

HAZARDS AND RISKS TO CONSUMERS' HEALTH CAUSED BY POPSICLES ON SALVADOR BEACHES – BAHIA STATE

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ABSTRACT | Introduction: Beaches are a place for interaction and leisure, as well as a scenery for the provision of services, including the street food trade. In this segment, different workers with different type of foods are included, especially the popsicles. **Methods:** This study aimed to characterize microbiologically the popsicles commercialized on the beaches of Salvador, Bahia State. A cross-sectional study was carried out on 13 beaches, with the application of semi-structured questionnaires to 33 vendors to characterize microbiologically the popsicles sold on the beaches of Salvador, Bahia State, and the collecting of 198 samples, which were submitted to analysis: counting of Psychrotrophic microorganisms and coagulase-positive staphylococci, estimation of the Most Likely Number of total and thermolerant Coliforms/*Escherichia coli* and *Salmonella* spp research. **Results:** The results showed that in the microbiological profile, most of the samples were in compliance with the standards. However, 34.3% (68) of non-compliance were recorded, including contamination by the various microorganisms studied, except for *Salmonella* spp., which was not identified. **Conclusion:** The study identified risks to the customer's health, given the contamination in the products, for both groups of sellers.

Keywords: Cross-sectional studies, *Escherichia coli*, *Salmonella*, food safety.

INTRODUCTION

In Brazil, beaches are a place of coexistence and leisure, also important in the generation of work and income, mainly as a survival strategy for the poorest populations. On the other hand, although it presents contributions to the urban social balance, the beach economy has not been constituted as the object of public policies and studies, what makes the services to be rendered, to a large extent, informally developed, in the margin of regulation systems¹.

In this scenario, the street food trade deserves to be highlighted, since, besides maintaining the local food culture and attending to the beach-goers needs, it constitutes an opportunity of work for socially excluded groups².

In Salvador - Bahia State, street food sale on the beach is a tradition that has been perpetuated by the social and economic characteristics of the city. Thus, considering the high level of unemployment in the city, the activity is an attraction; A wide range of foods, including typical snacks of African cuisine, fruits in natura, fish with different preparations, skewers of cheese and beef, homemade salty snacks and sweets, nuts and peanuts, quail eggs, popsicles, among others.

It is added to the description that many consumers opt for street food because it is cheap and easily accessible³. This option, however, assumes risks related to the health of sold products, since studies in this field have evidenced the microbiological contamination of several foods that appear in the preference of the population and the tourists, including in the city of Salvador^{4,5}.

According to epidemiological surveys, the association of the consumption of popsicles with outbreaks of food-borne diseases has been verified, emphasizing the importance of the composition aspects of the products and the technological stage of the manufacturing sites⁶. Among the studies conducted in the microbiological perspective, many have portrayed the presence of deteriorating and pathogenic microorganisms, especially the contamination by *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* spp and psychrotrophic microorganisms^{6,7,8,9}.

In Salvador, the manufacture of popsicles on artisanal scale is also notable, with subsequent sales in different parts of the city, including beaches, with the participation of smaller sellers¹⁰. Thus, this study aimed to characterize microbiologically the popsicles sold on the beaches of Salvador, Bahia State.

METHODS

This is a cross-sectional, descriptive and exploratory study, conducted from 2009 to 2010 along the entire coastline of the city of Salvador, with the inclusion of 13 identified beaches according to the delimitation and geographical denomination already established in the city, where the collection sites are constituted and characterized by the intense commerce and great flow of people, where the sellers and the consumers were concentrated.

For the composition of the sample, it was followed a model of itinerant sampling 11, together with sellers of popsicles, with approach and interview of 13 sellers under 18 years old and 20 adults, followed by the acquisition of a set of 198 samples.

In order to obtain samples that allowed to evaluate the microbiological profile of foods and considering the number of vendors referred to, six samples per vendor were sold, packaged and unpackaged, three of which were milk based and three were fruit based. In total, 78 samples sold by children and teenagers and 120 samples sold by adult sellers were gathered/obtained.

The samples were collected aseptically, packed in sterile Nasco® plastic bags, placed in isothermal boxes containing recyclable ice and transported to the Food Microbiology Research Laboratory of the Pharmacy College/UFBA, being kept under cooling until the moment of analysis, in a break of no more than four hours.

The microbiological analyzes included: counting

of psychrotrophic microorganisms, Most Probable Number (MPN) of total and thermotolerant coliforms/*Escherichia coli*, coagulase-positive staphylococci and *Salmonella* spp research. The procedures followed the techniques established by Silva et al¹².

The results were compared to the standards presented by the Collegiate Board Resolution 12/2001, of the National Agency of Sanitary Surveillance (ANVISA, Ministry of Health), the Food Group - popsicles, "A" category¹³, with the exception of the enumeration of psychrotrophic microorganisms. In this case, considering that the psychrotrophic microorganisms are a subgroup of the mesophiles, it was used as a reference the FAO/WHO specifications for total counts of mesophilic aerobes in foods, specifically for the group of frozen mixtures¹⁴.

The data referring to the forms and the microbiological analysis were tabulated and composed a database using the statistical package SPSS version 13.0. The results were statistically treated by descriptive analysis, while for the ones related to the microbiological analysis the values were converted to logarithmic scale and analysis were carried out by a comparison test of means, Student's *t* test, to verify differences between products sold by adults and by minors, as well as to verify the variation in counting between milk-based products and fruit-based products. In addition, tests were conducted for differences in proportions *Z*. In both cases, it was adopted the level 0.05 of probability.

ETHICAL CONSIDERATIONS

In order to comply with ethical principles in health research with human beings, the presence of children and adolescents among the individuals interviewed was also highlighted. The project was approved by the Ethics Committee of the Clímério de Oliveira Maternity (Opinion 090/2008) and also by the Municipal Council for the Rights of the Child and Adolescent (198th Ordinary Assembly, June 18, 2008).

RESULTS

The results of the microbiological analysis of the popsicles samples collected on the beaches of Salvador are shown in Table 1, and the discussion is presented by the group or microorganism analysis, as follows:

- Psychrotrophic microorganisms

The analyzed popsicles samples presented average results in accordance with the FAO/WHO limit of 4.3 log of CFU/g 14, in samples sold by underage vendors and adults.

Among the fruit-based popsicles samples, it was observed that there was a significant difference between the averages of counting of psychrotrophs registered for children and adults ($p = 0.03$). On the other hand, the higher count of these microorganisms was observed in a sample of an adult salesman.

For the analyzed sample, only 4% exceeded the values recommended by FAO/WHO (1989)¹⁴.

- Total, thermotolerant and *E. coli* coliforms

As shown in Table 1, it was possible to identify the presence of total coliforms in the samples of both categories of products, although there is no legal standard for this group of microorganisms. At the same time, it was found that in the milk-based category the average values were always higher than those obtained for fruit products, although these results did not reach a significant difference.

Table 1. Characterization of popsicles samples for microbial contamination (log of Colony Forming Units (CFU)/g or Most Likely Number (MLN)/g or Presence).

Microorganism	Popsicles categories and microbiological standards									
	Milk-based samples				RDC Standard 12/2001	Fruit-based samples				RDC Standard 12/2
	Adults		Underages			Adults		Underages		
	Average	Amplitude	Average	Amplitude	Average	Amplitude	Average	Amplitude		
Psychotropic	2	0,0 – 6,0	1,7	0,0 – 5,1	4,3	2,6	0,0 – 5,5	0,3	0,0– 4,0 0,0–	4,
Total Coliforms	2,2	0,0 – 3,9	2,1	0,0 – 3,3	NSA*	1,6	0,0 – 3,3	1,5	3,2	NS
Thermotolerant Coliform Coagulase-positive staphylococci	1	0,0 – 3,3	1,4	0,0 – 3,2	1,7	1,3	0,0 – 3,2	1,1	0,0– 3,3 0,0–	1,
	0,9	0,0 – 4,1	1,1	0,0 – 3,4	2,7	0,1	0,0 – 3,2	0,6	3,3	NS
		Presence	Presence	Presence	Presence					
Salmonella spp		0	0	0	0					
Escherichia coli		7	10	10						

As for thermotolerant coliforms, most of the samples showed compliance with the legislation. For the set of analyzed samples in Salvador - BA, 8.08%⁸ of the milk-based samples and 7.07%⁷ of the fruit-based samples were classified as unfit for consumption because they exceed the microbiological limit established. There was no difference in the averages comparison between the adult and underage groups.

However, the confirmation of the presence of high-frequency of E. coli in both milk-based and fruit-based popsicles in both groups of vendors was a matter of concern.

- Coagulase-positive staphylococci

The average values recorded for coagulase-positive staphylococci in the analyzed popsicles were lower than those recommended by the legislation for this food category (2.7 log CFU / g). However, there was a correspondingly higher incidence of this microorganism in the milk-based popsicles samples sold by both adults and children, reaching almost a quarter of the milk-based samples obtained.

In this case, given that some of the popsicles were obtained in the packaged form, it is presumed that the contamination came from production establishments, where the insufficient application of Good Practices and the lack of heat treatment resulted in products already contaminated. For the sample set 5.05%¹⁰

were considered nonconforming.

- Salmonella spp

Salmonella spp was absent in the analyzed samples.

- Evaluation of the global condition of conformity of samples.

The results for compliance for all samples are shown in Table 2.

As it can be seen, milk-based samples had the highest incidence of non-compliant products when compared to fruit-based popsicles.

For the groups of sellers, the highest incidence of non-conforming samples was observed for the group of children and adolescents in both categories of products and also in the general statement, although this last proportion of non-conformity did not result in a significant difference in the comparison between these two groups (p = 0.08).

Table 2. Distribution (%) of samples for compliance, observing product categories and vendor groups.

Seller	Milk-based samples		Fruit-based samples		Total in conformity	Total nonconforming
	In conformity	Nonconformity	In conformity	Nonconformity		
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Underage	18 (46.2)	21 (53.8)	26 (66.7)	13 (33.3)	44 (56.4)	34 (43.6)
Adult	43 (71.7)	17 (28.3)	43 (71.7)	17 (28.3)	86 (71.6)	34 (28.4)
Total	61 (61.7)	38 (38.3)	69 (69.7)	30 (30.3)	130 (65.7)	68 (34.3)

DISCUSSION

- Psychrotrophic microorganisms

Regarding the findings on psychrotrophic microorganisms, the result can be explained by the fact that popsicles, are almost always acquired at points of sale - establishments of artisanal production, and taken directly to commercialization on the beaches of Salvador and elsewhere, being exposed for a long time to higher temperatures, which would alter the sensorial characteristics of this food, due to the fusion of the product, leading to rejection by consumers.

According to Silva et al.¹², psychrotrophs are microorganisms that grow in the food under refrigeration (0-7°C / 32-44,6°F), even though they still are present in temperatures above 20°C (68°F).

They are further defined by their ability to produce visible growth at 7 + 1°C (44,6 + 33,8°F), in the period of 7 to 10 days, regardless of their optimal temperature.

It is considered that, since adult vendors were carrying popsicles boxes with greater capacity and spending more time on the beach, there was a greater opportunity for exposures and further contamination of the product during the trade.

Children and adolescents, because of their short physical sizes, sold small volumes, which reduced the chances of contamination, which may explain the higher count of psychrotrophs for adult sellers.

Although there is no standard for these microorganisms in the current Brazilian legislation, these data reflect precariousness in the hygienic quality of popsicles, since most pathogenic microorganisms are mesophilic

- including psychrotrophic ones, and when they are present in high amounts, they provide an idea about the state of conservation of a product¹⁵. According to Silva et al.¹² psychrotrophic microorganisms comprise a subgroup of mesophiles because they do not die at room temperature, as do psychrophiles - which grow exclusively under refrigeration; instead, psychrotrophs grow best at mesophilic standard temperatures.

As for thermotolerant coliforms, most of the samples showed compliance with the legislation, which is close to a result presented by Queiroz et al.⁹, when analyzing samples of tapioca ice cream, in Fortaleza – Ceara State.

The presence of *E. coli* at high frequency in both milk-based and fruit-based popsicles and in both groups of vendors was similar to those reported by Ferrari et al.⁸ and, in higher percentages than those reported by Diogo et al.⁶, in studies conducted with ice cream analysis, at Paraná State, in the cities of Londrina and Ponta Grossa, respectively. Thus, the evidence of risks of other pathogenic microorganisms of enteric origin is highlighted, since *E. coli* indicates recent contamination, which also signals the viability of other organisms, including parasites, bacteria and viruses¹².

As for coagulase-positive staphylococci, the higher incidence of this microorganism in the milk-based popsicles samples, commercialized by both adults and children, reaching almost a quarter of the milk-based samples obtained, represents important information since the low temperature of the popsicles do not indicate microbiological safety, even because microbial contamination can occur both by the use of poor raw material and by contact

with utensils and food handler⁹.

Compared to other studies conducted on the subject, the results obtained in Salvador are similar to the study described by Queiroz et al⁹, who reported the presence of coagulase-positive staphylococci at values below the legal limit. However, different results were found by Warke et al¹⁷, who analyzed ice creams in Mumbai, India, and by Diogo et al⁶, who evaluated ice creams in Ponta Grossa-PR. According to these authors, 100% and 66.7% of the popsicles samples, respectively, were in unsatisfactory hygienic conditions.

The absence of *Salmonella* spp in the analyzed samples complies with the current legislation and resembles to the found by Warke et al¹⁷, who did not detect *Salmonella* spp in any of the 30 ice cream samples analyzed in Mumbai, India, and by Diogo et al⁶, in his study in Brazil. On the other hand, there is a divergence in reference to the study by Queiroz et al⁹, which evidenced the presence of *Salmonella* spp in 75% of the analyzed samples. El-Sharef et al¹⁸ also identified the microorganism in 8% of the ice-cream samples analyzed in Tripoli, Libya.

In this perspective, it should be noted that *Salmonella* spp is characterized by low competition capacity in the food matrices and, therefore, are often found in low numbers, and there is also difficulty in recovering the microorganism in the classic laboratory techniques¹⁶.

Thus, although there was no identification of this microorganism, the evidence of total and thermotolerant coliforms, as well as coagulase-positive staphylococci, confirms the production of popsicles outside the microbiological standards.

The milk-based samples showed the highest percentage of nonconformity, which may be related to the specific composition of the first ones, since the milk, besides comprising a food matrix very rich in nutrients and susceptible to contamination from the time of its production until the later processing processes, may confer protection to the microorganisms due to the presence of glycerol, lactose, amino acids, protein salts and seroproteins, which differs markedly from the solids present in the fruit-based popsicles¹⁹.

Noting that the total of non-conformities reached almost a third of the sample set, it is worth to note the concern with the public health and the microbiological quality of the popsicles sold on the beaches. Thus, questions are raised, both in the scope of workers and their precarious working conditions, as well as in regard to the origin and hygienic-sanitary conditions of the manufacturing sites of the products.

This confirms the need for measures that can promote the quality of commercialized food and protect the consumer's health.

CONCLUSION

Considering the objectives established in the study and the obtained results, it is concluded that: Most of the popsicles samples analyzed were within the standards. However, almost one third of non-compliant samples were registered, including contamination by the various microorganisms researched, with the exception of *Salmonella* spp, for which there was no identification. Among the categories of analyzed products, the frequency of non-compliance was higher for milk-based popsicles.

Thus, the need to keep products at a controlled temperature is emphasized, as well as to guide sellers to avoid direct food contact with the hands, limiting the access to the food by microorganisms. In this way, it will be possible to avoid foodborne diseases from popsicles, contributing to the maintenance of consumer's health on the beaches of Salvador, Bahia.

AUTHOR CONTRIBUTIONS

Menezes ROS collected and analyzed the data and wrote the manuscript under the supervision of Guimarães AG and Cardoso RCV.

COMPETING INTERESTS

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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