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Microbiological Quality and Heavy Metals Content of some Spices and Herbs Kinds

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ABSTRACT

This study included the assessment of microbial contamination of about 25 samples of spices and herbs in addition to the content of heavy metals for these samples. The highest number of bacteria was $25.40x10^7$ cfu/g in the pepper powder and the lowest number was (34.50x10 cfu/g) in cinnamon, followed by black pepper powder and turmeric powder were $63.66x10^6$ cfu/g and 68.87 $x10^6$ cfu/g; respectively. Yeasts were found in caraway seeds and spices blends only, while fungi found in all plates of the samples. The fungi and yeasts count were ranged from $29.44x10^4$ cfu/g to $19.26x10^6$ cfu/g of caraway whole seeds and cumin whole seeds; respectively, while in the cayenne pepper powder was the highest count of fungi and yeasts was higher than $10x10^6$ cfu/g. The analysis of heavy metals for about 12 samples of spices and herbs showed that the aluminum level was very high in both spices and herbs, ranging from 137.1 to 900.8 ppm. Arsenic ranged from 0.1 ppm to 4.8 ppm, with the highest percentage in spices blends (4.8 ppm). The cadmium concentration ranged from 0.01 ppm in cayenne pepper to 0.10 ppm in cumin, the chromium ranged between 1.0 ppm in green cardamom to 11.6 ppm in coriander. Nickel was not present in all studied samples and its results were zero. Lead ranges from 2.3 ppm in cumin to 13.9 ppm in spice blends. Many of these values are higher than the maximum allowable limits as recommended by FAO / WHO and can be considered unacceptable for many of the samples studied.

Keywords: Spices, Herbs, Moisture, Ash, Microbiological quality, Heavy metals.

INTRODUCTION

Spices and herbs had many uses for centuries in many different functions and uses. In ancient times, spices and herbs were so valuable that they were used in financial transactions and profitability, and for many years they were so expensive and expensive that they were available only to wealthy people. They were not only used as spices to season the foods, but they had other uses, mostly as cosmetics, perfume and sexual aphrodisiacs. Spices and herbs were often used for medicinal purposes, as found in Roman, Greek and ancient Chinese writings (Parry, 1953). Spices and herbs have been used to date for aroma and flavor and some of the properties they provide for foods. In the past, keeping food was not easy, so spice was used to cover food corruption, but this is no longer an acceptable use of spices and herbs today, but because of the increasing popularity of spicy foods as well as the desire to eat delicious foods with low sodium content and fat has increased the use of spices and herbs for those purposes (Przybyla, 1986).

Unfortunately, spices and herbs contribute greatly to the sensory and sensational properties of foods. Many spices are grown and harvested in poor hygiene in areas where the climate is warm, and humidity is high. Such conditions encourage growth and potential microbiological contamination (McKee, 1995). Many agricultural products are exposed to a wide range of microbial contamination in the environment during assembly, processing, retail markets, dust, sewage, animal waste and even human waste. This also happens with spices and herbs (De Boer *et al* 1985).

Eating some spice-containing foods can cause a risk to public health because it is often added to foods that are not treated or eaten raw as they are. In many spice-producing countries, including India, spice is often sown after harvest in open fields or on open roads, and then sold without any treatment after drying in order to reduce microbial load. Thus, the spices sold in these areas are expected to contain microflora from agricultural and production areas to some extent. These spices were of poor quality when compared to international standards (Garcı´a *et al*., 2001; Geeta and Kulkarni, 1987; Kaul and Taneja, 1989 and Shah *et al*., 1996).

Spices are important agricultural commodities and are almost indispensable in cooking food. It can be used on different forms, namely fresh, mature, dried, broken, powder, etc. Which contribute to the delivery of food smell, taste, flavor, color and sharpness. Spices may be in the form of bark, buds, flowers, fruits, roots, leaves, seeds, stigma, rhizomes, patterns, or whole plant tops (Takeda *et al*., 2008). Contaminated spices have been found to be a cause of certain diseases and corruption transmitted by certain foods (Ahene *et al*., 2011)

The number of fungi and Yeasts varies significantly between spices and some, but they are usually found at very low rates (Abou-Donia, 2008). Spice is good not only for our own tasting pleasure but also for its health (Rathore and Shekhawat, 2008). Now, because of the various usage of heavy metals in industry, medicine, agriculture and technology, this has led to a widespread distribution in nature raising concerns about their sides effects on human health and environment, unfortunately these metallic ions may interact or unite with cellular particles. This causes the occurrence of extensive damage by heavy metal poisoning on various organs of the body, the investigation and identification of therapeutic methods for poisoning with heavy metals is very important (Mehrandish *et al.*, 2019).

Therefore, this research was conducted to shed light and conduct microbiological survey and heavy metals of spices and herbs in the local market that man uses directly. The objective of this study was to provide information on microbiological contamination and heavy metals of spices and herbs, and thus to take an idea of any potential risks. This study represented data of 25 different types of locally collected spices and herbs in Assiut government, Egypt.

MATERIALS AND METHODS

Materials:

A total of 25 locally collected unpacked samples representing different type of spices and herbs were randomly collected from different market in Assiut, Egypt during 2018. Classifications of spice and herbs samples are scheduled in Table (1). The experimental material included 25 samples of commercial spices and herbs products: 18 samples of spices, 13 samples were whole (black seeds, cumin, black pepper, coriander, cinnamon, cardamom, laurel leaves, clove, cayenne pepper, turmeric, curry, paprika and spices blends) and 5 samples were powder (cumin, black pepper, coriander, cinnamon and cayenne pepper). In addition to 7 samples of herbs, 5 samples were whole (caraway, fenugreek, aniseed, rosemary and chamomile) and 2 samples were powder (ginger and thyme).

Table 1. Classifications of different spice and herbs kinds:

	Spices and Herbs	Botanical name	Local name	English name	Part used
1	Black seeds	*Nigella sativa*	alhaba alsuwda'	Black seeds	Seeds
2	Cumin	*Cuminum cyminum*	kamun	Cumin	Seeds
3	Caraway	*Carum carvi*	karawia	Caraway	Seeds
4	Black pepper	*Piper nigrum*	alfilfil al'aswad	Black pepper	Seeds
5	Coriander	*Coriandrum sativum*	alkasbra	Coriander	Seeds
6	Cinnamon	*Cinnamomum zeylanicum*	alqerfa	Cinnamon	bark
7	Cardamom	*Elettaria cardamomum*	alhabhan	Cardamom	fruits
8	Fenugreek	*Trigonella foenum-graecum*	alhelba	Fenugreek	Seeds
9	Aniseed	*Pimpinella anisum*	alyansoon	Aniseed	Seeds
10	Laurel leaves	*Laurus nobilis*	waraq lawry	Laurel leaves	leaves
11	Clove	*Syzygium aromaticum*	alqurnfil	Clove	buds
12	Rosemary	*Rosmarinus officinalis*	ruwzmari	Rosemary	leaves
13	Chamomile	*Matricaria recutita*	albabunj	Chamomile	flowers
14	Cayenne pepper	*Capsicum frutescens*	alfilfil shatta	Chilli pepper	fruits
15	Ginger	*Zingiber officinale*	zanjabeel	Ginger	rhizomes
16	Turmeric	*Curcuma longa*	alkorkum	Turmeric	rhizomes
17	Curry	*Murraya koenigii*	alkari	Curry	leaves
18	Paprika	*Capsicum annuum*	albabrika	Paprika	fruits
19	Thyme	*Thymus vulgaris*	zaetar	Thyme	leaves

Microbiological Characteristics:

The microbiological analysis was Transferred to the laboratory immediately after samples are obtained and collected. Bacterial growth was performed by plating appropriate dilutions on Plate Count Agar (PCA, Oxoid), incubated for 48 to 72 hours at 32˚C, while the Fungi and Yeasts growth was performed by plating appropriate dilutions on Czapek-Dox agar with Rose Bengal as bacterial inhibitor, in incubated for 7 days at 28˚C according to Vanderzant and Splittstoesser (1992). All the samples were carried to food sicence and technology department laboratory, faculty of agriculture, assiut university. Enumeration of total plate count, counting of yeasts and fungi was performed by following the bacteriological analysis guide, total plate count was enumerated by pour plate method on plate count agar. Yeasts and fungi counts were carried out by spread plate technique on potato dextrose agar (PDA) media with Rose Bengal as bacterial inhibitor.

Moisture and Ash Content:

Determination of moisture and ash content of spices and herbs were determined as described by A.O.A.C. (2005).

Experimental procedure of heavy metals:

For the determination of heavy metals, dried samples were moistly digested according to Jones and Case (1990) method for heavy metal analysis, using conc.H_2SO_4 and 30% H_2O_2 mixture to a 0.5 g of dry ground sample placed in 100 ml beaker, 3.5 ml of 30% H_2O_2 was added .The content of the beaker was heated to 100˚C , and the temperature was gradually increased to 250˚C, and left at this temperature for 30 minutes. The beaker was cooled and then added 1 ml of 30% H_2O_2 to the digestion mixture and the contents were reheated again. The digestion was repeated several times until a clear solution was obtained. Take the clear solution into a 50 ml volumetric flask and complete the marker with double distillation water. A blank digested sample was also performed for comparison. A standard solution for each element to be analyzed was prepared and used for calibration. Metal measurement was performed were measured by using the Inductivity Coupled Plasma Emission Optical Emission Spectrometry (ICP–OES thermo iCAP 6000 series).

RESULTS AND DISCUSSION

The moisture results are well complied with the European Spice Association (ESA., 2007) and International Standards Organization (ISO., 2003) standards for spices. The moisture content was measured in the whole seeds and in the powder samples and the data are illustrated in Table (2). The moisture content in the whole seed ranged between 5.06 to 7.99 gm/100gm, the highest value was recorded in cinnamon (7.99%) while the lowest value was in black pepper (5.06%), In the case of powder, Turmeric was also the highest in the moisture, it was 8.63%. Although thyme recorded the lowest value of moisture, reaching about 4.72%.

On the other hand, the obtained data in Table (2) showed that cumin contain on the highest value of ash content (8.57%) forward to caraway (8.24%). Meanwhile, the laurel leaves had a percentage of ash was the least amount, it was 2.87%. In the case of spices and herbs powder was the cayenne pepper that contains the highest percentage of ash and then ginger and turmeric, and values were 9.62, 6.38 and 6.38 %; respectively. And the cinnamon had a percentage of ash is the least (3.67%). The humidity and ash in spices and herbs did not exceed the maximum limits mentioned by the European Spice Association (ESA, 2018), except for the percentage of ash in the caraway sample was slightly higher.

Table 2. Mean values of Moisture and Ash content of the studied spices and herbs (gm/100gm) *:

	Spices kind	Whole		Spices kind	Powder	
		Moisture	Ash**		Moisture	Ash
1	Black seed	5.63	3.69	Black pepper	8.35	4.39
2	Cumin	6.41	8.57	Cumin	7.67	6.06
3	Caraway	6.35	8.24	Cinnamon	8.26	3.67
4	Black pepper	5.06	3.32	Ginger	7.41	6.38
5	Coriander	6.06	5.89	Coriander	6.22	6.19
6	Cinnamon	7.99	3.12	Turmeric	8.63	6.38
7	Green cardamom	5.94	6.38	Curry	7.36	5.92
8	Fenugreek	5.24	2.95	Cayenne pepper	7.21	9.62
9	Aniseed	6.67	7.38	Paprika	5.98	5.93
10	Laurel leaves	6.15	2.87	Spice blends	5.62	6.22
11	Cloves	5.57	4.19	Thyme	4.72	4.39
12	Rosemary	7.00	6.26			
13	Chamomile	7.86	7.74			
14	Cayenne pepper	7.38	6.16			

***Mean of three replicates for each sample. (**): Calculated on dry bases.**

Bacterial, fungi and yeasts analysis results of 25 samples of spices and herbs are summarized in Tables (3). While, some variations occur, specifications for microbial parameters in spices and herbs have been laid out by several countries. Here, in this the study, the mean bacterial plate count of powder spice and herbs samples were higher than the whole samples (Table 3). The highest count of bacteria, yeasts and fungi may be due to poor hygienic standard of preparation and handling of spices and herbs harvested. The International Microbiological Standard recommended limits for bacteria contaminants in spices and herbs are in the range of 10^1 to 10^5 cfu/g total microbial plate count, 10^1 to 10^3 cfu/g for Yeasts and fungi (Awe *et al.,* 2009). After compared these results with International Microbiological Standards, found that some microbiological data count of samples was above the recommended limits of spices and herbs.

The data presented in this studied in Table 3 indicate a high level of contamination of some powder samples, were in the unacceptable range (>10^6 cfu/g). The mean load of total aerobic mesophilic bacteria count was found maximum (25.40 x10^7cfu/g) in cayenne pepper powder and minimum (34.50 x10 cfu/g) in cinnamon. Krishnaswamy *et al.* (1974) observed that in black pepper the counts of total aerobic mesophilic bacteria count ranged between 10^4 and 10^8 cfu/g. The highest value of total aerobic mesophilic bacteria count after cayenne pepper powder in black pepper powder and turmeric powder samples, were 63.66 x10^6 cfu/g and 68.87 x10^6 cfu/g, respectively.

Table 3. Bacteria, fungi and yeasts total count of the studied spices and herbs (cfu/g):

	Spices kind	Bacteria		Fungi and Yeasts	
		Whole	Powder	Whole	Powder
1	Black seeds	21.48x10^3	--	52.24x10^2	--
2	Cumin	10.80x10^3	45.04x10^4	19.26x10^4	37.00x10
3	Caraway	43.65x10^4	--	29.44x10^4	--
4	Black pepper	64.87x10^4	63.66x10^6	68.00	17.30x10
5	Coriander	84.63x10^3	25.19x10^6	19.59x10^3	44.20x10
6	Cinnamon	34.50x10	13.44x10^6	41.05x10^2	10.00x10^2
7	Green cardamon	15.62x10^3	--	19.00x10	--
8	Fenugreek	22.92x10^3	--	43.44x10^2	--
9	Aniseed	19.88x10^3	--	33.30x10	--
10	Laurel leaves	16.49x10^4	--	36.00x10	--
11	Cloves	22.00x10^3	--	11.00x10	--
12	Rosemary	15.00x10^2	--	69.00x10	--
13	Chamomile	45.60x10^6	--	21.42x10^2	--
14	Cayenne pepper	21.01x10^6	25.40x10^7	27.60x10^3	> 10.00x10^6
15	Ginger	--	42.85x10^6	--	44.20x10
16	Turmeric	--	68.87x10^6	--	44.20x10
17	Curry	--	29.23x10^6	--	93.02x10^2
18	Paprika	--	11.31x10^6	--	66.00x10
19	Spice blends	--	99.90x10^5	--	58.75x10^2
20	Thyme	--	16.49x10^4	--	42.26x10^3

Yeasts were detected in caraway seeds and spice blends, while fungi occurred in all plates of the samples. The maximum fungi and yeasts count were in caraway whole seeds forward to cumin whole seeds (29.44x10^4 cfu/g and 19.26x10^6 cfu/g, respectively), but in the cayenne pepper powder was the highest amount of fungi and yeasts count (>10x10^6 cfu/g). A similar observation was made by Christensen *et al.,* (1967) and Bhat *et al.,* (1987).

Gallo *et al.* (1992) found that faulty food handling techniques especially storage of food at an inappropriate temperature for a long time it was considered one of the most important causes of food contamination. Some manufacturers produce spices and herbs under an inadequate hygienic environment, such as spices being inadequately dried, contaminated raw materials can be added or packaging is done manually. These factors cause the number of microbes in these products to rise.

Therefore, there is a need to ensure that production is conducted under healthy conditions until it is delivered to consumers. It may also be necessary to re-evaluate the production steps to include microbial load reduction technology. It is desirable that sterilization technology be used throughout production, and this will go a long way in verifying the risks associated with the presence of microbial contaminants. Care must also be taken to maintain good hygiene requirements, select good leaves and dispose of them, and seeds must be dried properly before production (Awe *et al*., 2009). The wide variation in microbial profile between cayenne pepper and cinnamon purchased from the same dealers was attributed to the chemical composition of the spices, antimicrobial factors, environmental conditions, and potential differences in handling by personnel.

Heavy metals content such as Al, As, Cd, Cr, Ni and Pb were compared with various spices and herbs with the maximum permissible limit (MPL) based on National Dietary Standards listed in Table (4). Herbs and spices belong to a group of spices, so heavy metal levels are compared to the appropriate safety standards as set by the MPL, which applies to "food and other spices".

Heavy metals (Al, As, Cd, Cr, Ni and Pb) analyses have been performed on 12 samples of spices and herbs and the result has been presented in Table (5). In the Table (5) showed the heavy metals contents of 12 spices and herbal plants analyzed. Higher contents of aluminum were recorded in cayenne pepper (900.8 ppm) followed by cumin (847.3 ppm) and black pepper (617.3 ppm). Remaining samples contained aluminum content of less than 415 ppm. Arsenic content was the highest in spices blends with 4.8 ppm, followed by green cardamon (4.0 ppm), cinnamon (3.5 ppm), cloves (3.2 ppm), laurel leaves (2.8 ppm) and turmeric 2.3 ppm. Remaining samples contained arsenic content less than 0.5 ppm. Cadmium content was highest with cumin (0.10 ppm) followed by laurel leaves and cloves (both with 0.09 ppm each of cadmium). Remaining samples contained cadmium content less than 0.08 ppm.

Table 4. Maximum Permissible Limit values for Al, As, Cd, Cr, Ni and Pb (in ppm) of different Spices:

Sr. no.	Name of heavy metal	MPL (in ppm)
1	Aluminum	--
2	Arsenic	1.0
3	Cadmium	0.2
4	Chromium	--
5	Nickel	1.63
6	Lead	5.0

Chromium (Cr) The concentration of chromium content in different spices and herbs samples are shown in Table (5). Chromium was highest in coriander with 11.6 ppm followed by cayenne pepper (9.0 ppm), laurel leaves (8.7 ppm) and black pepper (8.1 ppm). Remaining samples contained chromium content less than 7.0 ppm. Nickel metal was not present in all studied samples of both spices and herbs and the results were all zero as shown in Table (5).

Lead content was highest with spices blends (13.9 ppm) followed by laurel leaves (13.4 ppm) and turmeric (8.6 ppm). Remaining samples contained cadmium content less than 0.06 ppm.

The data given in Table (4 and 5) outlined the aluminum level was very high in both spices and herbs of levels from 137.1 to 900.8 ppm. This is well above the allowable level (0.2 ppm). Aluminum, as a mineral when present in our food, water supply and soil can stimulate individuals to suffer from aluminum toxicity. After years of exposure to aluminum and accumulated storage in our bodies, this can lead to brain degeneration and skeletal abnormalities (http://www.drpepi.com). It is believed that a key to Alzheimer's disease is that it is linked to aluminum toxicity (Derouesne, 2004).

Arsenic - The concentration of arsenic ranged from 0.1 ppm in samples black pepper, coriander, cayenne pepper and thyme to 4.8 ppm in spices blends which exceeded the MPL for arsenic (Table 5). Arsenic concentration in black pepper, cumin, coriander, chili, curry and thyme is good within the MPL. The high concentration of arsenic may be due to the use of fertilizers and pesticides containing it. But it has low effects on human nausea, vomiting or even damage to blood vessels.

Table 5. Heavy metals content of the studied spices and herbs kinds.

	Spices kind	Heavy metals (mg/kg).					
		Al	**As**	**Cd**	**Cr**	**Ni**	**Pb**
1	Black pepper	617.3	0.1	0.04	8.1	0.0	3.4
2	Cumin	847.3	0.4	0.10	6.8	0.0	2.3
3	Coriander	414.7	0.1	0.04	11.6	0.0	3.6
4	Cayenne pepper	900.8	0.1	0.01	9.0	0.0	2.8
5	Curry	403.4	0.5	0.04	6.3	0.0	4.5
6	Turmeric	319.3	2.3	0.04	5.1	0.0	8.6
7	Thyme	327.4	0.1	0.08	5.9	0.0	8.5
8	Laurel leaves	188.6	2.8	0.09	8.7	0.0	13.4
9	Cloves	234.8	3.2	0.09	3.9	0.0	6.4
10	Cinnamon	182.9	3.5	0.06	1.7	0.0	7.6
11	Green cardamon	137.1	4.0	0.05	1.0	0.0	7.6
12	Spices blends	221.3	4.8	0.06	7.0	0.0	13.9

Cadmium, it was agreed that the lowest classification of it as a carcinogen to humans (Waalkes, 2003). For this, increasing the cadmium content in food is always harmful. As shown, the cadmium content in the 12 samples studied showed that the Kaha samples, without exception, were below the maximum allowable level (0.2 ppm) as recommended by FAO/WHO (1984). The concentration of cadmium ranged from 0.01 ppm in cayenne pepper to 0.10 ppm in cumin. Chromium - The concentration of chromium ranged from 1.0 ppm in green cardamom to 11.6 ppm in coriander.

Nickel, the given data showed accumulation of 0.0 ppm which is lowest, the permissible limit set by FAO/WHO (1984) in edible plants was 1.63 ppm (Tables 4 and 5). But WHO (2005). No nickel toxicity limits have been set for spices or herbs, because its toxicity is not common, because its absorption by the body is very weak. (Jabeen *et al*., 2010).

Lead - one of the most toxic substances in the environment for living organisms. It interacts with many biomolecules and strongly affects different body systems, nervous system and immune system as well as many different biological processes (Oehme, 1989). The lead content of the 12 different samples is given in Table (5). Lead concentration ranges between 2.3 ppm in cumin to 13.9 ppm in spices blends. These values are higher the MPL as recommended by FAO/WHO (1984) and can be considered as intolerable, except of samples black pepper, cumin, coriander, cayenne pepper and curry. High levels of lead may be due to the use of fertilizers containing lead or because of the practice of cultivating these crops on soil irrigated with sewage sludge.

CONCLUSION

Spices and herbs contribute to many microorganisms, whether from bacteria, fungi or yeasts, in food products. Although sweet peppers often contain the highest percentage of microbial load. Proper harvesting methods, hygienic treatment, proper storage conditions, and post-harvest treatments should be considered to prevent and minimize any possible contamination that may occur or affect food. Food borne diseases due to spice and contaminated herbs. Looking at the results obtained in this study, mentioned that spices and herbs contain at a high level of microorganisms.

These results show that the health conditions in different production stages of spices and herbs should be improved and considered to reduce the expected health risks. Therefore, there is difficulty in determining a single microbiological index to estimate the quality of these food additives and the extent to which they contain microbes, because they are used as small components in a wide variety of foodstuffs that are manufactured in different ways. Therefore, there is an urgent need to provide a control system to improve the quality of spices and herbs. Hence, the researchers noted that spices may be high-risk products because they may contain many pathogenic microbes, so further studies are needed to determine the causes and methods of contamination. Sterilization techniques should be ensured at all stages of production and treatment to prevent contamination of spices and herbs from pathogenic microorganisms.

The results of the analysis of heavy metals in spices and herbs showed that there is no risk of daily use of the spices mentioned above if taken in a moderate amount. It should be under constant monitoring because some concentrations, such as cadmium, show that the heavy metal content is higher in most spices and herbs that are higher than MPL. Therefore, the content of heavy metals should be reduced in chemical fertilizers and the use of organic fertilizer instead of which is added to the soil, since the absorption of heavy metals in the plant is through the soil that is used for agriculture.

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الجودة الميكروبيولوجية ومحتوى المعادن الثقيلة لبعض أنواع التوابل والأعشاب

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اشتملت هذه الدراسة على تقييم التلوث الميكروبى لحوالى 25 عينة من التوابل والأعشاب بالاضافة الى المحتوى من المعادن الثقيلة لهذه العينات. كان أكبر عدد فى العدد الكلي للبكتيريا هو($25.40x10^7$ cfu/g) في مسحوق الفلفل الحريف وأقل عدد هو (34.50x10 cfu/g) في القرفة. ثم تبع ذلك مسحوق الفلفل الأسود ومسحوق الكركم حيث كانت ($63.66x10^6$cfu/g) و($68.87x10^6$ cfu/g) على التوالي. تم العثور على الخمائر في بذور الكراوية وطحين التوابل فقط ، في حين وجدت الفطريات في جميع أطباق العينات. تراوحت أعداد الفطريات والخمائر من($29.44x10^4$ cfu/g) الى ($19.26x10^6$ cfu/g) في بذور الكراوية الكاملة وبذور الكمون الكاملة ، على التوالي ، بينما في مسحوق الفلفل الحريف كان عدد الفطريات والخمائر أعلى من($10x10^6$ cfu/g). أظهر تحليل المعادن الثقيلة لحوالى 12 عينة من التوابل والأعشاب أن مستوى الألومنيوم كان مرتفعًا للغاية في كل من التوابل والأعشاب، حيث تراوح ما بين 137.1 و 900.8 جزء في المليون. وتراوح الزرنيخ من 0.1 إلى 4.8 جزء في المليون ، وكان نسبته الأعلى في طحين التوابل (4.8 جزء في المليون) ، تراوح تركيز الكادميوم من 0.01 جزء في المليون في الفلفل الحريف إلى 0.10 جزء في المليون في الكمون، وتراوح الكروم ما بين 1.0 جزء في المليون في الهيل الأخضر إلى 11.6 جزء في المليون في الكزبرة. لم يكن معدن النيكل موجودا في كل العينات المدروسة وكانت نتائجه صفرية. أما الرصاص فتراوح ما بين 2.3 جزء في المليون في الكمون إلى 13.9 جزء في المليون في طحين التوابل. كثير من هذه القيم أعلى من الحدود القصوى المسموح بها على النحو الموصى به من قبل منظمة الأغذية والزراعة / منظمة الصحة العالمية ويمكن اعتبارها غير مقبولة للعديد من العينات التي تمت دراستها.