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Physico-chemical and Sensory Properties of Cookies Produced by Partial Substitution of Margarine with Avocado Pear (*Persia americana*)

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ABSTRACT

The partial substitution of margarine with mature avocado pear pulp in the production of cookies was investigated. Five cookie samples were produced with avocado pear pulp and margarine blends in the ratios 80:20%, 70:30%, 60:40%, 50:50%, and 100% margarine serve as the control, labeled as B, C, D and E and A, respectively while the other ingredients used remain constant. The physico-chemical (proximate compositions, free fatty acids (FFA), iodine value, and peroxide value) and sensory qualities of the cookies were evaluated using standard methods. The results show ranged in moisture (11.13 to 14.60%), crude protein (6.93 to 7.83%), crude fat (16.00 to 18.03%), ash (1.40 to 2.09%), crude fiber (0.29 to 0.62%), carbohydrate (59.70 to 62.79%), FFA (0.35 to 1.01 mg KOH/g), iodine value (75.63 to 81.17 g I_2/100 g) and peroxide value (2.96 to 5.27 meq/kg). The partial substitution of margarine with avocado pear pulp produced nutritious cookies with desirable organoleptic qualities. Also, the results demonstrated that cookies had acceptability up to a 30% level of substitution with avocado pear pulp. The findings indicated the feasibility of avocado pear pulp in fat-reduced cookies preparation, this will reduce the pressure in using only margarine in cookies making and diversify the use of avocado pear.

Introduction

In recent times, the consumption of snack foods is increasing worldwide due partly to demographic trends and urbanization, the growing proportion of working mothers, school-age children receiving meals, mobility of the population, and ready availability of convenience food markets. Cookies which happen to be among the convenience food are widely consumed. Cookies are nutritive snacks produced from single or composite dough which has been transformed into digestible and more appetizing products through the action of heat in the oven (Singh et al., 2000). Compared to biscuits, cookies tend to be larger with a softer chewier texture (International Food Information Service IFIS (2005)).
Cookies production requires the use of butter, egg, milk, sugar, and wheat flour to make the dough. Butter is defined as a plastic product derived from cream, inverted to a water-in-oil emulsion (W/O) with a minimum of 80% fat. Chemically a butterfat consists of a mixture of triglycerides, particularly those derived from fatty acids, such as palmitic, oleic, myristic, and stearic acids. Butter has 61% saturated fats and 33% unsaturated fats. The consumption of butter in large amounts for a long period of time might have the following effects on the body; increased cholesterol levels and increased risk of heart disease. Besides increasing the serum lipid levels, butter has also been shown to increase the level of inflammatory markers which in turn increases the risk of heart diseases (Engel and Tholstrup, 2015).
Thus, one suggested way to reduce the intake of saturated fats was the replacement of these fats in baked foods with avocado pear as a natural fat replacer rich in a variety of health promoting compounds (Navder and Wekwete,

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2008). Avocados pear contains a large amount of healthy monounsaturated fats, cancer-fighting phytochemicals, dietary fiber, and a host of other nutrients (Cadet et al., 2014). The avocado pulp makes up to 65% of the fruit, the seed 20%, and the skin 15%. The pulp contains 67 – 78% moisture, 13.50 – 24.00% lipids, 0.80 – 4.80% carbohydrate, 1.00 – 3.00% protein, 0.80 – 1.50% ash, 1.40 – 3.00% fiber, and energy density between 140 and 228 kcal (Soares and Ito, 2000). The pulp of mature avocado fruit is rich in proteins, fats and oils and low in sugar. It also has a sweet pleasant taste and is consumed as human food.

Saturated fat in the diet is currently a focus of nutritional concern since it is so prevalent in the foods eaten today. Briggs et al. (2017) reported that the consumption of saturated fat increases the levels of low-density-lipoprotein (LDL) cholesterol which has been positively associated with cardiovascular disease (CVD) risk. The butter-like texture of avocado flesh suggests the potentiality to be used as fat replacer thereby encouraging its utilization. Also, the fact that avocado is a functional food is an added advantage to the cookies produced from the partial substitution of margarine with avocado pulp. Therefore, the target of this study was to replace margarine, a regular baking ingredient with avocado pear as natural health-promoting and fat replacer.

Materials and Methods

Sources of materials

Matured Avocado Pear (*Persia americana*) fruits (Hass variety) were purchased from an orchard in Jambutu, Bye-pass road, Jimeta Yola, Adamawa State, Nigeria. Commercial wheat flour (Golden Penny, Flour mills of Nigeria Limited) and other ingredients such as granulated sugar and salt (Dangote, Nigeria), sodium bicarbonate (baking powder), milk powder (Peak), Margarine (Unilever, Nigeria), Vanilla flavour, and egg (layers) were purchased from at Jimeta Modern Market, Yola, Adamawa State, Nigeria. The chemicals and reagents used were of analytical grade. Other equipment and apparatus used in the study were obtained from the laboratory of Food Science and Technology, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria.

Preparation of samples

The avocado pears were sorted, cleaned thoroughly by washing under tap water, rinsed with distilled water. The pericarp was scraped with a stainless steel knife and the seed was removed. The pulp was extracted into a clean container and mashed with laboratory mortar and pestle. The required quantity needed for the production was weighed to prepare the formulations.

Formulation of ingredients and production of cookies samples

The standard formulation procedure for cookies reported by Oyewole et al. (1996). The proportions of the ingredients are shown in Table 1. The wheat flour was sifted into a clean bowl then mashed avocado pulp or margarine, sugar, salt, milk, water, and vanilla flavour which were initially creamed in a mixer (Hamilton Beach Classic Hand and Stand Mixer; Model: 64654) to produce a creamy mixture were blended. Thereafter, the mixture was thoroughly mixed to form consistent dough. The dough obtained was thoroughly kneaded manually on a smooth clean table for about 5 minutes. The dough was thinly rolled on a wooden board with a rolling pin to a uniform thickness of about 4 mm. Then cut out with a cookie cutter (Stainless steel round cookies cutter, size 6 cm) into similar round shapes. The cutout dough pieces were placed in a greased baking tray and baked in an electric oven (Model no: TO008GA-34; AKAI-TOKYO, JAPAN) at 200 °C for 20 minutes to produce cookies. The cookie samples were cooled immediately after baking and packed in polyethylene bags, sealed and kept at ambient temperature (28±2 °C) until used for further analyses.

Determination of proximate compositions

The proximate compositions were determined as described by AOAC (2010). Two grams of each sample was dried at 105 °C for 3 h inside the preset oven (Fisher Scientific Isotemp Oven, model 655F, Chicago, USA). The difference in weight was calculated as a percentage of moisture contents. The micro Kjeldahl method was used for protein determinations. Two grams of each sample was mixed with 10 mL of concentrated H_2SO_4 in a heating tube. One tablet of selenium catalyst was added to the tube and the mixture was heated inside a fume cupboard. The digest was then transferred into a 250 mL volumetric flask and filled up to mark with distilled water. Ten (10 mL) of the digest mixed with an equal volume of 45% NaOH was distilled with a Kjeldahl distillation apparatus and the distillate was collected into 4% boric acid solution containing 3 drops of methyl red indicator. A total of 100 mL distillate was titrated with 0.1 N HCl and the average value was taken.

Table 1. Cookie Recipe Formulations

Ingredients	Sample A	Sample B	Sample C	Sample D	Sample E
Wheat Flour (g)	200	200	200	200	200
Margarine (g)	100	80	70	60	50
Mashed Avocado Pulp (g)	0	20	30	40	50
Sugar (g)	70	70	70	70	70
Vanilla Flavour Powder (g)	0.2	0.2	0.2	0.2	0.2
Liquid Egg (g)	48.3	48.3	48.3	48.3	48.3
Milk Powder (g)	20	20	20	20	20
Baking Powder (g)	2	2	2	2	2
Salt (g)	0.2	0.2	0.2	0.2	0.2

Sample codes: A = 100% Margarine (Control); B = 20% Avocado Pear Pulp and 80% Margarine; C = 30% Avocado Pear Pulp and 70% Margarine; D = 40% Avocado Pear Pulp and 60% Margarine; E = 50% Avocado Pear Pulp and 50% Margarine.

The nitrogen content was calculated and multiplied with 6.25 to obtain the crude protein contents. The soxhlet extraction method was used for fat determination. Two grams of each sample was loosely wrapped with a filter paper and put into the extracting thimble which was fitted to a round bottom flask which contains 120 mL of n-hexane. The experimental set-up was heated (70 °C) with a heating mantle and allowed to reflux for 5 hours. The difference in weight was received as mass fat and was expressed in the percentage of the sample.
The crucibles containing 2 g of the samples were placed inside a heated furnace (Fisher Isotemp Muffle Furnace, model 186A, USA) at 600 °C for 6 h after which they were cooled to room temperature in desiccators and weighed. The weight of the residues was calculated as the percentage of ash contents. Two grams of each sample and 1g asbestos were put into 200 mL of 1.25% of H_2SO_4 and boiled for 30 min. The solution was then filtered with a Büchner funnel equipped with a muslin cloth and secured with an elastic band. The residue was thereafter boiled with 200 mL NaOH for 30 min and filtered with the Buchner funnel. The residue obtained was then washed twice with alcohol and thrice with petroleum ether. The crucible contacting the washed residue was dried at 105 °C for 3 h inside the preset oven (Fisher Scientific Isotemp Oven, model 655F, Chicago, USA). The difference of weight (i.e. loss in ignition) was recorded as crude fibre and expressed in percentage crude fibre. The carbohydrate content was determined by the difference between 100 and the total sum of the percentage of moisture, protein, fat, fibre, and ash.

Determination of acid value or free fatty acids (FFA)

Acid value or free fatty acids of an oil or fat is defined as the number in milligram of potassium hydroxide required to neutralize the free acid of the sample (AOAC, 2010). It also measures the extent to which the glycerides in the oil have been decomposed by lipase action. Twenty-five (25) mL of diethyl ether was mixed with 25 mL of alcohol and 1 mL phenolphthalein solution (1%) was carefully added. Thereafter, 2 g of extracted fat from cookie samples was measured and titrated with aqueous 0.1 M KOH shaking constantly on until pink colour which persists for 15 seconds was obtained. Calculation:

$$FFA = \frac{Titre\ (mL) x\ 5.61}{Weight\ of\ Extracted\ fat\ Used} \quad (1)$$

Determination of iodine value

Iodine value was determined using the Hanus Iodine solution which was prepared by weighing 13.6 g of iodine and dissolving in 825 mL of acetic acid by heating and cooling (AOAC, 2010). The extracted fat (0.5 g) from the cookie sample was weighed into the iodine flask and dissolved with 10 mL of chloroform. The Hanus iodine (25 mL) solution was pipetted into the sample and mixed well. The solution was allowed to stand in the dark for 30 min with occasional shaking. Ten (10) mL of 15% potassium iodide was added and shaken thoroughly, thereafter 100 mL of freshly boiled and cooled water was added, washing down free iodine on the stopper. Then 0.1 N of sodium thiosulphate was titrated against the solution until colour turned almost colourless. A few drops of the starch indicator were added and titrated until the blue colour completely disappeared. Towards the end of the titration, the flask was stoppered and shaken vigorously so that any iodine remaining in the solution in $CHCl_3$ is taken up by potassium iodide solution. These procedures were repeated without the sample, this served as blank.

$$Iodine\ Value = \frac{(B-S)\ x\ N\ x\ 12.69}{Weight\ of\ extracted\ fat\ used\ (g)} \quad (2)$$

Where: B = mL thiosulphate for blank
S = mL thiosulphate for sample

N = normality of thiosulphate solution
12.69 = Iodine equivalent value.

Determination of peroxide value

Peroxide value was determined as described by AOAC (2010). One (1) g of the extracted fat from the cookie sample was weighed into a boiling tube, 1 g of powder potassium iodide was added and 20 mL of solvent mixture (2 volume of glacial acetic acid + 1 volume of chloroform). Thereafter, the tube was placed in boiling water so that the liquid boils within 30 seconds and allows boiling vigorously for more than 30 seconds. The content was poured into a flask containing 20 mL of 5 % potassium iodide solution. The tube was washed out twice with 25 mL of water and titrated with 0.002 M of sodium thiosulphate using starch as an indicator. These procedures were repeated without the sample, this served as blank.

$$Peroxide\ value\ (milliequivalent\ peroxide/kg\ sample) = \frac{S\ x\ N\ x\ 1000}{Weight\ of\ extracted\ fat\ used\ (g)} \quad (3)$$

Where: S = mL ($Na_2S_2O_3$) (Test – Blank)
N = Normality of Sodium thiosulphate ($Na_2S_2O_3$).

Sensory Evaluation

Sensory evaluation was carried out on each coded cookie sample. Fifty (50) semi-trained panelists who were familiar with cookies were selected at random from the staff and students of the Department of Food Science and Technology, Moddibo Adama University of Technology Yola Adamawa State, Nigeria. Each coded sample was rated from 1 to 9 (1 and 9 for extremely like and extremely dislike, respectively) as described by Iwe (2010). Assessed quality attributes include colour, texture, crunchiness, taste, flavour, and overall acceptability.

Statistical Analysis

All experiments were performed in triplicate, and the results were expressed as means ± standard error (SE). Analysis of variance (ANOVA) was determined to check any significant differences in measurements using the SPSS statistical software (SPSS 22.0 version; SPSS Inc., Chicago, IL, USA). The significance of the means was determined using the Duncan's Multiple Range Test, and the confidence level was considered at $p > 0.05$.

Results and discussion

Proximate composition of experimental cookies

The results obtained from the proximate composition of the cookies produced from the partial substitution of margarine with avocado pear pulp are shown in Table 2. The moisture content ranged from 11.13% to 14.60% (wet basis) with sample E (50% avocado pear pulp and 50% margarine) having the highest value and sample A (100% margarine (control) had the lowest value. The moisture content of the cookies increases significantly ($p>0.05$) with increase in the percentage substitution of avocado pear pulp in the cookie fat mixes. This can be explained by the high moisture content of avocado pear pulp, which is about 72.3 g/100 g (Dreher and Davenport, 2013) used as a substitute for margarine. A similar observation was reported by Nurul Ain et al. (2016) for the incorporation of avocado pulp in a muffin. Besides, the fiber content in avocado pulp (about 6.80 g/100 g) might also increase the moisture content in cookies as fiber has a strong affinity for water (Sadaf et al., 2013). Low moisture content (low water activity) ensures retardation of microbial growth to prevent cookies from quick microbiological spoilage and have a long shelf life if they are protected from absorbing moisture from damp surroundings or atmosphere.
The crude protein content ranged from 6.93% to 7.83%. The crude protein of samples A, B, and C cookies were not significantly different ($p<0.05$) from one another. However, they were seen to be significantly different ($p>0.05$) from samples D and E cookies as the percentage level of substitution increases. Previous studies confirmed a similar trend in which incorporation of a fat replacer either significantly or insignificantly increased the protein content of baked goods (Grigelmo-Miguel et al., 2001; Hussien, 2016). The increment in the protein content of the cookies could be as a result of protein content in avocado pear since all other ingredients were kept constant. A similar increase in protein content (6.56% to 9.15%) was also observed by Sadaf et al. (2013) the for incorporation of peanut butter in biscuits. Protein is needed as a building blocks for the body, necessary for growth and for the repair of damaged tissues (Wardlaw and Kessel, 2002). Thus, regular consumption of these cookie samples by people of different ages could help to increase their protein intake.
The crude fat content ranged from 16.00% to 18.03% with sample E (50% avocado pear pulp and 50% margarine) having the lowest value and sample A (100% margarine (control) had the highest value.

Table 2. Proximate composition of the cookie samples produced from partial substitution of margarine with avocado pear pulp (%)

Sample	Moisture	Crude Protein	Crude Fat	Ash	Crude Fiber	Carbohydrate
A	11.13±0.27[d]	6.93±0.07[c]	18.03±0.12[a]	1.40±0.18[b]	0.29±0.01[c]	62.22±0.33[b]
B	11.47±0.24[cd]	6.95±0.13[c]	17.00±0.15[b]	1.72±0.16[ab]	0.33±0.03[c]	62.53±0.31[ab]
C	11.93±0.13[bc]	7.00±0.06[c]	16.17±0.09[c]	1.71±0.15[ab]	0.45±0.03[b]	62.74±0.27[a]
D	12.60±0.20[b]	7.43±0.09[b]	16.03±0.09[c]	1.63±0.20[ab]	0.54±0.02[a]	61.77±0.24[b]
E	14.60±0.21[a]	7.83±0.03[a]	16.00±0.06[c]	2.09±0.10[a]	0.62±0.02[a]	58.86±0.16[c]

Values are means, n=3 ± SE (Standard Error). Mean in a column with the same superscript are not significantly different at $p < 0.05$. Sample codes: A = 100% Margarine (Control); B = 20% Avocado Pear Pulp and 80% Margarine; C = 30% Avocado Pear Pulp and 70% Margarine; D = 40% Avocado Pear Pulp and 60% Margarine; E = 50% Avocado Pear Pulp and 50% Margarine.

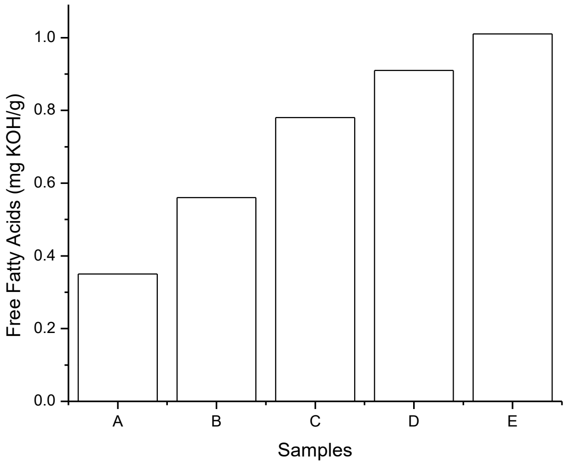

Fig. 1. The free fatty acid of the extracted fat from cookies produced from partial substitution of margarine with avocado pear pulp; Sample codes: A = 100% Margarine (Control); B = 20% Avocado Pear Pulp and 80% Margarine; C = 30% Avocado Pear Pulp and 70% Margarine; D = 40% Avocado Pear Pulp and 60% Margarine; E = 50% Avocado Pear Pulp and 50% Margarine.

The fat content of the cookie samples reduces with increasing the level of substitution of avocado pear pulp. This could be as a result of the avocado which is rich in fat but less compared to margarine (Dreher and Davenport, 2013). Also, the high moisture content in the fresh pulp of avocado is the main obstacle in obtaining high oil extraction yield (Dreher and Davenport, 2013) and thus, the fat contents decreased. Sample E cookies would be a better choice for weight watchers who are only interested in reducing the fat but still wanted to maintain other nutrients such as protein and ash content.

The ash content ranged from 1.40% to 2.09%. Sample E had the highest ash content (2.09%) and therefore indication of high mineral contents. The crude fibre content of the samples ranged from 0.26% to 0.62% with sample E (50% avocado pear pulp and 50% margarine) having the highest value and sample A (100% margarine (control) had the lowest value. The crude fibre content of the cookies increases significantly ($p>0.05$) with an increase in the percentage substitution of avocado pear pulp in the cookie fat mixes. Fibre aids in lowering blood cholesterol levels and slows down the process of absorption of glucose thereby helps in keeping blood glucose levels in control. Hence, the experimental cookies samples rich in fibre could control blood glucose levels in consumers.

Carbohydrate content was observed not significantly different ($p> 0.05$) following the increment of avocado pear pulp incorporation. The carbohydrate content ranged from 59.70% to 62.79%. Avocado pear pulp incorporation contributed to the increase in carbohydrate content of the cookies since the quantity of other ingredients was kept constant.

Free fatty acid, iodine and peroxide values of fat extracted from the experimental cookies

The free fatty acid (FFA) of the fat extracted from cookies produced from the partial substitution of margarine with avocado pear pulp is represented in Figure 1. The FFA ranged from 0.35 mg KOH/g to 1.01 mg KOH/g with sample E (50% avocado pear pulp and 50% margarine) having the highest value and sample A (100% margarine (control) had the lowest value. These values are relatively lower than 1.69 – 1.83 mg KOH/g reported by Nnaji and Okereke (2016) for fat extracted from three varieties of avocado pear pulp. The FFA value was observed to increase significantly ($p>0.05$) with an increase in the percentage of avocado pear pulp. This shows that sample E which has higher FFA has been decomposed by the lipase more readily than the other samples at room temperature. Also, since margarine was substituted for by unsaturated-fats of avocado pear pulp, the FFA improved as predicted. This shows that saturated fats were decreased while monounsaturated fats were increased with avocado incorporation. A similar result was reported by Othman et al. (2018). The FFA of the cookies produced is low which shows the stability of the product. Adeleke and Abiodun (2010) reported that low FFA in a product indicates the stability of the products. However, an increase in FFA with an increase in the percentage of avocado pear pulp substitutions causes a decrease in the palatability of the cookies.

Iodine value is a measure of unsaturation in lipid, which again determines the degree of flow. The iodine value of the cookie samples fat ranged from 75.63 g I_2/100 g to 81.17 g I_2/100 g (Figure 2). It also increased with an increase in the quantity of avocado pear pulp inclusion in the cookies. However, values fell within the range of 65 – 95 g I_2/100 g reported for fat extracted from avocado pear pulp (AOCS, 1998). The high iodine value of sample E (50% avocado pear pulp and 50% margarine) is an indication of unsaturated fat/oil occurrence in the cookies. Increasing iodine value is an indication of an increased in the degree of unsaturation of fat in the cookies. A similar result was reported by Moigradean et al. (2012).

The peroxide value gives an indicator of the detoriation of fat in the products (Adeleke and Abiodun, 2010). The peroxide value of the cookie samples ranged from 2.96 meq/kg to 5.27 meq/kg (Figure 3). The peroxide value was observed to increase significantly ($p>0.05$) with an increase in the percentage of avocado pear pulp. Moigradean et al. (2012) classified a product with a peroxide value above 10 meq/kg as a high oxidation state and below as a low oxidation state. Thus, all the cookies produced in this study can stay long because the values are low and found to be within values for low oxidation state products. Hence the cookie samples are not prone to oxidative rancidity.

Sensory attributes of cookie samples

The organoleptic properties of the cookies produced from the partial substitution of margarine with avocado pear pulp are presented in Table 3. The colour ratings of the cookies ranged from 6.70 to 8.05 with sample A (100% margarine (control) having the highest rating and sample E (50% avocado pear pulp and 50% margarine) had the lowest rating. The result obtained showed that with increase in the avocado pear pulp addition lowered the scores for colour. A similar result was observed by Hussien (2016) in cake produced with cantaloupe as a fat replacer that full-fat replacement lowered the colour score as compared to the control product. It was observed that the greenish-yellowish colour of avocado pear pulp produced undesirable and detectable colour changes in cookies produced compared to the control samples. Suriya et al. (2017) reported that colour is an important parameter in judging properly baked cookies that not only reflect the suitable raw materials used for the preparation but also provide information about the formulation and quality of the products. Thus, the results demonstrated that cookies were liked moderately.

In terms of texture, crunchiness, taste, and flavour, the panelists detected no significant difference ($p > 0.05$) as the incorporation of avocado pear pulp increases. This is because avocado pear pulp seems not to have a strong effect of qualities on the product. Also, these attribute scores were lower as the incorporation increases, which revealed that as the avocado substitution increases, sensory properties were negatively affected. The crunchiness is an important quality that influences the customers' acceptability of cookies (Lusas and Rooney, 2001). The decrease in texture and crunchiness score of cookies was linked to the increase in moisture and protein contents which resulted in poor entrapment of air during dough mixing and made the cookies harder. A similar decrease in colour score was also observed by Sadaf et al. (2013) for the incorporation of peanut butter in biscuits. The overall acceptance of the cookies was like moderately by the panelists. Thus, the incorporation of avocado pear pulp up to 30% substitution was preferred among panelists. However, the acceptance level reduces with an increase in avocado pear pulp substations. The acceptance of the cookies seems to be dependent on the colour, texture, crunchiness, taste, and aroma parameters since the pattern of overall acceptance was similar to these test qualities.

All of the assessed quality parameters were significantly affected ($p < 0.05$) with the increasing level of avocado pear pulp incorporation concerning the hedonic scale used by panelists. Thus, since all the panelists used in this sensory evaluation are semi-trained and familiar with the qualities of cookies, then it could be recommended that partial substitution of margarine with avocado pear pulp up to 30% in the production of cookies be used.

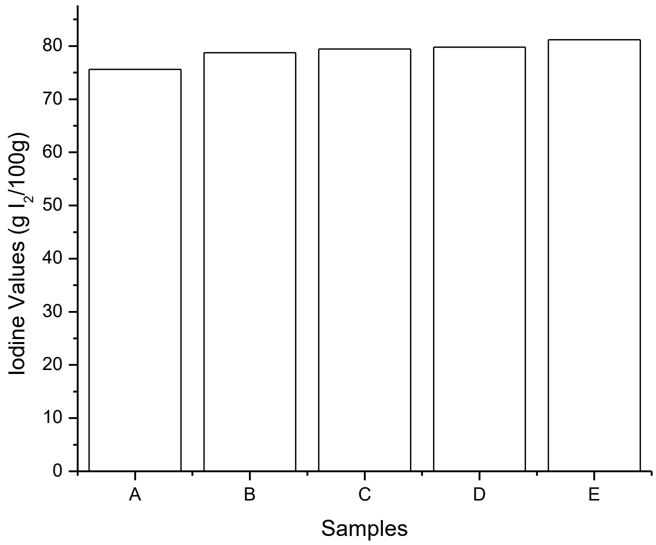

Fig. 2. The iodine value of the extracted fat from cookies produced from partial substitution of margarine with avocado pear pulp; Sample codes: A = 100% Margarine (Control); B = 20% Avocado Pear Pulp and 80% Margarine; C = 30% Avocado Pear Pulp and 70% Margarine; D = 40% Avocado Pear Pulp and 60% Margarine; E = 50% Avocado Pear Pulp and 50% Margarine.

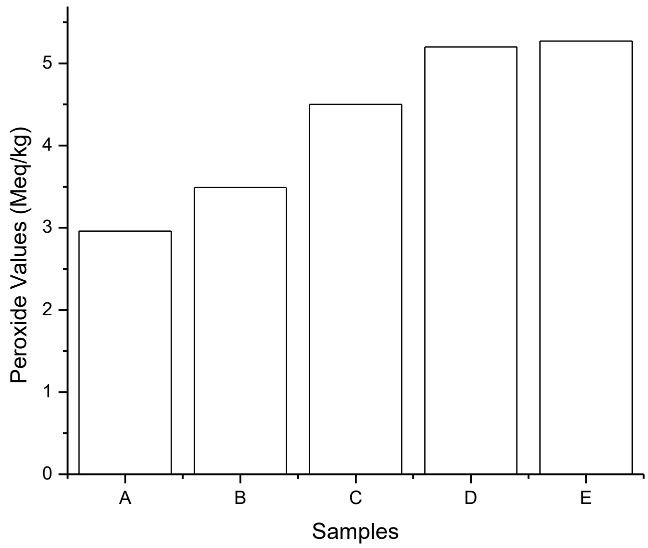

Fig. 3. The peroxide value of the extracted fat from cookies produced from partial substitution of margarine with avocado pear pulp; Sample codes: A = 100% Margarine (Control); B = 20% Avocado Pear Pulp and 80% Margarine; C = 30% Avocado Pear Pulp and 70% Margarine; D = 40% Avocado Pear Pulp and 60% Margarine; E = 50% Avocado Pear Pulp and 50% Margarine.

Table 3. Sensory attribute scores of the cookies produced from partial substitution of margarine with avocado pear pulp

Sample	Colour	Texture (ns)	Crunchiness (ns)	Taste (ns)	Flavour (ns)	Overall Acceptability
A	8.05 ± 0.20^{a}	7.30±0.31	6.75±0.34	7.85±0.23	7.95±0.18	7.90 ± 0.16^{a}
B	7.90 ± 0.23^{a}	7.50±0.41	7.30±0.40	7.60±0.39	7.15±0.31	7.85 ± 0.22^{ab}
C	7.40 ± 0.27^{ab}	7.20±0.41	7.10±0.38	7.50±0.30	7.55±0.29	7.55 ± 0.23^{ab}
D	6.95 ± 0.42^{b}	6.90±0.34	6.85±0.24	6.85±0.33	7.00±0.37	7.25 ± 0.36^{ab}
E	6.70 ± 0.31^{b}	6.85±0.36	6.65±0.50	6.65±0.50	6.95±0.44	7.10 ± 0.23^{b}

Values represent means, n = no. of panelists ± SE (Standard error). Mean in column with the same superscript are not significantly different at $p < 0.05$. Sample codes: A = 100% Margarine (Control); B = 20% Avocado Pear Pulp and 80% Margarine; C = 30% Avocado Pear Pulp and 70% Margarine; D = 40% Avocado Pear Pulp and 60% Margarine; E = 50% Avocado Pear Pulp and 50% Margarine. ns = not significant

Conclusion

Investigation in this work has revealed the feasibility of avocado pear pulp as a margarine substitute cookies. The partial substitution of margarine with avocado pear pulp produced nutritious cookies with desirable organoleptic qualities. Also, the results demonstrated that cookies had acceptability up to a 30 % level of substitution. Since margarine was substituted for by unsaturated-fats in avocado pear pulp, the fatty acid profile would improve. These products would be a better choice for weight watchers who are only interested in reducing fat intake.
This study would promote an expanded usage of avocado fruit beyond domestic utilization. However, further studies are needed to examine the stability and shelf life properties of the avocado pear pulp-based cookies. Also, processing and storage studies on avocado pear fruits should be encouraged to ensure the continuous supply of the fruit throughout the year.

Author Contributions: Jelili Babatunde Hussein designs the study and supervised the data analysis, Seember Bernadette Kave analyzed the data and wrote the manuscripts, Joseph Idowu Olaniyi assisted in the planning and supervision of the work, and Esther Anjikwi Msheliza involved in the critical review of the manuscript. It is herein agreed that we will not publish the above manuscript anywhere else without the prior written permission of the publisher.
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References

Adeleke, R.O., Abiodun, O.A. (2010): Nutritional and Physico-chemical Properties of Bombax glabrum Seeds. *Pak. J. Nutr.* 9, 856-857

AOAC (2010): Official Methods of Analysis of Association of Official Analytical Chemists (18th ed.). Washington D.C

AOCS (1998): Official Method Cd 1d-92, Iodine Value of Fats and Oils, Cyclohexane-Acetic Acid Method. In D. Firestone (Ed.), Official Methods and Recommended Practices of the American Oil Chemists (5th ed.). Champaign: AOCS.

Briggs, M.A., Petersen, K.S., Kris-Etherton, P.M. (2017): Saturated Fatty Acids and Cardiovascular Disease: Replacements for Saturated Fat to Reduce Cardiovascular Risk. *Healthc.* 5 (2), 29. https://doi.org/10.3390/healthcare5020029

Cadet, C., Coste, P., Kerloch, I., Lequesne, M., Maheu, E., Moyse, D. (2014): Ramdomised, Controlled Trial of Avocado-Soybean Unsaponifiable Effect on Structure Modification in Hip Osteoarthritis. *Ann. Rheum. Dis.* 2 (73), 376-384.

Dreher, M.L., Davenport, A.J. (2013): Hass Avocado Composition and Potential Health Effects. *Crit. Rev. Food Sci. Nutr.* 53 (7), 738-750. https://doi.org/10.1080/10408398.2011.556759

Engel, S., Tholstrup, T. (2015): Butter Increased Total and LDL Cholesterol Compared with Olive Oil but Resulted in Higher HDL Cholesterol Compared with a Habitual Diet. *Am. J. Clin. Nutr.* 102 (2), 309-315. https://doi.org/10.3945/ajcn.115.112227

Grigelmo-Miguel, N., Carreras-Boladeras, E., Martin-Belloso, O. (2001): Influence of the Addition of Peach Dietary fiber in Composition, Physical Properties and Acceptability of Reduced-Fat Muffins. *Food Sci. Technol. Int.* 7, 425-431. https://doi.org/10.1106/FLLH-K91M-1G34-Y0EL

Hussien, H.A. (2016): Using Vegetable Puree as a Fat Substitute in Cakes. *Int. J. Food Sci. Nutr.* 5, 284-292. https://doi.org/10.11648/j.ijnfs.20160504.18

IFIS (2005): Dictionary of Food Science and Technology. 9600 Garsington Road, Oxford OX4 2DQ, UK: Blackwell Publishing Ltd.

Iwe, M.O. (2010): Some Sensory Methods and Data Analysis. In: Handbook of Sensory Methods and Analysis. Enugu, Nigeria: Rojoint Communication Services LTD, 2nd ed., pp. 80 – 85.

Lusas, E.W., Rooney, L.W. (2001): Snack Foods Processing. Lancaster: PA : Technomic Publishing Company.

Moigradean, D., Poiana, M., Gogoasa, I. (2012): Quality Characteristics and Oxidative Stability of Coconut Oil During Storage. *J. Agroaliment. Processes Technol.* 18 (4), 272-276.

Navder, K., Wekwete, B. (2008): Effects of Avocado Fruit Puree and Oatrim as Fat Replacers on the Physical, Textural and Sensory Properties of Oatmeal Cookies. *J. Food Sci.* 2 (31), 131-141.

Nnaji, J.C., Okereke, O.B. (2016): Proximate Composition and Physico-Chemical Properties of Three Avocado (*Persea Americana*) Varieties in Umuahia Nigeria *J. Appl. Chem. Sci. Int.* 5 (4), 195-200.

Nurul Ain, O., Marina, A.M., Sakinah, H. (2016): The Effect of Avocado Puree as Fat Replacer on the Physical Quality of Muffin. *Malays. Appl. Biol.* 45 (2), 11-16.

Othman, N.A., Abdul-Manaf, M., Harith, S., Wan-Ishak, W.R. (2018): Influence of Avocado Purée as a Fat Replacer on Nutritional, Fatty Acid, and Organoleptic Properties of Low-Fat Muffins. *J. Am. Coll. Nutr.* 37 (7), 583-588. https://doi.org/10.1080/07315724.2018.1451408

Oyewole, O.B., Sanni, L.O., Ogunjobi, M.A. (1996): Production of Biscuits using Cassava Flour. *Nig. Food J.* 14, 24-29.

Sadaf, J., Bibi, A., Raza, S., Waseem, K., Jilani, M.S., Ullah, G. (2013): Peanut Butter incorporation as Substitute for Shortening in Biscuits: Composition and Acceptability Studies. *Int. Food Res. J.* 20, 3243-3247.

Singh, R., Singh, G., Chauhan, G.S. (2000): Nutritional Evaluation of Soy Fortified Biscuits. *J. Food Sci. Technol.* 37, 162-164.

Soares, H.F., Ito, M.K. (2000): The Monounsaturated Fatty Acids From Avocado in the Control of Dyslipidemia. *Revistacliencias Medicas* 9 (2), 47-51.

Suriya, M., Rajput, R., Reddy, C.K., Haripriya, S., Bashir, M. (2017): Functional and Physicochemical Characteristics of Cookies Prepared from Amorphophallus Paeoniifolius Flour. *J. Food Sci. Technol.* 54 (7), 2156–2165. https://doi.org/10.1007/s13197-017-2656-y

Wardlaw, G.M., Kessel, M. (2002): Perspective in Nutrition (5th Ed.): McGraw-Hill, Boston.