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## Influence of storage temperature and time on microbiological quality of birthday cakes

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Birthday cake containing milk or cream is a rich nutrient media for microbial growth. Microbial spoilage is the major problem causing deterioration in birthday cake. Time and temperature abuse are the primary factors responsible for harmful microbial accumulation and proliferation in food. In our research, the microbiological quality of birthday cake during storage at retail outlet in Soc Trang province (Vietnam) was examined. Birthday cake samples were kept in various temperature (4, 8, 12, 16, 20°C) and time (0, 4, 8, 12, 16 hours) to monitor the microbiological profile. Different microbial parameters such as total plate count, *Coliforms*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella*, and *Listeria monocytogenes* were analyzed. Our results revealed that that proper storage temperature and time were critical factors in ensuring the biological safety of birthday cake during storage at retail outlet. Birthday cake should not be stored over 4 hours at 8°C after making.

**Keywords:** Birthday cake, microbiological, retail outlet, storage temperature, time

### INTRODUCTION

Food poisoning is very urgent because it's always the main cause of foodborne disease outbreaks significantly impacting to the health of millions of people around the world (Ahmad et al., 2020). Food safety is presumably the ultimate goal in global public health care (Velusamy et al., 2010). Improper making, handling and distributing are major factors leading to low microbial food quality. Dirty hygiene manipulations, low hygiene of the utensils or equipments directly contacted to food surface have been directly related to food cross-contamination as well as the proliferation of pathogenic bacteria which ultimately cause food poisoning (Samara et al., 2014). Microbial spoilage has caused serious outbreaks of food poisoning (Smith et al., 2004).

Baked products are gaining popularity because of their availability, ready to eat convenience and reasonable good shelf life and taste (Chaudhari et

al., 2017). Microbiological spoilage by bacteria, yeast and molds is the concern in high moisture bakery products (Saranraj and Geetha, 2012). The pastry filling or topping may be more susceptible to microbial growth than the cereal product. Fillings supported the growth of spoilage bacteria (Sherif et al., 2018). Most cakes are normally laid out on shelves at room temperature rather than being stored in refrigerators (Jariyawanugoon, 2013; Chaudhari et al., 2017).

Birthday cake is one kind of ready-to-eat bakery products that are very popular all over the world. However, it is classified as a type of cake providing an excellent nutrient medium at high moisture content and neutral pH for different kinds of microorganisms to grow. In the present study, the microbial contamination of birthday cake (total plate count, *Coliforms*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella*, and *Listeria monocytogenes*) collected

from local street vendor in SocTrang province (Vietnam) was examined.

## MATERIALS AND METHODS

### Material

Birthday cakes were randomly collected from 9 shop stores in SocTrang province, Vietnam. After collecting, they must be stored in different time and temperature before being analyzed the microbial parameters.

### Researching method

Experiment #1: Birthday cakes were kept in different times (0, 4, 8, 12, 16 hours) at 4°C. Periodically, samples were analyzed total plate count (TPC), *Coliforms*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella*, and *Listeria monocytogenes*

Experiment #2: Birthday cakes were kept at different temperatures (4, 8, 12, 16, 20°C) in 4 hours. In each storage temperature, samples were analyzed total plate count (TPC), *Coliforms*, *Escherichia coli*, *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella*, and *Listeria monocytogenes*.

### Microbial analysis

Total plate count (cfu/g), *Coliforms* (cfu/g), *Escherichia coli*(cfu/g), *Staphylococcus aureus*(cfu/g), *Bacillus cereus*(cfu/g), *Salmonella*(cfu/g), and *Listeria monocytogenes*(cfu/g) were detected by 3M-Petrefilm.

### Statistical analysis

The experiments were run in triplicate with three different lots of samples. The data were presented as mean±standard deviation. Statistical analysis was performed by the Statgraphics Centurion version XVI.

## RESULTS AND DISCUSSION

### Effect of storage time to microbial load on the birthday cake

Birthday cakes were kept in different times (0, 4, 8, 12, 16 hours) at 4°C. It's clearly noticed that when the storage time increase to 4 hours, there was not significant difference of microbial load compared to the beginning. However if the storage time extended from 8 to 16 hours, there was significant accumulation of harmful bacteria on the birthday cakes (see table 1). Therefore, birthday cake should not be stored over 4 hours at 4°C after making.

High load of TPC might be owing to the poor personal hygiene of the food handlers. Walker et al. (2003) showed that the most common problems in the catering services were personal hygiene failures, cross-contamination, poor food handling and temperature abuse. *Coliforms* were used as a hygienic indicator. *E. coli* is a gram-negative, facultative anaerobic bacterium that belongs to the *Enterobacteriaceae* family and is one of the important causes of food poisoning (Licandro et al., 2013; Adenipekun et al., 2015). The existing of *coliforms* and *E. coli* in foodstuffs indicated that the food handlers' personal hygiene practice was poor and cross-contamination of utensils could happen in food making (Yousif et al., 2013). *Staphylococcus aureus* was a gram-positive, nonmotile, nonspore forming facultative anaerobe which was significant in food industries and causes a range of illnesses, especially foodborne diseases, via enterotoxins (Normanno et al., 2005; Argudin et al., 2010). *Staphylococcus aureus* was one type of bacteria known to contaminate pie fillings. *Staphylococcus aureus* was transferred from faecal-oral route or skin contact as well as the hygiene of kitchen surrounding and utensils (Bajzik et al., 2012). Ropiness which was the most important spoilage of bread after moldiness occurred particularly in summer when the climatic conditions favoured bacterial proliferation. It is mainly caused by *Bacillus* spp (Saranraj and Geetha, 2012). *Bacillus cereus* spores were thermal and acidic stability without being eliminated by normal sanitation or pasteurization Hence, the occurrence of *B. cereus* spores could survive during heating and germinate during keeping (Mosupye and Holy, 2000). A major source of *Bacillus* contamination was from the raw ingredients. Prevention of rope problems required strict sanitary as well as good manufacturing practices designed to control the spores of *Bacillus* species. *Listeria* spp. and *Salmonella* spp. were pathogenic bacteria not be allowed in foodstuffs. They could be infected from food handler improperly handled the food (Newell et al., 2010). Moreover, cake could be cross-contaminated in the preparation area from a contaminated egg hazards from *Salmonella* ingredient, particularly from a dried egg product. A wide range of contaminated foods was associated with *Salmonella* food poisoning, including eggs, milk and dairy products, cake mixes, cream-filling desserts and chocolate.

**Table 1: Effect of storage time (hours) to microbial load on the birthday cake**

Storage time (hours)	0	4	8	12	16
<b>TPC (10<sup>2</sup>cfu/g)</b>	1.1±0.2 <sup>d</sup>	1.2±0.1 <sup>d</sup>	3.8±0.2 <sup>c</sup>	5.7±0.1 <sup>b</sup>	7.6±0.3 <sup>a</sup>
<b>Coliforms (10<sup>1</sup> cfu/g)</b>	0.2±0.1 <sup>c</sup>	0.3±0.3 <sup>c</sup>	1.6±0.0 <sup>b</sup>	2.0±0.2 <sup>ab</sup>	2.8±0.1 <sup>a</sup>
<b>Escherichia coli (cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Staphylococcus aureus(cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Bacillus cereus (cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Salmonella (cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Listeria monocytogenes(cfu/g)</b>	N.D	N.D	N.D	N.D	N.D

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ( $\alpha = 5\%$ ). N.D: Not detected

**Table 2: Effect of storage temperature (°C) to microbial load on the birthday cake**

Storage temperature (°C)	4	8	12	16	20
<b>TPC (10<sup>2</sup>cfu/g)</b>	1.2±0.1 <sup>c</sup>	1.4±0.3 <sup>c</sup>	1.9±0.1 <sup>bc</sup>	2.6±0.0 <sup>b</sup>	4.7±0.2 <sup>a</sup>
<b>Coliforms (10<sup>1</sup> cfu/g)</b>	0.3±0.3 <sup>c</sup>	0.5±0.2 <sup>c</sup>	1.1±0.0 <sup>b</sup>	1.7±0.1 <sup>ab</sup>	2.5±0.0 <sup>a</sup>
<b>Escherichia coli (cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Staphylococcus aureus(cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Bacillus cereus (cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Salmonella (cfu/g)</b>	N.D	N.D	N.D	N.D	N.D
<b>Listeria monocytogenes(cfu/g)</b>	N.D	N.D	N.D	N.D	N.D

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ( $\alpha = 5\%$ ). N.D: Not detected

Bacteria can multiply rapidly on birthday cake at high temperature creating more high risk of food contamination (Houška et al., 2007).

#### Effect of storage temperature to microbial load on the birthday cake

Storage temperature played a dominant role in microbial proliferation. The storage temperature of birthday cake at the end of food supply chain which was in the retail outlets became important as it might affect the microbiological stability of the cake upon consumption. Birthday cakes were kept at different temperatures (4, 8, 12, 16, 20°C) in 4 hours. It's clearly noticed that at the storage temperature 4°C or 8°C, there was non-significant difference of microbial load. However at higher the storage temperature, there was significant accumulation of harmful bacteria on the birthday cakes (see table 2). Hence, birthday cake should not be stored over 4 hours at 8°C after preparation.

Noor et al. (2016) proved that chocolate cakes stored at room temperature spoiled about 3.5 times faster than storage at chill temperature. Mold and yeast contaminants also played major role in the spoilage of the baked products due to inadequate preparatory steps like cooling, slicing and transport (Shahbaz et al., 2013). Bioaerosols in human

breath expelled from the mouth might be a source of bacteria transferred to cake surfaces (Paul et al. 2017).

#### CONCLUSION

Birthday cake because of its ingredients is a suitable environment for growth and proliferation of microorganisms and microbial agents transmitted infection or food poisoning to consumers. Birthday cake is highly perishable and pose a potential public health risk if subjected to time and temperature abuse at any stage of its production, storage, distribution and marketing as well as its production under unhygienic conditions. In this research, In this study, different duration of storage was used for microbial observation at chill temperature. We have successfully demonstrated that storage temperature and time are the most efficient means to control microbial growth.

#### CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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### AUTHOR CONTRIBUTIONS

Minh Phuoc Nguyen arranged the experiments and also wrote the manuscript.

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