Indian Journal of
Nutrition

Open Science Publications

Volume 2, Issue 2 - 2016

www.opensciencepublications.com

Quality Characteristics of Cookies Produced from Composite Flours of Unripe Plantain, Wheat and Watermelon Seed

Research Article

Oludumila Omolara Racheal*, Adetimehin Abosede Margaret

Department of Food Science and Technology, Federal University of Technology, Akure, Ondo State, Nigeria

***Corresponding author:** Oludumila Omolara Racheal, Department of Food Science and Technology, Federal University of Technology, Akure, Ondo State, Nigeria; E-mail: heniolarh@yahoo.com

Article Information: **Submission:** 17/01/2016; **Accepted:** 01/02/2016; **Published:** 06/02/2016

Abstract

This study was carried out to evaluate the quality and acceptability of cookies produced from the flour blends using cookies prepared from wheat flour as control. Acceptability of the produced cookies and chemical properties of the flour blends were determined. Response Surface Methodology was used to develop the mixing ratio and also model the protein and crude fibre responses. Results showed that the cookies prepared from the blend of plantain, wheat and watermelon flour 71.48/18.52/10.00 had higher crude fibre content (4.01%) than wheat flour (1.69 %) and significantly different protein content (2.44%) than that produced from wheat flour (6.81%). The Iron (Fe) content of the cookies produced from the blend 72.08/22.93/5.00 was 2.71% which was similar to that of wheat (2.70 %) and the Phosphorus (P) content of the cookies prepared from the flour blend 72.08/22.93/5.00 (1.46 %) was significantly different from the cookies produced from wheat (1.20%). The overall acceptability of the cookies produced from the blend 72.08/22.93/5.00 was 6.98 while that of wheat flour was also 6.98 without any significant difference. The study thus shows that cookies of produced from plantain, wheat and watermelon seed blend 72.08/22.93/5.00 had the highest acceptability in terms of taste, texture, crispness, aroma and appearance.

Keywords: RSM; Chemical Properties; Acceptability; Optimization

Introduction

Cookies are one of the confectionary food product consumed in Nigeria especially among children. It is ready to eat, convenient and inexpensive food product, containing digestive and dietary principles of vital importance [1]. In Nigeria, reliance on wheat flour in the pastry and bakery industries has over the years restricted the use of other cereals and tuber crops available to domestic use. In recent years, government has through intensive collaboration with research institutes encouraged the use of composite flours in the production of bread and related food products such as biscuit. This initiative has enhanced the use of flours from cassava, sweet potato, bread-fruit, plantains and other under-utilized crops that are good sources of flour. The adoption of these locally produced flours in the bakery industry will increase the utilization of indigenous crops cultivated in Nigeria and also lower the cost of bakery products [2].

Plantains are highly perishable staple foods and according to FAO [3], over 2.3 million metric tons of plantains are produced in Nigeria annually. However, about 35 % - 60 % post-harvest losses had been reported and attributed to lack of storage facilities and inappropriate technologies for food processing [4]. Nutritionally, plantain (*Musa paradisca*) constitute a rich energy source with carbohydrate accounting for 22 and 32% of the fruit weight for banana and plantain respectively and also rich in vitamins A, B6, C, dietary fibre, iron potassium and calcium [5]. Plantain is known to be a highly perishable food which is largely produced in Nigeria but

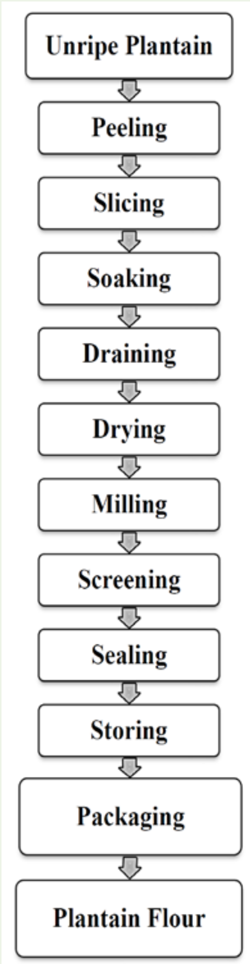

Figure 1: Flow diagram for unripe plantain flour.

underutilized and the fact that Nigeria does not grow wheat and relies heavily on importation of the commodity justifies the continued search for flour composites for local use [6].

Watermelon seed is one of the major under-utilized fruits grown in the warmer part of the world. The juice or pulp from watermelon is used for human consumption, while rind and seeds are major solid wastes. The seeds can be cooked and dried and served as snacks and fermented for use as a flavour enhancer in gravies and soups [7]. Watermelon seed is a rich source of dietary fiber which is desired in developing functional foods and is an underutilized fruit by-product and is reported to be high in protein and has excellent functional properties and has been found to be effective in baking [8].

Response Surface Methodology (RSM) is a collection of statistical and mathematical techniques by analyzing the response surface contour to find optimal process parameters and using multiple quadratic regression equation to fit between the factors and the response function. RSM is a useful technology in developing processes and optimizing their performance [9]. To develop or to optimize processes, many companies use statistical approaches, such as response surface methodology (RSM), in their research department in order to achieve the best combination of factors that will render the best characteristic of a product and or process response [10].

Materials and Methods

Sample Collection

The unripe plantain, watermelon pods, wheat flour baking ingredients and packaging materials were obtained from Erekesan Market. All reagents used were of analytical grades and were obtained from Pascal Laboratories, Akure, Ondo State, Nigeria.

Sample preparation

Preparation of Unripe Plantain Flour: Matured unripe plantain fruits were washed under running water hand peeled and the edible portion (pulp) was sliced with a stainless knife into 2.5 cm thick slices (6.0x4.0 cm). The slices were immersed in 0.25 g L^{-1} sodium metabisulphite at 30 °C for 10 min. The slices were dried at 60 °C in a cabinet dryer for 24 h and then ground into flour using an attrition mill. The flour samples were passed through a 0.45 mm mesh size sieve to obtain the flour and poured in plastic containers with lids and stored at room temperature (25 °C) for further analysis according to Akubor and Ukwuru [11]. The procedure is shown in Figure 1.

Preparation of Watermelon Seed Flour: Watermelon pods were washed, cut into slices and the seeds were extracted, washed, drained and dried at temperature of 60 °C for 6 h. The dried seeds were milled and sieved through 0.45 mm mesh sieve. The watermelon seed flour was sealed in a cellophane bag and stored at room temperature, for further analysis modifying Ubbor and Akobundu [6] method. The procedure is shown in Figure 2.

Formulation of flour composites: To optimize the experiment optimal design of the response surface methodology was employed with three-level-factor design which generated 16 experimental runs. The samples ranged from 60% - 80% (plantain flour), 15% - 30% (wheat flour) and 5% -15% (watermelon seed). The responses were protein (%) and crude fibre (%). Table 1 shows the level and factor of the experimental design (version 9.01).

Preparation of Cookies: The cookies were prepared according to the method of AOAC with some modifications in the recipe [12]. The dry ingredients (flour, sugar, salt, milk powder, milk, preservative and baking powder) were weighed and thoroughly mixed in a bowl by hand for 3 min. Vegetable shortening was added and mixed until uniform with enough water. The batter was then rolled out and cut with a cookie cutter. The cookies were placed on baking trays, leaving 25 mm spaces in between and were baked at 180 °C for 10 min in the baking oven. Following baking, the cookies were cooled at ambient temperature, packed in polyethylene bags and stored at 23 °C prior to subsequent analysis and sensory evaluation. The procedure is shown on Figure 3.

Proximate analysis of samples: The moisture content, crude fibre at 60 °C for 24 h, ash content, fat content, protein were determined according to AOAC, while the carbohydrate was determined by difference [12].

Evaluation of functional properties: Functional properties

Table 1: Variables Using Response Surface Methodology.

S/N	Plantain flour	Wheat Flour	Watermelon Seed Flour
1	64.12	25.88	10.00
2	**72.08**	**22.93**	**5.00**
3	68.42	26.58	5.00
4	74.69	19.06	6.25
5	77.53	15.00	7.48
6	**71.48**	**18.52**	**10.00**
7	78.84	16.15	5.00
8	60.00	30.00	10.00
9	65.00	30.00	5.00
10	60.00	30.00	10.00
11	78.84	16.15	5.00
12	75.00	15.00	10.00
13	65.00	30.00	5.00
14	69.12	22.67	8.21
15	**77.53**	**15.00**	**7.48**
16	75	15	10

Table 2: Proximate composition (%) of Plantain - Wheat - Watermelon seed flour runs**.**

RUNS	Carbohydrate	Fat	Moisture Content	Protein	Crude Fibre	Ash
1	66.93	15.75	9.00	2.84	3.50	1.98
2	**64.69**	**15.62**	**9.00**	**3.69**	**2.10**	**4.90**
3	65.71	15.54	9.50	2.41	1.90	4.94
4	64.81	17.18	9.50	2.27	3.30	2.94
5	66.18	16.05	7.00	3.12	2.70	4.95
6	**64.39**	**19.23**	**6.50**	**2.70**	**3.30**	**3.92**
7	64.53	17.79	10.00	2.98	1.70	3.00
8	66.91	16.78	10.00	1.85	2.00	2.46
9	59.71	23.66	8.50	1.99	3.20	2.94
10	66.91	16.78	10.00	1.85	2.00	2.46
11	64.53	17.79	10.00	2.98	1.70	3.00
12	70.64	14.52	8.50	2.56	2.80	0.98
13	59.71	23.66	8.50	1.99	3.20	2.94
14	69.39	12.54	9.00	1.14	3.10	4.83
15	**66.18**	**16.05**	**7.00**	**3.12**	**2.70**	**4.95**
16	70.64	14.52	8.50	2.56	2.80	0.98

Highlighted values were selected based on the high content of protein and crude fiber content.
KEYS: 2 - 72.08g Plantain flour: 22.93g Wheat flour: 5.00g Watermelon seed flour
6 - 71.48g Plantain flour: 18.52g Wheat flour: 10.00g Watermelon seed flour
15 - 77.53g Plantain flour: 15.00g Wheat flour: 7.48g Watermelon seed flour

(water absorption capacity, oil absorption capacity and bulk density) of the variable flour blend gotten from the response surface methodology were carried out using the method described by Edema [13].

Microbiological analysis: The cookies were subjected to fungal and bacterial count (Escherichia coli, staphylococcus aureus and total viable count), according to Onuorah and Akinjede and was done for 21 days with 7 days interval [14].

Anti-nutrient determination: Phytate was estimated by spectrophotometer method as described by Harbone [15]. Tannin

Citation: Racheal OO, Margaret AA. Quality Characteristics of Cookies Produced from Composite Flours of Unripe Plantain, Wheat and Watermelon Seed. Indian J Nutri. 2016;2(2): 117.

Figure 2: Watermelon seed flour production flow chart.

and Saponin determination was done using forth and emulsion test as described by Onwuka [16].

Mineral analysis: Iron (Fe), Zinc (Zn), Potassium (K), Calcium (Ca) and Sodium (Na) were determined using Atomic Absorption Spectrophotometer and Flame Photometer according to IITA, (2002).

Determination of physical properties of cookies: The texture, break strength and crumb of the cookies were measured using Physical Analyser. Thickness (T) of the cookies was determined according to AACC method [17].

Determination of sensory properties of cookies: Sensory properties of cookies were determined using a twenty-member panelist consisting of students of Federal University of Technology, Akure, Nigeria. The cookies were evaluated for quality characteristics; aroma, taste, crispiness, colour, texture and overall acceptability. Each sensory attribute was rated on a 9-point Hedonic scale (1 = disliked extremely while 9 = liked extremely) according to Oyeyinka et al. [1].

Statistical analysis: Statistical analyses were conducted using SPSS (Statistical Program for Social Sciences) version 21.0 for Windows. Data were presented as mean ± SD in all tables analysed by the general analysis of variance.

Results and Discussion

Proximate composition of the samples: The proximate composition of the Plantain - Wheat - Watermelon seed (PWWs) flour obtained from the 16 RSM runs is shown in Table 2. Carbohydrate content (%) of the runs range from 59.71 to 70.64, while the moisture content (%) of the runs range from 6.50 to 10.00, the crude fiber content (%) of the runs range from 1.70 to 3.50, the fat content of the runs range from 12.54 to 23.66, the protein content (%) of the runs range from 1.14 to 3.69 and the ash content (%) ranges from 0.98 to 4.94. From the runs, three samples were selected based on high protein and high fibre content and are highlighted on the Table 2. The proximate composition of cookies produced from composite flour is shown in Table 3.

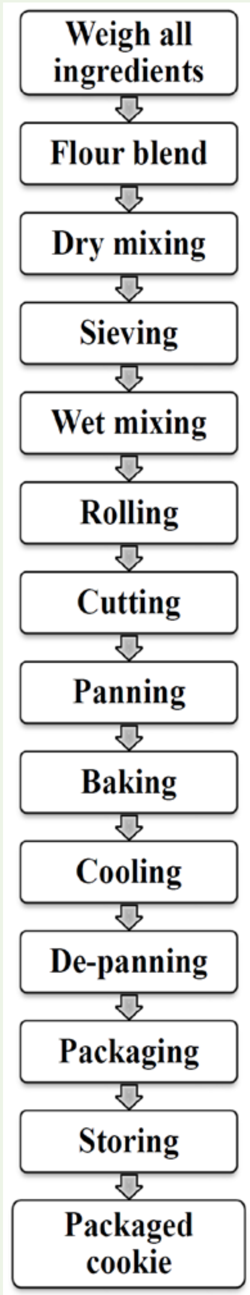

Figure 3: Flow diagram for cookie production.

Citation: Racheal OO, Margaret AA. Quality Characteristics of Cookies Produced from Composite Flours of Unripe Plantain, Wheat and Watermelon Seed. Indian J Nutri. 2016;2(2): 117.

Table 3: Proximate Composition (g/100g) of cookies made from Composite flour blend.

Flour Blend	Carbohydrate	Fat	Protein	Crude Fibre	Ash	Moisture Content
$PWWs_1$	56.55 ± 1.87^b	20.41 ± 1.00^b	3.04 ± 0.20^b	2.75 ± 0.30^c	4.98 ± 1.00^a	12.27 ± 0.20^{ab}
$PWWs_2$	51.87 ± 2.15^c	25.11 ± 2.00^a	2.44 ± 0.20^c	4.01 ± 0.04^a	4.05 ± 0.10^a	12.52 ± 0.30^a
$PWWs_3$	55.28 ± 0.24^b	21.53 ± 2.00^b	2.87 ± 0.02^b	3.20 ± 0.02^b	5.02 ± 0.30^a	12.10 ± 0.02^b
W	61.90 ± 1.33^a	15.63 ± 1.00^c	6.81 ± 0.12^a	1.69 ± 0.02^d	1.65 ± 0.02^b	12.32 ± 0.10^{ab}

Values represent the mean of triplicates. Values in a column with same superscript are not significantly different at $p\leq 0.05$

KEYS

$PWWs_1$ - 72.08 g Plantain flour: 22.93 g Wheat flour: 5.00 g Watermelon seed flour
$PWWs_2$ - 71.48 g Plantain flour: 18.52 g Wheat flour: 10.00 g Watermelon seed flour
$PWWs_3$ - 77.53 g Plantain flour: 15.00 g Wheat flour: 7.48 g Watermelon seed flour
W – 100 g Wheat flour

Table 4: Functional properties of the composite flour.

SAMPLES	B.D. (g/ml)	W.A.C. (g water/g flour)	O.A.C. (g oil/g flour)
1	0.82	1.7	0.70
2	**0.79**	**1.7**	**0.59**
3	0.8	1.8	0.70
4	0.8	1.5	0.70
5	0.82	1.7	0.70
6	**0.79**	**1.7**	**0.66**
7	0.76	1.7	0.50
8	0.77	1.6	0.70
9	0.81	1.6	0.66
10	0.77	1.6	0.70
11	0.76	1.7	0.50
12	0.81	1.7	0.70
13	0.81	1.6	0.66
14	0.79	1.6	0.53
15	**0.80**	**1.5**	**0.70**
16	0.81	1.7	0.70

KEYS:

B.D. - Bulk Density
W.A.C - Water Absorption Capacity
O.A.C. - Oil Absorption Capacity

The moisture content of the cookies prepared from the composite flour ranged from 12.10 % - 12.57 % and was of significant difference to that produced from wheat and the result is similar to that produced by Oyeyinka et al [1] which were made from plantain and wheat flour blends. Low moisture content enhances the shelf life of a food product.

The crude fibre content ranged from 2.75% - 4.01% and is similar to the cookies produced using unripe plantain and defatted sesame flour by Chinma et al. [18]. The results shows that there is significant different between the composite flour and the wheat flour in terms of crude fibre which is known to aid the digestive system of human.

Cookies could enhance the intake of minerals as ash is an index to determine mineral constituents in food. The ash content from Table 4.2 ranged from 4.05 % - 5.02 % and this is because during drying, moisture and organic matters are removed in the presence of an oxidizing agent according to Sanni et al. [19].

The fat content of the cookies produced from the composite flour blend ranged from 20.41 % - 25.11 %. There was significant difference within the column. Result is shown in Table 4.2. Fat plays a major role in determining the shelf life of foods.

Proteins are building blocks of the body and foods that are rich in protein are known to reduce protein energy malnutrition. The protein content of the composite flour blend ranged from 2.44% - 3.04%. There was significant difference in the result for all blends as shown on Table 3.

The carbohydrate content of the cookies produced from the composite flour ranged from 51.87 % - 56.55 % which was significantly

Table 5: Anti-nutrient content of Composite flour blend.

Flour blend	Saponin (mg/100 g)	Tannin (mg/100 g)	Phytate (mg/100 g)
$PWWs_1$	0.40^b	0.07^a	0.85^a
$PWWs_2$	0.50^a	0.06^a	0.88^a
$PWWs_3$	0.50^a	0.06^a	0.84^a
W	0.44^b	0.06^a	0.83^a

Values represent the mean of triplicates. Values in a column with same superscript are not significantly different at p≤ 0.05

KEYS

$PWWs_1$ - 72.08 g Plantain flour: 22.93 g Wheat flour: 5.00 g Watermelon seed flour

$PWWs_2$ - 71.48 g Plantain flour: 18.52 g Wheat flour: 10.00 g Watermelon seed flour

$PWWs_3$ - 77.53 g Plantain flour: 15.00 g Wheat flour: 7.48 g Watermelon seed flour

W - 100 g Wheat flour

Table 6: Mineral content of Composite flour blend.

Flour blend	Fe	Zn	K	Ca	Na
$PWWs_1$	2.71±0.01^{ab}	1.55±0.02^c	1.46±0.02^a	0.49±0.02^a	1.34±0.10^a
$PWWs_2$	2.74±0.02^a	1.71±0.02^a	1.36±0.02^b	0.42±0.01^a	1.35±0.02^a
$PWWs_3$	2.72±0.02^{ab}	1.70±0.03^a	1.36±0.02^b	0.46±0.02^a	1.35±0.01^a
W	2.70±0.02^b	1.64±0.03^b	1.20±0.02^c	0.44±0.02^a	1.33±0.10^a

Values represent the mean of triplicates. Values in a column with same superscript are not significantly different at p≤ 0.05

KEY

$PWWs_1$ - 72.08 g Plantain flour: 22.93 g Wheat flour: 5.00 g Watermelon seed flour

$PWWs_2$ - 71.48 g Plantain flour: 18.52 g Wheat flour: 10.00 g Watermelon seed flour

$PWWs_3$ - 77.53 g Plantain flour: 15.00 g Wheat flour: 7.48 g Watermelon seed flour

W - 100 g Wheat flour

Fe - Iron

Zn - Zinc

K - Phosphorus

Ca - Calcium

Na - Sodium

different from the wheat flour which was 61.90 %. Values observed for the carbohydrate content of the cookies in this study are similar to those reported by Falola et al. [20], for cookies produced using cassava flour and cucurbitamixta seed flour blends.

Functional properties of the samples: Table 4 shows the functional properties of the flour blend. Water absorption capacity of the flour blend ranged from 1.50 - 1.80 (g water/g flour). The difference in WAC could be due to difference in the granule size of the various formulations which may enhance the ability of the flours to absorb water.

Water absorption capacity is important in bulking and consistency of product as well as in baking applications as reported by Niba et al. [21].

The oil absorption capacity of the flour ranged from 0.53 - 0.70 (g oil/g flour). Oil absorption in starch relies predominantly on the physical entrapment of oil within the starch structure as starch does not possess nonpolar sites compared to those found in proteins by Abu et al. [22].

Bulk density gives an indication of the relative volume of packaging material required. The bulk density of the composite flour ranged from 0.76 - 0.82 g/ml and is shown. The bulk density is shown in Table 4.3. The bulk densities reported in this study are similar to those reported (0.83-0.85 g/ml) by Akubor for cowpea-plantain-wheat flour blends [23].

Microbial analysis: According to Onuorah and Akinyede in the determination of shelf life, microorganisms play very important roles as they also hasten the rate of deterioration [14]. Limits of microbial counts have been recommended in most foods to make them safe for consumption and to store longer without deteriorating. Though food might be produced and packaged in aseptic environment, microbial contamination can still occur if not properly handled. No growth was noticed all through storage and this shows that the preservative used, sodium bicarbonate is effective and microorganism growth is as a result of contamination from the environment.

Anti-nutrient content: From the results shown on Table 5, there was a no significant difference among all the samples (p ≥0.05) in all the phytochemicals determined except for saponin whose difference between the samples was minimal. Anti-nutritional properties (side effects) of some phytochemicals, when ingested in excess can disrupt the absorption of some essential minerals by binding them. For example, tannins bind essential minerals such as calcium, iron, magnesium and zinc in the digestive tract to form insoluble salts, thereby decreasing or reducing bioavailability or absorption of nutrients. Saponins have haemolytic activity against RBC [24].

Mineral content: The cookies produced from the flour blends revealed significantly (p ≤ 0.05) higher iron, zinc, and phosphorus level content than the control (Table 6). This is may be due to the addition of plantain flour which contains higher amount of iron and zinc [25,26]. However, the calcium and sodium content were of no significant difference.

Physical analysis: Table 7 shows the physical properties of the composite flour blend of unripe plantain, wheat and watermelon seed flours. The texture of the samples showed that the composite flour were coarse and that of the wheat flour particulate. The texture

Table 7: Physical analysis of cookies.

Flour blend	Thickness (mm)	Crumb	Texture	Break
$PWWs_1$	0.3	More	Coarse	high
$PWWs_2$	0.3	Much	Coarse	highest
$PWWs_3$	0.5	much-more	Coarse	higher
W	0.7	Excess	Particulate	Low

Values represent the mean of triplicates. Values in a column with same superscript are not significantly different at p≤ 0.05

KEYS

$PWWs_1$ - 72.08 g Plantain flour: 22.93 g Wheat flour: 5.00 g Watermelon seed flour

$PWWs_2$ - 71.48 g Plantain flour: 18.52 g Wheat flour: 10.00 g Watermelon seed flour

$PWWs_3$ - 77.53 g Plantain flour: 15.00 g Wheat flour: 7.48 g Watermelon seed flour

W - 100 g Wheat flour

Citation: Racheal OO, Margaret AA. Quality Characteristics of Cookies Produced from Composite Flours of Unripe Plantain, Wheat and Watermelon Seed. Indian J Nutri. 2016;2(2): 117.

Table 8: Sensory Analysis of Cookies

Flour blend	Appearance	Taste	Crispness	Aroma	Overall acceptability
$PWWs_1$	7.15±1.66[a]	6.35±1.42[a]	6.70±1.49[a]	6.65±1.53[a]	6.98±1.06[a]
$PWWs_2$	6.70±1.45[a]	6.20±1.74[a]	6.60±1.57[a]	6.35±1.95[a]	6.49±1.19[a]
$PWWs_3$	7.25±1.45[a]	6.45±1.05[a]	6.80±0.95[a]	6.55±1.28[a]	6.76±0.73[a]
W	7.60±1.35[a]	6.75±1.29[a]	6.90±1.55[a]	6.65±1.53[a]	6.98±1.06[a]

Values represent the mean of triplicates. Values in a column with same superscript are not significantly different at p≤ 0.05

KEYS

$PWWs_1$ - 72.08 g Plantain flour: 22.93 g Wheat flour: 5.00 g Watermelon seed flour

$PWWs_2$ - 71.48 g Plantain flour: 18.52 g Wheat flour: 10.00 g Watermelon seed flour

$PWWs_3$ - 77.53 g Plantain flour: 15.00 g Wheat flour: 7.48 g Watermelon seed flour

W - 100 g Wheat flour

enhances the mouth feel when chewing. The crumb was ranged from much to much-more for the composite flour blends and this will affect the type of packaging material that would be used for transportation. The physical properties of the cookies produced can be compared to that of the control (wheat) and of good physical properties.

Sensory evaluation: Table 8 shows the result of the sensory properties of cookies produced from unripe plantain, wheat and watermelon seed and wheat cookies. There was no significant (p≥0.05) difference in appearance, taste, crispness, aroma and overall acceptability of the cookies prepared from the composite flour blends and wheat flour.

The result from the sensory properties shows that there is no difference from the composite flour blend and the wheat sample. With regards to the overall acceptability, the composite flour blend $PWWs_1$, was equal to that of wheat sample and this result is similar to the acceptability of cookies produced by Ubbor and Akobundu using Watermelon seed, Cassava and Wheat flour blends [6].

Conclusion

This research has revealed that proximate composition of cookies produced from plantain, wheat and watermelon seed flour blends are comparable to those produced from wheat flour and hence can be substituted for the production of cookies. The research has also shown that the most suitable blending ratio for the production of cookies from plantain and watermelon seed flour blends is 72.08g Plantain flour, 22.93g Wheat flour and 5.00g Watermelon seed flour because it was more preferable during the sensory analysis. Furthermore, the cookies produced from the composite flour of plantain, wheat and watermelon seed flour blend was acceptable by the sensory panelist.

References

1. Oyeyinka SA, Oyeyinka AT, Karim OR, Toyeeb KA, Olatunde SJ, et al. (2014) Biscuit making potentials of flours from wheat and plantain at different stages of ripeness. Croat J Food Sci Technol 6: 36-42.
2. Ayo JA, Gaffa T (2002) Effect of undefatted soybean flour on the protein content and sensory quality of “KunnuZaki” Nig Food J 20: 7-9.
3. FAO (2009) Food and Agriculture Organisation of the United Nations. Joint Meeting of the Fourth Session of the Sub-group on Bananas and the Fifth Session of the Sub-Group on Tropical Fruits held in Rome, 9 - 11th December 2009.
4. Onuoha ON, Eme PE, Ekpo UE (2014) Chemical Evaluation of Unripe Plantain Dishes Commonly Consumed by Type 2 Diabetics Attending the University of Uyo Teaching Hospital in Akwa Ibom State, Nigeria. Pakistan Journal of Nutrition 13: 331-334.
5. Adeniji TA, Barimalaa IS, Achinewhu SC (2006) Evaluation of bunch characteristics and flour yield potential in black Sigatoka resistant plantain and banana hybrids. Glob J Pure Appl Sci 12: 41-43.
6. Ubbor SC, Akobundu EN (2009) Quality characteristics of cookies from composite flours of watermelon seed, cassava and wheat. Pakistan Journal of Nutrition 8: 1097-1102.
7. Koocheki A, Razavi S, Milani E, Moghadam T, Abedini M, et al. (2007) Physical properties of watermelon seed as a function of moisture content and variety. Int Agrophysics 21: 349-359.
8. El-Adawy TA, Taha KM (2001) Characteristics and composition of watermelon, pumpkin and paprika seed oils and flours. J Agric Food Chem 49: 1253-1259.
9. Raissi S (2009) Developing new processes and optimizing performance using response surface methodology. World Acad Sci Eng Technol 49: 1039-1042.
10. Montgomery DC (2009) Design and analysis of experiments, 5th edn. John Wiley & Sons, Inc., New York.
11. Akubor PI (2003) Functional properties and performance of cowpea/plantain/wheat flour blends in Biscuits. Plant food for Human Nutri 58: 1-8.
12. AOAC (2000) Association of Official Analytical Chemist. Official methods of analysis 17th edition Washington.
13. Edema MO (2004) Characterization and functional properties of selected starter cultures for the production of sour maize bread. Ph.D Thesis Department of Botany and Microbiology, University of Ibadan, Nigeria.
14. Onuorah CE, Akinyede FA (2004) Comparative evaluation of flour formulated weaning foods and commercial product. Nigeria Food Journal. 22: 48-53.
15. Harbone JB (1973) Phytochemical methods;a guide to modern technique of plant Analysis: Chapman and Hall, London, New York 182- 191.
16. Onwuka GJ (2005) Food analysis and instrumentation, theory and practice. First Edition, Naphtali prints. Lagos. Nigeria 1-219.
17. AACC (2000) Approved Methods of the American Association of Cereal Chemists. 10th Edn., American Association of Cereal Chemists Press, St. Paul, MN., USA.
18. Chinma CE, Igbabul BD, Omotayo OO (2012) Quality Characteristics of Cookies Prepared from Unripe Plantain and Defatted Sesame Flour Blends. American Journal of Food Technology 7: 398-408.
19. Sanni SA, Adebowale AA, Olaiwola IO, Maziya-Dixon B (2006) Chemical composition and pasting properties of iron fortified maize flour. Food, Agriculture and Environment 6: 172 -175.
20. Falola AO, Olatidoye OP, Balogun IO, Opeifa AO (2011) Quality Characteristics Of Cookies Produced From Composite FloursOf Cassava And Cucurbita Mixta Seed. Journal Of Agriculture And Veterinary Sciences.
21. Niba LL, Bokanga M, Jackson FI, Schlimme DS, Li BW (2001) Physicochemical properties and starch granular characteristics of flour from various *Manihotesculenta*(cassava), genotype. J Food Sci 67: 1701-1705.
22. Abu JO, Müller K, Duodu KG, Minnaar A, (2006) Gamma irradiation of cowpea (*Vignaunguiculata* L.Walp) flours and pastes: effects on functional, thermal and molecular properties of isolated proteins. Food Chem. 95: 138-147.

23. Akubor PI, Ukwuru MU (2003) Functional properties and biscuit making potential of soybean and cassava flour blends. Plant Foods Hum Nutr 58: 1-12.

24. Khalil AH, Eladawy TA (1994) Isolation, Identification and Toxicity of Saponins from different legumes. Food Chem 50: 197-201.

25. INIBAP (1999) Nutritive value of banana in: INIBAP annual report. INIBAP: Montpellier; (FRA), 2000 pp. 28-31.

26. Nasr S.I. AbuFoul (2004) Using free fat watermelon (Citrullus vulgaris) seed kernels in preparing high protein biscuits. Al-Azhar University Gaza, Gaza Palestine 7: 45-54.

Citation: Racheal OO, Margaret AA. Quality Characteristics of Cookies Produced from Composite Flours of Unripe Plantain, Wheat and Watermelon Seed. Indian J Nutri. 2016;2(2): 117.