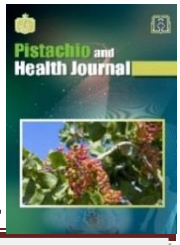

Performance Evaluation of Two Types of Pistachio Peeler by Examining the Quality of the Peeled Product

Ahmad Shakerardakani (PhD)[1*], Fatemeh Bagherinasab (MSc)[2,3]

[1] *Pistachio Research Center, Horticultural Sciences Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Rafsanjan, Iran*

[2] *Master of Science in Food Science & Technology, Department of Agriculture Kar Higher Education Institute, Rafsanjan, Iran*

[3] *Pistachio Safety Research Center, Rafsanjan University of Medical Sciences, Rafsanjan, Iran*

Information

Article Type:

Original Article

Article History:

Received: 12.05.2019
Accepted: 03.06.2019
DOI: 10.22123/phj.2020.203716.1038

Keywords:

Pistachio
Peeling
Screw Peeler
Screw-Blade Peeler
Manual Peeling

Corresponding Author:

Name: *Ahmad Shakerardakani*

Email: *shaker@pri.ir*
Tel: +98-*3434225204*

Abstract

Introduction: Peeling is one of the most important steps in pistachio processing. Optimizing the peeling step can improve the quality of the finished product.

Materials and Methods: In this research, the technical function of two kinds of peeling machine (screw-blade and screw) and the manual peeling method were evaluated. The tested pistachio was Fandoghi in the ripening stage. The samples were peeled, the number of fully-peeled, partially-peeled, unpeeled, and broken nuts were counted, and the percentage of each one was determined. Then, the changes in peroxide value, shell and kernel color, texture, and sensory properties (taste, color, texture, and overall acceptance) were evaluated at different intervals of 0, 1, 2, 3, and 4 months. The experiment was conducted in a completely randomized design with the factorial arrangement.

Results: The results showed that the high percentage of fully-peeled nuts (87.95%) belonged to the screw-blade method. The percentage of partially-peeled and broken nuts in the screw method was more comparable with the screw-blade machine. There was no considerable difference in the screw and screw-blade methods in terms of peroxide value. The manual peeling method was better in color attributes (L*, a*, b*) compared with screw-blade and screw methods. The highest taste, color, and overall acceptance rate belonged to the manual peeling method, showing a big difference from the other methods. The quality of color in the screw-blade method was more than that in the screw method.

Conclusion: In general, the screw-blade method is suggested to be used for peeling pistachio nuts.

►Please cite this article as follows:

Shakerardakani A, Bagherinasab F. Performance evaluation of two types of pistachio peeler by examining the quality of the peeled product. Pistachio and Health Journal. 2019; 2 (3): 61-73.

1. Introduction

In the last decade, due to the increased level of pistachio cultivation globally and the variety of pistachios offered to world markets, there has been intense competition among exporting countries. Improving the hygienic quality and appearance characteristics of pistachios (shell splitting and proper packaging) are essential factors in this regard. Iran's pistachio has high quality due to suitable climatic conditions. Accelerated post-harvest processing stages, especially peeling and drying, are of great importance in its quality [1].

Studies have shown that the type of product processing can affect the quality of the processed product differently. In mechanized processing, since the more advanced machinery is used and the product is processed more quickly, the quality of the processed product is higher. Processing systems that use machines to speed up pistachio post-harvest affairs have become increasingly popular.

A processing system, indeed, is an interconnected set of machines, which perform peeling, cleaning, drying, and grading operations. An important point in using machines is the order of their use, which enhances the processing efficiency [1].

Afzali (2014) evaluated the performance of three common pistachio cylinders, including screw, screw-blade, and rubber in three harvesting times with 15 days interval. The percentage of broken, incomplete-peeled, and unpeeled nuts were determined. The rubber peeler was superior in all treatments with the lowest nut breakage and nut yield in all three harvesting times [2]. The lowest fracture percentage of nut and shell was 0.47 and 0.23% for rubber peeler, respectively. The highest fracture percentage of nut and shell was 2.75% and 3.86%, respectively, for the rotary screw peeler. The lowest percentage of non-peeled nuts was obtained by 2.5% at the end of harvest season [2].

Rekabi and Shamsi (2010) conducted a study on the pistachio centrifugal plate peeler. The results showed the blade position to be effective in the peeling and fracture rate. Reduction in fracture rate and small pistachio loss were the advantages of this machine [3].

Naseri et al. (2014) designed walnut peeler considering all walnut crop physiological properties. The walnut green skin was separated from the wood shell by the rotary fingers [4].

Salajeghe et al. (2012) investigated the effects of genotyping and peeling methods on chemical and organoleptic indices and aflatoxin levels in walnuts. Their results showed that the method of peeling in walnut and kernel samples had no significant effect on sensory properties (taste, aroma, and color). Since aflatoxin was not found in the industrial peeling method, it may be suitable for the processing [5].

Rostami (2008) conducted a study to design, manufacture, and evaluate a peanut peeler to remove its peel and then separate the seeds and pods. The results showed a significant effect of the cylinder linear

velocity and its distance with the anti-crushing network on the peeling efficiency; however, only the distance factor affected the fracture rate of the grains. Interaction between these two factors was not significant for either of the parameters. The results also showed that if the peanut peeling process had the best efficiency with the lowest fracture, the cylindrical linear velocity should be 5 or 6 m/ s [6].

Jafari et al. (2011) tested the almond peeling machine and determined the best combination of speed and distance between the rollers to separate the green peel from the almond pod, thus increasing the peeling speed efficiency. In the case of the almond peeling process, the best peeling efficiency with the lowest percentage of semi-peeled and undisturbed almonds was considered to have a rotational speed of 300 rpm with an anti-crushing distance of 8 mm. Almond sheath fracture (crushed or double cotyledons) was zero in all treatments, and non-peeled almonds were mostly small, premature, or kernel-free and worthless [7].

83.5% of pistachios suspected of aflatoxin contamination (early split pistachios with soft and dry skin, pistachios with irregularly split, damaged pistachio by bird) were peeled by screw peeler, while the peeling percentage was 54% by rubber peeler. Rubber peeler may not play a key role in aflatoxin removal from the garden since it does not peel large portions of cracked pistachios, as well as those damaged by pests and birds. It should be noted that the lower peeling percentage of pistachio suspected of aflatoxin contamination, identifying, and removing them is easier in the next stage of processing. Rubber cylindrical peeler is more effective when pistachios are seeded [2, 8, 9].

In this research, the technical performance of two types of pistachio peelers, including cylindrical screw and blade, is compared with that of the manual peeling method. The fracture and peeling rate, besides color and shelf life, are evaluated in each peeling method. Finally, the best high-efficiency peeling machine with the least negative effect on pistachio appearance and quality is introduced.

2. Materials and Methods

2.1. Sample collection

The matured Fandaghi samples of the same age were collected from a pistachio orchard in Shahrabak on September 28, 2016; they then were divided into 9 sections (20 kg each). The screw and screw-blade peelers evaluated in this project were manufactured by companies in Kerman province; they were selected in terms of nominal capacity, age, and similar manufacturer. Before testing each machine, adjustments were made to ensure their operation within the standard and permissible range of losses and similar test conditions.

The specimens were peeled with screw and screw-blade peelers, then the number of fully peeled, partially peeled, unpeeled, and broken pistachios were counted, and the percentage of each was calculated. In the manual peeling method, pistachio nuts were

peeled by hand, and percentages were measured. The pistachios were then washed separately and dried in the sun completely. After drying, the split pistachios were separated and randomly divided into 5 equal portions. Later, changes in shell and kernel color, texture, peroxide value, and sensory properties (taste, color, texture, and overall acceptance) were evaluated at 0, 1, 2, 3, and 4 months intervals in each of the available treatments. Each sample was weighed 2 kg; then, fully peeled, partially peeled, unpeeled, and broken pistachios were weighed, and peeling efficiency was calculated.

2.2. Oil extraction

Oil extraction was performed by SOXTHERM S306 AK Soxhlet for measuring peroxide value. At first, 20 g of pistachio kernel was powdered in the mill. The kernel powder was put in filter paper and then placed in special cartons and sole glass. They were poured into 120 cc n-hexane and placed in the Soxhlet apparatus for 2.5 hours. These extracted oils were used to measure the peroxide value [10].

2.3. Peroxide value

To determine peroxide value, 5.00± 0.05 gr of oil or lipid extract of the kernel sample was placed in a 250 ml-glass flask. Next, 30 ml of 3:2 acetic acid/chloroform solution was added and stirred until the oil was dissolved. Also, exactly 0.5 ml of saturated potassium iodide solution was added. The solution was kept for 1 min in the dark with occasional shaking. Then, 30 ml of distilled water was added, along with a standardized amount of 0.1 N sodium thiosulfate containing 0.1 N sodium carbonate (Na_2CO_3). These steps were taken for the titration of the solution until the yellow color almost disappeared. The total added sodium thiosulfate volume was recorded. During the titration, the mixture was shaken constantly and vigorously. Then, 0.5 ml of 1% (w/v) starch was used as an indicator of the solution. The titration was continued by adding sodium thiosulfate solution containing 0.1 N sodium carbonate (Na_2CO_3) drop by drop until the violet color disappeared [11].

$$PV= (S-B) \times N \times 1000)/W$$

S= the volume (ml) of sodium thiosulfate required to titrate the sample

B= the volume (ml) of sodium thiosulfate required to titrate the blank

N= the normality of the standardized sodium thiosulfate solution

W= the weight of the sample (g)

2.4. Measurement of the color of pistachio shell and kernel

In this study, the color properties of the samples were measured using a colorimeter (Japan CR-400, Japan). Before the test, the device was calibrated using standards. L*, a*, and b* were measured.

2.5. Measurement of texture hardness

Taiwan's Latron FG5020 stiffness tester and Khatib et al. (2011) method were used to measure kernel hardness (in kilograms-force) [12]. The probe was attached (in 8 millimeters) to the device, and the whole kernel was placed underneath, being then pressed until a fracture appeared. The

average hardness of 10 pistachios per repetition (in kilograms-force) was expressed [9].

2.6. Sensory evaluation

The sensory properties, including taste, shell color, texture, and total acceptance, were evaluated using a five-point hedonic test with a score of 1= unacceptable, 2= partial satisfactory, 3= moderate satisfactory, 4= well, and 5= excellent by 26 panelists [13].

2.7. Statistical analysis

The experiment was factorial on the basis of a completely randomized design. Analysis of variance and Duncan test were performed using SPSS 21 software.

3. Results

3.1. Percentage of fully-peeled seeds

A comparison of the three peeling methods (Table 1) showed a significant difference between them. The highest (87.95%) and lowest (74.4%) percentage of peeling belonged to the screw-blade and manual method, respectively. The screw-blade machine had the highest peeling efficiency.

3.2. Percentage of partially-peeled seeds

There was a significant difference between the three peeling methods. The highest and lowest percentage of partially-peeled nuts belonged to screw and screw-blade methods, respectively (Table 1).

3.3. Percentage of unpeeled nuts

There was no significant difference between the two screw-blade and screw methods; however, the former had the lowest percentage of unpeeled grains with 5.28% and better quality. The highest percentage of unpeeled grains, with 22.35%, belonged to the manual method, which had a significant difference from the two machine methods (Table 1).

3.4. Percentage of broken nuts

The percentage of broken nuts was significantly different among the three methods. There was no nut fracture in the manual method. The lowest grain fracture rate was 1.616% for the screw-blade machine, and the highest grain fracture rate was 2.513% for the screw machine. The broken nuts in the screw-blade machine were 0.89% less than the screw machine.

3.5. Peroxide value

According to Table 2, the peroxide value increased significantly during storage. This value was 0.166, 0.167, and 0.168 in manual, screw-blade, and screw method at the end of the four-month storage, respectively. Based on the results, the peroxide value of these 3 hulling methods showed no significant difference.

3.6. Measurement of texture hardness

According to Table 3, by increasing storage time, the texture hardness decreased in all three methods. There was no significant difference between the three methods of hulling in terms of hardness.

Table 1- Comparison of the average traits (%) in the three peeling methods

Peeling method	Fully-peeled	Partially-peeled	Unpeeled	Broken nuts
Screw-blade	87.95 ± 0.01 a	4.81 ± 0.01 b	5.28 ± 0.03 b	1.62 ± 0.02 b
Screw	85.36 ± 0.05 b	5.92 ± 0. 01 a	6.17 ± 0.02 b	2.51 ± 0.01 a
Manual	74.4 ± 0.02 c	3.21 ± 0.01 c	22.35 ± 0.01a	0.00 ± 0.00 c

*The values with different letters at a 1% level of statistical difference are significant

Table 2- Comparison of peroxide value (meq/ kg) in samples

Peeling method	Storage month				
	0	**1**	**2**	**3**	**4**
Screw-blade	0.134 ± 0.01 e	0.140 ± 0.03 de	0.146 ± 0.02 d	0.156 ± 0.06 c	0.167± 0.01 ab
Screw	0.136 ± 0.02 e	0.144 ± 0.01 d	0.145 ± 0.06 d	0.154 ± 0.02 c	0.168± 0.01 a
Manual	0.135 ± 0.03 e	0.143 ± 0.01 d	0.144 ± 0.02 d	0.155 ± 0.04 c	0.166± 0.01 abc

*The values with different letters at a 1% level of statistical difference are significant

Table 3- Comparison of texture hardness (kg) in samples

Peeling method	Storage month				
	0	**1**	**2**	**3**	**4**
Screw-blade	3.95 ± 0.65 ab	3.61±0.5cde	3.26±0.25f	2.81±0.05g	2.17±0.65i
Screw	3.86 ± 0.51 abc	3.55±0.61de	3.37±0.59f	2.79±0.65g	2.26±0.65hi
Manual	4.03 ± 0.65 a	3.71±0.35bc	3.37±0.64ef	2.59±0.24g	2.44±0.02h

*The values with different letters at a 1% level of statistical difference are significant

3.7. Pistachio shell color

The shell color parameters are provided in Table 4. The color indices L*, a*, and b* in the manual peeling method were different from the two others. The manual method was better in color. There was no significant difference between the two methods of screw-blade and screw at the 1% level. As the storage time increased, the index of L* decreased, while the index of a* and b* increased. In all pistachio samples, lower L* (darkening skin), higher a* (less green), and more b* (more yellow) were observed during the four-month storage, showing pigment destruction.

3.8. Pistachio kernel color

No significant differences were observed between the L*, a*, and b* color indexes. As the storage time increased, the index of L* decreased, while the index of a* and b* increased.

3.9. Sensory properties

3.9.1. Taste

According to Table 6, by increasing the storage time, the taste index decreased in the three methods. The highest taste acceptance rate (4.9%) was obtained in the manual peeling method, significantly different from that in the screw-blade and screw ones. There was no significant difference between the two methods of screw-blade and screw.

3.9.3 Texture

According to Table 8, by increasing storage time, the texture hardness decreased. Further, there was no significant difference between the three methods.

3.9.2. Shell color

Based on Table 7, with increasing storage time, the shell color quality index decreased slightly. The highest color quality was obtained by the manual peeling method, significantly different from the two others. The screw-blade method had better color quality than the screw method.

3.9.4. Overall acceptance

According to Table 9, with increasing storage time, overall acceptance decreased in all three methods. The highest overall acceptance (4.87%) was obtained by the manual peeling method, significantly different from the screw-blade. There was no significant difference between the two methods of screw-blade and screw.

Table 4- Effect of peeling method on L*, a*, and b* in pistachio shell

Peeling Mthod		Storage Month				
		0	1	2	3	4
L*	Screw-blade	66.32±0.10a	64.88±0.74abc	63.12±0.36b-e	62.65±0.51c-f	59.89±1.70gh
	Screw	66.29±0.62a	65.41±0.17ab	63.58±0.31bcd	62.016±0.12d-h	60.52±0.51e-h
	Manual	63.39±0.08bcd	62.51±0.06c-g	61.28±0.03d-h	60.21±0.06fgh	59.38±0.12h
a*	Screw-blade	3.54±0.20cde	3.69±0.25bcd	3.71±0.22bcd	4.07±0.06abc	4.38±0.08a
	Screw	3.05±0.07ef	3.416±0.16de	3.70±0.16bcd	4.14±0.31ab	4.35±0.05a
	Manual	2.28±0.19g	2.65±0.06fg	3.00±0.03ef	3.35±0.10de	3.84±0.29a-d
b*	Screw-blade	17.44±1.08cde	17.51±0.25cde	17.94±0.41a-d	18.43±0.08a-d	19.36±0.08ab
	Screw	16.69±1.31c-f	17.82±0.28a-d	18.27±0.12a-d	18.51±0.75abc	19.50±0.29a
	Manual	15.18±0.21f	15.84±0.24ef	16.62±0.17def	17.36±0.67cde	17.62±0.33b-e

The values with different letters at a 1% level of statistical difference are significant

Table 5- Comparison of color indices of L*, a*, b* in pistachio kernels

Peeling Method		Storage Month				
		0	1	2	3	4
L*	Screw-blade	65.36±0.57ab	64.58±0.08ab	62.40±0.84abc	60.49±0.07bcd	57.07±0.22de
	Screw	65.27±0.58ab	65.07±1.38ab	64.85±5.26ab	63.84±1.12ab	58.01±0.18cde
	Manual	66.01±0.44a	61.44±0.15a-d	57.97±1.64cde	54.08±0.34d	49.47±0.45e
a*	Screw-blade	-8.35±1.05a-d	-8.85±1.05a-d	-9.08±1.66a-d	-9.66±0.26bcd	-10.71±1.03d
	Screw	-7.96±0.15abc	-8.50±0.12a-d	-8.87±0.05a-d	-9.34±0.14a-d	-10.22±0.09cd
	Manual	-6.94±0.76a	-7.25±0.96ab	-7.89±0.29abc	-7.89±0.29abc	-9.40±0.64bcd
b*	Screw-blade	25.74±0.23def	26.14±0.89b-f	26.62±0.78a-e	27.29±0.19ab	27.42±0.33ab
	Screw	25.66±0.16ef	26.13±0.11b-f	26.46±0.86a-e	27.11±0.18a-d	27.16±0.41abc
	Manual	24.8767±0.01f	25.32±0.11ef	25.87±0.04c-f	26.63±0.12a-e	27.74±0.10a

The values with different letters at a 1% level of statistical difference are significant

Table 6- Comparison of the peeling method and storage time in terms of taste

Peeling Method	Storage Month				
	0	1	2	3	4
Screw-blade	4.84±0.02b	4.64±0.02c	4.34±0.02d	3.95±0.01f	3.48±0.01i
Screw	4.87±0.02ab	4.65±0.02c	4.31±0.02d	3.83±0.004g	3.65±0.02h
Manual	4.90±0.01a	4.64±0.02c	4.36±0.01d	4.06±0.01e	3.68±0.01h

*The values with different letters at a 1% level of statistical difference are significant

Table 7- Comparison of the peeling method and storage time in terms of color

Peeling method	Storage month				
	0	1	2	3	4
Screw-blade	4.54±0.02b	4.52±0.08b	3.80±0.09d	3.36±0.02fg	3.23±0.03g
Screw	4.41±0.05b	4.39±0.01b	3.89±0.02d	3.32±0.04fg	3.32±0.09fg
Manual	4.78±0.02a	4.73±0.06a	4.07±0.01c	3.56±0.005e	3.46±0.01ef

*The values with different letters at a 1% level of statistical difference are significant

Table 8 - Comparison of the peeling method and storage time in terms of texture

Peeling method	Storage Month				
	0	1	2	3	4
Screw-blade	4.51±0.04a	4.37±0.00bcd	4.18±0.01f	4.02±0.05g	3.80±0.03h
Screw	4.44±0.01abc	4.36±0.002cde	4.17±0.01f	3.87±0.01h	3.85±0.02h
Manual	4.33±0.04de	4.47±0.03ab	4.26±0.02ef	4.02±0.04g	3.83±0.04h

*The values with different letters at a 1% level of statistical difference are significant

Table 9- Comparison of the peeling method and storage time in terms of overall acceptance

Peeling method	Storage month				
	0	1	2	3	4
Screw-blade	4.37±0.01c	4.26±0.03d	4.12±0.01e	3.84±0.01g	3.74±0.03h
Screw	4.33 ±0.02c	4.18 ±0.01e	4.13±0.01e	3.92 ±0.01f	3.71 ±0.01h
Manual	4.87±0.01a	4.52±0.01b	4.26±0.01d	4.16±0.003e	3.94±0.01f

*The values with different letters at a 1% level of statistical difference are significant

4. Discussion

4.1 Peeling efficiency

Based on the results, the highest percentage of fully-peeled nuts (87.95%) was obtained by the screw-blade method, and there was a significant difference between the three methods.

The percentage of partially-peeled nuts in the screw-blade machine was lower than the screw one. There was a significant difference between the three methods.

The percentage of unpeeled nuts was not significantly different among the screw-blade and the screw machine. The highest percentage of unpeeled nuts was obtained by the manual method with 22.35%. The highest grain fracture rate was assigned to the screw machine with 2.513%. The screw-blade machine showed 0.89% lower broken nuts than the screw one. These results were similar to Afzali's report (2014), in which the lowest percentage of unpeeled pistachios was 2.5% obtained by the screw-blade peeler. Overall, the screw-blade machine had a higher peeling efficiency.

4.2. Peroxide value

A comparison of means showed that with increasing storage time, the peroxide value increased significantly in all pistachio samples since pistachio was exposed to air and light for a longer period, resulting in high oxidation and peroxide content. Dabestani Rafsanjani et al. (2018) reported that higher storage temperature resulted in higher peroxide of pistachio powder[14]. Further, Shakerardekani et al. reported that the peroxide value of the pistachio butter increased with an increase in storage time [15]. Esmaeili et al. (2018) stated that high levels of unsaturated fatty acids (linoleic-about 90%) could lead to high oil oxidation [16].

At the end of the four-month period, the amount of peroxide value was 0.166, 0.167, and 0.168 meq/kg in manual, screw-blade, and screw peeling methods, respectively, which were not significantly different. The maximum permitted peroxide value for pistachio oil is 5 meq/kg, according to ISIRI (2002)[17].

4.3. Texture

There was no significant difference between the three pistachio peeling methods in terms of texture. With increasing storage time, the hardness decreased due to the activity of some degrading enzymes and moisture absorption. This was consistent with the research by Edalatian et al. [18].

4.4. Shell color

The color indexes of pistachio shell (L*, a*, b*) were divided into two statistical levels, the manual peeling method at one level and screw and screw-blade peeling ones at the other level. In the manual method, the pistachio peel was very well-colored compared to instrumental methods. In all pistachio samples, lower L* (darker skin), higher a* (less green), and higher b* value (more yellow) were observed for 4 months, indicating pigment degradation. Nakhei-Nejad (2002) reported that when the hull was not quickly removed from pistachios after harvesting, the shells were discolored [19].

4.5. Kernel color

L* and a* color indexes of pistachio kernel were similar to those of shell. In the instrumental methods, the pistachio kernel was slightly darkened due to the infiltration of small amounts of liquids from pistachio nuts, possibly entering infection. No significant differences were observed between the peeling methods in terms of b* indices. As the storage time increased, the L* index decreased, while

the indexes of a* and b* increased, indicating the pigment destruction. Shakerardekani (2015) reported that pistachio paste green color was destroyed by storage [20].

4.6. Sensory properties

Taste, color, and overall acceptance were decreased by increasing the storage time in three peeling methods, possibly due to pistachio fatty acid changes and pistachio oil rancidity caused by storage time [18].

The highest taste, color, and overall acceptance rate was related to the manual peeling method, which was significantly different from the other methods.

There was no significant difference between the screw-blade and screw methods. The screw-blade method had a slightly better color quality than the screw method. Based on the made comparison, with increasing storage time, the texture hardness decreased, and there was no significant difference between the three peeling methods, probably due to the activity of some degrading enzymes and moisture absorption over time. The results were in line with those of Edalatian et al. (2007) [18].

5. Conclusion

Using the screw-blade machine imposes less damage to pistachios compared to the screw machine. The best quality belongs to manually peeled pistachios. The manual method is better in terms of broken nuts, color, and sensory properties; however, it is not recommended to peel the high pistachio volume by this method.

The screw-blade machine is better in terms of peeling efficiency, as well as broken and partially-peeled nuts. There is no significant difference between the two screw-blade and screw methods; however, the percentage of screw-blade traits is better. Therefore, generally, the screw-blade machine is recommended to be used for pistachio peeling.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgments

The authors would like to thank the Pistachio Research Center for its financial support.

References

1. Shakerardekani A, Karim R, Ghazali HM, Chin NL. Types of dryers and their effect on the pistachio nuts quality-A review. Journal of Agricultural Science. **2011**;3(4):*13-21*.

2. Afzali H. Evaluation and comparison of three types of pistachio hullers used in kerman province. Journal of Agricultural Machinery. **2014**;4(2): *206-13*.

3. Rekabi M, Shamsi M. Evaluation of pistachio peel with centrifugal plate peeler. 6th National Congress of Agricultural Machinery and Mechanization; Tehran: Tehran University; **2010**.

4. Naseri M, Emami M, Keidashti M. Design and manufacture of walnut peeler machine. 1st National Conference on Harvest and Postharvest Novel Technologies of Agricultural Products; Mashhad: Khorasan Razavi Agricultural and Natural Resources Research Center; **2015**.

5. Salajagheh F, Azadshahraki F, Mozaffari M. Effect of dehulling methods and genotype on chemical, aflatoxin and sensorial indices for walnuts. Journal of Agricultural Engineering Research. **2012**;13(3):*37-50*.

6. Rostami MA. Design, manufacture, and evaluation of peanut peeler. Journal of Agricultural Engineering Research. **2008**;9(1):*1-14*.

7. Jafari S, Rashidi M, Ranjbar I, Seifzadeh S. Effect of crushing speed and gap between crushing and crushing on the performance of green almond crusher machine,. First National Conference on Modern Agriculture; Saveh: Islamic Azad University of Saveh **2011**.

8. Shakerardekani A, Karim R, Mirdamadiha F. The effect of sorting on aflatoxin reduction of pistachio nuts. J Food Agric Env. **2012**;10(1): *459-61*.

9. Shakerardekani A, Mirdamadiha F. The Effects of Segregating Stained Nuts on Reducing the Aflatoxin Content of Ahmad-Aghaei, Fandoghi and Kale-Ghoochi Pistachio Cultivars. Pistachio and Health Journal. **2018**;1(4):*32-7*.

10. Shakerardekani A, Karim R, Ghazali HM, Chin NL. Oxidative stability of pistachio (Pistacia vera L.) paste and spreads. Journal of the American Oil Chemists' Society. **2015**;92(7):*1015-21*.

11. Wrolstad RE, Acree TE, Decker EA, Penner MH, Reid DS, Schwartz SJ, Shoemaker CF, Smith DM, Sporns P. Current Protocols in Food Analytical Chemistry. New York: Wiley; **2001**.

12. Khatib H, Mirdehghan SH, Doraki N. The effect of UV-C irradiation on the quality and shelf life of fresh pistachio nut cultivars (Ohadi and Akbari). Journal of Horticulture Science. **2012**;25(4): *443-52*.

13. Stone H. Bring the refrence for sensory evaluation. Academic press; **2012**.

14. Dabestani Rafsanjani N, Daneshi M, Shakerardekani A. Effect of freezing and vacuum packaging on quality properties of pistachio powder during storage. Journal of Nuts. **2018**;09(2):*169-79*.

15. Shakerardekani A, Tavakolipour H. An investigation of the effects of the addition of pistachio hul and testa on the oxidative stability of pistachio butter. Pistachio and Health Journal. **2019**;1(3):*8-14*.

16. Esmaeili M, Goli SA, Shirvani A, Shakerardakani A. Improving storage stability of pistachio oil packaged in different containers by using rosemary (Rosmarinus officinalis L.) and peppermint (Mentha piperita) essential oils. European Journal of Lipid Science and Technology. **2018**;120(4):*1700432*.

17. ISIRI. Edible fats and oils- Virgin pistachio oil-Specifications and test methods (6655). Karaj: Institute of Standards and Industrial Research of Iran; **2002**.

18. Edalatian MR, Sedaghat N. Effect of temperature, packaging and time Storage on instrumental hardness and sensory evaluation of Ohadi pistachio variety. First National Conference on Pistachio Processing and Packaging; Mashhad: Mashhad Ferdowsi University; **2007**.

19. Nakhei-Nejad M. Pistachio huller. Google Patents; **2002**.

20. Shakerardekani A. Effect of milling process on colloidal stability, color and rheological properties of pistachio paste. Journal of Nuts (IJNRS). **2014**;5(2):*57-65*