

ORIGINAL ARTICLE

Assessment of Microbial Quality of Semi Dry and Cream Pastries from Confectionaries of Arak Province, Iran

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ABSTRACT

Background: Confectionary products especially eclairs are a major part of food manufacturing in Iran. Considering high consumption levels and also the possibility of microbial contamination in this section of food products, the present study aimed to determine the degree of microbial contamination of eclairs supplied to Arak province confectionaries and the association between contamination level and adherence to hygiene principles at production sites.

Methods: Sampling was undertaken from 44 different types of eclairs and microbial tests were performed based on Iran National Standards. Data analysis was conducted using Spearman correlation and linear regression tests.

Results: This study showed that 43.2% of samples were contaminated with *Escherchia coli*, 59.1% with *Enterobacteriaceae*, 13.6% with mold, 20.5% with yeast and 13.6% with *Bacillus cereus*.

Conclusion: High contamination rate of eclairs with bacteria, molds and yeasts needs using different methods to control microbial growth, including promotion of sanitary awareness among labors, regular cleansing and disinfecting of equipments, improvement in sanitation of confectionaries proper food storage methods and quick preparation of confections.

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Introduction

Nowadays, foodborne pathogens are among the most common nutrition and health related problems worldwide with huge economic and health implications in many countries including Iran. Families spend a major part of their income for treatment of foodborne diseases and vulnerable groups including children, elderly and pregnant

women suffer largely from these diseases (1). Currently, more than 250 foodborne illnesses have been identified and bacteria, mold and yeast are considered as the main causal factors (2). Foods mainly involved in food poisoning include dairies, bakery products and meats (3). Bakery products are good environments for bacterial growth and spoilage can result from unsuitable and insanitary

manufacturing and storage conditions (4).

The spoilage problems of bakery products can be sub-divided into physical, chemical and microbiological spoilage (4). Among these, microbiological spoilage is of great health and economic significance. This type of spoilage not only limits the shelf life of bakery products, but also leads to higher food poisoning prevalence. Food poisonings caused by bakery products have been reported in many countries. For instance, Todd *et al.* reported that 35% to 47% of all foodborne diseases in Poland, Portugal, Bulgaria and Sweden are due to consumption of contaminated bakery products (3). Also, various food infections due to consumption of these products have been reported in Brazil (5). Among bacteria involved in prevalence of foodborne diseases, *Escherichia coli* (*E. coli*) is a fecal coliform bacterium which leads to 2000 admissions and 60 deaths across united states based on reports from Centers for Disease Control and Prevention (6). Presence of this bacterium in food products is considered as a fecal contamination indicator (7). *Bacillus cereus* is another genus causing food poisoning. First report regarding food poisoning caused by this bacterium was in 1906 when 300 employees in a hospice were poisoned. In 1950, *B. cereus* was introduced as a food poisoning factor. In the same year, 600 people in Norway suffered from food poisoning due to consumption of vanilla sauce contaminated with this bacterium (8). Moreover, fungal contamination limits the shelf-life of (9) bakery products and leads to undesirable smell and flavor and change of color in these products. Eclairs are likely to be contaminated with these pathogens because of their constituents and manufacturing and maintenance conditions. The origin of this contamination could be in different stages including labors, raw material (flour, sugar, milk or cream), equipment, transportation, etc. Given the high possibility of contamination in bakery products especially eclairs, also due to high consumption level of this product which increases the likelihood of food poisoning (9), the present study was performed to determine the degree of eclairs' contamination with microbial pathogens supplied in Arak province and also to assess the association between these contaminations and sanitary conditions at manufacturing sites.

Materials and Methods

This was a cross-sectional descriptive study. Samples included 44 different types of eclairs produced in Arak province selected by convenience sampling method. Samples were randomly selected and sent to laboratory of food and drug department

of Arak University of Medical Sciences. Ten gram of the sample was added to 90 ml of Ringer's solution (0.1 dilution) and other dilutions were prepared by sterile Ringer solution (Institute of Standards & Industrial Research of Iran, Microbiology, issue 365).

Methods used in microbiological tests were based on written standards of Institute of Standards and Industrial Research of Iran. In order to perform different tests involving *Enterobacteriaceae*, *E. coli*, *Bacillus cereus*, molds and yeasts, samples of the prepared suspensions were placed onto specific mediums for each species and incubated at different temperatures (each sample was incubated based on tested bacterium for a given duration of time). Then, the degree of contamination with each species was reported and compared with national standards.

Samples with contamination level of more than standard range were reported to be unusable and samples without contamination or less than standard levels were included and used for further analysis. The association between personal sanitary factors, food hygiene and health in construction and contamination level was assessed using Article 13 of the Executive Regulations amending the Law on Foodstuffs, beverage and cosmetics. A 4-part questionnaire regarding personal hygiene, equipment and instruments hygiene, food hygiene and construction hygiene was devised and answers ranged from very good (4 points), good (3 points), moderate (2 points) to weak (1 point). Data analysis was performed with SPSS software (Version 20, Chicago, IL, USA) using Spearman correlation and linear regression tests. A p value less than 0.05 was considered statistically significant.

Results

The mean number of colonies formed by studied bacteria and fungi and allowed contamination limits are shown in Table 1. As it can be seen, the mean number of *Enterobacteriaceae* colonies is 40.62×10^2 cfu/gr which is much higher than allowed limit of 1×10^2 cfu/gr indicating the high frequency of these bacteria in studied samples. Contamination with yeast, mold and *B. cereus* was in next orders, respectively. Interestingly, the mean amounts of colonies formed by *Enterobacteriaceae*, *B. cereus* and yeasts were higher than permitted limits and only the mean contamination level with molds was lower than standard values. Table 2 shows the frequency and percentage of contamination with bacteria, molds and yeasts separately. As the table shows, the highest amount of contamination was with *Enterobacteriaceae* (59.1%) and the lowest level was for yeasts and *B. cereus* (13.6%).

Table 1: The mean contamination rate of Enterobacteriaceae, mold, yeast and *Bacillus cereus*.

Contamination	Mean±SD	Standard level
Enterobacteriaceae	40.64×102±152.56	1×102
Mold	2.44×102±15.07	3×102
Yeast	6.09×103±17.54	1×103
<i>Bacillus cereus</i>	2.31×102±15.06	1×102
<i>E. coli</i>	-	-

Table 2: The frequency and percentage of bacterial, mold and yeast contaminations.

Type of contaminant	Total number of confectionaries	Frequency of contaminant	Percentage of contaminant (%)
Enterobacteriaceae	44	26	59.1
<i>E. coli</i>	44	19	43.2
Mold	44	9	20.5
Yeast	44	6	13.6
<i>Bacillus cereus</i>	44	6	13.6

Regression analysis and Tables 3 and 4 show the effects of personal hygiene, hygiene, construction and food hygiene on *Enterobacteriaceae* to be -0.995, -0.822, -0.736 and -0.642, respectively. These effects were all statistically significant ($p<0.05$). The negative mark shows that with higher adherence to sanitary conditions in all items, the amount of contamination was lower. Overall, the most effective factors in reducing *Enterobacteriaceae* contamination were personal, equipment, construction and food hygiene, respectively. The effects of personal, equipment, food and construction hygiene on contamination with *E. coli* were -0.841, -0.707, -0.636 and -0.516, respectively.

These effects were all statistically significant ($p<0.05$). Overall, the most effective factors in reducing *E. coli* contamination were personal, equipment, food and construction hygiene, respectively. The effects of personal, equipment, construction and food hygiene on contamination

with *B. cereus* were -0.596, -0.547, -0.513 and -0.452, respectively. These effects were all statistically significant ($p<0.05$). Overall, the most effective factors in reducing *B. cereus* contamination were personal, equipment, construction and food hygiene, respectively. The effects of personal, food, construction and equipment hygiene on contamination with yeast were -0.596, -0.547, -0.453 and 0.514, respectively.

These effects were all statistically significant ($p<0.05$). Overall, the most effective factors in reducing mold contamination were personal, food, construction and equipment hygiene, respectively. The effects of personal, construction, equipment and food hygiene on contamination with molds were -0.707, -0.5093, -0.73, and -0.445, respectively. These effects were all statistically significant ($p<0.05$). Overall, the most effective factors in reducing mold contamination were personal, construction, equipment and food hygiene, respectively.

Table 3: The association between sanitary factors and bacterial contamination in eclairs.

Variable	<i>Bacillus cereus</i>		<i>E. coli</i>		<i>Enterobacteriaceae</i>	
	p-value	β	p-value	β	p-value	β
Personal hygiene	0.001	-0.596	0.001	-0.841	0.005	-0.995
Food hygiene	0.001	-0.547	0.001	-0.707	0.004	-0.822
Equipment hygiene	0.002	-0.452	0.001	-0.636	0.032	-0.642
Construction hygiene	0.001	-0.513	0.001	-0.516	0.022	-0.736

Table 4: The association between sanitary factors and fungal (mold and yeast) contamination in eclairs.

Variable	Mold		Yeast	
	β	p-value	β	p-value
Personal hygiene	-0.707	0.001	-0.596	0.011
Food hygiene	-0.537	0.001	-0.547	0.001
Equipment hygiene	-0.390	0.009	-0.453	0.002
Construction hygiene	0.544	0.001	-0.514	0.001

Discussion

Food contamination especially with *E. coli* is microbiologically of great importance because *E. coli* is a fecal coliform and, based on national standards pertaining to eclairs, the amount of these bacteria in each gram of samples should be negative. Due to importance of these bacteria in food poisoning, various studies in Iran have been conducted regarding the contamination of eclairs with *E. coli*. For instance, in a study by Khezri *et al.* in Mashhad (10), it was reported that 26% of eclairs were contaminated with *E. coli*.

In Fars province, 69% of creams used in bakeries were contaminated with *E. coli*. Moreover, in another study in Zahedan (11), *E. coli* contamination was reported in 53.8% of samples. Finally, Nicknaz *et al.* (12) showed that 48.8% of eclairs were infected with *E. coli*. Therefore, it could be said that contamination with *E. coli* is high in Iran. The reasons for this could be due to not using pasteurized creams, storage of cream outside of the fridge, insufficient cooling, preparing food in contaminated containers, and most importantly, non-adherence to personal hygiene principles by labors working in confectionaries. In this study, the percentage of yeast and mold contamination in eclairs was 13.6% and 20.5%, respectively (13).

Nicknaz *et al.* (12) also reported 27.5% and 70% contaminations were with mold and yeast. Also, in another study in Tehran, Soltan dalal *et al.* (14) observed that 5% and 33% of samples were infected with mold and yeast. Khezri *et al.* (10) and Shadan *et al.* (11) stated that 9% of mold contaminations and 54.9% contaminations with mold and yeast in Mashhad and Zahedan, respectively Contamination with mold is not only associated with adverse health consequences and lower quality of the product, but also is of great economic importance in confection (4).

Fungal spores, abundant in air, could result in contamination of eclairs. Besides airborne infection, contaminated instruments and also the fungal contamination of raw material including sugar, flour and cream, and contaminated hands of labors in manufacturing and distribution could result in eclairs' infection (4). Yeast contamination leads to appearance of white and pink spots and spoilage of confectionary products and also has effects on flavor and smell of the products. These are partly preventable through conformity with sanitary principles and storage and distribution of bakery products in a suitable environment and use of preservatives such as sorbates and benzoates (4).

Regarding contamination of eclairs with *Enterobacteriaceae*, the present study showed that 59.1% of samples contained these Gram-

negative bacilli. Also, a study in Tehran by Soltan-Dalal *et al.* reported 40% contamination with *Enterobacteriaceae* in eclairs. This could be attributed to the labors working at confectionaries and non-conformity with personal hygiene and also transfer of microbial infection through these labors to raw materials. 13.6% of samples were also contaminated with *B. cereus*. A study by Soltan-Dalal *et al.* showed that 8% of eclairs in Tehran were contaminated with *B. cereus* (14).

Conclusion

It could be concluded that contamination of eclairs is a major issue in Arak and further investigations are warranted to reach the standard levels. Therefore, actions including more education regarding the proper methods of food storage, the ways contamination transfers to foods, the appropriate hand washing methods, faster preparation methods and transfer of eclairs to refrigerators, cleansing and disinfection methods of equipment and the place of work could eliminate the contamination or reduce it to lower than allowed limits which guarantees a healthy society.

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Conflict of Interest

None declared.

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