Evaluating Contamination Level of Raw and Roasted Nuts Distributed in Commercial Markets in Mazandaran Province, Iran

Maryam Azizkhani, Fereshteh Jafari, Pouyan Haghighi, Maedeh Dehghan

Department of Food Hygiene, Faculty of Veterinary Medicine, University of Special Modern Technologies, Amol, Iran

Abstract

BACKGROUND: Raw and roasted nuts are one of the most popular snacks consumed in Iran but mishandling and poor storage conditions and practices may lead to promote the growth of microorganisms and foodborne intoxications and infections.

OBJECTIVES: The purpose of this study was to investigate the microbial quality of raw and roasted (salted and unsalted) nuts, distributed in commercial markets in Mazandaran province, Iran.

METHODS: The moisture content, total colony counts, total coliform, fecal coliform, Staphylococcus aureus, and fungal contamination were evaluated according to procedures of Iran national standards.

RESULTS: The moisture content of raw and roasted hazelnut, pistachio, almond, and cashew nut samples were above the standard limits. The moisture content of the raw peanuts was within the standard approved limit (maximum 9%). But the moisture content of the roasted peanut was higher than the permissible limit of 5%. For yeasts and moulds, except for all almond samples and 56% of cashew nut samples, all products tended to be loaded with unsatisfactory limits. The total viable count was within the standard limits in hazelnut, almond, and cashew nut samples (less than 4log cfu/gr). Satisfactory limits of coliforms (lower than 1log cfu/gr) were observed in all almond samples, 91.6% of hazelnut, and 16.7% of pistachio samples. No fecal coliforms were detected in samples. S.aureus contamination was observed in 6.5% of hazelnut, 8% of almond, 25% of cashew nut, and 33% of peanut samples.

CONCLUSIONS: According to the findings, almond and hazelnut showed the least, and pistachio and peanut samples showed the highest microbial contamination.

KEYWORDS: Almond, Cashew nut, Hazelnut, Microbial load, Peanut, Pistachio

Correspondence
Maryam Azizkhani, Department of Food Hygiene, Faculty of Veterinary Medicine, University of Special Modern Technologies, Amol, Iran, Tel: +98 (11) 44271057, Fax: +98 (11) 44271054, Email: m.azizkhani@ausmt.ac.ir
Received: 2019-11-17
Accepted: 2020-01-14

How to Cite This Article
Introduction

Nuts are generally consumed in many parts of the world directly as a snack with high nutritive value and desirable taste, accepted by almost everyone. Also, nuts are used in various parts of the food industry such as infant food, complementary food for athletes and kids, cooking, and extraction of oils is common for home and industrial uses. Types of nuts, hazelnut, pistachio, almonds, cashew nut, and peanuts, are rich in high-quality proteins, unsaturated good fats, minerals, and vitamins, and they have low water content; therefore, nuts are highly vulnerable to microbial spoilage especially fungal attack. Microorganisms may enter into the nuts' shell while still on the trees and this usually occurs when the pods or hard shells of the nuts are split open and the seeds are attacked by insects or pests which make space for the microbial spores to access the developing seeds. Other possible ways of contamination of nuts by microorganisms include harvesting process, sorting practices, and washing of the nuts before storage. If the nuts are not properly treated during these stages, it could lead to bacterial and mould growth especially when nut seeds are not properly dried to the safe moisture content before storage or distribution (Adetunji et al., 2014). As mentioned above, both fungi and bacteria are responsible for microbial biodeterioration of food crops resulting in food and economic losses, hence reducing the consumer acceptance value of the food products. The fungal contamination occurs without necessarily showing any form of moldiness, moulds produce mycotoxins as secondary metabolites, which are consumed by humans and lead to different forms of diseases such as cancers, spontaneous abortion, cirrhosis, and other liver diseases, and also immune suppression interference with micronutrient metabolism and therefore stunted growth (Abbas et al., 2005; Lutfullah and Hussain, 2011; Ritter et al., 2011).

This research has focused on evaluating the microbiological quality and safety of different types of nuts and the effect of packaging type through analyzing the total colony counts, total coliform bacteria, fecal coliform bacteria, Staphylococcus aureus and fungal (yeasts and moulds) counts. The objective of the present study was to investigate the microbial quality of raw and roasted (salted and unsalted) nuts, distributed in commercial markets and consumed in Mazandaran province, Iran.

Materials and Methods

Sampling

The analyses of the bulk nut samples were conducted in four different sampling times (interval between successive samples, also called the sampling interval), for a total period of four months (April-July 2018). The sampling procedure was conducted according to sampling guidelines of the European Commission for nuts (in a shell and shelled or otherwise prepared). So, the random selection was done from different parts of the consignment, at least five conventional points (one at the top, three at different depths in the middle, and one at the bottom). The recommended minimum quantity for each final sample was 100-500 gr. In this study, the sample size was equivalent to 200 gr. For sample collection, five different types of bulk nuts (raw, roasted and salted, roasted and unsalted) including shelled hazelnut, unshelled pistachio, shelled almonds, cashew nut and shelled peanuts were obtained from local markets of different cities in Mazandaran.
ran province (Iran). Samples were collected from four different markets in each city. The mixed samples were blended aseptically using a mixer grinder and 100 g portions kept in zip lock envelopes. Samples that were not used immediately were kept at −20 °C before analysis.

**Chemicals**

All were purchased from Sigma Chemical Co. (St. Louis, USA).

**Moisture content**

Moisture content was determined according to Iran national standard (2015) for dry fruits. Briefly, 5 gr of samples were oven-dried in a pre-weighed dish at 105 °C for 4 h and cooled in a desiccator until a constant weight was obtained. The moisture content was calculated from the reduction in weight and expressed as a percentage of the original weight.

**Total viable count**

Ten grams of each nut sample (shelled) were weighted in a sterilized stomacher bag and homogenized using a sterile physiological normal saline solution (0.85% NaCl), then serial dilutions were prepared. Pour plate method was applied for aerobic mesophilic bacteria count, using PCA (Plate Count Agar). PCA plates were incubated at 30 °C for 48 h (Iran national standard, 2015).

**Total coliform bacteria and fecal coliform bacteria**

For total coliforms counts, the method described by Iran national standard (2007) was used. Growth of coliforms was detected using VRBA (Violet Red Bile Agar) incubated at 37 °C for 48 h, and confirmation step was performed through subculturing of suspected colonies into BGLB (Brilliant Green Lactose Bile Broth) and evaluating gas production at 37 °C for 48 h, and at 44 °C for 24 h for fecal coliforms.

**Staphylococcus aureus**

To detect the presence of *S. aureus*, 0.2 ml of dilution 1 (first dilution) was spread onto an of Baird Parker Agar plate complemented with 5% of Egg Yolk Tellurite Emulsion. The plates were incubated at 37 °C for 48 h, and then they were evaluated for the typical morphology of *S. aureus* colonies (Iran national standard, 2005).

**Fungal contamination**

One gram of each blended and well-mixed nut was added to 9 ml of sterile peptone water in a sterile test tube and the solution was diluted decimally. 20 ml of sterilized molten Potato Dextrose Agar (PDA) plates supplemented with 0.01% chloramphenicol were cooled to 45 °C and poured into plates (in triplicate) and 0.1 ml aliquots of each sample were added. The plates were gently swirled and allowed to solidify. The PDA plates were incubated at 25 °C for 5 days for the determination of fungal counts (Spangenbergi and Ingham, 2000).

**Statistical analysis**

Means and standard divisions of the microbial counts and moisture content were analyzed using SPSS 22.0 by the One-Sample t-test. Means were compared by the least significant difference (LSD) test when the P-value was <0.05.

**Results**

Different samples of nuts, including hazelnut, pistachio, almond, cashew nut, and peanut, collected from the local markets of Mazandaran province (Iran) during four months were analyzed. The samples included raw and roasted-salted and roasted-unsalted nuts. The moisture content of all the samples was measured and presented in Table 1. The moisture content of raw and roasted hazelnut, pistachio, almond, and cashew nut samples
was above the standard limits (5%, 5 and 3%, 5 and 4%, 4%, respectively) according to the Iran national standards. The moisture contents of the raw peanuts were within the permitted limits (max 9%) but that of roasted peanut samples was above the permissible recommended moisture limit of 5% (Iran national standard, 2015).

**Table 1.** Moisture content in different nut products

<table>
<thead>
<tr>
<th></th>
<th>$T_1$</th>
<th>$T_2$</th>
<th>$T_3$</th>
<th>$T_4$</th>
<th>Standard limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hazelnut</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>$^{*}6.25\pm0.114^a$</td>
<td>$6.38\pm0.713^a$</td>
<td>$5.85\pm0.320^a$</td>
<td>$6.41\pm0.328^a$</td>
<td>Max 5%</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>5.45±0.371$^a$</td>
<td>4.02±0.836$^b$</td>
<td>5.47±0.513$^a$</td>
<td>6.25±0.914$^a$</td>
<td>-</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>5.11±0.230$^a$</td>
<td>5.5±0.937$^a$</td>
<td>5.03±0.184$^a$</td>
<td>5.95±0.320$^a$</td>
<td>-</td>
</tr>
<tr>
<td><strong>Pistachio</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>7.23±0.922$^a$</td>
<td>7.5±0.691$^b$</td>
<td>6.92±0.515$^a$</td>
<td>7.54±0.216$^a$</td>
<td>Max 5%</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>6.45±0.560$^a$</td>
<td>7.11±0.573$^a$</td>
<td>7.05±0.384$^a$</td>
<td>6.90±0.738$^a$</td>
<td>Max 3%</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>6.70±0.732$^a$</td>
<td>6.83±0.447$^a$</td>
<td>6.55±0.821$^a$</td>
<td>7.04±0.580$^a$</td>
<td>Max 3%</td>
</tr>
<tr>
<td><strong>Almonds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>8.50±0.673$^a$</td>
<td>7.33±0.838$^a$</td>
<td>7.15±0.037$^a$</td>
<td>8.60±0.511$^a$</td>
<td>Max 5%</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>7.73±0.315$^a$</td>
<td>6.15±0.190$^a$</td>
<td>5.90±0.834$^a$</td>
<td>6.74±0.809$^a$</td>
<td>Max 4%</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>7.50±0.528$^a$</td>
<td>6.55±0.411$^a$</td>
<td>5.17±0.610$^a$</td>
<td>6.35±0.314$^a$</td>
<td>Max 4%</td>
</tr>
<tr>
<td><strong>Cashew nut</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>8.25±0.451$^a$</td>
<td>7.92±0.174$^a$</td>
<td>8.5±0.116$^a$</td>
<td>8.47±0.219$^a$</td>
<td>-</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>7.10±0.603$^a$</td>
<td>6.75±0.900$^a$</td>
<td>6.68±0.450$^a$</td>
<td>5.81±0.564$^a$</td>
<td>Max 4%</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>5.05±0.380$^a$</td>
<td>6.44±0.815$^a$</td>
<td>7.28±0.315$^a$</td>
<td>6.5±0.259$^a$</td>
<td>Max 4%</td>
</tr>
<tr>
<td><strong>Peanut</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>7.65±0.825$^a$</td>
<td>8.5±0.794$^a$</td>
<td>8.13±0.620$^a$</td>
<td>7.75±0.310$^a$</td>
<td>Max 9%</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>6.80±0.254$^a$</td>
<td>7.90±0.433$^a$</td>
<td>7.15±0.340$^a$</td>
<td>6.55±0.241$^a$</td>
<td>Max 5%</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>6.47±0.318$^a$</td>
<td>7.63±0.651$^a$</td>
<td>7.84±0.895$^a$</td>
<td>7.50±0.414$^a$</td>
<td>Max 5%</td>
</tr>
</tbody>
</table>

* Time of sampling
** Data are presented as mean ± standard deviation
a Mean values with the same superscript along the same column are not significantly different ($P<0.05$).

The whole samples were evaluated microbiologically to detect the levels of a total viable count, coliforms, fecal coliforms, *S. aureus*, yeasts, and moulds (Tables 2 and 3). For yeasts and moulds (Table 2), except all almond samples and 56% of cashew nut samples, all kinds of pistachio products ended up being loaded with unsatisfactory limits (>2.69logcfu/gr) (Iran national standard, 2014). There is still no microbiological permissible limit for hazelnut and peanut in Iran national standards but it is obvious that yeast and mould count in peanut samples is high.
The total viable count was within the standard limits in hazelnut, almond, and cashew nut samples (less than 4 log cfu/gr). Satisfactory limits of coliforms (lower than 1 log cfu/gr) were observed in all almond samples, 91.6% of hazelnut and 16.7% of pistachio samples (Table 3). No fecal coliforms were detected in samples (results are not shown). S. aureus contamination was found in 6.5% of hazelnut, 8% of almond, 25% of cashew nut, and 33% of peanut samples.

Table 2. Fungal contamination of different nut products

<table>
<thead>
<tr>
<th></th>
<th>Yeast and Moulds (log cfu/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T₁</td>
</tr>
<tr>
<td><strong>Hazelnut</strong></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>2.30±0.518**</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>1.81±0.655*</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>2.14±0.430*</td>
</tr>
<tr>
<td><strong>Pistachio</strong></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>4.85±0.672*</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>3.70±0.201*</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>3.31±0.622*</td>
</tr>
<tr>
<td><strong>Almonds</strong></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>1.33±0.217*</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>0.57±0.010*</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>1.08±0.105*</td>
</tr>
<tr>
<td><strong>Cashew nut</strong></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>1.05±0.118*</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>2.60±0.214*</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>1.90±0.272*</td>
</tr>
<tr>
<td><strong>Peanut</strong></td>
<td></td>
</tr>
<tr>
<td>Raw</td>
<td>4.50±0.335*</td>
</tr>
<tr>
<td>Roasted-salted</td>
<td>3.11±0.525*</td>
</tr>
<tr>
<td>Roasted-unsalted</td>
<td>3.47±0.680*</td>
</tr>
</tbody>
</table>

* Time of sampling
** Data are presented as mean ± standard deviation
a Mean values with the same superscript along the same column are not significantly different (P< 0.05).
Table 3. Results of bacteriological contamination of different nut products

<table>
<thead>
<tr>
<th>Nut Product</th>
<th>Time of Sampling</th>
<th>Total Viable Count (log cfu/g)</th>
<th>Total Coliform (log cfu/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>T₁</td>
<td>T₂</td>
</tr>
<tr>
<td>Hazelnut</td>
<td>Raw</td>
<td>3.05±0.185*</td>
<td>3.41±0.117*</td>
</tr>
<tr>
<td></td>
<td>Roasted-salted</td>
<td>3.89±0.446*</td>
<td>2.20±0.238*</td>
</tr>
<tr>
<td></td>
<td>Roasted-unsalted</td>
<td>3.55±0.475*</td>
<td>2.15±0.289*</td>
</tr>
<tr>
<td>Pistachio</td>
<td>Raw</td>
<td>4.58±0.713*</td>
<td>5.27±0.671*</td>
</tr>
<tr>
<td></td>
<td>Roasted-salted</td>
<td>3.95±0.483*</td>
<td>3.81±0.115*</td>
</tr>
<tr>
<td></td>
<td>Roasted-unsalted</td>
<td>4.35±0.550*</td>
<td>4.05±0.205*</td>
</tr>
<tr>
<td>Almonds</td>
<td>Raw</td>
<td>3.51±0.225*</td>
<td>3.90±0.426*</td>
</tr>
<tr>
<td></td>
<td>Roasted-salted</td>
<td>2.07±0.135*</td>
<td>1.72±0.085*</td>
</tr>
<tr>
<td></td>
<td>Roasted-unsalted</td>
<td>2.66±0.190*</td>
<td>2.81±0.115*</td>
</tr>
<tr>
<td>Cashew nut</td>
<td>Raw</td>
<td>3.67±0.275*</td>
<td>3.11±0.455*</td>
</tr>
<tr>
<td></td>
<td>Roasted-salted</td>
<td>2.14±0.129*</td>
<td>2.51±0.167*</td>
</tr>
<tr>
<td></td>
<td>Roasted-unsalted</td>
<td>2.80±0.320*</td>
<td>3.07±0.285*</td>
</tr>
<tr>
<td>Peanut</td>
<td>Raw</td>
<td>4.09±0.239*</td>
<td>4.57±0.360*</td>
</tr>
<tr>
<td></td>
<td>Roasted-salted</td>
<td>4.31±0.181*</td>
<td>4.89±0.172*</td>
</tr>
<tr>
<td></td>
<td>Roasted-unsalted</td>
<td>3.22±0.290*</td>
<td>4.07±0.158*</td>
</tr>
<tr>
<td>Standard limit</td>
<td>Max 4</td>
<td>Max 1</td>
<td></td>
</tr>
</tbody>
</table>

* Time of sampling  ** Data are presented as mean ± standard deviation  a  Mean values with the same superscript along the same column are not significantly different (P< 0.05).
Discussion

The moisture contents of all the raw and roasted nuts, except for raw peanut, were above the permissible recommended moisture limit. In comparison to our study, lower moisture content, 5.10-7.2%, and 6.48-7.05% were reported for peanuts from different states of Nigeria by Adetunji et al. (2018) and Oyedele et al. (2017), respectively. Also, the moisture content of our raw and roasted cashew nuts was higher than the results of Adebajo and Diyaolu (2003) who reported a range of moisture content of 4.1–6.8% and higher than the findings of Oluwafemi et al. (2009) who reported a low moisture content range of 3.7–4.3 and 3.2–5.4% for cashew nuts during the dry and raining seasons. Similar results to our work were found by Adetunji et al. (2018) who obtained 5.2-8.6% of moisture content for cashew nuts. There is no report on the moisture content of hazelnut, pistachio or almond. As nuts are hygroscopic materials, they absorb moisture from the surrounding atmosphere. The higher moisture content of the raw samples could be as a result of their raw nature as they have not yet been treated by any form of the drying process. The high moisture contents of the samples may also be as a result of inappropriate packaging, use of improper packaging compositions, and harvesting methods in the farms (Oladapo et al., 2014).

Nuts are vulnerable to fungal attacks at different stages of cultivation, harvesting, sorting, processing, and storage. If the nuts are not properly handled at these stages, it could result in mould development especially when they are not dried enough to be considered as the safe moisture level and stored under conditions suitable for mould growth such as high humidity and temperature (Abdulla, 2013; Adetunji et al., 2014). However, the total bacteria, total coliforms, and fungi load of the almond samples were less than the limits recommended in nuts by the Iran National Standard Commission on Specification for almond as $10^4$ cfu/gr, $10^1$ cfu/gr and $10^2$ cfu/gr, respectively. As reported by Adetunji et al. (2018), total viable count of groundnut and cashew nut in Nigeria was 4.85 and 4.47 log cfu/gr, respectively, which is almost the same as our findings of peanut samples and a little higher than our results from cashew nut microbiological analysis.

The lower counts of viable organisms in the almond, hazelnut and cashew nut samples possibly is due to the presence of amygdalin in almond and phenolic compounds in all these three nuts which exert inhibitory effects against bacteria, yeast, and fungi. Although the cashew nut is known to be a rich substrate for microbial growth, an outbreak of intoxication and infections through its consumption had rarely been reported. Also, Torquato et al. (2004) observed that the cashew nut contains the anacardic acid which is an inhibitor for microbial growth. Anacardic acid has lateral chains that are effective against the growth of *S. aureus*. Contaminated food handlers, surfaces, and types of equipment may result in staphylococcal infections that is one of the most important pathogens as a cause of foodborne intoxication. The results show *S. aureus* contamination was observed in all groups of nuts samples except the pistachio. It seems that the shell of pistachio decreases the probability of staphylococcal cross-contamination through handlers or surfaces. Adetunji et al. (2018) reported the presence of *S. aureus* in groundnuts and roasted cashew nuts in Nigeria (2 and 2.1 log cfu/gr). Also, Oluwafemi et al. (2009) announced high contamination of *S.
aureus (> 4 logs cfu/gr) in Nigerian roasted cashew nuts.

As it is observed in the findings of the present work, almond and hazelnut showed the least and pistachio peanut samples the highest microbial contamination. Higher microbial counts of the pistachio and peanut samples than the recommended limit show poor handling practices of the products by the farmers, producers, and sellers. It is recommended that nut processors and handlers meet all the sanitary principles such as personal hygiene, avoid handling nuts in conditions such as sneezing, coughing and getting cold, flu, diarrhea, wounds and lesions, and following proper cleaning standard operation procedure (SOP) for the surfaces and equipment.

Acknowledgments

This work has been supported by a research grant from the Amol University of Special Modern Technologies, Amol, Iran.

Conflict of Interest

The authors declared that there is no conflict of interest.

References


Institute of Standards and Industrial Research of Iran. (2005) Microbiology of food and animal feeding stuffs – Enumeration of coagulase – Positive staphylococci (Staphylococcus aureus and other species) – Test method Part 1: Technique using baird – parker agar medium. ISIRI no 6806–1. (1st ed.). Karaj, Iran. (Per-


چکیده
زمینه مطالعه: آجیل های خام و بو داده یکی از محبوب‌ترین میان وعده‌های غذایی مورد مصرف در ایران هستند. اما شرایط و روش نگهداری نامناسب زمینه مطالعه: می‌تواند منجر به رشد میکروب‌گانیسم‌ها در آجیل و در نتیجه بروز مسمومیت و عفونت‌های غذایی در مصرف‌کننده شود.
هدف: هدف از مطالعه حاصل بررسی کیفیت میکروبی آجیل خام و برنجه شده (شور و بدون نمک) توزیع شده در بازارهای تجاری استان مازندران (ایران) بود.
روش کار: میزان رطوبت، تعداد الکتری، کلی فرم متفوکوس، استافیلوکوکوس اورتئوس و آلودگی فاصله مطلق با روش های استاندارد میل ایران مورد بررسی قرار گرفت.
نتایج: مقادیر رطوبت محصولات فندق، پسته و بادام درختی و بادام زمینی، برنجه شده بالا در ارتفاع استاندارد بود. میزان رطوبت بادام زمینی خام در محدوده مجاز (حداکثر 24٪) قرار داشت اما نمونه‌های بادام زمینی برنجه شده در رطوبت بالاتر از حد مجاز بودند. در مورد مخبره و آلودگی که بجز همه نمونه‌های بادام درختی و 65٪ نمونه‌های بادام زمینی، سایر نمونه‌ها دارای فاصله بین از حد مجاز بودند. تعداد کل باکتری‌ها در نمونه‌های فندق، پسته و بادام درختی و بادام زمینی در محدوده استاندارد (کمتر از 10 log cfu/gr) بودند. نمونه‌های فندق و پسته با باید در حد مجاز باقی خواهند ماند. نمونه‌های بادام زمینی که نمونه‌های فندق و پسته در حد مجاز باقی خواهند ماند. نمونه‌های بادام زمینی که نمونه‌های فندق و پسته در حد مجاز باقی خواهند ماند.
نتیجه‌گیری نهایی: اهمیت پذیری بادام درختی و فندق کمترین نمونه‌های بادام زمینی و بادام درختی قرار دارد.
دانشگاه: دانشگاه دامپزشکی تهران، ایران
واژه‌کلیدی: بادام درختی، بادام زمینی، بادام هندی، پسته، فندق، باکتری‌ها.