Evaluation of Two Common Dryers on Physicochemical, Microbial and Sensory Characteristics of Pistachio during Storage

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Abstract

Introduction: Drying is one of the most important stages of pistachio processing. The aim of this study was to investigate two common types of dryers available in Rafsanjan with emphasis on health related aspects. Fresh pistachio cultivars of Fandoghi were harvested from Rafsanjan gardens and the pistachio samples were dried after peeling and washing using Silage and Wagon dryers.

Materials and Methods: After drying, pistachio cultivars of Fandoghi were tested for 0, 1.5 and 3 months at room temperature (20 ± 2 ºC). Moisture content, peroxide value, conjugated dienes and conjugated triene, mold and yeast count were measured with three replicates. The experiment was conducted as a factorial experiment in a completely randomized design with three replications.

Results: Peroxide value of dried pistachio samples in two drying machines were in the permissible range (less than 1 millequivalent /kilogram). Silage dryer samples showed less peroxide value, conjugated dienes and conjugated trienes than wagon dryer samples. At the end of the three-month period, the growth rate of mold and yeast in pistachio samples dried using wagon dryer decreased and their growth rate was less than the permissible limit (less than 1000 cell forming unit/gram).

Conclusion: Mold and yeast growth were not observed in dried pistachio samples using silage dryer. It is recommended to use more silage dryer in pistachio processing units.

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1. Introduction

Pistachio drying is one of the most important steps in the processing of this product. It has a great impact on the shelf life and final quality of the product [1, 2]. During this process, the moisture content of pistachios must be reduced from 35-45% on a wet basis to 5%, so that the product can be properly stored and free from spoilage and mold. The dried product can be stored under normal conditions for up to one year or longer. The main purpose of drying is to prevent spoilage and contamination of the product and extend its shelf life [3]. One of the factors that reduce the quality of pistachio can be the inefficiency of pistachio dryers that is needed over time to use modern drying systems.

Midilli (2001), in a study comparing the drying conditions of pistachio shell and kernels with solar dryers and sun-drying ones, reported that pistachio dried using solar dryers at approx. 50± 10°C, takes approximately 6 hours, while samples dried under the sun experience a temperature of 28± 4°C and this time takes at least 2 days [4]. Pistachio dried in a solar dryer is not only of high quality but also is protected from adverse environmental conditions such as dust and contamination. It also does not use fossil fuels for processing.

Ghazanfari et al. (2003) reported that box dryer is one of the most common dryers in Rafsanjan city for pistachio drying. Changes in temperature and thickness parameters of crop in this dryer will have a significant effect on process time and quality of processed pistachio. The results indicated that there was a significant difference between treatments in terms of drying time and amount of moisture in each layer. No differences were observed between the dried pistachios of a given cultivar at different temperatures. Curves of moisture changes in different layers demonstrated the lack of drying uniformity in different layers of the product in the case of high thicknesses [5].

Midilli et al. (2003) studied the energy of the pistachio drying process when solar dryers were used. Energy analysis indicated that the amount of dissipation, the amount of absorption and conversion of solar energy can be interpreted using the second law of thermodynamics [6].

Kashani Nejad et al. (2003) investigated a study on how moisture content develops in pistachios during drying. The results showed that the drying intensity and speed were not constant and complete drying of pistachio occurs at the descending stage of drying cycle. Inside pistachio kernel, moisture transfer is very slow, while it is quite rapid on the surface. The time needed to reach 10% moisture for pistachio kernels at 55 and 70°C is 1660 and 640 minutes, respectively[7] .

Kashani Nejad et al. (2003) investigated the effect of drying methods on the quality of the pistachio varieties. Solar dryers and box dryers had a higher percentage of split pistachios than other dryers. The different drying methods studied in this study did not have any significant difference in the amount of free fatty acids, peroxide and tiobarbituric acid. Instead, differences in drying methods caused a significant difference in the appearance of pistachio and the split rate. Overall, the final product of box dryers had higher quality than other dryers [8].

Fooladi and et al. (2006), in a study on the amount of aflatoxin in dried pistachios using hot air dryers and drying in the sun, reported that the amount of aflatoxin in pistachios using the hot air had less aflatoxin than the pistachio which sun dried. What more, it took more than two days for the pistachios to dry out in the sun [9].

Kashaninejad and et al. (2007) examined the drying properties of pistachios and modeled the process. The results showed that the drying air temperature, the intensity of the air flow inside the dryer, and the relative humidity of the air dryer had the greatest effect on the drying time, respectively. The pistachio ripening occurs during the descending period of the drying curve. At this stage, the drying of the inner cells becomes more resistant to the transfer of moisture and heat, thereby reducing the drying process over time. The activation energy for this reaction indicates how much energy is required for infiltration and displacement of water, and it is evident that with the increase in the amount of energy that manifests as temperature rise, the intensity of drying increases [10].

Shakerardekani et al. (2011), in a review article has investigated the effect of various dryers on the quality of final dried pistachio kernels. In this review, the ultimate quality of pistachios from industry-based dryers including sunlight drying, solar dryer, box (wagon) dryer, continuous vertical dryer, funnel cylinder dryer, Vertical cylinder dryer, continuous dryers with movable and fixed trays, roller dryer and belt continuous dryer are discussed. The appearance of dried pistachio shells and their splitting quality were significantly affected by the type of dryers. Therefore, choosing the dryer type is a critical point in pistachio processing. Although drying out in the sun can provide good final quality, but there always is the weather condition to be concerned about. The combination of box dryer and sun-drying can be a good idea to improve the quality of the final product [2].

Kouchakzadeh and Haghighi (2011) investigated the drying of two different types of Iranian pistachios using vacuum and infrared waves in a drying laboratory. A combination of vacuum and infrared is eight to ten times faster than other dryers that rely solely on traditional heat transfer [11].

Tavakolipour (2011) conducted a study on the most important post-harvest operations of pistachio seeds including: handling, transportation, harvesting, storage and packaging. The results showed that air temperature had a significant effect on drying time; however air flow rate had no significant effect on drying time. The single layer moisture content had the longest shelf life. Both higher temperature and longer storage time increase the oxidation rate [12].

The aim of this study was to investigate the qualitative effects (in terms of peroxide value, conjugated dienes and trienes, moisture content, total yeast and mold) of two dryers on pistachio drying and to introduce the best drying method.

2. Materials and Methods

20 kilogram fresh pistachio cultivars of Fandoghi were harvested from Rafsanjan gardens and the pistachio samples were dried after peeling and washing using silage and wagon dryers. Pistachio samples of Fandoghi cultivar were stored for 0, 1.5 and 3 months and the tests were performed with three

replications. The case was that 500 g of each sample of pistachio nuts and oils were extracted. The oil samples were kept in opaque glass jars and after 6 h, the oil on the surface of the opaque glass was poured in plastic tubes and stored at -18°C in the freezer [13].

2.1. Peroxide Value Measurement

The spectrophotometer was used to measure the peroxide value [14]. 0.3 g of oil was pour into a glass tube of borosilicate and 9.9 ml of chloroform-methanol 3: 7 pre-prepared solution was prepared. The oil was added and homogenized for 2 to 4 seconds. Then the sample was added to 50 microliter of orange solution of oxidant. 2 to 4 seconds after the solution of ferric chloride (II) was added to 50 milliliters. The final volume of the prepared solution reached 10 ml per test tube. The spectrophotometer was then set at 560 nanometer and the chloroform-methanol solvent was used as a blank solution. The solution was kept at room temperature for 5 minutes and read. The peroxide value was obtained by using the following equation:

$$PV= [(AS-AB)\times mi] /(W\times 55.84\times 2)$$

AS: Sample Absorption, AB: Standard Sample Absorption, mi: Inverse Slope whose value is 25.5, W: Sample Weight (g)

2.2. Conjugated Dienes and Conjugated Trienes

0.02 g oil was poured into a 25 ml volumetric flask and dissolved in 2,2,4-trimethyl pentone (isoctane) and reached a volume of 25 ml with isoactane. the volume flask shaked for 2-4 seconds to completely dissolve the oil in the isoctane. Then the conjugated dienes and trienes was read using spectrophotometer at 234 and 268 nm, respectively. The following equations were used to calculate the CD conjugate and the CT conjugate:

$$CCD= A233/(E\times L),\ CD= CCD\ (2.5\times 104)/W,$$
$$CCT= A268/(E\times L),\ CT= CCT.(2.5\times 104)/W$$

CCD Concentration (mmol/ ml) CD, CCT Concentration (mmol/ ml) CT, A: Absorbance read at corresponding wavelength, E (Epsilagen): Molar absorption at 2.525, L: Cm length And: W Sample weight (g) [15].

2.3. Measurement of Moisture Content

A Crucible put in the oven first to dry it to a constant weight. Then the weight of crucible recorded. 10 g of sample was poured into a container and oven dried at 95-100ºC for 5 hr. The samples weight after drying. the sample weight before and after drying was calculated and reported as the moisture content [16].

2.4. Measuring Total Mold and Yeast

Since the source of the changes in this study was the type of dryer and storage time, therefore, the population of molds and yeasts was evaluated as a general index. Molds and yeasts counts were masured via surface plating in YGC agar (Yeast extract, glucose, chloranphenicol) and incubated at 25ºC for 5 days [17].

2.5. Statistical Analysis

The experiment was conducted as a factorial experiment in a completely randomized design with three replications.

3. Results

3.1. Peroxide Value

According to Table 1, peroxide value of dried pistachio oil with and wagon dryer increased during the three months of storage and peroxide value of the treatments was 0.15 and 0.20 meq/ kg, respectively, which was statistically significant. There was a significant difference between peroxide value of silage and wagon dryers. Peroxide value of dried pistachio oil with silage dryer was lower than the number of pistachio oil dried with wagon dryer which may indicate proper oxidation stability of this oil. In each column, letters with non-common letters had a significant difference.

Table 1. Evaluation of peroxide value (meq/ kg) in dried pistachio samples in wagon and silage dryer

Conjugated triene (µM/g)	Conjugated diene (µM/g)	Peroxide value (meq/kg)	Storage time (day)	Dryer type
3.50 ± 0.00 e	11.90 ± 0.05 e	0.15± 0.03 c	0	wagon
4.37 ± 0.03 c	13.30 ± 0.00 c	0.18± 0.03 b	45	wagon
9.03 ± 0.03 a	14.60 ± 0.02 a	0.20± 0.03 a	90	wagon
2.97 ± 0.03 f	10.83 ± 0.03 f	0.15± 0.03 c	0	silage
3.93 ± 0.06 d	12.40 ± 0.00 d	0.15± 0.01 c	45	silage
4.73 ± 0.03 b	14.23 ± 0.03 b	0.15± 0.03 c	90	silage

In each column, letters with non-common letters had a significant difference.

3.2. Conjugated Dienes and Trienes

Comparison of means based on Table 1 showed that the conjugated diene and conjugated triene increased when storage time increased. In general, the amount of conjugated triene (in micromole/ g) after the three-month period was 4.73 in silage -dried pistachio samples and 9.03 in wagon dried pistachio samples. The amount of conjugated diene (in micromole/ g) after the three-month period was 14.23 in silage-dried pistachio samples and 14.60 in wagon-dried pistachio samples. The mean difference of data showed that the effect of time on conjugated dienes and trienes was significant at 5% level.

3.3. Measurement of Moisture Content

According to Table 2, mean comparisons showed that moisture content of pistachio nuts increased after three months of storage in both wagon and silage dryers. The moisture content in the silage drying method was below 5% which was statistically significant at the 5% level with the wagon-drying method. In each column, letters with non-common letters had a significant difference.

Table 2. Evaluation of moisture (%) in dried pistachio samples in wagon and silage dryer

Mold & yeast (cfu)	Moisture (%)	Storage time (day)	Dryer type
127 ± 5.2 b	5.16± 0.03 e	0	wagon
266 ± 7.9 a	5.76± 0.01 b	45	wagon
269 ± 6.0 a	5.85± 0.00 a	90	wagon
9 ± 0.1 c	4.77± 0.03 f	0	silage
15 ± 1.0 c	5.25± 0.03 d	45	silage
25 ± 1.3 c	5.42± 0.03 c	90	silage

In each column, letters with non-common letters had a significant difference.

3.4. Counting total yeast and molds

According to Table 2, the growth rate of mold and yeast in the dried pistachio samples was increased by increasing the storage time (three months). In the dried pistachio samples, there was significant difference at the level of 5% with the drying of pistachio with the silage and wagon dryer. The silage dryer showed better microbial quality than wagon dryer.

4. Discussion

The results showed that the peroxide value of the dried pistachio samples in both dryers increased steadily during the storage and it was lower than the permissible limit recommended (1 milligram per kg) at the end of three months storage period at ambient temperature. The lowest peroxide value was observed in the pistachio dried by silage dryer. These results are in accordance with Iranian national standard (ISIRI, 2007) [16].

Mokhtarian and Tavakoli (2019) reported that solar drying systems had meaningful and significant effects ($p<0.05$) on the hydro-peroxide forming of pistachio oil [18]. In A study was conducted by Kouchakzadeh et al. (2011) to investigate the effect of vacuum conditions on the qualitative properties of dried pistachios during storage, the peroxide value increased steadily during storage and was lower than the permissible limit at the end of the six-month storage at ambient temperature. Conjugated dienes and trienes (in micromole/ gram) values were higher in pistachio-dried using wagon dryer than those in the silage dryer during the three-month period. Pistachios dried by silage dryer had lower conjugated dienes and trienes values in comparison with those in wagon dryer [11].

The results of this study are in accordance with the results of Hosseini et al. (2015), the longer the shelf life of walnut is, the higher conjugated dienes and triene values become [19]. Over time, moisture content increased and the highest moisture content was observed in wagon dryer. In this study, walnut shelf life was evaluated using high temperatures (62, 72, 82°C). Conjugated dienes and trienes values were measured to evaluate the oxidation process. The values were higher in relation to time (day) at all temperatures in walnuts, which correspond to the production of conjugated dienes and trienes in walnut kernels rather than in ripped walnut. The conjugated dienes and trienes values increased for the samples stored in the accelerated environment versus the storage time. Overall, the storage of pistachio samples at ambient temperature at the end of the three-month period showed that the increase in oxidation in UV absorption is proportional to that of oxygen and the production of peroxides due to the formation of conjugated dienes and trienes.

There was a significant difference at the 5% level with samples dried by two types of dryer. Silage-dried pistachio samples showed less growth of mold and yeast than wagon dryer. From the results, it can be concluded that the moisture content of the dried pistachio samples in the silage dryer was lower than the permitted temperature over time, and as a result the conditions for mold and yeast growth eliminated.

5. Conclusion

Low capacity silage dryer is able to dry pistachio with good quality. In this dryer the hot air flow is driven by a blower into a chamber where the pistachio seeds are placed on the plenum plate. The temperature of the air dryer is adjustable and also measured by the temperature sensors of the humid air temperature, but the wagon dryer has the disadvantages of using labor to stir the product, having the possibility of physical damage to the product, as well as uniformly in lowering pistachio moisture as required. It provides the conditions for mold and yeast growth so that human health can be at risk.

Conflict of Interest

The authors declare no conflict of interest.

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