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The Effects of Fat Substitution Using Palm Stearin on the Colorimetric and Sensorial Characteristics of Cake

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Abstract: *Fats used in baking contain trans fatty acid that has been proven to contribute towards various health problems. Palm stearin is used to substitute shortening in different ratios to observe the effects on the sensorial and colorimetric properties of cake. Formulations A, B, C, D, and E each has palm stearin substitution of 0%, 25%, 50%, 75%, and 100% respectively. All formulations were analysed for its colour analysis and sensory analysis. At 25 % level of substitution (formula B), overall liking in sensory analysis (5.5 ± 1.10) are found to be similar with formula A. Formula B for colour analysis 80.84 ± 0.20 (L*), 2.79 ± 0.40 (a*), and 30.30 ± 0.64 (b*) are however significantly different with formula A. It is found that a different substitution ratio does affect the sensorial and colorimetric characteristics of the cakes. Substitution up to 25 % shows that it is best in producing cakes most similar to formula A. Further studies need to be carried out in order to find a method that may incorporate higher palm stearin substitution as well as palm stearin functionality in a cake system.*

Keywords: *Baking, palm stearin, cakes, sensory evaluation, fat substitution.*

I. Introduction

Palm stearin is one of the products of palm oil; also it is the less expensive counterpart. Due to its naturally occurring high solid fatty acid content, it is considered to be suitable in the production of shortening [1]. It has been successfully incorporated with other vegetable oils in the production of plastic shortenings and the functionality has been proven to be effective [2; 3]. Fat replacement studies have been carried out over the years for various reasons which include finding a cheaper alternatives and an option that is more beneficial for the health. In finding alternatives, palm oil has caught the attention of various industries and studies are carried out to see how it can be applied accordingly due to their quality and properties [2]. The industry has been hydrogenating oil to produce commercial plastic fats for baking purposes [4]. This process is to transform liquid oil into solid fat that will be used in food products. The problem with these fats are due to the presence of *trans*-fatty acid that is causing health problems such as increased body fat, obesity and increased risk of coronary heart diseases [5]. Studies have been done to find mixtures of different oil blends that could provide the same functionality as fats without the *trans*-fatty acids. Palm stearin is a very promising substitute that could be used as an alternative based on its natural high level of solid fat.

Cakes are baked product that is widely appreciated for its taste and flavour. The science behind cake baking involves the understanding of ingredients functionality from mixing until baking. Basic cake ingredients such as flours, eggs, fats and sugars could be generally classified into toughenners, tenderizers, moisteners and driers. Interactions between them are important and needs to be understood well [6]. These ingredients must be balanced with the right amount of leavening in order for the cake to bake and rise as intended. There are many types of cakes that could be classified based on the ingredients and their ratio. Fats are one of the major ingredients that have great influence towards the final product.

Due to the adverse effects that commercial fats have, there is a need to find replacements for them to be used in the baking industry and palm stearin is suitable for it. In this experiment, palm stearin was used to substitute fats in the cake using different ratios.

Cake can be classified into two, high ratio cake or low ratio cake. High ratio cakes are those that generally has flour to sugar ratio that equals or exceeds 1.0 and low ratio cakes are those ratio that is less than 1.0 [7]. The basic ingredients of any type of cakes are flour, sugar, eggs, fat and leavening agent that are mixed together to form a batter and then baked. During baking, the temperature causes gas cells inside the batter to expand, fat crystals to melt, and the liquid batter turns to solid foam as the structure sets [8; 9]. In order to achieve a good quality cake these ingredients not only need to be incorporated by a correct method, it also needs to be in accurate quantities. Cake batter is a complex emulsion and foam system that is achieved by creaming sugar and fat first, followed by the addition of eggs and flour. All the major ingredients play an important role

in the cake system whereby the interactions between these major ingredients are what determine the properties of the cake.

Sensory characteristics of bakery products such as cakes are very attractive especially when they are freshly baked. There are some factors which impact on the sensory characteristics such as batter ingredients, processing methods and duration of baking [10]. The present study aimed to evaluate the effects of fat substitution palm stearin on the colorimetric and sensorial characteristics of cakes.

II. Materials And Methods

Cake Preparation

All the baking ingredients involved in making the cake were locally purchased by the Universiti Sains Islam Malaysia. The cakes were made using self-rising flour, castor sugar, eggs, shortening, salt, and vanilla essence. The palm stearin used was obtained from Sime Darby Jomalina Sdn. Bhd, Malaysia. The flour, sugar, and salt were all kept at room temperature while eggs, shortening, palm stearin and vanilla essence were kept refrigerated at 5˚C. All chemicals or reagents used for chemical analysis are of analytical grades.

The control cake was baked according to the standard model ratio of flour, sugar, eggs and fat that equals to 1. Ingredients measured used mechanical weighing balance (Sartorious, Mechatronics). Sufficient creaming of sugar and fat were done in an electric mixer (Kitchen Aid Mixer, St Joseph, Michigan, USA) followed by the addition of vanilla essence, while mixing was done by hand by folding in of eggs and flour and salt. The percentages of each of the ingredients are presented in TABLE 1. Baking was done in an oven (EKA Convection Oven) at 180˚C for 30 – 40 minutes or until cooked. Fig. 1 shows the general procedure outline of cake baking.

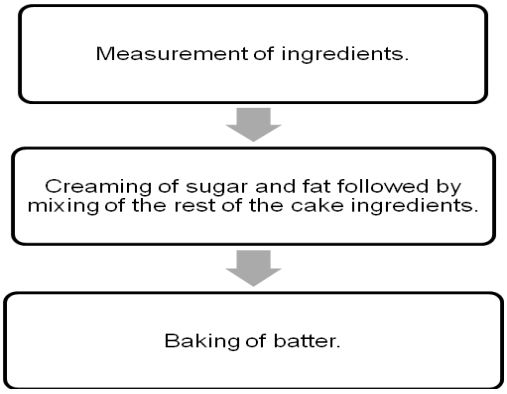

Figure 1: Cake baking procedure outline

All measurements will be calculated using baker's percentage. To measure the weight of the ingredient needed, the equation is as follows.

$$ingredient\ weight = \frac{flour\ weight\ \times\ baker's\ percent_{(ingredients)}}{100\ \%}$$

Baker's percentage expresses the amount of ingredient compared to the total amount of flour in the formula [11] because flour is the predominant ingredient. All formulation will be in baker's percentage where total flour will always be 100 % and the percentage total of all ingredients will exceed 100 %. The different samples would differ in the ratio of shortening and palm stearin in the formulation while flour, sugar, eggs, salt and vanilla essence will be fixed throughout all formulation.

Colour Analysis of the cake formulations

The analysis for colour was carried out using the Hunter Lab system Lab Scan XE based on the L*a*b* colour scale system [12]. The colour scale system measures colour based on the standards developed by the Commission Internationale de I'Eclairage (CIE) in 1976 which provides consistent colour measurement. The principle of this system involves measuring the amount of light reflected by the sample and is compared to light reflected by the standard template [13; 14].The colour expression developed by CIE is represented by L* (lightness), a* (redness) and b* (yellowness). Crumbs of cake measuring 3 cm x 3 cm x 3 cm cube not including the crust were prepared for the analysis. The system was calibrated using a white standard porcelain plate (L=0.00, a= -0.00, b=100.00).

Sensory Evaluation

The hedonic test was applied in carrying out the sensory evaluation of the cake formulation. Based on the method of the Institute of Food Technologists, IFT [15], this test is a scale rate test that reflects the perceived

intensity of attributes specified. Sixty (60) panelists from students of the Faculty of Science and Technology, USIM participated in the evaluation. For this study, a hedonic scale of 7 points (1 = dislike extremely and 7 = like extremely) was used and the attributes asked were appearance, aroma, colour, texture, taste and overall liking. The samples were randomly sorted with random three digit codes and given to panelists at room temperature along with plain water to rinse their mouth.

Statistical analysis

Three replicates were used for all experiments. All measurements were recorded and the mean and standard deviation were calculated as well as ANOVA to represent the data. All the data were analysed using the statistical software Minitab 16 (Minitab Inc., PA, USA) and Microsoft Excel 2010.

III. Results And Discussion

Colour Analysis

The colour analysis results are presented in TABLE 2. From the colour analysis, the L* value obtained was highest for formula A (82.58) and the lowest was for formula E (78.64). For the a* value, the highest value is obtained for formulation **D** (3.47) and the lowest is for formula A (0.87). The highest b* value obtained was for formulation **D** (35.48) and the lowest is for formulation **A** (25.97). The result of the F-test obtained from ANOVA, all three p-value is less than 0.05. From regression analysis, the R-squared value obtained was 97.79 % for L*, 95.31 % for a*, and 98.46 % for b*. The colour analysis showed that increasing level of palm stearin substitution contributed to a decrease in lightness with an increase in redness and yellowness. There were significant differences ($P < 0.05$) in the colour throughout the different formulations except for formulations **B** and **C** where L*a*b* values are not significantly different ($P > 0.05$) in both formulations. The differences in colours are mainly the direct result of palm stearin and shortening colour. The inconsistent change in colours for formulations **D** and **E** may result from the colour of egg yolk that could also impart colour towards the product.

Sensory Evaluation and Descriptive Analysis of the cake formulations

Sensory evaluation is a quantitative technique in which numerical data are obtained to establish lawful and specific relationships between product characteristics and human perception [58]. The results for sensory properties of the cakes provide interesting preliminary findings [27]. Sensory evaluation of the cakes samples was undertaken and the most acceptable in terms of appearance, aroma, colour, texture, taste, and overall liking. The results of the sensory analysis of the cake samples were presented in TABLE 3. From descriptive analysis, the highest scored attribute is appearance (4.91) followed by colour (4.73) and aroma (4.70). The bottom three scored attributes are overall liking (4.57), taste (4.41) and the lowest, texture (4.39). Fig.2 is a representation of the data that shows the score trends based on attributes for all five formulations. It can be seen from the graph that formulation **A** had the highest score in all attributes and formulation **E** had the lowest score in all attributes too. F-test from ANOVA has p value less than $\alpha = 0.05$ for all six attributes. The R-squared value obtained ranged from 37.76 % to 21.86 %. From the sensory evaluation aspects, appearance had the highest mean of scores while texture had the lowest mean of scores. The degree of liking in all six attributes decreased from formulation **A** to formulation **E**. Formulation **A** which has no palm stearin and it had the highest score for the degree of overall liking among all the six attributes determined while formulation **E** was scored the lowest. Formulation **A** did not have any palm stearin and formulation **E** had 100 % palm stearin substitution. Although the results for the five formulations showed a decrease in all attributes, there were no significant difference ($P > 0.05$) in formulations **A** and **B**. Formulations **B** and **C** too had no significant difference ($P > 0.05$) from each other except for colour which had no significant difference. Formulation **D** was not significantly different ($P > 0.05$) from formulation **C** except for colour. All attributes for formulation **B** were also significantly different from **E** except for the aroma which was not significantly different ($P>0.05$). The difference in the attribute scores was due to the ability of the panelists to express the level of likeness of each attribute.

IV. Figures And TABLES

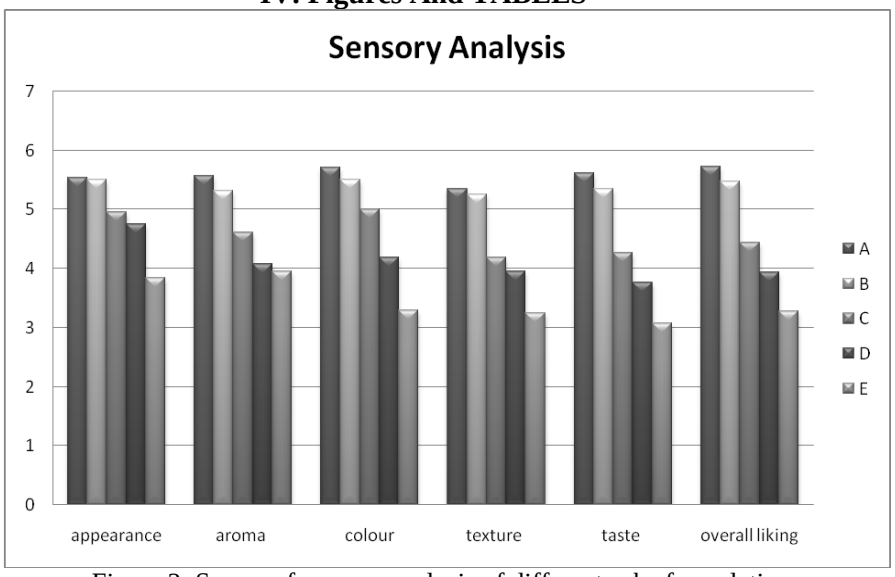

Figure 2: Scores of sensory analysis of different cake formulations

Table 1: Cake Formulations' Percentage

	Formulations				
Ingredients (%)	**A**	**B**	**C**	**D**	**E**
Flour	100	100	100	100	100
Sugar	100	100	100	100	100
Eggs	100	100	100	100	100
Shortening	100	75	50	25	-
Palm stearin	-	25	50	75	100
Salt	2	2	2	2	2
Vanilla Essence	3.6	3.6	3.6	3.6	3.6

Table 2: Colour analysis result of the different formulations

Parameters	**Formulations**				
	A	**B**	**C**	**D**	**E**
L*	82.58 ± 0.15^{a}	80.84 ± 0.20^{b}	80.45 ± 0.46^{b}	75.91 ± 0.57^{c}	78.64 ± 0.52^{d}
a*	0.82 ± 0.16^{a}	2.79 ± 0.40^{b}	2.89 ± 0.14^{bc}	3.47 ± 0.24^{c}	3.41 ± 0.29^{c}
b*	25.97 ± 0.61^{a}	30.30 ± 0.64^{b}	29.58 ± 0.23^{b}	35.48 ± 0.12^{c}	31.19 ± 0.50^{b}

Values are all mean ± standard deviation.
Superscripts within the same row with the same letter are not significantly different at $P < 0.05$.

Table 3**:** Sensory analysis result of the different cake formulations

Parameters	Formulations				
	A	**B**	**C**	**D**	**E**
Appearance	5.54 ± 1.01^{a}	5.5 ± 1.10^{a}	4.95 ± 1.18^{b}	4.75 ± 1.33^{b}	3.84 ± 1.20^{c}
Aroma	5.57 ± 0.99^{a}	5.32 ± 1.11^{a}	4.61 ± 1.19^{b}	4.07 ± 1.35^{bc}	3.95 ± 1.51^{c}
Colour	5.71 ± 0.85^{a}	5.50 ± 1.09^{a}	5.00 ± 1.11^{a}	4.19 ± 1.27^{b}	3.29 ± 1.40^{c}
Texture	5.34 ± 1.20^{a}	5.25 ± 1.25^{a}	4.18 ± 1.43^{b}	3.95 ± 1.38^{b}	3.25 ± 1.51^{c}
Taste	5.61 ± 1.10^{a}	5.34 ± 1.20^{a}	4.27 ± 1.51^{b}	3.77 ± 1.66^{b}	3.07 ± 1.39^{c}
Overall liking	5.73 ± 0.84^{a}	5.48 ± 1.16^{a}	4.43 ± 1.28^{b}	3.94 ± 1.43^{b}	3.27 ± 1.43^{c}

Values are all mean ± standard deviation.
Superscripts within the same row with the same letter are not significantly different at $P < 0.05$.

V. Conclusion

Sensory analysis was done to assess the cakes' qualities. The result of this study shows that palm stearin substitution does have an effect on the physicochemical properties as well as the quality of cake. Among the five formulations, shortening to palm stearin ratio in formula A (100:0) and B (75:25) are the most similar for all the properties tested except in colour. Based on the sensory evaluation however, the highest degree of liking for all attributes was scored for formula A. Formula B however had no significant difference with formula A which shows that the differences between these two formulas were not detectable. It can be concluded that up to 25 % of palm stearin substitution into high-ratio cake is successful and up to 50 % substitution has a very high potential. For substitution exceeding 25 %, identification of methods best to incorporate a higher amount of palm stearin should be identified. It is recommended that further study is carried out to determine more on the

functionality of palm stearin and what kind of interaction does it have with the rest of the ingredients present in the cake system to make it most suitable to be used as fat substitute.

References

[1] I.N. Aini and C.H.C Maimon, Characteristics of White Pan Bread as Affected by Tempering of the Fat Ingredient. Cereal Chemistry, 73 (4), 1996, 462- 465

[2] A. AbdulAzis, Y. Mohamud, K. Roselina, H.C. Boo, L.C. Nyuk and Cheman, Rheological, chemical and DSC thermal characteristics of different types of palm oil/palm stearin based shortenings. International Food Research Journal, 18, 2011, 189-200

[3] G. Pande and C.C Akoh, Enzymatic synthesis of trans-free structured margarine fat analogs with high stearate soybean oil and palm stearin and their characterization. Food Science and Technology, 50, 2013, 232-239.

[4] J. Zhou, J.M. Faubion and C.E. Walker, Evaluation of different types of fats use in high-ratio layer cakes. Food Science and Technology, 44, 2011, 1802-1818.

[5] I. S. Dogan, I. Javidipour and T. Akan, Effects of interesterified palm and cottonseed oil blends on cake quality. International Journal of Food Science and Technology, 42, 2007, 157-164.

[6] M. Mizukoshi, Model studies of cake baking. VI. Effects of cake ingredients and cake formula on shear modulus of cake. American Association of Cereal Chemists. 62, 1985, 247-251.

[7] J.A. Delcour and R.C. Hoseney, (2010). Principles of cereal science and technology. Third edition. St Paul, MN: USA. AACC International Inc, 2010.

[8] H.M. Al-Dmoor, Cake Flour Functionality and Quality (Review). European Scientific Journal, 9(3,) 2013, 166-179.

[9] E. Wilderjans, A. Luyts, H, Goesaert, K. Btijs, and A. Delcour, A model approach to starch and protein functionality in a pound cake system, Journal of Food Chemistry, 120, 2010, 44-51.

[10] P. Schieberle, Intense aroma compounds - useful tool to monitor the influence of processing and storage on bread aroma, Advances in Food Science, 18, 1996, 237-244.

[11] P.I. Figone, 2010. How Baking works 3rd Edition. (New Jersey, USA. Wiley & Sons. p 9).

[12] E. Hera, E. Ruiz-Paris, B. Oliete and M. Gomez, Studies of the quality of cakes made with wheat-lentil composite flours. Food Science and Technology. 49, 2012, 48-54.

[13] M. Fernando, P. Dejmek and J. Aguilera, Calibrated Colour Measurements of Agricultural Foods using Image Analysis. Postharvest Biology and Technology, 41(3), 2006, 285-295.

[14] T.E. Kgatla, S.S. Howard and D.C. Hiss, Colour Stability of wild Cactus Pear Juice, World Academy of Science, Engineering and Technology, 56, 2011, 249-254.

[15] Sensory Evaluation Guide for Testing Food and Beverage Products, Institute of Food Technologists, 1981, 54-57.

[16] D. Wing, and A. Scott, The Bread Builders: Hearth Loaves and Mansory Ovens (Hartford, USA: Chelsea Green Publishing, 1999).

[17] K.F. Finney and M.A. Barmore, Loaf volume and protein content of hard red winter and spring wheat, Cereal Chemistry , 25, 1948, 291–312.