Abstract

Objective: the objective of the present investigation is to study the microbiology of banana peel being sold in the city of Rio de Janeiro, in an attempt to determine the possibility that the peel may represent a source of infection for women who use it to treat nipple fissures.

Methods: the following microorganisms were studied in 20 banana peel samples: mesophiles, total coliforms, fecal coliforms, *Pseudomonas aeruginosa*, lipolytic and proteolytic microorganisms, molds and yeasts, lactic bacteria, and coagulase-positive staphylococcus.

Results: the microbiological analyses revealed the occurrence of several typical groups of microorganisms, with the following distribution of positive results being detected in banana peel samples: mesophiles, 100%; total coliforms, 20%; coagulase-positive staphylococcus, 25%; molds and yeasts, 30%; proteolytic microorganisms, 70%; lipolytic microorganisms, 30%, and lactic bacteria, 95%. Fecal coliforms and *Pseudomonas aeruginosa* were not isolated.

Conclusion: the results show the presence of potentially pathogenic microorganisms in levels which could compromise the microbiological quality of the banana peel. Its use for the treatment of nipple fissures can initiate an infectious process.

Introduction

The act of breastfeeding brings with it innumerable advantages for the nursing mother, such as faster involution of the uterus, savings for the family budget, emotional satisfaction and a better, more affectionate, physical relationship with the child.1 Human milk (HM) production begins during gestation and the earlier that contact between mother and baby occurs, the faster it is established.2

Human milk is produced with highly specific nutritional and immunological characteristics, meeting the child’s organic maturity specifications.3 It is the diet most properly indicated for the survival and rapid development of the child since it performs the dual roles of nutritional and protective element, intervening directly in the child’s organism in search of equilibrium in its health.4

One obstacle to successful breastfeeding is nipple fissures, primarily due to problems with positioning or holding the baby at the breast.5 Correct treatment of fissures will impede their progression to mastitis which is a common cause of interrupted breastfeeding.6,7

In general, the appearance of fissures does not signify a need to interrupt breastfeeding, since despite causing pain they can heal quickly.8,9 To this end some alternatives are on offer, such as grated green banana peel lining applied to the nipple10 or the application of the peel directly over the fissures.

In the south of India, green bananas are used for the treatment of patients with peptic ulcers, prescribed in a powdered form.11 In work performed by Best et al.,12 a number of different banana preparations, used on rats with ulcers induced by aspirin, proved themselves effective both for prophylactic and remedial treatment. It was further demonstrated that the active ingredient is water soluble and that mature bananas lose their therapeutic effect.12

Green banana extract does not only increase the density of mucus, but also increases the incorporation of thymidine into cell DNA, demonstrating its effect on cell multiplication. Histological study revealed that the treatment increased proliferation both of apical cells and of deeper mucus layers, suggesting not only an increased resistance to substances capable of provoking ulcers, but also that a cure is promoted by the induction of cell proliferation.13 The active component found in banana peel was extracted and identified as a flavonoid leuocyanidin.14

The works cited above demonstrated the existence of a substance which promotes healing in green bananas, showing the popular treatment of applying the peel of unripe bananas to nipple fissures is not just a myth. Despite this, the use of banana peel in the treatment of nipple fissures is not well documented in scientific literature.

In the light of this, this research took as its objectives: 1) to study the microbiology of banana peel being sold in the city of Rio de Janeiro; 2) study the reduction of microbial contaminants by techniques which could be reproduced by nursing mothers.

Methods

The unripe banana samples were acquired and transported under the same conditions as they are supplied to nursing mothers by commercial outlets, i.e. in newspaper, paper bags or plastic bags. The samples were acquired from 20 different retail establishments, 12 of which were open markets and 8 supermarkets located a minimum of 1 km apart, within the city of Rio de Janeiro, in the period between January and August of 2002, and were analyzed at the Food Controls Laboratory of the Instituto Fernandes Figueira of the Fundação Oswaldo Cruz.

The peel to be analyzed was ground in the previously sterilized jar of a liquidizer, maintaining in all cases a proportion of 1:10 with respect of the volume of sterile peptonated water used for dilution.

With the aim of achieving a wide coverage of the groups of microorganisms possibly to be found in the banana peel, the following groups of microorganisms were studied:

Mesophiles - The method described in the Compendium of Methods of the Microbiological Examination of Foods was adhered to during proceedings.15 One milliliter portions of the selected homogenate and its decimal dilutions were seeded in duplication, by the pour plate technique in Standard-Method-Agar PCA (Plate Count Agar Merck). After the media had solidified, the samples were incubated at 35°C for 48 hours. Colonies were counted and the results expressed in colony-forming units (CFU) per gram of banana peel.

Total Coliforms - Determined by the Most Probable Number technique as described in Standard Methods for the Examination of Dairy Products.16 Portions of the decimal dilutions selected from the homogenate were inoculated in a series of three tubes containing Brilliant-green Bile Broth - Bile 2% - BGBL (Merck). The tubes were incubated at 36 ± 1 °C for 24/48 hours. After incubation, the production of gas was monitored. The most probable number of coliforms was calculated using the McGrady table.15 Positive tubes were divided with a bacteria spatula into new tubes containing BGBL and incubated at 36 ± 1 °C for 24/48 hours for the confirmation test and the results were expressed as the most probable number per gram (MPN/g).

Fecal Coliforms - Proceedings were in accordance with those described in the Standard Methods for the Examination of Dairy Products.16 The tubes in which a total coliform presence was detected were individually divided with a
bacteria spatula into tubes containing EC broth (Merck) and incubated at 44.5 ± 0.1 °C in an ultra-thermostatic water bath, and agitated for 24/48 hours. After incubation gas production was observed and results expressed in MPN/g.

**Pseudomonas aeruginosa** - Proceedings were as described by Thornley. Portions of 0.1 ml of the selected dilutions were seeded in duplicate by the surface inoculation technique using a Drigalsky spatula, in Cetrimide Agar (Merck) and incubated at 37 °C for 24 hours, typical colonies were then counted and the results expressed in CFU/g of banana peel.

**Coagulase-positive Staphylococcus** - Investigation was according to the method described in the *Compendium of Methods for the Examination of Foods*. Portions of 0.1 ml of and its selected dilutions were seeded in duplicate by the surface inoculation technique using a Drigalsky spatula, in Baird-Parker Agar (Merck). The plates were incubated at 35-37 °C for 48 hours. Typical colonies were then counted and the results expressed in CFU/g.

**Moulds and Yeasts** - Proceedings followed the method described by Marvin. Portions of 1.0 ml of the homogenate and its selected decimal dilutions were seeded by the pour plate technique, in Potato Dextrose Agar - PDA (Merck). After the media had solidified the plates were incubated at 25 °C for 5 days. Colonies were counted and the results expressed in CFU/g.

**Lipolytic microorganisms** - Portions of 1 ml of the decimal dilutions were selected and seeded in duplicate, by the pour plate technique in Tributyrin Agar (Merck) and incubated at 37 °C for 5 days. Characteristic colonies were counted and the results expressed in CFU/g.

**Proteolytes** - Proceedings were as described by Marth. Portions of 1.0 ml of the selected dilutions were seeded in duplicate, by the pour plate technique in Standard-Method-Agar PCA (Merck), containing 10% skimmed milk. After the media had solidified, the plates were incubated at 21 ± 2 °C for 72 hours. After incubation, 3 ml de of acetic acid solution at 10% v/v was poured over the plates and left for one minute and characteristic colonies were counted and the results expressed in CFU/g.

**Lactobacilli** - Proceedings were as described by Lima, employing Standard-Method-Agar PCA (Merck) with the addition of 0.004 g of bromocresol purple and 0.5 g of lactose, per 100 ml of medium. With the intention of avoiding the diffusion of the acid produced by the colonies, 0.2% calcium carbonate was added. Portions of 1.0 ml of the homogenate and it selected decimal dilutions were seeded in duplicate, by the pour plate technique. The plates were incubated at 32°C for 48 hours and colonies surrounded by a yellow halo were counted and the results expressed in CFU/g.

In addition, the reduction of these microorganisms found on the surface of the banana peel was studied; by means of immersion in 96 GL alcohol for 10 minutes and by washing, for 3 minutes, with the market leading domestic detergent.

In relation to ethical aspects, the work was conducted in accordance with the standards and directives regulated by resolution 196/9619 and was begun after being approved by the Committee for Ethics in Research of the Instituto Fernandes Figueira.

**Results**

The distribution, in percentages, of positive results from the banana peel samples was as follows: mesophiles, 100%; total coliforms, 20%; coagulase-positive staphylococcus, 25%; moulds and yeasts, 30%; proteolytes, 70%; lipolytic microorganisms, 30% and lactobacilli, 95%. Fecal coliforms includes the majority of the contaminants present, including the pathogenic ones, and gives a good overall idea of the microbial payload.15

The occurrence of yeasts and moulds was recorded in 30% (6/20) of the samples, and they presented counts of 1.8 x 10² to 3.0 x 10³ CFU/g. The presence of these contaminants is associated with unsatisfactory hygienic and sanitary conditions along the production chain of the bananas analyzed.21

In studying the reduction of microbiology of the banana peel subjected to 96 °GL alcohol and detergent a more homogenous distribution of microorganisms was observed across the peel examined. The effects of the techniques employed to reduce contaminating microorganisms in the banana peel can be observed in Figure 1. It is worth pointing out that in none of the 20 samples used in this experiment was coagulase-positive staphylococcus growth observed.

There was a reduction of the microbial payload of the banana peel through the use of the methods proposed (paired t test p < 0.05),20 however this was not sufficient to eliminate the contaminants that were present (Figure 1).

**Discussion**

Populations of microorganisms of the mesophiles group were observed in 100% of the samples analyzed. This group includes the majority of the contaminants present, including the pathogenic ones, and gives a good overall idea of the microbial payload.15

The results revealed the presence of coagulase positive staphylococcus in 25% (5/20) of the samples, with 100% of the counts less than 10³ CFU/g. The greatest concern relating to the presence of this microorganism is that *S. aureus* is intimately linked with the majority of mastitis episodes observed in clinical practice during breastfeeding.15

The occurrence of yeasts and moulds was recorded in 30% (6/20) of the samples, and they presented counts of 1.8 x 10¹ to 3.0 x 10³ CFU/g. The presence of these contaminants is associated with unsatisfactory hygienic and sanitary conditions along the production chain of the bananas analyzed.21

The presence of lipolytic bacteria was detected in 40% (8/20) of the samples, with counts which varied from 1.3 x 10¹ to 2.7 x 10² CFU/g and the presence of proteolyte microorganisms occurred in 70% (14/20) of the samples, with counts varying from 1.6 x 10² to 1.7 x 10³ CFU/g. Such
results become a cause for concern as these microorganisms may become opportunists as a result of their capacity to multiply in a wide variety of necrotized tissues.\textsuperscript{16}

Lactobacilli populations were present in 95\% (19/20) of the samples analyzed, with all counts being lower than $10^3$ CFU/g. Substances produced by these lactic acid bacteria in the contact solution may hinder healing.\textsuperscript{16}

Evaluation of the results in conjunction reveals the presence of potentially pathogenic microorganisms at levels capable of compromising the sanitary qualities of the banana peel tested. Taking into account the fact that the procedures employed to reduce the microbial payload were not effective in eliminating the contaminants present - which could initiate an infectious process if

### Table 1 - Distribution of groups of microorganisms analyzed in 20 samples of banana peel

<table>
<thead>
<tr>
<th>Count (per gram)</th>
<th>Mesophiles</th>
<th>Total coliforms</th>
<th>Coagulase Staphylococcus (+)</th>
<th>Molds and yeasts</th>
<th>Lipolytic</th>
<th>Proteolytic</th>
<th>Lactic bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence</td>
<td>0</td>
<td>16</td>
<td>15</td>
<td>14</td>
<td>12</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>$10^0$ – $10^1$</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$10^1$ – $10^2$</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>$10^2$ – $10^3$</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>$10^3$ – $10^4$</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Figure 1 -** Effect of 96 \textsuperscript{\circ}GL alcohol and detergent on the contaminants found on the surface of banana peels
they found favorable conditions - and that bacteria located on the exterior of the banana peel could, with manipulation, easily be transferred to the part which comes into contact with the fissures, it is possible that the application of banana peel during treatment of fissures acts as a source of microorganisms capable of initiating an infectious process. Furthermore, there may be hypersensitivity cross-reaction between certain composites which exist in bananas and in natural rubber latex, i.e. people who are allergic to latex frequently exhibit a hypersensitive reaction to bananas.22 In the experience of the authors, many nursing mothers with symptoms of allergy on the skin of the breasts report having used banana peel to treat nipple fissures. Nevertheless, the association between allergies of the breast and the use of banana peel need to be better documented with appropriately delineated studies to test this hypothesis.

Concluding, the results of this study are an alert to the possibility of damaging effects (infections of the breast) from the use of banana peel in the treatment of fissures. The delineation of the study did not permit the evaluation of the association between the use of banana peel and infection. Further studies delineated specifically to evaluate this association are necessary in order that recommendations can be made with respect of the use of banana peel in the treatment of nipple fissures. Meanwhile, until it is proved that the (theoretical) therapeutic effect of banana peel in the healing of fissures outweighs the risks of its use it would be prudent to avoid this procedure.

References

Banana peel: a possible source of infection... – Novak FR et alii

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