Original Research Article

Microbiological Quality Assessment of Dairy Desserts Sold in New Valley Governorate

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Abstract

A hundred fifty randomly collected samples of ice cream, rice pudding and mahlabia (50 samples each) from different localities in El-Dakhla city, New Valley Governorate, Egypt, were microbiologically examined. The average counts of the aerobic plate, psychrotrophic bacteria, total coliforms, fecal coliforms, Staphylococcus aureus counts and yeast and mold in the examined ice-cream samples were 6.47 × 105, 9.17 × 105, 5.23 × 105, 2.73 × 106, 1.05 × 107, 1.97 × 106 and 1.04 × 106 CFU/ml, respectively. While, in rice pudding samples the average counts of the aerobic plate, total coliforms, fecal coliforms, Staphylococcus aureus counts and yeast and mold were 1.17 × 107, 6.99 × 106, 5.35 × 106, 1.37 × 107, 9.81 × 106 and 5.32 × 106 CFU/ml, respectively, while in mahlabia samples, the counts were 6.44 × 106, 3.04 × 106, 2.06 × 106, 8.19 × 106, 7.09 × 105 and 7.40 × 106 CFU/ml, respectively. Escherichia coli was detected in 20, 16, and 10% in ice cream, rice pudding and mahlabia samples, respectively. All the examined samples in this study were negative for anaerobes. In conclusion, strict hygienic measures should be followed during the production and handling of milk products with health education programs for producers and handlers.

Keywords: Dairy desserts, Microbiological examination.

Introduction

Dairy desserts as ice cream, rice pudding and mahlabia (a traditional dessert in Egypt) are popular frozen and refrigerated foods consumed particularly in summer, as well as, throughout all the year. They continue to present a dominant interest in a large segment of the population. They are usually formulated with milk, modified starch, sugar, hydrocolloids such as carrageenan, flavorings, and colorants (De Wijk et al. 2003; González-Tomás, and Costell 2006). Furthermore, dairy desserts are important vehicles for the transmission of various pathogens especially in countries where hygienic standards are not strictly applied. So, the microbial quality of dairy desserts is determined by total viable bacterial count, coliform count, and presence of pathogenic microorganisms (Meyer-Broseta et al. 2003). The total bacterial count indicates the farm’s general hygienic condition, herd health status, milking equipment, sanitation, and milk storage temperatures (Hayes et al. 2001). Psychrotrophic can cause spoilage of milk and dairy products because they are able to produce extracellular or intracellular thermoresistant enzymes (proteases, lipases, and phospholipases) (Rankin et al. 1984; Fuhr et al. 1986; Joshi et al. 2004). Coliforms are used as indicator to the quality of milk and milk products as some members of coliforms are responsible for the development of objectionable taints in milk and they are products rending them of inferior quality or even
unmarketable (Yabaya and Idrs, 2012). E. coli in food is an indicative of fecal contamination and the presence of other dangerous pathogenic microorganisms which can compromise the health and wellbeing of consumers (Atanfie et al. 2017). S. aureus is a major food borne pathogen due to its capability to produce a wide range of heat stable enterotoxins that when ingested through contaminated dairy desserts could cause food human with varying severity (Peles et al. 2005). Yeast is unicellular eukaryotic fungi that are widely present in the natural environment (Kurtzman et al. 2011). Economically, the presence of yeast and molds in dairy desserts are undesirable even when found in small numbers as they rapidly grow in the product in a wide range of temperature, humidity, and PH, resulting in objectionable changes that render the product of inferior quality or even unmarketable. The objectives of this study were to evaluate the bacteriological quality of some dairy desserts (ice cream, rice with milk and mahlabia) consumed in New Valley Governorate, Egypt.

Materials and Methods

Collection and preparation of samples
150 samples of dairy desserts including ice cream samples of different flavors, rice pudding and mahlabia (50 samples each), were collected randomly from dairy shops and street vendors in El-Dakhla city, New Valley Governorate, Egypt.
All samples were transferred to the laboratory in their package to subject to sanitary evaluation and microbiological evaluation to judge and give a decision that the products were fit for consumption.

Preparation of samples
Eleven ml or grams of the prepared samples were mixed with 99 ml of sterile 0.1% peptone water and thoroughly mixed to give a dilution of 1/10, and then tenfold serial dilution were carried out (A.P.H.A., 1994)

Microbiological evaluation
   3.1. Isolation of E. coli (Collee et al., 1996).
   3.2. Identification of E. coli:
   a) microscopic examination (Oyeleke et al. 2008).
   Triple Sugar Iron (TSI), Indole test, Methyl Red Test, Voges-Proskauer test and Citrate utilization test.
Identification of S. aureus:
   a) microscopic examination (A.P.H.A., 2004):
   b) Biochemical reaction (Quinn et al., 1994): Coagulase test and Mannitol fermentation test.
5. Detection of anaerobic spore formers (Stormy fermentation test) (Cruckshank et al. 1969).

Results

Table 1. Statistical analytical results of total bacterial count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml or gm)

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>No. of positive samples</th>
<th>%</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>50</td>
<td>100%</td>
<td>$2.0 \times 10^7$</td>
<td>$2.0 \times 10^6$</td>
<td>$6.67 \times 10^6$</td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>50</td>
<td>100%</td>
<td>$3.0 \times 10^6$</td>
<td>$1.3 \times 10^6$</td>
<td>$1.17 \times 10^6$</td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>50</td>
<td>100%</td>
<td>$4.25 \times 10^5$</td>
<td>$4.25 \times 10^4$</td>
<td>$9.17 \times 10^4$</td>
</tr>
</tbody>
</table>

Table 2. Statistical analytical results of psychrotrophic count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml)

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>No. of positive samples</th>
<th>%</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>33</td>
<td>66%</td>
<td>$1.0 \times 10^4$</td>
<td>$1.0 \times 10^3$</td>
<td>$4.25 \times 10^3$</td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>-</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 3. Statistical analytical results of total coliforms count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml or gm):

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>No. of positive samples</th>
<th>%</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>3.0 × 10⁷</td>
<td>1.0 × 10⁸</td>
<td>5.23 × 10⁷</td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>47</td>
<td>94</td>
<td>2.90 × 10⁴</td>
<td>1.80 × 10⁵</td>
<td>6.99 × 10⁵</td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>45</td>
<td>90</td>
<td>9.0 × 10³</td>
<td>5.0 × 10⁴</td>
<td>3.0 × 10⁴</td>
</tr>
</tbody>
</table>

Table 4. Statistical analytical results of fecal coliforms count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml or gm):

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>No. of positive samples</th>
<th>%</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>1.0 × 10⁷</td>
<td>1.5 × 10⁷</td>
<td>2.71 × 10⁷</td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>45</td>
<td>90</td>
<td>1.0 × 10⁵</td>
<td>1.8 × 10⁶</td>
<td>5.35 × 10⁵</td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>40</td>
<td>80</td>
<td>5.0 × 10⁴</td>
<td>1.4 × 10⁵</td>
<td>2.65 × 10⁴</td>
</tr>
</tbody>
</table>

Table 5. Incidence of the isolated E. coli in the examined ice cream, rice pudding and mahlabia samples:

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>Positive samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>10 20</td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>8 16</td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>5 10</td>
</tr>
</tbody>
</table>

Table 6. Statistical analytical results of S. aureus count in ice cream, rice pudding and mahlabia samples (CFU/ml or gm):

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>No. of positive samples</th>
<th>%</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>9 18</td>
<td>6.00 × 10⁶</td>
<td>3.0 × 10⁷</td>
<td>1.65 × 10⁷</td>
<td></td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>5 10</td>
<td>2.00 × 10⁶</td>
<td>6.40 × 10⁵</td>
<td>1.37 × 10⁷</td>
<td></td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>6 12</td>
<td>1.40 × 10⁵</td>
<td>1.7 × 10⁵</td>
<td>8.19 × 10⁵</td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Incidence of anaerobes in ice cream, rice pudding and mahlabia samples:

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>Positive samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>7 3</td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>8 5</td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>5 5</td>
</tr>
</tbody>
</table>

Table 8. Statistical analytical results of yeast count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml or gm):

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>No. of positive samples</th>
<th>%</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>48 96</td>
<td>8.50 × 10⁵</td>
<td>2.70 × 10⁶</td>
<td>1.57 × 10⁶</td>
<td></td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>47 94</td>
<td>8.00 × 10⁵</td>
<td>5.80 × 10⁴</td>
<td>9.81 × 10⁵</td>
<td></td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>45 90</td>
<td>6.00 × 10⁵</td>
<td>3.0 × 10⁵</td>
<td>7.00 × 10⁵</td>
<td></td>
</tr>
</tbody>
</table>
Table 9. Statistical analytical results of mold count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml or gm):

<table>
<thead>
<tr>
<th>Samples</th>
<th>No. of examined samples</th>
<th>No. of positive samples</th>
<th>%</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice cream</td>
<td>50</td>
<td>35</td>
<td>70</td>
<td>2.0 × 10^3</td>
<td>1.0 × 10^4</td>
<td>1.0 × 10^3</td>
</tr>
<tr>
<td>Rice pudding</td>
<td>50</td>
<td>37</td>
<td>74</td>
<td>1.9 × 10^4</td>
<td>4.9 × 10^6</td>
<td>5.32 × 10^5</td>
</tr>
<tr>
<td>Mahlabia</td>
<td>50</td>
<td>32</td>
<td>64</td>
<td>1.0 × 10^3</td>
<td>3.0 × 10^5</td>
<td>7.40 × 10^4</td>
</tr>
</tbody>
</table>

Discussion

Data recorded in Table 1 showed that the total bacteria could be detected in 100% of the examined ice cream samples with an average count of 6.47 × 10^6 CFU/ml. These results were nearly similar were obtained by Abo El-Makarem (2017) and Attalla et al. (2018). The higher count that reported by Edward et al. (2017), Youssif et al. (2020) and Alsagher et al. (2021), while the lower results are indicated by Kumar et al. (2011) and Usman (2015). According to the limits proposed by the Egyptian standards (2005), (76%) of ice cream samples failed to comply with the limits. While, in the rice pudding samples, the total bacterial count was detected in 100% of the samples, which ranged from 1.31 × 10^5 to 7.30 × 10^7 CFU/ml, with an average 1.17 × 10^7 CFU/ml. Nearly similar results were obtained by Abdel-Latif and Saad (2016), while higher results were cleared by Ali et al. (2001), Al-Gendi (2004) and Hassan and Afifi (2016). In mahlabia samples, the total bacterial count found in 100% of the samples with counts ranged from 3.0 × 10^5 to 2.0 × 10^7 CFU/ml with an average 6.44 × 10^6 CFU/ml. The higher results were revealed by Ali et al. (2001), Al-Gendi (2004) and Hassan and Afifi (2016). The high total bacterial counts are due to poor quality raw materials and ingredients utilized in the manufacturing of these items, insufficient heat treatment, and post-heat treatment contamination, as well as unsanitary production circumstances.

According to Table 2, the incidence of psychrotrophic bacteria was 66% in the examined ice cream samples, with the minimum, maximum and average counts were 1.0 × 10^4, 4.25 × 10^4 and 9.17 × 10^5 CFU/ml, respectively. These results are higher than those reported by Al-Gendi (2004) and El-Malt et al. (2013), on the other side the lower results were recorded by El-Kholy et al. (2008) and Armmanios et al. (2017). The presence of psychrotrophic bacteria in milk and milk products can be significant since these organisms can grow and proliferate during storage, even at low temperatures like 5°C, resulting in the spoilage of these products (Mahmud et al. 2012). Psychrotrophic bacteria cannot be detected in any of the examined rice pudding and mahlabia samples.

It is apparent from Table 3 that 100% of the examined ice cream samples were contaminated with coliforms. The average coliform count was 5.23 × 10^6 CFU/ml. The obtained results agreed with the finding of Alam et al. (2015) and Bushra et al. (2016), while higher than those indicated by Abou El-Makarem (2017), Barman et al. (2017), Armmanios et al. (2017), El-Kholy et al. (2018), Wafy (2019) and Youssif et al. (2020). All the ice cream tested samples failed to meet the limitations recommended by Egyptian regulations (2005).

Regarding rice pudding samples, the average count was 6.99 × 10^6 CFU/ml with an incidence of 94% of the examined samples. The higher results were shown by Abdel-Latif and Saad (2016) and Hassan and Afifi (2016). Also, in mahlabia samples, 90% of the tested samples were contaminated with total coliform with an average of 3.04 × 10^6 CFU/ml. Higher counts were demonstrated by Ali et al. (2001), Al-Gendi (2004) and Hassan and Afifi (2016).

The coliforms are considered an indicator of poor sanitation and handling of the dairy desserts throughout preparation (Finstein, 1973 and Banwart, 1981).

The summarized results in Table 4 pinpointed that 100% of the analyzed ice cream samples were contaminated by fecal coliforms. The indicated results were higher than those reported by Abou-El Khair et al. (2014), Hassan and Afifi (2016) and El-Kholy et al. (2018). Also, the results showed that 90% of the examined rice pudding samples were contaminated with fecal coliforms. These results are higher than those recorded by Ali et al. (2001), Al-Gendi (2004), Abdel-Latif and Saad (2016) and Hassan and Afifi (2016). In mahlabia examined samples 80% were contaminated by fecal coliforms. These results were extremely higher than those recorded by Ali et al. (2001), Al-Gendi (2004) and Hassan and Afifi (2016).
Table 5 showed that \textit{E. coli} could be isolated from 20% of the ice cream examined samples. A nearly similar result was recorded by Al-Gendi (2004) and Ojokoh (2006), however, the higher results were recorded by Ahmed \textit{et al.} (2016), Edward \textit{et al.} (2017) and Jabuk \textit{et al.} (2019), while lower than pointed by Hassan and Afifi (2016), Abo El-Makarem (2017), Kandil \textit{et al.} (2018), Jawdat \textit{et al.} (2019) and Hassan \textit{et al.} (2021). According to the limits proposed by Egyptian standards (2005), (20%) of the examined ice cream samples, failed to comply with the limits. While detected in 16% in rice pudding examined samples. These lower results were conducted by Ali \textit{et al.} (2001) and Hassan and Afifi (2016), while higher than those cleared by Al-Gendi (2004). In mahlabia samples were found in 10% of the examined samples; these results are lower than those shown by Ali \textit{et al.} (2001), Al-Gendi (2004) and Hasan and Afifi (2016).

\textit{E. coli} is found in the gastrointestinal systems of humans and animals. Hence, its isolation from milk and dairy products is considered an indicator of direct or indirect fecal pollution. \textit{E. coli} has been implicated in cases of cystitis, pyletitis, septicemia, as well as food-borne epidemics Farahat (1999).

The results pointed in Table 6 revealed that \textit{S. aureus} was isolated from 9 (18%) of the examined ice cream samples with an average $1.05 \times 10^7$ CFU/ml. The Lower results were reported by Hassan and Afifi (2016), Kandil \textit{et al.} (2018), Samir \textit{et al.} (2018), Meshref \textit{et al.} (2019) and Youssif \textit{et al.} (2020). While the higher results carried by Ahmed \textit{et al.} (2016), Edward \textit{et al.} (2017), Elmaghraby \textit{et al.} (2018) and Badr (2018). According to Egyptian standards (2005), 18% of the ice cream samples analyzed failed to meet the criteria.

Although the observed counts of \textit{S. aureus} can't be enough to cause disease, these counts may reach high levels under temperature conditions. These can usually get into ice cream from sources like soil, dust, contaminated equipment, and people's hands, both during storage and vending machine filling and selling (Mathews \textit{et al.} 2013).

\textit{S. aureus} was detected in 5 (10%) with an average $1.37 \times 10^7$ CFU/ml, of the rice pudding, examined samples. The lower results were revealed by Hassan and Afifi (2016) and Hussein \textit{et al.} (2015). Moreover, it was found in 6(12%) with an average $8.19 \times 10^6$ CFU/ml of the examined mahlabia samples. Higher results were obtained by Hussein \textit{et al.} (2015) and Hassan and Afifi (2016).

All the examined samples (ice cream, rice pudding and mahlabia) in this study were negative for anaerobes (Table 7). The failure of anaerobes detection is because they live only in the absence of oxygen and must be stored in a closed container for a long time. So, they were not found in these products.

Results achieved in Table 8 showed that the average of the examined ice cream samples was $1.97 \times 10^6$ CFU/ml. These findings agreed with those recorded previously by Caglayanlar \textit{et al.} (2009) and Youssif \textit{et al.} (2020). The higher results were detected by Ali \textit{et al.} (2001), Al-Gendi (2004), El-Malt \textit{et al.} (2013), Abdel-Latif and Saad (2016) and Jawdat \textit{et al.} (2019). According to the limits proposed by the Egyptian standards (2005), (96%) of the examined ice cream samples, failed to comply with the limits. While in the rice pudding samples, they recorded that the average count of yeast was $9.81 \times 10^6$ CFU/ml, these results agreed with those shown by Al-Gendi (2004). In addition, in mahlabia samples, the average count of yeast was $7.09 \times 10^5$ CFU/ml. These results were lower than those recorded by Al-Gendi (2004).

The results shown in Table 9 clarified that the prevalence of mold was 70% with a minimum, maximum and average mold counts in the examined ice cream samples were $2.0 \times 10^2$, $6.50 \times 10^6$ and $1.04 \times 10^6$ CFU/ml, respectively. These results were nearly similar were mentioned by Youssif \textit{et al.} (2020), while the higher results were detected by Ali \textit{et al.} (2001), El-Malt \textit{et al.} (2013) and Abdel-Latif and Saad (2016). According to the limits proposed by the Egyptian standards (2005), (70%) of the examined ice cream samples, failed to comply with the limits. The prevalence of mold in rice pudding samples was 74% with a minimum count $1.0 \times 10^2$, maximum count $4.0 \times 10^6$ and an average count $5.32 \times 10^6$ CFU/ml. The higher results were detected by Ali \textit{et al.} (2001). While in mahlabia samples the incidence of mold was 64% with counts ranging from $1.0 \times 10^2$ to $4.0 \times 10^6$ CFU/ml with an average $7.40 \times 10^6$ CFU/ml in the examined mahlabia samples. The higher results were reported by Ali \textit{et al.} (2001).

Yeasts and molds contaminate dairy products from the air, and incorrect storage, and packaging containers, result in a variety of problems in dairy products (Robinson, 2002). They provide a yeasty flavor as well as frothy growth (Judkins and Keener, 1960).

**Conclusion**

From this study, it is concluded that hygienic procedures during the production, handling and distribution of milk desserts used for human consumption in El-Dakhla city, are neglected. Most examined samples are highly contaminated, rendering them of poor quality and unfit for human consumption, exposing the consumers to health hazards. Therefore,
during the manufacture and handling of these products, strict hygiene precautions should be followed, as well as health education programs for producers and handlers.

References


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ISO (International Organization of Standardization) (2008): "No. 21527-1. Microbiology of food and animal feeding stuffs-Horizontal method for the enumeration of yeasts and moulds – part 1: Colony count technique in products with water activity greater than 0.95". Ed.1.


