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Partial Substitution of Margarine with Avocado Fruit Puree for Healthy Pound Cake Preparation using Various Flour Types and Baking Methods

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Abstract

Avocado (Persea americana) is known to have high dietary fiber and monounsaturated fatty acids which can reduce low density lipoprotein (LDL); thus, reduced risk of heart attack. The research objective was to partially substitute margarine with avocado puree in the preparation of pound cakes to reduce the saturated fat and increase the nutritional values. The pound cakes were prepared with five different ratios of avocado puree to margarine which were 0:1, 1:3, 1:1, 3:1, and 1:0 using three types of flour (all-purpose, cake, or bread flour) and baked using two methods (oven and microwave baking). Results showed that avocado contains 81.37±1.38 (%, wb), 53.09±3.64 (%, db), 6,98±0.49 (%, db), 34.57±3.63 (%, db), and 5.36±0.49 (%, db) of moisture, fat, protein, carbohydrate, and ash, respectively. From each type of flour, one poundcake was selected based on its physical properties i.e. firmness, volume expansion, L value, and °hue. Selected pound cakes were further evaluated with scoring and hedonic tests by 70 panelists to observe its consumer acceptance and selected the best pound cake from each type of baking methods (oven and microwave baking). The results showed that oven-baked pound cake with avocado puree to margarine ratio 1:1 prepared with cake flour and microwave-oven-baked pound cake with avocado puree to margarine ratio 1:1 prepared with bread flour exhibited the highest acceptance with overall hedonic values of 4.96±1.18 and 4.83±1.09, respectively. However, considering the time needed for baking and that the microwave baked pound cakes exhibiting higher protein, the pound cake baked in the microwave oven is more preferrable for further commercial manufacture.*

Keywords: *avocado;baking; fat-substitution;flour types, pound-cake*

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INTRODUCTION

Cake is one of favorite foods of children and adults. Based on the amount of fat used, cake is divided into shortened and un-shortened (Manay and Shadaksharaswamy, 2001). Shortened cakes are most commonly used as birthday or wedding cakes where pound cake is one of the examples of them (Conforti, 2007). However, the amount of fat used in pound cake making is quite high. Meanwhile, the global prevalence of people with hypercholesterolemia tends to increase (WHO, 2015). Cholesterol is divided into two types, high density lipoprotein (HDL) and low-density lipoprotein (LDL). Unlike the HDL, LDL can cause strokes and heart attacks. As LDL is oxidized, it can infiltrate the artery lining and accumulated in the artery wall. Margarine or butter intake can cause LDL levels to rise (Hemat, 2004).

Avocado (*Persea americana*) is a fruit that contains high content of monounsaturated fatty acids which do not induce LDL level raise (Chow, 2007). Hence, avocado can be used as a fat-source replacer instead of other monounsaturated fatty acid sources like olive, algae, etc. due to its wide availability. Very few previous works have been performed to study the use of avocado as a fat-source replacer. Avocado has been used to successfully replace butter by 50 % in oatmeal cookies (Wekwete and Navder, 2008). Although butter and margarine are originated from different sources (i.e. animal and plant), they demonstrate very close chemical and physical properties. Another study successfully replaced margarine in brownies where avocado puree to margarine ratio of 1:3 in brownies made from cake flour and baked in a microwave oven exhibited excellent characteristics (Lambertha, 2018). Thus far, avocado has not been used for pound cake preparation. It may be a challenging idea to use avocado to reduce the usage of margarine in pound cakes. That is why, a study on the potential use of avocado as a fat replacer or substitute to margarine in pound cake making is interesting to be carried out. In addition, the sensory and physical characteristics of the product can be used as other determining parameters to find out the best condition. The objectives of this research were to study the use of avocado as a natural fat replacer to partially substitute margarine in pound cake as well as to find out the most suitable flour and baking method for pound cake preparation.

MATERIALS AND METHOD

Main materials used in this research for preparation of pound cakes were avocado (*Persea americana* var. *Mentega*), "Blue Band" margarine, "Kunci Biru" cake flour, "Segitiga Biru" all-purpose flour, "Cakra Kembar" bread flour, "Alini" sugar, eggs, and "Koepoe-koepoe" baking powder. Other materials used for analyses and assays were of analytical and/or food grades.

Preparation of Avocado Puree

Ripe avocado was selected based on the physical texture (soft when pressed). Firstly, approximately 680 g of avocado fruit was washed with water, blanching of it using boiling water for 10 s and followed by cooling it in cold iced water (Kalra and Pant, 2004). Then, the avocado fruit was cut into two parts with a kitchen knife. The flesh was taken and cut into big chunks. Finally, the avocado flesh was milled using a domestic blender to obtain avocado puree for making a batch of formulations. The analysis on the avocado puree was done in duplicate.

Preparation of Pound Cake

The procedure of making pound cakes was based on Wibowo (2016) with modification on the formulation by partially substitution of margarine with avocado puree and flour with various types of flour (cake flour, all-purpose flour, and bread flour). The formulations can be seen in Table 1. To make the pound cake, all ingredients were prepared and weighed according to the formulation showed in Table 1. All formulations except avocado and margarine were the same amount for each ratio. Sugar and flour were sieved during preparation to prevent lumps when they were added into the batter. Next, eggs and sugar were mixed in a bowl using a mixer with high speed until leavened. Then, margarine and/or avocado puree was added and blended using a hand mixer. Flour, salt, and baking powder were then introduced into the batter mixture. Batter was mixed with the help of a spatula to obtain a visible homogeneous mixture. Then, the batter was poured into a baking pan or -

Table 1. Formulation of pound cakes

Ingredients	**Avocado Puree to Margarine Ratio**				
	0:1 (C*)	**1:3**	**1:1**	**3:1**	**1:0**
-Avocado puree (g)	0	37.5	75	112.5	150
-Margarine (g)	150	112.5	75	37.5	0
-Wheat flour (cake/ all-purpose/bread flour) (g)	150	150	150	150	150
-Sugar (g)	150	150	150	150	150
-Egg (g)	150	150	150	150	150
-Baking powder (g)	1.50	1.50	1.50	1.50	1.50
-Salt (g)	0.5	0.5	0.5	0.5	0.5
Total (g)	602	602	602	602	602

*C: Control (Wibowo, 2016)

microwaveable pan that was covered with baking paper. Pan was then baked in a conventional oven for 30 min that had been preheated to 180°C or in a domestic microwave oven for 7 min. When finished, pound cake was withdrawn and let to equilibrate with ambient environment.

Proximate Analysis of Avocado Puree

Proximate analysis of avocado puree was conducted for its moisture content, protein, fat, ash, all based on (AOAC, 2005) and carbohydrate content calculated by difference. For moisture content, approximately 5 grams of avocado puree was dried in a 105°C oven for 3-5 h and proceeded the rest according to the standard method of AOAC (2005). Protein content was examined to 2 g of sample according to the Kjeldahl method (AOAC, 2005). Fat content evaluation to 5 g of sample was performed by Soxhlet method (AOAC, 2005). Ash content was determined using the combustion method at 500°C, following the protocol of AOAC (AOAC, 2005). Finally, the carbohydrate content was calculated using difference method (100 - the sum of moisture content, ash content, protein content, and fat contents) (AOAC, 2005).

Physical Characterization of Pound Cake

Firmness and Volume Expansion

Firmness of pound cakes was measured using Texture Analyzer-XT (Stable Micro System, Surrey, UK) with cylindrical probe P/25P. Sample was compressed twice up to 5 mm for each replication with speed of 1.67 mm/s. The volume expansion of pound cake was calculated from the volume before and after baking. The volume before baking was measured by the volume of batter (pan length × pan width × batter height). Volume after baking was measured by using the seed displacement method.

Color Determination

Color measurement was conducted using a Konica Minolta CR-400 chromameter (Konica Minolta Sensing Singapore Pte Ltd) with L* value and °hue as the parameter. Measurement was done twice for each replication.

Sensory Evaluation of Selected Pound Cake

Scoring and Hedonic Tests

Scoring test was subjected to 12 samples consisting of six selected pound cakes and six control pound cakes employing 70 untrained panelists. The panelists were assigned to give a score from 1 - 6. The attributes measured were color, aroma, texture, and taste.

Hedonic test was also performed to the 12 samples used in the scoring test. The parameters in this hedonic test were taste, aroma, color, texture, and overall acceptance of pound cake. Seventy untrained panelists rated the samples from 1 - 7 of the hedonic scales.

Statistical Analysis

Statistical analysis was carried out using Completely Randomized Design conducted using SPSS application program.

RESULTS AND DISCUSSION

Chemical Composition of Avocado

Chemical composition of avocado used in this study is shown in Table 2. Avocado was mainly composed of water with a moisture content of 81.37 ± 1.38% (wb) not far different from a previous report (USDA, 2018) of 73.23% (wb). Fat came next in terms of the content of 53.09 ± 3.64%, followed by carbohydrate of 34.57 ± 3.63% and protein with an amount of 6.98 ± 0.49%, and ash content the lowest.

Table 2. Chemical composition of avocado puree

Composition	Content (%)	
	Value	USDA (2018)
Moisture content (wb)	81.37±1.38	73.23
Fat (db)	53.09±3.64	54.30
Carbohydrate (db)	34.57±3.63	31.59
Protein (db)	6.98±0.49	7.41
Ash (db)	5.36±0.49	5.56

The differences of the chemical composition of avocado puree with that of USDA (2018) might be due to differences in climate, temperature, soil, agricultural practices, such as the use of fertilizers, pesticides, harvest timings and the cultivation system used by the farmers (Florkowski *et al.*, 2014).

Physical Characteristics of Pound Cake

Firmness

Oven Baked Pound Cake Prepared with All-purpose Flour, Cake Flour, and Bread Flour

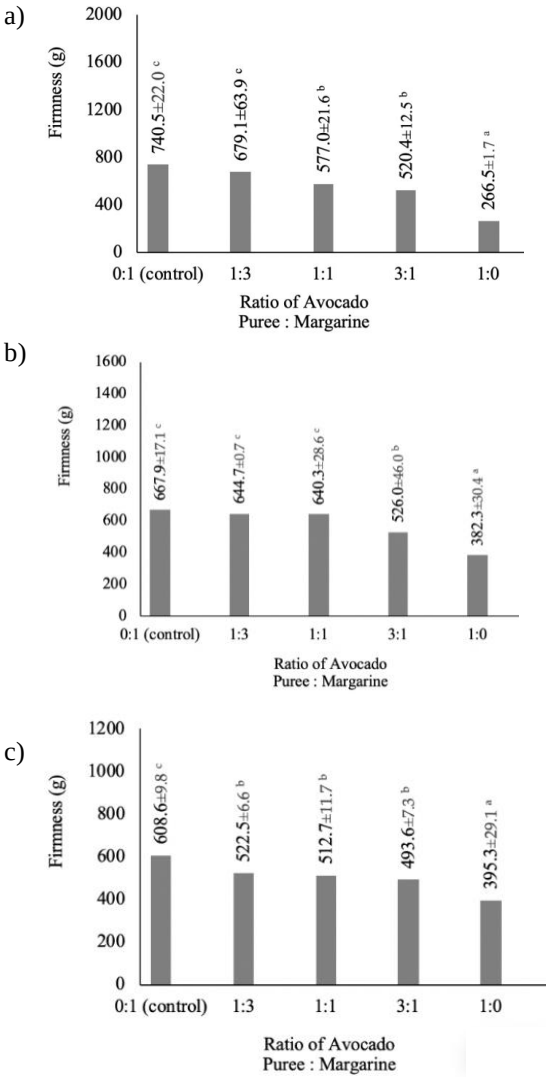
Firmness of pound cake prepared with all-purpose flour baked in oven is shown in Figure 1. Based on statistical analysis, there was a significant effect ($p \leq 0$ .05) of the ratio of avocado puree to margarine on firmness of the oven baked pound cake made with all-purpose flour. From Figure 1, similar to the control, pound cake with ratio 1:3 had the highest firmness (679.1 ± 63.9 g); whereas the lowest firmness was ratio 1: 0 (no margarine added) with a value of 266.5 ± 1.7 g.

Firmness of oven baked pound cake prepared with cake flour is shown in Figure 1b. Based on statistical analysis, an obvious significant effect ($p \leq$ 0.05) of ratio of avocado puree to margarine on firmness of the oven baked pound cake prepared with cake flour can be seen. From Figure 1b, pound cake made with ratio 1:3 had the highest firmness (644.7 ± 0.7 g) and was not significantly different with the control as well as and ratio 1:1. On the other hand, pound cake made with ratio 1:0 had the lowest firmness and significantly different to the other pound cakes.

Firmness of oven baked pound cake prepared with bread flour is shown in Figure 1c. Based on statistical evaluation, there was significant effect ($p \leq 0.05$) of ratio of avocado puree to margarine on firmness of the oven baked pound cake prepared with bread flour. Figure 1c shows that the firmness was all significantly different to the control.

Microwave-Oven Baked Pound Cake Prepared with All-purpose Flour, Cake Flour, and Bread Flour

Firmness of microwave-oven baked pound cake prepared with all-purpose flour is shown in Figure 2a. There was significant effect ($p \leq 0.05$) of the ratio of avocado puree to margarine on firmness of microwave-oven baked pound cake prepared with all-purpose flour.



Note: Different superscripts indicate significant difference ($p \leq 0.05$)

Figure 1. Firmness of oven baked pound cake prepared with a) all-purpose flour, b) cake flour, c) bread flour

From Figure 2a, pound cakes made with avocado puree to margarine with ratio 1: 3 (642.15±29.56 g) exhibited the highest firmness and it was not significantly different to the control as well as to pound cakes with ratio 1:1 and ratio 3:1 with values of 782.25±35.36 g, 608.25±8.06 g, and 597.88±5.27 g, respectively. Pound cake with the lowest firmness was the one made ratio of avocado puree to margarine 1: 0 with a firmness of 309±6.36 g. Pound cake with ratio 1: 0 was significantly different from the pound cakes and had the lowest firmness.

Firmness of microwave oven baked pound cake prepared with cake flour is shown in Figure 2b. There was significant effect ($p \leq 0.05$) of ratio of avocado puree to margarine on firmness of microwave oven baked pound cake prepared with cake flour. Figure 2b shows that the highest and closest firmness value to control was pound cake with ratio 1: 3 with firmness of 770.55 ± 5.59 g. However, ratio 1:3 was also not significantly different to pound cake with ratio 1:1. On the other hand, pound cake with ratio 1:0 was the one with the lowest firmness of 470.38 ± 7.46 g. This shows that with more avocado puree used, the cakes had less firmness which is in accordance with the report of Conforti (2007).

Firmness of microwave oven baked pound cake prepared with bread flour is shown in Figure 2c. Based on statistical analysis, there was significant effect ($P \leq 0.05$) of the ratio of avocado puree to margarine on firmness of microwave baked pound cake prepared with bread flour. Figure 2c shows that pound cake with ratio 1:3 (585.95 ± 10.61 g) had the highest firmness than other ratios and was not significantly different with the control sample. Meanwhile, pound cake with ratio 1:0 had the lowest firmness with firmness of 308.28 ± 24.15 g.

Generally, in all cases of oven and microwave-oven baked pound cakes, the graphs tend to show that the more avocado puree was used instead of margarine, the lower the firmness was. This low firmness might be due to high amount of fat in avocado puree which caused the cake to be softer or soggy in texture resulting less dense matrix, hence decreasing the firmness. Other contributing factors may be the heterogeneous nature of avocado puree as compared to homogenous one of margarine (mostly fat) resulting in different dynamic structural interactions where the homogenous material may interact better with other components, hence more firmness.

Volume Expansion

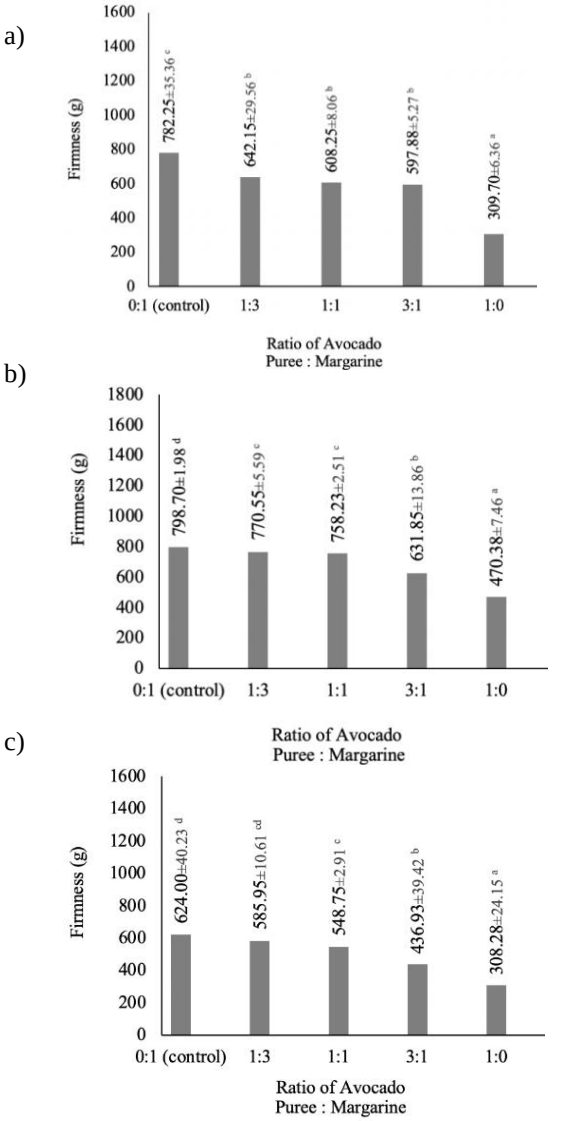
Oven Baked Pound Cake Prepared with All-purpose Flour, Cake Flour, and Bread Flour

Volume expansion of oven baked pound cake prepared with all-purpose flour is shown in Figure 3a. Based on statistical analysis, there was a significant effect ($p \leq 0.05$) of the ratio of avocado puree to margarine on volume expansion of oven baked pound cake prepared with cake flour. From Figure 3a, the volume expansion of pound cake made with avocado

puree to margarine ratio of 1: 3 (142.95 ± 2.72%) was the highest which was similar with the control as well as with pound cake with ratio 1:1. The lowest volume expansion was the pound cake made with ratio 1:0, with an expansion of 114.09 ± 2.25% which was similar with ratio 3:1.

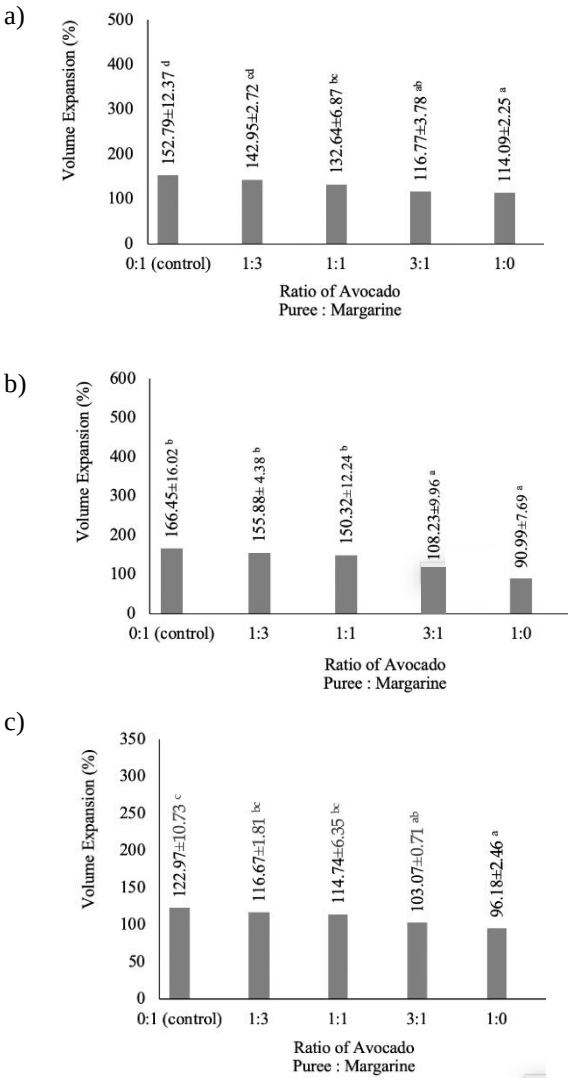
Volume expansion of oven baked pound cake made with cake flour is shown in Figure 3b. There was significant effect ($p \leq 0.05$) of ratio of avocado puree to margarine on the volume expansion. Figure 3b shows that the highest volume expansion was the pound cake made with ratio 1:3 with volume expansion of 155.88 ± 4.38% although it was not significantly different with those of the control and ratio 1:1. Ratio 1:0 had lowest volume expansion. Figure 3b shows that with less margarine used, the lower the volume expansion was which was in accordance with the observation of Conforti (2007).

Volume expansion of oven baked pound cake prepared with bread flour is shown in Figure 3c. Based on statistical analysis, there was significant effect ($p \leq 0.05$) of ratio of avocado puree to margarine on volume expansion of oven baked pound cake prepared with bread flour. From Figure 3c, the highest volume expansion was from pound cake made with ratio 1:3 and similar to the control (116.67 ± 1.81%) as well as to pound cake with ratio 1:1 (114.74 ± 6.35%). Pound cake made with ratio 1:0 (no margarine added) had the lowest volume expansion with only 96.18 ± 2.46%.



Note: Different superscripts indicate significant difference ($p \leq 0.05$)

Figure 2. Firmness of microwave-oven baked pound cake prepared with a) all-purpose flour, b) cake flour, c) bread flour.



Note: Different superscripts indicate significant difference ($p \leq 0.05$)

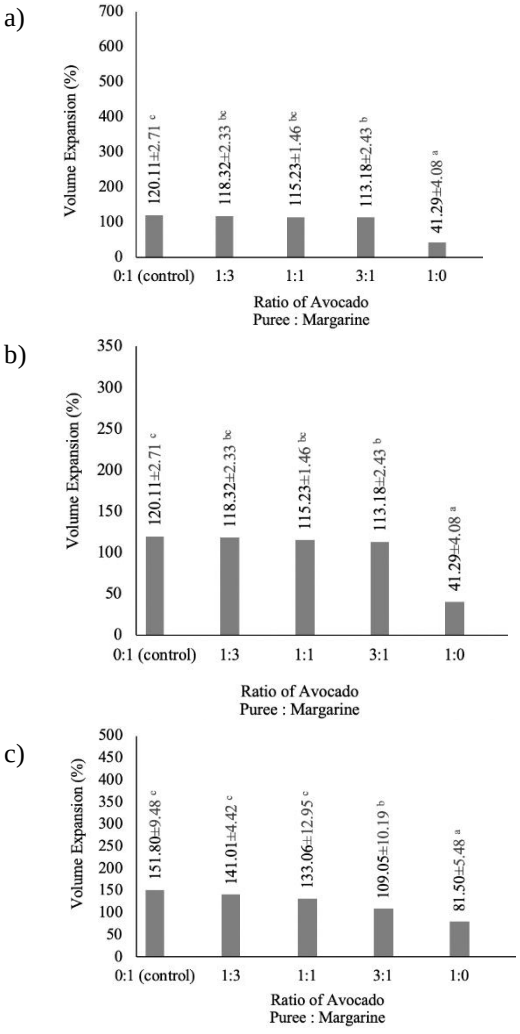
Figure 3. Volume expansion of oven baked pound cake prepared with a) all-purpose flour, b) cake flour, c) bread flour

Microwave-Oven Baked Pound Cake Prepared with All-purpose Flour, Cake Flour, and Bread Flour

Volume expansion of microwave-oven baked pound cake prepared with all-purpose flour is shown in Figure 4a. Based on statistical analysis, there was significant effect ($p \leq 0.05$) of avocado puree to margarine on volume expansion of microwave oven baked pound cake prepared with all-purpose flour.

Pound cake made with avocado puree to margarine with ratio 1:3 was the highest volume expansion of 118.32 ± 2.33 than the other pound cakes although was not significantly different with the control as well as pound cake with ratio 1:1. On the other hand, pound cake made with ratio 1:0 had the lowest volume expansion as much as 41.29 ± 4.08% which might be caused by reasons mentioned by Conforti (2007).

Volume expansion of microwave oven baked pound cake prepared with bread flour is shown in Figure 4c.



Note: Different superscripts indicate significant difference ($p \leq 0.05$)

Figure 4. Volume expansion of microwave-oven baked pound cake prepared with a) all-purpose flour, b) cake flour, c) bread flour

Based on statistical analysis, there was significant effect ($p \leq 0.05$) of ratio of avocado puree to margarine on the volume expansion of microwave oven baked pound cake prepared with bread flour.

Volume expansion of microwave oven baked pound cake prepared with cake flour is shown in Figure 4b. There was significant effect ($p \leq 0.05$) of ratio of avocado puree to margarine on volume expansion of the microwave oven baked pound cake prepared with cake flour. Figure 4b shows that like control, pound cake with ratio 1:3 (118.32 ± 2.33%) had the highest volume expansion as well as being similar to pound cake with ratio 1:1 and ratio 3 :1. Pound cake with the lowest firmness was pound cake with ratio 1: 0 (41.29 ± 4.08%). The volume expansion of the pound cakes decreased as less margarine used in the formulation.

As shown Figure 4c, the volume expansion of the pound cake with ratio 1:3 (141.01 ± 4.42%) had the highest volume expansion and was not significantly different with ratio 1:1 and the control. The lowest expanding was the pound cake made with ratio 1: 0 (no margarine added) with volume expansion of 81.50 ± 5.48% only.

The usage of fat caused the entrapment of air which results in leavening of the product (Sumnu and Sahin, 2008). The entrapment of air might be due the interaction between fat and other components such protein resulting a matrix which entraps air. Ratio 1: 0 used no margarine at all while fat in margarine (having a more homogenous matrix) contributes to increasing volume by trapping air (Conforti, 2007). Avocado puree as a composite material may have less ability to entrap air due to a more heterogeneous matrix which may negatively disrupt the entrapment of air by the matrix, thus resulted in lower volume expansion.

L* Value and °Hue

Oven and Microwave-oven Baked Pound Cake Prepared with All-purpose Flour, Cake Flour, and Bread Flour

For the oven method, there was no significant effect ($p > 0.05$) of ratio of avocado puree to margarine on L* value and °hue of the oven baked pound cake prepared with all-purpose flour, cake flour, and bread. The L* values of pound cake prepared with all-purpose flour, cake flour, and bread ranged, respectively, from 69.76 ± 0.27 up to 71.43 ± 1.38 with the control having an L* value of 71.21 ± 1.99, 65.64 ± 1.60 to 72.81 ± 0.37 with the control having the highest L* value, and 67.44±0.87 up to 70.07 ± 3.06 with the control having the highest L* value. The °hue of pound cake prepared with all-purpose flour, cake flour, and bread ranged, respectively, from 178.48 ± 0.02 to 178.55 ± 0.03 with the control having the lowest °hue, 178.54±0.02 to 178.57 ± 0.02 with the control and ratio 1:3 having the lowest °hue, and 178.54 ± 0.01 to 179.26 ± 1.05 with the control having the highest °hue.

For the microwave-oven method, there was also no significant effect ($p > 0.05$) of ratio of avocado

puree to margarine on L* value and ºhue of the microwave-oven baked pound cake prepared with all-purpose flour, cake flour, and bread. The L* values of pound cake prepared with all-purpose flour, cake flour, and bread ranged, respectively, from 69.25 ± 0.29 to 71.36 ± 0.48 with the control having L* value of 70.47 ± 4.17, 69.25 ± 1.26 to 73.28 ± 1.38 with the control having L* value of 73.28 ± 1.38, and 69.90 ± 0.81 to 71.24 ± 0.89 with the control having L* value of 71.24 ± 0.89. The ºhue of pound cake prepared with all-purpose flour, cake flour, and bread ranged, respectively, from 178.51 ± 0.01 to 178.58 ± 0.00 with the control having ºhue of 178.51 ± 0.01, 178.53 ± 0.02 up to 178.61 ± 0.04 with the control having ºhue of 178.53 ± 0.02, and 178.53±0.01 up 178.60 ± 0.01 with the control having ºhue of 178.53 ± 0.01.

Overall, for the oven and microwave-oven method, results of L* value as a measure of lightness from 0-perfect black to 100-perfect white (Lindon *et al.,* 2016) indicate that the pound cakes lightness was in the range of that of control indicating that the lightness of avocado puree did not affect that of the pound cakes obtained using the 3 types of flour. The ºhue (color) of the pound cakes was categorized as in the range of green color altogether based on ºhue interpretation according to Hutchings (1999). Since the hue of the control and treated pound cakes was similar, this would indicate that avocado puree did not affect the hue (color) of pound cakes prepared with the 3 types of flour.

Selection of Pound Cake Formulations Based on Physical Characteristics

Pound Cakes Baked in Oven

There are 3 best pound cakes baked in oven were selected which were with ratios 1:3, 1:1 and 1:1each from all-purpose flour, cake flour, and bread flour, respectively. Figure 1ashows that ratio 1:3 was chosen for the all-purpose flour as it was the only one that was the closest or not significantly different with the control. In Figure 3a, it was also shown the volume expansion of ratio 1:3 was not significantly different with the control. Ratio 1:1 was chosen for the cake flour since as seen in Figure 1b that firmness of ratio 1:3 and ratio 1:1 is both not significantly different with the control. Ratio 1:1 was chosen as it used more avocado puree (50% avocado puree:50% margarine) to substitute the margarine and its nutritional benefit over ratio 1:3 (more margarine). In Figure 3b, although the volume expansion of ratio 1:3 was not significantly different from the control, ratio 1:1 was not significantly different with ratio 1:3 thus ratio 1:1 is chosen for the same reason i.e. more avocado. In Figure 1c, none were close to the control and among them ratio 1:3 is the closest to the control. However, ratio 1:1 was not significantly different with ratio 1:3. The volume expansion of ratio 1:1 was also not significantly different to the control as shown in Figure 3c; thus, ratio 1:1 was chosen.

Pound Cakes Baked in Microwave Oven

There are also 3 best pound cakes baked in microwave oven were selected which were with ratio 1:1 for all flour types i.e., all-purpose flour, cake flour, and bread flour. Figure 2a shows that ratio 1:3 was closest to the control although it was significantly different. However, ratio 1:1 was chosen because ratio 1:1 was not significantly different with ratio 1:3 and had more margarine substituted as well as better nutritional values as compared to ratio 1:3. The volume expansion of ratio 1:1 was also not significantly different with the control as can be seen from Figure 4a. Ratio 1:1 was also chosen for the cake flour based on the same reason for the all-purpose flour. Ratios 1:3 and ratio 1:1 were not significantly different with each other as seen in Figure 2b but ratio 1:1 was chosen for it had more margarine substituted with avocado puree. In Figure 4b also showed that the volume expansion of ratio 1:1 was not significantly different with the control. In Figure 2c, ratio 1:3 was the closest to the control, however ratio 1:1 was not significantly different with ratio 1:3. Having more margarine replaced and considering the nutritional values, ratio 1:1 was chosen.

Comparison of Baking Methods Based on Physical Characteristics

The firmness, volume expansion, L* value, and oHue of pound cakes made with oven and microwave oven are shown in Figures 1-4. The firmness of pound cakes baked with microwave oven were firmer than cakes baked in the oven. This was in accordance with the theory of Proctor (2011). Pound cakes AF-0:1, CF-0:1, and CF-1:1 baked in microwave oven had less volume formed than the ones baked in oven while pound cakes BF-0:1 and BF-1:1 baked in microwave oven had more volume expansion than the ones baked in oven which was in accordance with the theory of Regieret. Regieret stated cakes baked with microwave oven are generally having very low volume and very firm texture. However, baking cakes made from bread flour in microwave oven results in higher volume ofthe product (Singh and Heldman, 2001). Pound cakes in microwave oven were generally having higher L* value than those baked in oven. This might be because microwave-oven baking causes much less browning reaction on their products, unlike oven baking (Proctor, 2011). The ohue of the pound cakes ranged from 178.48±0.01 to 179.26±1.05; hence, considered green (Hutchings, 1999) as discussed elsewhere.

Visual Observation of Selected Pound Cakes

Oven Baked Pound Cake Prepared with All-purpose Flour, Cake Flour, and Bread Flour

For the all-purpose flour pound cake as shown in Figure 5, the color of the pound cake with ratio 1:3 was slightly greener than the ratio 0:1. Although both pound cakes were categorized as green colored as discussed previously, the L* value or lightness of the

control was higher than the ratio 1:3 which explains why the control did not look as green as ratio 1:3. The control was more compact with less irregular air cells than ratio 1:3. This may be due to more avocado puree used which had less ability to incorporate air evenly like margarine did (Conforti, 2007). Other factors that may affect the compactness of the control might be the gluten network that may interact with more homogenous attributes of margarine i.e. almost all fat.

a) b)

Figure 5. Oven baked pound cakes prepared with all-purpose flour (a) Ratio 0:1 (control) and (b) ratio 1:3

For the cake flour pound cake in Figure 6, the color of the pound cake made with ratio 1:1 was greener than the control. The L*value of pound cake with ratio 0:1 was closer to 100 (perfect white) than ratio 1:1, which might be the cause why ratio 0:1 did not look green visually. Ratio 1:1 also had more irregular air cells and less compact compared to ratio 0:1.

a) b)

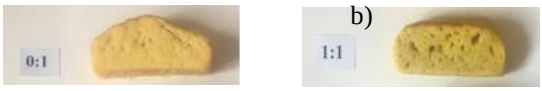


Figure 6. Oven baked pound cakes prepared with cake flour (a) Ratio 0:1 (control) and (b) ratio 1:1

For the bread flour pound cake as shown in Figure 7, the color of oven baked pound cake prepared with bread flour with ratio of avocado puree to margarine of 1:1 was greener than the control although both of them had green hue as had been discussed in section 4.2.3.3. This may happen as the control had higher L*value or lightness than the pound cake made with ratio 1:1 as can be seen from Table 5. Pound cake with ratio 1:1 also had more irregular and bigger air cells than the control which looked more compact.

a) b)

Figure 7. Oven baked pound cakes prepared with bread flour (a) Ratio 0:1 (control) and (b) ratio 1:1

Microwave Oven Baked Pound Cake Prepared with All-purpose Flour, Cake Flour, and Bread Flour

For the all-purpose flour pound cake as shown in Figure 8, the microwave oven baked pound cake made with ratio 1:1 exhibited a greener color compared to the control. The L* value of the control was also higher, which explains why the control did not look green although both control and ratio 1:1 had green hues. The control also looked more compact than ratio 1:1, with less air cells. Pound cake made with ratio 1:1 seemed to have more irregular air cells.

a) b)

Figure 8. Microwave oven baked pound cakes prepared with all-purpose flour (a)Ratio 0:1 (control) and (b) ratio 1:1

For the cake flour pound cake as in Figure 9, the color pound cake made with of ratio 1:1 had greener color than the control (no avocado added).

a) b)

Figure 9. Microwave oven baked pound cakes prepared with cake flour (a) Ratio 0:1 (control) and (b) ratio 1:1

Ratio 1:1 displayed more irregular air cells on it which might be due to the substitution half of the margarine with avocado which had less ability to incorporate air compared to margarine (Conforti, 2007). On the other hand, ratio 1:0 which fully used margarine looked more compact with less irregular air cells.

For the bread flour pound cake as in Figure 10, the pound cake with ratio 1:1 appeared to be greener than the control (no avocado added). Although both control and ratio 1:1 had green hue as discussed elsewhere, the L* value of the

a) b)

Figure 10. Microwave oven baked pound cakes prepared with bread flour (a) Ratio 0:1 (control) and (b) ratio 1:1

control was higher than ratio 1:1. The pound cake with ratio 1:1 had more irregular air cells on it compared to the control.

Sensory Characteristics of Selected Pound Cakes

Scoring Values

Scoring Values of Oven Baked Pound Cakes

The scoring results of the selected pound cakes baked in oven are shown in Table 3a. There was significant effect ($P \leq 0.05$) of formulations on color, aroma, texture, taste, and aftertaste of the oven baked pound cakes. From Table 3a, the color score of the control pound cakes was higher than the selected pound cakes (AF-1:3, CF-1:1, BF-1:1). Thismay be due to the addition of avocado in the formulations which made the color of the selected pound cakes and the controls different.

The aroma of AF-1:3 was shown to be significantly different from AF-0:1 as well as BF-1:1 with BF-0:1. However, the aroma of CF-1:1 and CF-0:1 was not significantly different. In terms of texture, the textures of the selected pound cakes were shown to be higher (moister) than the controls. This was due to the substitution of the margarine with avocado puree partially. The selected pound cakes were shown to be significantly different with the controls. The least moist in terms of texture between the selected pound cakes was BF-1:1 with a score of 4.21 ± 1.09. This was because bread flour has more gluten formation and produce firmer products (Conforti, 2007). However, the score was not significantly different with CF-1:1 and AF-1:3.

Table 3. Scoring values

a) Scoring values of oven baked pound cakes

Formula-tion[2]	Parameter[1]				
	Color	Aroma	Texture	Taste	Aftertaste
AF - 0:1 (control)	5.21±0.78^{c1}	2.31±1.22^{a}	3.10±1.11^{a}	2.63±1.41^{a}	2.13±1.27^{a}
AF - 1:3	3.17±1.12^{a}	3.06±1.25^{c}	4.50±1.28^{b}	4.29±5.04^{b}	3.31±1.58^{c}
CF - 0:1 (control)	5.31±0.75^{c}	2.44±1.33^{ab}	3.26±1.14^{a}	2.41±1.25^{a}	1.77±0.90^{a}
CF - 1:1	3.57±1.03^{b}	2.86±1.18^{b}	4.24±1.11^{b}	3.27±1.39^{b}	2.70±1.22^{b}
BF - 0:1 (control)	5.30±0.97^{c}	2.41±1.32^{ab}	3.24±1.32^{a}	2.21±0.98^{a}	1.99±0.83^{a}
BF - 1:1	3.19±1.01^{a}	3.06±1.34^{c}	4.21±1.09^{b}	3.41±1.48^{b}	3.23±1.49^{c}

b) Scoring values of microwave baked pound cakes

Formula-tion[2]	Parameter[1]				
	Color	Aroma	Texture	Taste	Aftertaste
AF - 0:1 (control)	5.29±0.84^{b}	2.19±0.94^{a}	2.29±1.04^{a}	2.30±1.07^{a}	2.21±1.18^{a}
AF - 1:1	3.45±1.12^{b}	2.57±1.06^{a}	2.77±1.11^{b}	2.76±1.20^{bc}	2.67±1.06^{b}
CF - 0:1 (control)	5.10±0.93^{b}	2.36±1.05^{a}	2.33±1.15^{a}	2.37±1.21^{ab}	2.17±0.99^{a}
CF - 1:1	3.41±1.19^{a}	2.50±0.50^{a}	3.43±1.14^{c}	2.93±1.47^{c}	2.91±1.49^{b}
BF - 0:1 (control)	5.03±1.06^{a}	2.20±1.10^{a}	2.49±1.21^{ab}	2.20±0.93^{a}	2.16±1.03^{a}
BF - 1:1	3.54±1.16^{a}	2.56±1.03^{a}	3.19±1.12^{c}	2.79±1.21^{bc}	2.56±1.19^{ab}

Range: Color (1-extremely green & 6-extremely not green); Aroma (1-odd aroma extremely not sensed & 6-odd aroma extremely sensed); Texture (1-extremely not moist & 6-extremely moist); Taste (1-odd taste extremely not sensed & 6-odd taste extremely sensed); Aftertaste (1-bitter aftertaste extremely not sensed & 6-bitter aftertaste extremely sensed)

Notes: [1]Different superscripts indicate significant difference ($p \leq 0.05$); [2]AF: All-purpose flour, CF: Cake flour; BF: Bread flour

In general, the bitter aftertaste of the selected pound cakes was rather not sensed. CF-1:1 had the least sensed bitter aftertaste with a score of 2.70 ± 1.22 when compared to the other selected pound cakes.

Scoring Values for Microwave Oven Baked Pound Cakes

The scoring values of the selected pound cakes baked in microwave oven were shown in Table 4b. Based on statistical analysis there was significant effect ($p \leq 0.05$) of formulations on color, texture, taste, and aftertaste of the pound cakes while there was no significant effect ($p > 0$ .05) on aroma.

From Table 3b, the color of the selected pound cakes (AF-1:1, CF-1:1, and BF-1:1) had lower score than the controls. This showed that the selected pound cakes were greener in color compared to controls. The aroma of the pound cakes themselves were not different from the controls statistically. The texture of the selected pound cakes was higher than the controls which means that the selected pound cakes were moister. This might be caused as the selected pound cakes contained avocado puree that is high in moisture. The taste of the selected pound cakes was significantly different with the controls. The bitter aftertaste of AF-1:1 and CF-1:1 was significantly different with AF-0:1 and CF-0:1. On the other hand, BF-1:1 was shown to be not significantly with BF-1:1.

Hedonic Scores

Hedonic Scores for Oven Baked Pound Cakes

The hedonic results of the selected pound cakes baked in oven are shown in Table 4a. Based on statistical analysis, there was significant effect ($p \leq 0.05$) of formulations on the acceptability of the color, aroma, taste, aftertaste, and overall acceptance of the pound cakes while there was no significant (P>0.05) on the acceptability of the aroma.

From Table 4a, the acceptability of color of the selected pound cakes (AF-1:3, CF-1:1, and BF-1:1) was significantly different with the controls. The color of the selected pound cakes was less acceptable compared to the controls. CF-1:1 had the highest acceptability in terms of color with a score of 4.43±1.36. The aroma of CF-1:1 was also more accepted than AF-1:3 and BF-1:1 with a score of

5.30±1.16 and was not significantly different from the control, CF-0:1. The texture of the selected pound cakes were not significantly different with the controls. AF-1:3 (4.93±1.64) had the highest acceptability in texture but was not significantly different to CF-1:3 and BF-1:1. In terms of taste, BF-1:1 also had the highest acceptability but was not significantly different with the other selected pound cakes. Meanwhile, CF-1:1 had the highest acceptability in terms of the aftertaste with a score of 4.80±1.55. Overall, selected pound cake that had the highest acceptability was CF-1:1 with a score of 4.96±1.18.

Table 4. Hedonic values

a) Hedonic values of oven baked pound cakes

Formula-tion[2]	Parameter[1]					
	Color	Aroma	Texture	Taste	Aftertaste	Overall
AF - 0:1 (control)	5.70±0.73^{c}	5.19±1.07^{bc}	4.66±1.42^{a}	5.21±1.26^{bcd}	5.27±1.13^{b}	5.33±0.96^{bc}
AF - 1:3	3.90±1.37^{a}	4.66±1.30^{a}	4.93±1.64^{a}	4.73±1.28^{a}	4.64±1.56^{a}	4.63±1.24^{a}
CF - 0:1 (control)	5.73±0.76^{c}	5.43±1.03^{bc}	4.89±1.45^{a}	5.51±1.11^{d}	5.61±1.05^{b}	5.40±1.00^{c}
CF - 1:1	4.43±1.36^{b}	5.30±1.16^{bc}	4.89±1.39^{a}	4.86±1.39^{ab}	4.80±1.55^{a}	4.96±1.18^{ab}
BF - 0:1 (control)	5.76±0.86^{c}	5.57±1.11^{c}	4.69±1.57^{a}	5.36±1.09^{cd}	5.36±0.99^{b}	5.27±0.99^{bc}
BF - 1:1	3.87±1.45^{a}	5.06±1.19^{b}	4.61±1.54^{a}	4.94±1.30^{abc}	4.57±1.42^{a}	4.76±1.23^{a}

b) Hedonic values of microwave oven baked pound cakes

Formula-tion[2]	Parameter[1]					
	Color	Aroma	Texture	Taste	Aftertaste	Overall
AF - 0:1 (control)	5.37±1.14^{b}	4.90±1.11^{abc}	3.64±1.59^{a}	5.09±1.25^{b}	5.11±1.26^{a}	4.80±1.14^{a}
AF - 1:3	4.17±1.50^{a}	4.59±1.34^{a}	4.17±1.35^{abc}	4.46±1.43^{b}	4.47±1.40^{a}	4.44±1.22^{a}
CF - 0:1 (control)	5.46±0.86^{b}	5.04±1.11^{bc}	3.64±1.48^{a}	5.10±1.08^{b}	4.90±1.28^{a}	4.89±1.07^{a}
CF - 1:1	4.19±1.49^{a}	4.64±1.46^{ab}	4.47±1.58^{c}	4.97±1.41^{b}	4.77±1.48^{a}	4.77±1.26^{a}
BF - 0:1 (control)	5.54±0.86^{b}	5.13±1.19^{c}	3.83±1.68^{ab}	4.90±1.44^{ab}	4.99±1.36^{a}	4.91±1.19^{a}
BF - 1:1	4.36±1.29^{a}	4.97±1.06^{abc}	4.36±1.36^{bc}	4.74±1.25^{ab}	4.97±1.24^{a}	4.83±1.09^{a}

Range: 1-extremely dislike & 7-extremely like

Notes: [1]Different superscripts indicate there is significant difference ($p \leq 0.05$); [2]AF: All-purpose flour, CF: Cake flour; BF: Bread flour

Hedonic Scores for Microwave Oven Baked Pound Cakes

The hedonic results of the selected pound cakes baked in microwave oven are shown in Table 4b. There was significant effect ($P \leq 0.05$) of formulations on the acceptability of the color, aroma, texture, and taste while there was no significant effect ($P > 0.05$) on the acceptability of the aftertaste and overall acceptance. The scores of the selected pound cakes (AF-1:1, CF-1:1, and BF-1:1) in terms of color were lower than those of the controls. However, their scores themselves were not significantly different from each other. In terms of aroma, the score of the selected pound cakes were not significantly different with their respective controls. CF-1:1 had the highest acceptability on texture and taste but were not significantly different with the other pound cakes. However, in terms of aftertaste, all selected pound cakes were not significantly different with the controls with BF-1:1 having the highest acceptability on no aftertaste. In terms of overall acceptance, the most acceptable was BF 1:1 with score of 4.83±1.09 although it was not significantly different with the other selected pound cakes and the controls.

Selected Pound Cake Formulations Based on Sensory Characteristics

From the three best pound cake formulations selected based on physical characteristics from each baking methods, they were then subjected to sensory tests. As a result, from those 3 selected pound cakes baked in the oven, CF-1:1 was selected as the best. Based on the result of the overall hedonic test, although CF-1:1 was not significantly different with the other selected pound cakes, CF-1:1 had a little bit higher absolute value than the others. In terms of color, CF-1:1 was also more superior with a significant difference with the other selected pound cakes. Although CF-1:1 was not the highest in terms of texture and taste, it was also not the lowest score and was not significantly different with the highest. The acceptability on the no aftertaste of CF-1:1 was the highest despite that the scores were not significantly different with the others.

On the other hand, BF-1:1 was chosen as the best since BF-1:1 had the highest score despite that the scores were not significantly different with the other selected pound cakes. BF-1:1 was also more superior in terms of color, aroma, and acceptability of the no aftertaste despite the scores of the pound cakes were

not significantly different. In terms of color and texture, BF-1:1 was the second highest, but the scores were not significantly different with the one that had the highest score.

Chemical Composition of Selected Pound Cakes

The chemical composition of the selected pound cakes was shown in Table 5. For oven baked pound cakes, there was significant effect ($p \leq 0.05$) of pound cake formulations on fat, protein, ash, and carbohydrate content of microwave oven baked pound cakes. From Table 5a, the moisture content of the oven baked selected pound cakes were higher and significantly different than their respective controls. The reason might be because margarine was substituted with avocado puree which is high in moisture.

Table 5. Chemical composition of selected pound cakes

a) Chemical composition of oven baked pound cakes

Formulations	Content (%, db)				
	Moisture (%, wb)	Fat	Protein	Ash	Carbohydrate
Oven-AF-0:1 (control)	22.71±1.28^{a}	29.20±0.69^{c}	8.13±0.39^{a}	1.45±0.09^{bc}	61.57±0.83^{a}
Oven-AF-1:3	28.24±1.00^{b}	21.30±0.83^{b}	8.32±1.03^{a}	1.23±0.08^{b}	68.50±0.51^{bc}
Oven-CF-0:1 (control)	20.24±0.16^{a}	30.69±0.46^{c}	7.78±0.05^{a}	1.57±0.03^{b}	59.61±0.89^{ab}
Oven-CF-1:1	30.45±0.91^{c}	25.44±1.33^{a}	8.97±1.26^{a}	1.45±0.06^{a}	64.79±2.30^{d}
Oven-BF-0:1 (control)	20.82±2.19^{a}	29.98±1.25^{c}	8.24±0.08^{a}	1.65±0.10^{c}	60.13±1.42^{a}
Oven-BF-1:1	28.48±1.72^{bc}	21.58±0.69^{a}	8.97±1.26^{a}	1.41±0.08^{ab}	67.97±1.51^{cd}

b) Chemical composition of microwave oven baked pound cakes

Formulations	Content (%, db)				
	Moisture (%, wb)	Fat	Protein	Ash	Carbohydrate
Microwave-AF-0:1 (control)	11.97±0.51^{a}	29.83±0.64^{b}	7.78±0.19^{a}	1.49±0.01^{c}	60.91±0.45^{a}
Microwave-AF-1:1	21.50±1.52^{b}	19.92±0.65^{a}	9.58±0.16^{c}	1.30±0.03^{a}	69.20±0.52^{b}
Microwave-CF-0:1 (control)	13.85±0.64^{a}	30.36±0.72^{b}	7.38±0.26^{a}	1.45±0.01^{c}	60.81±0.47^{a}
Microwave-CF-1:1	24.54±1.70^{c}	20.43±1.45^{a}	9.21±0.21^{bc}	1.35±0.02^{b}	69.01±1.63^{b}
Microwave-BF-0:1 (control)	12.08±1.15^{a}	30.00±0.79^{b}	8.91±0.32^{b}	1.29±0.01^{a}	59.80±1.10^{a}
Microwave-BF-1:1	22.03±0.77^{bc}	19.82±0.31^{a}	10.41±0.29^{d}	1.28±0.01^{a}	68.47±0.59^{b}

The fat content of the selected pound cakes was significantly lower than the controls. The protein contents of the selected oven baked pound cakes were all statistically similar. This might be due to the destruction of proteins caused by the high baking temperature in oven. The carbohydrate contents of the selected pound cakes were higher than the controls. This might be due to the high amount of fiber in avocado puree (Shintani, 2002).

From Table 5b, the moisture content of the microwave oven baked selected pound cakes was higher than, and significantly different with their respective controls. The fat contents of the selected pound cakes were significantly lower while the protein contents were all significantly higher than their respective controls. This might be due to the less destruction of proteins during baking (Rosenthal, 1992). Microwave-BF-1:1 had the highest protein content of 10.41±0.29%. Pound cakes made with avocado puree exhibited higher carbohydrate content as compared to the controls (Shintani, 2002).

CONCLUSION

The pound cakes with reduced margarine due to partial replacement with avocado puree exhibited lower fat contents resulting in an increase overall nutritional value. In addition, partial substitution of margarine with avocado puree in the pound cakes preparation exhibited relatively similar physical characteristics with those of without avocado puree substitution. Further, pound cakes obtained from baking using microwave oven showed higher protein content than pound cakes baked in oven. Therefore, considering that microwave baking consumed a shorter time, the microwave oven baked pound cake made with bread flour with ratio of 1:1 would be preferable for commercial application.

Further researches should be focused on the fiber content and shelf-life of the pound cakes made with

avocado puree by selecting the best ingredient composition.

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