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Investigating the amount of aflatoxin B1, lead, cadmium, *Escherichia coli* and *Staphylococcus aureus* in 18 and 28% Gaz pistachio nuts of Chaharmahal and Bakhtiari province

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ABSTRACT

Gaz is one of the widely consumed food products with a long shelf life, which is always discussed by food industry experts because of the quality of pistachio nuts. The purpose of this research was to investigate the number of harmful compounds important to health according to the national standard of Iran, including aflatoxin B1, lead, cadmium, Escherichia coli and Staphylococcus aureus in 10 best-selling brands of Gaz, as well as to investigate the effects of shelf life and pistachio percentage in these products on the harmful compounds. The results showed that the concentration of aflatoxin B1, lead and cadmium in 18% Gaz was 3 to 5 ppb, 0.005 to 0.010 ppm and 0.012 to 0.029 ppm, respectively. Also, Escherichia coli and Staphylococcus aureus were not observed. The sensory evaluation of the samples showed that the evaluated Gaz samples were in good condition and Asli (A), Ferdovs (F) and Shahkar (SH) samples had more general acceptance and customer satisfaction. In general, it can be concluded that the product of Gaz with pistachio nuts, as one of the popular sweet and traditional products of the society, has a good status in terms of the quality characteristics of Iran's standard.

1- Introduction

Gaz is one of Iran's traditional confectionery products and is particularly associated with the provinces of Chaharmahal and Bakhtiari and Isfahan. Owing to its distinctive characteristics, this product occupies a unique position among confectionery products worldwide. The annual production of Gaz in Iran is estimated at approximately 750,000 tons, of which nearly 90% is produced in Isfahan Province. The history of Gaz production dates back nearly 450 years. Notably, no artificial or synthetic additives are used in its manufacture [1].

The traditional and well-known ingredient used in Gaz is the natural manna known as *Gaz-angabin*. However, due to the substantial decline in its harvest in recent years, it has increasingly been replaced with similar substances such as *Taranjabin* and *Shirkhesht*. Since all-natural manna used in Gaz production is derived from the feeding activity of insects, scientifically identified as *Psylla csylla* and *Larinus*, on the sap-bearing stems of shrubs such as *Alhagi pseudoalhagi* (Papilionaceae) and *Astragalus adscendens* (Papilionaceae), the term "Gaz," derived from the Persian verb meaning "to bite," was adopted for this product [2,3].

Gaz differs substantially from other confectionery and sweet products in its composition. No oils, starch, or flour are used in its preparation. In addition, Gaz possesses remarkable shelf-life stability, as few food products can maintain their quality for several months without the use of synthetic preservatives. Today, Gaz, once regarded as a unique gift from Isfahan and Chaharmahal and Bakhtiari provinces, has become internationally recognized as a traditional Iranian confectionery product [4].

Food safety depends on the absence of foodborne hazards at the time of consumption. Since food safety hazards may arise at any stage of the food chain, the implementation of appropriate control measures throughout the entire chain is essential. Therefore, food safety can only be achieved through the collective efforts of all stakeholders involved in the food supply chain [5]. Organizations within this chain range from feed manufacturers and primary producers to food manufacturers, transportation and storage operators, contractors, retailers, and food service providers, as well as related industries such as packaging manufacturers, detergent producers, additive suppliers, and ingredient manufacturers. Service providers are also included within this scope [6,7].

In recent decades, industrialization and mass production of food products, increasing environmental contamination, changes in dietary patterns, and growing consumer awareness have intensified attention toward food safety among consumers, producers, scientific communities, and regulatory authorities. Consequently, systems have been developed with a primary focus on standardizing workplace and hygienic conditions to minimize the possibility of producing unsafe food products [8].

To this end, the Hazard Analysis and Critical Control Point (HACCP) system was established by the International Organization for Standardization (ISO), the World Health Organization (WHO), and the Food and Agriculture Organization (FAO). HACCP was designed to ensure food hygiene and safety and, because of its compatibility with ISO quality management systems, has become one of the fundamental

components in the implementation of Food Safety Management Systems (FSMS). FSMS was specifically developed for the food industry to ensure food safety and is applied throughout all stages of the food supply chain under ISO 22000 standards. Currently, implementation of FSMS in food manufacturing plants is considered essential for the production of safe and high-quality products. Successful implementation of this system requires adherence to prerequisite programs (PRPs), including HACCP, Good Laboratory Practice (GLP), Good Hygienic Practice (GHP), Good Manufacturing Practice (GMP), and ISO requirements. These systems are widely and practically implemented in European and American countries. The United States Food and Drug Administration (FDA) has emphasized the critical role of PRPs in FSMS implementation, while WHO recognizes them as essential preliminary requirements for the production of safe food products [9–11].

Various approaches have been proposed to reduce microbial contamination and aflatoxin levels in nuts and dried fruits, including gamma irradiation, ultraviolet radiation, cold plasma technology, and chemical treatments. Nevertheless, one of the most effective strategies for minimizing such contaminants in final products such as Gaz may be the initial screening, testing, and selection of high-quality raw nuts and dried fruits.

To the best of our knowledge, no published study has yet reported contamination levels in Gaz products. Therefore, the present study aimed to evaluate the levels of health-related hazardous compounds specified in the Iranian National Standard, including aflatoxin B1, lead, cadmium, *Escherichia coli*, and *Staphylococcus aureus*, in ten of the most commercially popular Gaz brands. In addition, the effects of storage duration and pistachio percentage on the levels of these hazardous compounds were investigated.

2-Materials and Methods

2.1. Collection of Gaz Samples

Ten commercially available pistachio-containing Gaz samples (18% and 28% pistachio content) representing different commercial brands in Chaharmahal and Bakhtiari Province were collected from the local market. The investigated brands included Saadat (S), Asli (A), Ferdows (F), Misagh (ME), Dariush (D), Shahkar (SH), Beshtar (B), Mellat (M), Radfar (R), and Nazari (N). Samples were stored under cool and dry conditions and analyzed after two storage periods of six months and one year.

2.2. Chemicals

All chemicals used in this study, including sodium chloride, methanol, hexane, hydrochloric acid, and nitric acid, were purchased from Merck (Germany).

2.3. Chemical and Microbial Contaminant Analyses

2.3.1. Determination of Aflatoxin B1

Fifty grams of each sample were weighed using a balance with 0.1 g precision into a 500 mL stoppered Erlenmeyer flask. Subsequently, 5 g sodium chloride (Merck, Germany) and 300 mL methanol–water solution (80:20, v/v) were added. To

remove lipids, 100 mL hexane (Merck, Germany) was introduced into the flask. The mixture was homogenized at high speed for 3 min. The extract was filtered through Whatman filter paper, and 20 mL of the filtrate was diluted with 130 mL distilled water and further filtered through cellulose filter paper. Thereafter, 70 mL of the filtered extract was passed through an immunoaffinity column at a flow rate of 2–3 mL/min without external pressure. Subsequently, 1500 µL methanol (Merck, Germany) was added to the column, and the eluate was finally mixed with 1500 µL HPLC-grade water.

A calibration curve was prepared by plotting aflatoxin standard concentrations (ng/mL) against peak area or peak height. Then, 100 µL of each sample extract was injected into an HPLC system (Waters, USA). The resulting peaks were identified by comparing their retention times with those of standard aflatoxin peaks, and contamination levels were quantified using the calibration curve [12]. The limit of detection (LOD) for aflatoxin determination was 0.07 ppb.

2.3.2. Determination of Lead and Cadmium

For sample digestion, 40 g of each sample were initially dried in a water bath. The dried samples were subsequently charred on a heater and incinerated in a furnace at 650°C for approximately 8 h until white ash was obtained. Five milliliters of 6 M hydrochloric acid (Merck, Germany) were added to the ash, and the mixture was evaporated to dryness on a heater. Subsequently, 25 mL of 0.1 M nitric acid (Merck, Germany) were added to dissolve the ash completely. After clarification, the solution was filtered using a volumetric flask, funnel, and Whatman filter paper. The filtrate volume was adjusted to 100 mL [13,14].

Lead and cadmium concentrations were measured using a graphite furnace atomic absorption spectrometer (PG Instruments, UK). The LOD values for lead and cadmium were 0.907 and 0.066 ppb, respectively.

2.3.3. Detection of *Escherichia coli*

Detection of *Escherichia coli* was performed according to the Iranian National Standard (ISIRI 2946) [15]. The procedure included enrichment in selective lactose broth medium (Merck, Germany), inoculation into EC broth containing Durham tubes and peptone water, followed by incubation at 44°C for 24–48 h. Under these conditions, *E. coli* produces gas and exhibits a positive indole reaction. Based on these characteristics, the number of *E. coli* per gram of sample was determined.

2.3.4. Detection of *Staphylococcus aureus*

Enumeration of *Staphylococcus aureus* was conducted according to the Iranian National Standard (ISIRI 6806-1) using Baird-Parker Agar (BPA) medium [16]. To homogenize the samples, 25 g portions were initially frozen at −18°C for 2 h. Mortars were sterilized in a hot-air oven, after which the pistachio kernels were completely ground. Five grams of the homogenized sample were mixed with 45 mL Ringer's solution and allowed to stand for 15 min to ensure proper dispersion.

Ten milliliters of the primary suspension were transferred into 9 mL Giolitti-Cantoni broth (double-strength; Merck, Germany). Subsequently, 1 mL agar was

added, the tubes were sealed with cotton plugs, and incubated at 37°C for 24–48 h. Egg yolk emulsion was then added to Baird-Parker agar medium, mixed thoroughly, and poured into Petri dishes. The culture was streaked onto the medium using an inoculating loop and incubated again at 37°C for 24–48 h.

The appearance of shiny black colonies surrounded by clear halos was considered presumptive evidence of *S. aureus*, after which confirmatory testing was performed. For the coagulase test, 2 mL distilled water were added to a commercial rabbit plasma kit and mixed thoroughly. The prepared plasma was distributed into four test tubes (0.5 mL each) and incubated at 37°C for 4 h. Coagulation of rabbit plasma by the coagulase enzyme was then evaluated. Positive coagulase activity confirmed the presence of *Staphylococcus aureus*.

2.4. Sensory Evaluation

Sensory evaluation of the samples was performed after 180 days of storage at 25°C using a five-point hedonic test conducted by ten trained panelists. The assessors evaluated flavor and taste, color, texture, and overall acceptability on a scale from 1 to 5, where 5 represented the highest quality and 1 represented the lowest quality [17].

2.5. Statistical Analysis

All experiments were carried out in a completely randomized design with three replications. Mean comparisons were performed using Duncan's multiple range test at a significance level of $P < 0.05$. Graphs were prepared using Microsoft Excel software, and quantitative data were statistically analyzed using SAS software version 9.1.

3-Results and Discussion

3.1. Evaluation of Aflatoxin B1

Aflatoxin B1 is one of the most important mycotoxins associated with nuts and dried products, and its occurrence in products such as pistachio kernels and almonds has made it a significant concern in the Gaz industry. The results of aflatoxin B1 determination in Gaz samples containing 18% and 28% pistachio are presented in Table 1, while the instrumental chromatographic profile is shown in Figure 1.

Evaluation of aflatoxin levels in the 18% pistachio Gaz samples during the first storage period demonstrated that aflatoxin concentrations ranged from 3 to 5 ppb, with sample R exhibiting the highest contamination level. In addition, sample S showed an increase in aflatoxin concentration over storage time. In the 28% pistachio Gaz samples, aflatoxin concentrations during the first storage period ranged from 3.17 to 5.17 ppb, and sample R again exhibited the highest aflatoxin level. Furthermore, samples S and A showed increased aflatoxin concentrations over time. This increase may be associated with fungal contamination in the pistachio kernels used as raw materials.

According to the Iranian National Standard No. 5925, the maximum permissible level of aflatoxin B1 in food products is 8 µg/kg. The results of the present study demonstrated that all collected samples complied with the

national standard for aflatoxin B1 contamination.

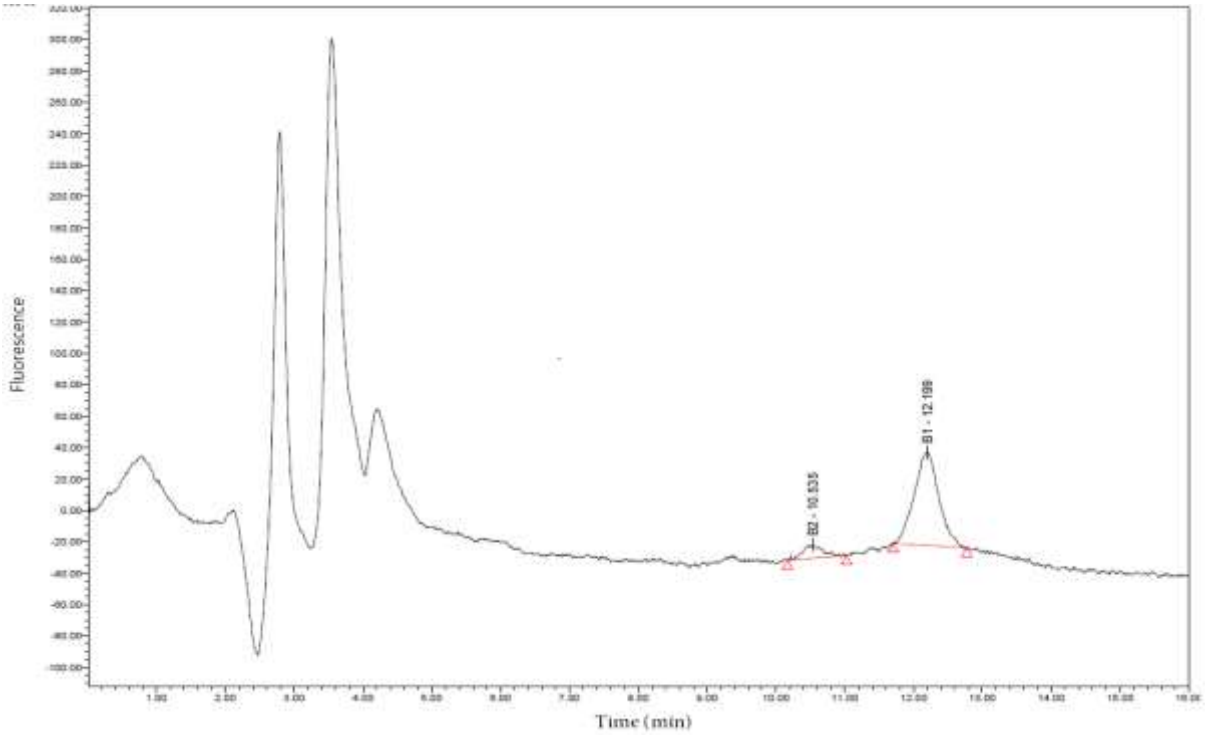


Fig. 1. Aflatoxin B1 graph in Gaz sample

In a study by Dehghani et al. [7], aflatoxin contamination was evaluated in Gaz products manufactured in Isfahan. The findings showed that total aflatoxin concentrations in 40 analyzed Gaz samples ranged from non-detectable levels to 13.97 ng/g. Among the tested samples, 39 samples (97.5%) were contaminated, and the mean total aflatoxin concentration was reported as 4.11 ± 3.55 ng/g. The mean contamination levels in Gaz samples containing 28% and 40% pistachio kernels were 3.53 ± 2.49 and 4.70 ± 4.40 ng/g, respectively, with no statistically significant difference observed between the two groups. Total aflatoxin concentrations in all samples were below the maximum level established by the Iranian National Standards Organization (15 ng/g); however, in four samples (10%), total aflatoxin concentrations exceeded the European regulatory limit (10 ng/g).

Rezaei et al. [18] investigated aflatoxin contamination in nuts and dried fruits, including figs, almonds, hazelnuts, walnuts, pistachios, and sunflower seeds available in Tehran markets. A total of 200 samples, including figs (n = 30), almonds (n = 25), hazelnuts (n = 25), walnuts (n = 40), pistachios (n = 40), and sunflower seeds (n = 40), were collected and analyzed for aflatoxin contamination using the ELISA method. The results indicated that 96.5% (193 samples) were positive for aflatoxin contamination, with an average concentration of 1.68 µg/kg (0–6 µg/kg). In addition, 6% (12 samples) exceeded the European Union limit (4

μg/kg), whereas all samples complied with the Iranian National Standard limit (8 μg/kg or 8 ppb). Despite the high prevalence of contamination, none of the samples reached hazardous levels, likely due to unsuitable environmental conditions for fungal growth or the antioxidant activity of nuts in Tehran. The contamination levels reported in that study were higher than those observed in the present investigation.

In another study, Keng-wen et al. [19] assessed the risk of aflatoxin exposure from imported peanuts and peanut products in Taiwan. A total of 1089 samples, including peanut candies, peanut butter, and peanuts collected between 2011 and 2017, were analyzed using liquid chromatography–mass spectrometry (LC-MS). The average contamination levels of aflatoxin B1, B2, G1, and G2 were reported as 2.40, 0.41, 0.19, and 0.03 μg/kg, respectively. In this study, the Margin of Exposure (MOE) approach was used as a tool to improve food safety management. Based on MOE values, aflatoxin levels in peanut products imported from China, Indonesia, Thailand, the United States, and the Philippines were below the critical safety threshold of 10,000, indicating no significant public health concern for the majority of consumers. However, products imported from Vietnam exhibited lower MOE values, suggesting that continued regulatory monitoring is necessary to prevent excessive consumer exposure. The findings of that study are consistent with the results of the present investigation.

Shakeri et al. [20] evaluated aflatoxin contamination in 88 nut samples, including pistachios (28 samples), almonds (28 samples), hazelnuts (28 samples), and walnuts (20 samples), using HPLC analysis for aflatoxins B1, B2, G1, and G2. The results showed that 2.5%, 5.5%, 5.7%, 7.2%, and 10% of the samples were contaminated with aflatoxins B1, G1, B2, G2, and total aflatoxins, respectively. The mean concentrations of aflatoxins were 8.32, 5.63, 3.067, 1.705, and 10.37 μg/g, respectively. Moreover, 66.67% of the aflatoxin B1-positive samples exceeded the Iranian National Standard limit (8 ppb). Pistachio samples exhibited significantly higher aflatoxin contamination than other nut types. The contamination levels reported in that study were higher than those observed in the present study.

Table 1. Aflatoxin B1 (ppb) content of the Gaz samples in Chaharmahal and Bakhtiari province

		6M	12M	6M	12M
	Sample	18%	18%	28%	28%
1	S	3.50±1.05ABb	5.00±0.82Aa	3.50±1.05ABb	5.33±1.03Aa
2	A	3.00±1.26Bb	3.50±1.05AB	3.17±1.17Bb	5.25±0.96Aa
3	F	3.67±1.03ABa	4.00±1.41Aa	3.63±1.41ABa	5.33±1.63Aa
4	ME	3.50±1.38ABa	4.29±0.95Aa	4.25±1.67ABa	4.75±1.83Aa
5	D	3.57±1.51ABa	4.25±1.67Aa	4.60±1.14ABa	5.33±1.63Aa
6	SH	4.14±1.35ABa	4.57±1.51Aa	4.67±1.63ABa	5.17±1.17Aa
7	B	3.50±1.05ABa	3.88±1.64Aa	3.86±1.35ABa	4.20±1.30Aa
8	M	3.86±1.21ABa	4.33±1.03Aa	3.83±1.47ABa	4.75±1.67Aa
9	R	5.00±1.26Aa	5.00±1.73Aa	5.17±1.47Aa	5.60±1.52Aa
10	N	3.67±1.63ABa	4.00±1.85Aa	3.86±1.35ABa	4.38±2.00Aa

M: storage time (months)

Saadat (S), Asli (A), Ferdovs (F) Misagh (ME), Dariush (D), Shahkar (SH), Beshtar (B), Melat (M), Radfar (R), Nazari (N)

*Data represent mean ± standard deviation of ten independent repeats.

**Different capital letters in each column and lowercase ones in each row indicate significant differences ($P < 0.05$).

3.2. Evaluation of Lead

The results of lead determination in Gaz samples containing 18% and 28% pistachio are presented in Table 2. Analysis of the 18% pistachio samples during the first storage period showed that lead concentrations ranged from 0.005 to 0.010 ppm, with sample SH exhibiting the highest lead level. No changes in lead concentration were observed during storage.

Similarly, in the 28% pistachio samples, lead concentrations during the first storage period ranged from 0.005 to 0.010 ppm, with no significant differences observed among samples. In addition, no changes in lead concentration were detected over time.

According to Iranian National Standard No. 12968, the maximum permissible concentration of lead in food products is 0.01 μg/g. The results indicated that all collected samples were within the acceptable standard range for lead contamination. The presence of lead in these products may originate from the raw materials used in their production [21].

Table 2. PB content (ppm) of the Gaz samples in Chaharmahal and Bakhtiari province

		6M	12M	6M	12M
	Sample	18%	18%	28	28
1	S	0.007±0.004ABa	0.012±0.015Aa	0.005±0.003Aa	0.005±0.003Aa
2	A	0.007±0.002ABa	0.008±0.010ABa	0.008±0.006Aa	0.006±0.003Aa
3	F	0.007±0.006ABa	0.006±0.002ABa	0.006±0.003Aa	0.006±0.002Aa
4	ME	0.006±0.003Ba	0.005±0.002Ba	0.009±0.011Aa	0.007±0.004Aa
5	D	0.005±0.003Ba	0.006±0.004Ba	0.008±0.006Aa	0.008±0.006Aa
6	SH	0.011±0.003Aa	0.008±0.006ABa	0.006±0.002Ab	0.006±0.003Ab
7	B	0.006±0.005ABa	0.006±0.003ABa	0.010±0.020Aa	0.005±0.003Aa
8	M	0.006±0.003Ba	0.006±0.003ABa	0.005±0.003Aa	0.005±0.003Aa
9	R	0.006±0.005ABa	0.005±0.003Ba	0.007±0.006Aa	0.005±0.003Aa
10	N	0.005±0.003Ba	0.008±0.006ABa	0.005±0.004Aa	0.008±0.006Aa

M: storage time (months)

Saadat (S), Asli (A), Ferdovs (F) Misagh (ME), Dariush (D), Shahkar (SH), Beshtar (B), Melat (M), Radfar (R), Nazari (N)

*Data represent mean ± standard deviation of ten independent repeats.

**Different capital letters in each column and lowercase ones in each row indicate significant differences ($P < 0.05$).

3.3. Evaluation of Cadmium

The results of cadmium determination in Gaz samples containing 18% and 28% pistachio are presented in Table 3. Evaluation of the 18% pistachio samples

during the first storage period showed cadmium concentrations ranging from 0.011 to 0.022 ppm, with no significant differences observed among samples. Furthermore, cadmium concentrations remained unchanged during storage.

In the 28% pistachio samples, cadmium concentrations during the first storage period ranged from 0.012 to 0.029 ppm. Samples R and S exhibited the highest cadmium concentrations, while no changes were observed over time.

According to Iranian National Standard No. 12968, the maximum permissible concentration of cadmium in food products is 0.05 µg/g. Similar to lead, the source of cadmium contamination may be associated with the raw materials used in the production of these products [22].

Table 3. Cadmium content (ppm) of the Gaz samples in Chaharmahal and Bakhtiari province

		6M	12M	6M	12M
	Sample	18%	18%	28	28
1	S	0.022±0.014Aa	0.023±0.015Aa	0.024±0.017ABa	0.022±0.019Aa
2	A	0.013±0.011Aa	0.015±0.008Aa	0.012±0.008Ba	0.019±0.016Aa
3	F	0.012±0.003Aa	0.014±0.009Aa	0.013±0.004Ba	0.014±0.006Aa
4	ME	0.012±0.009Aa	0.014±0.010Aa	0.013±0.010Ba	0.012±0.008Aa
5	D	0.012±0.005Aa	0.015±0.011Aa	0.012±0.006Ba	0.014±0.009Aa
6	SH	0.014±0.006Aa	0.013±0.009Aa	0.013±0.004Ba	0.018±0.008Aa
7	B	0.011±0.010Aa	0.011±0.005Aa	0.012±0.006Ba	0.016±0.010Aa
8	M	0.014±0.008Aa	0.012±0.006Aa	0.013±0.005Ba	0.013±0.007Aa
9	R	0.015±0.023Aa	0.017±0.020Aa	0.029±0.037Aa	0.014±0.007Aa
10	N	0.011±0.005Aa	0.013±0.009Aa	0.012±0.009Ba	0.012±0.007Aa

M: storage time (months)

Saadat (S), Asli (A), Ferdovs (F) Misagh (ME), Dariush (D), Shahkar (SH), Beshtar (B), Melat (M), Radfar (R), Nazari (N)

*Data represent mean ± standard deviation of ten independent repeats.

**Different capital letters in each column and lowercase ones in each row indicate significant differences ($P < 0.05$).

3.4. Evaluation of *Escherichia coli*

Escherichia coli is one of the major pathogenic bacteria associated with the food industry and is commonly transmitted to food products through contaminated water sources. The results of *E. coli* evaluation in Gaz samples containing 18% and 28% pistachio demonstrated that all samples were free from this bacterium. In addition, storage time had no effect on the presence or count of *E. coli*.

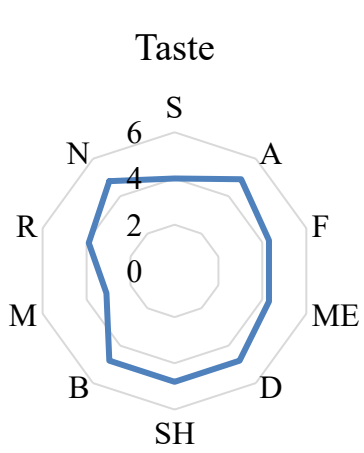
According to Iranian National Standard No. 2946, *E. coli* must be absent in each gram of the product. Khosravi Fard [23] investigated the presence of *E. coli* in Gaz samples containing 18% and 28% pistachio in 2022. The results indicated that all 18 samples of 18% pistachio Gaz were free from *E. coli*, while 10 out of 11 samples containing 28% pistachio showed no contamination with this bacterium.

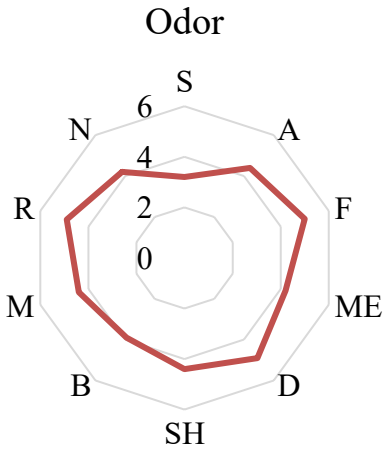
3.5. Evaluation of *Staphylococcus aureus*

The results of *Staphylococcus aureus* evaluation in Gaz samples containing 18% and 28% pistachio demonstrated that all samples were free from this bacterium. Furthermore, storage time had no effect on the presence or count of *S. aureus*.
According to Iranian National Standard No. 6806-3, *Staphylococcus aureus* must be absent in each gram of the product. Khosravi Fard [23] also evaluated the presence of *S. aureus* in Gaz samples containing 18% and 28% pistachio. The findings showed that all 18 samples of 18% pistachio Gaz were free from *S. aureus*, while 10 out of 11 samples containing 28% pistachio were negative for this bacterium.

3.6. Sensory Evaluation

The results of sensory evaluation, including taste, aroma, color, texture, and overall acceptability of 18% and 28% pistachio Gaz samples, are presented in Figure 2.
Evaluation of flavor and taste indicated that samples A, D, SH, B1, and N possessed desirable sensory characteristics and achieved higher consumer acceptability. Aroma evaluation demonstrated that samples F, D, and R had more favorable odor profiles and greater consumer preference. Assessment of color showed that samples S, A, ME, D, SH, M, R, and N exhibited more desirable color attributes and higher consumer acceptance. Texture evaluation revealed that samples S, A, F, ME, SH, and N possessed superior textural properties and were more favorably accepted by consumers. Finally, analysis of overall acceptability indicated that samples A, F, and SH achieved the highest overall sensory acceptance and consumer preference.





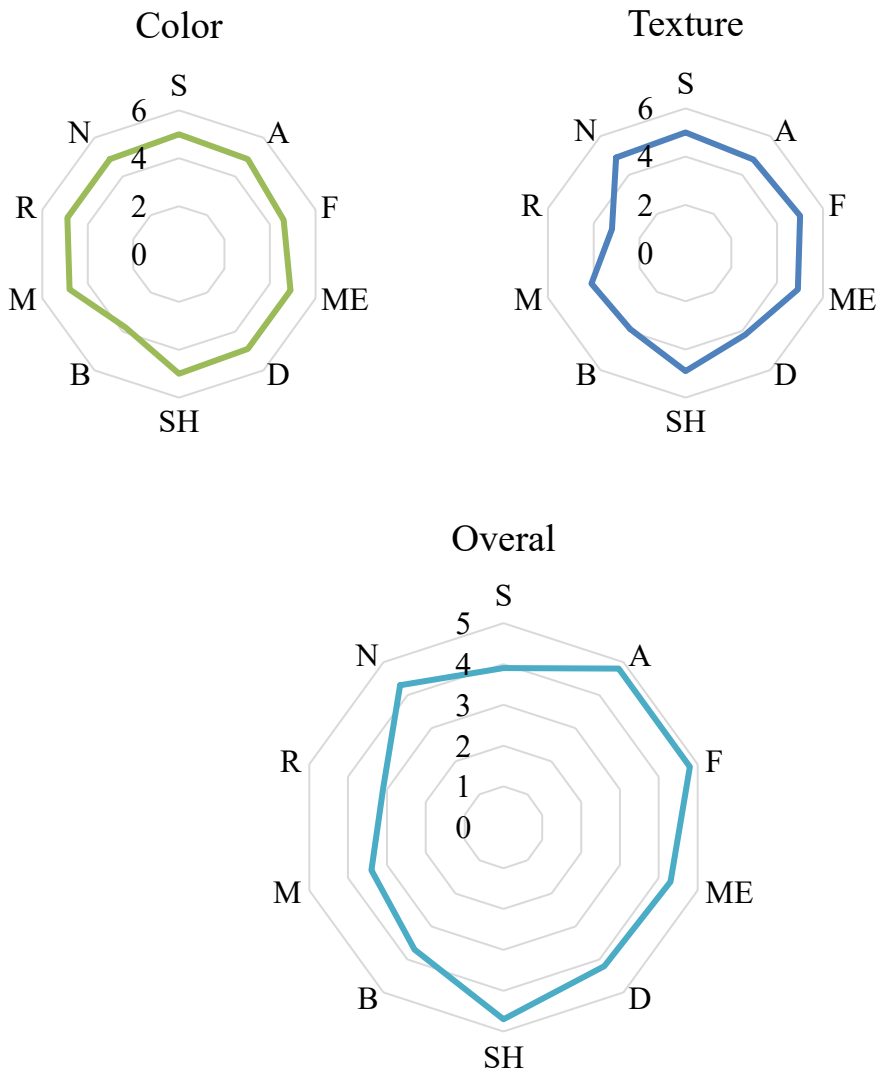


Fig. 2. Sensorial properties of the Gaz samples in Chaharmahal and Bakhtiari province

Saadat (S), Asli (A), Ferdovs (F) Misagh (ME), Dariush (D), Shahkar (SH), Beshtar (B), Melat (M), Radfar (R), Nazari (N)

4- Conclusion

Gaz is one of the most widely consumed traditional Iranian confectionery products, particularly in the provinces of Isfahan, Chaharmahal and Bakhtiari, and Kerman. To date, however, no comprehensive study has been reported regarding its contamination profile. Therefore, the present study was conducted to evaluate the effects of manufacturing source, pistachio content, and storage time on the levels of aflatoxin B1, lead, cadmium, *Escherichia coli*, and *Staphylococcus aureus* in Gaz products.

The results demonstrated that the levels of *E. coli* and *S. aureus* in all evaluated samples complied with the Iranian National Standards. In addition, the concentrations of aflatoxin B1, lead, and

cadmium in the 18% pistachio Gaz samples ranged from 3 to 5 ppb, 0.005 to 0.010 ppm, and 0.012 to 0.029 ppm, respectively. Moreover, no contamination with *E. coli* or *S. aureus* was detected in any of the analyzed samples.

Sensory evaluation indicated that all investigated Gaz samples possessed acceptable sensory quality, while samples A, F, and SH achieved the highest overall acceptability and consumer preference. Overall, the findings suggest that Gaz, as one of the most popular traditional sweet products in Iran, demonstrates satisfactory quality and safety characteristics in accordance with Iranian food standards.

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Conflict of Interest

The author confirms that there are no financial conflicts of interest or competing interests in this study.

Author Contributions

All aspects of the study were carried out solely by the author.

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مقاله علمی_پژوهشی

بررسی میزان آفلاتوکسین B1، سرب، کادمیوم، *اشریشیا کلای* و *استافیلوکوکوس اورئوس* در گز مغز پسته ای ۱۸ و ۲۸ درصد استان چهارمحال و بختیاری

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چکیده

گز یکی از محصولات خوراکی پرمصرف و با زمان ماندگاری بالا می‌باشد که همیشه به دلیل کیفیت پسته موجود در آن مورد بحث کارشناسان صنعت غذا است. هدف از این پژوهش بررسی میزان ترکیبات مضر سلامتی مورد توجه در استاندارد ملی ایران ازجمله آفلاتوکسین B1، سرب، کادمیوم، *اشریشیا کلای* و *استافیلوکوکوس اورئوس* در ۱۰ نشان تجاری پرفروش گز و همچنین بررسی گذشت زمان و درصد پسته این محصولات بر ترکیبات مضر مد نظر بود. نتایج نشان داد غلظت آفلاتوکسین B1، سرب و کادمیوم در گز ۱۸ درصد به ترتیب ۳ تا ۵ ppb، ۰/۰۰۵ تا ۰/۰۱۰ ppm و ۰/۰۱۲ تا ۰/۰۲۹ppm بود. همچنین باکتری‌های *اشریشیا کلای* و *استافیلوکوکوس اورئوس* در آن‌ها مشاهده نشد. بررسی ارزیابی حسی نمونه‌ها نشان داد که نمونه‌های گز مورد ارزیابی از وضعیت مناسبی برخوردارد بوده و نمونه‌های اثلی (A)، فردوس (F) و شاهکار (SH) از پذیرش کلی و رضایت مشتری بیشتری برخوردار بودند. به طور کلی می‌توان نتیجه گرفت محصول گز مغز پسته به عنوان یکی از محصولات شیرین و سنتی پرطرفدار جامعه از نظر ویژگی‌های کیفی استاندارد ایران از وضعیت مناسبی برخوردار است.