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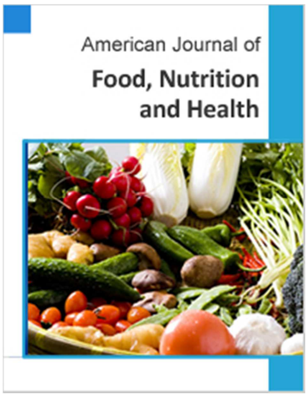

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Quality Evaluation of Cookies from Under-Utilized Crop Source Blends

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Abstract

This study investigated the proximate, mineral, sensory and physical properties of cookies produced from wheat, plantain, and whole almond flour blends at different ratio of 100:0:0, 90:5:5, 80:10:10, 70:20:10, 60:20:20, and 50:30:20 respectively. The results of the proximate composition of flour blends ranged from 10.07% to 22.77% for moisture; 4.43% to 5.47% for ash; 13.33% to 18.17% for fat; 0.07% to 0.90% for crude fibre; 7.77% to 12.50% for protein; 55.83% to 63.69% for carbohydrate and 403.47% to 432.70 calories for energy value, while the result of the cookies ranged from 4.77% to 5.07% for ash; 8.97% to 10.37% for moisture; 8.19% to 12.63% for protein; 53.66% to 64.30% for carbohydrate; and 414.19 to 472.03 calories for energy value. The mineral composition of flour blends ranged from 0.21 to 0.31 mg/100g for phosphorous; 0.06 to 1.89mg/100g for potassium; 0.06 to 0.08mg/100g for calcium; 0.06 to 0.23 mg/100g for magnesium; 240.50 to 523.67 mg/100g for iron; 35.67 to 385.50 mg/100g for Zinc; 0.08 to 0.16mg/100g for sodium. The mineral composition of cookies produced from flour blends of wheat, plantain, and whole almond flours ranged from 0.24 to 0.33 mg/100g for phosphorus; 0.26 to 1.18 mg/100g for magnesium; 0.06 to 0.31mg/100g for calcium; 1.18 to 1.98mg/100g for potassium; 9.50mg/100g to 295.33mg/100g for Iron; 0.11 to 2.81mg/100g for sodium; 64.57 to 875.50mg/100g for Zinc. However, there was increase in protein, fat, crude fibre, ash, carbohydrate, and energy value in cookies compared with the composite flour. Replacing wheat flour with 20% almond flour and above improves the nutritional quality of the composite flour and the cookies. Cookies of composite flours supplemented with up to 30% plantain and 20% almond flour were accepted in terms of sensory attributes.

1. Introduction

Cookies are consumed all over the world as a snack food by children and adult. Cookies are form of confectionary product dried to low moisture content [1], soften when compared to biscuits. Cookies had relatively high amount of protein which make cookies attractive in countries where protein energy mal-nutrition is prevalent [2] also in child feeding programs Studies have reported the use of wheat based composite flour in cookies production [3]. All these efforts were aimed at improving the nutritional content of cookies and also enhanced crop utilization. They are commonly baked until crisp or just long enough that they remain soft, but some kinds of cookies are made in a wide variety of styles using an array of ingredients including sugars, species, chocolate, butter, peanut butter, nuts or dried fruits. The softness of the cookies may depend on how long it is baked. Wheat varieties are classified in soft and hard accordingly to gluten quality. When gluten content is below 9%, the varieties are classified as soft wheat and it is advisable to use for biscuits. Instead when gluten content ranges around 10% - 14%, these are classified as hard wheat varieties and the flour is suitable for baking flour. The flour from soft wheat varieties is comparatively low in gluten and thus results in a loaf with a finer crumbly texture [4]. Wheat is the most important stable food crop for more than one third of the world population and contributes more calories and proteins to the world diet than any other cereal crops. Thus, it has become principal cereal being more widely used for producing bread than any cereal because of the quality and quantity of its characteristic protein called gluten. Plantain is the major food staple in West and Central Africa. It contains more starch and less sugar than dessert bananas and are therefore usually cooked or otherwise processed before being eaten. Dried plantain powder is mixed with other flours especially wheat, to form composite flour. It is made of dried and pulverized sliced plantain. It is rich in fiber content, low in sodium and fat content and relatively rich in protein between 3.0% to 3.5% compared to other fruits, It contain high level of ascorbic acid, carotene, and some other vitamins, valuable to the development of the body [5]. Bengal almond tree (*Terminaliacatappa L.*) is a specie of tree native to the Middle East, the Indian sub-continent and North Arica. The fruit of bengal almond is a drupe, consisting of an outer hull and a hard shell with the seed which is not of true nut, inside shelling almonds refers to removing the shell to reveal the seed while the almond is often eaten on its own, raw or toasted). Flour from Bengal almond is often used as a gluten free alternative to wheat flour in cooking and baking. The polyphenols content of skins consisting of flavonols, flavan 3-ols, hydroxyl benzoic acids and flavanones analogous to those of certain fruits and vegetables. These phenolic compounds and Bengal almond skin prebiotic dietary fiber have commercial interest as food additive or dietary supplements depended on the nature of the product to be baked. Therefore, this paper studied the potentials of under-utilized Almond (*Terminaliacatappa*) seed as a source of essential nutrients to develop novel nutritious food.

2. Materials and Methods

2.1. Materials

Wheat, Plantain, Carrot, Basil leaf, and Ginger were purchased from bisi market at Ado Ekiti and that of the Almond fruits were obtained from theschool premises of Federal Polytechnic Ado Ekiti, Ekiti State Nigeria.

2.2. Sample Preparation

Almond fruits were sorted to obtain mature and healthy nuts, cleaned by de-hulling, winnowed, oven driedat 60°C for 72 hr and milled into dried powder. Matured unripe plantain were also sorted, washed, hand peeled and diced into equal size of thickness 2mm using stainless steel knife into a solution of Sodium metabisulpite, after draining, it was oven dried at 60°C for 72 hr to obtain dry chips which were milled to get the dried powder [6]. Composite flour; mixing of wheat, plantain, and whole almond flour was obtained in ratio 100:0:0, 90:5:5, 80:10:10, 70:20:10, 60:20:20, 50:30:20 respectively.

2.3. Cookies Production

The method used for the preparation of dough was the creaming method where fat and sugar were creamed together using the Kenwood mixer at medium speed for two minutes. [7] After creaming, flour, baking powder, milk, vegetable and ginger were added and mixed until dough was well mixed. The dough was manually kneaded to ensure uniformity. The dough was then transferred to a clean tray and gently rolled using a roller. The dough sheath was cut into round shape using a cutter. Shaped dough pieces were placed into a greased pan and baked in the hot air oven at 200°C for 15minutes. The baked cookies were placed on a cooling rack for 30minutes to cool before packaging.

Table 1. *Recipes for vegetable cookies production.*

Ingredients	Quantity (g)					
	WPA_{100}	WPA_{5-5}	WPA_{10-10}	WPA_{20-10}	WPA_{20-20}	WPA_{30-20}
Wheat flour	100	90	80	70	60	50
Plantain flour	0	5	10	20	20	30
Almond flour	0	5	10	10	20	20
Fat	62.5	62.5	62.5	62.5	62.5	62.5
$NaHCO_3$	1	1	1	1	1	1
Sugar	37.5	37.5	37.5	37.5	37.5	37.5
Salt	1	1	1	1	1	1
Water	20	20	20	20	20	20
Carrot	1	1	1	1	1	1
Ginger	1	1	1	1	1	1
Basil	1	1	1	1	1	1
Vanilla	1.3	1.3	1.3	1.3	1.3	1.3

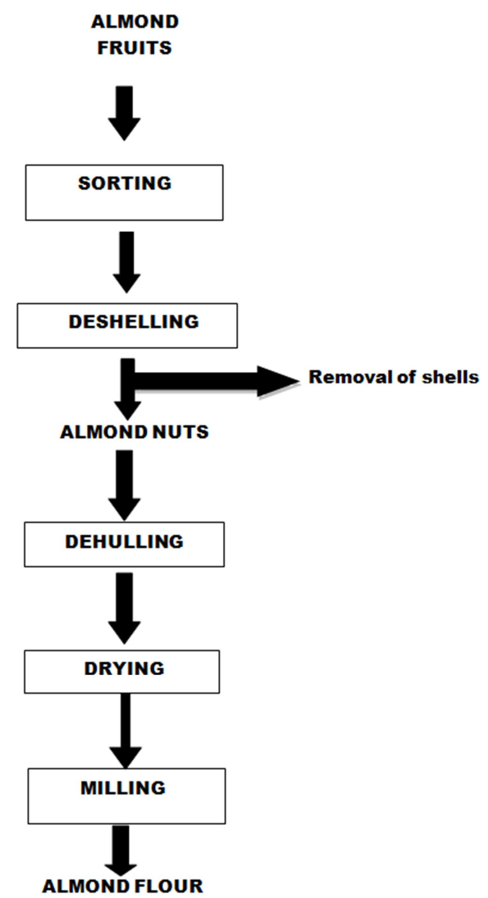

Figure 1. *Flow chart for the preparation of Almond flour.*

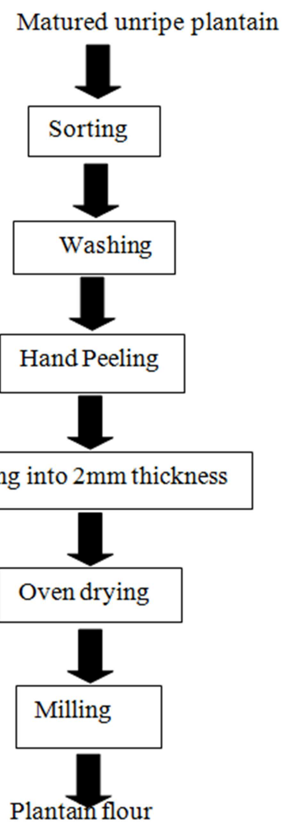

Figure 2. *Flow chart of plantain flour production.*

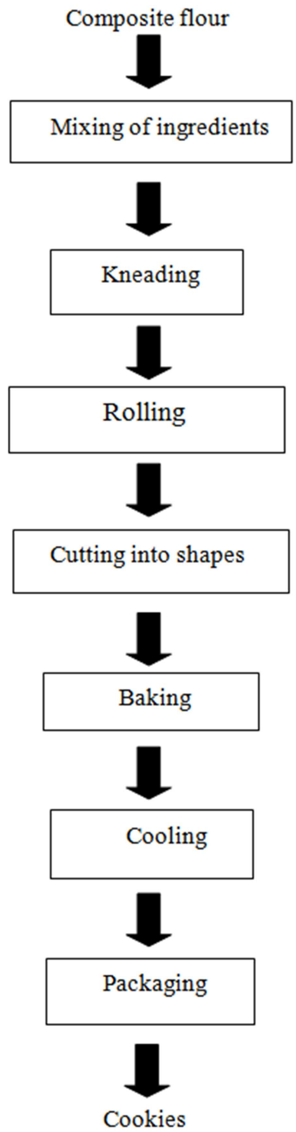

Figure 3. *Flow chart for cookies production.*

2.4. Chemical Analysis

Proximate composition and mineral analysis of both the composite flour and cookies were determined as well as physical properties of the cookies. The moisture, ash, fat, protein and crude fibre of each of the samples were analyzed following the [8] methods. Total carbohydrate content was estimated by difference. All the proximate values were reported in percentages. The mineral composition of the samples were analyzed by dry–ashing the samples at 550°C to constant weight and dissolving the ash in volumetric flask using distilled ionized water with a few drops of concentrated HCl. Sodium (Na) and Potassium (k) were determined using a flame photometer (Model 405 Corning, UK.), using NaCl and KCl to prepare standards. Other metals were determined by Atomic Absorption Spectrophotometer (Perkin Elmer model 403, Norwalk C T, London). Sensory properties of cookies were determined by semi-trained panelists, using a 9 point hedonic scale with a scale ranging of 1 to 9 with 1 representing the least score (dislike extremely) and 9 the highest score (like extremely).[9]. Physical properties of the cookies was determine by measuring the weight of the cookies with the aid of a weighing balance (model, Mettler PE 1600, mettle Instrument Corporation, Greinfensee, Zurich Switzerland) with an accuracy of 0.1mg). The diameter was measured with a calibrated ruler as described by [10]. The thickness of cookies was measured by placing six cookies on top of each other followed by a duplicate reading recorded as described by [11]. All the measurements were done in two replicates of six cookies each and all the readings were divided by six to get the values per cookie. Spread factor was calculated according to the following formula SF = (D/T x CF) x 10. Where CF is the correction factor at constant atmospheric pressure (1.0 in the present study)

3. Statistical Analyses

The data were subjected to analysis of variance (ANOVA) and a difference was considered to be significant at $p \leq 0.05$. Error was reported as standard deviation from the mean. Mean were separated using Duncans' Multiple Range Tests through SPSS software (version 21.0)

4. Results and Discussion

Table 2. *Proximate Composition of composite flour blends.*

Sample	$UWPA_{5-5}$	$UWPA_{20-20}$	$UWPA_{30-20}$	$UWPA_{10-10}$	$UWPA_{100}$	$UWPA_{20-10}$
Ash (%)	4.43 ± 0.12^{a}	4.60 ± 0.00^{a}	5.47 ± 0.12^{c}	4.43 ± 0.12^{a}	5.13 ± 0.12^{b}	5.33 ± 0.06^{c}
Moisture (%)	10.07 ± 0.21^{a}	11.27 ± 0.09^{d}	12.77 ± 0.23^{f}	10.53 ± 0.12^{b}	10.87 ± 0.06^{c}	11.67 ± 0.12^{e}
Fat (%)	16.03 ± 3.06^{bc}	14.93 ± 0.06^{ab}	16.23 ± 0.12^{bc}	13.33 ± 0.12^{a}	18.17 ± 0.12^{c}	15.48 ± 0.03^{ab}
Crude Fiber (%)	0.67 ± 0.06^{a}	$0.870 \pm .06^{bc}$	0.83 ± 0.06^{bc}	0.83 ± 0.06^{bc}	0.90 ± 0.00^{c}	0.80 ± 0.00^{b}
Protein (%)	8.44 ± 0.01^{c}	12.50 ± 0.17^{f}	9.07 ± 0.02^{d}	9.64 ± 0.29^{e}	7.77 ± 0.03^{a}	8.15 ± 0.04^{b}
Carbohydrates (%)	63.69 ± 0.40^{f}	55.83 ± 0.23^{a}	56.27 ± 0.40^{a}	61.23 ± 0.58^{d}	57.17 ± 0.03^{b}	58.56 ± 0.18^{c}
Energy Value (calorie)	432.70 ± 26.15^{b}	$407.070.75^{a}$	407.46 ± 2.56^{a}	403.47 ± 0.12^{a}	423.23 ± 1.27^{ab}	406.22 ± 0.84^{a}

Mean standard deviation of triplicate determinations. Mean bearing the same superscripts within the same row are not significantly different ($p< 0.05$)
Key: $UWPA_{100}$ =100% wheat flour, $UWPA_{5-5}$= 90%wheat flour + 5%each of plantain and almond flour, $UWPA_{10-10}$= 80% wheat flour +10% plantain flour + 10% almond flour, $UWPA_{20-10}$ = 70%wheat flour +20%plantain flour + 10% almond flour, $UWPA_{20-20}$= 60%wheat flour +20%each of plantain and almond flour, $UWPA_{30-20}$ = 50%wheat flour+ 30%plantain flour + 20%almond flour.

Table 3. *Proximate Composition of cookies produced from composite flour.*

Sample	WPA_{20-20}	WPA_{20-10}	WPA_{30-20}	WPA_{100}	WPA_{5-5}	WPA_{10-10}
Ash (%)	$4.87 \pm 0.12a$	4.87 ± 0.06^{a}	4.77 ± 0.12^{a}	5.07 ± 0.12^{b}	4.73 ± 0.12^{a}	4.83 ± 0.06^{a}
Moisture (%)	8.97 ± 0.12^{a}	9.57 ± 0.06^{c}	8.97 ± 0.06^{a}	10.37 ± 0.06^{d}	9.08 ± 0.03^{ab}	9.17 ± 0.06^{b}
Fat (%)	16.57 ± 0.06^{c}	18.67 ± 1.62^{d}	16.67 ± 0.06^{c}	17.97 ± 0.06^{d}	11.50 ± 0.17^{a}	14.27 ± 0.23^{b}
Crude Fiber (%)	0.77 ± 0.06^{b}	0.60 ± 0.00^{a}	0.80 ± 0.00^{b}	0.80 ± 0.00^{b}	0.57 ± 0.06^{a}	0.97 ± 0.06^{b}
Protein (%)	12.63 ± 0.58^{f}	8.19 ± 0.01^{b}	7.32 ± 0.02^{a}	12.14 ± 0.01^{e}	9.95 ± 0.02^{c}	10.53 ± 0.06^{d}
Carbohydrates (%)	55.80 ± 0.17^{b}	59.90 ± 0.17^{c}	61.48 ± 0.02^{e}	53.66 ± 0.01^{a}	64.30 ± 0.24^{f}	60.91 ± 0.18^{d}
Energy Value (Calorie)	422.83 ± 1.10^{a}	440.37 ± 13.83^{a}	425.31 ± 0.61^{a}	424.90 ± 0.52^{a}	472.03 ± 126.50^{a}	414.19 ± 2.59^{a}

Mean standard deviation of triplicate determinations. Mean bearing the same superscripts within the same row are not significantly different ($p>0.05$)
Key: WPA_{100} = cookies of 100%wheat flour, WPA_{5-5}= cookies of 90% wheat flour + 5% plantain flour + 5% almond flour, WPA_{10-10}= cookies of 80% wheat flour +10% plantain flour + 10% almond flour, WPA_{20-10} = cookies of 70% wheat flour +20% plantain flour +10% almond flour, WPA_{20-20}= cookies of 60% wheat flour + 20% plantain + 20% almond flour, WPA_{30-20} = 50% wheat flour + 30% plantain flour + 20% almond flour

Table 4. *Minerals Composition of composite flour blends.*

Sample	$UWPA_{5-5}$	$UWPA_{20-20}$	$UWPA_{30-20}$	$UWPA_{10-10}$	UWW_{100}	$UWPA_{20-10}$
Phosphorus (mg/100g)	0.21 ± 0.01^{a}	0.26 ± 0.01^{b}	0.24 ± 0.06^{ab}	0.28 ± 0.01^{b}	0.21 ± 0.01^{a}	0.31 ± 0.01^{c}
Calcium (mg/100g)	0.08 ± 0.01^{f}	0.08 ± 0.01^{e}	0.07 ± 0.01^{c}	0.07 ± 0.00^{b}	0.06 ± 0.01^{a}	0.08 ± 0.01^{d}
Potassium (mg/100g)	1.42 ± 0.01^{d}	1.54 ± 0.02^{e}	1.89 ± 0.02^{f}	1.26 ± 0.01^{c}	0.06 ± 0.01^{a}	0.89 ± 0.02^{b}
Magnesium (mg/100g)	0.21 ± 0.01^{c}	0.23 ± 0.01^{c}	0.26 ± 0.01^{d}	0.14 ± 0.01^{b}	0.06 ± 0.01^{a}	0.13 ± 0.03^{b}
Sodium (mg/100g)	0.08 ± 0.01^{a}	0.14 ± 0.01^{d}	0.16 ± 0.01^{f}	0.08 ± 0.01^{b}	0.13 ± 0.01^{c}	0.15 ± 0.01^{e}
Iron (mg/100g)	523.67 ± 0.29^{f}	446.33 ± 0.58^{c}	487.67 ± 0.29^{e}	343.67 ± 0.29^{b}	459.67 ± 0.29^{d}	$240.50 \pm 0.50a$
Zinc (mg/100g)	131.50 ± 0.50^{c}	140.50 ± 0.50^{d}	318.50 ± 0.50^{e}	385.50 ± 0.50^{f}	105.50 ± 0.50^{b}	35.67 ± 0.29^{a}

Mean standard deviation of triplicate determinations. Mean bearing the same superscripts within the same row are not significantly different ($p< 0.05$)
Key: $UWPA_{100}$ =100% wheat flour, $UWPA_{5-5}$= 90%wheat flour + 5%each of plantain and almond flour, $UWPA_{10-10}$= 80% wheat flour +10% plantain flour + 10% almond flour, $UWPA_{20-10}$ = 70%wheat flour +20%plantain flour + 10% almond flour, $UWPA_{20-20}$= 60%wheat flour +20%each of plantain and almond flour, $UWPA_{30-20}$ = 50%wheat flour+ 30%plantain flour + 20%almond flour.

Table 5. *Mineral Composition of Cookies Produced from composite flour.*

Sample	WPA_{20-20}	WPA_{20-10}	WPA_{30-20}	WPA_{100}	WPA_{5-5}	WPA_{10-10}
Phosphorus (mg/100g)	0.31 ± 0.01^{d}	0.31 ± 0.01^{d}	0.33 ± 0.01^{e}	0.24 ± 0.01^{a}	0.30 ± 0.01^{c}	0.28 ± 0.01^{b}
Calcium (mg/100g)	0.28 ± 0.01^{e}	0.25 ± 0.01^{d}	0.31 ± 0.01^{f}	0.20 ± 0.01c	0.18 ± 0.01^{b}	0.06 ± 0.01^{a}
Potassium (mg/100g)	1.64 ± 0.02^{d}	1.98 ± 0.01^{e}	1.98 ± 0.01^{e}	1.18 ± 0.02^{a}	1.32 ± 0.02^{b}	1.45 ± 0.01^{c}
Magnesium (mg/100g)	0.23 ± 0.01^{e}	0.26 ± 0.01^{f}	0.22 ± 0.01^{d}	0.12 ± 0.01^{a}	0.17 ± 0.00^{b}	0.17 ± 0.01c
Sodium (mg/100g)	0.16 ± 0.01^{a}	2.81 ± 4.60^{a}	0.11 ± 0.01^{a}	2.77 ± 4.62^{a}	0.11 ± 0.01^{a}	2.76 ± 4.62^{a}
Iron (mg/100g)	141.00 ± 0.50^{b}	186.67 ± 0.29^{d}	150.50 ± 0.50^{c}	9.50 ± 0.50^{a}	295.33 ± 0.58^{f}	283.67 ± 0.29^{e}
Zinc (mg/100g)	804.50 ± 0.50^{e}	349.50 ± 0.50^{d}	124.50 ± 0.50^{c}	64.50 ± 0.50^{a}	102.50 ± 0.50^{b}	875.50 ± 0.50^{f}

Mean standard deviation of triplicate determinations. Mean bearing the same superscripts within the same row are not significantly different ($p>0.05$)
Key: WPA_{100} = cookies of 100%wheat flour, WPA_{5-5}= cookies of 90% wheat flour + 5% plantain flour + 5% almond flour, WPA_{10-10}= cookies of 80% wheat flour +10% plantain flour + 10% almond flour, WPA_{20-10} = cookies of 70% wheat flour +20% plantain flour +10% almond flour, WPA_{20-20}= cookies of 60% wheat flour + 20% plantain + 20% almond flour, WPA_{30-20} = 50% wheat flour + 30% plantain flour + 20% almond flour

Table 6. *Sensory Evaluation of cookies produced from composite flour.*

Sample	Texture	Taste	Colour	Crispiness	Flavour	Overall acceptability
W_{100}	6.20 ± 2.35^{a}	6.70 ± 0.67^{b}	6.90 ± 0.99^{b}	7.40 ± 1.07^{b}	5.90 ± 0.99^{a}	5.70 ± 1.83^{a}
WPA_{5-5}	5.90 ± 2.28^{a}	6.10 ± 1.37^{ab}	6.80 ± 0.63^{b}	5.50 ± 1.18^{a}	4.60 ± 1.90^{a}	4.60 ± 2.27^{a}
WPA_{10-10}	6.60 ± 1.07^{a}	5.30 ± 0.82^{a}	5.60 ± 1.58^{ab}	6.10 ± 1.29^{ab}	4.60 ± 1.65^{a}	5.40 ± 1.71^{a}
WPA_{20-10}	5.50 ± 2.07^{a}	6.70 ± 1.34^{b}	5.10 ± 2.23^{a}	6.60 ± 1.26^{ab}	5.90 ± 1.60^{a}	4.40 ± 2.12^{a}
WPA_{20-20}	6.30 ± 1.70^{a}	5.60 ± 2.17^{ab}	6.20 ± 1.75^{ab}	5.90 ± 1.79^{a}	5.40 ± 2.32^{a}	4.10 ± 2.28^{a}
WPA_{30-20}	7.30 ± 1.25^{a}	6.90 ± 0.99^{b}	6.70 ± 0.95^{b}	6.60 ± 1.35^{ab}	6.10 ± 1.37^{a}	5.30 ± 2.16^{a}

Mean standard deviation of triplicate determinations. Mean bearing the same superscripts within the same row are not significantly different ($p>0.05$)
Key: WPA_{100} = cookies of 100%wheat flour, WPA_{5-5}= cookies of 90% wheat flour + 5% plantain flour + 5% almond flour, WPA_{10-10}= cookies of 80% wheat flour +10% plantain flour + 10% almond flour, WPA_{20-10} = cookies of 70% wheat flour +20% plantain flour +10% almond flour, WPA_{20-20}= cookies of 60% wheat flour + 20% plantain + 20% almond flour, WPA_{30-20} = 50% wheat flour + 30% plantain flour + 20% almond flour

Table 7. *Physical Properties of Cookies Produced from Composite Flour.*

Sample	Diameter (cm)	Thickness (cm)	Spread factor
W_{100}	5.00	0.60	8.58
W PA_{10-10}	5.25	0.50	10.50
WPA_{20-10}	5.20	0.50	10.00
WPA_{20-20}	4.90	0.65	9.80
WPA_{5-5}	5.00	0.50	11.11
WPA_{30-20}	5.20	0.45	11.33

4.1. Proximate Composition of Composite Flour

Table 2 shows the proximate composition of 100% wheat flour and different substitution level of plantain and whole almond flour to form composite flours. The ash content of the composite flour ranged from 4.43% to 5.47%. There was no significant difference between Sample $UWPA_{30-20}$ (5.47%) and $UWPA_{20-10}$ (5.33%) but were significantly higher compare to other samples. However, it was observed that the ash content of the flour was low when the wheat flour was substituted with the same ratio of plantain and almond flour and the higher value was obtained when substituted with 30% plantain flour while almond flour is very low in ash content. The moisture content ranged from 10.07% to 12.77% across the samples. It was observed that all the samples were significantly different ($p<0.05$) from one another. The least moisture content was found in sample $UWPA_{5-5}$ (10.07%) while the highest moisture content was recorded in sample $UWPA_{30-20}$ (12.27%). This shows that the composite flour contain high amount of moisture since the moisture content increases as the substitution level increases. Although, the moisture content of each of the sample is still within the acceptable range for flour products, this is an indication of longer shelf life. The fat contents ranged between 13.33% - 18.17%. There was no significant difference ($p<0.05$) between samples $UWPA_{5-5}$ (16.03%) and sample $UWPA_{30-20}$ (16.23%). Also, sample $UWPA_{20-20}$ (14.93%) and sample $UWPA_{20-10}$ (15.48%) were not significantly difference ($p<0.05$) from each other. The highest value for fat was recorded in sample $UWPA_{100}$ (18.17%) which is 100% wheat flour. This could be due to high content of fat present in wheat, while the least value was noticed in sample $UWPA_{10-10}$. The crude fibre ranged between 0.67% to 0.90%. It was observed that samples $UWPA_{20-20}$ (0.87%), $UWPA_{30-20}$ (0.83%) and $UWPA_{10-10}$ (0.83%) were not significant different ($p<0.05$) from one another. The control sample had the highest crude fibre content. This shows that wheat flour is a good source of fibre for human consumption. The protein content ranged from 7.77%to 12.50%. There were significantly differences among the samples. The least protein content was recorded in control sample (7.77%) while the highest protein value was recorded in sample $UWPA_{20-20}$ (12.50%). This shows that plantain and almond flours contain high amount of protein which can be used to improve the protein content in wheat for cookies production. Protein is an essential nutrient for human body. They are one of the building blocks of body tissue. Carbohydrate contents ranged from 55.83% to 63.64%. It was observed that there was no significant different ($p>0.05$) between sample $UWPA_{20-20}$ and $UWPA_{30-20}$, although other samples were significantly different ($p<0.05$) from one another. The highest carbohydrate content was found when wheat flour was substituted with 5% each of plantain and almond flour. This shows that wheat flour contain high amount of gluten content than other flours but little substitution with other flours help to increase the carbohydrate content. The energy value ranged from 403.47 caloric to 432.70 calories. It was observed that sample $UWPA_{20-20}$ (407.73 calorie), $UWPA_{30-20}$ (407.46 calorie) and $UWPA_{10-10}$ (403.46 calorie) and sample $UWPA_{20-10}$ (406.22 calorie) were not significantly different ($p>0.05$). Wheat flour substituted with 30% of plantain and 20% almond flour had the highest value which could be as a result of high starch content in wheat flour.

4.2. Proximate Composition of Cookies

Table 3 shows the proximate composition of cookies produced from 100% wheat flour and different substitution level of plantain and whole almond flour to form composite flour. The ash content ranged from 4.73% - 5.07%. It was observed that sample WPA_{100} (5.07%) was significantly different ($p>0.05$) from one another. Control sample have the highest ash content (5.47%). The supplementation of wheat flour with other flours decreases the ash content of wheat flour. Moisture contents ranged from 8.97% to 10.37%. There was no significant difference between ($p>0.05$) sample WPA_{20-20} (8.97%) and WPA_{30-20} (8.97%), although the other samples were significantly difference from one another. Sample WPA_{100} had the highest moisture (10.37%) content, when substituted with other flour such as plantainand whole almond flour reduces the moisture value. This could be due to high water absorption power of plantain and almond flour, thus prolonging the shelf-life of the cookies because the higher the moisture the more it is susceptible for microbial spoilage. Although these value obtained are in close agreement with 11% to 15% as reported by [12]. The fat content ranged from 11.50% to 18.67% in sample. It was observed that sample WPA_{20-20} and sample WPA_{30-20} were significantly different ($p>0.05$) from each other likewise sample WPA_{20-10}, WPA_{100} were not significantly different ($p>0.05$) from each other. The difference in the fat contents of the samples did not depend on the supplementation rather it could be due to amount of fat used in the preparation of the flour for cookies. The crude fibre ranged from 0.57% to 0.80%. It was observed that sample WPA_{20-20} (0.77%), WPA_{30-20} (0.80%), WPA_{100} (0.80%) and WPA_{10-10} (0.77%) were not significantly different ($p>0.05$) from one another. Sample WPA_{20-10} (0.60%) and WPA_{5-5} were not significantly different ($p>0.05$) from one another. From the result, the addition of other flour did not increase the crude fibre content except wheat flour. The protein contents ranged from 7.32% to 12.63%. All the samples were significantly different ($p<0.05$) from one another. It was discovered that supplementation of wheat flour with higher ratio of plantain flours reduces the protein content of the cookies. But the same proportion of wheat supplemented with other flour increases the protein content. Protein is a nutrient needed by the human body for growth and maintenance. Carbohydrate ranged from 53.66% to 64.30%. All the samples were significantly different ($p<0.050$ from one another. The highest value was recorded in sample WPA_{5-5}. This could be due to high gluten content present in the flour. However, the reduction in carbohydrate content in the cookies is vital in reducing the risk of diabetes. The energy value of the cookies produced ranged from 414.19 calorie to 472 calorie. There was no significant difference ($p>0.05$) in all the samples. The highest energy value was recorded in sample with 90% wheat flour substituted with 5% each of plantain and almond flour. The energy contents of the cookies produced were higher than those reported by [13]. This increase could be due to high protein, fat and carbohydrate contents in the flour blends.

4.3. Mineral Composition of Composite Flour

Table 4 shows the mineral composition of 100% wheat flour and different substitution level of plantain and almond flour to form composite flour. The phosphorus contents ranged from 0.21 to 0.31 mg/100g. Sample $UWPA_{20-10}$ (0.21 mg/100g) and sample UWW_{100} (0.21 mg/100g) were not significantly different ($P>0.05$) from each other. Likewise sample $UWPA_{20-20}$ (0.26%) and sample $UWPA_{10-10}$ (0.28 mg/100g) was not significantly different ($P>0.05$) from each other, while sample UWPA $_{20-10}$ was significantly different from other samples. The least value for phosphorus was recorded in sample UWW_{100} (0.21 mg/100g) and $UWPA_{5-5}$ (0.21 mg/100g) while the highest value was recorded in sample $UWPA_{20-10}$ (mg/100g). This shows that the plantain and almond flour had appreciable amount of phosphorus which could help in enriching flour for cookies production. The calcium contents ranges from 0.06 to 0.08 mg/100g. It was noticed that all the samples was significantly difference ($P\leq0.05$) from one another. The least calcium content was noticed in sample UWW_{100}; this was significantly lower than other samples. This shows that plantain and almond flour had high content of calcium capable of improving wheat flour. The potassium contents ranged from 0.06 to 1.89 mg/100g. It was observed that all the samples were significantly difference ($P<0.05$) from one another. The least potassium value was found in sample UWPA (0.06 mg/100g) while the highest value was recorded in sample $UWPA_{30-20}$ (1.89 mg/100g). This could be due to high content of potassium in plantain flour, since the highest value was obtained when wheat flour was substituted up to 30% plantain flour. The magnesium content ranged from 0.06 to 0.23 mg/100g. The least value was recorded in sample $UWPA_{100}$ (0.06 mg/100g) while the highest value was recorded in sample $UWPA_{20-20}$ (0.23 mg/100g). This shows that plantain flour and almond flour are good sources of magnesium. The sodium contents ranged between 0.08 to 0.16 mg/100g. It was observed that all the samples were significantly difference ($P<0.05$) from one another. The least value was recorded in sample $UWPA_{5-5}$ (0.08 mg/100g) while the highest value was found in sample $UWPA_{30-20}$ (0.16 mg/100g), this could be as a result of high Sodium content in plantain and Almond flours. The iron contents range between 240.50 to 523.67 mg/100g. It was observed that all the samples were significantly different ($p<0.05$) from one another. The highest value is recorded in sample $UWPA_{5-5}$ (52.37mg/100g) which means that to have a high percentage of iron, wheat flour should not be substituted with not more than 5% of other flours. Zinc content ranged between 35.57 to 385.50mg/100g. It was noticed that all the samples were significantly different ($p<0.05$) from one another. Although the substitution level of wheat flour with 10% each of plantain and almond flour seems to be the best at which wheat flour could be substituted.

4.4. Mineral Composition of Cookies

Table 5 shows the mineral composition of cookies produced from 100% wheat flour and different substitution level of plantain, and whole almond flour to form composite flours. From the result, the phosphorus contents range between 0.24 to 0.33 mg/100g. It was observed that all the samples were significantly different (p<0.050 from one another. The highest value for phosphorus was recorded in sample WPA_{30-20} (0.33 mg/100g). This could be due to the high content of phosphorus present in plantain and almond flour. The calcium content ranged between 0.06 to 0.31 mg/100g. The samples were significantly different ($p<0.05$) from one another. The least calcium value was recorded in sample WPA_{10-10} (0.06 mg/100g), while the highest value was recorded in sample WPA_{30-20}. The calcium level increases as the addition of plantain and almond flour increases in substitution level. This shows that plantain and almond flour contain high amount of calcium which could increased the calcium level of the cookies. The potassium contents ranged between 1.18 mg/100g to 1.98 mg/100g. It was observed that sample WPA_{30-20} (1.98 mg/100g) and sample WPA_{20-10} (1.98 mg/100g) were not significantly different ($p>0.05$) from each other but significantly different ($p<0.05$) from other samples. The least potassium value was recorded in sample WPA_{100} (1.18 mg/100g) while the highest value was recorded in sample WPA_{20-10} (1.98 mg/100g) and WPA_{30-20} (1.98 mg/100g); this could be due to high content of potassium present in plantain and almond flour. It was observed that all the samples were significantly different ($p<0.05$) from one another. The highest value for magnesium was found in sample WPA_{20-10} (0.26 mg/100g) while the least value was found in control sample (1.18 mg/100g). This could be due to high content of Magnesium present in plantain flour. The sodium contents ranged from 0.11 to 2.81 mg/100g. It was observed that there was no significant different ($p>0.05$) in all the samples, this could be due to even distribution of sodium between the flour blends during baking. The highest sodium content was recorded in sample WPA_{20-10} (2.81 mg/100g) although not so much differs from whole wheat flour. This shows that all the flours contain high amount of sodium which made them not to be significantly difference ($p>0.05$) from one another. The iron contents ranged from 9.50mg/100g to 295.33mg/100g. All the samples were significantly different ($p<0.05$) from one another. The least iron value was recorded in sample WPA_{100} (9.50%) while the highest iron value was recorded in sample WPA_{5-5}. This is an indication that wheat flour have lower amount of iron and when substituted with lower level of plantain ratio and almond flour greatly increase the iron contents in cookies production. Zinc contents ranged from 64.50 to 875.50mg/100g. It was noticed that all the samples were significantly different ($p<0.05$) from one another. This shows that 10% each of plantain and almond flour is enough to enrich the cookies produced from the composite flour with enough zinc content. Generally, it was observed from the results that baking process did not have negative effect on mineral contents of all the samples except for iron which decreases in value from 52.37mg/100g in flour to 29.53mg/100g of the cookies. This shows that iron can easily be destroyed by high heat treatment. However, supplementation of wheat flour with plantain and whole almond flour in appreciable amount will improve the mineral contents in cookies.

4.5. Sensory Properties of Cookies

Table 6 shows the sensory quality of the cookies produced from 100% wheat flour and different ratio of wheat, plantain, and whole almond flour blends. From the result, it was observed that the texture of all the samples was not significantly different ($p>0.05$) from one another. This could be due to gelatinization of the dough during baking, since they all contain high percentage of gluten. The colour of the samples was not significantly different ($p>0.05$) from one another except for sample WPA_{20-10} (5.10) which was significantly lower in term of colour rating compared with other samples. This could be due to processing control which includes temperature, time regulation, and efficient heat transfer in the oven which help to prevent colour darkening and encourage browning (milliard reaction) of the product as reported by [4]. The flavour of all the samples was not significantly different ($p>0.05$) from one another. This could be due to incorporation of protein present in wheat and in almond at high proportion. There was not significant different ($p>0.05$) in the crispiness of the samples except for sample WPA_{5-5} (5.50%) and sample WPA_{20-20} (5.90%). This could be due to high gluten content present in the wheat flour and the baking time and temperature. The taste of sample W_{100} (6.70%), WPA_{30-20} (6.90%), and WPA_{20-10} (6.70%) were not significantly different ($p>0.05$) from one another, but significantly different from sample WPA_{10} (5.30%). This could be due to sugar level present in the flour at different substitution level, since sweetness play a vital role in the acceptability of any products. The overall acceptability of all the samples was not significantly different ($p>0.05$) from one another. This confirmed that the quality of colour, texture, taste, crispiness, and flavor actually influenced the overall acceptability of the cookies. This result shows that wheat flour could be replaced up to 30% plantain flour and 20% whole almond flour in cookies production leading to better sensory qualities of the cookies.

4.6. Physical Properties of Cookies

Table 7 shows the diameter of cookies produced from 100% wheat flour and different substitution level of plantain and whole almond flour blends. It was observed that sample WPA_{20-20} (60% wheat flour plus 20% each of plantain and almond flour) had the least diameter after baking; this could be as a result of non-uniformity of heat at the initial stage of baking while sample WPA_{10-10} had the highest diameter. However, the thickness of cookies produced from 100% wheat flour and different substitution level of plantain and whole almond flour. The thickness of all the samples was not obviously different from one another except sample WPA_{20-20} with the highest thickness of 0.65. High thickness of cookies can cause delay in baking. The spread factor of cookies produced from 100% wheat flour and different substitution level of plantain and whole almond flour. The spread factor ranged from 8.58 to 11.38 although there was no significant different among these values except sample WPA_{30-20} which had the spread value of 11.38.

5. Conclusion

This study has shown that acceptable cookies of high nutritive content can be produced from flour blends of wheat, plantain and whole almond flour blends. Cookies of composite flours supplemented with up to 30% plantain flour and 20% almond flour were accepted in terms of sensory attributes. More so, cookies produced from the composite flour blends had better mineral quality than those produced from 100%wheat flour because of their high calcium and iron content. The uses of locally grown crops will go a long way in reducing dependence on wheat flour, thereby reducing foreign exchange used in importing wheat. The findings of the present study have clearly demonstrated the possibility of utilizing plantain flour and almond flour alongside with wheat flour in production of cookies. This would support industrial utilization and the consumption of under-utilized products such as almond. Therefore, Plantain flour and whole almond flour should be encouraged especially in the industries in production of cookies and other baked products. Also storage studies should be carried out on how to harvest and process almond nut into flour for further use.

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