Original Research Article

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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 6.47×10^6, 9.17×10^5, 5.23×10^6, 2.73×10^6, 1.05×10^7, 1.97×10^6 and 1.04×10^6 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 1.17×10^7, 6.99×10^6, 5.35×10^6, 1.37×10^7, $9.81 \times 10^6$and 5.32×10^6 CFU/ml, respectively, while in mahlabia samples, the counts were 6.44×10^6, 3.04×10^6, 2.06×10^6, 8.19×10^6, 7.09×10^5 and 7.40×10^6 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 (Atnafie 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

1. Determination of aerobic plate count on standard plate count agar (A.P.H.A., 2004).
2. Determination of psychrotrophic count on standard plate count agar (A.P.H.A., 1992).
3. Determination of total coliform and fecal coliform on Violet Red Bile agar (A.P.H.A., 2001).
    3.1. Isolation of E. coli (Collee et al., 1996).
    3.2. Identification of E. coli:

a) microscopic examination (Oyeleke et al. 2008).
b) Biochemical reactions (A.P.H.A., 2004).

Triple Sugar Iron (TSI), Indole test, Methyl Red Test, Voges-Proskauer test and Citrate utilization test.

4. Determination and isolation of S. aureus (US-FDA, 2016).

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) (Cruickshank et al. 1969).
6. Determination of total Yeast and Mold count (ISO 21527-1: 2008).

Results

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

Samples	No. of examined samples	No. of positive samples	%	Minimum	Maximum	Average
Ice cream	50	50	100%	5.50×10^4	2.30×10^7	6.47×10^6
Rice pudding	50	50	100%	1.31×10^5	7.30×10^7	1.17×10^7
Mahlabia	50	50	100%	3.0×10^5	2.0×10^7	6.44×10^6

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

Samples	No. of examined samples	No. of positive samples	%	Minimum	Maximum	Average
Ice cream	50	33	66	1.0×10^4	4.25×10^6	9.17×10^5
Rice pudding	50	-	0	-	-	-
Mahlabia	50	-	0	-	-	-

Table 3. Statistical analytical results of total coliforms count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml or gm):

Samples	No. of examined samples	No. of positive samples	%	Minimum	Maximum	Average
Ice cream	50	50	100	5.0×10^4	3.0×10^7	5.23×10^6
Rice pudding	50	47	94	3.0×10^4	2.90×10^7	6.99×10^6
Mahlabia	50	45	90	9.0×10^3	2.10×10^7	3.04×10^6

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

Samples	No. of examined samples	No. of positive samples	%	Minimum	Maximum	Average
Ice cream	50	50	100	1.0×10^4	1.55×10^7	2.73×10^6
Rice pudding	50	45	90	1.0×10^4	1.8×10^7	5.35×10^6
Mahlabia	50	40	80	5.0×10^3	1.4×10^7	2.06×10^6

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

Samples	No. of examined samples	Positive samples	
		No.	%
Ice cream	50	10	20
Rice pudding	50	8	16
Mahlabia	50	5	10

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

Samples	No. of examined samples	No. of positive samples	%	Minimum	Maximum	Average
Ice cream	50	9	18	6.00×10^5	3.0×10^7	1.05×10^7
Rice pudding	50	5	10	2.00×10^5	6.0×10^7	1.37×10^7
Mahlabia	50	6	12	1.40×10^5	1.7×10^7	8.19×10^6

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

Samples	No. of examined samples	Positive samples	
		No.	%
Ice cream	50	-	0
Rice pudding	50	-	0
Mahlabia	50	-	0

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

Samples	No. of examined samples	No. of positive samples	%	Minimum	Maximum	Average
Ice cream	50	48	96	8.50×10^3	7.0×10^6	1.97×10^6
Rice pudding	50	47	94	8.0×10^2	5.0×10^6	9.81×10^6
Mahlabia	50	45	90	6.0×10^2	3.0×10^6	7.09×10^5

Table 9. Statistical analytical results of mold count in the examined ice cream, rice pudding and mahlabia samples (CFU/ml or gm):

Samples	No. of examined samples	No. of positive samples	%	Minimum	Maximum	Average
Ice cream	50	35	70	2.0×10^2	6.50×10^6	1.04×10^6
Rice pudding	50	37	74	1.0×10^2	4.0×10^6	5.32×10^6
Mahlabia	50	32	64	1.0×10^2	3.0×10^6	7.40×10^6

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 2.0×10^7CFU/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 ,4.25×10^6 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 Armnanios *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 Abo El-Makarem (2017), Barman *et al.* (2017), Armnanios *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 *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 *et al*. (2016), Edward *et al.* (2017) and Jabuk *et al*. (2019), while lower than pointed by Hassan and Afifi (2016), Abo El-Makarem (2017), Kandil *et al*. (2018), Jawdat *et al*. (2019) and Hassan *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 *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 *et al*. (2001), Al-Gendi (2004) and Hassan and Afifi (2016).

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. *E. coli* has been implicated in cases of cystitis, pyletitis, pyelonephritis, peritonitis, and septicemia, as well as food-borne epidemics Farahat (1999).

The results pointed in Table 6 revealed that *S. aureus* was isolated from 9 (18%) of the examined ice cream samples with an average 1.05×10^7 CFU/ml. The Lower results were reported by Hassan and Afifi (2016), Kandil *et al*. (2018), Samir *et al*. (2018), Meshref *et al*. (2019) and Youssif *et al.* (2020), While the higher results carried by Ahmed *et al*. (2016), Edward *et al.* (2017), Elmaghraby *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 *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 *et al*. 2013).

S. aureus was detected in 5 (10%) with an average 1.37×10^7 CFU/ml, of the rice pudding, examined samples. The lower results were revealed by Hassan and Afifi (2016) and Hussein *et al*. (2015). Moreover, it was found in 6(12%) with an average 8.19×10^6 CFU/ml of the examined mahlabia samples. Higher results were obtained by Hussein *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 1.97×10^6 CFU/ml. These findings agreed with those recorded previously by Caglayanlar *et al*. (2009) and Youssif *et al.* (2020). The higher results were detected by Ali *et al*. (2001), Al-Gendi (2004), El-Malt *et al.* (2013), Abdel-Latif and Saad (2016) and Jawdat *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 9.81×10^6 CFU/ml, these results agreed with those shown by Al-Gendi (2004). In addition, in mahlabia samples, the average count of yeast was 7.09×10^5 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 2.0×10^2 , 6.50×10^6 and 1.04×10^6 CFU/ml, respectively. These results were nearly similar were mentioned by Youssif *et al*. (2020), while the higher results were detected by Ali *et al*. (2001), El-Malt *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 count1.0×10^2 , maximum count 4.0×10^6 and an average count 5.32×10^6 CFU/ml. The higher results were detected by Ali *et al*. (2001). While in mahlabia samples the incidence of mold was 64% with counts ranging from 1.0×10^2 to 4.0×10^6 CFU/ml with an average 7.40×10^6 CFU/ml in the examined mehallabia samples. The higher results were reported by Ali *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.

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