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Development of sterilized durian cake roll

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Abstract The development of durian cake roll was investigated by using a sterilization process for extending its shelf life. The first study was reported the durian cream filling with the sterilized conditions of 121℃ for 15 minutes. Two types of commercial modified starch (SMS and SPF) were studied with concentrations of 6, 8 and 10% to improve the quality of the sterilized durian cream filling. The increased concentrations of both modified starches caused to increase firmness in cream. Sensory evaluation showed higher liking score on odor, taste and overall acceptance in cream with SMS modified starch than the control. The durian cake roll was improved by three hydrocolloids with different concentrations (Hydroxypropyl methylcellulose 0.8, 1.0%, Carboxymethyl cellulose 0.5, 1.0%, Xanthan gum 0.5 and 1.0%) and improved the sterilized durian cake roll. CMC of 1.0 % affected higher liking score on taste, texture and overall acceptance than trhe control which significantly lowest hardness on texture measurement. The change of durian cake roll was stored at 35 and 55℃ for four weeks. Result showed that the tendency of increase in hardness and decrease in springiness of sterilized durian cake roll when kept in storage with temperature and time. Microbiology analysis using total plate count and yeast and mold count of both storage at 35 and 55℃ for four weeks were lower than 1 x 10^1 CFU which requires for Thai regulated standard.

Keywords: Durian cake, Hydrocolloids, Modified starch, Sterilization, Longer shelf life

Introduction

Cake roll is a type of sponge filled with whipped cream, jam or icing and is a the popular desserts that has many flavours including vanilla, chocolate and coffee. Nowadays, the trend is for bakery products to be more healthy and one method of helping to achieve this trend is to include fresh fruit including strawberry, raspberry and blueberry for decoration or for inclusion in the mixture. Tropical fruit in Asian countries could also be used in developing new bakery products. Durian (*Durio zibethinus*), which is an Asian tropical fruit that has a shelf-life of up to 3 weeks at ambient temperatures, depending on their harvest maturity (Thompson, 2015), has a unique odour and flavour. In Southeast Asia, durian has been called "King of Fruit" and it is very popular in

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Thailand and other countries. Also fresh durians are a major exported from Thailand (Pinsorn *et al.*, 2018). Therefore, durian is condidered to be a prospected tropical fruit to be used in cake rolls.

Bakery products face deterioration due to physical and chemical changes and microbial spoilage (Sangsawang, 2004). Microbial spoilage is the main factors that limit the shelf-life of bakery product that might be caused by many factors, for example, packaging, sanitary practise in manufacturing and storage conditions (Saranraj and Geetha, 2012). Some bakery products were found to be almost always contaminated with microorganism such as *Staphylococcus aureus* (Stewart *et al.*, 2003). Cake rolls have a cream filling that is more perishable than the cake. In order to increase the shelf life of many bakery products some manufacturers have used chemical food additives that can prevent microbial or enzymatic deterioration (Vaclavik and Christian, 2014). For example propionic and sorbic acids have been shown to extend the shelf life of a variety of bakery products (Membré *et al.*, 2001; Sofos and Busta, 1981). Guynot *et al*. (2002) reported that using weak acid preservatives such as potassium sorbate, calcium propionate and sodium benzoate were effective in preventing *Aspergillus nier, A. flavus* and *Penicillium corylophilum* spoilage in sponge cake. Potassium sorbate was found to be a suitable preservative for sponge cake with a combination of common levels of pH and water activity. However, chemical food additives can be harmful to health (Özay and Özyıldırım, 2017) and increasingly people tend to avoid chemical addatives.

An alternative to chemical addatives for prolonging the shelf life of bakery products is thermal processing. Thermal sterilization has been used to extend the shelf-stable in canned foods (Albaali and Farid, 2006) after which is sealed in the container, a method that has been used for well over 100 years and is accepted throughout the world (Teixeira and Tucker, 1997). The canning process relies on heat treatment for the destruction of microorganisms and preservation of the food (Pither, 2003). Canned food continues to be popular due to its convenience and long shelf-life. (Durance, 1997). The temperature and duration of treatment are depent on the chemical and physical composition of the product (Pither, 2003). In general, temperatures in range of 116–121 ℃ are used for canning, that will destroy microorganisms (Vaclavik and Christian, 2014).

Regarding the effects of high temperature on both physical and chemical products during processing and storage important factors to consider include sensory properties and nutrient content in order to ensure that the processed product is acceptable (Pither, 2003). Hydrocolloids could be considered as a solution to some unacceptable attributes. Hydrocolloids have wide application in a food products such as ice-cream, dairy products and bakery products for improving

functional properties such as a thickening agent, gelling agents, emulsifiers and stabilizers. Hydrocolloids are useful for improving rheology and texture of aqueous suspensions (Dziezak, 1991). The addition of hydroxypropyl methylcellulose, xanthan gum and alginate improved overall sensory qualities of cake (Gómez *et al*., 2007). Modified starch can also be also used for improving the textural properties of cake or cake fillings. Shi and Bemiller (2002) reported that modified starch had many functions including the improvement of texture, moisture and water mobility of food products.

The objective of this study was therefore to develop the shelf-stability of durian cake rolls using the sterilization processes, including the effects of modified starches on the properties of the durian cream filling and |the effects of hydrocolloids to improve the durian cake. To achieve these objectives the changes in quality of sterilized durian cake rolls will be monotored during storage at both 35 and 55 ℃ for four weeks.

Materials and methods

Materials used were: wheat flour (United Flour Mill Public Co., Ltd.), durian flavour (Greathill Co., Ltd.), modified starch (Siam Modified Starch Co., Ltd. and Special Food Co., Ltd.), xanthan gum (Chemipan Corporation Co., Ltd.), carboxymethyl cellulose, hydroxypropyl methylcellulose (Bronson & Jacobs, Thailand) and freeze-dried durian (Talaysub Freeze Dry Co., Ltd.) all obtained locally.

The recipe used for the durian cream filling was: sugar (50g), milk (250g), whole eggs (15.6g), butter (25g), durian flavour (5g). Two different types of modified starch (SMS and SPF) with three concentrations (6, 8 or 10% of total weight: SMS 6, SMS 8, SMS 10, SPF 6, SPF 8 and SPF 10) for stability of the fillings after sterilization. All ingredients, except durian flavour, were mixed in a pan at moderately heat with continuous stirring for 8 mins until it thickened, durian flavour was added before cooling to 30 ℃.

The durian cake recipe was: wheat flour (225g), egg (270g), sugar (1) (170g), sugar (2) (120g), milk (200g), soybean oil (100g), durian powder (25g), durian flavor (8.4g), salt (4.6g) and cream of tartar (9.2g). Three hydrocolloids, each at two levels, added as a percentage of flour weight, hydroxypropyl methyl cellulose at 0.8 or 1.0% (HPMC 0.8, HPMC 1.0), carboxyl methyl cellulose at 0.5 or 1.0% (CMC 0.5, CMC 1.0) and xanthan gum at 0.5 or 1.0% (XG 0.5, XG 1.0). The cake was mixed by combining milk, oil, egg yolk, sugar (1), salt, durian powder and flour with baking powder in a mixer for 2 mins at medium speed 1. In another mixing bowl, egg white and cream of tartar were whisked using the highest speed for 1 min, then sugar (2) was added and further whisked for 1½ mins to

obtain a stiff egg white foam. Mixture 1 was gradually added to the egg white foam and mixed gently at medium speed for 2 min until well blended. The final cake batter was placed in an aluminium tray (20x30x4cm) for baking in an electric oven at 180 ℃ for 12 mins, then, cooled to 30 ℃. The durian cream filling was spread over the top of the cake, rolled and then cut into 6cm diameter pieces.

100g of cream filling or 5x8cm sections of durian cake were placed into glass bottles (diameter 6cm x height 10cm), the air was exhausted and sterilized by autoclave at 121 ℃ for 15 mins and then analyzed for colour and texture. 5x8cm sections of the sterilizing durian cake rolls, with different types and amounts of hydrocolloids, were sterilized in the same way. Their moisture content and sensory characteristics were analysed. The sterilized durian cake roll was stored at 35 or 55 ℃ and changes in microbial level, moisture content, colour and texture were analysed at weekly intervals each week for 4 weeks.

Moisture content of sterilized durian cake rolls was measured according to AOAC (2000) where they were homogeneous in a blender and about 3g were weighed into aluminium cans placed in an oven at 105 ℃ for 3 hrs cooled in desiccators and reweighed.

Colour was measured, using a chroma meter (CR-400 Minolta, Japan) identifying colour differences using CIE *L*a*b** values at three different regions on the surface of the cake and cream filling.

Texture measurement was by a texture analyser (TA-XT plus, England) with 5 kg load cell at a pre-test speed of 1.5 mm s^{-1}, a test speed of 1.0 mm s^{-1} and a post-test speed of 10.0 mm s^{-1} at distance of 5 mm, for determining the maximum force required. The cream fillings were placed in the glass bottles using a 1/2 inch diameter cylinder was used to measure its firmness (maximum force) and the durian cake, they were cut into a dimension of 2 cm and 1.5 cm of height pieces and tested with a 50 mm aluminium cylindrical probe for hardness and springiness.

Sensory analysis was carried out by 80 untrained panellists who were served six different samples of sterilized durian cream fillings for evaluation of colour, odour, taste, texture and overall liking with using 5-point hedonic scale.

For microbial analysis, 25g of durian cake rolls were weighed and Butterfield's phosphate buffer added and diluted in 225 mL water and put in stomacher bag and mixed in a stomacher machine. The total plate count used plate count agar and yeast and mould count used potato dextrose agar and were analyzed according to AOAC (2000).

For statistical analysis three replications of all measurements were recorded as mean standard deviations. The experimental design, except sensory analysis, was a completely randomized design and for sensory analysis a

randomized complete block design. Analysis of Variance and Duncan's New Multiple Range Test (significant at $p<0.05$) were used to determine a significant difference using SPSS (IBM SPSS Statistics 20.0).

Results

Improving the sterilized durian cream filling by using two types and three concentrations of commercial modified starches

Two types of commercial modified starch, SMS and SPF were studied with concentrations of 6, 8 and 10% to improve the quality of sterilized durian cream filling. The properties of durian cream filling with modified starch after sterilization process were shown in Table 1. Moisture content and colour of durian cream filling were not significant different ($p\geq0.05$) in all samples. Its firmness tended to increase significantly when adding more concentration of both modified starches. The SPF modified starch showed a tendency of more firmness of cream filling at a lower concentration.

For the sensory evaluation shown in Table 2, the liking score of colour and texture of durian cream filling were not a significant difference ($p\geq0.05$). The overall acceptance, odour and taste liking score of durian cream filling with SMS 6% was the highest. However, our preliminary experiment when storage in the long term, the durian cream filling with SMS 6% was not stable. Therefore, SMS 10%, which obtained a higher score comparing to others was chosen for making durian cream filling for durian cake roll in further study.

Table 1. The properties of sterilized durian cream filling using two different types of modified starches

Sample	Moisture content^{ns} (%)	Colour^{ns}			Firmness (g.F)
		L*	a*	b*	
SMS 6	38.38 ± 0.12	67.01 ± 0.82	0.71 ± 0.14	17.53 ± 1.17	47.55^{a} ± 6.35
SMS 8	39.39 ± 0.11	67.57 ± 0.61	0.87 ± 0.51	16.68 ± 0.69	73.58^{bc} ± 2.84
SMS 10	38.59 ± 0.24	66.46 ± 4.24	0.74 ± 0.04	19.52 ± 3.17	80.76^{cd} ± 4.33
SPF 6	38.93 ± 0.18	67.43 ± 1.31	0.70 ± 0.30	19.31 ± 1.93	66.51^{b} ± 8.49
SPF 8	38.59 ± 1.58	69.11 ± 2.97	0.73 ± 0.11	19.55 ± 1.80	72.72^{bc} ± 2.54
SPF 10	38.56 ± 1.65	67.86 ± 2.25	0.78 ± 0.17	18.51 ± 2.74	89.24^{d} ± 0.89

^{a,b,c} The difference letters in each column indicated a significant difference ($p<0.05$);
^{ns} The same letters indicate no significant differences ($p\geq0.05$).

Table 2. The sensory evaluation of sterizied durian cream filling using two different types of modified starches (n=80, 5 - point hedonic scale)

Sample	Colour[ns]	Odour	Taste	Texture[ns]	Overall acceptance
SMS 6	3.78 ± 0.95	3.75[c] ± 0.67	3.70[b] ± 0.91	3.45 ± 1.04	3.70[b] ± 0.97
SMS 8	4.00 ± 0.96	3.35[ab] ± 0.89	3.48[b] ± 0.91	3.50 ± 0.85	3.52[b] ± 1.01
SMS 10	4.08 ± 0.86	3.70[ab] ± 0.94	3.55[b] ± 0.91	3.50 ± 1.01	3.68[b] ± 0.89
SPF 6	3.83 ± 0.90	3.55[bc] ± 0.71	3.35[ab] ± 0.89	3.45 ± 1.08	3.50[b] ± 0.91
SPF 8	4.03 ± 1.00	3.35[ab] ± 1.01	3.48[b] ± 0.96	3.57 ± 1.06	3.30[ab] ± 0.76
SPF 10	3.68 ± 0.94	3.15[a] ± 0.86	3.03[a] ± 0.95	3.52 ± 1.24	3.10[a] ± 0.84

[a,b,c] The difference letters in each column indicated a significant difference ($p<0.05$);
[ns] The same letters indicate no significant differences ($p\geq0.05$).

Improving the sterilized durian cake roll by using three types and two concentrations of hydrocolloids

Improving the durian cake after sterilization process using three types of hydrocolloids with two concentrations were studied with two concentrations. Table 3 showed the properties of durian cake after the sterilization process. The moisture content increased significantly when adding more hydrocolloids. Xanthan gum of 1.0% showed the tendency of the highest moisture content. The L*of durian cake with xanthan gum of 1.0% shows highest. The redness and yellowness of durian cake with CMC of 1.0% is highest. The hardness of durian cake roll with CMC was the significantly lowest ($p<0.05$). Springiness of all samples were not significantly different ($p\geq0.05$).

The sensory evaluation of sterilized durian cake roll with the tested hydrocolloids shown in Table 4, durian cake with CMC of 0.5% had the highest score in colour and odour while, durian cake with CMC of 1.0% had the highest score in taste, texture and overall acceptance. Therefore, durian cake roll with CMC of 1.0% was chosen for further study the change of durian cake roll during storage.

Table 3. The properties of sterilized durian cake roll with three types and two different levels of hydrocolloids

Sample	Moisture content	Colour			Hardness	Springiness[ns]
	(%)	L*	a*	b*	(g.F)	
HPMC 0.8	59.97[a] ± 0.42	78.56[ab] ± 0.72	1.42[a] ± 1.06	28.44[ab] ± 1.75	883.47[c] ± 68.75	0.97 ± 0.01
HPMC 1.0	61.18[b] ± 0.07	77.49[ab] ± 3.40	0.53[a] ± 1.07	25.71[a] ± 1.71	719.60[b] ± 91.96	0.95 ± 0.02
CMC 0.5	61.29[b] ± 1.07	78.53[ab] ± 0.52	0.86[a] ± 0.40	27.88[a] ± 2.33	556.43[a] ± 16.42	0.96 ± 0.03
CMC 1.0	63.30[c] ± 0.29	76.03[a] ± 1.34	3.10[b] ± 1.24	31.88[b] ± 1.74	540.54[a] ± 82.42	0.95 ± 0.01
XG 0.5	61.50[b] ± 0.10	79.00[ab] ± 0.54	0.62[a] ± 0.78	26.00[a] ± 2.17	638.77[ab] ± 18.21	0.97 ± 0.01
XG 1.0	64.74[d] ± 0.36	79.58[b] ± 1.48	1.04[a] ± 0.75	27.86[a] ± 2.73	605.76[a] ± 117.96	0.95 ± 0.02

[a,b,c] The difference letters in each column indicated a significant difference ($p<0.05$);
[ns] The same letters indicate no significant differences($p\geq0.05$).

Table 4. The sensory evaluation of sterilized durian cake roll with three types and two different levels of hydrocolloids (n=80, 5 - point hedonic scale)

Sample	Colour	Odour	Taste	Texture	Overall acceptance
HPMC 0.8	2.8[a] ± 0.97	2.63[a] ± 1.17	2.98[a] ± 1.07	3.0[a] ± 1.34	2.80[a] ± 0.88
HPMC 1.0	3.85[b] ± 0.98	3.15[b] ± 0.98	3.33[ab] ± 1.07	3.3[ab] ± 1.06	3.22[b] ± 0.95
CMC 0.5	4.05[b] ± 0.88	3.28[b] ± 1.11	3.23[ab] ± 0.83	3.35[ab] ± 0.92	3.28[b] ± 0.85
CMC 1.0	3.18[a] ± 1.45	3.18[b] ± 1.34	3.55[b] ± 1.01	3.48[ab] ± 1.09	3.63[b] ± 1.15
XG 0.5	3.18[a] ± 1.11	3.15[b] ± 0.86	3.23[ab] ± 1.03	3.38[ab] ± 1.08	3.28[b] ± 1.09
XG 1.0	3.88[b] ± 1.04	3.30[b] ± 1.07	3.40[ab] ± 1.22	3.33[b] ± 1.02	3.30[b] ± 0.99

[a,b,c] The difference letters in each column indicated a significant difference ($p<0.05$);
[ns] The same letters indicate no significant differences ($p\geq0.05$).

Table 5. The properties of the improved the sterilized durian cake roll during storage at 35 ℃ for four weeks

Week	Moisture content[ns]	Colour			Hardness	Springiness[ns]
	(%)	L*[ns]	a*	b*[ns]	(g.F)	
1	62.60 ± 0.87	81.72 ± 6.52	0.17[ab] ± 1.04	26.84 ± 0.96	645.24[a] ± 59.29	0.96 ± 0.01
2	63.04 ± 2.11	78.53 ± 0.52	0.18[ab] ± 0.60	25.97 ± 0.54	647.06[a] ± 7.22	0.95 ± 0.03
3	62.48 ± 0.56	79.32 ± 0.81	0.86[b] ± 0.39	25.13 ± 1.21	754.70[b] ± 27.79	0.93 ± 0.02
4	61.65 ± 0.87	76.66 ± 2.49	1.08[a] ± 0.13	24.86 ± 1.99	758.10[b] ± 20.80	0.94 ± 0.02

[a,b,c] The difference letters in each column indicated a significant difference ($p<0.05$);
[ns] The same letters indicate no significant differences ($p\geq0.05$).

Table 6. The properties of the improved the sterilized durian cake roll during storage at 55 ℃ for four weeks

Week	Moisture content[ns]	Colour			Hardness	Springiness
	(%)	L*	a*	b*[ns]	(g.F)	
1	62.39 ± 8.19	76.03[c] ± 1.35	3.09[a] ± 1.24	31.88 ± 1.75	653.08[a] ± 61.64	0.97[d] ± 0.01
2	61.50 ± 0.08	67.52 [b] ± 4.48	7.55[b] ± 3.25	32.02 ± 2.81	767.57[a] ± 54.99	0.89[c] ± 0.01
3	58.84 ± 3.84	59.32[a] ± 3.71	10.47[b] ± 2.37	29.63 ± 1.03	947.69[b] ± 44.00	0.68[b] ± 0.01
4	58.29 ± 0.09	58.20[a] ± 3.04	10.92[b] ± 0.86	30.01 ± 1.88	1084.25[c] ± 80.39	0.57[a] ± 0.02

[a,b,c] The difference letters in each column indicated a significant difference ($p<0.05$);
[ns] The same letters indicate no significant differences ($p\geq0.05$).

The change for improving the sterilized durian cake roll during storage at 35 and 55 ℃ for four weeks

Durian cake roll was stored at 35 and 55 ℃ for four weeks and analyzed the properties every week, The microbial analysis using total plate count and yeast and mould count of durian cake roll both stored at 35 and 55 ℃ for 4 weeks storage were lower than 1 x 10^1 CFU. This range of microbial analysis was within the Thai Community Product Standard (TCPS) for cakes (TCPS 459/2555).

The result in Table 5 showed that the moisture content of durian cake roll kept at both storage temperature was not significant different ($p \geq 0.05$). The lightness of durian cake roll decreased at both storage temperature whole 4 weeks. The remarkable change of lightness appered in the longer stoage time and higher temperature. The sterilized durian cake roll turned into more redness (a*) at higher storage temperature and longer storage time. Hardness of sterilized durian cake roll increased significantly ($p < 0.05$) by more storage time. The hardness of the durian cake roll kept in the accelerated temperature (55 C°) was harder than that kept at 35 ℃. The springiness of durian cake roll kept at 35 ℃ was not significantly different ($p \geq 0.05$) however it apparently decreased at 55 ℃ storage.

Table 7. The microbial analysis for improving the sterilized durian cake roll during storage at 35 and 55 ℃ for four weeks

Storage temperature (℃)	Week	Total plate count (CFU)	Yeast and mould count (CFU)
35 ℃	1	< 1 x 10^1	< 1 x 10^1
	2	< 1 x 10^1	< 1 x 10^1
	3	< 1 x 10^1	< 1 x 10^1
	4	< 1 x 10^1	< 1 x 10^1
55 ℃	1	< 1 x 10^1	< 1 x 10^1
	2	< 1 x 10^1	< 1 x 10^1
	3	< 1 x 10^1	< 1 x 10^1
	4	< 1 x 10^1	< 1 x 10^1

[a,b,c] The difference letters in each column indicated a significant difference ($p<0.05$);
[ns] The same letters indicate no significant differences($p \geq 0.05$).

Discussion

Improving the sterilized durian cream filling by using two types and three concentrations of commercial modified starches

Two types of commercial modified starch SMS and SPF were studied with concentrations of 6, 8 and 10%. Table 1 shows the properties of durian cream filling with the two modified starch after the sterilization process. The

result showed that the hardness of durian cream filling increased when adding more modified starch. It might be caused by SMS which was distarch phosphate, a cross-linking modified starch. It can improve texture properties of starch. The hydrogen bonds in the granule with chemical bonds act as bridges between molecules (Yook *et al*., 1993). Rutenberg and Solarek (1984) mrntioned that cross-linked starches were resistant to high temperature and increase strength of starch. For SPF, a modified starch from hydroxypropyl distarch phosphate is a starch that modified by a combination of substitution and cross-linking methods (Kishida *et al*., 2001). Both of the two modified starch were modified by cross-linking, which could modify the firmness of durian cream filling in this study. However, SMS with 10% concentration corroborated better qualities of durian cream filling than that of SPF.

Improving the sterilized durian cake roll by using three types and two concentrations of hydrocolloids

Three types of hydrocolloids with two concentrations were studied to improve the durian cake after the sterilization process. Table 3 shows the properties of durian cake roll after the sterilization process. Their moisture content increased when adding more hydrocolloids due to hydrocolloids have a large number of hydroxyl groups which can bind water molecules (Saha and Bhattacharya, 2010). Therefore, the hardness of the sterilized cake roll decreased when adding more hydrocolloids. Mezaize *et al.* (2009) also reported that adding hydrocolloids in bakery product led to softer than that of the control (no-added hydrocolloids). For the sensory evaluation of sterilized durian cake roll with the studied hydrocolloids after sterilization process shows in Table 4. Durian cake roll with CMC of 0.5% had the highest score in colour and odour. The sterilized durian cake roll with CMC of 1.0% had the highest score in taste, texture and overall acceptance. According to Ranjbar *et al.* (2012) and Mohammadi *et al*. (2014) who reported that adding CMC in bakery products could improve their sensory properties such as taste and overall linking score. This also agreed with BeMiller (2019) who stated CMC was used in food products to absorb and hold water, to increase shelf-life, and to provide desired texture.

The change of improved sterilized durian cake roll during storage at 35 and 55 ℃ for four weeks

The improved sterilized durian cake roll was stored at 35 and 55℃ for four weeks and analyzed the properties every week. The microbial analysis using total plate count, yeast and mould count of durian cake roll stored at both 35 and 55℃ for four weeks storage was lower than 1 x 10^1 CFU which is within the Thai Community Product Standard (TCPS) for cakes (TCPS 459/2555). It could be explained that the sterilization processed at 121 ℃ for 15 min can destroy food spoilage and pathogen microorganisms which, are

harmful to consumer health (Vaclavik and Christian, 2014). Besides durian cake roll was kept in an airtight glass container that no air can leave or enter into the container.

In Table, the moisture content of sterilized durian cake roll decreased remarkably at 55 ℃ storage especially in storage time of week 3-4. This indicated that the moisture content migrated from the cake crumb which happened more in the higher storage temperature and longer time. For the lightness and yellowness of cake roll decreased but the redness increased exhibited more changes in the higher storage temperature and time, it might be caused by the Millard reaction, which is enhanced by heating (Hedegaard and Skibsted, 2013). Regardings the change of hardness shown in Table 5. Hardness of sterilized cake roll increased with more storage time and the higher storage temperature. In addition, the springiness of the sterilized cake roll drasticly decreased in cake kept at 55 ℃. This might be the impact of the moisture migration from the cake crumb which resulted in the more hardness in cake roll (Wilderjans *et al.*, 2013).

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