Physico-Chemical and Sensory Properties of Wheat-Margarine-Avocado Cake Blends

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Authors’ contributions

This work was carried out in collaboration among all authors. Author GOE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NIO and TTI managed the analyses of the study. Author FZI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The nutrient contents of wheat-margarine used in the preparation of cakes in Nigeria is low with high fat leading consumers to several nutritional and health challenges such as overweight, obesity and cardiovascular diseases. This research was aimed at determining physicochemical and sensory properties of wheat-margarine- avocado cake blends. Cake blends of margarine and avocado were prepared in the proportions of 100:0, 80:20, 60:40, 40:60, 20:80 and 0:100. The chemical composition and physical properties of the cakes were determined using standard methods. The cakes were assessed for their sensory characteristics using 9 point hedonic scale. The physical properties of wheat, margarine and avocado cake blends showed that the replacement of margarine with avocado fruit pulp in cake production increased the cake weight with no increase in volume and height of the cakes. The proximate composition of the cakes showed that 100% wheat/avocado cake contained higher moisture (11.65±0.00), crude protein (16.85±0.00), crude fiber (2.10±0.09), ash (2.52±0.0) and carbohydrates (57.86±0.78) contents than 100% wheat/margarine which were 6.99, 12.33, 1.44, 2.10 and 54.62 respectively. However, the fat content of 100% wheat/margarine cake (29.51±0.00) was rather higher than that of the

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wheat/avocado cake (20.67±0.00). The mineral contents of the cakes significantly increased with increase in avocado fruit pulp. Colour, aroma, taste, texture and general acceptability decreased with the addition of avocado but were all accepted by the panelists. It was concluded that substitution of margarine with avocado fruit pulp in cake production significantly increased the cake weight, the moisture, protein, fibre, ash, carbohydrate, mineral elements and a decrease in fat content as well as a mean scores of sensory attributes.

Keywords: Incorporating; fatty acids; polyphenol; bake.

1. INTRODUCTION

In Nigeria, there are green and purple-fruited types of avocados. Avocados are harvested with hand-held poles and baskets. Fruits are picked when mature but still hard. Avocado fruits on the same tree do not mature at the same time, so selective harvesting is usually practiced. Crop statistics, compiled by the Bureau of Agricultural Statistics of the National Statistics Office showed that the Nigeria had a very large production of Avocado during 2000-2011 [1].

Avocado is one of the most healthiest fruits, because of its nutrient contents such as Vitamin K, dietary fiber, potassium, folic acid, Vitamin B6, Vitamin C, copper, and calories. Avocado is one of the most recommended fruits for body building and medicine for cholesterol-related diseases and it was found to have high cholesterol levels [2].

Avocado (Persea americana) is one of the fruits that provide various health benefits. It is rich in monounsaturated fatty acid and contains high level of antioxidants such as polyphenols, tocopherols and carotenoids [3].

Baked products are on top of the world demand for food and are mainly flour-based. Products such as bread, cookies, cakes and other baked products are a good source of energy giving nutrients. These products are obtained from a variety of cereals, which includes rye, wheat, barley and corn, processed to give high quality baking flour [4].

Fat is a relevant food ingredients that impact positively on nutritional and sensory qualities of food such as flavour, mouth feel and odour. High fat diet may lead to several health challenges such as obesity, overweight and cardiovascular disease [5]. Studies have shown that increases in obesity and overweight were related to increase in fat and calorie intake [5].

High consumption of fruits and vegetables is correlated with lower incidence of some types of cancer and cardiovascular disease [6] Thus, incorporating avocado in baked products can greatly enhanced the nutritional value as well as improving the functional value of the baked products [3].

The study was aimed at determination of physicochemical and sensory properties of wheat-margarine-avocado cake blends.

2. MATERIALS AND METHODS

2.1 Sources of Material

Fresh avocado fruits were purchased from Ikom Market, Ikom Local Government Area of Cross River State. While wheat flour, margarine, sugar, eggs and baking powder were purchased at wurukum market Makurdi, Benue State.

2.2 Preparation of Avocado

The avocado fruits were thoroughly sorted, washed, drained and peeled. The creamy mesocarp was homogenized using a mixing bowl and a wooden stick to obtain a smooth puree or paste.

2.3 Blend Formulation for Wheat Margarine and Avocado Cake Production

Cake blends of margarine and avocado were prepared in the following proportions: 100:0, 80:20, 60:40, 40:60, 20:80 and 0:100.

2.4 Production of Wheat/Margarine/Avocado Cake Blends

The method of Akubor [7] was used for the cake preparation. Specified ratios of margarine and avocado were creamed separately with sugar in mixing bowls with wooden stick until it becomes soft and fluffy. The eggs were beaten in a separate bowl and added to the creamed
margarine and avocado mixture and mixed together. Wheat flour was sieved and added to the mixture by folding-in method and the last portion of the flour mixed with baking powder was added to the mixture and mixed together until soft dough was formed. The dough was then transferred into greased pan and baked in a preheated oven at 200°C for 60 minutes.

2.5 Determination of Physical Properties of Wheat-Margarine-Avocado Cake Blends

The volume, weight and height were determined by the method described by Onwuka [8].

The individual weight of the cakes was weighed using the digital top loading weighing balance by Harvard Apparatus Ltd. A foil paper was placed on the scale and the weight tarred to zero before introducing the cakes individually and their weights were recorded in grams (g).

The heights of the cakes were measured using a calibrated meter rule. The cakes were placed on a flat surface and the meter rule was placed vertically on the cakes individually to take the measurement and their heights were recorded in centimeters (cm).

Volume of the cake blends were determined by seeds displacement method. The cakes were wrapped in transparent cellophane bags and placed in a graduated transparent container, the seeds poured into the container up to the height of the cake, and the readings were taken and recorded as the initial reading. The cakes were then removed from the container filled with seeds and the readings also were taken and recorded as final reading. The volume of the cakes were taken by subtracting the final reading from the initial reading and recorded in cm³.

2.6 Determination of Proximate Composition

Moisture, crude protein, fat, fibre, ash and carbohydrate were determined according to the Association of Official Analytical Chemist [9] methods on triplicate samples of the composite flour.

2.7 Mineral Determination

The mineral contents (calcium, magnesium, phosphorus, potassium, iron and zinc) of the composite flour were determined using AOAC [10].

2.8 Sensory Evaluation

The samples of the composite cakes were evaluated using hedonic method for sensory characteristics and the overall acceptability by panelists of 20 judges from students of Federal University of Agriculture, Makurdi using a 9 point hedonic scale preference test as described by Ihekoronye and Ngoddy [11] was used. The cakes were assessed for organoleptic properties such as colour, aroma, taste, texture and general acceptability. The quantities evaluated were rated on a scale ranging from one to nine (1= Dislike extremely to 9=Like extremely).

2.9 Data Analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) and mean separation was done by Duncan multiple range test (p=0.05), using Statistical Package for Social Sciences (SPSS, Version 20, Inc. USA).

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Wheat-Margarine-Avocado Cake Blends

Table 1 shows the physical properties of wheat-margarine-avocado cake blends. The volume of wheat-margarine-avocado cakes decreased significantly with increased substitution of avocado pear pulp with wheat-avocado cake having the least (201.09 cm³) volume relative to wheat-margarine cake. Volume decreases (96.40 cm³ - 92.60 cm³) was also reported by Nurul Ain et al. [12] when avocado puree was used as fat replacer on muffin. Similar volume decreases were reported by Martinez-Cervera et al. [13], when fat content in muffin was replaced with nutriose. Marina et al. [14] also reported volume decrease when Percea americana puree was used as fat replacer with butter. The decrease in volume could be attributed to the inability of avocado pear pulp to entrap air during batter mixing (Nurul Ain et al. [12]. This was also observed by Lee et al. [15] when shortening was replaced with oatrim in cake.

The weight of wheat-margarine-avocado cake blend in sample 80:20 was significantly (p>0.05) lower compared to the weight of other composite samples. The weight of wheat-avocado cake was
significantly (p>0.05) higher (1301.76 g) when compared to weight of wheat-margarine cake (1226.25 g). The weight of wheat-margarine-avocado cakes significantly increased with every 10% replacement of margarine with avocado pulp. This could be attributed to the high fibre, protein and fat content of avocado pulp. This result disagrees with the report of Nurul Ain et al. [12] who reported no significant difference in muffin weight with addition of avocado pulp but agreed with Alshima [16] findings when flour was replaced with marjoram powder in cake [(277±2.9% (control) – 302±5.8% (marjoram Powder)].

**Table 1. Physical properties of wheat-margarine-avocado cake blends**

| M:A      | Volume (cm$^3$) | Weight (g)      | Height (cm) |
|----------|-----------------|-----------------|-------------|
| 100:0    | 220.25±0.02     | 1226.25±0.01    | 10.02±0.03  |
| 80:20    | 220.94±0.02     | 1247.26±0.01    | 10.03±0.04  |
| 60:40    | 220.20±0.01     | 1254.44±0.01    | 10.05±0.00  |
| 40:60    | 220.14±0.03     | 1283.13±1.59    | 10.06±0.01  |
| 20:80    | 220.12±0.02     | 1305.52±0.01    | 10.09±0.02  |
| 0:100    | 201.09±0.18     | 1301.76±0.01    | 10.09±0.01  |

Values are means ± Standard deviation (n=3). Values with same superscript in a column do not differ significantly (p>0.05). M= Margarine and A=Avocado

**Fig. 1. Proximate composition of wheat-margarine-avocado cake blends**

$M = $ Margarine and $A = $ Avocado

**Fig. 2. Mean sensory score of wheat-margarine-avocado cake blends**

$M = $ Margarine and $A = $ Avocado; Like extremely-9, Like very much-8, Like moderately-7, Like slightly-6, Undecided-5, Dislike slightly-4, Dislike moderately-3, Dislike very much-2 and Dislike extremely-1
3.2 Proximate Composition of Wheat/Margarine/Avocado Cake Blends

The proximate composition of the cakes prepared from wheat/margarine/avocado cake blends is shown in Fig. 1. The moisture content of the wheat-avocado cake (11.45%) increased significantly higher than the wheat-margarine cake (6.99%). This result is consistent with work by Hanan [18], who reported that using vegetable puree in place of fat in cake production elevated the moisture content of the cake. Dadkhah et al. [19] also reported moisture increase by replacing shortening with nutrim oat bran on shortened cakes. The higher moisture content of wheat-avocado cake than wheat-margarine cake could be attributed to the high moisture 14.05% and 77.72% content of avocado pulp Macey et al. [20], This was probably due to the ability of avocado to retain more water. The high moisture content of wheat-avocado cake may impact negatively on its shelf-life at ambient temperature [21].

The result showed that protein content of the cakes was significantly (P<0.05) enhanced with addition of avocado puree. The wheat-avocado cake had higher protein content (16.85%) than (12.33%) wheat-margarine cake. This is in line with the report of Hussein et al. [22] that protein content of cakes is slightly increased when fat is being replaced with artichoke. Hanan [18] also reported a slight increase (9.38% control - 9.41% fat replaced) in protein content using vegetable puree (cantaloupe) as fat replacer in cake, because protein in cakes mainly comes from eggs. Macey et al. [20] reported that low protein content was desired for crisp or tender products, such as snacks or cakes. This demonstrates the beneficial effect of blending foods in food product development, which also agreed with the report of Akubor [7] that nutritional enhancement, would be the advantage in the use of composite food products.

The fat content of wheat-avocado cake (20.67%) was significantly (p<0.05) lower than wheat-margarine cake (29.51%). This is comparable with the report of Hanan [16] and Pooja et al. [23] that fat content in cake is lowered when fat is being replaced with vegetable puree (30.7% control and 11.80% vegetable puree) and avocado pear (18.29% control and 9.14% avocado pear). Crude fat determines the free fatty lipids, and this property can be used as the basis in determining processing temperatures as well as auto-oxidation which can lead to rancidity and can also affect flavor of food [20].

Fiber was significantly higher (p<0.05) in the wheat-avocado cake (2.10%) than in the wheat-margarine cake (1.44%). Hanan [18] reported increase in fiber content (0.16% control – 0.35% vegetable puree) in cakes when vegetable puree was used as fat replacer. The crude fibre content is a significant component of a diet. It increases stool bulk and decreases the time that waste materials spend in the gastro intestinal tract [24]. Evidence from randomized controlled trial observational studies, and animal models demonstrates that dietary fiber lowers level of low density lipoprotein cholesterol [25], which are common risk factors for cardiovascular disease and increase the HDL-C [25].

The ash content among the wheat-margarine-avocado cake blends increased significantly (p<0.05) from 1.35% (80:20) to 2.50% (20:80) at every level of increase of avocado. Ash content is the residue remaining after all the moisture and organic materials have been removed. The value for wheat-avocado cake (2.52%) was

| M:A   | Calcium     | Magnesium   | Iron        | Sodium      | Potassium    |
|-------|-------------|-------------|-------------|-------------|-------------|
| 100:0 | 0.33±0.00   | 0.14±0.00   | 2.24±0.03   | 0.53±0.01   | 0.23±0.00   |
| 80:20 | 0.33±0.00   | 0.16±0.00   | 2.26±0.06   | 0.53±0.00   | 0.24±0.00   |
| 60:40 | 0.36±0.00   | 0.21±0.00   | 2.30±0.00   | 0.52±0.01   | 0.24±0.00   |
| 40:60 | 0.35±0.00   | 0.22±0.00   | 2.52±0.01   | 0.49±0.00   | 0.26±0.01   |
| 20:80 | 0.42±0.00   | 0.24±0.01   | 2.59±0.01   | 0.48±0.00   | 0.26±0.01   |
| 0:100 | 0.42±0.00   | 0.26±0.00   | 2.72±0.01   | 0.43±0.01   | 0.26±0.01   |

Values are means ±Standard deviation (n=3). Values with same superscript in a column do not differ significantly (p>0.05). M= Margarine and A=Avocado
significantly (p<0.05) higher compared to the wheat-margarine cake (2.10%). These values are comparable with the values reported by Pooja et al. [23] for butter and avocado (1.37% and 1.78%).

The carbohydrate content as determined by difference was significantly (p<0.05) higher in the wheat-avocado cake (57.86%) compared to the wheat-margarine cake (54.62%). The fiber in the wheat-avocado cake was also higher compared to the wheat-margarine cake. This was also comparable with the values (59.92% control and 78.78% puree) reported by Hanan [18].

3.3 Mineral Composition of Wheat-Margarine-Avocado Cake Blends

The mineral content of cakes prepared from wheat-margarine-avocado cake blends are presented in Table 2. Minerals are essential for the maintenance of human health. Increasing the level of avocado puree in cake formulation among wheat-margarine-avocado cake blends also increased their mineral elements.

Calcium content of wheat-avocado cake was significantly (p<0.05) higher (0.42mg/100g) than the wheat-margarine cake (0.33mg/100g). Calcium content of avocado fruit according to the report of Maitera et al. [26] in elemental Analysis of Avocado Fruit was 0.064 mg/kg lower than 042mg/100g (wheat-avocado cake). Also, related report by Akubor and Ishiwu [27], showed that calcium was increased from 30.4mg/100g (wheat flour cake) to 45mg/100g (plantain peel flour cake) when Wheat flour was supplemented with Plantain Peel Flour in cakes. Calcium is essential for proper bone and teeth formation [26].

Magnesium content followed similar trend. The magnesium content of wheat-avocado cake (0.26mg/100g) was (p<0.05) higher than wheat-margarine (0.14mg/100g) cake. These values were a bit higher than the one (0.103mg/kg) reported by Maitera et al. [26], but significantly lower than the ones obtained by Nermin [28], when wheat germ 82.8mg/100g and resistance starch (41.1mg/100g) were used in cake baking. Magnesium is an essential constituent of all cells and is necessary for the functioning of enzymes involved in energy utilization and it is present in the bone [29].

The iron contents of wheat-avocado cakes (2.72mg/100g) increased significantly higher than the wheat-margarine cake 2.24mg/100g. This value was higher than 0.069mg/kg as reported by Maitera et al. [26]. However, the high percentage of iron content reported in this work might be due to the high iron content (3.30%) of wheat flour as reported by Ihsanullah et al. [30].

The sodium content of wheat-avocado cake was (p<0.05) significantly lower 0.43mg/100g than wheat-margarine cake of 0.53mg/100g. These values are still higher than the 0.230mg/kg reported by Maitera et al. [24] for avocado fruit, but partially agrees with the report of Marina et al. [14] for sodium (3 g control and 3 g avocado) when avocado was used as fat replacer in butter cake. According to the report of the American Diabetes Association, the required daily intake for sodium is 0.12 g to 1.8 g per day [29]. The American Diabetes Association [29] reported that the amount of sodium in the diet should be limited since sodium helps to increase blood pressure and the tendency to retain fluid. The mineral contents in avocado pear help promote good cardiovascular health [31].

The Potassium content of the wheat-avocado cake also increased (0.26mg/100g) higher than the wheat-margarine cake 0.23mg/100g. However, the increase in potassium content was fairly constant showing no significant difference (p>0.05) among the cake blends. This value (0.26mg/100g) is lower than the value (2.040mg/kg) reported by Maitera et al. [26]. Clinical evidence also suggests that adequate potassium intake may promote blood pressure control in adults [32].

3.4 Mean Sensory Score of Wheat-Margarine-Avocado Cake Blends

The sensory properties of the wheat-margarine-avocado cakes blend are shown in Fig. 2. The wheat-margarine cake was more preferred to the taste panelists with respect to colour, aroma, taste, texture and general acceptability and this could be attributed to the fact that they are used to wheat-margarine cake and will likely take a long time to adapt to the new wheat-avocado cake. The wheat-avocado cake rated lowest with respect to other cakes for all the sensory characteristics assessed. The scores for all the characteristics decreased steadily as the level of avocado increased in the cakes. However, there was significant difference (P<0.05) from the wheat-margarine cake in the entire sensory
attributes including overall acceptability. Physically, the colour of the wheat-margarine cake was golden brown (Appendix Plate 1), while that of the wheat-avocado cake was brownish-red (Appendix Plate 6). *Persea americana* seed oil was reported in a study of Physiochemical properties and antioxidant potential to give a brownish-red colour [33], also similar to that reported for *Persea gratissima* [34]. This consequently affected the score given by the panelists for the cakes containing avocado. The observed colour of the wheat-avocado cake could be attributed to the presence of residual tannic substances in the processed avocado [35]. The acceptability of the avocado cakes colour decreased with the addition of avocado because avocado had dull colour. The aroma was mostly acceptable (8.27) in sample containing 100% of margarine and least acceptable (5.80) in sample having 100% avocado. This means addition of avocado to wheat margarine cakes greatly affect the aroma of the cakes. However, all the tasted cake samples were generally acceptable for aroma. The score for taste reduced slightly with increased level of avocado possibly due to the presence of tannins impacting bitter taste in avocado however, the presence of tannins in the body can improve appetite and reduce respiratory problem and circulatory disorder like lowering blood pressure and reduce cholesterol in the blood [36].

There was significant difference (p<0.05) in the texture of the cake samples and textural attributes were all accepted by the panelists. Generally, sample 100% margarine had more mean texture (7.40) by the panelists. There was significant different (p<0.05) from all other samples. However, all samples were generally acceptable by the panelists.

4. CONCLUSION

Substitution of margarine with avocado fruit pulp in cake production significantly increased the cake weight with no increase in volume and height of the cakes; Use of avocado fruit pulp in cake production significantly increased the moisture, protein, fibre, ash, carbohydrate and a decrease in fat content. The mineral elements of the cakes significantly increased with increased substitution of margarine with avocado fruit pulp except for K (potassium) that showed no significant increase. The mean sensory scores of colour, aroma, taste, texture and general acceptability decreased with the addition of avocado but were all accepted by the panelists.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Sampled cakes of wheat margarine and avocado blend

Plate I: Sample A (100% wheat/margarine cake).
Plate II: Sample B (80% margarine/20% avocado/wheat)
Plate III: Sample C (60% margarine/40% avocado/wheat)
Plate IV: Sample D (40% margarine/60% avocado/wheat cake)
Plate V: Sample E (20% margarine 80% avocado/wheat cake)
Plate VI: Sample F (100% wheat/avocado cake)

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