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APPENDICES

APPENDIX A

RECIPE

Table A.1 Recipe of custard cream (Suan Dusit International Culinary School, 2006)

	Amount (% weight) in recipe	
Ingredients	Basic	Adjusted
Egg	21.7	25.0
Evaporated milk	16.4	18.8
Sugar	26.2	15.1
Reversed osmosis water	11.8	13.6
Wheat flour	8.6	9.9
Butter	8.6	9.9
Skimmed milk powder	3.3	3.8
Corn flour	2.6	3.0
Vanilla flavour	0.8	0.9

Table A.2 Recipe of Chinese steamed bun (Suan Dusit International Culinary School, 2006)

Ingredients		Amount (% weight) in basic recipe
First step	Cake flour	38.3
	Reversed osmosis water	19.7
	Sugar	3.3
	Yeast	1.6
Second step	Cake flour	16.4
	Sugar	8.0
	Reversed osmosis water	6.6
	Shortening	3.3
	Cakes emulsifier	1.5
	Baking powder	1.1
	Salt	0.4

APPENDIX B

ANALYTICAL METHODS

B.1 Water activity (a_w)

The a_w of the samples were measured using water activity analyzer (AQUA LAB, model Series 3TE, U.S.A.). Samples of steamed bun or custard cream were put and spread in disposable sample cup. In case of steamed bun, it was crushed, sliced, or ground before putting in the sample cup. Turn the sample drawer knob to the OPEN/LOAD position and pull the drawer open. Place your prepared sample in the drawer. Check the top lip of the cup to make sure it is free from sample residue. Carefully slide the drawer closed. Turn the sample drawer knob to the READ position to seal the sample cup with the chamber. This would start the read cycle. When the instrument has finished its read cycle, the a_w is displayed on the LCD (Fig B1), accompanied by the LED flash and beeper. The measurements were done in triplicate.

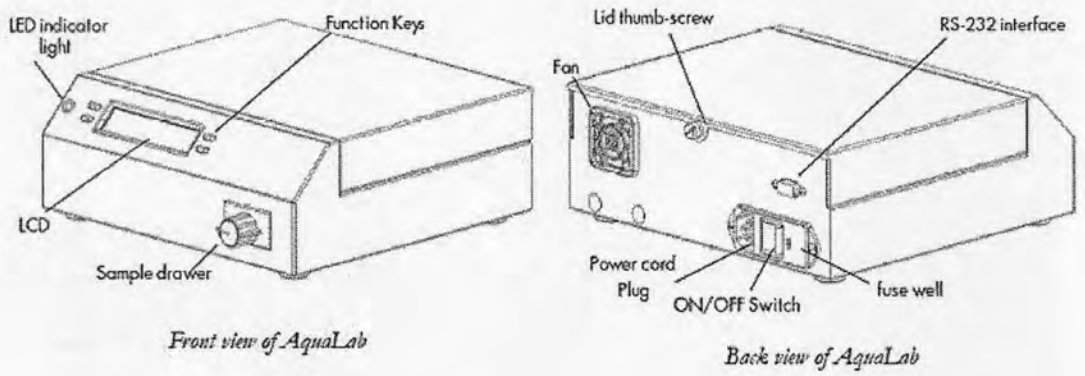


Figure B.1 AQUA LAB, model Series 3TE features

B.2 pH

pH of the samples were measured using pH-meter (Eutech, model Cyberscan pH100 Bench, Singapore). Samples of steamed bun were diced into 2 cm cubes. Turn the meter on. Remove the protective cap from the tip of the probe. Dip the probe into sample until the display stabilizes. When the instrument has finished, the pH is displayed on the LCD. The measurements were done in triplicate.

B.3 Texture

Instrumental texture evaluation of steamed bun was performed using a TA-XT2i Texture Analyzer equipped with a 25 kg load cell (Stable Micro Systems, Goldalming, UK) and a Texture Expert for Windows software (version 1.20) for data analysis.

Texture profile analysis (TPA) was carried out to evaluate the texture using a cylindrical aluminium probe (100mm diameter; P/100) and a crosshead speed of 60 mm/min to compress samples to 50% of their original height. Measurements were carried out on two slices (2 cm cubes) taken from the centre of the bun. The textural parameters considered were hardness (peak force of the first compression cycle in N), cohesiveness (ratio of positive force area during the second compression to that during the first compression area, dimensionless), springiness (ratio of the time duration of force input during the second compression to that during the first compression area, dimensionless) and gumminess (product of hardness multiply with cohesiveness) (Figure B.2) (Bourne, 1978).

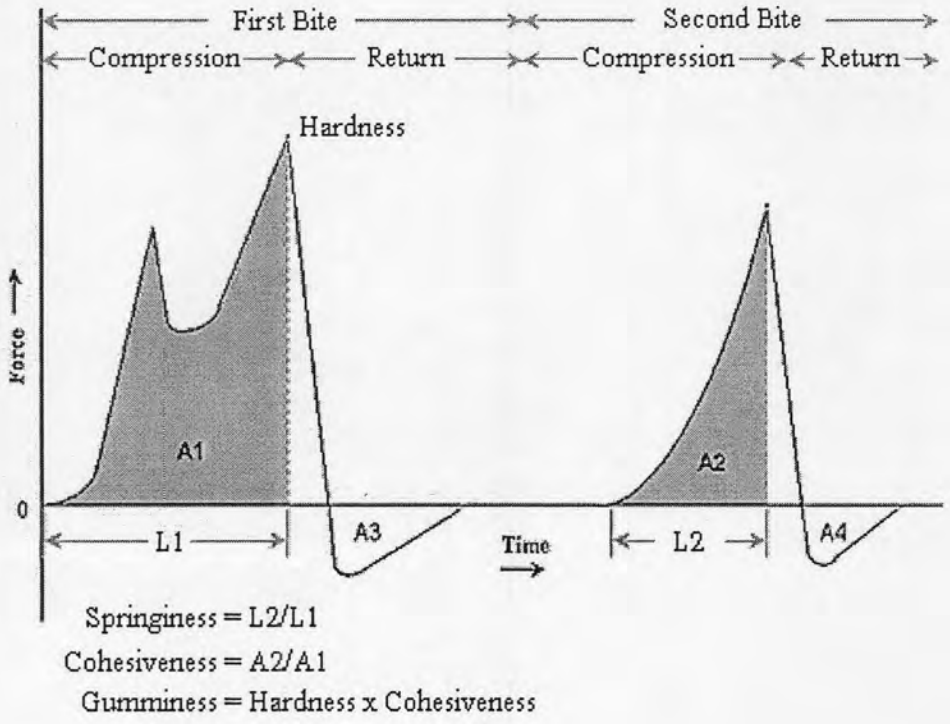


Figure B.2 Definitions of standard TPA terms

Sample calculation

Parameter	peak 1	peak 2
Force (N)	11.43	10.29
Time (s)	10.00	32.85
Distance (mm)	9.99	9.82
Area (N s)	84.74	42.61

2^{nd} compression time = 24.00 s

Hardness	(Peak force of the 1^{st} compression)	=	11.43 N	
Cohesiveness	(Area2/ Area1)	=	42.61/84.74	= 0.50
Springiness	(Length2/ Length1)	=	(32.85-24.00)/10.00	= 0.89
Gumminess	(Hardness × Cohesiveness)	=	11.43 N × 0.50	= 5.72 N

B.4 Microbiology

B.4.1 Aerobic plate count

Aerobic plate count was evaluated using 3M Petrifilm™ aerobic count (AC) plates. The 10 grams of samples were crushed using 90 ml of 0.1% peptone water as a diluent in sterile bag by stomacher (AES Laboratoire, Combourg, France) for 120 seconds. Then, dilute it to the working concentration at 2 levels and the measurements were done in 2 replicate. With pipette perpendicular to the Petrifilm plate, place 1 ml of sample onto the center of the bottom film and release the top film, then apply pressure on the spreader to distribute the inoculum over a circular area. Incubate plates with the clear side up in stacks of up to 20 plates at 32°C (±1 °C) for 48 hours (AOAC, 1995). Bacterial colonies on Petrifilm AC plates are red because of the indicator dye in the medium and they can be counted on a standard colony counter or other light source.

B.4.2 Yeast and mould plate count

Yeast and mould plate count was evaluated using 3M Petrifilm™ yeast and mould count (YM) plates. The samples were prepared similarly aerobic plate count but they are incubated at 25°C (±1 °C) for 5 days (AOAC, 1995). Yeast colonies will be small with defined

edges and will be pink-tan to blue-green in color. Mould colonies will be large, diffuse, and variable in color.

B.5 Statistical analysis

All the mean values and standard deviations form replicate tests were analyzed by several statistical methods. SPSS 15.0 for Windows software was used to perform the statistical analysis. For two treatments data (verification in Experiment 3.2.1 and 3.2.4), independent sample t-test was used. Analysis of variance (ANOVA) was performed for multiple treatments data and differences in samples were tested for statistical significance at $p = 0.05$ level. Duncan's multiple range tests was used to differentiate between the mean values.

The results from Experiment 3.2.1 and 3.2.2 were analyzed using Response surface methodology (RSM) (Gan *et al.,* 2007). Design-Expert 6.0.6 software was used to perform optimization. Optimal levels were determined by superimposing the plots for all response variables. The optimum levels were selected and used for calculating the predicted values of response variables using the prediction equations derived by RSM (Montgomery, 1997).

APPENDIX C

SENSORY EVALUATION FORMS

Acceptance test of custard cream filling

Sample No..... Date.....

Name..... Gender..... Age.....

Please evaluate acceptance of the sample by scoring on the scale.

Sweetness

0 — Dislike extremely
5 — Neither like nor dislike
10 — Like extremely

Texture

0 — Dislike extremely
5 — Neither like nor dislike
10 — Like extremely

Overall acceptance

0 — Dislike extremely
5 — Neither like nor dislike
10 — Like extremely

Suggestions.....

.....

THANK YOU VERY MUCH

Figure C.1 Sensory evaluation form for the study of effect of humectants on sensory qualities of custard cream

Acceptance test of Chinese steamed bun

Sample No..... Date.....

Name..... Gender..... Age.....

Please evaluate acceptance of the sample by scoring on the scale.

Appearance

0 — Dislike extremely | 5 — Neither like nor dislike | 10 — Like extremely

Flavour

0 — Dislike extremely | 5 — Neither like nor dislike | 10 — Like extremely

Texture

0 — Dislike extremely | 5 — Neither like nor dislike | 10 — Like extremely

Overall acceptance

0 — Dislike extremely | 5 — Neither like nor dislike | 10 — Like extremely

Suggestions.....

.....

THANK YOU VERY MUCH

Figure C.2 Sensory evaluation form for the study of effect of humectants and lactic acid on sensory qualities of Chinese steamed bun

Acceptance test of Chinese steamed bun

Sample No..... Date.....

Name..... Gender..... Age.....

1. Please evaluate different of the sample by using (✓) in the box.

☐ Same ☐ Different

2. Please evaluate acceptance of the sample by scoring (✓) on the scale.

Scale	Sample No.	
1 = dislike extremely		
2 = dislike very much		
3 = dislike moderately		
4 = dislike slightly		
5 = neither like nor dislike		
6 = like slightly		
7 = like moderately		
8 = like very much		
9 = like extremely		

Suggestions.....

.....

THANK YOU VERY MUCH

Figure C.3 Sensory evaluation form for the study of effect of preservative on shelf life of Chinese steamed bun

Acceptance test of custard cream Chinese steamed bun

Sample No..... Date.....

Name..... Gender..... Age.....

Please evaluate acceptance of the sample by scoring (✓) on the scale.

Scale	Appearance	Texture		Flavour	Overall acceptance
		bun	cream		
1 = dislike extremely					
2 = dislike very much					
3 = dislike moderately					
4 = dislike slightly					
5 = neither like nor dislike					
6 = like slightly					
7 = like moderately					
8 = like very much					
9 = like extremely					

Suggestions.....

.....

THANK YOU VERY MUCH

Figure C.4 Sensory evaluation form for verification of CCSB

APPENDIX D

STATISTICAL ANALYSIS DATA

Table D.1 ANOVA: overall effect of independent variables (0, 2.5, 5.0 % glycerol and fructose) on response variables of custard cream

D.1.1 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.002	2	.001	23.226	.000
Fructose	.004	2	.002	36.138	.000
Glycerol*Fructose	.001	4	.000	5.094	.024
Rep	.000	1	.000	6.184	.038
Error	.000	8	5.189×10^{-5}		
Total	15.677	18			

D.1.2 Dependent Variable: Sweetness

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.037	2	.018	.277	.765
Fructose	2.674	2	1.337	20.076	.001
Glycerol*Fructose	.547	4	.137	2.054	.179
Rep	.019	1	.019	.281	.611
Error	.533	8	.067		
Total	804.076	18			

D.1.3 Dependent Variable: Texture

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.106	2	.053	.261	.777
Fructose	1.291	2	.645	3.187	.096
Glycerol*Fructose	.734	4	.184	.907	.504
Rep	.712	1	.712	3.517	.098
Error	1.620	8	.202		
Total	770.432	18			

D.1.4 Dependent Variable: OAA

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.095	2	.047	.426	.667
Fructose	1.203	2	.602	5.420	.033
Glycerol*Fructose	.631	4	.158	1.421	.311
Rep	.344	1	.344	3.103	.116
Error	.888	8	.111		
Total	805.697	18			

Table D.2 ANOVA: overall effect of independent variables (3, 6, 9 % glycerol and fructose) on response variables of custard cream

D.2.1 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.002	2	.001	412.292	.000
Fructose	.003	2	.001	590.042	.000
Glycerol*Fructose	$3.537x10^{-5}$	4	$8.842x10^{-6}$	4.010	.034
Rep	$7.200x10^{-6}$	1	$7.200x10^{-6}$	3.265	.101
Error	$2.205x10^{-5}$	10	$2.205x10^{-6}$		
Total	16.870	20			

D.2.2 Dependent Variable: Sweetness

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	2.633	2	1.317	29.586	.000
Fructose	3.596	2	1.798	40.403	.000
Glycerol*Fructose	1.508	4	.377	8.474	.003
Rep	.133	1	.133	2.985	.115
Error	.445	10	.045		
Total	853.072	20			

D.2.3 Dependent Variable: Texture

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	3.153	2	1.577	100.533	.000
Fructose	1.584	2	.792	50.511	.000
Glycerol*Fructose	.453	4	.113	7.229	.005
Rep	.025	1	.025	1.562	.240
Error	.157	10	.016		
Total	820.034	20			

D.2.4 Dependent Variable: OAA

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	1.524	2	.762	52.285	.000
Fructose	2.023	2	1.011	69.383	.000
Glycerol*Fructose	.443	4	.111	7.607	.004
Rep	.055	1	.055	3.782	.080
Error	.146	10	.015		
Total	886.138	20			

Table D.3 t-test: data verification of custard cream

D.3.1 Variable: a_w

	t-test for Equality of Means		
a_w	t	df	Sig. (2-tailed)
Equal variances assumed	.412	1	.751

D.3.2 Variable: Sweetness

	t-test for Equality of Means		
Sweetness	t	df	Sig. (2-tailed)
Equal variances assumed	.241	1	.850

D.3.3 Variable: Texture

	t-test for Equality of Means		
Texture	t	df	Sig. (2-tailed)
Equal variances assumed	.176	1	.889

D.3.4 Variable: OAA

	t-test for Equality of Means		
OAA	t	df	Sig. (2-tailed)
Equal variances assumed	.378	1	.770

Table D.4 ANOVA: overall effect of independent variables (0, 2.5, 5.0 % glycerol and 0, 0.25, 0.50 % lactic acid) on response variables of Chinese steamed bun

D.4.1 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.004	2	.002	53.660	.000
Lactic â	2.411×10^{-5}	2	1.206×10^{-5}	.329	.729
Glycerol*Lactic â	.001	4	.000	3.559	.060
Rep	.000	1	.000	8.758	.018
Error	.000	8	3.664×10^{-5}		
Total	14.589	18			

D.4.2 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.003	2	.001	.104	.902
Lactic â	3.062	2	1.531	121.170	.000
Glycerol*Lactic â	.014	4	.004	.280	.883
Rep	.023	1	.023	1.858	.210
Error	.101	8	.013		
Total	616.754	18			

D.4.3 Dependent Variable: Appearance

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	1.677	2	.838	2.987	.107
Lactic â	.632	2	.316	1.126	.371
Glycerol*Lactic â	1.167	4	.292	1.039	.444
Rep	.008	1	.008	.027	.873
Error	2.245	8	.281		
Total	790.469	18			

Dependent Variable: Flavour

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.182	2	.091	.411	.676
Lactic â	5.073	2	2.537	11.463	.004
Glycerol*Lactic â	1.276	4	.319	1.441	.305
Rep	.527	1	.527	2.382	.161
Error	1.770	8	.221		
Total	700.748	18			

D.4.4 Dependent Variable: Texture

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.061	2	.030	.076	.927
Lactic â	.505	2	.253	.634	.555
Glycerol*Lactic â	.914	4	.229	.573	.690
Rep	.247	1	.247	.620	.454
Error	3.190	8	.399		
Total	764.767	18			

D.4.5 Dependent Variable: OAA

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.141	2	.070	.282	.762
Lactic â	3.041	2	1.520	6.082	.025
Glycerol*Lactic â	.673	4	.168	.673	.629
Rep	.284	1	.284	1.135	.318
Error	2.000	8	.250		
Total	769.240	18			

Table D.5 ANOVA: overall effect of independent variables (0, 2.5, 5.0 % glycerol) on response variables of Chinese steamed bun

D.5.1 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.004	2	.002	32.815	.000
Rep	.000	1	.000	5.356	.036
Error	.001	14	5.991×10^{-5}		
Total	14.589	18			

D.5.2 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.003	2	.001	.006	.994
Rep	.023	1	.023	.103	.753
Error	3.177	14	.227		
Total	616.754	18			

D.5.3 Dependent Variable: Appearance

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	1.677	2	.838	2.902	.088
Rep	.008	1	.008	.026	.873
Error	4.044	14	.289		
Total	790.469	18			

D.5.4 Dependent Variable: Flavour

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.182	2	.091	.157	.856
Rep	.527	1	.527	.909	.357
Error	8.119	14	.580		
Total	700.748	18			

D.5.5 Dependent Variable: Texture

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.061	2	.030	.092	.912
Rep	.247	1	.247	.751	.401
Error	4.609	14	.329		
Total	764.767	18			

D.5.6 Dependent Variable: OAA

Source	Sum of Squares	df	Mean Square	F	Sig.
Glycerol	.141	2	.070	.173	.843
Rep	.284	1	.284	.695	.418
Error	5.714	14	.408		
Total	769.240	18			

Table D.6 ANOVA: overall effect of independent variables (0, 0.25, 0.50 % lactic acid) on response variables of Chinese steamed bun

D.6.1 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Lactic â	2.411×10^{-5}	2	1.206×10^{-5}	.036	.965
Rep	.000	1	.000	.946	.347
Error	.005	14	.000		
Total	14.589	18			

D.6.2 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Lactic â	3.062	2	1.531	181.826	.000
Rep	.023	1	.023	2.788	.117
Error	.118	14	.008		
Total	616.754	18			

D.6.3 Dependent Variable: Appearance

Source	Sum of Squares	df	Mean Square	F	Sig.
Lactic â	.632	2	.316	.869	.441
Rep	.008	1	.008	.021	.887
Error	5.089	14	.363		
Total	790.469	18			

D.6.4 Dependent Variable: Flavour

Source	Sum of Squares	df	Mean Square	F	Sig.
Lactic â	5.073	2	2.537	11.002	.001
Rep	.527	1	.527	2.286	.153
Error	3.228	14	.231		
Total	700.748	18			

D.6.5 Dependent Variable: Texture

Source	Sum of Squares	df	Mean Square	F	Sig.
Lactic â	.505	2	.253	.850	.448
Rep	.247	1	.247	.832	.377
Error	4.164	14	.297		
Total	764.767	18			

D.6.6 Dependent Variable: OAA

Source	Sum of Squares	df	Mean Square	F	Sig.
Lactic â	3.041	2	1.520	7.565	.006
Rep	.284	1	.284	1.412	.255
Error	2.814	14	.201		
Total	769.240	18			

Table D.7 ANOVA: overall effect of independent variables; Condition (Hurdle or control product) and Calcium Propionate level (0, 0.1, 0.2 %) on response variables on various days of Chinese steamed bun

Day 0

D.7.1 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.000	1	.000	.000	1.000
CaP	.015	2	.007	.250	.788
Hurdle*CaP	.045	2	.022	.750	.519
Rep	.030	1	.030	1.000	.363
Error	.150	5	.030		
Total	39.120	12			

D.7.2 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.003	1	.003	423.148	.000
CaP	3.622×10^{-5}	2	1.811×10^{-5}	2.359	.112
Hurdle*CaP	4.667×10^{-6}	2	2.333×10^{-6}	.304	.740
Rep	1.600×10^{-5}	1	1.600×10^{-5}	2.084	.160
Error	.000	29	7.678×10^{-6}		
Total	30.103	36			

D.7.3 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	4.299	1	4.299	916.712	.000
CaP	.053	2	.026	5.602	.009
Hurdle*CaP	.003	2	.002	.342	.713
Rep	.393	1	.393	83.747	.000
Error	.136	29	.005		
Total	1258.515	36			

Day 2

D.7.4 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	18.062	1	18.062	638.467	.000
CaP	2.338	2	1.169	41.327	.000
Hurdle*CaP	1.792	2	.896	31.677	.000
Rep	.053	1	.053	1.886	.197
Error	.311	11	.028		
Total	205.093	18			

D.7.5 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.003	1	.003	759.442	.000
CaP	3.889×10^{-7}	2	1.944×10^{-7}	.054	.948
Hurdle*CaP	4.167×10^{-6}	2	2.083×10^{-6}	.574	.570
Rep	2.500×10^{-7}	1	2.500×10^{-7}	.069	.795
Error	.000	29	3.629×10^{-6}		
Total	30.530	36			

D.7.6 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	4.027	1	4.027	1738.005	.000
CaP	.067	2	.033	14.355	.000
Hurdle*CaP	.005	2	.003	1.152	.330
Rep	.105	1	.105	45.123	.000
Error	.067	29	.002		
Total	1285.194	36			

Day 4

D.7.7 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	26.572	1	26.572	353.526	.000
CaP	3.063	2	1.532	20.379	.000
Hurdle*CaP	1.021	2	.511	6.792	.011
Rep	.367	1	.367	4.880	.047
Error	.902	12	.075		
Total	291.444	19			

D.7.8 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.004	1	.004	1466.281	.000
CaP	1.339×10^{-5}	2	6.694×10^{-6}	2.742	.081
Hurdle*CaP	1.389×10^{-6}	2	6.944×10^{-7}	.284	.755
Rep	2.778×10^{-8}	1	2.778×10^{-8}	.011	.916
Error	7.081×10^{-5}	29	2.442×10^{-6}		
Total	30.860	36			

D.7.9 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	4.361	1	4.361	3660.872	.000
CaP	.060	2	.030	25.232	.000
Hurdle*CaP	.007	2	.003	2.884	.072
Rep	.001	1	.001	.842	.366
Error	.035	29	.001		
Total	1259.394	36			

Day 6

D.7.10 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	30.044	1	30.044	173.116	.000
CaP	.900	2	.450	2.593	.119
Hurdle*CaP	.553	2	.277	1.595	.247
Rep	.082	1	.082	.471	.507
Error	1.909	11	.174		
Total	318.061	18			

D.7.11 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.005	1	.005	592.992	.000
CaP	1.239×10^{-5}	2	6.194×10^{-6}	.783	.467
Hurdle*CaP	9.500×10^{-6}	2	4.750×10^{-6}	.600	.555
Rep	1.469×10^{-5}	1	1.469×10^{-5}	1.857	.183
Error	.000	29	7.913×10^{-6}		
Total	31.199	36			

D.7.12 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	4.767	1	4.767	984.236	.000
CaP	.083	2	.041	8.539	.001
Hurdle*CaP	.004	2	.002	.424	.659
Rep	.027	1	.027	5.508	.026
Error	.140	29	.005		
Total	1275.943	36			

Day8

D.7.13 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	48.840	1	48.840	735.023	.000
CaP	4.674	2	2.337	35.172	.000
Hurdle*CaP	3.994	2	1.997	30.054	.000
Rep	.081	1	.081	1.216	.290
Error	.864	13	.066		
Total	454.153	20			

D.7.14 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.004	1	.004	1291.650	.000
CaP	1.172×10^{-5}	2	5.861×10^{-6}	1.810	.182
Hurdle*CaP	1.722×10^{-6}	2	8.611×10^{-7}	.266	.768
Rep	2.778×10^{-6}	1	2.778×10^{-6}	.858	.362
Error	9.389×10^{-5}	29	3.238×10^{-6}		
Total	31.413	36			

D.7.15 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	5.003	1	5.003	1783.742	.000
CaP	.073	2	.036	12.947	.000
Hurdle*CaP	.016	2	.008	2.928	.069
Rep	.023	1	.023	8.023	.008
Error	.081	29	.003		
Total	1267.340	36			

Day 10

D.7.16 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	47.368	1	47.368	257.846	.000
CaP	4.538	2	2.269	12.352	.003
Hurdle*CaP	1.324	2	.662	3.603	.071
Rep	.002	1	.002	.012	.915
Error	1.653	9	.184		
Total	353.507	16			

D.7.17 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.004	1	.004	671.184	.000
CaP	6.500×10^{-6}	2	3.250×10^{-6}	.553	.581
Hurdle*CaP	1.339×10^{-5}	2	6.694×10^{-6}	1.138	.334
Rep	5.625×10^{-5}	1	5.625×10^{-5}	9.563	.004
Error	.000	29	5.882×10^{-5}		
Total	31.583	36			

D.7.18 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	4.594	1	4.594	2695.598	.000
CaP	.079	2	.040	23.179	.000
Hurdle*CaP	.017	2	.008	4.862	.015
Rep	4.444×10^{-5}	1	4.444×10^{-5}	.026	.873
Error	.049	29	.002		
Total	1297.621	36			

Day12

D.7.19 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	11.388	1	11.388	65.822	.000
CaP	.572	2	.286	1.652	.258
Rep	.004	1	.004	.021	.889
Error	1.211	7	.173		
Total	135.312	12			

D.7.20 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.002	1	.002	220.384	.000
CaP	1.433×10^{-5}	2	7.167×10^{-6}	.953	.403
Rep	.000	1	.000	48.974	.000
Error	.000	19	7.518×10^{-6}		
Total	20.857	24			

D.7.21 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	1.733	1	1.733	2681.224	.000
CaP	.064	2	.032	49.283	.000
Rep	.029	1	.029	44.415	.000
Error	.012	19	.001		
Total	804.786	24			

Day 14

D.7.22 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	24.510	1	24.510	245.864	.000
CaP	2.744	2	1.372	13.762	.003
Rep	.210	1	.210	2.104	.185
Error	.798	8	.100		
Total	212.728	13			

D.7.23 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	.001	1	.001	148.858	.000
CaP	3.000×10^{-6}	2	1.500×10^{-6}	.199	.821
Rep	.000	1	.000	60.983	.000
Error	.000	19	7.533×10^{-6}		
Total	21.045	24			

D.7.24 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
Hurdle	1.725	1	1.725	546.810	.000
CaP	.028	2	.014	4.487	.025
Rep	.078	1	.078	24.787	.000
Error	.060	19	.003		
Total	793.310	24			

Day 16

D.7.25 Dependent Variable: AC

Source	Sum of Squares	df	Mean Square	F	Sig.
CaP	.642	2	.321	7.921	.041
Rep	.338	1	.338	8.329	.045
Error	.162	4	.041		
Total	79.521	8			

D.7.26 Dependent Variable: a_w

Source	Sum of Squares	df	Mean Square	F	Sig.
CaP	4.311×10^{-5}	2	2.156×10^{-5}	2.109	.158
Rep	2.689×10^{-5}	1	2.689×10^{-5}	2.630	.127
Error	.000	14	1.022×10^{-5}		
Total	15.609	18			

D.7.27 Dependent Variable: pH

Source	Sum of Squares	df	Mean Square	F	Sig.
CaP	.005	2	.002	.919	.422
Rep	.033	1	.033	13.072	.003
Error	.035	14	.003		
Total	576.374	18			

Table D.8 t-test: overall effect of independent variables; Condition (with and without O_2 absorber) on response variables on various days of CCSB

Day 0

D.8.1 Variable: AC

	t-test for Equality of Means		
AC	t	df	Sig. (2-tailed)
Equal variances assumed	.513	6	.659

D.8.2 Variable: Bun a_w

	t-test for Equality of Means		
Bun a_w	t	df	Sig. (2-tailed)
Equal variances assumed	.331	10	.747

D.8.3 Variable: Cream a_w

	t-test for Equality of Means		
Cream a_w	t	df	Sig. (2-tailed)
Equal variances assumed	.227	10	.825

Day 2

D.8.4 Variable: AC

	t-test for Equality of Means		
AC	t	df	Sig. (2-tailed)
Equal variances assumed	.381	6	.716

D.8.5 Variable: Bun a_w

	t-test for Equality of Means		
Bun a_w	t	df	Sig. (2-tailed)
Equal variances assumed	1.369	10	.201

D.8.6 Variable: Cream a_w

Cream a_w	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	1.384	10	.197

Day 4

D.8.7 Variable: AC

AC	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	4.398	6	.005

D.8.8 Variable: Bun a_w

Bun a_w	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	1.185	10	.263

D.8.9 Variable: Cream a_w

Cream a_w	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	0.582	10	.574

Day 6

D.8.10 Variable: AC

AC	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	13.482	6	.000

D.8.11 Variable: Bun a_w

Bun a_w	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	0.542	10	.599

D.8.12 Variable: Cream a_w

Cream a_w	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	0.894	10	.392

Day 8

D.8.13 Variable: AC

AC	t-test for Equality of Means		
	t	df	Sig. (2-tailed)
Equal variances assumed	60.052	6	.000

D.8.14 Variable: Bun a_w

	t-test for Equality of Means		
Bun a_w	t	df	Sig. (2-tailed)
Equal variances assumed	.210	10	.838

D.8.15 Variable: Cream a_w

	t-test for Equality of Means		
Cream a_w	t	df	Sig. (2-tailed)
Equal variances assumed	1.071	10	.309

Table D.9 t-test: data verification

D.9.1 Variable: Bun a_w

	t-test for Equality of Means		
Bun a_w	t	df	Sig. (2-tailed)
Equal variances assumed	.312	10	.762

D.9.2 Variable: Cream a_w

	t-test for Equality of Means		
Cream a_w	t	df	Sig. (2-tailed)
Equal variances assumed	.174	10	.865

D.9.3 Variable: AC

	t-test for Equality of Means		
AC	t	df	Sig. (2-tailed)
Equal variances assumed	1.472	2	.279

D.9.4 Variable: Hardness

	t-test for Equality of Means		
Hardness	t	df	Sig. (2-tailed)
Equal variances assumed	.255	6	.807

D.9.5 Variable: Springiness

	t-test for Equality of Means		
Springiness	t	df	Sig. (2-tailed)
Equal variances assumed	.000	6	1.000

D.9.6 Variable: Cohesiveness

	t-test for Equality of Means		
Cohesiveness	t	df	Sig. (2-tailed)
Equal variances assumed	.465	6	.658

D.9.7 Variable: Gumminess

	t-test for Equality of Means		
Gumminess	t	df	Sig. (2-tailed)
Equal variances assumed	.841	6	.433

APPENDIX E

PRODUCT PICTURE

Figure E.1: Laboratory type mixer (Kenwood)

Figure E.2: Mixed dough

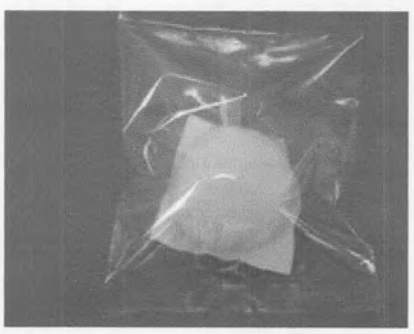
Figure E.3: Proofed dough

Figure E.4: Custard cream

Figure E.5: 25 grams of divided proofed dough

Figure E.6: Electric steamer (Hanabishi)

(a)



(b)

Figure E.7: Custard cream filled Chinese steamed bun (a) and product with packaging (PVDC pouch) (b)

APPENDIX F

COST CALCULATION

	Per 20 piece			Per 20 piece	
Custard cream	Weight (g)	Cost* (฿)	Bun	Weight (g)	Cost* (฿)
Egg	49.5	4.00	Cake flour	250.0	13.75
Evaporated milk	37.5	1.99	Sugar	51.5	1.18
Sugar	60.0	1.38	Shortening	15.0	0.98
Wheat flour	19.5	1.07	Glycerol	11.4	9.12
Butter	19.5	2.67	Yeast	7.3	2.38
Glycerol	13.7	10.96	Cakes emulsifier	7.0	1.71
Fructose	13.7	6.85	Baking powder	5.0	1.10
Skimmed milk powder	7.5	0.60	Salt	2.0	0.02
Corn flour	6.0	0.45	Lactic acid	1.1	0.39
Vanilla flavour	1.9	1.00	**TOTAL COST**	**(฿)**	**61.60**

* Reference cost from local supermarkets in Bangkok (3 October 2008)

Hurdle treated CCSB (shelf-stable) per piece (37 g)

Raw material cost	=	3.08	฿
Packaging cost (PVDC pouch 1.30 ฿, OA 0.65 ฿)	=	1.95	฿
Raw material and packaging cost (RPC)	=	5.03	฿
Energy and overhead cost (estimation: 20% of RPC)	=	1.00	฿
Overall cost	=	6.03	฿

Commercial ready-to-eat CCSB (required frozen storage) per piece*

Jade dragon (37 g)	=	6.88	฿
7-eleven (30 g)	=	8.00	฿
Surapon foods (30 g)	=	9.05	฿
MK-restaurants (30 g)	=	12.00	฿

* Reference cost from local supermarkets in Bangkok (3 October 2008)

VITA

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