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Proximate composition, Amino acid profiles and Sensory properties of confectionery products supplemented with African Pear (*Dacryodes edulis* var. *edulis)* seed flour.

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Abstract: *The nutrient compositions, amino acid profiles and sensory studies of ready-to-eat confectionery products supplemented with African pear (Dacryodes edulis) seeds were investigated. The large African pear fruits were cleaned, sorted and split open. The seeds were extracted, dried, size-reduced and sieved to obtain fine powder. White flour was blended with the powder in the ratios; 95:5, 90:10, 85:15 and 100:0 which served as the control. Distinct measures of composite flour were respectively mixed with other ingredients and processed separately to produce bread, cake and cookie samples. The bakery products were analysed with the following results: For Proximate composition (Mean values); Protein (6.75 – 8.36%, 8.29 – 10.65% and 8.87 – 9.80%), crude fat (14.21 – 15.42%, 10.82 – 13.44% and 13.21 – 15.36%), ash (1.44 – 1.79%, 3.60 – 4.19% and 2.15 – 3.33%), crude fibre (0.44 – 0.51%, 0.51 – 0.60% and 0.42 – 0.48%), moisture (15.15 – 18.03%, 4.10 – 6.22% and 15.71 – 22.37%) and carbohydrate (57.72 – 59.98%, 67.65 – 70.06% and 50.71 – 59.64%) for bread, biscuit and cake samples respectively. The amino acid profiles of the bakery products showed that they contained all the eight essential amino acids, including histidine which is essential for babies. The total essential amino acids ranged between 18.78 – 21.02g/100g protein, 19.54 – 29.05g/100g protein and 22.63 – 28.45g/100g protein for the samples of biscuit, bread and cake respectively. The 95:5 sample across the products had favourable sensory acceptance ratings by the taste panel constituted, as increased levels of African pear seed flour evoked unpleasant responses. The investigations revealed potential applications of the seed meals for feed and food industries.*

Background: *African pear fruit seed is commonly wasted in seasons of glut, with minimal to zero uses available. Few studies on it indicate that it has good nutrient potential. The cost implications of sustaining regular imports of wheat are astronomical. There exists the possibility of optimizing and diversifying locally available but underutilized plant products for food applications – notably, via ready-to-eat flour confections.*

Materials and Methods: *The large African pear fruits were cleaned, sorted and split open. The seeds were extracted, dried, size-reduced and sieved to obtain fine powder. White flour was blended with the powder in the ratios; 95:5, 90:10, 85:15 and 100:0 (Control). 500g measures of composite flour were respectively mixed with other ingredients and processed separately to produce bread, cake and cookie samples. The bakery products were analysed for proximate and amino acid compositions and sensory acceptability.*

Results: *Significant differences (p>0.05) were observed in the values of the various parameters across the samples and products. Protein, ash and fiber contents of the samples across the products were observed to increase with incremental inclusions of African pear flour in the recipe. The highest levels of these parameters were recorded for the 85:15 blend across the various products. For amino acids composition, Glutamic acid (18.62 – 20.44g/100g protein), leucine (6.19 – 7.73g/100g protein), alanine (5.31 – 6.75g/100g protein) and glycine (4.42 – 5.80g/100g protein) had the overall highest values amongst the product samples tested. Across all sensory parameters assessed, the 95:5 sample had the most favourable consumer responses amongst the composite flour samples.*

Conclusion*: The composite flour bakery products supplemented with African pear seed flour exhibited good nutritional profile (both in proximate composition and amino acid profile). There was a link between a decrease in the level of addition of African pear seed powder in the product and an increase in the degree of acceptance by the consumer taste panel for each parameter and product. The 95:5 wheat-African pear seed sample, across the products, had favourable sensory acceptance ratings by the taste panel constituted, as increased levels of African pear seed flour evoked unpleasant responses.*

Key words: African pear seed, proximate composition, essential amino acids, bakery products*.*

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I. Introduction

Bakery products or Bakers' confectionery include sweet baked goods, especially those that are served for the dessert course of a three-course meal. Bakers' confections are sweet foods that feature flour as a main ingredient and are baked. Major categories include cakes, sweet pastries, doughnuts, scones, and cookie. Confections are low in micronutrients, fibre and protein but high in calories. They may be fat-free foods, although some confections, especially fried doughs, are high-fat foods [1]. The physiological value of confectionery, as a source of essential nutrients is small. They contain large amounts of fat (from 5 to 35%), carbohydrates (47 to 100%), the main part of which is sucrose (39.6–100%), starch (34.7–66%) and small amounts of protein (from 3.2 to 10.4%). Energy value ranges from 350 to 528 Kcal, and depends mainly on the set of recipe ingredients (flour, egg and milk products, various additives - nuts, soybeans and others.) [2]. Excessive consumption of these products interferes with the balance of the diet in terms of nutrients as well as energy value. Children accustomed to such diets may no longer seek the meals that are beneficial to them [3]. A significant drawback of confectionery is the virtual absence of these important biologically active substances, like vitamins, carotenoids, macro- and microelements. Available scientific studies show that 100 grams of flour confectionery goods provide about 4–5% of the daily requirement of vitamins B_1 and B_2. At the same time, their contribution to the total dietary energy intake at this level may reach 18-20%. A similar pattern is typical for other groups of confectionery goods [2].

The African pear (*Dacryodes edulis*) is subsumed in the *pome* family, *Burseraceae*, which is symbolised by a middle core encircled by an edible and succulent stratum. The plant is a member of the popular local fruit trees in the tropical rain forest zone of some nations in the African continent – Western and Central African regions to be specific. Such countries include Nigeria, Ghana, Cote d'Ivoire, Western Cameroun, Senegal, sections of Congo DR and Sierra Leone [4]. *Dacryodes edulis* (African pear) is a well-known crop in West Africa, the fruit is referred to as "*Ube*" in the South–East of Nigeria, "Native pear" in Ghana, "*Safoutier*" in Cameroun and "Bush pear" in many other areas of tropical regions of Africa. The fruit pulp and seed are well known for richness in protein, fat, fiber, minerals and essential amino acids. Domestically, the fruits are gathered for household uses such as eating raw or consumed with roasted corn as a local delicacy [5].

There are two morphological types of African pear fruits; the small and large sized fruits (based on their weights) with respectively small and large seeds [6]. There exist dual morphological presentations of *Dacryodes edulis* in Nigeria - *Dacryodes edulis* (variety *parvicarpa*) and *Dacryodes edulis* (variety *edulis)*. The fruit of *Dacryodes edulis* var. *edulis* is larger and the tree has stout, ascending branches; while *Dacryodes edulis* var. *parvicarpa* has smaller fruit and slender, dropping branches [7]. The fruit is a pome; the pulpy mesocarp surrounds the central leathery shelled capsule containing small cluster of winged seeds. At maturity, the fruit turns to purple, blue or indigo colour from its initial reddish-pink colour. African pear fruit (APF) has glabrous glossy skin or epicarp. The green-coloured edible pulpy mesocarp may be eaten raw or softened with hot water, hot wooden ash or oven heat before being eaten. The pulpy mesocarp has a good sour or acidic taste and turpentine smell. It is often eaten as an accompaniment to boiled or roasted corn and can also be eaten with boiled or roasted yam, cocoyam or unripe plantain. Unlike other fruits, APF is rich in oil and protein. It is a major and cheap source of other nutrients such as dietary fibre, carbohydrates, vitamins and minerals [8]. Preliminary studies on the African pear seed suggest that it possesses up to 76g/kg carbohydrates (exempting crude fibre), 126g/kg lipids, zero obnoxious materials and could be have high proportions of crude fibre (273g/kg) [9]. The seeds have been shown to be extraordinarily dense in metabolisable energy, ash, crude protein, fat, dry matter, fibrous matter, vitamins, minerals, essential and non-essential amino acids [10].

The seeds of African pear constitute 25 - 45% of the entire fruit [11]. African pear seed (APS) is not usually consumed and is not used for any agricultural or industrial purposes. Only a handful of discarded seeds are eaten in the rural areas by goats and sheep that roam around some villages. Almost 100% of the seeds are thrown away with the spoilt fruits, as the fruit is highly perishable. APS, therefore, constitutes an environmental waste problem when the fruit is in season (May – October). The seed has considerable nutritional value and does not contain toxins [12]. The seed is rich in ash, dry matter, dietary fibre, protein, essential and non-essential amino acids, vitamins and minerals [10, 13].

Composite flour has been defined as a mixture of several flours obtained from roots and tubers, cereals, legumes etc with or without the addition of wheat flour that is created to satisfy specific functional characteristics and nutrient composition [14]. Flour confectionery preparations are exorbitant baking operations in the food industry, premised on the costly nature and insufficiency of its constituents which are predominantly imported in Nigeria, particularly when restrictions are placed on the importation of some of these ingredients. From the fore-going, this research intends to achieve the following: (i) convert a commonly-discarded item into a value-added edible product (ii) create fresh product options for consumers (iii) lower the cost of production of commonly consumed flour confections (iv) assess the nutrient quality of the various products composed of blends of white flour and African pear seed powder to ascertain whether there are variations in their chemical compositions.

II. Materials and Methods

Wholesome, mature and ripe large fruits of African pear (*Dacryodes edulis*) were harvested from some compounds in Nekede Autonomous Community, Owerri-West Local Government Area of Imo State, Nigeria. The solvent and chemicals used for the study were purchased from Chemiscience Laboratory Limited, Owerri, Imo State, Nigeria.

Study Design: Experimental observational study.

Study Location: Nekede Autonomous Community, Owerri-West Local Government Area of Imo State, Nigeria.

Study Duration: June, 2020 to April, 2021.

Procedure methodology

African pear seed powder preparation

The freshly-harvested fruits of the large fruit type were cleaned and sorted to eliminate the defective ones. The fruits were split open with the aid of a kitchen knife, dried in an electric oven at 60^{o}C for 24 h, cooled, ground with a single disc attrition mill, sieved to fine particle size and packaged in an air-tight glass jar (to keep out moisture and dust particles). It was held briefly at room temperature prior to the conduct of analyses.

Recipe formulation

An overall flour weight of 500g was adopted for the production of the various flour confections using the following proportions of ingredients:

Tables nos 1 - 3: Recipes of the different flour confectionery products.

For Cookies;

	SAMPLE			
Ingredient	**85:15**	**90:10**	**95:5**	**100:0**
Wheat flour	425g	450g	475g	500g
African pear seed flour	75g	50g	25g	-
Margarine	200g	200g	200g	200g
Sugar	150g	150g	150g	150g
Salt	10g	10g	10g	10g
Evaporated milk (liquid)	80ml	80ml	80ml	80ml

For Bread;

	SAMPLE			
Ingredient	**85:15**	**90:10**	**95:5**	**100:0**
Wheat flour	425g	450g	475g	500g
African pear seed flour	75g	50g	25g	-
Margarine	200g	200g	200g	200g
Sugar	150g	150g	150g	150g
Salt	10g	10g	10g	10g
Yeast	50g	50g	50g	50g
Water	100ml	100ml	100ml	100ml

For Cake;

	SAMPLE			
Ingredient	**85:15**	**90:10**	**95:5**	**100:0**
Wheat flour	425g	450g	475g	500g
African pear seed flour	75g	50g	25g	-
Margarine	200g	200g	200g	200g
Sugar	150g	150g	150g	150g
Salt	10g	10g	10g	10g
Baking powder	10g	10g	10g	10g
Eggs	4 jumbo pieces	4 jumbo pieces	4 jumbo pieces	4 jumbo pieces

Production of cookies

The cookies were prepared according to the methods adopted by [15]. The flour, sugar and baking powder were manually mixed in a glass bowl. The margarine and beaten whole egg were well creamed for 1 min, and the dried ingredients were added at once and mixed for another minute to form dough. The dough was rolled out on a table to a uniform thickness using a rolling pin and cut with a 72 mm diameter cookie cutter. The cut pieces of cookie dough were placed on baking trays and baked at 170^{o}C for 20 min in the oven. After baking, the cookies were cooled at ambient temperature, packaged in polythene bags, sealed and stored in plastic vessels prior to analyses.

Production of bread

The Straight dough method was used in baking of the bread following the method described by [16]. Flour and all other ingredients were weighed accordingly and placed into an electric mixer (Kenwood® brand). All the ingredients were properly mixed within twenty-five (25) minutes to form dough. The dough was allowed to ferment for 150 min. At the end of this period, the fermented dough was cut with a knife, re-mixed mechanically for five (5) minutes and then allowed to ferment for another 90 min. The dough was cut into pieces, rolled into a ball, subsequently moulded into shapes and placed into individual previously-greased baking pans. Proofing was done at 38^{o}C for 45 min in a proofing cabinet and later baked in an oven at 220^{o}C for 45 min. The loaves were de-panned, allowed to cool, packaged and stored in a cool and dry place.

Production of cake

The method described by [17] was adopted. The margarine and sugar were placed in a bowl and creamed by mixing for 20 min until soft and fluffy. The well-beaten eggs were slowly added while mixing continuously. The sieved flour was lightly mixed in, with baking powder and salt. The resultant batter was poured out into greased baking tins and baked at 160^{o}C for 1 h. The cakes were de-panned, allowed to cool, packaged and stored in a cool and dry place.

Proximate Composition Analysis

Moisture, protein, fat, ash and crude fibre contents of the confectionery product samples were determined according to the methods described by [18]. The carbohydrate was obtained by difference as follows:

$$\%\,\text{Carbohydrate} = 100 - (\%\text{Moisture} + \%\text{Protein} + \%\text{Fat} + \%\text{Ash} + \%\,\text{Crude fibre}) \quad (1)$$

Determination of amino acid profile of the seeds

The amino acid profile analysis of the confectionery product samples was carried out using the methods as described by [19] involving the defatting of sample, determination of nitrogen, hydrolysis of defatted sample and loading into high performance liquid chromatography (HPLC) amino acid analyser (Sykam-S7130). The tryptophan content was determined according to the method described by [20]. The tryptophan in the known sample was hydrolyzed with 4.2 M Sodium hydroxide (NaOH). In general terms, the known sample was dried to constant weight, defatted, hydrolyzed, evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer. An integrator attached to the analyzer calculates the peak area proportional to the concentration of each of the amino acids.

Sensory Evaluation

The sensory evaluation was done using a twenty-member panel of judges drawn from the Polytechnic community. The procedure was explained to them before commencement. The quality attributes assessed were appearance (colour), flavour (aroma and taste), texture and overall acceptability. The coded samples were presented to the panelists with water to rinse their mouths between determinations, thus masking the sensory attributes of the previous determination. The 9-point hedonic scale described by [21] was used. The rating scale was as follows: 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.

Statistical Analysis

The results generated were subjected to statistical analysis using SPSS version 20 (SPSS Inc., Chicago, IL) and MS-Excel (Microsoft Inc., USA) at 95% confidence level. T-test was used to compare single test results while the analysis of variance (ANOVA) was used for replicate determinations to detect the existence (or otherwise) of significant differences amongst the results. For replicate determinations, the mean and standard deviation from the mean for each measured parameter were calculated. Duncan's new multiple range test was used to separate the means at 5% level of significance. Where applicable, the results are presented as mean ± standard deviation.

III. Results

Tables nos 4 - 6: Proximate composition of the bakery products supplemented with African pear seed flour.

COOKIES

Sample	Protein	Fat	Ash	Crude fiber	Moisture	NFE
95:5	8.99±0.04^{b}	11.47±0.34^{bc}	3.80±0.15^{bc}	0.55±0.01^{b}	5.67±0.10^{b}	69.52±0.06^{a}
90:10	9.08±0.09^{b}	10.82±0.25^{c}	4.08±0.13^{ab}	0.55±0.02^{b}	6.22±0.10^{a}	69.25±0.14^{a}
85:15	10.65±0.33^{a}	11.65±0.23^{b}	4.19±0.13^{a}	0.60±0.02^{a}	5.26±0.08^{c}	67.65±0.18^{b}
100:0	8.29±0.46^{b}	13.44±0.17^{a}	3.60±0.14^{c}	0.51±0.01^{b}	4.10±0.10^{d}	70.06±0.68^{a}
LSD	0.7997	0.7122	0.3834	0.0471	0.2563	1.0080

Values are means of duplicate determinations. Means with identical superscripts in the same column are not significantly different (p>0.05). a>b>c>d. Proportions are between white flour and African pear seed flour.

BREAD

Samples	Protein	Fat	Ash	Crude fiber	Moisture	NFE
95:5	7.78 ± 0.08^{b}	15.12 ± 0.23^{a}	1.52 ± 0.04^{b}	0.45 ± 0.02^{b}	16.71 ± 0.24^{b}	58.42 ± 0.47^{b}
90:10	7.69 ± 0.03^{b}	14.35 ± 0.21^{b}	1.75 ± 0.09^{a}	0.46 ± 0.02^{ab}	18.03 ± 0.16^{a}	57.72 ± 0.35^{b}
85:15	8.36 ± 0.15^{a}	14.21 ± 1.07^{b}	1.79 ± 0.04^{a}	0.51 ± 0.01^{a}	15.15 ± 0.16^{d}	59.98 ± 0.36^{a}
100:0	6.75 ± 0.08^{c}	15.42 ± 0.31^{a}	1.44 ± 0.05^{b}	0.44 ± 0.01^{b}	16.03 ± 0.18^{c}	59.92 ± 0.30^{a}
LSD	0.2595	0.6958	0.1558	0.0500	0.5252	1.0452

Values are means of duplicate determinations. Means with identical superscripts in the same column are not significantly different (p>0.05). a>b>c>d. Proportions are between white flour and African pear seed flour.

CAKE

Samples	Protein	Fat	Ash	Crude fiber	Moisture	NFE
95:5	9.05 ± 0.08^{b}	14.02 ± 0.16^{b}	2.49 ± 0.10^{c}	0.44 ± 0.02^{ab}	22.37 ± 0.14^{a}	51.63 ± 0.29^{b}
90:10	9.66 ± 0.15^{a}	15.16 ± 0.28^{a}	2.82 ± 0.08^{b}	0.47 ± 0.02^{ab}	19.70 ± 0.28^{b}	52.19 ± 0.60^{b}
85:15	9.80 ± 0.03^{a}	15.36 ± 0.52^{a}	3.33 ± 0.06^{a}	0.48 ± 0.01^{a}	20.32 ± 0.60^{b}	50.71 ± 1.26^{b}
100:0	8.87 ± 0.10^{b}	13.21 ± 0.24^{b}	2.15 ± 0.11^{d}	0.42 ± 0.01^{b}	15.71 ± 0.28^{c}	59.64 ± 0.14^{a}
LSD	0.2771	0.9043	0.2495	0.0500	1.0276	1.9871

Values are means of duplicate determinations. Means with identical superscripts in the same column are not significantly different (p>0.05). a>b>c>d. Proportions are between white flour and African pear seed flour.

Table no 7: Amino Acid Profiles of the confectionery products supplemented with African pear seed flour.

	SAMPLES/CONCENTRATION (g/100g protein)											
	COOKIES				BREAD				CAKE			
AMINO ACID	**95:5**	**90:10**	**85:15**	**100:0**	**95:5**	**90:10**	**85:15**	**100:0**	**95:5**	**90:10**	**85:15**	**100:0**
Leucine†	6.65	7.00	6.36	6.60	7.62	7.00	6.19	7.30	7.73	7.18	7.53	6.83
Lysine†	2.25	3.08	2.02	2.23	3.50	3.08	1.86	3.18	3.50	3.18	3.42	2.92
Isoleucine†	2.88	3.01	2.95	3.01	3.41	3.01	2.82	2.88	3.50	3.21	3.31	2.98
Phenylalanine†	2.84	3.72	2.75	2.66	5.32	3.72	2.66	3.90	3.46	4.08	4.43	3.37
Trytophan†	0.68	0.68	0.68	0.63	0.76	0.68	0.68	0.74	0.81	0.71	0.79	0.74
Valine†	1.52	1.99	0.94	1.11	2.98	1.99	2.22	2.05	3.39	2.28	2.81	1.78
Methionine†	1.90	1.71	1.04	1.66	2.24	1.71	1.15	1.90	2.62	2.06	2.19	1.76
Proline	3.86	4.37	3.66	4.06	4.26	4.37	3.45	4.47	4.98	4.06	4.26	4.16
Arginine	3.18	3.18	3.01	3.10	3.27	3.18	2.92	3.27	3.27	3.27	3.10	3.18
Tyrosine	3.44	3.61	3.27	3.61	3.79	3.61	3.44	3.61	3.79	3.78	3.78	3.78
Histidine†	1.02	1.34	0.96	0.89	1.50	1.34	0.96	1.28	1.66	1.44	1.53	1.25
Cystine	1.27	2.06	1.33	1.57	3.33	2.06	1.21	2.30	3.45	2.36	2.42	2.06
Alanine	6.22	6.14	5.84	5.99	6.14	6.14	5.31	6.22	6.33	6.45	6.75	5.95
Glutamic acid	19.53	19.91	19.80	19.38	20.44	19.91	18.62	19.98	20.59	20.14	20.29	19.58
Glycine	4.70	5.01	4.75	4.89	5.80	5.01	4.42	5.18	6.13	5.37	5.20	4.94
Threonine†	1.28	1.39	1.08	1.17	1.72	1.39	1.00	1.55	1.78	1.50	1.67	1.00
Serine	4.67	4.75	4.54	4.38	4.81	4.75	4.24	4.70	5.02	4.81	1.70	4.65
Aspartic acid	4.34	5.40	3.81	4.03	5.21	4.90	5.09	5.05	5.61	4.96	5.30	4.50
TOTAL	**72.23**	**78.35**	**68.79**	**70.97**	**86.10**	**77.85**	**68.24**	**79.56**	**87.62**	**80.84**	**80.48**	**75.43**
∑EAA	*21.02*	*23.92*	*18.78*	*19.96*	*29.05*	*23.92*	*19.54*	*24.78*	*28.45*	*25.64*	*27.68*	*22.63*

† = Essential amino acid; *∑EAA* = Sum total of Essential Amino Acids

Tables nos 8 - 10: Sensory properties of the confectionery products supplemented with African pear seed flour.

BISCUIT

SAMPLE	Taste	Aroma	Colour	Crunchiness	Mouthfeel	General Acceptability
95:5	8.45 ± 0.94^{a}	7.65 ± 1.31^{a}	7.45 ± 1.32^{ab}	7.70 ± 1.45^{a}	7.45 ± 1.79^{a}	8.20 ± 1.77^{a}
90:10	6.55 ± 2.01^{bc}	6.55 ± 2.52^{ab}	6.30 ± 1.69^{bc}	7.15 ± 1.76^{ab}	6.95 ± 1.70^{ab}	7.60 ± 1.57^{a}
85:15	5.50 ± 2.12^{c}	5.40 ± 2.58^{b}	5.15 ± 2.41^{c}	5.80 ± 2.38^{b}	5.90 ± 2.61^{b}	6.25 ± 2.47^{b}

100:0	6.95±2.33[b]	6.75±2.71[a]	7.80±1.20[a]	6.70±2.30[ab]	7.35±1.60[a]	7.55±1.63[ab]
LSD	1.2266	1.3032	1.2525	1.4944	1.3796	1.3200

Values are means ± SD of twenty replications. Means with different superscripts along a column are significantly different ($p < 0.05$). a>b>c>d. Proportions are between white flour and African pear seed flour.

BREAD

SAMPLES	Taste	Aroma	Crumb colour	Crust colour	Chewability	General acceptability
95:5	7.00±1.81[a]	6.70±1.98[ab]	7.30±1.53[ab]	6.55±1.67[b]	7.05±1.88[ab]	7.70±1.75[ab]
90:10	5.05±2.50[b]	5.30±2.52[b]	6.60±1.70[bc]	6.40±1.79[b]	6.30±2.25[b]	6.40±2.21[bc]
85:15	4.90±2.61[b]	5.95±2.50[ab]	5.75±2.31[c]	5.65±2.18[b]	5.80±2.50[b]	6.10±2.70[c]
100:0	8.10±1.07[a]	7.55±1.15[a]	8.00±0.97[a]	8.35±0.88[a]	8.40±0.94[a]	8.40±1.19[a]
LSD	1.6920	1.7516	1.1517	1.2415	1.4733	1.3963

Values are means ± SD of twenty replications. Means with different superscripts along a column are significantly different ($p < 0.05$). a>b>c>d. Proportions are between white flour and African pear seed flour.

CAKE

SAMPLES	Taste	Aroma	Colour	Mouthfeel	General Acceptability
95:5	7.10±1.94[ab]	7.15±1.27[a]	7.20±1.40[ab]	7.95±0.94[a]	8.00±1.03[a]
90:10	6.20±1.96b[c]	6.15±1.42[ab]	6.65±1.42[bc]	6.75±1.48[a]	7.15±1.84[a]
85:15	5.20±265[c]	5.05±2.35[b]	6.00±1.97[c]	5.40±2.59[b]	5.45±2.65[b]
100:0	8.15±0.99[a]	6.95±1.88[a]	8.10±0.79[a]	7.65±1.27[a]	7.95±1.14[a]
LSD	1.3639	1.3081	1.0871	1.3367	1.2998

Values are means ± SD of twenty replications. Means with different superscripts along a column are significantly different ($p < 0.05$). a>b>c>d. Proportions are between white flour and African pear seed flour.

IV. Discussion

Proximate Analysis

The results of the proximate composition of the ready-to-eat flour confectionery products supplemented with African pear flour are shown in Tables 4 to 6. Significant differences ($p>0.05$) were observed in the values of the various parameters across the samples and products. Protein, ash and fiber contents of the samples across the products were observed to increase with incremental inclusions of African pear flour in the recipe. Thus, the highest levels of these parameters were recorded for the 85:15 blend across the various products. This implies that the body-building and mineral-bearing potentials of such products would be more elevated [3]. The ash content of any food material represents the inorganic elements obtained after the combustion of the organic materials in the food and these inorganic materials are composed of mineral element (calcium, magnesium, iron, phosphorus etc) which are important for building rigid structures and regulatory functioning of the body [22]. The trends of the numerical values of the fat, moisture and NFE were discontinuous, with significant differences ($p>0.05$) existent. These obvious variations were indicative of the contributions of the ingredients used. Cookies have low levels of moisture (about 1 – 5%). This low moisture content ensures that cookies are generally free from microbiological spoilage and have long shelf life if they are protected from absorbing moisture from damp surroundings or atmosphere [23].

Amino acid profiles of the confectionery product samples

Table 7 reveals the results of the amino acid profiles of the confectionery product samples. In decreasing order of magnitude, glutamic acid (18.62 – 20.44g/100g protein), leucine (6.19 – 7.73g/100g protein), alanine (5.31 – 6.75g/100g protein) and glycine (4.42 – 5.80g/100g protein) had the overall highest values amongst the product samples tested. The leucine values compared favourably with the values (7.41 and 6.27g/100g protein) reported for smoked tilapia fish [24] – in spite of the fact that smoked tilapia is a flesh food. Flesh foods are usually higher in protein than plant foods [25]. For bread and cake, the 95:5 blend of white flour and African pear seed flour had the highest proportions of essential amino acids (29.05 and 28.45g/100g protein respectively) amongst the samples assessed; whilst for the cookies, the 90:10 composite flour sample had the highest concentration of essential amino acids (23.92g/100g protein), compared to 24.78, 22.63 and 19.96g/100g protein for the control sample (100:0) for bread, cake and cookies respectively. Protein amino acids are composed of the one-score number of α–L-amino acids and some of their derivatives which perform the role of building materials of protein polypeptides. Eight of these are *essential* (because the body needs them, cannot synthesise them and must obtain them from the diet. They include phenylalanine, leucine, methionine, lysine, valine, isoleucine, tryptophan and threonine; *histidine*, the ninth one is needed by infants), while the rest are *non-essential* (because the body can synthesise them from a utilizable source of nitrogen, usually protein) [26]. The quantities of total amino acids present also concurs with the essential amino acids (EAAs) – as samples with higher EAAs also had correspondingly elevated amounts of total amino acids (Table 7). There seemed to be a possible value-increasing effect associated with African pear seed flour inclusion in the various products, as most of the highest values recorded were exhibited by samples with some level of African pear seed flour added.

Sensory properties of the confectionery products supplemented with African pear seed flour.

The results of the sensory properties of the ready-to-eat confectionery products supplemented with African pear seed flour are presented in Tables 8 – 10. Generally speaking, besides the Control sample (100:0), the 95:5 sample had the most favourable consumer responses amongst the composite flour samples across all sensory parameters assessed. There appeared to be a correlation between an increase in the level of inclusion of African pear seed powder in the product and the degree of rejection/poor sensory ratings by the consumer taste panel for each parameter and product (Tables 8 – 10).

V. Conclusion

The composite flour bakery products supplemented with African pear seed powder exhibited good nutritional profile (both in proximate composition and amino acid profile). There was a link between a decrease in the level of addition of African pear seed powder in the product and an increase in the degree of acceptance by the consumer taste panel for each parameter and product. The 95:5 sample across the products had favourable sensory acceptance ratings by the taste panel constituted, as increased levels of African pear seed flour evoked unpleasant responses.

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