

Pistachio Nuts Shelf Life Based on Sensory Evaluation

N. Sedaghat

Department of Food Science, Ferdowsi University of Mashhad (FUM), Mashhad, Iran

Abstract: Iran is one of the world's most important areas for the production of pistachio nuts, the Ohadee variety of Iranian raw dry pistachio nuts was selected for the experiments. The method of Accelerated Shelf Life Testing (ASLT) used for storage and sensory properties (taste, texture and overall acceptability) of raw dried pistachio nuts were investigated at 21%, 8% & < 2 % O₂ and different storage temperature (5,20,35,45°C). Samples were experimented at 4,6,8,10,12 weeks by use of split-plot design and estimate the modeling shelf life of this product at various conditions. Results showed that the sensory attributes (taste and texture) under factors of temperature, storage time and O₂ % were significant (p< 0.05) but overall acceptability was significant (p<0.05) under factor of storage time and maximum shelf life (284 days) for raw dried pistachio nuts determined at 5°C and < 2% O₂ based on overall acceptability. Linear Regression second order function had a best fit with R² > 98 at all levels of oxygen conditions (21%, 8% & < 2 % O₂) for raw dried pistachio nuts.

Key words: Modeling · Shelf life · Pistachio nuts · Sensory evaluation

INTRODUCTION

Pistachio nut (*Pistacia vera* L.) is one of the popular tree nuts. It is cultivated in the Middle East, United States and Mediterra and Mediterranean countries. A special feature of pistachios is its split shell. This feature makes roasted and salted pistachios an attractive snack food for eating out of hand. Splitting of the shell takes place while the nut matures on the tree. The harvested nuts under go a wet hulling process to remove the mushy hull covering the shell, the moisture content of pistachios vary between 35-40 % (wet basis) after de hulling and separation process it must be reduced to 5 % (wet basis) for safe storage and further process. Pistachio nuts dried to 4-6% moisture are very stable and could held for up 12 months at temperatures as high as 20°C without significant losses in quality attributes. Although the chemical composition and oil characteristics of pistachio nuts has been studied extensively. Despite an extensive literature search no published information was found on prediction shelf life of pistachio nuts [1-3].

The quality of many food and drinks products decreases during storage, although the speed at which this occurs varies considerably depending on the product type. The exceptions are products such as cheese and pickle, Where the quality is considered to increase during storage, as the product "matures" the time

from production to the point at which the quality of the product becomes unacceptable is referred to as the shelf life. The shelf life of food products is often difficult to specify and many definitions exist. So shelf life is a frequently used term that can be understood and interpreted differently. A consumer is generally concerned with the length of time a food product can be kept in the home before it can no longer be used. A retailer is particularly interested in the length of time a product can stay on its shelf in order to maximize sales potential. Here, shelf life is defined as the period of time under defined conditions of storage, after manufacture or packaging. The key points to consider are that the product remains safe, retains the desired sensory, chemical, physical and microbiological characteristics and complies with any label declaration of nutritional data. For the consumer the safety and wholesomeness are not easily judged. The consumer can not evaluate microbial load or nutritional value at moment of purchase. Purchase quality may include appearance (e.g. color, size, shape, absence of defects), firmness to the touch and aroma. Consumption qualities include flavor (taste and aroma) and mouth feel [4-7].

There are several established approaches such as ASLT, Sensory Evaluation, Instrumental Measurements, Chemical, Physical property and Microbiological tests for estimating shelf life of foods. The principles and the

methodology for conducting effective Accelerated Shelf Life Testing (ASLT) are described by some researchers [8-10]. Sensory evaluation by a trained panel, where by the food is graded a “standardized” hedonic scale, usually best approximates the overall quality state of the food even if that assumption can be made a cut –off level of acceptability has to be decided upon. The end of food shelf life is the time that a large percentage of panelist judge it is at outside of level [11].

The objectives of this work was to evaluate the sensorial changes of raw dried pistachio nuts stored at various conditions in order to detect the quality parameters and estimate the shelf life of this product.

MATERIALS AND METHODS

Materials

Pistachio Nut Samples: The Ohadee variety of Iranian pistachio nut was used for the experiments. The raw dry pistachio nut samples with an average moisture content of about 5% (wet basis) initially were supplied from Rafsanjan Pistachio Factory in Iran. Upon receiving, they were placed in sealed plastic bags and held at 0°C for experiments.

Methods

Experimental Design and Storage: One glass container was assigned to each of the combination of three variables studies:(1) Oxygen concentration: 21% (air), 8% and < 2% with nitrogen flushed atmosphere; (2) storage temperature: 5,20,35,45°C; (3) storage time 4,6,8,10,12 weeks. Each glass had two valves and after nitrogen flushing from one valve, air atmosphere go out from another valve and amount of O₂ concentration remained control with Oxygen Analyzer (GFG Company). Total of 600 g of the selected pistachio nuts was placed in each of the 60 jars (4*3*5). Aluminum foil was used to cover all jars to exclude light.

Sensory Evaluation: Sensory evaluation was performed using descriptive analysis and affective testing. 10 panelist participated, the panelist consist of staff member and graduate students with ages comprised between 20,30 years old in Department of Food Science of Ferdowsi University. a 5-point hedonic scale was used (5= excellent, 4= good, 3= fair, 2= poor, 1= bad). Samples were presented at room temperature in individual booths, each panelist received 6 nuts per sample in colorless transparent plastic dish coded with 3-digit random

numbers, fresh water was provided to drinks between evaluations each panelist was asked to rate three main components of raw dried pistachio nuts, taste, texture and overall acceptability in terms of the degree of liking each sample. The evaluation was performed with samples stored for different periods of time. A sensory score of 2.5 was taken as the cut off for acceptability and termination of shelf life [12].

Statistical Analysis: The results were compared by multifactor analysis of variance (multifactor ANOVA) to test for significant differences. Means of the groups were compared using the least significant difference (LSD) multiple range test by using a Statgraphics statistical packet (Statgraphics plus, 2000). Differences among sample means were reported to be significant when $p < 0.05$ and Sigma Plot 8(2002) soft ware used for drawing plots of linear regression for prediction shelf life of sample pistachio nuts.

RESULT AND DISCUSSION

Rancidity, the development of off – flavor which makes a food unacceptable for the consumer, is generally a major problem in nuts during storage. Deterioration in the quality of pistachio nuts during storage is also attributable to lipid oxidation. Oxygen is the main culprit when oxygen in the air reacts with unsaturated fat through a process called autoxidation various break down products are formed which can cause off –flavors. Changes in sensory characteristics of pistachio nuts during storage were compared as following.

Taste: The taste determined by sensory evaluation hedonic scale. Multiple factor ANOVA(data not shown) results showed that the taste of pistachio nuts factors of temperature, storage time and O₂ % were significant ($p < 0.05$) and the interaction of three factors weren't significant ($p \geq 0.05$). But LSD Multiple Range Test revealed that there was no significant difference between some levels of treatments (Table 1). It is seen from table 1 that increase of storage temperature the scale of taste has decreased and the differences in taste value due to the storage temperature between level of 5°C and 45°C was significant ($p < 0.05$) but non significant between levels of 20 and 35°C. The results of this experiment show that the effect of Oxygen percent at levels of 21% and 8% non significant. Changes in scores for sensory taste pistachio nuts was maximum 4.5 (out of 5) for <2% O₂, 5°C week 4 and minimum 2.7(out of 5) for 8% O₂, 35 C week 12.

Table 1: The results of LSD Multiple Range Test for Taste, Texture and overall acceptability of raw dried pistachio nuts at $\alpha = 0.05$ level, data represent a 5- point hedonic scale ranging from 1 (bad) to 5 (excellent). values with in a column followed by the same letter are not significantly different at the 95% confidence level

Variables	Levels	Count	Taste LS mean	Texture LS mean	Overall acceptance LS mean
Temperature (°C)	5	150	3.60 ^a	3.75 ^a	3.36 ^a
	20	150	3.48 ^{ab}	3.56 ^{ab}	3.12 ^{ab}
	35	150	3.39 ^{ab}	3.38 ^b	3.16 ^b
	45	150	3.29 ^b	3.10 ^c	3.10 ^b
Gas (O ₂ %)	21	200	3.37 ^c	3.32 ^d	3.17 ^c
	8	200	3.33 ^c	3.37 ^d	3.14 ^c
	<2	200	3.60 ^d	3.66 ^e	3.29 ^c
Storage time (Weeks)	4	120	3.93 ^e	4.02 ^f	3.39 ^d
	6	120	3.62 ^f	3.57 ^g	3.25 ^{de}
	8	120	3.40 ^{fg}	3.41 ^{gh}	3.23 ^{de}
	10	120	3.20 ^{gh}	3.26 ^h	3.13 ^{ef}
	12	120	3.01 ^h	2.98 ⁱ	2.99 ^f

This scale is upper than cut-off scale (2.5 out of 5) so the pistachio nuts remained reasonably good for 12 weeks at all temperatures. We attributed the stability of pistachio nuts at various conditions and good quality taste could be a consequence of high amount of oleic acid, so high oleic acid content provides the oil with a good stability [2].

Texture: The texture determined by sensory evaluation hedonic scale. Multiple factor ANOVA (data not shown) results showed that the texture of pistachio nuts factors of temperature, storage time and O₂ % were significant ($p < 0.05$) and the interaction of three factors weren't significant ($p \geq 0.05$). But LSD Multiple Range Test revealed that there was no significant difference between some levels of treatments (Table 1). The texture scale was minimum 2.7 (out of 5) for treatment of 21 % O₂, 35°C, week 12 and maximum 4.6 (out of 5) for treatment of 2 % O₂, 5°C week 4 (data not shown).

Overall Acceptability: The overall acceptability determined by sensory evaluation hedonic scale. Multiple factor ANOVA (data not shown) results showed that the overall acceptance of pistachio nuts under factors of storage time was significant ($p < 0.01$), but under factors of O₂ % and temperature were not significant ($p \geq 0.05$), moreover the interaction of three factors weren't significant ($p \geq 0.05$). LSD Multiple Range Test revealed that there was no significant difference between some levels of treatments (Table 1). Overall acceptability of pistachio nuts scored was maximum 3.8 (out of 5) for treatment of 2% O₂ 5°C, week 4 and minimum 2.8 (out of 5) for treatment of 21 % O₂, 45°C, week 12 (data not shown).

Shelf Life Prediction Models: Knowing the spoilage mechanism of a food product is the first step in the process of determining its shelf life. Essentially, how a food spoils and hence how long its shelf life is going to be influenced by a number of factors. This shelf life influencing factors are the properties of the final product and of the environment in which it is to be manufactured, stored, distributed and used. This factors can be divided in to the groups of intrinsic factors (raw product, composition and structure, a_w, pH, etc) and extrinsic factors (packaging materials, storage time, temperature, humidity, light). Temperature, the single most important environmental factor, influences all mechanisms of food spoilage, so the effects of temperature must be evaluated in all shelf life studies [13]. Changes in overall acceptability of the raw dried pistachio nuts during storage were compared Figure 1, data of multiple linear regression and estimated shelf life of pistachio nuts at various conditions are depicted in Table 2 respectively, at all storage temperatures (5,20,35 and 45°C).

The initial score for overall acceptability of raw dried pistachio nuts decreased in all three types of oxygen percent (21,8 and < 2%) after 12 weeks of storage (Figure 1) and maximum shelf life was 284 days for the sample stored at < 2% O₂ and 5°C. Minimum shelf life was 127 days for sample of stored at 21 % O₂ and 45°C, It is seen from Figure 1, the higher of storage time, the lower of shelf life. From Table 2 it is evident that the sample of raw dried pistachio nuts packed in < 2% O₂ were rated highest for overall acceptability and shelf life followed by the samples packed in 8% and 21% O₂.

Table 2: The linear model shelf life equations, R² and estimated shelf life pistachio nuts at various storage conditions

Temperature (°C)	O ₂ %	Model equation	R ²	Shelf life (Weeks)
5	21	Y=3.64-0.035X	0.942	32.5
	8	Y=3.66-0.035X	0.720	33.1
	< 2	Y=3.92-0.035X	0.942	40.5
20	21	Y=3.48-0.045X	0.920	21.7
	8	Y=3.32-0.035X	0.942	23.4
	< 2	Y=3.64-0.035X	0.942	32.5
35	21	Y=3.44-0.045X	0.920	20.8
	8	Y=3.52-0.05X	0.925	20.4
	< 2	Y=3.62-0.05X	0.926	22.4
45	21	Y=3.5-0.055X	0.916	18.1
	8	Y=3.58-0.055X	0.916	19.6
	< 2	Y=3.56-0.05X	0.892	21.2

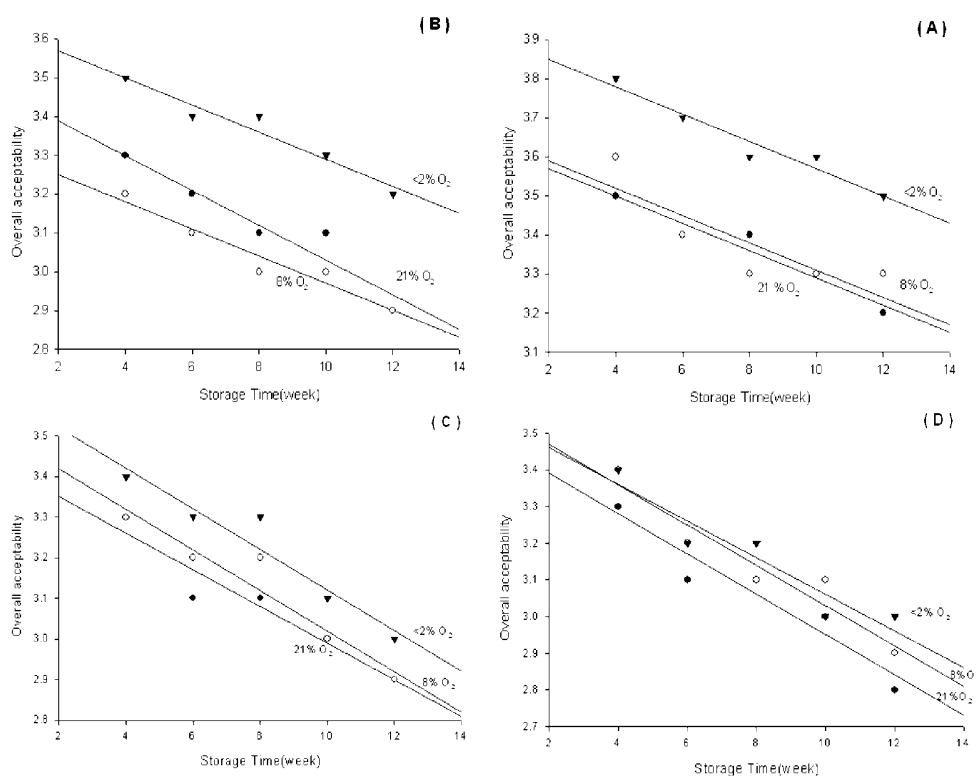


Fig. 1: Overall acceptability of raw dried pistachio nuts during storage at (A) 5°C, (B) 20°C, (C) 35°C, (D) 45°C. A 5-point hedonic scale was used (1=bad, 5=excellent)

The shelf life prediction curves for raw dried pistachio nuts at different storage temperature showed in Figure 2. It is clearly seen in Figure 2 that increase at storage temperature and oxygen percent decrease shelf life of raw dried pistachio nuts. For estimating the best fitting model data fit to the multiple linear regression, first order, second order and exponential decay (Table 3). The R² value of regression analyses were used to select the best fitting model from among them. Data showed (Table 3) that the second order function had a best fit with R² > 98 at all oxygen percent condition

levels (21, 8, & < 2% O₂). Our results showed a significant effect of O₂ % on the sensory attribute (taste, texture) of raw dried pistachio nuts. Rancidity, the development of off flavor which makes a food unacceptable for the consumer, is generally a major problem in nuts during storage in nut meat; this off flavor is the result of lipid oxidation. So the maximum shelf life of raw dried pistachio nuts resulted from treatment of < 2% O₂ (Figure 2 and Table 2). Therefore we introduce gas flushing packaging for packaging of raw dried pistachio nuts.

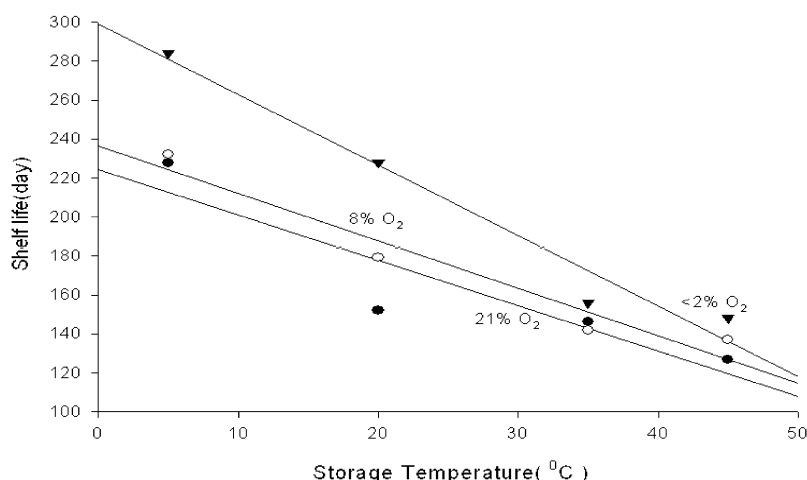


Fig. 2: Shelf life prediction curves for raw dried pistachio nuts at different storage temperature

Table 3: Type of equations and regression parameters for estimating shelf life of raw dried pistachio nuts at various O₂ % conditions

Type of equation	O ₂ %	Y ₀	a	b	R ²
y=y ₀ + ax	21	224.2	-2.32	----	0.837
	8	236.4	-2.43	.....	0.943
	<2	298.8	-3.61	.....	0.966
Y=y ₀ + a /x	21	123.9	523.3	....	0.978
	8	135.4	498	.....	0.912
	<2	152.2	688	.....	0.808
y=y ₀ + a /x + b /x ²	21	114.4	869.9	-1510	0.982
	8	92	2063	-6814	0.996
	<2	59.1	4077	-14760	0.992
Y=ae ^{-bx}	21	.....	234	0.014	0.883
	8	.....	245	0.014	0.973
	<2	.....	312	0.017	0.977

Blakistone [2] reported that flushing with N₂ is currently commonly used to reduce residual O₂ in packs containing cashews, pistachios, mixed nuts and dried fruit; it is being successfully used on raw, fried and roasted nuts. As a consequence we found that raw dried pistachio nuts had a good shelf life for storage at all storage condition, but use of cold storage and lower oxygen percent can be extended shelf life. High oleic Acid content, natural antioxidant such as tocopherols and low moisture gave a good shelf life and stability to raw dried pistachio nuts. Maskan and Karatas [14] reported that the pistachio nuts had a high stability.

CONCLUSION

According to results, the taste, texture and overall acceptance of pistachio nuts factors of temperature, storage time and O₂ % were significant (p< 0.05). Moreover, increase at storage temperature and oxygen

percent decrease shelf life of raw dried pistachio nuts and maximum shelf life was 284 days for the sample stored at < 2% O₂ and 5°C. Minimum shelf life was 127 days for sample of stored at 21 % O₂ and 45°C. The results also indicated that the second order function had a best fit with R²>98 at all oxygen percent condition levels (21, 8, & <2% O₂). Our results showed a significant effect of O₂ % on the sensory attribute (taste, texture) of raw dried pistachio nuts.

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