content of pistachio nut were reported by several researchers, such as 56% by Kucukoner and Yurt (2003), Pala et al. (1994) and between 40.6% and 53.5% by Koroglu (1997). Therefore, pistachio is a nut with high nutritional value, lipid content and very rich in unsaturated fatty acids. However, the unsaturated fatty acids make pistachio susceptible to oxidation, producing a variety of off-flavors and off-aroma.

Fats oxidation is one of the main factors for quality loss in pistachio. Factors affecting fat oxidation are free fatty acids, oxygen, water activity, temperature, heavy metals, light, enzymes, and antioxidants. There are different ways to evaluate oils and fats deterioration, such as sensory evaluation, determination of peroxide and thiobarbituric acid (TBA) values, measurement of the induction time period (IT), etc. (Ellis and Mam, 2000; Maskan and Karatas, 1997). In comparison with other food products, studies on the storage stability of pistachio nuts are very limited. In a study by Faruk Gamli and Hayoğlu (2007), samples of pistachio paste were produced by boiling a mixture of 51% sucrose, 16% pistachio, 8% glucose, and 25% water as long as final brix equaled 75. These samples were stored in 4°C and 20°C inside three types of packages, including polypropylene (pp) as a packaging material sealed either under vacuum or without vacuum, and glass jars sealed. This study showed that pistachio paste stored at 4°C in sealed glass jars had better acceptance with respect to chemical properties compared with other samples.

Raei et al. (2010) evaluated storage stability of pistachio cv. Ohadi under four different packaging materials and various storage conditions. They found that five layer plastic films or metallized films under N$_2$/CO$_2$ or vacuum kept the quality of pistachios for long time, while storage at 40°C was better than at 20°C for quality maintenance. Metal cans were not good barriers against oxygen and water vapor as expected. Kader et al. (1982) investigated the effect of temperature (0, 5, 10, 20 and 30°C) on chemical and sensory characteristics of pistachio nut during storage time of 6-12 months. Their results revealed that a moisture level of 4-6% resulted in the best quality. Dried pistachio nuts can be kept for 12 months at 20°C. Maskan and Karatas (1998) studied the storage stability of pistachio nuts under various conditions. Lowest rate of product oxidation and hydrolysis occurred at or near the monolayer moisture content and under CO$_2$ atmosphere. In another research, they showed that fatty acid reduction and peroxide formation were higher in ambient storage, but storing at monolayer moisture content and under CO$_2$ atmosphere improved the stability of pistachio nuts (Maskan and Karatas, 1999).