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Evaluating the Artificial and Microbial Contamination (Pathogenic Bacteria, Molds, Yeasts) of Confectionery Products in Iran: A Systematic Review

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KEYWORDS

Microbial Contamination; Chemical Contamination; Confectionery Products; Cream-Filled Pastry; Iran

ABSTRACT: The prevalence of contaminated foodborne diseases has always been a major challenge all around the world. A huge amount of money is spent on treating these diseases every year. This study investigated the status of chemical and microbial contamination of confectionery products in Iran. Data were collected from electronic databases including Pubmed, Science Direct, Elsevier, SID, Magiran, and Google Scholar during 2001 - 2017. Search keywords included microbial contamination, chemical contamination, confectionery products, cream-filled pastry, and Iran. The results indicated that the highest contamination rates in South Khorasan, Tehran, Gorgan, and Isfahan were related to Staphylococcus aureus (80%), Escherichia coli (57%), Enterobacteriaceae (25.1%), and yeasts (100%), respectively. Moreover, the least prevalent pathogens in west of Tehran, Tabriz, east of Gilan, and south of Tehran were S. aureus (4.81%), Coliform (2.51%), Bacillus cereus (1.2%), and *E. coli* (2%), respectively. In addition, there was no Salmonella in southeast of Tehran and Yasouj. Most confectionery products contained unauthorized artificial dyes, and authorized artificial dyes were also overused. The most commonly used artificial dye was sunset yellow with 80% use in Arak. Moreover, 100% of the samples in Arak contained unauthorized artificial dyes. Confectionery products are an important part of food products in the country. The likelihood of microbial and chemical spoilage of these products increases due to the use of such ingredients as eggs, milk, and color additives. Further training and supervision on the preparation and maintenance of these products by the local health authorities can be effective in reducing the contamination.

INTRODUCTION

Food consumption allows the transmission of many pathogens, including bacteria, viruses, and parasites to the human body. Bacteria are the cause of most diseases followed by viruses and parasites. Based on the US centers for disease control and prevention (CDC), it is estimated that 75 million people suffer from foodborne diseases annually. In the United States, foodborne diseases are the second major challenge after respiratory and pulmonary diseases [1] Based on the national health agency (NHA), the average incidence of foodborne diseases in European and third world countries was reported 38.3 and 91.8 per 100,000 population,

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respectively. Although there is no statistical evidence on the incidence of foodborne infections and poisonings in developing countries such as Iran, the prevalence of foodborne infections is estimated to be much higher than developed countries due to the lack of proper monitoring programs by responsible agencies, low levels of public health education, and inappropriate conditions of food production, storage, distribution, and consumption. Foodborne diseases are often the result of inadequate health and poor process of food preparation. In the meantime, such factors as the emergence of new strains of pathogens, increasing consumption and tendency to buy ready-to-cook products, and overeating take-away foods and fast-food items have led to the increase of these diseases worldwide [1]. While many studies have been conducted on the bacterial contamination of foods, most of these surveys have merely investigated the specific type of bacteria in a food group and there is little information available on the wide range of foods [2]. Sweet and confectionery products have a significant share in Iran's food production; and due to the high consumption of these products in the country, microbial control is required to increase shelf life and also maintain food quality [3]. They are also part of a balanced diet that, due to their formation of nutrients such as dairy products and eggs is a good place for bacteria to grow. Hence, these products become susceptible to spoilage when they are prepared and kept in poor conditions. Dairy products, confectionery, and meat products are among the foods with high food poisoning rates [4]. Poisoning caused by the consumption of confectionery products has been reported in many countries worldwide [5]. Spoilage refers to any change in food conditions making the food unpleasant to the consumer when consumed. The spoilage of confectionery products includes physical spoilage, chemical spoilage, and microbial spoilage. Microbial contamination of confectionery products is critical due to economic and health-related issues. This type of spoilage, in addition to limiting the shelf life of the products, can cause food poisoning[6]. Based on Code No. 2395 of the institute of standards and industrial research of Iran (ISIRI), confectionery is classified into three major groups: cream-filled, half-creamy, and non-creamy. The code also specifies the authorized microbial load of these products (Table 1).

Table 1. Microbial load of confectionery according to the ISIRI: (Code No. 2395) (gr)

Property \ Type of product	Cream-filled	Half-creamy	Non-creamy
Escherichia coli	Negative	Negative	Negative
Salmonella (25 gr)	Negative	Negative	Negative
Staphylococcus aureus coagulase positive	Negative	Negative	Negative
Bacillus cereus	10^2	----	---
Mold	3×10^2	10^2	10^2
Yeast	10^2	10^2	---

Nowadays, food processing technology has changed dramatically and the use of various food additives has increased[7]. Food additives are the substances being added to foods in small quantities during the production, storage, and packaging stages to increase shelf life, durability, appearance, texture, taste, color, odor, and nutritional value[8]. Food dyes are not only used for coloring the food, while they basically represent the quality of many health varieties. Thus, the use of these additives in foodstuff is increasing day by day [9]. Food dyes are categorized into three main groups in terms of production origin: 1) mineral dyes or non-edible artificial dyes, which are not found in nature, are made synthetically, and are not commonly used in the food industry; 2) natural food dyes, which have a plant origin such as Chlorophyll, Carotenoids, Tannins, and Anthocyanins; and 3) artificial or synthetic edible dyes such as Quinoline Yellow, Sunset Yellow, and Ponceau 4R [10]. A comparison between natural and artificial food dyes shows a greater tendency to use artificial ones in food products. The tendency to use artificial dyes can be due to the disadvantages of natural dyes, including instability under environmental conditions such as changes in environmental pH, high extraction and

preparation cost, and low efficiency [11] and the advantages of artificial dyes such as higher durability and brightness. Such advantages have outperformed the use of artificial dyes over natural ones. Many artificial dyes, especially those containing azo functional groups and aromatic rings in their structure, can cause a series of health problems if they are used continuously or absorbed through the skin. Such complications include: sleep disturbances, respiratory complications, hypertension, adverse effects on the function of kidney, liver, and hormones, weakening the immune system, lowering the levels of vitamins, asthma, urticaria, anaphylactic reactions, and carcinogenesis [12]. Natural dyes are healthier than artificial chemical ones. However, in some quantities and under certain conditions, natural dyes may also have toxic effects on humans. Therefore, regardless of toxicological studies, the absolute safety of dying substances cannot be confirmed [8]. Based on the statistics, the consumption of unauthorized dyes in restaurant foods, sweets, cookies, ice creams, and beverages is estimated to be 52 to 80 % [13]. Given the increasing food poisoning caused by the consumption of contaminated sweets in recent years, the statistics on the contamination of the confectionery, and the health hazards caused by the presence of pathogenic bacteria in foodstuffs, it seems essential to evaluate the past and present status of bacterial contamination in confectionery products, assess the related trend, and provide appropriate solutions for eliminating or reducing them. Despite the health risks of using artificial dyes, research in several parts of Iran has confirmed the unauthorized use of these substances. Therefore, it is significant to check the type of dye and also measure the amount of added artificial food dyes to ensure the food safety. Many consumers and even some suppliers of food products do not have enough knowledge about the type and health hazards of artificial dyes. Thus, it is vital to conduct research studies to find out the status and conditions of artificial dyes. To this end, the available data published in scientific journals, papers presented at congresses and conferences, student dissertations, and the results of research conducted by the national research organizations regarding the chemical and microbial spoilage of these products were collected and evaluated in this study.

MATERIALS AND METHODS

The reviewed data were related to the published studies by Iranian authors in national and international journals. In order to retrieve the data, such databases as Scopus, Pubmed, Science Direct, SID, Iran medex, Irandoc, Magiran, Science Direct, and Elsevier were searched (time period: 2001-2017). Search keywords included such terms as Iran, microbial contamination, chemical contamination, artificial dyes (colors), cream-filled pastries, confectionery products, molds, and yeasts in both Persian and English languages. Full texts of the articles were reviewed and the corresponding authors were contacted via e-mail if the full text was not available. If the full text was inaccessible and there was not sufficient information in the abstract, the paper would be excluded from the study. In addition, the references of selected articles were screened for related studies.

RESULTS

Microbial spoilage

Staphylococcus aureus

S. aureus is the most common cause of bacterial food poisoning and about one-third of its strains produce enterotoxin when placed on the food products. Following the absorption of this toxin in the intestine, food poisoning can occur with such symptoms as vomiting and diarrhea. The prevalence of enterotoxin A in food poisoning is higher than other types of enterotoxin [14]. Since Staphylococcal enterotoxins are heat-resistant, they maintain their biological activity during the pasteurization process and can be a significant contributor to foodborne toxicity. The presence of enterotoxins in dairy products such as milk and cheese, meat, vegetables, and sweets can cause food poisoning [15, 16]. Staphylococcal poisoning usually occurs after ingestion of the food contaminated by carriers. About 30 to 50 % of healthy people carry the Staphylococcal bacteria on their skin, throat, and nose. Due to the major role of human carriers in the preparation of confectionery products, the probability of contamination with S. aureus is very high [17] (Table 2).

Table 2. Research on the prevalence of S. aureus contamination of the confectionary (%).

Product	Contamination percentage	Region (Province)	Year	Reference
Cream-filled	15	Orumieh	2012	[18]
Creamy	34.67	Mazandaran	2014	[19]
Cream-filled	11.3	Khorram Abad	2012	[20]
Non-creamy	2.6			
Cream-filled	30	Yasouj	2014	[21]
Sweets	1.6	Gilan	2015	[1]
Cream-filled	43.3	Gorgan	2015	[22]
Cream-filled	12	Gorgan	2015	[5]
Sweets	4.81	West of Tehran	2012	[2]
Creamy	12	Southeast of Tehran	2010	[23]
Creamy	2.23	Tehran	2009	[24]
Non-creamy	0			
Cream-filled	62.5	Isfahan	2016	[25]
Creamy with fruit	73.7			
Creamy	64.3			
Cake	39			
Cookie	54.5			
Cream-filled	57.5	Hamedan	2016	[26]
Cream-filled	20	Kerman	2013	[27]
Sweets	56	Sirjan	2016	[28]
Cream-filled	22.5-31	Zahedan	2011-12	[29]
Creamy	38.5	Tonekabon	2013	[30]
Cream-filled	31.2	Tabriz	2007	[31]
Cake	0	Orumieh	2015	[32]
Cream-filled	38.1	Hamedan	2017	[33]

Escherichia coli

E. coli strains have an important role in foodborne gastrointestinal infections. Based on the food health regulations and standards, the presence of *E. coli* strains was considered as an indicator of fecal contamination for many years. Studies in this field have shown the potential of sweets offered in different communities as carriers of *E. coli* strains. Based on these studies, confectionery products were infected with Escherichia coli strains at various stages of production and supply [34]. The presence of these pathogens in processed foods indicates the lack of hygiene during their production and storage. Almost any nutrient that comes into contact with the stool can be a source of transmission for this organism [35, 36]. In line with the national standards for confectionery products, the amount of this bacterium per gram should be negative. Studies in Iran indicated that the confectionery products are highly contaminated with *E. coli*, indicating poor hygiene and insufficient supervision of the responsible health authorities (Table 3).

Table 3. Research on the contamination percentage of *E. coli* (%)

Confectionery Type	Contamination percentage	Region (Province)	Year	Reference
Cream-filled	30	Arak	2015	[37]
Cream-filled and Half-creamy	43.2	Arak	2017	[38]
Cake	0	Orumieh	2015	[32]
Cream-filled	29.2	Isfahan	2016	[25]
Creamy with fruit	31.6			
Creamy	32.1			
Cake	1.7			
Cookie	4.5			
Cream-filled	53.8	Zahedan	2003	[39]
Cream-filled	88.75	Ahvaz	2004	[40]
Cream-filled	5.72	Tabriz	2005	[41]
Cream-filled	48.8	Tabriz	2008	[4]
Sweets	43.8	Tonkabon	2013	[30]
Sweets	26	Tehran	2001	[42]
Creamy	2	Tehran	2010	[23]
Cream-filled	11-12	Zahedan	2012	[29]
Sweets	19	Isfahan	2015	[34]
Sweets	17.31	West of Tehran	2011	[2]
Cream-filled	30.76	Kazran	2014	[43]
Cream-filled	14	Kerman	2013	[27]
Sweets	17	Gilan	2015	[1]
Creamy	49.3	Mazandaran	2014	[19]
Cream-filled	0	Hamedan	2016	[26]
Cream-filled	50	Yasouj	2014	[21]
Traditional	5	Yazd	2015	[44]

Salmonella

One of the most essential indicators of microbial contamination in the confectionery industry is Salmonella, especially Salmonella enterica. Salmonella contamination can be caused by the use of egg, cocoa, coconut, garlic powder, egg alumina, or unpasteurized cream [45-47]. In general, few studies were carried out in Iran on the contamination of confectionery products with Salmonella. Among the existing literature, most results indicated that the organism is not present in sweets. A study by a team of researchers examined 120 samples of cream-filled pastry and reported a negative presence of Salmonella[37]. In addition, a study conducted in Urmia on 200 cakes indicated no presence of this organism [32]. A study in Tehran reported no isolated Salmonella in 121 samples of creamy pastry [23]. Similarly, in the study, which was conducted on 400 samples of cream-filled pastry in Zahedan, no Salmonella contamination was identified [29]. Moreover, a research in Tehran examined 140 samples of sweet and reported no contamination with this pathogen[2]. Again, in the study conducted on 130 samples of cream-filled pastry in Kazeroun, no Salmonella was isolated[43]. Furthermore, the results of a research on 81 samples in Gilan were negative for Salmonella [1]. Similarly, the results of the studies in Hamedan conducted on 80 samples of cream-filled pastry and in Yasouj conducted on 30 samples of creamy pastry were negative [21, 26]. However, the results of a study conducted in Isfahan on 200 samples indicated 25% contamination of cream-filled pastries, 10.5% of creamy pastry with fruit, 10.7% of creamy pastry, and 10.2% of

cakes while in their study, the cookies were free of Salmonella contamination [25].

Molds and yeasts

Yeast contamination of the confectionary is more likely to occur in products with high levels of active water. This is significant both in terms of the appearance of the substances (pink and white colored patches on the pastry) and also the fermentation of the confectionery products, resulting in unpleasant odor and taste [23]. Since fungal spores are scattered in the air, they can contaminate sweets. In addition to contamination through air, contamination of containers, contamination of distributors, and fungal contamination of confectionery raw materials, including sugar and flour, can also lead to fungal contamination of traditional pastries. Fungal contamination of traditional pastries is essential for the confectionery industry due to its economic reasons and also health complications [48] (Table 4).

Table 4. Research on the prevalence of fungal and yeast contamination of the confectionary (%).

Confectionery Type	Contamination percentage (Fungal and Yeast)	Region (Province)	Year	Reference
Cream-filled Half-creamy	(13.6 / 20.5)	Arak	2017	[38]
Cream-filled	(95.8 / 4.2)	Arak	2015	[37]
Cake	(100 / 100)	Orumie	2015	[32]
Cream-filled	(98.6 / 19.4)			
Creamy with fruit	(100 / 26.3)			
Creamy	(67.9 / 3.6)	Isfahan	2016	[25]
Cake	(35.6 / 5.1)			
Cookies	(27.3 / 9.2)			
Cream-filled	(70 / 27.5)	Tabriz	2008	[4]
Creamy	(To standard/ 29/2 over standard)	Tonkabon	2013	[30]
Creamy	(33 / 5)	Tehran	2010	[23]
Cream-filled	(11-21.5 / 3.5-4)	Zahedan	2012	[29]
Sweets	(22 / 20)	Sirjan	2016	[28]
Cream-filled pastry	(93.07 / 7.69)	Kazeroun	2014	[43]
Sweets	(0 / 0)	Gilan	2015	[1]
Creamy	(24 / 0)	Mazandaran	2015	[19]
Cream-filled	(82.5 / 37.5)	Hamedan	2016	[26]
Traditional pastry	(11.4 / 21.07)	Yazd	2015	[44]

Bacillus cereus

Bacillus cereus is widely distributed in nature and can grow on the surface of foods and produce an intestinal toxin (enterotoxin) or a vomiting toxin and cause food poisoning[6]. Food contamination by B. cereus often occurs when cooked foods are stored without refrigeration for several hours before consumption[23]. A study in Arak showed that 13.6% of cream-filled and half-creamy pastries were contaminated with B. cereus[38]. In addition, a study in Tehran revealed that out of 104 confectionery samples 4.81% were contaminated with B. cereus[2]. In another study conducted in Gilan on 81 samples it was reported that 1.2% of the sweets were contaminated to this organism[1]. Similarly, One study was conducted by a team of researchers on creamy confectionery products in Tehran and found that 8% of the samples were contaminated with B. cereus[23]. In Sirjan, a similar study was carried out on cream-filled and non-creamy pastries showing 21.3% of the samples were contaminated with B. cereus[28]. Also, in a study carried out in Mazandaran, the contamination rate of B. cereus was reported to be within normal levels[19]. Moreover, in

a study conducted on cream-filled pastries in Gorgan, the results showed 2% contamination with B. cereus[5]. Finally, results of a study reported that 27% of cream-filled pastries were contaminated with B. cereus[49].

Chemical spoilage

Food dyes

In food industry, especially in the confectionery industry due to its wide range of products, many food additives are used to satisfy consumers, most of which are dyes[50]. Food dyes are an important category of additives requiring careful monitoring in terms of the amount and type of color applied in a food product. A great deal of evidence exists about the adverse effects of artificial food dyes on human and animal organs. For example, a study conducted on the toxic effects of edible colors revealed that methylene blue can cause sperm morphological abnormalities in adult albino mice and its effects include weight loss, testicular weight loss, and reduced sperm count[51]. In addition, Macioszek's study (2004) confirmed genotoxicity of two commonly used food dyes, Quinoline Yellow and Brilliant Black, on human lymphocyte cells[52]. Another study indicated that the exposure of laboratory animals to semi-toxic doses of Yellow Sunset can result in certain changes in total body lipid storage; and such alterations can impair lipid metabolism and cause serious liver damages[53].

In a study on the effects of artificial food dyes on children, it was found that there was a significant relationship between the severity of illness in children and the amount of consumed products containing artificial dyes[54]. The results of a study reported a significant relationship between the prevalence of hyperactivity in children and the use of artificial dyes[55].Yellow tartrazine is a mono-azo dye widely used in confectionery products, jelly, candies, as well as pharmaceutical products and cosmetics. The presence of tartrazine in the foodstuffs may interfere with certain medications, such as aspirin or some additives such as benzoic acid or other allergenic compounds, which can aggravate allergic reactions such as asthma in susceptible individuals[56]. Based on the studies conducted in Iran regarding the confectionery industry, most manufacturers use artificial dyes and the use of unauthorized artificial dyes is too high. The amount of using authorized dyes is also too high, which makes most products unhealthy. The use of natural dyes has also been reported to be too low. Although using tartrazine is prohibited in Iran, it has been reported that some manufacturers use it in their products. The results indicated the importance of paying attention to this issue. Limited studies have been conducted on the amount of chemical spoilage in confectionery products in Iran. Table 5 briefly illustrates some of these studies.

Table 5. Existing literature on the contamination rate of confectionery products to food dyes (%).

Allura Red	Azorubine	Ponceau 4r	Quinoline Yellow	Sunset Yellow	Brilliant Blue	Tartrazine	Natural dye percentage	No color	Unauthorized dye percentage	Authorized dye percentage	Sample	City (year)	Reference
0.7	18.1	2.9	37	44.9	5.1	-	21	-	22	50.3	Non-creamy	Tehran (2007)	[57]
0	-	-	-	-	-	-	25.7	-	28.6	-	Non-creamy and creamy pastry	Qom (2007) (2008) (2009)	[58]
0	-	-	-	-	-	-	25.7	-	28.9	-			
0	-	-	-	-	-	-	30	-	28.1	-			
-	-	-	-	-	-	-	-	52	26.7	21.3	Non-creamy and creamy pastry	Qom (2010)	[50]
-	-	-	-	-	-	-	-	-	-	42.9	Creamy and Non-creamy pastry	Shahrkord (2010) (2011) (2012) (2013)	[13]
-	-	-	-	-	-	-	-	-	-	28.4			
-	-	-	-	-	-	18.8) without (cream	-	-	-	28.5			
-	-	-	-	-	-	6.8 (Creamy)	-	-	-	34.6			
1.3	1.3	1.3	-	36.6	2.6	5.3	-	41.95	11.5	-	Sweets	ShahrKrd (2012)	[8]
٠	40	15	60	80	-	70	-	0	100	-	Sweets	Arak (2014)	[11]
-	-	-	8(2 samples)	0	-	40(10 samples)	-	52(13 Samples)	-	-	Saffron sweet	Yazd (2015)	[10]
-	-	-	-	-	-	-	-	-	92.58	7.14	Non-creamy	NazarAbad (2016)	[59]
0	1 (Number)	0	2 (Number)	3 (Number)	0	3 (Number)	-	27.3	72.2	-	Sweets	Kashan (2016)	[60]
2.78	5	10	20	10	2.78	-	23.33	13.9	12.22	50.55	Creamy and Non-creamy pastry	Ilam(2017)	[61]
5	10	6.25	15	12.50	6.25	-	19	21	5	55	Creamy and Non-creamy pastry	Tuyserkan (2018)	[62]

DISCUSSION

Healthy food preparation and supply has always been a problem for many food industries in both developed and developing countries. Nowadays, quality control procedures and complete and accurate monitoring of the production process, including the reduction of food contact with hands and packaging of the food being considered as the most consistent principles in the food industry[1, 63]. Based on the results reviewed in this study, the contamination rate of confectionery products with all kinds of microorganisms including microbes was much higher than the existing standards; indicating the lack of attention to the hygienic and health principles of production and supply and the lack of thorough supervision by the relevant authorities. In Iran, food production centers are scored and rated technically and hygienically with regard to the guidelines presented by the Ministry of Health and Medical Education (excellent, good, moderate). Such centers are monitored both internally by the manufacturer's self-inspection checklists, and externally by health authorities. However, having a health license does not guarantee the healthy production and supply of food products in companies and distribution centers. Accordingly, the careful monitoring of these centers by licensing organizations is required [64]. Using healthy and hygienic raw materials and rising the level of health awareness of those involved in the preparation and distribution of these products are necessary. Confectionery products contain a variety of nutrients that are well known worldwide. Given the high consumption of these products, microbial control is needed both from a health and an industrial point of view to increase the shelf life and also preserve the quality of these products [22]. Poisonings caused by the consumption of confectionery products are reported in many countries around the world. For example, Todd et al. stated that 35-47% of all foodborne diseases in Poland, Portugal, Bulgaria, and Sweden were caused by contaminated confectionery products [48]. Creamy pastries are more likely to be contaminated with microbes due to their ingredients, cooking, and storage conditions. The source of this contamination can be traced back to various factors such as contact of food products with hands, use of unhealthy raw materials such as soured milk, and the contamination of food machinery [19]. Cream-filled pastries are suitable environments for the growth of pathogenic microorganisms, because they contain high levels of fat and protein [65]. Furthermore, traditional pastries are likely to be contaminated with pathogens due to the type of ingredients, the method of preparation, and their decoration. Yeast contamination can be reduced by such measurements as health observance, preserving and distributing confectionery products in a suitable and aseptic environment, and using preservatives such as sorbates and benzoates (ISIRI, Preservatives, Code No. 950) [44]. A team of researchers, compared the mean microbial contamination rate of cream-filled pastries before and after the health improvement of the confectionery workshops and reported that the improvement was very effective in increasing the microbial quality of the pastries [25]. Some international studies considered the creation of health management systems in confectionery production centers as the best way to reduce microbial contamination [66]. In a research in Romania conducted on a variety of cakes, an improved microbial quality of samples was reported after the establishment of the hazard analysis and critical control points (HACCP) system[67]. As mentioned above, the establishment of these systems alone is not sufficient for reducing the prevalence of confectionery contamination and the need for continuous and careful monitoring by regulatory agencies is also necessary. An important part of monitoring process is related to additives that may be added to products in different stages of production and distribution. Since artificial dyes are often considered as supplements in food processing industry, they are being used in an increasing manner [68]. Nowadays, manufacturers are more inclined to use artificial dyes rather than natural ones, because they are more durable and less expensive. However, they can use authorized artificial dyes in their products in accordance with the national standard Code No. 740. However, their use in foodstuffs should be under the supervision of the technical assistant of the industry, because they should be used within their legal ADI range. If these dyes are consumed too much, they can make health problems for the consumers [13]. The

long-term effect of these compounds is very important[57]. Food dyes can also cause anaphylactic, metabolic, and idiosyncratic reactions, or affect blood pressure, mitochondrial respiration, liver, kidney, and hormones function and vitamins levels [69]. For example, canthaxanthin, a synthetic carotenoid pigment, unlike beta-carotene, does not convert to vitamin A and can accumulate in the retina of the eye and cause retinopathy. Cross-reactivity may occur between additives and substances which naturally contaminate foodstuffs, just like what occurs between salicylates and tartrazine[50]. Tartrazine is a common colorant with an orange color; it is mainly used in beverages such as orange juice and a wide range of foods and even medicines. One of the toxic effects attributed to tartrazine is the induction of hyperactivity in children and the development of hives and red skin rashes[69]. Studies on various foods indicated the widespread use of this color. In addition, a study showed that the usage rate of edible artificial dyes, authorized by the Iranian food and drug administration (FDA), increased more than fivefold from the 1950s to 2012 (from 12 to 68 mg per day) [70]; indicating a growing interest in consuming these ingredients in the food industry, including sweets. In the study of a team of researchers, the most crucial factors in the use of unauthorized artificial dyes, from the point of view of health professionals and food manufacturing staff, were related to economic reasons and awareness criteria. The most significant criteria for health professionals were the cheap price of artificial dyes compared to natural ones and the low level of public awareness. However, these criteria for food manufacturing staff included being consumer-friendly and low awareness of food manufacturing staff. This study assessed the knowledge and attitude of confectionery producing staff regarding the use of artificial dyes in food preparation. As a result, the awareness level of the staff about the health risks of these dyes was about 50%, and it had a significant direct relationship with the level of education and a significant indirect relationship with age and work experience [71]. Due to the lack of technical assistants in the confectionery production workshops and also the lack of license, the products are prohibited from distribution even if authorized artificial dyes are used [57]. Most of the owners and people involved in pastry industry have no knowledge on the health effects of using edible or non-edible dyes. Hence, they may arbitrarily apply the amount of dye which is not permitted due to their inadequate awareness about the use of artificial dyes and the lack of a special device for measuring the density of these dyes [61]. Therefore, such food production workshops are only permitted to use natural and herbal dyes[57]. But studies have shown that confectionery producers use natural dyes less than artificial ones. Certainly, scientific introduction of natural dyes at public level and emphasis on their beneficial properties along with satisfying the consumer's sense of diversity can ensure community health and increase producers' enthusiasm for using natural dyes[50]. For example, replacing artificial red color with cranberry fruit anthocyanins is highly useful in the food industry, because it has such properties as anti-inflammatory effects, prevention of capillary fragility, and reduced vascular permeability [72]. Saffron is another color substance that is perfectly natural and can be a good substitute for artificial yellow colors such as tartrazine, Sunset Yellow, etc. Another problem in this area is the lack of a comprehensive approach to quantify the amount of authorized artificial dyes added to foodstuffs in Iran [73].

CONCLUSIONS

Previous studies have shown that serious measurements for creating suitable conditions at the food production centers can be highly effective in reducing microbial contamination of the final products. Therefore, a valid method should be provided by the relevant organizations for measuring the authorized edible dyes and the necessary research should be conducted in this regard. In summary, the overall pattern of dyes used in the studies revealed that authorized artificial dyes have been used more than expected. Thus, it is suggested that food laws and regulations be enforced in the country through much stricter monitoring systems. Meanwhile, the high percentage of using artificial dyes in the reviewed studies indicates that the supervision of responsible health organizations, including the Ministry of Health and Medical Education, is not efficient. The use of artificial dyes can be reduced by such measurements as restricting the production and distribution of confectionery products, stricter monitoring of health organizations, and increasing

the awareness level of both consumers and producers. Moreover, legal measures should be taken regarding all confectionery producing workshops that violate the rules. Therefore, decisive training and supervision is crucial in securing food production in terms of all kinds of spoilages and contaminations.

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Conflict of interests

Authors have no conflict of interest.

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