QUALITY EVALUATION OF BISCUITS PRODUCED FROM WHEAT, ALMOND AND PAWPAW FLOUR BLENDS

Abstract

Biscuit, also known as a cookie is a nutritive snack produced from dough that is transformed into an appetizing product through the application of heat in an oven. This study was aimed at evaluating the quality of biscuit produced from wheat, African almond and pawpaw flour blends. From the flours, blends were made and six (6) samples, A to F formulated. Sample A (100 % wheat flour) was used as the control, B (60 % Wheat flour: 0 % Almond Flour: 40 % Pawpaw Flour), C (60 % Wheat flour: 10 % Almond Flour: 30 % Pawpaw Flour), D (60 % Wheat flour: 20 % Almond Flour: 20 % Pawpaw Flour), E (60 % Wheat flour: 30 % Almond Flour: 10 % Pawpaw Flour), F (60 % Wheat flour: 40 % Almond Flour: 0 % Pawpaw Flour). The physical, proximate, anti-nutrients, vitamins, minerals, antioxidants and sensory properties of the biscuits were evaluated using standard methods. For physical parameters of the biscuit, the weight ranged from 8.86 g-10.60 g, diameter from 6.60 mm- 6.80 mm, the spread ratio from 0.58-0.61, breaking strength from 0.25 kg- 0.29 kg and thickness ranged from 11.08 mm- 11.43 mm. The anti-nutrients content of the biscuits were considerably low and within safe limits. The results showed an increase in ash, fibre, fats and protein content while the carbohydrate content of the biscuit reduced upon substitution of wheat flour with almond and pawpaw flours. The vitamin content of the biscuit was also improved especially the vitamin A content upon addition of pawpaw flour. The result for mineral composition showed a significant increase from 46.00-89.35mg/100g for sodium, potassiumfrom 323.44-486.95 mg/100g, calcium from 189.46-356.88mg/100g, magnesium from 44.34-132.88 mg/100g and phosphorus from 155.33-428.45mg/100g.6. Antioxidant activity also increased from 2.12-3.69mgAAE/g. The biscuit samples were all rated high in terms of their sensory attributes especially samples with high proportion of almond flour. This research indicates that almond and pawpaw flours are suitable for biscuit production especially at 40% and 10% substitution for almond and pawpaw flours respectively.

Key words: Tropical almond, pawpaw, underutilized, physical, anti-nutrients, proximate, vitamins, minerals, antioxidants and sensory.

1. Introduction

The core of food processing is transforming raw ingredients into consumable food products. This practice, which has been integral to human civilization, ensures the preservation, flavor enhancement, and safety of foods(Insights, 2023). In recent times, the food industry is being challenged by consumer pressure for natural foods with health promoting benefits. This has influenced the aims of the food industry which arefourfold; to extend shelf life, increase variety in diet, to improve the nutritional quality of food and to generate income for the manufacturing industry. Each of these aims exists more or less in all food processes. As reported byFellows, (2010), the processing of a given product may emphasize some more than others.

Biscuit,equally referred to as a cracker or cookie,is defined as a small baked product. It is a nutritive snack produced from dough that is transformed into an appetizing product through the application of heat in an oven.It is a dry product, usually with a golden-brown colour and a crisp texture. Biscuits together with other baked products belong to the class of foods that are sold as ready-to-serve foods (Egwujeh et al., 2017).Biscuit is one of the most popularly produced bakery products in the world. This is because it is produced from simple, affordable, available and easily accessible raw materials (Caleja et al., 2017and Warinporn and Geoffrey, 2018). Biscuit is a popular cereal food consumed by all age groups, especially pre-school and school age children. This food isa form of confectionary product with a low moisture content (Okoye and Okaka, 2019). It usually varies in shape, size and composition. Although biscuits differ in composition, they contain three main ingredients in common; wheat flour, sugar and fat (which can either be butter or vegetable fats). Other ingredients include milk, salt, flavoring agent and egg (Caponio et al., 2016). Commercially, biscuits contain about 50% of calories from fat and carbohydrates, with over 400 calories per 100g in plain biscuits. It is a nutritional food, contributing valuable quantities of iron, calcium, protein, calorie, fiber and some B-vitamins to our diet and daily food requirements (Protonotariou et al., 2016;Egwujeh et al., 2017).Despite its nutritional content, biscuit is limited by the fact that it is generally made from wheat flour and fat that is high-energy digestible foods. This has a negative impact on health if they are consumed regularly and in high amounts (Caleja et al., 2017). Based on their ingredient mix, biscuits can be categorized into two (2) main groups; hard and soft biscuits (Sudha et al., 2007). Commercial biscuits are prepared from refined wheat flour consisting mainly of carbohydrate as starch (70–75%), water (13-15%), protein (10-12%), fat 1-2%, together with some fiber, ash and minerals (Goesaert et al., 2015).It can thus be seen that, wheat flour is the fundamental ingredient for bakery products. This is due to its uniqueness in forming a cohesive gluten network when worked with water (Egwujeh et al., 2017).However, wheat flour is limited by its expensive nature since the climatic condition and soil type in Nigeria does not favor its cultivation. Therefore, substituting wheat flour with flours from other crops such as almond and pawpaw fruitswill significantly improve on the nutritional composition of the snack.

Fruits are rich sources of micronutrients such as minerals and vitamins. They also contain carbohydrates in the form of soluble sugar, cellulose and starch (Yusufu and Akhigbe, 2018),making it more appealing, affordable and of health benefit to the population.They constitute a very important part of the diet and also serve as food supplements and appetizers

(Joanne and Beate, 2012). The fruits of*Carica papaya* (pawpaw) are large and cylindrical, with a fleshy orange pulp, hollow berry and thin yellowish skin when ripe. The generic name is from the Latin word 'Carica', meaning 'edible fig', on account of the similarity of the leaves. It grows satisfactorily in a wide range of areas from the equatorial tropics to temperate latitudes (Orwa et al., 2009). Pawpaw belongs to the family Caricaceae and it is the most important in the family. According to Scheldeman et al., (2007), it is the fourth most important tropical fruit around the globe, with its major producers in the world being Australia, United States, Philippines, SriLanka, South Africa, India, Bangladesh, Malaysia and a number of other countries in tropical America (Anuara etal., 2008). The pulp of pawpaw is most often consumed fresh either in slices, in chunks as dessert and can equally be processed into a variety of products such as cookies, jams, jellies, marmalade, candies and fruit juices (Yusufu and Akhigbe, 2018). Pawpaw is highly rich in vitamin C and minerals such as potassium, magnesium, iron and sodium. It also contains some active compounds such as ascorbic acid, antioxidant, β-carotene, α-tocopherol, flavonoids, vitamin B1, papain and niacin (Oloyede, 2005; Leontowicz et al., 2007). Approximately, pawpaw contains; water 86.6g, protein 0.5g, fat 0.3g, carbohydrates 12.1g, fiber0.7g, ash 0.5g, potassium 204mg,calcium 34mg, phosphorus 11mg, iron 1mg, sodium 3mg, vitamin A 450mg, vitamin C 74mg, thiamine 0.03mg,niacin 0.5mg and riboflavin 0.04mgper 100 g edible portion. The energy value is 200kJ/100g. Major sugars are sucrose (48.3%), glucose(29.8%) and fructose (21.9%) (Orwa et al., 2009).

Tropical, almond also known as *Terminaliacatappa,* belongs to the family *Combretaceae*. Almond is known to have three (3) nuts producing varieties of which some are edible and others non-edible. One variety of almond produces edible sweet nuts, another produces non-edible bitter and poisonous nuts, while the third variety is a blend of both sweet and bitter almonds. Almond is native to western and central Asian countries. It is a small deciduous tree that usually grows to about 4-10m tall with a trunk diameter of about 30cm. Its fruits are 3.5 to 6.0cm long drupe, with a soft outer cover. They are known to survive best in well-drained soil of light to medium texture (Mushtaq et al., 2015). Almond consists mainly of three parts, that is, the kernel or meat, mid shell and outer green shell with a thin leathery layer called brown skin or seed coat. Almond seeds are a good source of proteins, edible oils and fats as well as they are rich in vitamins, minerals and fiber in the diets (Salawu et al., 2018). They are also a potential raw material for local industries where they are used to compliment local foods that are low in protein. They can be eaten either raw or roasted (Shahid et al., 2019a).This work therefore aims at substituting wheat flour with tropical almond and pawpaw flour for the production and quality evaluation of biscuits.

2. MATERIALS AND METHODS

2.1 Source of Raw Materials

Pawpaw fruits (fresh, mature, firm and partially ripe) and almond kennels were purchased from railway market, Makurdi, Benue State, Nigeria. Wheat flour, margarine, baking powder, sugar, eggs and salt were gotten from Wurukum market. All these were then taken to the Center for Food Technology and Research (CEFTER) food laboratory in theChemistry Department, Benue State University (BSU) where preparation, processing and analysis was carried out.

2.2 Preparation of Raw Materials

2.2.1 Preparation of pawpaw flour andalmond kernel flour

Pawpaw and almond kernel flour was produced as shown on Figure 1 and 2 with modification.

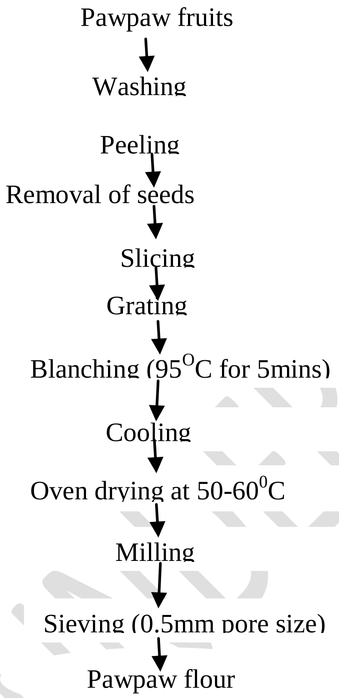

Figure1. Flow chart for the production of pawpaw flour

Source: (Yusufu and Akhigbe, 2018)

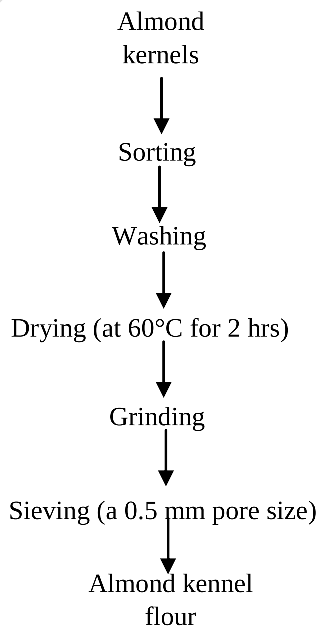

Figure 2: Flow chart for the production of almond kernel flour

Source**:** (Guyihet al., 2020)

2.3 Blend Formulation and Recipe

A flour blend of wheat, almond and pawpaw flour was formulated to obtain six (6) samples. The flour blends for biscuit production are shown in Table 1 and the recipe with modification in Table 2.

Table 1: Flour Blend Formulation

Sample	Wheat flour (%)	Almond flour (%)	Pawpaw flour (%)
A	100	0	0
B	60	0	40
C	60	10	30
D	60	20	20
E	60	30	10
F	60	40	0

Table 2; Recipe for the production of biscuit

Component	Composition (g)
Flour	**100**
Margarine	**33**
Sugar	**36**
Baking powder	**3**
Whole egg	**18 (ml)**
Vanilla essence	**0.25**
Salt	**1**

Source: (Samaa and Salim, 2020)

2.4 Biscuit Production

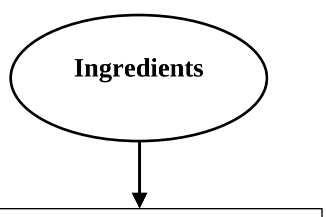

Figure 3: Flow diagram for the production of biscuits

Source: (Guyihet al., 2020;Akubor, 2018).

2.5 Analytical Methods

2.5.1 Determination of physical properties of biscuit

Physical properties such as weight, diameter, thickness and spread ratio were determined according to Bala et al., (2015), while the biscuit breaking strength was determined according to(Egwujeh et al., 2018).

2.5.2 Determination of proximate composition of biscuits

The nutrient content (proximate: moisture, ash, fiber, fat and protein, minerals: calcium, sodium, iron, magnesium and potassium), carbohydrate, vitamins and energy were determined according to standard methodsof(AOAC., 2010).

Total carbohydrate content was calculated using the following formula

$$\%Carbohyddrate = 100\% - (\%Moisture + \%Fat + \%Protein + \%Crudefibre + \%Ash) \quad (1)$$

Calorific values of the samples were calculated using the following formula

$$Energy\ value\ (Kcal/100g) = 9\times \%fat + 4 \times \%protein + 4 \times \%carbohydrate \quad (2)$$

2.5.3 Determination of anti-nutritional and phytochemical composition of flour and biscuit

The oxalate, tannins and cyanides were determined according to the method described by (Krishnaiahet al., 2009).

HPLC analysis of total phenolic compounds

The phenolic compounds were extracted from 1 g biscuits according to the procedure reported by(Laddomada et al., 2016).

Determination of total flavonoids content

The total flavonoids content was determined using aluminum chloride calorimetric method based on the methodology reported by Afify et al., (2012) with some modifications. According to this method, 0.5 mL of sample (1mg/mL) was mixed with 1mL of 10% aluminum chloride, 1mL of potassium acetate (1M) and 2.5 mL of distilled water. Quercetin was used to make the calibration curve. The absorbance of the mixtures was measured at 415 nm using UV-spectrophotometer. The total flavonoid content was then expressed in terms of quercetin equivalent (mg QE/g of sample). All the analyses were repeated three times and the mean value of absorbance obtained.

2.5.4. Determination of vitamin content

Vitamin A was determined according to the method described by AOAC, (2011) while vitamin C (ascorbic acid), thiamine (vitamin B1), riboflavin (vitamin B2) and niacin (vitamin B3) were determined according to (Krishnaiah et al., 2009).

2.5.5 Determination of minerals

A modified AACC (Cereals and Grains Association, formerly American Association of Cereal Chemists,2010) official inductively coupled plasma spectroscopy method 4075.01 was used for determination of calcium (Ca), sodium (Na), Magnessium (Mg), iron (Fe), potassium (k) and phosphorus (P)contentof biscuits.

2.5.6 Determination of antioxidant activity

Antioxidant activity using the Ferric Reducing/Antioxidant Power (FRAP) method was conducted following the method described by (Benzie and Strain, 1996).

2.5.7 Sensory Evaluation

A panel comprising of 30 students both MSc/Ph.D students of the Center for Food

Sample	**Weight**(g)	**Diameter** (mm)	**Spread ratio**	**Breaking strength** (Kg)	**Thickness** (mm)

Technology and Research, Benue State University Makurdi, was employed to evaluate the sensory attributes of the biscuits. The panelists were first of allguided on the procedure. Clean water was provided for the panelists to rinse their mouths after tasting each sample. Panelists were required to evaluate the aroma, appearance, taste, texture (crunchiness) and overall acceptability of the cookies using a 9-point Hedonic scale ranging from dislike extremely to like extremely. Where 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, 9=like extremely (Akinjayeju, 2009).

2.6 Statistical Analysis

Statistical package for social science (SPSS) v26 computer software was used to analyze raw data. Mean and standard deviation was calculated where appropriate. Analysis of variance (one-way ANOVA) was equally used to determine treatment different from others in the various parameters to be tested. Duncan's Multiple Range Test was performed to determine the difference of mean. Differences were considered at 95% ($p<0.05$) significant level.

3. RESULTS AND DISCUSSION

3.1 Physical Properties of Biscuits from Wheat, Almond and Pawpaw Flour Blends

Table 3 shows the various physical properties of biscuits that were analyzed. There was a significant difference between weight, diameter, spread ratio, breaking strength and the thickness. The weight was measured in grams and it ranged from 8.86g in sample A to 10.60 g in sample F.The diameter in mm ranged from 6.50 mm in sample C to 6.80 mm in sample D.For spread ratio, sample B and F showed a high spread ratio. It ranged from 0.58 to 0.61. Sample A recorded the highest (0.29kg) breaking strength while sample B recorded the least (0.25kg). The thickness decreased from 11.43mm in sample A to 11.08mm in sample B.

Table 3: Physical Properties of Biscuit from Wheat, Almond and Pawpaw Flour Blends

A	8.86^{a}±0.10	6.65^{b}±0.05	0.58^{a}±0.00	0.29^{d}±0.00	11.43^{e}±0.00
B	10.48^{d}±0.01	6.60^{b}±0.00	0.60^{d}±0.00	0.25^{a}±0.01	11.08^{a}±0.02
C	10.15^{b}±0.01	6.50^{a}±0.00	0.58^{a}+0.00	0.26^{b}±0.00	11.24^{c}±0.01
D	10.27^{b}±0.01	6.80^{c}±0.00	0.61^{e}±0.00	0.27^{c}±0.00	11.35^{d}±0.01
E	10.17^{c}±0.01	6.60^{b}±0.00	0.59^{c}±0.00	0.27^{c}±0.01	11.25^{c}±0.01
F	10.60^{e}±0.00	6.65^{b}±0.05	0.60^{d}±0.00	0.27^{b,c}±0.01	11.13^{b}±0.01

Values represent mean±SD of triplicate determinations. Means in the same column with different superscripts are significantly different at $p<0.05$.

Key; A- 100% Wheat Flour, B- 60% Wheat flour: 0% Almond Flour: 40% Pawpaw Flour, C- 60% Wheat flour: 10% Almond Flour: 30% Pawpaw Flour, D- 60% Wheat flour: 20% Almond Flour: 20% Pawpaw Flour, E- 60% Wheat flour: 30% Almond Flour: 10% Pawpaw Flour, F- 60% Wheat flour: 40% Almond Flour: 0% Pawpaw Flour.

The results showed a significant $p<0.05$ difference in the weight upon supplementation of wheat flour with almond and pawpaw flour. The weight was lower than the 11.28g to 13.09g reported by (Kiin-Kabari et al., 2021). Shittu et al., (2007) reported that the basic determinant of weight of baked products is the quantity of dough baked and the amount of moisture and carbon dioxide that diffused out of the product during baking. No significant difference was recorded between sample A, B, E and F for the diameter. Egwujeh et al., (2018) reported a diameter between 6.60 to 7.70mm for wheat flour biscuit supplemented with cricket flour. Supplementation of wheat flour with almond and pawpaw flour gave a spread ratio of 0.58 to 0.61. Sample B and F showed a high spread ratio. This could be due to their high water absorption capacity because of their fibre and protein content which tend to bind and retain more water. According to Dayakar et al., (2016), biscuit spread is affected by competition of ingredients for available water. Akubor, (2018) suggested that spread ratio is affected by the water absorption capacity of the ingredients. Flour or any other ingredient which absorbs water during dough mixing will reduce biscuit spread. Increased spread factor might be due to difference in particle size. Diameter and spread ration of biscuits are important parameters used for the evaluation of wheat varieties for biscuit making (Adejumo et al., 2020). Large biscuit diameter and high spread ratio are considered as desirable quality attributes (Ekissi et al., 2020). The level of supplementation equally affected the breaking strength of the biscuit. Sample A recorded the highest (0.29kg) breaking strength while sample B recorded the least (0.25kg). No significant difference was recorded between sample C, D, E and F. The relationship between breaking strength and thickness has been reported by (Nwosu and Akubor, 2016). The thinner the biscuit, the lesser the ability to withstand stress, as such a lower breaking strength. These results are far less than the 6.4 to 8.0kg reported by (Akubor and Ihotu, 2020). A significant ($p<0.05$) difference in thickness was recorded between the samples.Kiin-Kabari et al., (2021) reported a thickness of 6.85mm to 9.45mm for wheat flour biscuit supplemented with African walnut and carrot flour.

3.2 Proximate Composition of Biscuit from Wheat, Almond and Pawpaw Flour Blends

Table 4 shows the proximate composition of the biscuit samples. The results of moisture, ash, fat, fibre, protein, carbohydrate and energy showed a significant difference between samples.The moisture content ranged from 5.16 % in sample A to 8.75% in sample B. Ash content increased from sample A (2.21 %) to B (2.94%).The fat content increased from sample A (13.95) to F (43.55).Fibrecontent ranged from 0.10 in samples A to 1.07% in sample B.Sample F recorded the highest (22.41 %) while sample A recorded the least (9.93%) protein content. The carbohydrate content reduced from 68.65 to 23.3 %.Energy value increased significantly from 420.76 to 574.79 Kcal/100g

Table 4: Proximate Composition of Biscuit from Wheat, Almond and Pawpaw Flour Blends

	%						**Kcal/100g**
Sample	Moisture	Ash	Fat	Fibre	Protein	Carbohydrate	Energy
A	$5.16^{a}\pm0.11$	$2.21^{a}\pm0.01$	$13.95^{a}\pm0.00$	$0.10^{c}\pm0.00$	$9.93^{a}\pm0.04$	$68.65^{f}\pm0.15$	$502.27^{a}\pm0.31$
B	$8.75^{f}\pm0.24$	$2.94^{f}\pm0.00$	$14.36^{b}\pm0.31$	$1.07^{cd}\pm0.03$	$16.24^{b}\pm0.05$	$56.64^{e}\pm0.56$	$420.76^{e}\pm2.34$
C	$7.21^{d}\pm0.10$	$2.36^{b}\pm0.02$	$27.31^{c}\pm0.13$	$0.89^{a}\pm0.01$	$16.98^{c}\pm0.11$	$45.25^{d}\pm0.16$	$464.71^{b}\pm0.52$
D	$8.39^{e}\pm0.11$	$2.47^{c}\pm0.00$	$31.53^{d}\pm0.10$	$0.94^{b}\pm0.04$	$18.31^{d}\pm0.39$	$38.36^{c}\pm0.46$	$510.45^{c}\pm0.97$
E	$6.01^{b}\pm0.13$	$2.70^{d}\pm0.00$	$36.15^{e}\pm0.06$	$1.04^{d}\pm0.01$	$21.44^{e}\pm0.05$	$32.66^{b}\pm0.31$	$541.75^{d}\pm0.75$
F	$6.83^{c}\pm0.0$	$2.88^{e}\pm0.0$	$43.55^{f}\pm0.0$	$1.03^{d}\pm0.0$	$22.41^{f}\pm0.0$	$23.3^{a}\pm0.08$	$574.79^{d}\pm0.5$

7	0	6	0	5	5

Values represent mean±SD of triplicate determinations. Means in the same column with different superscripts are significantly different at p<0.05.

Key; A- 100% Wheat Flour, B- 60% Wheat flour: 0% Almond Flour: 40% Pawpaw Flour, C- 60% Wheat flour: 10% Almond Flour: 30% Pawpaw Flour, D- 60% Wheat flour: 20% Almond Flour: 20% Pawpaw Flour, E- 60% Wheat flour: 30% Almond Flour: 10% Pawpaw Flour, F- 60% Wheat flour: 40% Almond Flour: 0% Pawpaw Flour.

The moisture content of the biscuit samples increased with supplementation of wheat flour with almond and pawpaw flour(from 5.16 to 8.75 %). This increase in moisture content could be attributed to the high water absorption capacity of pawpaw flour. Amadi, (2019) reported a similar trend for moisture content. It increased as varying degrees of okra flour was added. The moisture content of biscuit in this study was significantly lower (p<0.05) than 17.01 to 26.23% reported by Akoja and Coker, (2018) on wheat flour biscuit incorporated with okra powder and in line with the 6.42 to 8. 04% reported by (Guyih et al., 2020). The low moisture content of the biscuit is advantageous as it limits microbial spoilage and increases its shelf life. The ash content increased significantly from sample A (2.21 %) to B (2.94%). This is due to the presence of higher amounts of pawpaw flour which is richer in minerals. Kiin-Kabari et al., (2021) reported a similar trend where ash content increased from 1.10% to 2.15%. A lower ash content of 1.7% was reported by Akubor, (2016) for biscuits made from wheat and cashew pomace flour.The ash content of a food material can be used as an index of mineral constituents of the food because ash is the inorganic residue that remains after water and organic matter have been removed by heating (Sanni et al., 2008). Sample F which contains 60% wheat flour and 40% almond flour had the highest fat content. The fat content increased from sample A to F as the percentage of almond flour increases. This is because almond is richer in fat than wheat and pawpaw flour. Guyihet al., (2020) also recorded an increase in the fat content of biscuit supplemented with almond and carrot flour as a result of increase in almond flour. A lower fat content of 3.78–4.23% was reported by Haimanot et al., (2017) for wheat bread supplemented with cassava and soybean flour. The fibrecontent increased with supplementation of wheat flour with almond and pawpaw flour, it ranged from 0.10% in sample A to 1.07% in sample B. These results are in agreement with that of (Guyih et al., 2020).Kiin-Kabari et al., (2021) also reported an increase in fibre content from 0.89 to 2.05%. Supplementation of wheat flour with almond and pawpaw flour resulted to a significant p<0.05increase in the protein content. This is due to the fact that almond is a very rich source of proteins. These results are higher than the 6.14 to 10.23% reported by Guyih et al., (2020) for wheat biscuit supplemented with almond and carrot flour while Kiin-Kabari et al., (2021) recorded a protein content between 10.55 to 15.10% for wheat biscuit supplemented with African walnut and carrot flour. The biscuit showed that substitution of wheat with almond and pawpaw flour reduces the carbohydrate content from 68.65 to 23.3 %. Presumably, this product could be beneficial to adults seeking to lose weight while maintaining a healthy diet. The results of this study arelower than 53.39 to 75.19% reported by (Azza et al., 2016). Jimoh, (2021) recorded a carbohydrate content of 68.48 to 85.80% for wheat flour biscuit fortified with tiger nuts and date palm fruit. The energy value increased significantly from 420.76 to 574.79 Kcal/100g with increase supplementation with almond flour. This is because almond has a high fat content. These results are in agreement with that of Azza et al., (2016) who recorded a significant increase in energy value with increase incorporation of flaxseed flour. It also agrees with the trend reported by (Guyih et al., 2020). From the results, it can be concluded that supplementing wheat flour with almond and pawpaw flour increases the nutrient content of the biscuit.

3.3 Anti-nutrient and Phytochemicals Content of Biscuit from Wheat, Almond and Pawpaw Flour Blends

The results of the ant-nutrients of the cookies showed that the oxalate content ranged from 0.01% in sample A to 0.09 % in sample B. The tannin content ranged from 0.20mg/100g to 0.50mg/100g.The cyanide content ranged from 0.01mg/100g to 0.05mg/100g.The total phenolic content of cookies obtained in this study ranged from 0.60mg/100g in sample A to 1.09 mg/100g in sample D and E.Total flavonoid content ranged from 1.04mg/100g in sample A to 1.90 mg/100g in sample F with increase in almond flour. The results showed a significant difference between the oxalate, tannin, cyanide, total phenols and total flavonoids. The results are shown in table 5.

Table 5: Anti-nutrient and Phytochemical Content of Biscuit from Wheat, Almond and Pawpaw Flour Blends

	%		**mg/100g**		
Sample	**Oxalate**	**Tannins**	**Cyanide**	**Total Phenolics**	**Total Flavonoids**
A	$0.01^{a}\pm0.00$	$0.20^{a}\pm0.00$	$0.01^{a}\pm0.00$	$0.60^{a}\pm0.00$	$1.04^{a}\pm0.00$
B	$0.09^{f}\pm0.00$	$0.47^{f}\pm0.00$	$0.04^{c}\pm0.00$	$1.07^{c}\pm0.00$	$1.84^{d}\pm0.15$

C	$0.03^{b}\pm0.00$	$0.36^{b}\pm0.00$	$0.03^{b}\pm0.00$	$1.06^{b}\pm0.00$	$1.48^{b}\pm0.02$
D	$0.04^{c}\pm0.00$	$0.37^{c}\pm0.00$	$0.04^{c}\pm0.00$	$1.09^{e}\pm0.00$	$1.68^{c}\pm0.01$
E	$0.05^{d}\pm0.00$	$0.48^{d}\pm0.01$	$0.04^{c}\pm0.00$	$1.09^{de}\pm0.00$	$1.89^{e}\pm0.01$
F	$0.06^{e}\pm0.00$	$0.50^{e}\pm0.01$	$0.05^{f}\pm0.00$	$1.08^{d}\pm0.01$	$1.90^{f}\pm0.02$

Values represent mean±SD of triplicate determinations. Means in the same column with different superscripts are significantly different at p<0.05.

Key; A- 100% Wheat Flour, B- 60% Wheat flour: 0% Almond Flour: 40% Pawpaw Flour, C- 60% Wheat flour: 10% Almond Flour: 30% Pawpaw Flour, D- 60% Wheat flour: 20% Almond Flour: 20% Pawpaw Flour, E- 60% Wheat flour: 30% Almond Flour: 10% Pawpaw Flour, F- 60% Wheat flour: 40% Almond Flour: 0% Pawpaw Flour.

The oxalate content reduced significantly (p<0.05.) as the percentage of pawpaw flour decreased. These values are lower than 0.31 to 0.7 % reported by Moktan and Ojha, (2016) and 0.95mg/100g recorded by (Amadi, 2019). Cyanide content increased from sample A to F with increase in almond flour. Adejumo et al., (2020) reported a similar result for whole wheat- based cookies supplemented with pigeon pea and banana flour.

Tannins are important in food, as they hasten the healing of wounds and inflamed mucus membrane.The tannin content increased as percentage of almond increased since it contains higher amount of tannins than pawpaw flour. Kiin-Kabari et al., (2021) recorded a tannin value from 0.23 mg/100g – 0.33 mg/100g for cookies produced from a blend of wheat, African walnut and carrot flours. Amadi, (2019) reported a much lower tannin content of 0.05% - 0.2 %. However, the tannin values obtained in this study were within permissible limit of 5-20mg/100g as reported by World Food Program, 2011. The total phenolic content of cookies obtained in this study ranged from 0.60mg/100g in sample A to 1.09 mg/100g in sample D and E. The results are coherent with 0.51 to 1.24mg/g and 0.21 to 2.35mg/g reported byKiin-Kabari et al., (2017) andGrah et al., (2014) but lower values ranging from 0.11 to 0.84mg/100g was reported by (Omah and Okafor, 2015). Phenols have been reported to have antioxidant and antimicrobial activity and can help fight against inflammation, degenerative diseases and allergies.

Total flavonoid content increased from 1.04mg/100g in sample A to 1.90 mg/100g in sample F with increase in almond flour. This is to show that almond is a good source of flavonoid. Akubor and Ihotu, (2020)recorded a flavonoid content of 0.4 to 1.3 mg/100g for biscuit supplemented with sun- and oven-dried sweet orange pulp flours.Flavonoids have antioxidant properties that play protective role in the development of cardiovascular diseases, atherosclerosis, hypertension, diabetes mellitus, neurodegenerative diseases, rheumatoid, arthritis, and aging. From the results, the anti-nutrient content of the biscuit is lower than those of the flours. This is as a result of the processing methods applied during production of the biscuit. However, anti-nutrients are not entirely dangerous when consumed in food since they have anti-oxidant properties when consumed at safe level (Petroski and Minich, 2020). It has been reported that tannin and phytate reduced blood glucose and insulin response to foods rich in starch (Udomkun et al., 2019). All samples analyzed were lower than the safe limit of 4–9 mg\100g as reported by Siddiq et al., (2009) for the effect of processing method on anti-nutritional properties of Indian tribal pulse. Schiavone et al., (2007)reported 150-200 mg/100g as the safe level for tannin. Hence it can be agreed that the anti-nutrient contents of the products of this study are considerably low and may not pose risk to health.

3.4 Vitamin Content of Biscuit from Wheat, Almond and Pawpaw Flour Blends.

Results of the various vitamins analyzed are shown in the table 6. The results showed that fortification of wheat flour with almond and pawpaw flour for the production of biscuit increases the vitamin content. The results of the individual vitamins varied significantly from each other.

Table 6: Vitamin Content of Biscuit from Wheat, Almond and Pawpaw Flour Blends

	mg/100g				
Sample	**A**	**B1**	**B2**	**B3**	**C**
A	0.12^{a}±0.00	0.04^{a}±0.00	0.01^{a}±0.00	0.01^{a}±0.00	0.00^{a}±0.00
B	0.83^{e}±0.00	0.39^{c}±0.00	0.32^{c}±0.00	0.53^{c}±0.00	21.39^{e}±0.05
C	0.35^{b}±0.00	0.32^{b}±0.00	0.17^{b}±0.00	0.47^{b}±0.00	15.80^{c}±0.53
D	0.55^{f}±0.02	0.62^{d}±0.00	0.85^{f}±0.00	0.53^{c}±0.00	16.74^{d}±0.23
E	0.58^{c}±0.01	0.74^{e}±0.01	0.64^{e}±0.00	0.55^{d}±0.00	15.32^{b}±0.00
F	0.70^{d}±0.01	0.76^{f}±0.00	0.87^{d}±0.01	0.62^{e}±0.01	$15.72^{d,c}$±0.01

Values represent mean±SD of triplicate determinations. Means in the same column with different superscripts are significantly different at p<0.05.

Key; A- 100% Wheat Flour, B- 60% Wheat flour: 0% Almond Flour: 40% Pawpaw Flour, C- 60% Wheat flour: 10% Almond Flour: 30% Pawpaw Flour, D- 60% Wheat flour: 20% Almond Flour: 20% Pawpaw Flour, E- 60% Wheat flour: 30% Almond Flour: 10% Pawpaw Flour, F- 60% Wheat flour: 40% Almond Flour: 0% Pawpaw Flour.

Vitamin A ranged from 0.12 to 0.83 mg/100g. Sample B (60% wheat and 40% pawpaw flour) had the highest amount of vitamin A. The other samples also recorded higher values than the control sample. This could be attributed to the presence of pawpaw flour which is a rich source of vitamin A. Makanjuola and Adebowale, (2020)reported a higher vitamin A content of 0.45 to 5.67mg/100g for biscuit produced from wheat-cocoyam flour blends. Vitamin A is a vital micronutrient in complementary food. Sample F had the highest vitamin B_2 content (0.87 mg/100g) while sample A had the lowest 0.01mg/100g. This could be due to the fact that almond is rich in vitamin B_2. Vitamin B_2 helps to break down proteins, fat and carbohydrates and plays a vital role in maintaining body's energy supply. These values fall within the recommended daily intake of 0.3-1.6 mg/100g (Zakpa, 2010). Sample A had no vitamin C while sample B recorded the highest with a value of 21.39mg/100g because it has the highest percentage of pawpaw flour which is highly rich in vitamin C. These results were lower than the 8.02 to 27.49mg/100g and 17.17 to 78.92mg/100g for vitamin B_2 and vitamin C reported by (Olakunle and Olalekan, 2020).

Substitution of wheat flour with almond and pawpaw flour increased the amount of vitamin B1 significantly from sample A to F as the percentage of almond increased. The highest value (0.76mg/100g) was recorded in sample F which contains 40% almond flour and 60% wheat flour and the lowest (0.04mg/100g) recorded in sample A which is the control sample. The results are similar to those of Ighere et al., (2019) who recorded a vitamin B1 content ranging from 0.54-0.60mg/100g for biscuits produced from wheat, beniseed and maize composite flour. Vitamin B_1 equally known as thiamin helps the body to convert carbohydrates into energy. It also helps in muscle contraction and conduction of nerve signals. The values recorded are within the recommended daily allowance which is 0.5-0.6mg/day for children from 1-8years. Vitamin B3 also known as niacin was equally analysed. The values were significantly different ($p<0.05$.) and increased as the percentage substitution with almond flour increased. The highest value (0.62mg/100g) was recorded in sample F and the lowest (0.01mg/100g) in sample A. Niacin aids in the biochemical degradation of carbohydrates, fats and proteins to release energy in the body. The results imply that fortification of wheat flour with almond and pawpaw flour for the production of biscuit increases the vitamin content which is of benefit to the body when consumed.

3.5 Mineral Composition of Biscuit from Wheat, Almond and Pawpaw Flour Blends

Generally, the mineral content of the biscuit increased with supplementation of wheat flour with almond and pawpaw flour. The values varied significantly from each other. Table 7 shows the results of the mineral results.

Table 7: Mineral Composition Biscuit from Wheat, Almond and Pawpaw Flour Blends

	mg/100g					
Sample	**Na**	**K**	**Ca**	**Mg**	**P**	**Fe**
A	46.00^{a}±0.01	323.44^{a}±0.01	189.46^{a}±0.01	44.34^{a}±0.01	155.33^{a}±0.01	5.00^{a}±0.00
B	89.35^{f}±0.01	405.00^{b}±0.00	311.77^{e}±0.01	132.13^{f}±0.01	333.77^{d}±0.01	7.66^{f}±0.01
C	61.45^{b}±0.01	411.67^{d}±0.02	266.71^{b}±0.01	61.34^{b}±0.01	233.93^{b}±0.01	5.16^{b}±0.01
D	69.03^{c}±0.01	411.46^{c}±0.01	283.77^{c}±0.01	84.34^{c}±0.01	240.06^{bc}±14.10	5.92^{c}±0.01
E	72.02^{d}±0.01	455.77^{e}±0.01	290.99^{d}±0.01	85.35^{d}±0.02	264.32^{c}±35.01	6.45^{d}±0.01
F	87.94^{e}±0.02	486.95^{f}±0.01	356.88^{f}±0.01	125.88^{e}±0.01	428.45^{e}±0.01	7.46^{e}±0.01

Values represent mean±SD of triplicate determinations. Means in the same column with different superscripts are significantly different at p<0.05.

Key; A- 100% Wheat Flour, B- 60% Wheat flour: 0% Almond Flour: 40% Pawpaw Flour, C- 60% Wheat flour: 10% Almond Flour: 30% Pawpaw Flour, D- 60% Wheat flour: 20% Almond Flour: 20% Pawpaw Flour, E- 60% Wheat flour: 30% Almond Flour: 10% Pawpaw Flour, F- 60% Wheat flour: 40% Almond Flour: 0% Pawpaw Flour.

The mineral composition of wheat flour biscuit supplemented with almond and pawpaw flour are shown in the table below. The results show a significant (p<0.05.) increase from 46.00 mg/100g -87.94 mg/100g in the sodium content with increase in almond. These results are higher than 14.11 mg/100 g to 16.08 mg/100 g reported by (Kiin-Kabari et al., 2021).Sodium is an electrolyte compound which helps in balancing fluids in the human body system. It is also required for nerve and muscle functioning but over-consumption can lead to kidney damage and increase chances of high blood pressure Munteanu and Iliuta, (2011). Potassium content was found to increase significantly with an increase in almond content. This is because almond is richer in potassium than wheat and pawpaw. Sample F (60% wheat flour and 40 % almond flour) contained the highest amount 486.95mg/100g of potassium while sample A which is 100 % wheat flour had the least amount 323.44 mg/100g. These results were far higher than the 122.5mg/100g reported by Akubor and Owuse, (2020) for wheat flour and tomato peel flour biscuit but lower than 877.62 to 984.26mg/100g recorded by (Guyihet al., 2020). Potassium influences osmotic pressure and contributes to normal pH equilibrium (ADA, 2002). It is also an important constituent of every living cell. It is very essential in neuron transmission and other cellular reactions in the body. Calcium levels equally increased from the control sample as almond and pawpaw flours were added. Values increased significantly $p<0.05$ from 189.46 to 356.88 mg/100g. Results are in agreement with those of Guyih et al., (2020) and Akubor and Owuse, (2020). Calcium helps in the formation of bones and also provides support and rigidity to skeletal bones. It acts as an antidote to the depressant action of potassium (Pravina et al., 2013). Calcium also aids rennin in the coagulation of milk in the stomach. Magnesium content, just like the other minerals, equally increased from 44.34mg/100g in sample A to 132.88 mg/100g in sample B. Sample B recorded the highest value because it contained the highest amount of pawpaw which is richer in this mineral than wheat and almond flour. Magnesium is involved in many metabolic reactions in the human body and is equally needed for making of new cells, activating B vitamins, relaxing nerves and muscles, blood clotting and in energy production. Phosphorus content equally increased with increase supplementation with almond and pawpaw flours. It ranged from 155.33 mg/100g in sample A to 428.45 mg/100g in sample F as percentage of almond increased. The results were far less than 1307.30mg/100g reported by (Amadi, 2019). Phosphorus is an important mineral as it helps mainly in the formation of bones and teeth. It also assists the body in the utilization of carbohydrates and fats. Iron content increased significantly from 5.00 mg/100g in sample A to 7.66mg/100g in sample B. This is because pawpaw is richer in iron. Iron is an essential trace element which plays vital roles such as hemoglobin formation and oxidation of fats, protein and carbohydrates (Mlitan et al., 2014). It is highly required for replenishment of blood in menstruating women and much more in pregnant women for proper development of the fetus.

3.6 Antioxidant Composition of Biscuit from Wheat, Almond and Pawpaw Flour Blends.

Antioxidants are compounds that have the ability to either delay or inhibit the oxidation process (Pisoschi and Negulescu, 2011). This reaction takes place under the presence of atmospheric oxygen or reactive oxygen species (ROS). Antioxidants act as a defensive mechanism against free radical attack. The effectiveness of antioxidant compounds results from their free radical-scavenging activity. Analysis carried out showed that sample B had the highest (3.69 mgAAE/g) free radical scavenging activity while sample A exhibited the lowest (2.12 mgAAE/g). This increase in antioxidant activity of the cookies could be attributed to Maillard reaction. Azuan et al., (2020)also reported an increase in antioxidant activity from 2.56 to 7.80% for cookiessupplemented with different levels of spent coffee ground extract. A similar trend was equally reported bySharma and Gujral, (2011) upon thermal processing barley.

Table 8: Antioxidant Activity Biscuit from Wheat, Almond and Pawpaw Flour Blends

Sample	**A**	**B**	**C**	**D**	**E**	**F**
FRAP (mgAAE/g)	$2.12^{a}\pm0.15$	$3.69^{d}\pm0.05$	$2.53^{b}\pm0.01$	$3.34^{c}\pm0.13$	$3.60^{d}\pm0.05$	$3.55^{d}\pm0.00$

Values represent mean±SD of triplicate determinations. Means in the same row with different superscripts are significantly different at p<0.05.

Key; A- 100% Wheat Flour, B- 60% Wheat flour: 0% Almond Flour: 40% Pawpaw Flour, C- 60% Wheat flour: 10% Almond Flour: 30% Pawpaw Flour, D- 60% Wheat flour: 20% Almond Flour: 20% Pawpaw Flour, E- 60% Wheat flour: 30% Almond Flour: 10% Pawpaw Flour, F- 60% Wheat flour: 40% Almond Flour: 0% Pawpaw Flour.

3.7 Sensory Properties of Biscuit from Wheat, Almond and Pawpaw Flour Blends

Sensory parameters such as appearance, aroma, taste, crunchiness and overall acceptability of the biscuit samples were analyzed using a 9-point hedonic scale. 1 on the scale represented dislike extremely and 9 represented like extremely. The appearance of the biscuit was rated between 6.75% in sample B and C to 8.80 % in sample F. There was no significant difference between sample A and F and equally between sample B, C, D and E. Results are in agreement with those of (Kiin-Kabari et al., 2021). Aroma was also highly rated between 6.75% in sample A and 8.30 % in sample F. The results showed that aroma increased upon substitution of wheat flour with almond and pawpaw flour. Sample F which contains 60% wheat and 40% almond flour was rated highest for its aroma. This could be attributed to the fat content of almond which contributes to the aroma. This result was similar to that of Uzo-Peters and Ola, (2020). Sample F still scored highest (8.60%) in terms of the taste followed by sample A with 7.85% which is the control sample. No significant difference was recorded between sample B, C, D, and E. The taste, however, increased with increase in almond flour. The results were in line with those reported by Stoin et al., (2018) and Guyih et al., (2020). The substituted biscuit samples significantly differed from themselves and from the control (sample A) in terms of crunchiness. The least score (6.60%) for crunchiness was recorded in sample B. This could possibly be as a result of the high-water absorption capacity of pawpaw flour. Sample F rated highest (8.60%) in terms of crunchiness because of its fat content. The results agreed with that of Kiin-Kabari et al., (2021). For overall acceptability, Sample F (60% wheat flour and 40% almond flour) was the most preferred (8.80%) followed by sample A (100% wheat flour) 8.10% while sample B (60% Wheat and 40% pawpaw flour) was the least (6.70%). Generally, the results showed that all samples scored positively from like slightly to like moderately indicating that almond and pawpaw are good raw materials that can be used for the substitution of wheat flour for the production of biscuit.

Table 9: Sensory Properties of Biscuit from Wheat, Almond and Pawpaw Flour Blends

Sample	Appearance	Aroma	Taste	Crunchiness	Overall acceptability
A	$8.60^{b}\pm0.60$	$6.75^{a}\pm1.12$	$7.85^{b}\pm0.93$	$8.15^{cd}\pm1.09$	$8.10^{c}\pm0.79$
B	$6.75^{a}\pm1.33$	$7.95^{c}\pm0.95$	$6.90^{a}\pm1.29$	$6.60^{a}\pm1.43$	$6.70^{a}\pm1.42$
C	$6.75^{a}\pm1.12$	$7.00^{ab}\pm01.12$	$7.15^{ab}\pm1.27$	$7.05^{ab}\pm1.40$	$7.20^{ab}\pm0.4$
D	$7.15^{a}\pm1.31$	$7.15^{ab}\pm1.23$	$7.15^{ab}\pm1.18$	$7.25^{ab}\pm1.12$	$7.50^{bc}\pm1.05$
E	$7.40^{a}\pm1.23$	$7.65^{bc}\pm1.18$	$7.60^{ab}\pm1.05$	$7.70^{bc}\pm1.42$	$7.80^{bc}\pm0.95$
F	$8.80^{b}\pm0.41$	$8.30^{c}\pm0.73$	$8.60^{c}\pm0.68$	$8.60^{d}\pm0.68$	$8.80^{d}\pm0.41$

Values represent mean±SD of triplicate determinations. Means in the same column with different superscripts are significantly different at $p<0.05$.

Key; A- 100% Wheat Flour, B- 60% Wheat flour: 0% Almond Flour: 40% Pawpaw Flour, C- 60% Wheat flour: 10% Almond Flour: 30% Pawpaw Flour, D- 60% Wheat flour: 20% Almond Flour: 20% Pawpaw Flour, E- 60% Wheat flour: 30% Almond Flour: 10% Pawpaw Flour, F- 60% Wheat flour: 40% Almond Flour: 0% Pawpaw Flour.

4. Conclusion

This research work aimed at evaluating the quality of biscuits produced from almond, pawpaw and wheat flour shows the potential use of these raw materials for the production of biscuit. Results obtained showed that substitution of wheat flour with almond and pawpaw flour lead to an increase in the nutritional value of biscuit. The results showed an increase in ash, fibre, fats and protein content while the carbohydrate content of the biscuit reduced upon substitution of wheat flour with almond and pawpaw flours. The vitamin content of the biscuit was also improved especially the vitamin A content upon addition of pawpaw flour. Also, mineral analysis showed that the biscuits contain appreciable amounts of minerals.The biscuit samples were all rated high in terms of their sensory attribute especially samples with high proportion of almond flour. Conclusively, judicious incorporation of African almond and pawpaw flours in suitable proportions into bakery products to enhance dietary quality and minimize post-harvest losses should be encouraged.

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