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Research Article
Risk Profile of Some Food Safety Hazards Associated with Ice-cream Sold in Egypt

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Abstract

Background and Objective: Ice cream is one of the most popular and massively consumed dairy products for children and adults. Contaminated ice cream is considered a potential threat to the population, so ensuring the safety of ice cream is a significant issue for the public health. This study aimed to determine the potential biological, chemical and physical hazards of small and large scale manufactured ice cream consumed in Egypt. **Materials and Methods:** Seventy five samples of ice-cream (35 large scale and 40 small scale) were collected from street vendors, dairy shops and supermarkets in Cairo and Giza governorates and inspected for different types of hazards. Independent samples t-test and the significant ($p \leq 0.05$) relationship between the hygienic status of small and large scale ice cream samples were calculated. **Results:** The *S. aureus* was detected with an incidence of 12.5% for small scale samples and 11.42% for large scale ice-cream samples, while *E. coli*, *Salmonella* and *L. monocytogenes* couldn't be detected in all examined samples. Total mesophilic bacteria; Psychrotrophs, Coliform, Fecal coliform, Yeast, Mold and Total staphylococci counts were also determined. Aflatoxin M1 was present in 16 of the 20 examined small scale and large scale ice-cream samples, while Organochlorinated pesticides and Polychlorinated biphenyls couldn't be detected in all examined samples. Physical hazard was inspected in 3(7.5%) samples of the examined small scale ice-cream including hair, plastic piece and metal piece. **Conclusion:** It is considered a top priority to improve the hygienic status of the produced ice-cream in addition to implementing regulatory measures for ensuring the safety and quality of ice cream.

Key words: Risk, food safety hazards, ice-cream, aflatoxin, pesticide residues, dairy products, organic pollutant

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Ice-cream is one of the favorite dairy products for large segments of the population as it is consumed by all aged groups, it is considered as nutritive food, due to its composition, which includes milk proteins, fat and lactose, it is also a rich supply of calcium, phosphorous and essential vitamins[1].

During production, handling, transportation and storage, ice cream may become contaminated with different types of hazards that are transmissible to human. Ice-cream is a good medium for microbial growth owing to its high nutrient value, almost neutral pH and long storage duration. Primary sources of microbial contamination to ice-cream incorporate water and raw milk, whereas secondary sources incorporate flavoring agents, utensils and inappropriate handling. Despite the fact that pasteurization, freezing and hardening steps in production can destroy the majority of microbial hazards, numerous microorganisms like *L. monocytogens*, *S. aureus*, *Salmonella*, *E. coli* and coliforms have been documented to contaminate ice-cream during the different steps of production[2,3].

Yeasts and molds may also get entry into ice-cream from the use of inadequately treated cane sugar, emulsifiers and flavorings, equipment, utensils, human hands and atmosphere[4,5].

The production of ice cream in Egypt is classified into three main classes, large scale industrialized plants, small scale manufacturers and street vendors. Large scale industrialized plants are typically supplied for pasteurization, freezing and machine packing; small scale manufacturers are supplied with a mechanical operated freezer, while street vendors (mainly modest community and villages) utilize the simplest materials and primitive techniques of production. Unfortunately, the sanitary condition of small scale ice-cream in Egypt is still underway in most cases due to lack of satisfactory hygiene and regular microbiological control[6].

Various chemical contaminants also might be presented during milk production, dairy processing or packaging, these chemical hazards include toxins as mycotoxins which can contaminate the animal feed and have some residues in milk and dairy products. The aflatoxins are groups of chemically similar toxic fungal metabolites produced by certain molds of the genus Aspergillus. Aflatoxin M1 (AFM1) might be found in the milk of animals that are fed with aflatoxin B1 (AFB1) containing feed[7].

Persistent Organic Pollutants (POPs) are chemical hazards that are resistant to degradation in the environment, bioaccumulate and are toxic. Organochlorine pesticides are one of POPs that can be transferred to milk through the contaminated feed of lactating cows or by their application to the cow's body, in the cow barn or even in the milk processing areas for pest infestation. These pesticides can cause a wide range of toxic effects, genotoxicity, carcinogenicity and hormonal disturbance[8,9].

Polychlorinated biphenyls (PCBs) which also categorized as POPs were used in electrical systems and in hydraulic fluid. Cow milk is a source of human exposure to polychlorinated biphenyls (PCBs), they are of particular concern because they are endocrine disruptors and neurotoxicants that persist and bio-accumulate due to their inherent high lipophilicity[8,10].

Milk and dairy products in general exposed to physical hazards from different sources, the main physical hazards found in milk and dairy products are insects, metals and plastics[11,12], which are major sources of consumer complaints as reported by numerous food manufacturers and retailers. Some of these sources can cause serious health risks to the consumer, for example injury to the oral cavity, damage to the teeth, asphyxiation, internal bleeding, throat pain, dysphagia, regurgitation and death[13].

Several aspects are significant in the production of high quality ice-cream and are related to the stages of production, which incorporate cleaning and sanitation, hygiene of storage area, hygienic design and personnel training. The failure to apply these practices may prompt high bacterial count and potential public health problems. As most of the ice-cream consumers are children of the vulnerable age groups, it is required to be microbiologically safe[5].

Risk assessment is the scientific logical procedure of determining the relationship between exposure to a given hazard under a defined set of conditions and the probability of an adverse health effect or disease. Risk assessments principally composed of four major steps, including hazard identification, hazard characterization, exposure assessment and risk characterization[14].

On account of the great importance of ice cream consumption and its role as a carrier of some public health risks, the present study was conducted to assess the different hazards, which can be associated with small scale and large scale ice cream samples which sold in Cairo and Giza governorates and evaluate their acceptability according to the Egyptian guidelines with the possible control measures of this hazards.

MATERIALS AND METHODS

Collection and preparation of samples: A total of 75 ice-cream samples (35 large and 40 small scale) was collected from street vendors, dairy shops and supermarkets from October 2018 to June 2019 in Cairo and Giza governorates. Ice-cream samples included wide varieties i.e., vanilla, strawberry, chocolate, peanut and almonds. The collected samples were labelled and immediately transferred to the laboratory in an ice-box at 4°C and stored at -20°C prior to examination, the samples were thawed up to 40 for not more than 15 min with continuous agitation in a thermostatically controlled water bath (polyscienceG35486)[15].

Investigation of some microbiological hazards: Decimal dilutions of the samples were prepared according to the standard method given by APHA[15]. The prepared samples and their decimal dilutions were subjected to the following microbiological examinations:

- **Total aerobic bacterial count:** It was adopted according to ISO[16] by using pour plate method. The inoculated plates of standard plate count agar and the control ones were incubated at 30°C/48 h for mesophilic counts and at 7±1/10 days for psychrotrophic counts. Plates showing 30-300 colonies were counted and the results were calculated as the number of colony forming units (CFU g^{-1}) of each ice-cream sample
- **Coliform and fecal coliform content (MPN/g):** This was conducted according to BAM[17] using Most Probable Number (MPN) technique. Identification of the isolated Coliforms and Isolation of *E. coli* were carried out according to BAM online and Silva *et al.*[18, 19]
- **Total yeast and mold counts:** It was depicted according to ISO[20]
- **Total staphylococci count:** It was determined as described by BAM[17]. Isolation and Identification of *S. aureus* were assessed according to BAM online[21]
- **Incidence of *Salmonella* and *Listeria monocytogenes:*** It was assessed according to BAM online[22,23]

Investigation of some chemical hazards

Quantitative determination of Aflatoxin M1: Aflatoxin M1 was detected using a commercial enzyme-linked immunosorbent assay (ELISA), Helica Biosystems Inc., Santa Ana, CA, USA, catalogue No. 961AFLM01M-96[24].

Determination of pesticide residues: Quick and easy method (QuEChERS) for determination of pesticide residues in foods using GC-MSMS, using the Multi-Residues technique standards. It analyzed organochlorine pesticides, α- hexachlorocyclohexane (α-HCH), β-hexachlorocyclohexane (β-HCH), γ-hexachlorocyclohexane (γ-HCH), p,p-dichlorodiphenyltrichloroethane (p,p-DDT), o,p-dichlorodiphenyltrichloroethane (o,p-DDT), p,p-dichlorodiphenyldichloroethylene (p,p-DDE), p,p-dichlorodiphenyldichloroethane (p,p-DDD), Aldrin, dieldrin, Endrin, Heptachlor, Heptachlor epoxide and PCB congeners 28, 52, 101, 118, 138, 153 and 180, European Standard Method EN 15662-2018. The standard mixture was supplied by QCAP (Quality Control of Agriculture Products), Central Laboratory of Residue Analysis of Pesticides and Heavy Metals in Food, Agricultural Research Center Ministry of Agriculture and Land Reclamation[25,26].

Investigation of physical hazards: The samples were examined for the presence of any foreign bodies and physical hazards by naked eye observation according to van Asselt[27].

Statistical analysis: The obtained data were analyzed statistically using SPSS statistics 17.0 for windows. The results of microbiological analysis of small scale and large scale ice cream samples were analyzed using independent-samples t-test to compare results between the two categories and using Levene's test for variances. The differences were considered significant at the $p<0.05$ level.

RESULTS

Total mesophilic bacterial count: The results in Table 1 revealed that total viable mesophilic bacterial count of the examined ice-cream samples ranged from 2.5-5.8 and 3.6-7.1 log CFU g^{-1} with mean values of 5.2±5.5 and 6.32±5.8 log CFU g^{-1} in large scale and small scale ice-cream samples, respectively, with significant difference ($t = 3.056$, $p<0.001$).

Psychrotrophic bacterial count: The obtained results in Table 1 revealed that psychrotrophic counts were recorded in all small and large scale ice-cream samples, the mean values of Psychrotrophs were 5.3±4.7 log CFU g^{-1} for large scale ice-cream samples and 4.8±4.4 log CFU g^{-1} for small scale ice-cream samples with non-significant statistical difference ($t = 0.834$).

Coliform count: The results illustrated in Table 1 showed that 17.1% of the examined large scale ice-cream samples were contaminated with coliform ranged from 2.8-3.5 with an average of 3.06±2.91 log CFU g^{-1}, while 77.5% of the small scale samples were contaminated with coliform ranged from 3.3-7.4 with an average of 6.1±5.8 log CFU g^{-1}.

Table 1: Microbiological profile of the examined small scale and large scale ice-cream samples (Log CFU g^{-1})

	Small scale ([a]n = 40)					Large scale ([a]n = 35)					T-test statistical results	
	Positive samples					Positive samples						
Microbiological parameters (CFU g^{-1})	Number	Percentage	Minimum	Maximum	Mean±S.E.M.	Number	Percentage	Minimum	Maximum	Mean±S.E.M.	t- test value	p-value
Total aerobic mesophilic bacteria	40	100.0	3.6	7.1	6.32±5.8	35	100.0	2.5	5.8	5.20±5.5	3.056	0.004[b]
Psychrotrophs count	40	100.0	2.6	5.9	4.80±4.4	35	100.0	3.4	6.1	5.30±4.7	0.834	0.407
Coliform count (MPN/g.)	31	77.5	3.3	7.4	6.10±5.8	6	17.1	2.8	3.5	3.06±2.91	2.114	0.041[c]
Fecal coliform count	14	35.0	4.17	6.17	5.13±4.75	1	2.9	2.55	2.55	2.55	2.564	0.041[c]
Yeast count	34	85.0	2.9	7.1	5.90±5.6	32	91.4	2.5	5.9	4.90±4.5	2.105	0.042[c]
Mold count	11	27.5	2.0	4.0	3.00±2.6	3	8.57	2.0	4.3	2.80±2.8	0.840	0.404
Total Staphylococci count	40	100.0	3.0	6.7	5.70±5.2	33	94.2	2.5	5.9	5.00±4.5	2.342	0.024[c]

[a]n: Total number of examined samples, [b]Significant at $p\leq 0.001$, [c]Significant at $p\leq 0.05$

Table 2: Acceptability of small scale and large scale ice-cream samples in relation to the Egyptian standard (2005/1185-1)

		Small scale ice-cream samples (n = 40)				Large scale ice-cream samples (n = 35)			
		Acceptable		Unacceptable		Acceptable		Unacceptable	
Microbiological parameter	Critical limit	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Total colony count	not >15×10[4] CFU g^{-1}	27	67.5	13	32.5	33	94.28	2	5.71
Coliform count	not >10 CFU g^{-1}	9	22.5	31	77.5	29	82.85	6	17.14
E. coli.	absent/g	40	100	0	0.0	35	100.00	0	0.00
S. aureus	absent/g	35	87.5	5	12.5	31	88.57	4	11.42
Salmonella spp.	absent/g	40	100	0	0.0	35	100.00	0	0.00
L. monocytogenes	absent/g	40	100	0	0.0	35	100.00	0	0.00

*n: Total number of examined samples

Table 3: Prevalence of some chemical hazards in the examined ice-cream samples

		Positive samples		Concentration			Unacceptable samples according to legislations	
Examined chemical hazards	Number of examined samples	Number	Percentage	Minimum	Maximum	Mean±S.E.M.	Number	Percentage
Aflatoxin M1 (ppt.[a])	20	16	80	2.17	108.7	24.31±8.11	5	25
Pesticide residues (ppm.[b])	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00

[a]ppt: Part per trillion, [b]ppm: Part per million

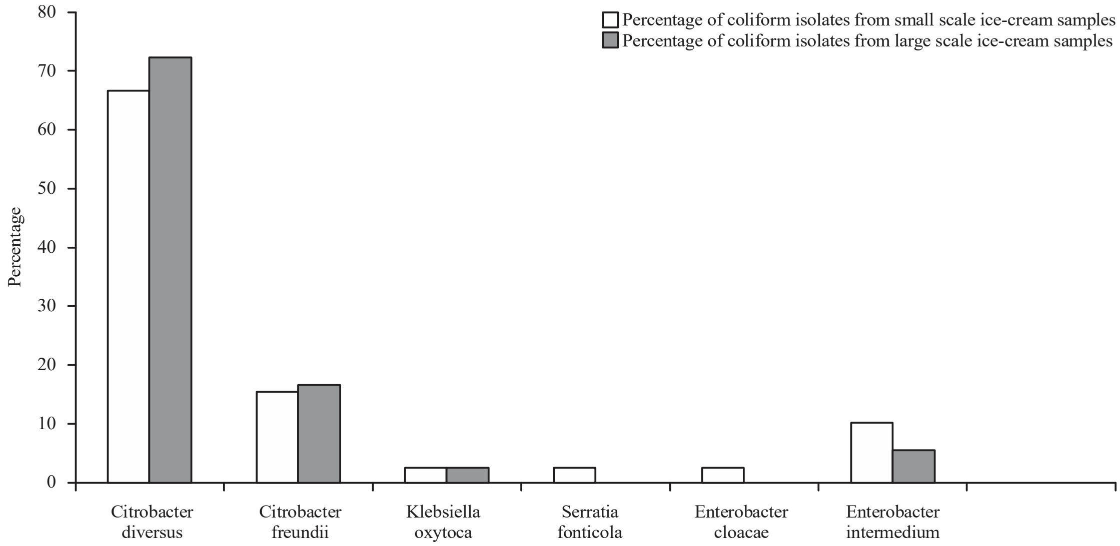

Fig. 1: Incidence of isolated Coliform organisms from the examined samples of small and large scale ice-cream

Fecal coliform count: In the present study, the incidence of fecal coliform was 35% in the examined small scale ice-cream samples with a count ranged from 4.17-6.17 with an average of 5.13±4.75 log CFU g^{-1}, while only one sample (2.9%) of the large scale ice-cream samples was contaminated with fecal coliform with a count of 2.55 log CFU g^{-1}, which differed significantly (t = 2.564, p<0.05), (Table 1).

Isolated coliform organisms: Results presented in Fig. 1 revealed that the isolated coliform organisms from the examined small scale ice-cream samples were *Citrobacter diversus, Citrobacter freundii, Klebsiella oxytoca, Serratia fonticola, Enterobacter cloacae* and *Enterobacter intermedium* in percentages of 66.67, 15.39, 2.56, 2.56, 2.56 and 10.25%, respectively; while that isolated from large scale ice-cream samples were *Citrobacter diversus, Citrobacter freundii, Klebsiella oxytoca and Enterobacter intermedium* in percentages of 72.22, 16.67, 2.55 and 5.55%, respectively. The *E. coli* could not be detected in the examined small and large scale ice-cream samples.

Yeast count: The data presented in Table 1 revealed that yeasts were found in the examined large and small scale ice-cream samples with percentages of 91.4 and 85%, respectively, with an average count of 4.9±4.5 and 5.9±5.6 log CFU g^{-1}, with significant difference (t = 2.105, p<0.05).

Mold count: Data illustrated in Table 1 inspected that molds were found in percentages of 8.57 and 27.5% with average

Fig. 2: Presence of piece of hair in small scale ice cream sample (2.5%)

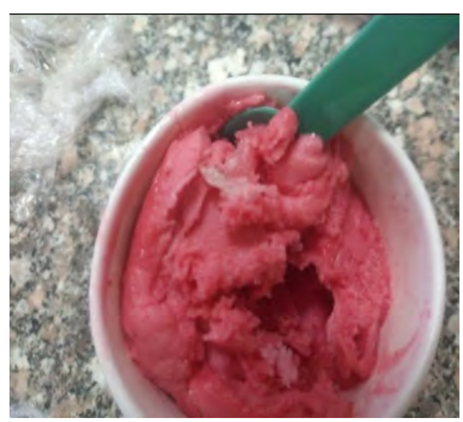

Fig. 3: Presence of piece of plastic in small scale ice cream sample (2.5%)

Fig. 4: Presence of piece of metal (Aluminum sheet) in small scale ice cream sample (2.5%)

counts of 2.8 ±2.8 and 3.0 ±2.6 log CFU g^{-1} for the examined samples of large and small scale ice-cream, respectively, with no significant difference statistically.

Total staphylococci count: From the results represented in Table 1 and 2, it was evident that Staphylococci were present in all examined small scale ice-cream samples, while detected in 94.2% of the large scale ones with mean values of 5.7±5.2 and 5.0±4.5 log CFU g^{-1} in the examined samples of small and large scale ice-cream, respectively; the incidences of *S. aureus* were 11.42 and 12.05%, respectively, that significantly differed ($t = 2.342$, $p<0.05$).

Prevalence of pathogenic micro-organisms: Data given in Table 2 explored that none of the examined samples were contaminated with *L. monocytogenes, Salmonella* and *E. coli*. On the other hand, 5 (12.5%) and 4 (11.42%) of the examined small scale and large scale ice cream samples were contaminated with *S. aureus*, respectively.

Incidence of some chemical residues

Aflatoxin M1: AFM1 was detected in 16 (80%) of 20 examined ice-cream samples at detection limit of 2.00 ppt with concentration ranged between 2.17-108.7 ppt with mean value of 24.31±8.11 ppt. According to the Egyptian standards (E.S., 7136/2010), which speculated that AFM1 shouldn't exceed 50 ppt., 5 (25%) of the examined samples were unacceptable according to the Egyptian legislation as shown in Table 3.

Pesticide residues: Data presented in Table 3 showed that organochlorine pesticides α-HCH, β-HCH, γ-HCH, p,p-DDT, o,p-DDT, p,p-DDD, p,p-DDE, Aldrin, dieldrin, Endrin, Heptachlor, Heptachlor epoxide and Polychlorinated biphenyl pesticides (PCB congeners 28, 52, 101, 118, 138, 153 and 180) couldn't be detected in the examined ice-cream samples at detection limit of 0.002 ppm. All of the examined samples were acceptable in accordance with Codex legislation, which stated that the allowed Maximum Residual Limits (MRL) of the examined pesticides were 0.01, 0.02, 0.006, , 0.0008, 0.006 and 0.0002 ppm for α-HCH, β-HCH, γ-HCH, p,p-DDT, o,p-DDT, p,p-DDD, p,p-DDE, Aldrin, dieldrin, Endrin, Heptachlor, Heptachlor epoxide and polychlorinated biphenyl pesticides (PCB congeners 28, 52, 101, 118, 138, 153 and 180), respectively.

Physical hazards: Our visual inspection revealed the presence of physical hazards in 3 (7.5%) samples of the examined small scale ice-cream including hair, plastic piece and metal piece, respectively, while the examined large scale samples were free from these physical hazards as shown in Fig. 2-4.

DISCUSSION

Our results of total mesophilic bacteria showed a comparatively higher count of microbial contamination of the examined small scale ice-cream samples, that could be attributed to the initial microflora of raw milk and other ingredients, insufficient or no heat treatment, poor personal hygiene, improper cleaning and sanitation and unhygienic measures during manufacturing, handling, storage, transportation and distribution[6]. These results were in agreement with those obtained by EL-Malt[6], Edward *et al.*[5] and Abo El-Makarem[28]. Higher counts were recorded by Kumar *et al.*[29] and Barman *et al.*[30], while, lower results obtained by Ambily and Beena[31]. Higher Total Colony Count (TCC) was the main reason for microbiological non-acceptability of the ice-cream samples[32].

The presence of psychrotrophic bacteria in ice-cream could be of great significance as these organisms may grow and proliferate during the storage even at low temperatures and bring about the spoilage of these products[2,30]. The high results of psychrotrophic bacterial counts of the examined ice cream samples were similar to the findings obtained by EL-Malt[6], who investigated the presence of Psychrotrophs in 100% of the examined small scale and 78% of large scale ice-cream samples with mean values of 4.9 and 3.9 log CFU g^{-1}, respectively and the results obtained by Barman *et al.*[30], that were ranged from 3.32-4.7 log CFU g^{-1}. The high incidence of psychrotrophs in ice-cream samples may be attributed to post processing contamination during freezing, packaging, storage and distribution. In this respect ageing period is very important as ageing temperature (0-5°C) is suitable for proliferation of psychrotrophs.

It is evident from the obtained results that coliforms and fecal Coliforms contaminate high percentages of small scale ice cream samples, which may attribute to poor quality ingredients, ineffective cleaning methods and unhygienic practices during manufacturing, packaging and storage[28]. The presence of coliform in large scale ice-cream samples could be backed to faulty heat process or to post-pasteurization contamination from the added ingredients to the mix after pasteurization, contaminated water, improperly cleaned equipment and handlers with poor sanitary practices[6,33]. These findings were similar to those obtained by Abo El-Makarem[28], Barman *et al.*[30] and Damer *et al.*[34], relatively higher results were obtained by EL-Malt and Bahareem *et al.*[6,35], while comparatively lower results were obtained by Yaman *et al.*[36], Rizzo-Benato and Gallo[37] and El-Ansary[38]. Some members of coliform bacteria can be implicated in gastrointestinal illness as gastroenteritis, epidemic diarrhea in children and cases of food poisoning[30,39]. The incidence of coliform isolates that reported in Fig. 1 were higher than that reported by Abo El-Makarem[28], who revealed that *Citrobacter diversus, Citrobacter freundii, Enterobacter cloacae* and *E. coli* could be isolated form ice-cream samples with percentages of 6.39, 6.39, 4.25 and 48.96%, respectively, while *E. coli* couldn't be isolated from the examined ice cream samples. *Citribacter* spp. and *Enterobacter* spp. are implicated in gastrointestinal illness, food poisoning and respiratory tract infections[39].

Yeast and mold contamination of ice cream causes various types of defects, spoilage and severe economic losses; in addition, certain species may induce public health hazard to human. Samples with high mold contamination have the probability to be a source of mycotoxins, which incriminated in food poisoning outbreaks. The high incidence of yeast in the examined ice-cream samples may be attributed to contaminated ingredients, ineffective pasteurization and contamination during distribution in containers or during holding after serving. Discrepantly, lower percentages of yeast and mold were recorded by Mathews *et al.*[4], Edward *et al.*[5] and Barman *et al.*[30], while higher incidence was documented by El-Malt[6]. The reduced incidence of mold in the examined samples may be related to the different conditions under which each of the ice cream samples is stored and distributed or served, that magnifies the need for high sanitary conditions, control of adequate heat treatment of ice-cream and appropriate storage conditions[5,40].

Our results show high incidence of staphylococci in both small and large scale ice cream samples, that were in accordance with those reported by Barman *et al.*[30], El-Malt[6], Edward *et al.*[5] and Abo El-Makarem[28]. Higher findings were obtained by El-Malt[6], Edward *et al.*[5] and Nazem *et al.*[41]. Staphylococcal presence may have resulted from the insufficient pasteurization of milk and unhygienic manufacturing conditions[4,36]. The presence of staphylococcus organisms in ice-cream is highly undesirable and has a great significance in relation to consumer health because of *S. aureus* is highly pathogenic micro-organisms producing enterotoxins, which lead to food intoxication[5]. The high prevalence of *S. aureus* in the examined samples could be explained as it can survive better and increased in counts in frozen products like ice-cream, in addition, *S. aureus* favors the presence of starch and protein to elaborate enterotoxin[42].

On studying the degree of acceptability of the examined ice cream samples according to the requirements of the Egyptian standards, data given in Table 2 explored that 100% of the examined samples of both large scale ice cream and small scale ice cream were acceptable regarding their content of *L. monocytogenes, Salmonella* and *E. coli*. On the other hand, 67.5, 22.5 and 87.5% of the examined small scale ice cream samples were acceptable according to their content of the total aerobic mesophilic count, total coliforms and *S. aureus*, respectively, while 94.82, 82.85 and 88.57% of the examined large scale ice cream samples were acceptable for the critical limit of the same organisms, respectively.

Our results were coincided with El-Ziney[32] and Edward *et al.*[5], who failed to isolate *E. coli*. from the examined ice-cream samples. On the contrary, a higher prevalence of *E. coli* were investigated in previous studies as 48.96% of unpacked ice-cream samples and 27% of packed ice-cream samples[28], 30% of the examined ice-cream samples[41], 41 and 22% of the examined small and large scale ice-cream samples, respectively[6] and 96% in examined ice-cream with fruits[43]. Our findings are certainly alarming about the possible hazard due to the consumption of ice-cream as *S. aureus* is a significant cause of food-borne disease and important pathogen due to a combination of "toxin-mediated virulence, invasiveness and antibiotic resistance"[44].

Fortunately, the examined ice cream samples were free from salmonella and *L. monocytogenes,* as *Salmonella* is an enteric bacterial pathogen that causes food poisoning, paratyphoid fever, hematosepsis and gastroenteritis, the presence of *Salmonella* spp. in ice-cream may come from either eggs or egg powder used in the ice-cream production[36,45]. *L. monocytogenes* is a food-borne human pathogen responsible for listeriosis with a fatality rate up to 20-30%. More often, systemic infection, such as Septicemia, meningitis, life threatening meningoencephalitis may occur in immuno-compromised individuals, newborn and elderly. *L. monocytogenes* can cause abortion and stillbirth in pregnant women[46,47]. Our findings were similar to the studies adopted by El-Ziney[32] and Varga[48]. These results were nearly in agreement with Kahraman[49], who revealed that none of the examined ice-cream samples contained Salmonella and only one sample was positive for *L. monocytogenes*. Discrepantly, higher percentages were recorded by El-Sharef *et al.*[50], who found *Salmonella* spp. (5%) and *L. monocytogenes* (4%) in the examined ice-cream samples and Edward *et al.*[5] who found salmonella with incidence rate of 17.65% and with a mean count of 3.95 log CFU g^{-1}.

From the results shown in Table 3, Aflatoxin M1 was detected in 16 (80%) of 20 examined ice-cream samples, these higher figures were nearly similar to those obtained by Fallah[51] (69.4%, with a range of 15-132 ppt), Darsanak *et al.*[52] (68.88%, with a range of 8.4-147.7 ppt) and Rahimi[53] (56.7%), this high incidence of AFM1 may be attributed to that AFM1 is a very stable aflatoxin during milk processing such as; pasteurization, autoclaving, freezing and storage; therefore it is usually found in the dairy products[54,55]. The amount of AFM1 in milk and milk products varies widely according to geography, animal species, season, milking time and level of AFB1 intake[56,57]. Due to the high toxicity and carcinogenicity of AFM1, the Egyptian standards established a permissible limit of 50 ppt. The obtained results from our study revealed that (25%) of the examined samples exceeded the recommended safety limits outlined by Egyptian standards and these results were analogues to those obtained by Moktabi *et al.*[58] (30%) and Khoshnevis *et al.*[59] (22.2%); while lower results were reported by Darsanaki *et al.*[52] (12.22%). This high prevalence of AFM1 in the examined samples magnifies the need to decrease AFM1 in milk to the lowest point, the feed stuff ration should be checked regularly to be free from AFB1 contamination and it should be kept away from fungal contamination[60].

Recently, there is a raised concern about the risk of pesticide residues through the food chain and particularly via milk and dairy products, most pesticied residues are characterized by a strong persistence in the environment, a high volatility and lipophilicity, which lead to their accumulation in fat tissues[61]. The presence of OCPs and PCBs were associated with high risk to public health, they can cause neurobehavioral changes and adverse neurologic development [8,10]; make it of great importance to monitor their level in ice cream. Investigation of pesticide residues in the examined ice cream samples revealed that (α-HCH, β-HCH, γ-HCH), (p,p-DDT, o,p-DDT, p,p-DDD, p,p-DDE), (Aldrin, dieldrin), Endrin, (Heptachlor, Heptachlorepoxide) and Polychlorinated biphenyl pesticides (PCB congeners 28, 52, 101, 118, 138, 153 and 180), couldn't be detected in the examined ice-cream samples at detection limit of 0.002 ppm. Higher results were obtained by Schecter *et al.*[8], who found PCB-180 in ice-cream with a limit of 0.091 ng g^{-1}. ww and p,p-DDT, p,p-DDE and dieldrin with limits of 0.038, 1.23, 0.13 ng g^{-1}. All of the examined samples were acceptable in accordance with the European Community[62] and Codex[63] MRLs in food; this may be attributed to the proper control in using pesticides in the last few years with increasing the public awareness about the dangerous effect of these toxic materials. It is worth mentioning that there is hardly any available recent research data concerning the pesticide residues evaluation in ice cream.

Physical hazards can be described as any extraneous objects present in food products and they can cause several health risks to the consumer including injury, illness, or psychological trauma[64]. Our visual inspection revealed the presence of physical hazards in 3 (7.5%) samples of the examined small scale ice-cream, while the examined large scale samples were free from physical hazards as shown in Fig. 2-4. Physical hazards can be controlled by Good Manufacturing Practices (GMPs) and are avoided in the final products by means of visual observations or other methods as metal detection techniques[65]. It is recommended to implement regulatory measures as GMPs and HACCP system as they consider powerful tools for ensuring the safety and quality of ice cream, in addition to the evaluation of risk assessment of safety hazards associated with ice cream.

CONCLUSION

The results of this study showed an inferior level of hygiene in both small and large scale ice-cream samples vended in Cairo and Giza governorates in Egypt, that constitutes a high health risk to consumers especially children and defenseless elderly people. Small scale ice-cream showed a lower quality than large scale ice-cream. Ice-cream has been contaminated by both pathogenic and spoilage microorganisms as well as AFM1 with a level in disagreement with the recommended legislation. Thus, it is considered a top priority to keep ice-cream safe and fit for consumption by improving the hygienic status of the produced ice-cream in all steps of production, distribution, storage and at the retail level. Pesticides couldn't be detected by examining ice-cream samples which may be ascribed to the use of integrated pest management options that allow controlling pests with the least possible hazard due to increasing the public awareness about the proper use of pesticides as well as the control measures from the concerning authorities which minimize these toxic materials.

SIGNIFICANCE STATEMENT

This study discovers the possible health risks associated with the consumption of ice cream through the detection of some existed biological, chemical and physical hazards of small scale and large scale ice cream; in addition we discover the significant correlation between inadequate hygienic measures of small scale ice cream production and its high incidence of being more hazardous than large scale ice cream; which can be beneficial for the manufacturers to pay more attention to improve the hygienic quality. This study will help the researcher to reveal various hazards linked to ice cream especially chemical hazards (Aflatoxin M1 and Pesticides residues) and physical hazards that many researchers were not able to explore; as there is hardly any available recent research data concerning residues evaluation in ice cream; that need more investigation.

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