CONSUMER ACCEPTABILITY AND QUALITY CHARACTERISTICS OF COOKIES PRODUCED FROM COMPOSITE FLOURS OF WHEAT AND BANANA/AVOCADO PEELS

Olusegun Ayodele Olaoye[1,*], Josephine Ifeyinwa Ekeh[2], Chidiebere John Okakpu[1]
Anaga Chidinma Uka[1]
[1]Department of Food Science and Technology, Michael Okpara University of Agriculture
Umudike, Abia State, Nigeria
[2]Department of Home Science, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
* E-mail: olaayosegun@yahoo.com

Abstract
This study evaluated consumer acceptability and quality characteristics of cookies produced from composite flours of wheat and banana/avocado peels. Banana peel flour (BPF) and avocado peel flour (APF) were substituted in wheat flour at 5 and 10 % and used to produce cookies. Analysis of the composite flours showed that the highest ash content (%) was recorded in the flour sample containing 10% AF (flour-E), having a value of 1.40 while wheat flour (flour-A) had the lowest. Crude fibre (%) ranged from 1.71 and 3.28, with flour-A and flour-E having the lowest and highest values respectively. Result of proximate composition of the cookies indicated that the cookies containing APF and BPF had higher ash and crude fibre contents than their counterparts containing only wheat flour. From the result of mineral analysis (mg/100g), it was observed that potassium, calcium, sodium, magnesium and iron ranged between 412.47-460.82, 20.48-65.26, 1.89-8.56, 31.21-42.65, and 2.10-3.19 respectively. Cookies with supplementation with flours of avocado/banana peel had higher contents than those produced from wheat flour alone. Assessment of the consumer acceptability of the cookies indicated that those produced from composite flours of wheat and avocado/banana peels favourably compared with those of wheat flours in the sensory attributes tested; hedonic mean scores of 6.0 and above were recorded for all the samples. It was concluded that the use of flours from avocado and banana peels as composites of wheat had good potential for production of nutritionally superior cookies compared to the use of wheat alone. This study may be an economically viable approach towards promoting utilization of food wastes for production of value added products in developing countries such as Nigeria, where food security has been a major challenge.

Keywords: cookies produced, banana/avocado peels

Received: 06.01.2019 Reviewed: 07.03.2019 Accepted: 08.03.2019

1. INTRODUCTION

The technology of composite flours represents an interesting option for the management of costs associated with importation of wheat flour in developing countries where wheat is not cultivated for climatic reasons (Olaoye *et al*., 2006). With the constant increase in the consumption of bread and other baked products such as cookies in many developing countries, coupled with ever-growing urban populations, the composite flour technology in the making of baked food products could be very useful (Olaoye and Ade-Omowaye, 2011).

Avocado pear (*Persea americana*) is a fruit from an evergreen tree native to Mexico, Central America and South America but it is now grown worldwide (Talabi *et al*., 2016). The fruit is high in antioxidants, vitamins and monounsaturated fatty acids, fibre and potassium (Kim and Uhl, 2011). The avocado fruit has a multipurpose value as food, medicine, source of high quality oil and numerous industrial uses, its edible fleshy part is amongst the most nutritious of all salad fruits. It is served as a salad vegetable. It can also be eaten raw or on bread and tortills. The peels of the fruits are usually removed to reveal the edible flesh, and in most cases are discarded after removal; this is because consumers are interested in the edible fleshy portion. The peels have been reported to be rich in some nutrients, and could therefore be utilized in the production of value added food products which may be of nutritional advantage to consumers and promote food security.

One of the most cultivated fruit crops in the tropical and subtropical climate countries is banana, and is about the fourth most important agricultural commodity in the world (Gomes *et al.*, 2016). Gomes *et al.* (2016) noted that out of the total production of banana, approximately 40% is lost in the post-harvest period. Banana peels have been noted to represent 47-50% of the weight of the fruit, however the food values of the peels and their possible use in the production of value added products have not been known. The peels are known to be discarded or used as animal feed or fertilizer in few cases (Fatemeh *et al.*, 2012). The use of banana peels in food products may help improve nutritional quality as they have high contents of vitamins, minerals and fiber (Gomes *et al.*, 2016).

Studies on the utilization of flours from peels of banana and avocado in the production of value added food products have been very scares. Castelo-Branco *et al.* (2017) investigated the potential of banana peel flour in the production of pasta, an extruded food product. More studies are therefore required in exploring the potential use of flours from peels of avocado and banana in composite flour technology towards production of value added food products which may find usefulness in bakery and others areas of food production. The present study therefore aimed at evaluating consumer acceptability and quality characteristics of cookies produced from composite flours of wheat and banana/avocado peels.

2. MATERIALS AND METHODS

Source of raw materials

The raw materials used, including banana (*Musa Sapietum* L.), avocado (*Persea America*) and wheat flour, were purchased from Ndioru market in Ikwuano local government area (LGA) of Abia State, Nigeria. Other ingredients used, granulated sugar, table salt, butter, nutmeg, egg, powdered milk and vanilla flavor, were obtained from the same source.

Processing of avocado and banana peels into flours

Healthy and ripened banana and avocado were washed in clean water and allowed to drain in perforated baskets (Figure 1). Peels were carefully obtained from them using hand with the aid of a knife, and then placed in clean containers separately. They were chopped into small pieces and blanched over steam for 5 min, and then allowed to drain. The blanched peels were dried in air drying oven (Gallenkamp, USA) at 55ºC for 24-36 h. The dried peels were thereafter milled into flour, hammer mill machine (tiger-extruda 6.5 hp, UK) and sieved (using 0.02 µm mess size sieves). The resulting flours were packaged and stored for use as composites of wheat flour in the production of cookies.

Formulations of wheat, avocado and banana peel composite flours

Five different formulations of composite flours from wheat, avocado and banana peels were used in the production of cookies, including Cookie A, Cookie B, Cookie C, Cookie D and Cookie E. The different compositions of the different flours in the various formulations are shown in Table 1.

Functional properties of flours

Water absorption capacity and bulk density of the different flours were determined using the methods described by Wang and Kinsella (1976) and Mbofung *et al.* (2006) respectively. Foam and emulsifying capacities were determined by standard methods (Okezie and Bello, 1988; Abulude, 2001).

Oil absorption capacity of the composite flours was determined using the method of Sathe *et al.* (1981). A quantity of flour (2 g) was weighed and mixed with 20 ml of oil in a Moulinex blender (Model dePC 3, France) at high speed for 30 - 60 sec. This was allowed to stand at 30°C for 30 min and then centrifuged (10,000 rpm for 30 min); the resulting supernatant in a graduated cylinder was measured. Wettability was determined by modified methods of Ubbor and Akobundu (2009) and Nwosu *et al.* (2014).

Proximate composition of flours and cookies

The proximate components of moisture, ash, fat, and protein contents of the different composite flours and cookies produced from them were determined using the methods of the Association of Official Analytical Chemists (AOAC, 2005). Carbohydrate was determined by difference.

Production of cookies from wheat, avocado and banana peel composite flours

The different formulations of flours obtained from wheat, avocado and banana peels were used to produce cookies using the modified method of Okpala and Chinyelu (2011). The ingredients were weighed separately into different containers (Table 1); sugar and fat were creamed until a fluty mixture was realized. Liquid eggs were battered and poured into the cream with dry ingredients, including flour, milk, baking powder and vanilla flavour, added and mixed. After approx. 4 min of mixing, salt was added and mixed properly to obtain a uniform and texture consistent batter. The batter was rolled on a flat clean and hard surface rolling board which had been pre-sprinkled with wheat flour. The batter was then cut into desired shapes using a local device, and arranged in a greased baking tray for baking in a forced air convection electric oven (380V, ROHS Deck BakingOven, Hangzhou 311121, China). Baking of was done at 160ºC for 15min, after which the baked cookies were allowed to cool before packaging.

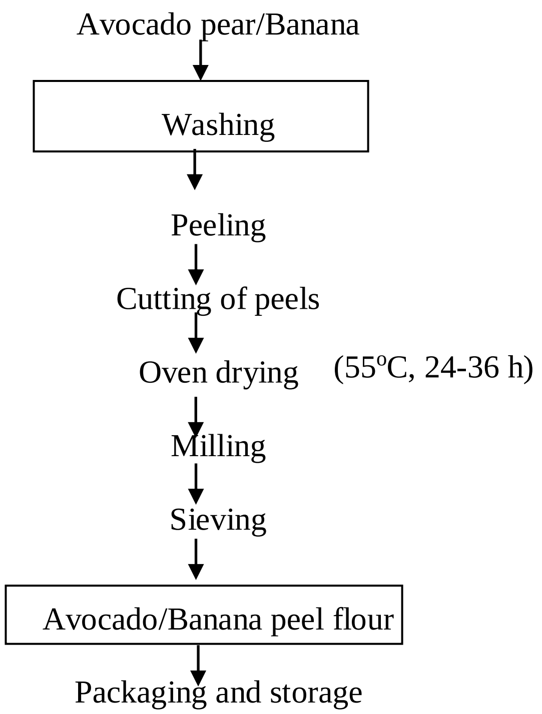

Fig. 1 Flow chart for avocado/banana peel flour production

Table 1 Formulation of ingredients (grams) used for the flour blends

Sample codes	WF	BPF	APF	Total
Flour-A	500	-	-	500
Flour-B	475	25	-	500
Flour-C	450	50	-	500
Flour-D	475	-	25	500
Flour-E	450	-	50	500

WF, wheat flour
BPF, banana peel flour
APF, avocado peel flour

Mineral composition of cookies

Mineral composition of the cookies produced from the different flour formulations was determined using the methods of Saura-Calixto *et al*. (1983) and Bonire *et al*. (1990). Potassium and sodium were determined by digesting the ash of samples with perchloric acid and nitric acid, and then taking the readings on Jenway digital flame photometer (spectronic20). Calcium, magnesium, iron and zinc were determined spectrophotometrically by using Buck 200 atomic absorption spectrophotometer (Buck Scientific, Norwalk) and compared with absorption of standards of the minerals.

Sensory evaluation of cookies

The different samples of cookies were subjected to sensory evaluation for the attributes of taste, crispiness, aroma, appearance, and general acceptability. A semi trained twenty member panel was used and scores were allocated to the attributes based on a 9-point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely). The data collected were subsequently subjected to statistical analysis to determine possible differences among samples.

Statistical analysis

The data obtained, which depended on cookies produced from different formulations of banana and avacado peel flours, were analyzed using the means of three replicates of each sample. Means were separated and analyzed using the *t*-test in data analysis functionality of Microsoft Excel 2010 SP2 (version 14.0.7015.1000) to establish differences. Significant differences among samples were determined at $P < 0.05$.

3. RESULTS AND DISCUSSION

In the present study, composite flours were obtained from wheat and peels of banana and avocado; their potential for production of good and acceptable cookies was evaluated. The proximate composition of the various composite flours is presented in Table 2. Moisture contents ranged between 9.81 and 11.01%, with flour-E (flour from 90% wheat flour and 10% avocado peel flour), having the highest value while the lowest was recorded for flour-B (flour from 95% wheat flour and 5% banana peel flour). The moisture contents recorded in this study were similar to those reported in previous studies by other research investigators (Ubbor and Akobundu, 2009; Nwosu *et al.*, 2014; Olaoye *et al.*, 2015). Protein content was highest in the wheat flour (flour-A), having a value of 12.72% while flour-E had the lowest, 9.46; significance difference was recorded between protein value of wheat in comparison with others ($P < 0.05$). Wheat is known to have higher protein value than banana and avocado (Mahawan *et al.*, 2015; Castelo-Branco*et al.*, 2017); this may be responsible for the higher protein recorded in flour-A than others. In a study carried out by Mahawan *et al.* (2015), protein content recorded in the flour produced from avocado seed was higher than in the whole wheat counterpart. In a related study, similar observation was reported by Castelo-Branco *et al.* (2017) for flour obtained from banana. It is noteworthy to state that the quality of protein in wheat has been reported to be superior to those of other vegetable flours, especially in terms of ability to form elastic networks responsible for trapping carbon dioxide (produced by yeast action) in dough. This quality index is of importance in baked food products such as bread, but may be less important in other baked products such as cookies and biscuit where rising of dough (batter) through yeast action is of no significance. The high protein content recorded for flour-A in the present study may therefore not be very important, except for nutritional importance, since no rising is required in the batter used in production of cookies. Ash contents of the composite flours (from wheat, banana and avocado peels) were higher than, and significantly difference from ($P < 0.05$), their whole wheat counterpart; flour-E sample had the highest value of 1.40% while the least (1.06) was recorded for flour-A. Similar observations were recorded in studies carried out by Mahawan *et al.* (2014) and Castelo-Branco *et al.* (2017) on avocado and banana peel flours respectively, in comparison to wheat flour. The result of the ash contents of the different flours therefore indicates that the composite flours may be of nutritional significance when used in the production of baked food products, since ash is generally indicative of the mineral contents of foods. The fat contents ranged between 0.54 and 0.84%; higher contents were recorded in the composite flours than flour-A, prompting the assumption that banana and avocado might contain more fat than wheat. Findings from the studies carried out by Turker*et al.* (2016) and Gomes*et al.* (2016) on banana peel flour substitution in wheat in the production of cake and bread respectively are supportive of this assumption; the authors recorded higher fat contents in banana peel flours than wheat. In related studies, Mahawan *et al.* (2015) and Nnaji and Okereke (2016) reported higher values of fat than normally found in wheat. Wheat flour recorded the lowest fibre content (1.71%) compared to the composite flour counterparts, and differed significantly ($P < 0.05$); flour-E sample had the highest value of 3.28. Crude fibre could be very important in dietary intake of many people as it aids digestion, and hence promotes optimal absorption of food. The carbohydrate contents in the flour samples ranged within 71.04 and 76.91, with the highest value being recorded for the whole wheat flour..

The higher contents of protein, ash and fibre recorded in the composite flours from banana and avocado peel flours than in flour-A indicate that they could find uses in the production of nutritionally superior food products, including baked products, compared with the use of wheat flour. This may contribute significantly to food security in many countries, especially developing nations, where capabilities of many consumers to afford protein rich foods have been a great challenge.

Table 3 presents the functional properties of the flour samples. The functional attribute of bulk density (g/ml) was highest (0.38) for flour-B while the lowest (0.33) was recorded for flour-C.

TABLE 2 Proximate composition of wheat, banana and avocado peels composite flours

	← FLOUR SAMPLES →				
PARAMETERS (%)	**FLOUR-A**	**FLOUR -B**	**FLOUR -C**	**FLOUR -D**	**FLOUR -E**
Moisture	10.04^{b}±0.03	9.81^{c}±0.01	10.87^{a}±0.01	10.57^{ab}±0.01	11.01^{a}±0.01
Protein	12.72^{a}±0.01	9.94^{b}±0.01	9.71^{bc}±0.01	10.13^{b}±0.01	9.46^{bc}±0.02
Ash	1.06^{c}±0.01	1.12^{c}±0.01	1.46^{a}±0.01	1.23^{b}±0.01	1.40^{ab}±0.01
Fat	0.84^{a}±0.01	0.60^{b}±0.01	0.69^{b}±0.02	0.43^{c}±0.01	0.54^{bc}±0.01
Crude fibre	1.71^{c}±0.02	2.25^{b}±0.02	2.48^{b}±0.01	2.62^{ab}±0.02	3.28^{a}±0.01
Carbohydrates	76.91^{a}±0.01	76.64^{a}±0.01	74.54^{ab}±0.01	75.25^{bc}±0.01	71.04^{c}±0.01

Values are means of duplicate determinations. Means across rows with different superscript letters are significantly different ($P < 0.05$).

FLOUR-A, flour from 100% wheat flour (WF); FLOUR-B, flour from 95% WF and 5% banana peels flour (BPF); FLOUR-C, flour from 90% WF and 10% BPF; FLOUR-D, flour from 95% WF and 5% avocado peels flour (APF); FLOUR-E, flour from 90% WF and 10% APF

TABLE 3 Functional properties of wheat, banana and avocado peel composite flours

	← FLOUR SAMPLES →				
PROPERTIES	**FLOUR-A**	**FLOUR -B**	**FLOUR -C**	**FLOUR -D**	**FLOUR -E**
Bulk density (g/ml)	0.36^{a}±0.01	0.38^{a}±0.01	0.33d^{b}±0.01	0.37^{a}±0.01	0.35^{b}±0.01
WAC (g/ml)	1.00^{a}±0.01	0.65^{b}±0.01	0.85^{ab}±0.01	0.75^{ab}±0.01	1.09^{a}±0.01
OAC (g/ml)	1.18^{b}±0.01	2.00^{a}±0.00	1.70^{a}±0.01	1.85^{ab}±0.01	2.05^{ab}±0.01
EC (%)	4.32^{b}±0.02	4.34^{b}±0.01	4.29^{b}±0.01	5.32^{a}±0.01	4.35^{b}±0.01
Foam capacity (%)	72.50^{a}±0.71	71.00^{a}±1.41	61.01^{c}±1.41	61.00^{c}±1.41	67.00^{bc}±1.41
Wet-ability (%)	110.0^{b}±0.00	99.50^{c}±0.71	158.00^{a}±1.41	112.5^{b}±0.71	104.00^{c}±0.00

Values are means of duplicate determinations. Means across rows with different superscript letters are significantly different ($P < 0.05$.

FLOUR-A, flour from 100% wheat flour (WF); FLOUR-B, flour from 95% WF and 5% banana peels flour (BPF); FLOUR-C, flour from 90% WF and 10% BPF; FLOUR-D, flour from 95% WF and 5% avocado peels flour (APF); FLOUR-E, flour from 90% WF and 10% APF; WAC, water absorption capacity; OAC, oil absorption capacity; EC, emulsifying capacity.

Water absorption capacity (WAC) ranged between 0.65 and 1.09 (g/mg) while a range of 1.18 and 2.05 (g/ml) was obtained for oil absorption capacity (OAC) of the flour samples. Emulsifying capacity (EC) was highest (5.32%) for flour-D while flour-C had the lowest value of 4.29. Foaming capacity and wet-ability (%) ranged between 61.00-72.50 and 99.50-110.0 respectively. Significant difference was recorded between most of the composite flours and whole wheat flour (flour-A), indicating noticeable influence of flours from avocado and banana peels. The implication of this is that using flours from peels of avocado and banana as composite of wheat may result in varieties of composite flour technology which could be useful in bakery technology and other food formulations. It has been noted that functional properties are intrinsic physico-chemical characteristics of food (especially flours) which affect the behaviour of properties in food systems during processing, manufacturing, storage and preparation (Olaoye and Obidegwe, 2018). From the report of the investigation by Olaoye and Obidegwe (2018), results of the functional properties in the current study, it could be inferred that the composite flours from wheat and banana/avocado peels may find applications in food preparations such as bread, biscuits and cookies.

Table 4 shows the proximate composition of the cookies. Results indicate that cookies from whole wheat flour (cookie-A) had higher protein contents than their counterparts from composite flours of wheat, banana and avocado peels. While the highest value of 10.53% was recorded for cookie-A, cookie-E had the lowest, 9.48. Conversely, crude fibre and ash contents were higher in cookies from composite flours of wheat and avocado/banana peels than those from whole wheat flour. This becomes very significant, as a result of nutritional advantage inherent in the cookies made from the peel flours of the vegetables (avocado and banana), especially in developing countries like Nigeria where food security remains a major challenge to a large populace because of low per capital income. Cookie-D and cookie-E samples (which contained peel flour of avocado) had higher contents of fibre and ash than other samples, indicating that avocado could be a good source of minerals and dietary fibre (Talabi *et al.*, 2016).

Mineral analysis of the cookies indicated that potassium ranged from 412.47 to 460.82 mg/100g, with the cookie-E sample recording the highest, while cookie-A had the lowest (Table 5). The result recorded for calcium, sodium, magnesium and iron in the cookies were similar to that of potassium while zinc had a contrary pattern, with Cookie-A having the highest content of 4.38 (mg/100g). The higher contents observed in the cookie samples containing peel flours from avocado and banana may be nutritionally beneficial to consumers compared to samples made from whole wheat flour alone. The higher contents of minerals in the cookies made from the peel fours than in wheat flour alone have been noted (Olaoye and Ade-Omowaye, 2011). In a research investigation, Olaoye *et al.* (2007) reported higher contents in the ash of biscuits made from composite flours of breadfruit and wheat compared with those from wheat flour alone. Gomes *et al.* (2016) also observed a value of ash in bread made from banana peel flour/wheat higher than those in their counterparts from wheat flour.

The mean sensory scores recorded for the different cookie samples are shown in Table 6. Higher mean scores were observed for cookie samples made from whole wheat flour than others in the attributes of taste and aroma; cookie-D had highest scores in the attributes of crispiness and appearance. Cookie-D also compared favourably with cookie-A in terms of general acceptability. No significant difference (P>0.05) was recorded between cookie-A, cookie-C and cookie-D in the mean scores recorded for them in the attribute of crispiness.

TABLE 4 Proximate composition of cookies produced from wheat, banana and avocado peel composite flours

PARAMETERS (%)	FLOUR SAMPLES COOKIE-A	COOKIE-B	COOKIE-C	COOKIE-D	COOKIE-E
Moisture	9.55^{b}±0.02	10.23^{a}±0.02	10.27^{a}±0.01	10.42^{a}±0.01	10.28^{a}±0.01
Protein	10.53^{ab}±0.01	10.57^{ab}±0.01	11.16^{a}±0.02	11.28^{a}±0.02	9.48^{b}±0.02
Crude Fibre	1.47^{d}±0.01	2.19^{c}±0.01	2.33^{bc}±0.02	2.49^{ab}±0.02	2.98^{a}±0.01
Fat	3.12^{a}±0.01	2.17^{c}±0.01	2.33^{b}±0.01	2.21^{c}±0.01	2.53^{b}±0.01
Ash	0.73^{d}±0.01	0.99^{c}±0.01	1.18^{bc}±0.01	1.28^{b}±0.01	2.06^{a}±0.02
Carbohydrates	74.61^{a}±0.02	73.88^{a}±0.01	72.75^{a}±0.04	72.33^{ab}±0.04	72.69^{bc}±0.01
Dry matter	90.46^{a}±0.02	89.78^{a}±0.02	89.73^{ab}±0.01	89.58^{bc}±0.01	89.72^{cd}±0.01
Energy value (kcal)	368.62^{a}±0.01	357.45^{ab}±0.12	356.57^{ab}±0.07	354.31^{bc}±0.08	351.41^{bc}±0.11

Values are means of duplicate determinations. Means across rows with different superscript letters are significantly different (P < 0.05.

COOKIE-A, cookie from 100% wheat flour (WF); COOKIE-B, cookie from 95% WF and 5% banana peels flour (BPF); COOKIE-C, cookie from 90% WF and 10% BPF; COOKIE-D, cookie from 95% WF and 5% avocado peels flour (APF); COOKIE-E, cookie from 90% WF and 10% APF

TABLE 5 Mineral composition of cookies produced from wheat, banana and avocado peel composite flours

MINERALS (mg/100g)	FLOUR SAMPLES COOKIE-A	COOKIE-B	COOKIE-C	COOKIE-D	COOKIE-E
Potassium	412.47^{a}±1.92	453.61^{a}±1.68	455.35^{ab}±2.10	458.29^{bc}±2.06	460.82^{cd}±2.25
Calcium	30.48^{d}±0.51	52.36^{bc}±0.65	55.85^{ab}±0.75	59.56^{ab}±0.24	65.26^{a}±0.84
Sodium	1.89^{d}±1.60	6.90^{c}±1.42	7.82^{bc}±1.73	8.12^{ab}±1.26	8.56^{a}±1.80
Magnesium	31.21^{d}±0.16	35.40^{c}±0.14	37.37^{c}±0.15	39.13^{bc}±0.11	42.65^{ab}±0.18
Zinc	4.38^{a}±0.10	2.74^{d}±0.11	2.95^{cd}±0.10	3.08^{c}±0.12	3.26^{bc}±0.13
Iron	2.10^{d}±0.13	2.55^{c}±0.12	3.04^{b}±0.11	3.12^{a}±0.12	3.19^{a}±0.12

Values are means of duplicate determinations. Means across rows with different superscript letters are significantly different (P < 0.05.

COOKIE-A, cookie from 100% wheat flour (WF); COOKIE-B, cookie from 95% WF and 5% banana peels flour (BPF); COOKIE-C, cookie from 90% WF and 10% BPF; COOKIE-D, cookie from 95% WF and 5% avocado peels flour (APF); COOKIE-E, cookie from 90% WF and 10% APF

TABLE 6 Mean sensory scores for cookies produced from of wheat, banana peels and avocado peel composite flours

PARAMETERS	FLOUR SAMPLES COOKIE-A	COOKIE-B	COOKIE-C	COOKIE-D	COOKIE-E
TASTE	7.6^{a} ± 0.84	6.9^{c} ± 1.20	6.8^{c} ± 1.44	7.4^{ab} ± 1.04	7.2^{bc} ± 0.04
CRISPNESS	7.1^{a} ± 1.12	6.9^{a} ± 1.35	7.1^{a} ± 1.44	7.4^{a} ± 1.34	6.6^{b}± 1.34
AROMA	7.4^{a} ± 1.27	6.8^{b} ± 1.27	6.7^{b} ± 1.30	7.0^{ab} ± 1.41	6.4^{c} ± 1.20
APPEARANCE	7.3^{a} ± 1.01	6.8^{b} ± 1.02	6.9^{b} ± 1.37	7.4^{a} ± 1.66	6.1^{c} ± 1.89
GENERAL ACCEPTABILITY	7.6^{a} ± 0.84	7.1^{ab} ± 1.00	6.7^{b} ± 1.43	7.6^{a} ± 1.31	6.7^{b} ± 1.01

Values are means of duplicate determinations. Means across rows with different superscript letters are significantly different (P < 0.05).

COOKIE-A, cookie from 100% wheat flour (WF); COOKIE-B, cookie from 95% WF and 5% banana peels flour (BPF); COOKIE-C, cookie from 90% WF and 10% BPF; COOKIE-D, cookie from 95% WF and 5% avocado peels flour (APF); COOKIE-E, cookie from 90% WF and 10% APF

The mean sensory scores recorded for the different cookie samples are shown in Table 6. Higher mean scores were observed for cookie samples made from whole wheat flour than others in the attributes of taste and aroma; cookie-D had highest scores in the attributes of crispiness and appearance. Cookie-D also compared favourably with cookie-A in terms of general acceptability. No significant difference (P>0.05) was recorded between cookie-A, cookie-C and cookie-D in the mean scores recorded for them in the attribute of crispiness.

4. CONCLUSION

This study concluded that good and consumer acceptable cookies could be made from wheat and banana/avocado peel flours. The cookies obtained from composite wheat and banana/avocado peel flours were superior to their counterparts from whole wheat in terms of ash and crude fibre contents. Furthermore, the composite cookies contained higher amounts of minerals than their whole wheat counterparts. Therefore cookies of nutritional advantage to consumers could be made by partially substituting flours from banana/avocado peels in wheat. Besides the inherent nutritional advantage, if production of cookies from composite flours of wheat and avocado/banana peels is transformed into practice on commercial scale, it may help resolve the problem of food insecurity that is widespread in many developing countries, especially Nigeria.

5. REFERENCES

[1]. Abulude F.O. (2001). Functional properties of cowpea (*Vigna unguiculata* L. Walp) seed sprayed with neem (*Azadirachta indica*) leaf extracts. *Advances in Food Sciences*, 23, pp. 68-71.

[2]. AOAC, Association of Official Analytical Chemists (2005). Official methods of analysis of the Association of Analytical Chemists International.18th ed. AOAC, Gaithersburg, MD.

[3]. Bonire J.J., Jalil N.S.N., Lori J.A. (1990). Sodium and potassium content of twocultivars of white yam *(Dioscorea rotundata*) and their source soils. *Journal of Science of Food Agriculture*, 53, pp. 271-274.

[4]. Castelo-Branco V.N., Guimarães J.N., Souza L., Guedes M.R. (2017). The use of green banana (Musa balbisiana) pulp and peel flour as an ingredient for tagliatelle pasta. Brazilian *Journal of Food Technology*, 20, pp. 1-8; DOI: 10.1590/1981-6723.11916

[5]. Fatemeh S.R., Saifullah R., Abbas F.M.A., Azhar M.E. (2012). Total phenolics, flavonoids and antioxidant activity of banana pulp and peel flours: influence of variety and stage of ripeness. *International Food Research Journal*, 19, 1041-1046.

[6]. Gomes A.A.B., Ferreira M.E., Pimentel T.C. (2016). Bread with flour obtained from green banana with its peel as partial substitute for wheat flour: Physical, chemical and microbiological characteristics and acceptance. *International Food Research Journal*, 23(5), 2214-2222.

[7]. Kim M.J., Uhl K. (2011). Sex and Lifestyle Drugs: The Pursuit of the Fountain of Youth. *Clinical Pharmacology and Therapeutics*,89(1), pp. 3-9.

[8]. Mahawan M.A., Tenorio F.N., Gomez J.A., Bronce R.A. (2015). Characterization of Flour from Avocado Seed Kernel. *Asia Pacific Journal of Multidisciplinary Research*, 3(4), pp. 34-40.

[9]. Mbofung C.M.F., Abuobakar Y.N., Njintang A., Abduo Boubak B.F. (2006). Physico-chemical and functional properties of six varietes ofTaro (*Colocasiaesculenta L.schott*) flour. *Journal of Food Technology*, 4, pp. 135-142.

[10]. Nnaji J.C., Okereke O.B. (2016). Proximate composition and physico-chemical properties of three avocado (*persea americana*) varieties in Umuahia, Nigeria. *Journal of Applied Chemical Science International*, 5(4), pp. 195-200.

[11]. Nwosu J.N., Owuamanam C.I., Omeire G.C., Eke C.C. (2014). Quality parameters of bread produced from substitution of wheat flour with cassava flour using soybean as an improver. *American Journal of Research Communication*, 2(3), pp. 99-118.

[12]. Okezie B.O., Bello A.B. (1988). Physicochemical and functional properties of winged-bean flour and isolate compared with soy isolate. *Journal of Food Science*, 53, pp. 450-454.

[13]. Okpala O., Chinyelu V.A. (2011). Physiocochemical, nutritional and Organoloptic Evaluation of cookies from pidgeon pea (*Cajanus Cajan*) and avocado peel (*Xanthosoma* spp) flour blends. *Afr. J. Food Agriculture and Development*, 11(6), pp. 5432 - 5443.

[14]. Olaoye O.A., Ade-Omowaye B.I.O. (2011). Composite flours and breads: potential of local crops in developing countries. In V. R. Preedy, R. R. Watson, & V.B. Patel, (Eds.), Flour and breads and their fortification in health and disease prevention (pp.183- 192). London, Burlington, San

Diego: Academic Press, Elsevier. ISBN: 9780123808868

[15]. Olaoye O.A., Lawrence I.G., Cornelius G.N., Ihenetu M.E. (2015). Evaluation of quality attributes of cassava product (gari) produced at varying length of fermentation. *American Journal of Agricultural Science*, 2(1), pp. 1-7.

[16]. Olaoye O.A., Obidegwe F. (2018). Chemical Composition, Anti-Nutrients and Functional Properties of Composite Flours Formulated from Wheat and Three Cultivars of Cocoyam Corms (*Xanthosoma Sagittifolium*) Commonly Found in Nigeria. *HSOA Journal of Food Science and Nutrition*, 4, pp. 1-6; DOI: 10.24966/FSN-1076/100029

[17]. Olaoye O.A., Onilude A.A., Idowu O.A. (2006). Quality characteristics of bread produced from composite flours of wheat, plantain and soybeans. *African Journal of Biotechnology*, 5, pp. 1102-1106.

[18]. Olaoye O.A., Onilude A.A., Oladoye C.O. (2007). Breadfruit flour in biscuit making: effects on product quality. *African Journal of Food Science*, 1, pp. 020 – 023

[19]. Sathe S.K., Ponte I.G., Rangnekar P.D., Salunkhe D.K. (1981). Effects of addition of great northern bean flour and protein concentrates on the rheological properties of dough and baking quality of bread. *Cereal Chemistry*, 58, pp. 97-100.

[20]. Saura-Calixto F., Canellas J., Soler L. (1983). Dietary fibre components of thenitrogen free extract of almond kernels. *Journal of Science Food Agriculture*, 36, 1419-1422.

[21]. Talabi J.Y., Osukoya O.A., Ajayi O.O., Adegoke G.O. (2016). Nutritional and antinutritional compositions of processed Avocado (*Persea americana* Mill) seeds. *Asian Journal of Plant Science and Research*, 6(2), pp. 6-12

[22]. Turker B., Savlak N., KasIkcI M.B. (2016). Effect of green banana peel flour substitution on physical characteristics of gluten-free cakes. *Current Research in Nutrition and Food Science*, SI.1, pp. 197-204.

[23]. Ubbor S.C., Akobundu E.N.T. (2009). Quality characteristics of cookies from composite flours watermelon seed, cassava and wheat. *Pakistan Journal of Nutrition*, 8(7), pp. 1097-1102.

[24]. Wang Y.D., Kinsella J.E. 1976. Functional properties of novel protein. *Journal ofFood Science*, 41, pp. 286-294.