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The Influence of Different Formulations of Palm Oil/Palm Stearin-Based Shortenings on the Quality of White Bread

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Abstract: The objective of the study was to determine the effect of different formulations of palm oil/palm stearin-based shortenings on the quality of white bread. In total, eight formulations of bread were prepared, while those made without shortening were used as comparisons with other formulations. The fatty acid compositions of experimental and commercial shortenings were investigated using gas chromatography (GC). The samples of bread were tested for loaf volume, specific volume, crust colour, crumb colour and texture profile analysis. The regression analyses showed that breads made from 100% palm stearin had the highest volume and specific volume, but they were the least in terms of density. In addition, bread crusts without shortening were observed to have lighter colour than those made with shortenings. The hardness (g), springiness (mm), cohesiveness, gumminess (g) and chewiness (gmm) were found to range between 616.7-1430.9, 0.862-0.912, 0.699-0.759, 456.7-1084.8 and 394.7-933.4, respectively. This study demonstrated that using palm oil/palm stearin-based shortenings in breadmaking may contribute to better quality.

Key words: White bread · Shortening · Color · Volume · Texture

INTRODUCTION

Bread is a product made from grains, legumes and tubers which are ground into meals, moistened, usually added with a leavening agent, kneaded, made into loaves and baked [1]. Good quality bread, however, can be achieved by using suitable types and amount of ingredients. Using only the basic ingredients (namely, flour, salt, yeast, sugar and water) is not enough to produce bread of high quality [2]. As compared to other types of baked products such as cakes and biscuits, breads require relatively small amount of shortenings (2-5%). Shortenings are fat which is added to bakery products and it comprises of a mixture of oil and fat that are hydrogenated to various degrees and is sometimes coupled with the addition of emulsifiers and other additives [3, 4].

The effect of shortening can be exerted by interaction with flour and sugar, which are the two other major components of baked products [5]. Since less shortening is required in bread making than in other baked products, the amount of shortening used in bread is significant because the consumption of bread is the largest among all the bakery products [6]. Shortening, being insoluble in water, prevents the cohesion of gluten strands during mixing and hence, it gives the product its tenderness and softness characteristics [7].

Thus, shortening plays a very important role as a plasticizer and it is closely related to the expansion of the bread dough during the second fermentation stage and baking processes [8]. Meanwhile, emulsifiers (such as distilled monoglycerides (DMG) and diacetyl tartaric acid esters of mono-and diglycerides (DATEM) have significant effects on bakery shortening. Despite the small amount used, the amount as low as 0.5% of emulsifier can produce good quality bread [9]. When DMG is used on its own, it is permitted at a level of 10% of the shortening. Likewise, DATEM and any other ingredients which operate like mono- and diglycerides are also permitted in such a way that the combination of the ingredients should not exceed 20% of shortening weight [10].

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In order to satisfy and meet consumers' preference, high quality bread must at least have good volume, fresh with attractive aroma, soft crumb, crisp and brittle crust, low in density, as well as a clean colour with a long shelf life and good taste [11]. Since the roles of shortening in bread are to incorporate and entrap air during mixing to improve the volume, colour, texture, crust tenderness, as well as to keep the quality of bread and make dough more elastic, an appropriate amount of shortening should be added to bread dough. Several work done previously have shown that shortenings enhance the structure, provide a moisture barrier and extend the shelf life of bakery products [6, 12, 13]. Moreover, bread volume can be increased by incorporating shortening, while a maximum volume is achieved at the incorporation of about 6% shortening [14, 15]. The aim of the present study was to determine the volume, specific volume, density, as well as the colour and texture characteristics of white bread that was made from different formulations of refined, bleached and deodorized (RBD) palm oil/palm stearin-based shortenings.

MATERIALS AND METHODS

Raw Materials: Commercial wheat flour (14% moisture, 13% protein and 0.55% ash contents), which was obtained from local bakery, was used in this work. Sugar, salt and dry instant yeast were purchased from a market. The samples of refined, bleached and deodorized palm oil (RBDPO) and RBD palm stearin, with IV of 52.3 and 31.2, respectively, were purchased from a local refinery located in Selangor, Malaysia. Meanwhile, emulsifiers of diacetyl tartaric acid ester of mono-diglycerides (DATEM) and distilled monoglyceride (DMG), with IV of 40 and 105, respectively, were purchased from Danisco Malaysia Sdn. Bhd., a company that is based in Penang, Malaysia.

Preparation of Shortenings: Shortenings that were made from seven blends of RBD palm oil (RBDPO) and palm stearin (PS) were used in the bread making experiment. In more specific, these shortenings were blended in 100:0, 80:20, 60:40, 50:50, 40:60, 20:80 and 0:100 of the RBDPO:PS ratios, respectively. Each blend was added with 6.25% of DMG and 6.25% of DATEM. The shortenings were prepared after a complete melting of the oil at 70°C using a magnetic stirring. After that, the shortenings obtained were stored at room temperature (28°C) for later use in bread making.

Fatty Acid Composition: The fatty acid compositions of the shortenings were analyzed after converting the fatty acids into corresponding fatty acid methyl esters (FAME).

Table 1: The basic formulations used in bread-making

Ingredients	Baker's %
Wheat flour	100.0
Shortening	4.0
Water	55.0
Salt	1.5
Sugar (sucrose)	4.0
Dry instant yeast	1.8

All the samples were melted in oven prior to use and 50mg of the sample was weighed [16]. After methylation, the composition of fatty acid was determined using Hewlett-Packard 6890 chromatography (GC) that was equipped with an auto injector and a flame-ionization detector (FID) using a fused silica capillary column (60.0m×320 μm×0.25μm film thickness, id-BPX70) at 260°C maximum, with Helium as the carrier gas, at a flow rate of 1.6mL/min. The injector and detector temperatures were set at 220°C and 240°C, respectively. Meanwhile, the oven temperature was programmed in two stages, as follows: first from 50°C to 180°C (8°C /min) and then from 180°C to 240°C (8°C /min) [17]. Each analysis was conducted in triplicate, with a run time of 35.6min.

Iodine Value: The IVs of the samples were determined according to the procedure described in the AOCS method [18]. The sample (0.5g) was diluted in 20ml of cyclohexane (in this analysis, cyclohexane was used in place of chloroform) and 25ml of the Wijs solution (ICl) was added to halogenate the double bonds. After placing the bottles in the dark for 1hour, the mixtures were reacted with 20ml of potassium iodine and 100ml distilled water. Free I_2 was measured by titration with 24.9g/l $Na_2S_2O_3.5H_2O$ using starch (1.0g/100ml) as an indicator. IV was calculated as cg I_2 adsorbed/g sample. The iodine value of each sample was determined in triplicate.

Preparation and Baking of Dough: A straight dough process was carried out for the preparation of the bread samples using the formulation given in Table 1 below. In total, seven main steps were involved in the bread making process; these are mixing, dividing, intermediate proofing, moulding, final proofing, baking and cooling [2]. The ingredients were then combined in a mixer (Kenwood Chef, KMC500) and mixed for 4 min at a low speed and later for 6 min at a high speed. The whole dough was allowed to rest for 5 min after mixing. After resting, the dough was divided into 250g pieces and manually formed into round balls. The dough was placed into greased baking pans with a dimension of 32cm × 18.5cm × 10cm and sent for proofing for two hours. After proofing, the dough samples were baked at 210°C for 14 minutes in an electronic oven (SALVA Modular Deck Oven). After baking, the bread samples were immediately removed from the baking pans and placed on the wire rank to let them cool for approximately one hour at ambient temperature before further analyses.

Measurements of the Loaf Volume, Specific Volume and Density: The loaf volume (mL) was measured using the seed displacement method after cooling the bread to room temperature for 1 hour. The specific volume and density of the bread were determined as shown in Eq. 1 and 2 below:

$$\text{Specific volume (mL/g)} = \text{Loaf volume of bread/ Weight of bread} \quad (1)$$

$$\text{Density (g/mL)} = \text{Weight of bread/ Loaf volume of bread} \quad (2)$$

Colour Measurements: Crumb and crust colour of the bread samples were measured using the spectrophotometer (UltraScan PRO) with D65 standard illuminant, angle of 10° and software EasyMatchQC. Four loaves of each sample were used to evaluate the colour. Bread was sliced into slices with 25mm thickness using a sharp bread knife. The results were recorded using the International Commission on Illumination (CIE) colour values L* (lightness), a* (redness) and b* (yellowness) [19, 20, 21]. Each measurement was conducted in three replicates.

Texture Profile Analyses (TPA): After 12 hours of baking, the texture was determined using a texture analyzer (Stable Micro System Ltd. Surrey, England, UK) that was equipped with a 36mm radius cylinder probe (P/36) according to the AACC standard method 74-09 (2000). The operating conditions included load cell (5 kg), pre-test speed (2.0mm/s), test speed (2.0mm/s), post-test speed (2.0mm/s), trigger force (20g) and distance (10mm). Meanwhile, the following parameters were determined: hardness (g), maximum peak force during the first compression cycle (first bite), springiness (mm), height recovered (i.e. during the time that elapses between the end of the first bite and the start of the second bite), cohesiveness, ratio of the positive force area during the second compression to that during the first compression, gumminess (g), product of hardness × springiness and chewiness (g mm), product of gumminess × springiness. Later, two slices of bread (25mm in thickness for each) were stacked on top of each other and a 25% compression of 6.25mm compression distance was taken.

Statistical Analysis: In this study, the means and standard deviations (SD) were calculated using MINITAB (version 14.0, Minitab Inc.) statistical software. The MINITAB was used to perform the one-way analysis of variance (ANOVA) and Tukey's family error rate test at a 95% confidence level ($P<0.05$). Meanwhile, the analysis of the Pearson correlation and the multiple regression analysis were performed on the model.

RESULTS AND DISCUSSION

Fatty Acid Composition: Fatty acid analysis of the samples showed that the sample containing 0% palm oil and 100% palm stearin had that highest proportion of palmitic acid, but with the lowest proportions of oleic and linoleic acids which are the dominant unsaturated fatty acids as compared to the other samples. In more specific, saturated fatty acids include three types of fatty acids, namely myristic (C14:0), palmitic (C16:0) and stearic (C18:0) acids, while unsaturated fatty acids include two types of fatty acids, namely oleic (C18:1) and linoleic (C18:2) acids.

Other fatty acids were also present but in small amounts. The major fatty acids found in the shortening samples were palmitic and oleic acids. The detailed fatty acid compositions (mean ± SD) of all the samples are presented in Table 2.

Increasing the concentration of palm stearin and decreasing the content of palm oil in the blends gradualy increased total palmitic acid (44.88±0.4, 48.38±0.6, 51.17±1.2, 53.24±0.3, 53.62±0.8, 58.62±0.6, 61.91±1.06 and 47.64±1.2 for control, 80:20, 60:40, 50:50, 40:60, 20:80, 0:100 and commercial, respectively). Meanwhile, the total oleic acid was decreased gradually with increasing palm stearin content and decreased the concentration of palm oil (38.3±0.6, 37.19±0.4, 34.81±1.0, 33.18±0.2, 32.88±0.8, 28.70±0.4, 26.24±0.9 and 39.14±0.6 for control, 80:20, 60:40, 50:50, 40:60, 20:80, 0:100 and commercial, respectively).

Iodine value is a measure of the unsaturation of fat and oil. It is one of the most important parameters for measuring the quality of olein [17]. This study has shown that the iodine value of the experimental shortenings was decreased significantly ($p<0.05$) with increasing palm stearin content and vice versa (Table 2).

Determination of the Volume, Specific Volume and Density: The effects of different shortening formulations on the volume, specific volume and density of the bread were investigated using the regression analysis (Table 3). The results revealed that the volume of bread volume was increased with increasing palm stearin. The loaf volume provides a quantitative measurement of the baking performance and it is therefore the most important bread characteristics [22]. The regression equation for the bread volume (Y_1) and palm oil content (X) in the shortening formulations was Y_1=1193-313X. According to the regression equation, when the palm oil content was

Table 2: The compositions of fatty acid in the experimental shortenings of RBD palm oil/palm stearin blends and commercial shortenings

	Fatty acid compositions (wt %)					
Shortenings Ratio of PO:PS	C14:0	C16:0	C18:0	C18:1	C18:2	Iodine value
Control	1.02± 0.06^{a}	44.88± 0.40^{a}	4.07±0.05^{a}	38.3± 0.60^{a}	11.68± 0.3^{a}	52.45±0.89^{a}
80:20	1.25±0.08^{b}	48.38±0.60^{be}	3.54±0.20^{a}	37.19±0.40^{b}	9.64±0.20^{bc}	48.7±0.36^{b}
60:40	1.17±0.04^{b}	51.17±1.20^{b}	3.81±0.01^{a}	34.81±1.00^{c}	9.04±0.30^{b}	44.7±0.30^{c}
50:50	1.24±0.05^{b}	53.24±0.30^{c}	3.83±0.10^{a}	33.18±0.20^{d}	8.51±0.01^{c}	43.6±0.36^{cd}
40:60	1.25±0.03^{ab}	53.62±0.80^{c}	3.68±0.30^{a}	32.88±0.80^{d}	8.57±0.20^{c}	42.1±0.20^{d}
20:80	1.31±0.04^{c}	58.62±0.60^{d}	3.95±0.08^{ab}	28.70±0.40^{e}	7.42±0.10^{d}	37.3±0.90^{e}
0:100	1.19± 0.01^{b}	61.91±1.06^{cd}	4.52± 0.02^{b}	26.24± 0.90^{f}	6.13± 0.09^{d}	31.22± 0.51^{f}
Commercial	1.15±0.06^{ab}	47.64±1.20^{e}	3.86±0.20^{a}	39.14±0.60^{a}	8.21±0.40^{bc}	49.8±0.00^{g}

The data were obtained from the mean value of three replications

[a]values are means ± SD; Means with same letter within each column were not significantly different ($p<0.05$)

Table 3: Regression equations of white bread made from different shortening formulations

		Volume (Y_1)		Specific volume (Y_2)		Density (Y_3)	
Model		Coefficient	*P-value*	Coefficient	*P-value*	Coefficient	*P-value*
Palm oil (X)	β_0	1193	0.000	5.24	0.000	0.1930	0.000
	$\beta_1(X)$	-313	0.000	-1.36	0.000	0.0685	0.000
	R^2	0.70		0.71		0.7100	

Table 4: Coefficients of the correlations among the quality parameters of white bread

	Hardness (g)	Crumb yellowness	Crust yellowness	Crumb redness	Crust redness	Crumb lightness	Crust lightness	Density (g/mL)	Specific volume (mL/g)	Volume (mL)
Volume (mL)	0.546*	0.203	0.089	0.271	0.228	-0.023	0.104	-0.985*	0.990*	
Specific volume (mL/g)	0.553*	0.269	0.099	0.274	0.213	0.015	0.120	-0.990*		
Density (g/mL)	-0.506*	-0.223	-0.076	-0.220	-0.237	-0.003	-0.094			
Crust lightness	0.054	0.266	0.830*	0.137	-0.502*	-0.041				
Crumb lightness	0.239	0.286	-0.162	0.053	-0.203					
Crust redness	-0.065	0.147	-0.155	0.009						
Crumb redness	0.231	0.517*	0.013							
Crust yellowness	-0.004	0.356								
Crumb yellowness	0.212									
Hardness (g)										

*Correlation is significant at $p<0.05$

0% and the palm stearin content was 100% in the shortening formulation, the highest volume was obtained with 1193 mL.

The predicted equation that was determined for the specific volume (Y_2), influenced by the palm oil content (X_1) in the shortening formulations, is shown as Y_2=5.24 -1.36X. Meanwhile, the regression equation indicated that the highest specific volume (5.24mL/g) was obtained when palm oil and palm stearin content were 0% and 100% in the shortening formulation, respectively. Moreover, the regression equation of the bread density (Y_3) and palm oil content (X) in the shortening formulation was Y_3=0.193+0.0685X. In this work, the least density (0.19g/mL) was obtained when the palm oil and palm stearin contents were 0% and 100% in the shortening formulation, respectively.

Table 4 presents the correlation coefficients between the quality parameters of white bread, namely hardness (g), crumb yellowness, crust yellowness, crumb redness, crust redness, crumb lightness, crust lightness, density (g/mL), as well as specific volume (mL/g) and volume (mL).

In the present study, the volume, specific volume and density were found to be significantly correlated (*$p<0.05$*) with the hardness of bread. In particular, the specific volume of bread correlated most closely to the volume and density of bread. More importantly, a positive correlation (r=0.990, *$p<0.05$*) was found between the volume and specific volume. In addition, a negative correlation (r = -0.990, *$p<0.05$*) was also found between the specific volume and density. Likewise, the data indicated a good correlation (*$p<0.05$*) between the crumb yellowness and crumb redness, crust yellowness and crust lightness, as well as crust redness and crust lightness. On the contrary, no significant correlation was obtained between other parameters.

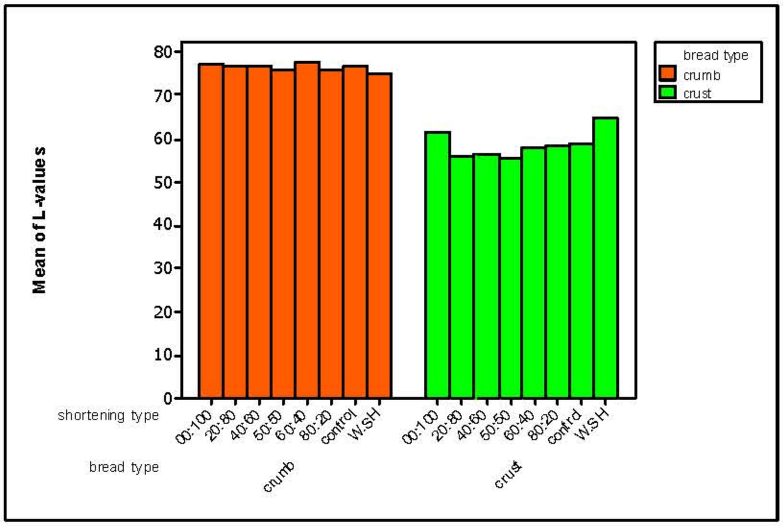

Fig. 1: L* values of breads made from different formulations of shortenings

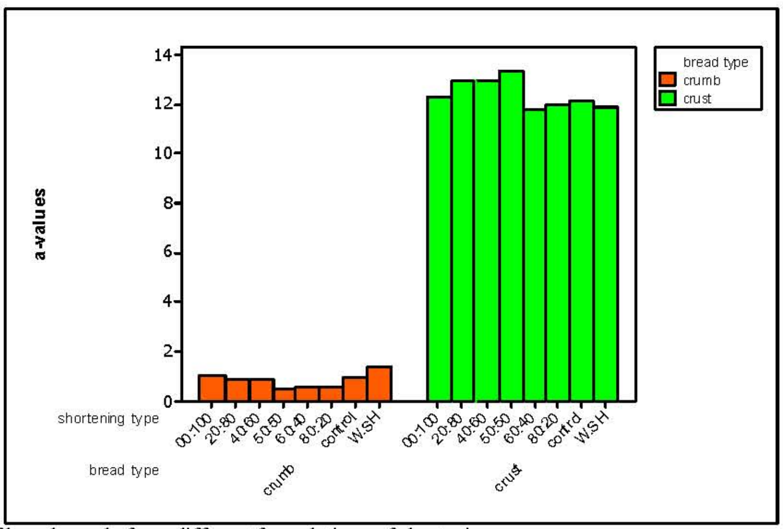

Fig. 2: *a** values of breads made from different formulations of shortenings

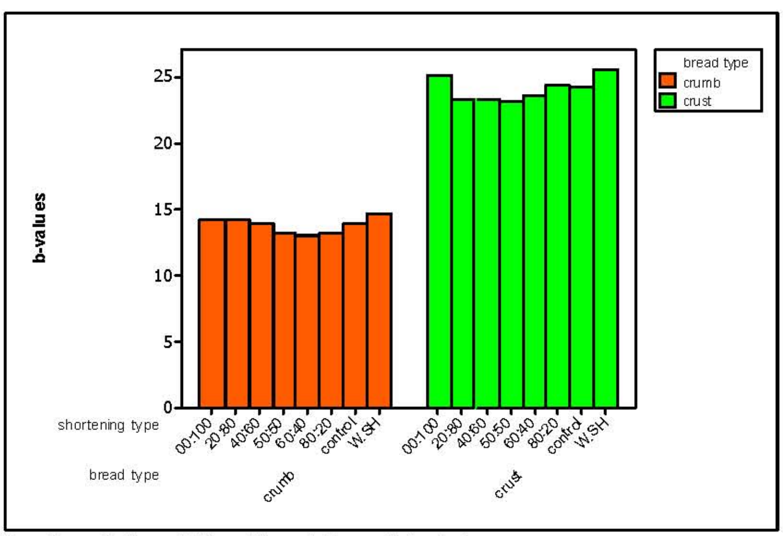

Fig. 3: *b** values of breads made from different formulations of shortenings

Table 5: The texture profile analyses (TPA) of white bread made using different formulations of RBD palm oil/palm stearin-based shortenings

	Hardness (g)		Springiness (mm)		Cohesiveness		Gumminess (g)		Chewiness (gmm)	
Bread samples	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Control	616.7^{c}	91.0	0.863^{b}	0.06	0.739^{a}	0.02	456.7^{c}	75.4	394.7^{c}	73.3
80:20	695.3^{ac}	124.2	0.906^{ab}	0.06	0.757^{a}	0.04	523.9^{ac}	80.1	473.1^{a}	65.9
60:40	723.0^{a}	94.1	0.881^{bc}	0.04	0.739^{a}	0.03	532.9^{a}	61.5	469.4^{a}	56.3
50:50	725.3^{ac}	124.2	0.902^{ab}	0.03	0.728^{ab}	0.04	525.4^{ac}	73.2	473.8^{a}	66.0
40:60	774.7^{a}	102.4	0.878^{abc}	0.06	0.736^{a}	0.03	568.7^{a}	67.1	499.7^{a}	69.1
20:80	777.1^{a}	116.6	0.912^{a}	0.03	0.739^{a}	0.03	574.5^{ab}	90.9	524.9^{ab}	87.6
0:100	945.1^{b}	151.3	0.900^{ab}	0.04	0.699^{b}	0.03	658.3^{b}	92.5	592.6^{b}	91.5
W.SH	1430.9^{d}	133.7	0.862^{c}	0.03	0.759^{a}	0.03	1084.8^{d}	101.8	933.4^{d}	73.5

^{a}within a column, the same letters are not significantly different (p<0.05);

W.SH: without shortening

Colour Measurements: Colour is one of the most important indicators of bread quality, as it contributes to consumers' preference [19, 23]. Chemical reactions, which cause browning colour, include the Maillard reactions and caramelization [19, 20, 24, 21]. Meanwhile, the Maillard reaction is said to occur when most food, such as bread, is heated [24]. The colour of the bread crust and the crumb samples that were made from the different types of shortenings as well as the bread made without shortening are reported in Figures 1, 2 and 3.

Yi *et al.* [23] stated that the most desirable crust and crumb colours of bread samples should be golden brown and creamy white, respectively. The mean L* values of the bread were found to range from 55.45±2.95 to 64.86±4.60 and from 75.18±1.40 to 77.64±2.73 for the bread crust and crumb, respectively (Fig. 1). In more specific, the bread crusts made without the use of any shortening were lighter in colour as compared to those with shortenings, while the ones made from shortening containing 50:50 of the PO:PS ratio had the darkest colour.

The *a** values, which are indications of the red colour in bread, for both bread crumb and crust are shown in Figure 2. Bread made from the shortening (type 50:50) was found to have the highest *a** values for crust and the lowest *a** values for crumb. In general, bread that was made from shortening type 50:50 was significantly different (*P*<0.05) from those made with the use of shortening type 0:100, as well as the bread made without shortening. Meanwhile, the highest and lowest *a** values for the crust were associated with the bread that was made from the shortening types 60:40 and 50:50, respectively. The highest and lowest *a** values for the crumb were related to the bread that was made from the shortening type 50:50 and the one that was made without the use of any shortening. Nonetheless, the *b** values, which indicate yellow, did not show any significant difference *(P<0.05)* between the bread types, except for the bread that was made from shortening type 50:50 and those without any shortening (Fig. 3). It is important to highlight that the effects of shortening type 50:50 on the crust and crumb colours of the white bread samples were more obvious than the other shortening types.

Texture Profile Analysis (TPA): The measurement with the texture Profile Analysis (TPA) permits bakers to consistently and objectively check the quality of their bread [22]. Textural properties, such as hardness (g), springiness (mm), gumminess (g), chewiness (gmm) and cohesiveness of bread that was made using shortenings of different formulations, were evaluated using the TPA (Table 5). Data indicated that the highest values of hardness, cohesiveness, gumminess and chewiness were observed for the bread samples that were made without using any shortenings, while the lowest values for hardness, gumminess and chewiness were shown for the bread samples that were added with shortening type 100:0 (control). However, the bread sample 0:100 had the lowest value of cohesiveness.

A significant difference (p<0.05) in the texture profile analyses of white bread was found between the bread samples that were made using shortening of different formulations and those that were made without the use of any shortening. Among the bread formulations, the bread sample 100:0 (control) was found to be significantly different (p<0.05) from the bread samples with 60:40, 40:60, 20:80 and 0:100 in hardness, gumminess and chewiness. Generally, texture is influenced by the concentration of palm stearin in the shortening formulations. The values of hardness heighten with increasing palm stearin content in the shortening formulation. Aini and Maimon [6] reported that the highest level of palm stearin in the shortening formulation, the firmer the bread texture would become.

CONCLUSIONS

These findings discussed in this article indicated that increasing the concentration of palm stearin in the shortening formulation increased the specific volume and loaf volume but decreased its density. In this study, positive correlations were obtained between volume and specific volume, while negative correlations were obtained between density and volume as well as specific volume. Therefore, this work has highlighted how different formulations of shortenings interact to influence the ultimate bread quality. As expected, bread that was made without the use of any shortening was completely different from all others. The main difference from all other samples was their high crumb hardness. In particular, the bread that was made from shortening type 50:50 turned out to have the darkest in colour, while those made without any shortening were the lightest. The lowest and highest loaf volume and specific volume were shown for the bread that was made without using any shortening and those made using shortening type 0:100, respectively. The TPA values showed that the textural characteristics were affected by the presence of palm stearin in the shortening formulations. Therefore, it can be concluded that shortening type 50:50 can be added to the formulations so as to obtain high quality characteristics of bread which include high volume, low density, good texture and golden brown crust.

REFERENCES

1. Baiano, A., R. Romaniello, C. Lamacchia and E.L. Notte, 2009. Physical and mechanical properties of bread loaves produced by incorporation of two types of toasted durum wheat flour. J. Food Engineering, 95(1): 199-207.
2. Chin, N.L., R.A. Rahman, D. Hashim and S.Y. Kowng, 2009. Palm oil shortening effects on baking performance of white bread. J. Food Process Engineering, 33(3): 413-433.
3. Braipson-Danthine, S. and C. Deroanne, 2004. Influence of SFC, microstructure and polymorphism on texture (hardness) of binary blends of fats involved in the preparation of industrial shortenings. Food Research International, 37(10): 941-948.
4. Jirasubkunakorn, W., A.E. Bell, M.H. Gordon and K.W. Smith, 2007. Effects of variation in the palm stearin: Palm olein ratio on the crystallisation of a low-trans shortening. Food Chemistry, 103(2): 477-485.
5. Gunstone, F.D., 2004. The Chemistry of Oils and Fats: Sources, Composition, Properties and Uses: Blackwell.
6. Aini, I.N. and C.HC. Maimon, 1996. Characteristics of white pan bread as affected by tempering of the fat ingredient. Cereal Chemistry, 73(4): 462-465.
7. Thomas, A.E., 1978. Shortening formulation and control. J. the American Oil Chemists' Society, 55(11): 830-833.
8. Aibara, S., N. Ogawa and M. Hirose, 2005. Microstructures of bread dough and the effects of shortening on frozen dough. Bioscience, Biotechnology and Biochemistry, 69(2): 397-402.
9. Miskandar, M.S., Y.B., Man, R.A. Rahman, I.N. Aini, and M.S.A. Yusoff, 2007. Effect of emulsifiers on crystal behavior of palm oil blends on slow crystallization. J. Food Lipids, 14(1): 1-18.
10. Weiss, T.J., 1983. Food oils and their uses: Westport.
11. Chin, N.L., S.K. Goh, R.A. Rahman and D.M. Hashim, 2007. Functional Effect of Fully Hydrogenated Palm Oil-based Emulsifiers on Baking Performance of White Bread. International J. Food Engineering, 3(3): 1-15.
12. Lee, J.H., C.C. Akoh and K.T. Lee, 2008. Physical properties of trans-free bakery shortening produced by lipase-catalyzed interesterification. Journal of the American Oil Chemists' Society, 85(1): 1-11.
13. Osman, A. and N. Aini, 1999. Physical and chemical properties of shortenings from palm oil:tallow and palm olein: tallow blends with and without interesterification. J. Oil Palm Res., 11(1): 1-10.
14. Cauvain, S.P. and L.S. Young, 2007. Technology of breadmaking: Springer Verlag.
15. Smith, P.R. and J. Johansson, 2004. Influences of the proportion of solid fat in a shortening on loaf volume and staling of bread. J. Food Processing and Preservation, 28(5): 359-367.
16. Chu, B.S., H.M. Ghazali, O.M. Lai, Y.B. Che Man and S. Yusof, 2002. Physical and chemical properties of a lipase-transesterified palm stearin/palm kernel olein blend and its isopropanol-solid and high melting triacylglycerol fractions. Food Chemistry, 76(2): 155-164.
17. Mamat, H., I. Nor Aini, M. Said and R. Jamaludin, 2005. Physicochemical characteristics of palm oil and sunflower oil blends fractionated at different temperatures. Food Chemistry, 91(4): 731-736.
18. AOCS., 1988. Recommended Practices of the American Oil Chemists' Society, pp: 1-2: AOCS Press, Champaign.

19. Esteller, M.S. and S.C.S. Lannes, 2008. Production and Characterization of Sponge-dough Bread Using Scalded Rye. J. Texture Studies, 39(1): 56-67.
20. Gómez, M., F. Ronda, C.A. Blanco, P.A. Caballero and A. Apesteguía, 2003. Effect of dietary fibre on dough rheology and bread quality. European Food Research and Technol., 216(1): 51-56.
21. Mohamed, A., P. Rayas-Duarte and J. Xu, 2008. Hard Red Spring wheat/C-TRIM 20 bread: Formulation, processing and texture analysis. Food Chemistry, 107(1): 516-524.
22. Hathorn, C.S., M.A. Biswas, P.N. Gichuhi and A.C. Bovell-Benjamin, 2008. Comparison of chemical, physical, micro-structural and microbial properties of breads supplemented with sweet potato flour and high-gluten dough enhancers. Food Science and Technol., 41(5): 803-815.
23. Yi, J., J.W. Johnson and W.L. Kerr, 2009. Properties of bread made from frozen dough containing waxy wheat flour. J. Cereal Sci., 50(3): 364-369.
24. Jooyandeh, H., 2009. Evaluation of physical and sensory properties of Iranian Lavash flat bread supplemented with precipitated whey protein (PWP). African J. Food Sci., 3(2): 028-034.