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Study On Retail Storage Temperatures Of Chocolate Cake In Meeting *Halalan-Toyyiban* Requirements

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Abstract

Storage temperature is one of the important requirements in *halalan-toyyiban* assurance pipeline for retailing. It is an important factor that affects the shelf life of a cake as to ensure the safety of the product upon consumption. Any foods that are hazardous to health upon consumption are considered not meeting the safety part (*toyyib*) in Islamic perspective. Hence the aim of this study was to evaluate the *halalan-toyyiban* status of the chocolate cake at retail storage with respect to chemical, microbiological and sensorial properties. Samples were stored at three different temperatures i.e. room temperature (25 ± 1°C), chilled temperature (4 ± 1°C) and frozen temperature (-18 ± 1°C), simulating the storage conditions at retail outlet. Chemical analyses were evaluated using Peroxide Value (PV) and Thiobarbituric Acid (TBA) tests while for microbiological analyses, total plate count (TPC) and yeast and mould count (YM) using petrifilm were conducted. As for sensorial evaluation, quantitative descriptive analysis (QDA) was performed on the chocolate cake samples. All analyses were conducted until the chocolate cake showed signs of spoilage either through microbiological, physical or chemical means. The results revealed that the proper storage conditions for all samples in meeting the *halalan-toyyiban* requirements with respect to chemical, microbiological and sensorial properties were ≤ 2 days at room temperature, ≤ 40 days at chilled temperature, and ≤ 300 days at frozen temperature.

Keywords: chocolate cake, storage temperature, retail, *halalan-toyyiban* requirements

Introduction

In general, retailing is the activity of selling of products and/or goods or commodities in small quantities directly to consumers. The importance of this retailing activity in preserving the *halalan-toyyiban* integrity of a product is emphasised in Part 3 of *Halalan-Toyyiban* Assurance Pipeline management requirements (MS 2400-3:2010). According to the standard, retail storage conditions such as temperature, which is one of the important requirements to

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ensure the integrity of products received, is not compromised, deteriorates or suffers loss or damage during the duration of storage.

Cakes are normally laid out on a shelf at room temperature rather than being stored in refrigerators when marketed. According to Food Hygiene Regulations (2009), a food handler shall not store, expose, or display for sale any food ready for human consumption in any food premises unless the food is adequately protected from contamination by using easily cleaned cabinet, display case, container, cover or other protective equipment, and system or device. Therefore, *halalan toyyiban* not only covers the contamination of *halal* product with non-*halal* items, but also the *toyyib* part which is the safety and wholesomeness aspect of the *halal* product. As mentioned in a number of Qur'anic verses: "O mankind! Eat of that which is lawful and good on the earth" [Surah Al Baqarah, 2:172]. "They ask you (O Muhammad SAW) what is lawful for them (as food). Say "Lawful unto you are At-Tayyibaat (all kind of *halal* foods) [Surah Al-Maidah, 5:4].

As stated in the MS 2400-3:2010, another element that is important is contamination by physical, chemical and biological contaminants which could render the goods to become non-*toyyib*. Thus, the storage temperature at retailing is considered as a *halalan-toyyiban* critical control point as the results may affects the *toyyib* status of the chocolate cake. Hence, the aim of this study was to assess the effects of storage temperature of chocolate cake on the storage stability of chocolate cake in terms of chemical, microbiological and sensorial properties, in meeting the *halalan-toyyiban* requirements.

Materials and Method

Materials

Three batches of JAKIM certified *halal* chocolate cakes without preservatives were purchased from a cake factory in Shah Alam, Selangor, Malaysia and were transported to the laboratory after being pre-stored in the cold room (0–5°C) for one day of post-processing. The weight of a mini heart shaped chocolate cake was

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80 g. All samples were stored at room temperature (25 ± 1°C), chilled (4 ± 1°C) and frozen temperature (-18 ± 1°C) simulating the real storage condition at retail market, prior to further analysis.

Experimental work of study

The analysis for cake samples which were kept at room temperature was conducted every two days. Meanwhile, for the chilled samples, the analysis was conducted every 20 days and for frozen samples, the analysis was conducted every 60 days. The number of days for the analysis of the three storage temperatures selected were based on our preliminary work of study. All the analysis was conducted until samples showed a sign of spoilage either through microbiological, physical or chemical means.

Determination of peroxide value

The peroxide value (PV) of samples was analysed according to the method described in the AOAC 965.33 method (AOAC, 2006).

Determination of thiobarbituric acid value

The thiobarbituric acid (TBA) test was determined according to the method described by Tarladgis et al. (1960).

Sample preparation for total plate count and yeast and mould count

A 25 g cakes from each batch was aseptically transferred into a sterile stomacher bag containing 225 ml Peptone Water (PW). The samples were homogenised in a Stomacher (Interscience- Bag Mixer 400) for 2 min. A ten-fold serial dilutions were prepared as required using 1 ml of homogenate and 9 ml of 0.1% PW (Siriken et al., 2009).

Determination of total plate count

Total plate count (TPC) was determined by using Petrifilm Aerobic Count plates following the AOAC 990.12 method (AOAC, 1994).

Determination of yeast and mould count

Yeast and mould count (YM) was determined by using Petrifilm YM plates based on AOAC 997.02 method (AOAC, 2000).

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Sensory evaluation

Samples were evaluated for sensory properties by a panel of trained judges. A 10-member trained panel participated in the descriptive analysis of the chocolate cake and the shelf life study. Panellists were trained for one month involving four training sessions. Meanwhile, chocolate cakes were prepared with different storage times and temperatures. After conducting discussions to reach a consensus, the panellists developed descriptive terms which included aroma, texture, mouthfeel, flavour, aftertaste and overall acceptability. For samples evaluation, panellists received four samples (3×3×3 cm^3) at each session. The panellists were seated in individual sensory booths and provided with distilled water to rinse between samples. All samples were coded with random three- digit numbers (Cheuamchaitrakun et al., 2011). Line scale of 15 cm was used for evaluating all attributes. Panellists indicated their judgments by placing a mark at any point on the line to indicate minor differences between samples that may have been grouped together under a category scale.

Statistical Analysis

All data were analysed using Statistical Package for Social Sciences (SPSS) IBM SPSS Statistics version 23 software. Analysis of variance (ANOVA) and Duncan's multiple range method was used to compare any significant differences between samples. Values were expressed as means ± standard deviations while differences were considered significant at $p< 0.05$. All analyses were carried out in triplicate.

Results and Discussion

Effect of storage temperature on storage stability

Rancidity indicates the storage stability of chocolate cake in which its parameters such as PV and TBA indicated the oxidation of fat resulting in off flavour of the cake. In the this study, all samples were considered not rancid and still acceptable as shown in Figure 1. The PV increased throughout storage period and the cake stored at room temperature maintained at PV <10 meq kg^{-1} which was 3.02 meq

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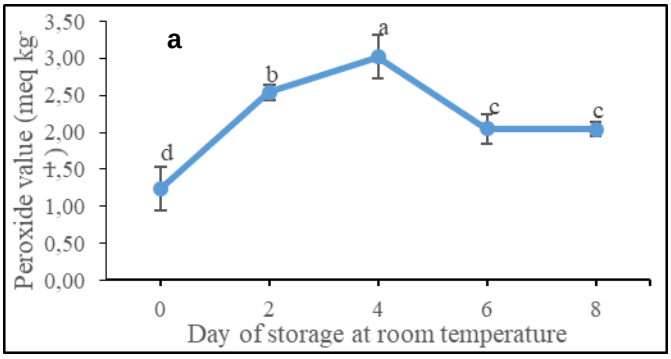
kg^{-1} (day 4) and decreased to 2.04 meq kg^{-1} (day 8). A study reported by previous researchers showed that the PV of a sponge cake also increased during storage period with 2.5 meq kg^{-1} on day 3 (Wu et al., 2013). The PV in the range of 10-20 meq kg^{-1}, of a food product is considered rancid but still acceptable, however, a value more than 20 meq kg^{-1}, is considered rancid and unacceptable to be consumed (Hafez, 2012).

The PV of the chocolate cake at chilled storage temperature increased gradually from 1.24 meq kg^{-1} (day 0) to 8.52 meq kg^{-1} (day 120) as shown in Figure 1 (b). Then, the PV drastically dropped to 6.92 meq kg^{-1} on day 140. This might due to the breakdown of hydroperoxides to volatile and non-volatile compounds (Seiza et al., 2006).

Seiza et al. (2006), reported that the PV increased with time to a maximum level after it decomposed rapidly to secondary products leading to a subsequent decrease in the PV. In addition, Figure 1 (c) shows significant difference of PV from day 0 until day 360 at a slower rate as compared to chill and room temperature storage. The PV showed significant increment from day 120 to day 360 (2.85 meq kg^{-1}); however it maintained within the range of acceptable level (less than 20 meq kg^{-1}) throughout the storage period.



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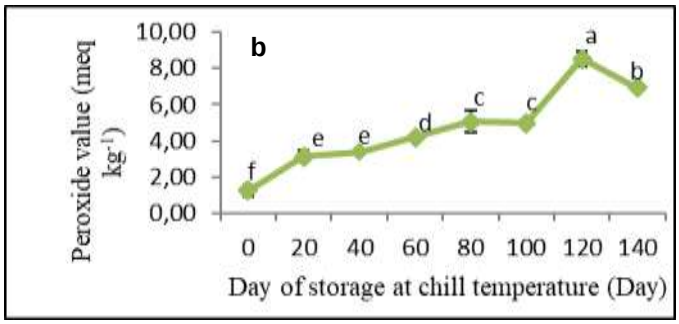

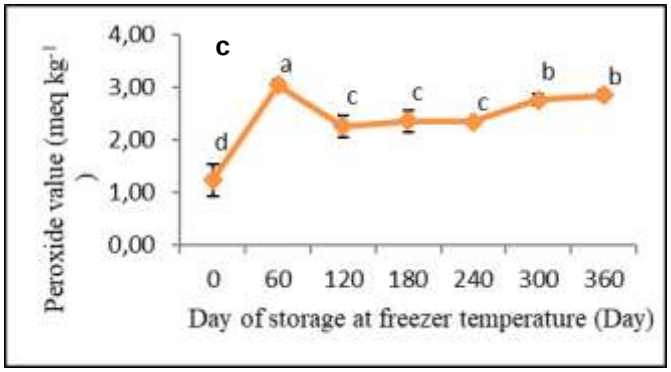

Figure 1. Changes in PV for Chocolate Cake Stored at Room (a), Chilled (b) and Frozen (c) Temperatures
Note: Different letter indicates significant difference $p<0.05$

Figures 2 shows changes in TBA values for chocolate cakes stored at three different storage temperatures (room, chilled, and frozen). The TBA values increased with time of storage for chocolate cake stored at room, chilled and frozen temperatures. It is due to the breakdown of primary fat oxidation product to secondary oxidation which produces rancid odour as reported by Rosari et al. (2014) and Fazilah et al. (2016).

Besides, the TBA values of chocolate cake stored at room temperature significantly increased ($p<0.05$) as shown in Figure 2 (a) with an initial value of 0.248 mg malonaldehyde/kg to 0.646 mg malonaldehyde/kg (day 8). Izzreen and Noriham (2011) also reported that TBA values of 0.70 mg malonaldehyde/kg (day 9) for cake stored at room temperature.

However, the TBA values for chocolate cake stored at chilled and frozen temperatures as shown in Figure 2 (b) and Figure 2 (c) were slightly increased

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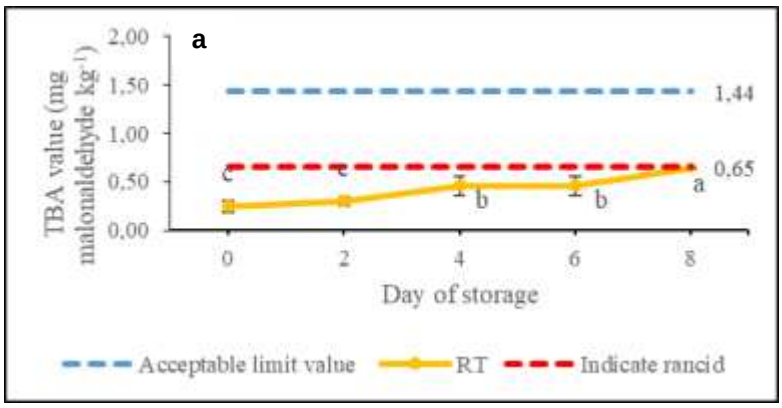
from 0.248 mg malonaldehyde/kg to 0.471 mg malonaldehyde/kg on day 140 (chilled storage) and from 0.248 mg malonaldehyde/kg to 0.661 mg malonaldehyde/kg on day 360 (frozen storage). Saxena et al. (2014) stated that most of the physical and chemical reactions decreased slower in temperatures during chilled or frozen storage, but they do not stop completely.

Studies conducted by Ibrahium, El-ghany, and Ammar, (2013) and Izzreen and Noriham, (2011) reported that TBA values lower than 0.576 mg malonaldehyde/kg sample are considered not rancid whereas the TBA values ranging from 0.65–1.44 mg malonaldehyde/kg sample are regarded as rancid but still acceptable and a product is consider rancid and unacceptable if the TBA value is greater than 1.5 mg malonaldehyde/kg sample. Thus, from our study, chocolate cake can only be stored at room temperature until day 6 as it turned rancid on day 8 while the cake stored at chilled temperature remained unrancid for 140 days. However, the study was stopped due to the microbial growth found on the cakes. As for the frozen temperature, the chocolate cake turned rancid from day 300 onwards.



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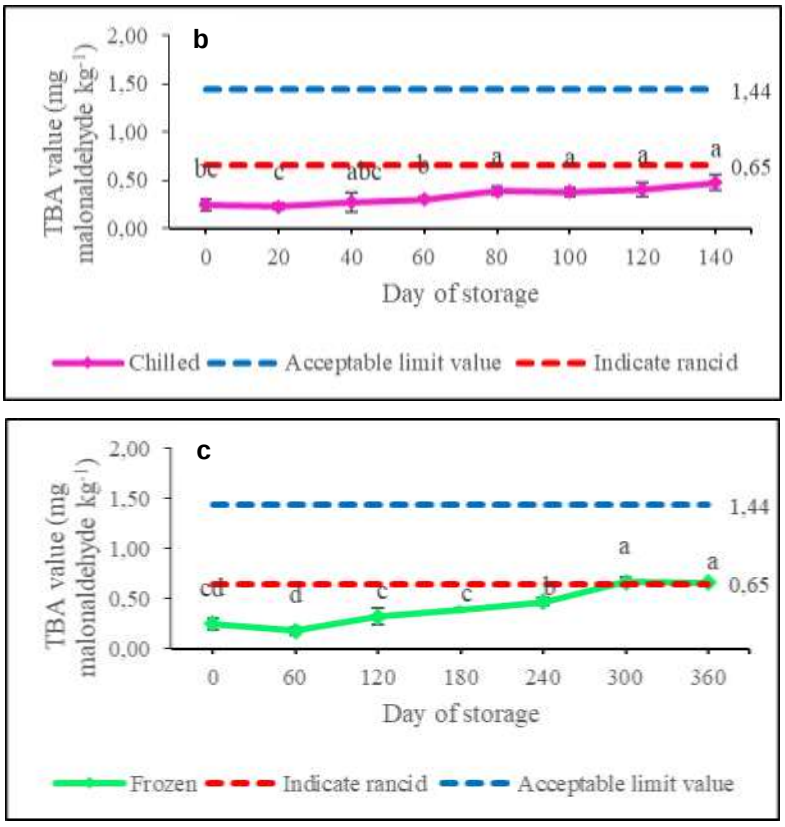

Figure 2. Changes in TBA for Chocolate Cake Stored at Room (a), Chilled (b) and Frozen (c) Temperatures

Note: Different letter indicates significant differences $p<0.05$

Effect of Storage Temperature on Microbiological Quality

Figure 3 (a) represents the results of TPC and YM of chocolate cakes during storage at room temperature simulating the storage condition at the retail outlet. The chocolate cakes stored at room temperature turn mouldy on day 4 of the storage through physical observation. Even though the early sign of mould growth on the chocolate cake was observed on day 4, the analysis was continued until day 8 in order to observe the trend of microbial growth. The TPC and YM increased from 2.95 $\log_{10}$ CFU/ g on day 0 to 4.44 $\log_{10}$ CFU/g on day 8 for TPC, while 2.41 $\log_{10}$ CFU/g on day 0 to 5.47 $\log_{10}$ CFU/g on day 8 for YM, respectively.

The increase in the microbiological count for chocolate cakes stored at room temperature (25°C-27°C) was detected because it fell under the danger zone (4.4 - 60ºC) temperature. Leaving food out too long at these temperatures can cause

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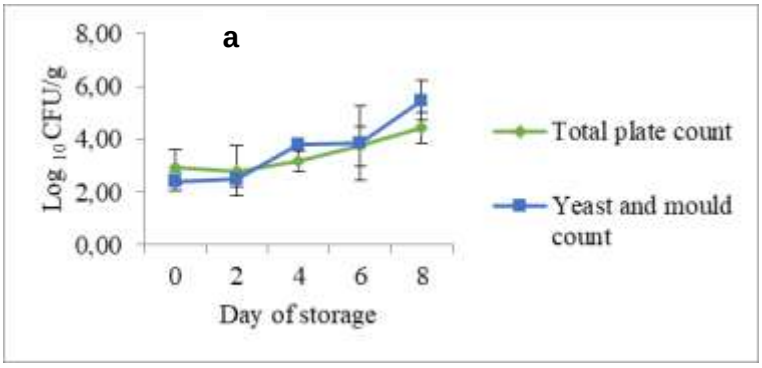
bacteria to grow to dangerous levels that can cause illness and doubling in number in as little as 20 mins (USDA, 2011).

The microbial count for chilled chocolate cakes simulating storage at retail outlet is shown in Figure 3 (b). The YM count increased from 2.41 $\log_{10}$ CFU on day 0 to 5.65 $\log_{10}$ CFU on day 140 exceeding the permissible values for TPC and YM count. The Institute of Food Science and Technology (IFST) reported about the microbiological specifications for cakes and pastries. It is stated that the maximum acceptable level for yeast was 5 $\log_{10}$ CFU and that for moulds was 4 $\log_{10}$ CFU (Carl, 2014). Besides, Food Standard Australia New Zealand (FSANZ) (2001) also stated the guidelines for the microbiological quality of ready to eat. It stated that food with values $\geq$ 5 $\log_{10}$ CFU is considered unsatisfactory level for TPC.

The TPC and YM count for chocolate cake at frozen storage is shown in Figure 3 (c). The TPC increased insignificantly to 3.59 $\log_{10}$ CFU and 2.72 $\log_{10}$ CFU for YM on day 300 then started to decrease on day 360. The declined in microbial count during storage could be due to ice crystal formation that damaged the cell wall of microorganisms leading to lysis of cell (Singh et al., 2014). Freezer temperatures just inactivate or inhibit bacteria from growing, but do not kill them (Abdulmumeen et al., 2012). Thus, the microbial count of chocolate cake at frozen storage was still under acceptable level even until 360 days of storage even though there were some physical defects (hardness and texture) as observed physically.



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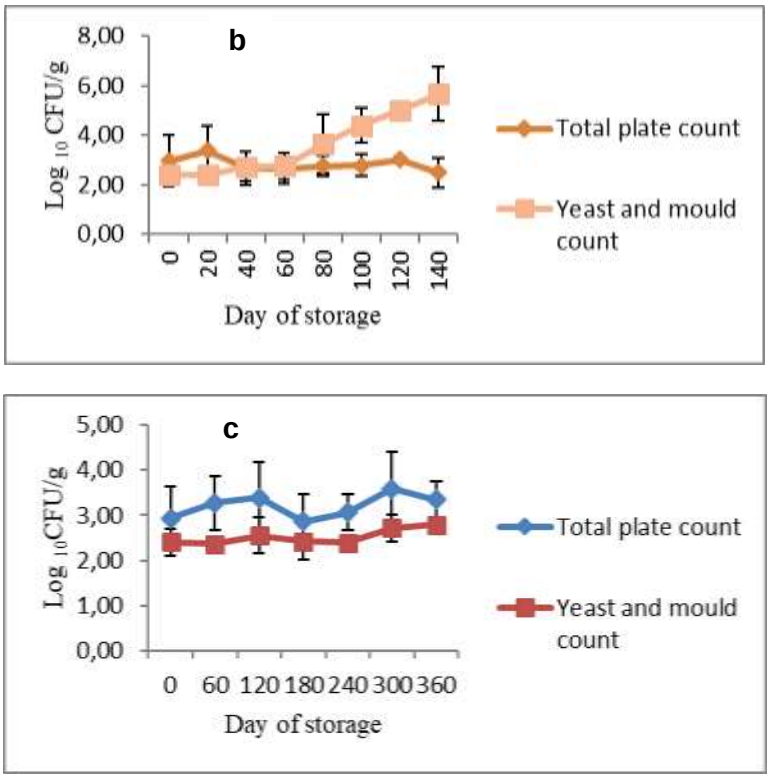

Figure 3. Microbial Count of Chocolate Cake Stored at Room (a), Chilled (b) and Frozen (c) Temperatures

Effect of Storage Temperature on Sensory Quality

The sensorial properties of the chocolate cake is shown in Figure 4 for 2 days of storage at room temperature, 40 days of storage at chilled temperature, and 300 days of storage at frozen temperature. The fresh sample (at day 0) was selected as the reference (R). Based on the spider web diagram, the overall acceptability of a fresh cake is the highest compared to the chocolate cakes stored at the three temperatures. Besides, the chocolate cakes stored at room temperature showed the highest mean score (more preferred) than the chocolate cakes stored at chilled and frozen temperatures. Mccurdy, Peutz, and Wittman (2009), stated that the quality of food will deteriorate with excessive frozen storage time but the safety is not compromised.

The results for aroma and flavour of the chocolate cakes at three storage temperatures also showed lower mean scores as compared to the fresh sample.

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The mean scores for the chocolate cakes at three storage temperatures showed almost moderate chocolate aroma. The chocolate cake stored at frozen temperature had the lowest mean score as it reached day 360 of storage compared to the other samples studied. This finding was supported by Cauvain (1998) who reported that the change was usually related to the loss of flavour and aroma of the bakery products throughout the storage period. Besides that, the result for mouthfeel of chocolate cakes stored at three storage temperatures (room, chilled and frozen) showed lower mean scores when compared to the fresh cake. The acceptability of the samples decreased as the moistness of chocolate cakes stored at these three storage temperatures reduced. A slight degree of hardening may occur due to moisture loss that is associated with the reduction of moistness (Lee, 2015). Thus, based on the results obtained, there is a relationship between sensorial properties with storage temperature of chocolate cakes at the retail outlet. Hence, from overall acceptability results, it can be concluded that the chocolate cakes from room temperature storage are acceptable within 2 days of storage while 40 days and 300 days for the cakes for chilled and frozen storage, respectively.

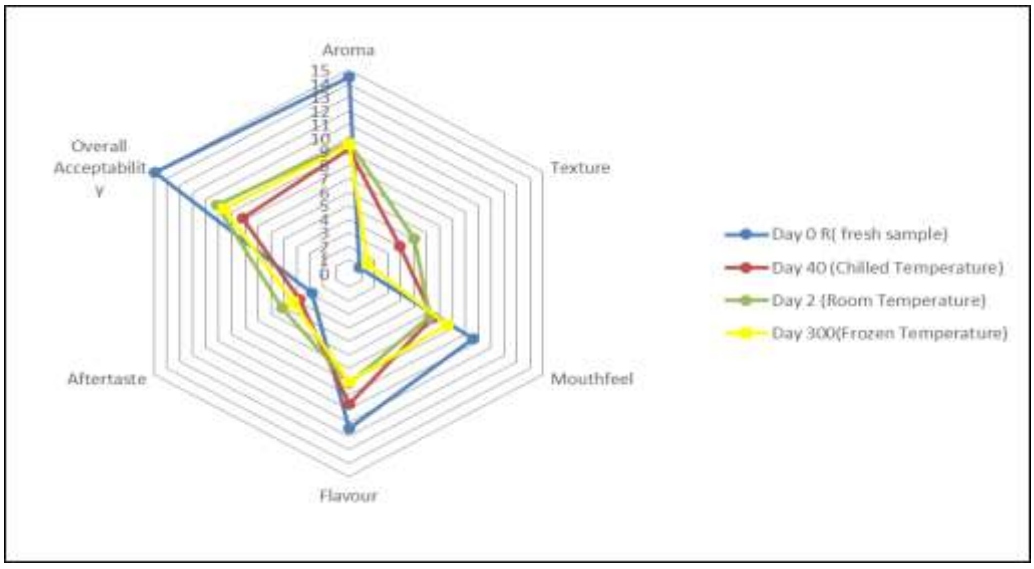

Figure 4 Sensory Attributes of Fresh Chocolate Cakes and Stored at Three Different Temperatures

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Halalan-Toyyiban Status of Chocolate Cake at Retail Storage

Hence from this study, the status of *halalan-toyyiban* was evaluated and summarised in Table 1. The chocolate cakes were not acceptable at room temperature (day 4) and chilled (day 140) storage temperature as they turned mouldy and microbiological count exceeding the permissible value and was therefore not safe to be consumed. As for the frozen chocolate cake, the count was found to be within the permissible value (safe) until 360 days of storage. Meanwhile, for detection of chemical hazards as indicated by PV and TBA values, all samples were found to be within the permissible limit for consumption. However, the analysis on the sensorial properties showed some decrement in quality on day 4 (room temperature), day 60 (chilled storage) and day 360 (frozen storage) for all samples. From this study it is suggested that the most appropriate storage period for chocolate cakes to comply *halalan-toyyiban* status in term of technical risks (*toyyib*) based on chemical, microbiological and sensorial properties at room temperature was within 2 days, 40 days at chilled storage and maximum of 300 days at frozen storage.

Table 1. Summary on *Halalan-toyyiban* Status of Chocolate Cake at Retail Storage

Critical Control Point	Storage Temperatures (°C)						
	Room (25 ± 1 °C)		Chilled (4 ± 1 °C)			Frozen (-18 ± 1 °C)	
	Day 2	≥ 4 days	Day 40	Day 60	≥ 120 days	Day 300	Day 360
Microbiological	√	×	√	√	×	√	√
Chemical							
PV	√	√	√	√	√		√
TBA	√	√	√	√	√	√	√
Physical							
Firmness	√	×	√	×	×	√	×
Sensory	√	×	√	×	×	√	×
Halal* status *(Shariatic)	√	√	√	√	√	√	√
***Toyyiban* status (Technical)**	√	×	√	√	×	√	√

Note: Sign (√) indicates acceptable while sign (×) indicates not acceptable

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Conclusion

The chocolate cakes, like many other processed foods, are subject to physical, chemical and microbiological spoilage which affects the *toyyib* aspect of the product upon storage at retail outlets. This study suggested the appropriate storage temperatures for chocolate cake in meeting *halalan-toyyiban* requirements were 2 days at room temperature, ≤ 40 days at chilled temperature and ≤ 300 days at frozen temperature.

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