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Chemical And Sensory Evaluation of Chin-Chin and Biscuit Developed from Blend of Rice and Cowpea Flours

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Abstract

The study produced good quality biscuits and chin-chin with blends of cowpea and rice flours that are nutritious and acceptable. Cowpea was also prepared for flour by de-hulling, washing, drying and milling and the same process was done to the rice. The flours were blended in three ratios: A combination of varying proportions of the flours said that is 70:30: of RF: CF with 20% WF, 80:20 RF: CF with 20% WF and 90:10 RF: CF with 20% WF. The biscuits and chin-chins that were produced were also subjected to proximate and sensory analyses to determine nutritional quality as well as metal contaminants of calcium, magnesium, copper and lead. The ash and crude fiber in chin-chin proved not significant ($p>0.05$) while other qualities such as protein, moisture, fat and carbohydrate values ($p<0.05$) differed significantly. Protein content raised as the percentage of cowpea flour in the diet between 7 and 11 percent. 06% to 11. 02%. There were no detectable Lead levels and low copper levels of 0. 32 - 0. 57mg, however there were elevated levels of magnesium 19. 228 – 20. 538mg and calcium levels 10. 225 – 11. 529 mg. The taste, texture and appearance analysis revealed significant differences ($p\leq0.05$) in overall acceptability of the samples with the samples with the 20% cowpea flour both in the chin-chin and biscuits being most preferred by the panelists.

Keywords: *Sensory evaluation**;** Cowpea flour; Rice flour; Biscuit; Chin-chin*

1 Introduction

Cereal foods are among the most consumed food products in the global market and especially in the developing countries where the following cereal-based food products are popular; Maize, wheat, sorghum, millet and rice. These grains supply more than half of daily energy needs but are normally insufficient in protein and contribute to protein energy malnutrition (PEM, internationally and especially in sub-Saharan Africa (FAO, 2020; WHO, 2018). Rice is a staple food in Nigeria and a source of carbohydrate but with low protein value and is therefore deficient where it is the major staple food (IRRI, 2021). Such a diet is characterized by increased consumption of Carbohydrate based foods that has little or no protein content and this has led to numerous nutrition related problems and more so among children (UNICEF, 2021).

Nzeagwu and Nwajike (2008) revealed that 40% of the Africa's population live below the poverty line which are a contributing factor to high incidence of PEM. , childhood malnutrition is still an issue in Nigeria; about 37% of children in Nigeria under the age of five are malnourished (National Bureau of Statistics [NBS], 2019). Poor intake of protein foods and more specifically foods containing the essential amino acids is a leading cause of this condition (Ajibola et al., 2021). Eradicating these deficiencies as a must do as education research has established that well fed students' bright scholars are often healthier than their malnourished counterparts (Chaudhary et al., 2018; Oluwole & Kosoko, 2012).

Many intervention suggestions have been made for managing PEM that include the use of composite flour such as flour from cereals, tubers and legumes that increases the nutritional quality of foods (Iwe, 2003; Uwaegbute *et al*., 1998). The use of composite flours is a cheaper method by which the protein content of foods most consumed can be enhanced. For instance, cowpea, a protein and essential amino acid containing legume, has been considered for increasing the nutrient densities of cereal-based food products (Alabi & Anuonye, 2007; IITA, 2020). Nutritionally, cowpea has a higher protein content and should be grown along with rice because rice is highly glycemic and offers carbohydrates mostly without protein (FAO, 2016; Onwuka & Onwuka, 2020).

Fortification of cereal based foods with legume flours has been shown to increase protein level and enhance amino acid profile thus making such foods more appropriate in the management of PEM (Mubarak, 2005; Agiriga & Iwe, 2008). Some other researchers have published different works concerning the possibility of incorporating cowpea flour in combination with other flours to produce snacks and other usable food items that will provided adequate nutrients while been well accepted by the consumers (Iwe & Onadipe, 2001; Adegunwa et al., 2014). Furthermore, literature on formulation of composite flour highlighted the importance of processing methods which maintain the nutrients that are potentially bio unavailable bound to anti nutrient factors (Lucey et al., 2012; Onwuka et al., 2017).

Intermittent snacks are biscuits, which are produced out of wheat flour, and consist of low protein content but high in Carbohydrates and fats (Okaka 1997). Studies aimed at improving the nutritional density of biscuits through supplementation with legume flours have established that composites flours can enhance protein weight of biscuits while maintaining appeal for taste, texture and acceptability (Ayo et al.; Olaoye *et al.*, 2020). Likewise, chin-chin, a Nigerian traditional snack, that is made from wheat flour, butter, and sugar. In chin-chin production, the use of various composite flours has been investigated to enhance the quality of the product especially by incorporating legume flour with rich protein content (Akubor, 2004; Oluwamukomi *et al*., 2011).

In addition to enhancing protein content, the use of composite flours can help to address malnutrition by non-starch sources based on research that shows that legume-based snacks can contribute up to 50% of the daily requirement of protein for children and adults (Henshaw *et al*., 2000; FAO, 2016). Besides the protein, cowpea is also rich in the micronutrients including iron, zinc and magnesium suitable for growth and development (Mubarak, 2005; IITA, 2020). These micronutrients missing in diet extended mainly on cereals are very essential in combating anemia and other deficiencies rampant in the developing world (Onwuka & Onwuka, 2020).

The objective of this research is to assess the characteristics/quality and nutrient content of biscuits and chin-chin formulated from rice – cowpea composite flours. The study therefore seeks to increase the protein value of these rice-based snacks by incorporating cowpea flour and ultimately increase the efficacy of these snacks in combating PEM in Nigeria. This research also evaluates the organoleptic qualities of these snacks with the aim of determining the acceptability of the snacks after the addition of cowpea flour.

2.0 METHODS

1.1 RAW MATERIALS

The major materials used for this project were Brown cowpea and Rice.

Sample Collection: Cowpea and Rice were purchased at Mushin Market in Lagos State

Ingredients: Cowpea-Rice composite flours, Sugar, Butter, Vegetable Oil, Filled Powder Milk, Baking powder flavour, preservative Salt.

1.2 PROCESSING METHODS

The Cowpea and Rice were first processed into cowpea and Rice flours respectively and from these flours, 3 different composite blends were made in the ratio 70:30, 80:20 and 90:10 of rice flour (RF) to cowpea flours (CF) while multi-purpose wheat flour was added to all the formulation at the ratio of 20%. Hence Biscuits and Chin-chin were be made from the blends.

Table 1. Products Formulation (Biscuit)

INGREDIENTS	10% (BTNP)	20% (BTWP)	30% (BTTP)
RICE FLOUR	70%	60%	50%
COWPEA FLOUR	10%	20%	30%
WHEAT FLOUR	20%	20%	20%
FAT	21, 7%	21.7%	21.8
SUGAR	26.7%	26.7%	26.7%
MILK	4.2%	4.2 %	4.2%
B. POWDER	3.3%	3.3 %	3.3%
FLAVOUR	2.9%	2.9%	2.9%
WATER	100ml	120ml	120ml
LECITHIN	1.3%	1.3%	1.3 %
PRESERVATIVE	0.08%	0.08%	0.08%

Table 2. Products Formulation (Chin-Chin)

INGREDIENTS	10% (CTNP)	20% (CTWP)	30% (CTTP)
RICE FLOUR	70%	60%	30%
COWPEA FLOUR	10%	20%	30%
WHEAT FLOUR	20%	20%	20%
FAT	28%	28%	28%
SUGAR	25.5%	25.5%	25.5%
B.POWDER	1%	1%	1%
FLAVOUR	1.3%	1.3%	1.3%
WATER	77ml	70ml	61ml

FLOURS AND PRODUCTS PROCESSING OPERATIONS

The unit processing operations to be adopted are shown in the below flow charts

Figure 1: Flow Chart for Cowpea Flour

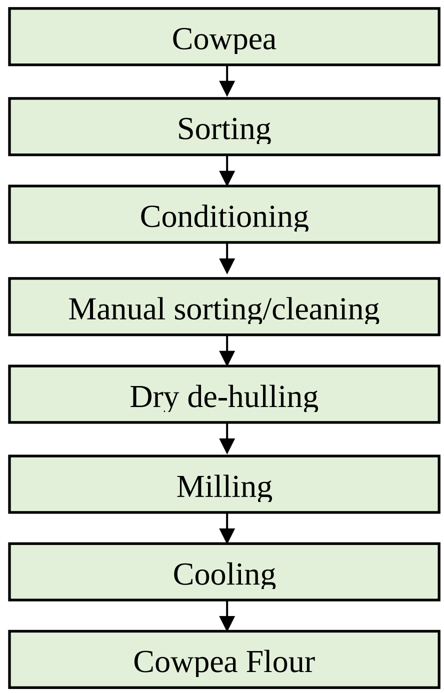


Figure 2: Flow Chart for Rice Flour Production

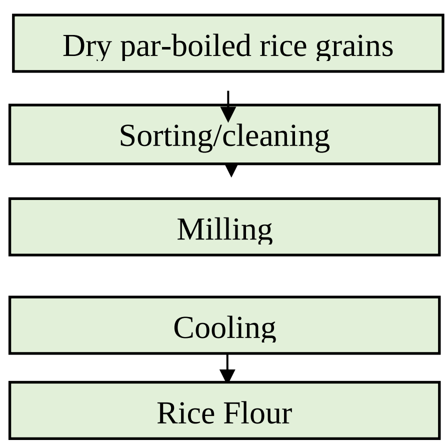


Figure 3: Flow chart for Cowpea –Rice Composite Flour Biscuit

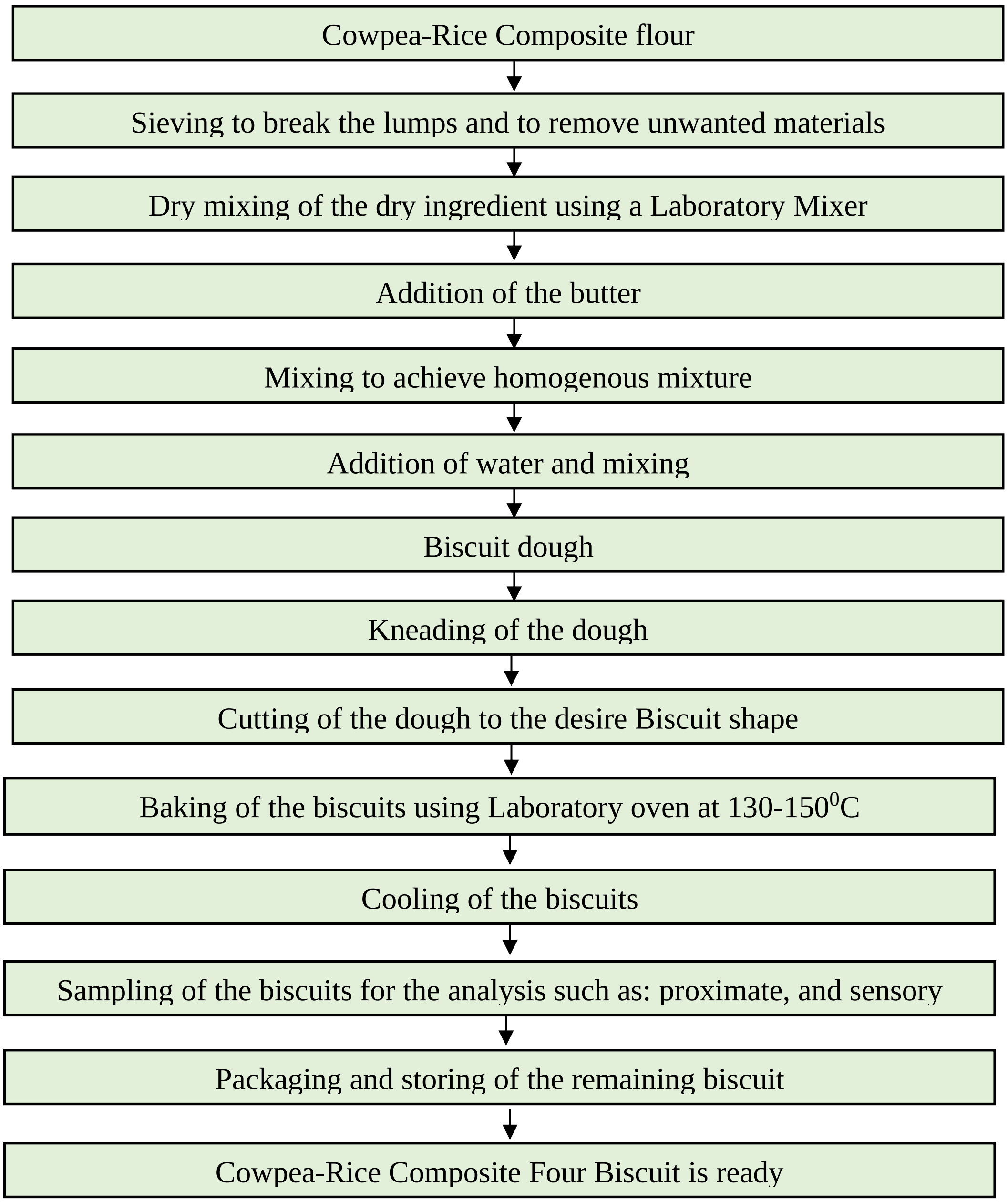
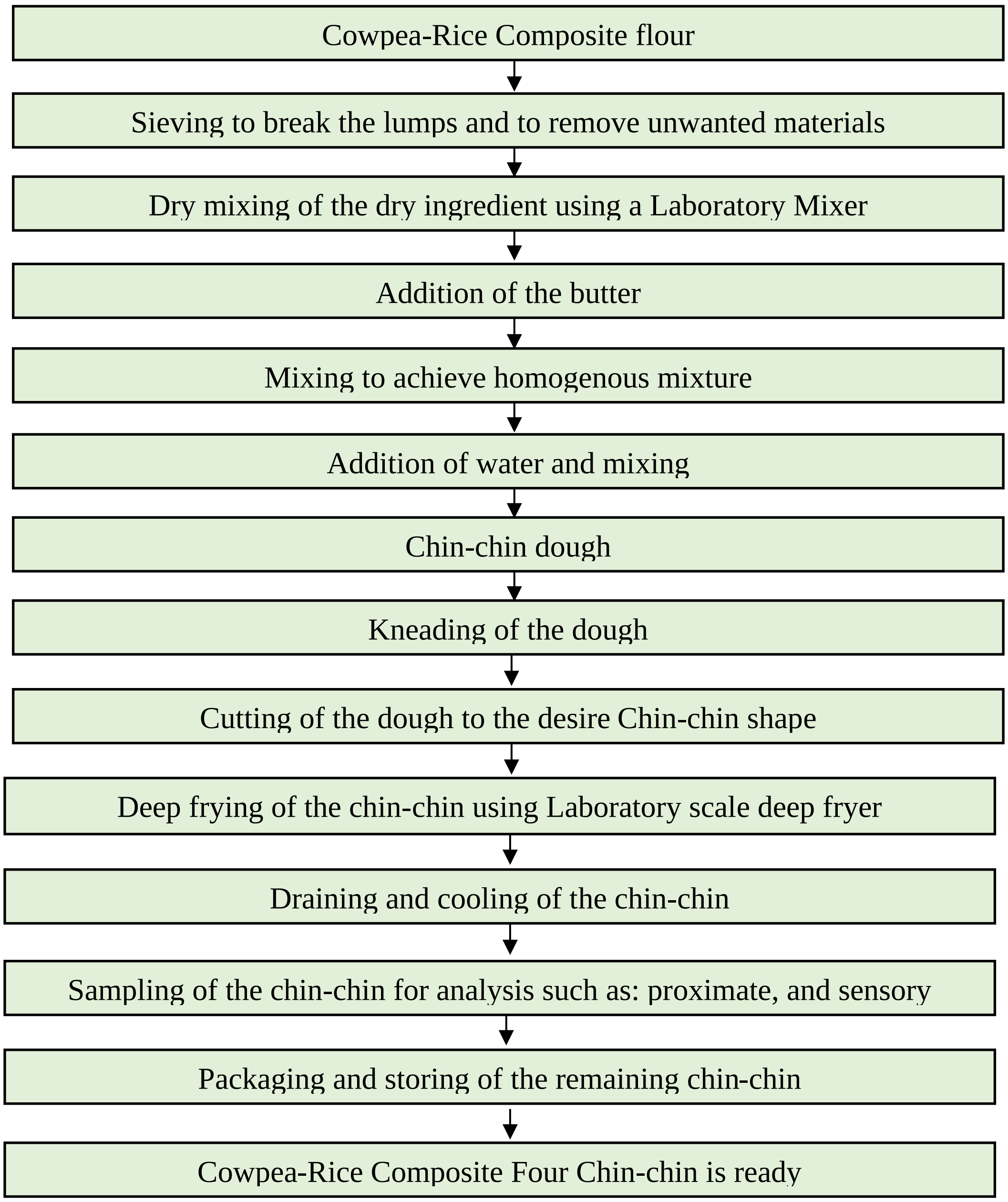


Figure 4: Flow chart for Cowpea –Rice Composite Flour Biscuit



1.2.1 Determination of Proximate Composition

- Moisture determination by Air- oven method.
- Crude Protein Determination by routine micro Kjeldahl method. This consists of three techniques of analysis namely Digestion, Distillation and Titration.
- Crude Fat Determination by soxhlet extraction method.
- Crude Fibre Determination using the standard method of AOAC, 2010.
- Ash Determination using the standard method of AOAC, 2010
- Carbohydrate Determination by difference
- Energy Determination by calculation using Art Water factor.

1.2.2 Moisture Determination

The moisture content was determined by the air oven drying, the principle was based on the loss of water and other matter that are volatile at temperature of 105^0c.

Procedure: A dish of silica and platinum were dried in an oven and cool in a desiccator. The cooled dish (W_1) was weighed, 5 grams of the sample were introduced and spread into the dish and weighed accurately (W_2), the dish was put in the oven at 105 ^{o}c and maintained at that temperature, dried for four hours, removed, cooled in a desiccator and weighed, then the dish was returned into the oven and re-dried for further 30 minutes and then remove, cooled and weighed. The drying continued until a constant weight was reached (W_3).

Calculation:

$$\% \, moisture = W_2 - W_3 \times 100$$

$$W_2 - W_1$$

1.2.3 Crude Protein Determination

Method: The Macro Kjeldahl

Procedure: The organic matter was oxidized by concentrated sulphuric acid in the presence of catalyst and the nitrogen converted to ammonium sulphate, this was then made alkaline and liberated ammonia was distilled and estimated. A large part of Nitrogen present in foods was dried. From proteins, the crude protein was estimated by multiplying the percentage of Nitrogen by an appropriate factor.

Reagent:

- Concentrated Sulphuric acid

- 50 % solution of sodium hydroxide
- Boric acid indicator; 40.0 gm boric acid in 450 ml distill, water 0.020 g methyl red and 0.06 gm bromocresol green in 1500ml ethanol, make them up to 2litre in volumetric flask
- 0.1 N Sulphuric acid, the catalyst 320 g of potassium sulphate + 80.0 g copper sulphate + 1.36 g sodium selenite.

Apparatus: Kjeldahl digestion and distillation apparatus

Digestion: 1g of the sample was weighed on the ashless filter paper. The paper was folded carefully and put inside a Kjeldahl digestion flask. 1-2 g of the catalyst mixture and 30ml of con H_2S0_4 acid were added. The flask was gently heated on the digesting section of the kjeldahl apparatus, increasing the heating when the initial fronting has ceased. The sample was left to digest to clear solution with shaking from time to time

Distillation: The content of the flask was cooled and diluted with 200ml of NH_3- free distilled water, 3-4 anti –bumping granule was added to the digest and the flask was put on the distillation section of apparatus.

The stopper bis used to tighten the flask two-hole with was connected to the thistle funnel containing the 50% of NaOH, and the condenser with its delivery tube dipping below the surface of 25ml boric acid solution + 25ml of distill water in a conical flask. The flask was heated until the digest starts boiling. This was made alkaline by adding the 50 % NaOH solution in small portion through the tap. As boiling commences, ammonia gas was released and passed through the delivery tube into the boric acid indicator solution. The NaOH tap was then closed when the solution in the Kjeldahl flask has turned brown and the distillation was left to continue for 20 more minutes.

The heat was put off and both the condenser and delivery tube were rinsed into the conical flask with distilled water. The boric acid mixture was titrated with 0.1N of H_2SO_4 acid.

Calculation:

$$\%\ Crude\ Protein - \%\ Nitrogen\ \times Protein\ Factor$$

$$\%\ Nitrogen = \frac{Titre \times 0.0014}{Weight\ of\ Sample} \times 100$$

1.2.4 Determination of Fat

Method: Werner Schmid

Principle: Free fats were estimated by continuous extraction with either light petroleum or n-hexane over a period in a Soxhlet type of apparatus.

Procedure: The procedure required the weighing of about 5g of the sample and placing it in a 250ml conical flask followed by the addition of 50ml of NaCl. The mixture was then refluxed for 2 hours with the help of an air condenser. It was then allowed to cool and then filtered using ashless filter paper with washing done on the residue on the paper. Filter paper was then left to dry in desiccator for the whole night. After that the dried filter paper was folded tidily and put into a thimble of proper size and shape. This thimble was having a Soxhlet extractor in which flask of ether (60ml) was at 60°C - 80°C. The jar with the sample was heated on a heating mantle, at the same time the extractor was equipped with a running water condenser so, fat samples were extracted into the flask. This extraction process took 5 hours so as to complete the extraction of the required information. After extraction, setup disconnect, and the solvent was transferred to its container accordingly too. This process of recovery went on, until the flask was almost devoid of the solvent as is suitably illustrated below. Last, the flask and the fat residue were left in oven at 105°C for one hour, then taken out, cooled in a desiccator and weighed.

Calculations:

$$Weight\ of\ Sample = W$$

$$Weight\ of\ Flask + Fat = W_2$$

$$Weight\ of\ Flask = W_1$$

$$\%\ Fat\ Extracted = \frac{W_2 - W_1}{W} \times 100$$

1.2.5 Crude fibre determination

Method: AOAC (2010)

Principle: The method involves subjecting the food sample to acid and alkali treatment, which are breakdown to inorganic component.

Reagent: HCl (0.3N), H_2SO_4 (0.3N), NaOH (1.5N) and Acetone

Calculation:

$$\frac{Weight\ of\ dish + Fibre\ W_1 - Weight\ of\ dish + Ash W_2}{Weight\ of\ Sample} \times 100$$

1.2.6 Carbohydrates determination

Method: By difference

Principle: The sum of all other proximate parameter minus hundred

Calculation: % of protein+ fat+ crude fibre +ash – 100 =% of carbohydrate

1.2.7 ENERGY DETERMINATION

Method: Using Art water factor

Principle: The total adding of the parameter after multiplying it with 4, 4, 9

Calculation: % of fat×9 +% of carbohydrate ×4 +% of protein×4 = % of energy

1.2.8 ASH DETERMINATION

Method: AOAC (2010)

Principle: The sample was subjected to very high temperature at 555^0c-570^0c until a constant weight is obtained; the remaining residue is the ash content.

Calculation:

$$\% \, Ash = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

1.2.9 Mineral determination/Metallic contamination

The ash content of the sample which is the inorganic part of the blend was used to prepare the samples for the mineral determination. The samples were digested in tubes with hydrochloric acid; all the minerals were determined by spectrophotometric method. The minerals that were determined are Cupper, Lead, Magnesium and Calcium.

1.3 Sensory Evaluation

Sensory evaluation of the products was conducted using 9-point Hedonic scale to determine the effect of fortification on the taste, odour, colour, aroma crispiness and overall acceptability of the products made from cowpea-rice composite flours from the one made from wheat flour.

Fifteen panelists were selected among the professionals. The panelists will comprise male and female of the Staff and I. T Students of The Department of Food Technology, Federal Institute of Industrial Research Oshodi, Lagos who are regular consumers of Biscuits and Chin-chin. Then the data obtained from the sensory evaluation test were analyzed using SPSS software.

2.0 Result and Discussion

2.1 Results

Table 3 shows the proximate analys
is of the three chin-chin samples developed based on this study. The proximate composition of the samples ranged from 5.62% to 5.70% for moisture content, 0.63% to 0.71% for ash, 0.51% to 0.52% for fibre, 7.06% to 8.63% for crude protein, 4.32% to 6.89% for fat and 80.21% to 81.06% for carbohydrate.

Table 3: Proximate Analysis of Chin-Chin

SAMPLE	% Composition						
	Moisture Content	Ash	Crude Fibre	Crude Protein	Fat	Carbohydrate (By Difference)	Energy (kcal)
CTNP	5.62^{b} ±0.05	0.71^{a} ±0.04	0.52^{a} ±0.02	7.06^{c} ±0.04	6.89^{a} ±0.04	81.06^{a} ±3.35	414.49
CTWP	5.34^{b} ±0.04	0.67^{a} ±0.04	0.49^{a} ±0.04	7.91^{b} ±0.03	6.19^{b} ±0.04	$80.21^{a\backslash}$ ± 0.070	408.19
CTTP	5.70^{a} ±0.05	0.63^{a} ±0.05	0.51^{a} ±0.04	8.63^{a} ±0.03	4.32^{c} ±0.02	79.40^{b} ±0.07	391

Mean value with different superscript within the same column are significant different at 5% probability level, where CTNP = 10 % cowpea flour inclusion, CTWP = 20 % cowpea flour inclusion and CTTP = 30% cowpea flour inclusion.

Table 4 shows the proximate analysis of the three Biscuit samples developed based on this study. The proximate composition of the samples ranged from 4.64% to 4.89% for moisture content, 1.24% to1.34% for ash, 0.51% to 0.54% for fibre, 8.22% to 11.02% for crude protein, 2.11% to 2.36% for fat and 80.23% to 82.92% for carbohydrate.

Table 4: Proximate Analysis of Biscuits

Sample	**% Composition**						
	Moisture Content	Ash	Crude Fibre	Crude Protein	Fat	Carbohydrate (By Difference)	Energy (kcal)
BTNP	4.89^{a} ±0.03	1.32^{a} ±0.03	0.54^{a} ±0.01	8.22^{c} ±0.06	2.11^{c} ±0.06	82.92^{a} ±0.15	383.55
BTWP	4.91^{a} ±0.02	1.10^{c} ±0.02	0.53^{a} ±0.01	9.69^{b} ±0.05	2.24^{b} ±0.05	80.53^{b} ±0.12	385.78
BTTP	4.64^{b} ±0.03	1.24^{b} ±0.03	0.51^{b} ±0.01	11.02^{a} ±0.04	2.36^{a} ±0.04	80.23^{c} ±0.11	386.24

Mean value with different superscript within the same column are significant different at 5% probability level, where, BTNP = 10% cowpea flour inclusion, BTWP = 20% cowpea flour inclusion and BTTP = 30% cowpea flour inclusion.

Table 5: Analytical Requirements for Biscuit

S/No.	Parameter	NIS Requirement %
1.	Moisture	5.0 max.
2.	Ash	2.0 max.
3.	Protein % (nx5.7)	4.5 mini.

Source: Nigeria Industrial Standard Draft NIS 1995

Table 6: Maximum Level of Permissible Metallic Contaminants

Metallic Contaminants	Maximum levels
Arsenic	1mg/kg
Copper	2mg/kg
Lead	2mg/kg

Source: Standard Organization of Nigeria Draft, NIS 1995

Table 7: Mineral analysis of the samples and Metallic contaminants

SAMPLES	COPPER	LEAD	MAGNESSIUM	CALCIUM
BTNP	$0.032^{b}\pm0.003$	ND	$20.538^{a}\pm0.141$	$11.529^{a}\pm0.141$
BTWP	$0.378^{a\pm}0.428$	ND	$19.228^{b}\pm0.311$	$10.225^{b}\pm0.283$
BTTP	$0.57^{b}\pm0.003$	ND	$20.349^{a}\pm0.283$	$10.579^{b}\pm0.283$

Mean value with different superscript within the same column are significant different at 5% probability level

Table 8: Sensory Results for Chin-Chin

SAMPLES	APPEARANCE	COLOUR	AROMA	TASTE	CRISPINESS	HARDNESS	AFTER-TA.STE	OVER ACCEPT
CTNP	8.20^{a}	6.20^{c}	8.00^{a}	7.80^{a}	4.20^{b}	3.80^{b}	3.80^{b}	7.60^{a}
CTWP	6.80^{b}	7.40^{a}	6.60^{b}	6.40^{b}	6.80^{a}	7.00^{a}	7.00^{a}	7.80^{a}
CTTP	6.6^{b}	6.80^{b}	4.40^{c}	3.40^{c}	6.60^{a}	7.20^{a}	7.20^{a}	3.60^{b}

Mean value with different superscript within the same column are significant different at 5% probability level, Where; CTNP = 10% cowpea flour inclusion,

CTWP = 20% cowpea flour inclusion and CTTP = 30% cowpea flour inclusion

Table 9: Sensory Results Biscuit

SAMPLES	APPEARANCE	COLOUR	AROMA	TASTE	CRISPINESS	HADNESS	AFTER TASTE	OVER ACCEPTABILITY
BTNP	7.20 ^{a}	6.20^{b}	4.00^{c}	3.60^{c}	4.80^{c}	4.20^{c}	7.20^{a}	6.00^{b}
BTWP	7.00^{a}	6.60^{b}	5.60^{b}	6.20^{b}	5.80^{b}	5.60^{b}	5.20^{c}	7.60^{a}
BTTP	7.20^{a}	7.20^{a}	7.20^{a}	7.20^{a}	6.80^{a}	7.40^{a}	7.00^{b}	6.20^{b}

Mean value with different superscript within the same column are significant different at 5% probability level Where: BTNP = 10% cowpea flour inclusion. BTWP = 20% cowpea flour inclusion and BTTP = 30% cowpea flour inclusion

2.2 DISCUSSIONS

2.2.1 Proximate Results

The amount of protein as obtained from the proximate analysis of the chin-chin and biscuit samples was quite high, having surpassed the minimum protein content that is required by the NIS 1995 for biscuits. The level of protein content, which has improved with the addition of the cowpea flour from 7.06%, 7.89%, 8.52%, 9.16% to 11.02%, has been supported by the outcome of prior researchers. Adegunwa *et al*., (2014) also observed expansion of protein content by about 20% in composite flour products enriched with legumes such as cowpea and soybeans. This is in accordance with previous findings that indicated that use of cowpea as a pulse, when incorporated into cereal based diet it provides high quality proteins and essential amino acids.

This study also revealed that fat and carbohydrate contents of the products were also relatively low. Considering the energy density the biscuits had moderate fat content especially in the biscuit analyzed above. These findings are like those of Henshaw *et al*. (2000) who assessed the nutritional analysis of cowpea fortified products and noted enhancement of both protein and fat content with no alteration on acceptability. Chin-chin and biscuits were predicted to continue having carbohydrates as the leading macronutrient, which is understandable due to the high percentage of rice flour, a starchy food item (FAO, 2016; Ajibola *et al.*, 2021). The ratio used of carbohydrates to proteins in these formulations follows adherence when it comes to the energy potential of the snacks which makes the snacks ideal for handling PE in developing nations (UNICEF, 2021).

Also, moisture contents of the samples analyzed were between 4.64 and 5.70 meaning that they complied with the 5% maximum allowed by SON regulations outlined by NIS in 1995, thus shelf life would be long since the chances of microbial activities were greatly limited by low moisture levels. Ash content was also within acceptable range, meaning that mineral content of the samples is sufficient without having high level of ash which is undesirable as it impairs quality of the product. These results agree with the study by Onwuka, and Onwuka (2020) where it was indicated that biscuit formulations containing legume flour possessed similar moisture and ash contents which enhanced stability and shelf life of the biscuits

2.2.2. Metallic Contamination

Pesticide residues are a major risk well known in the food chain and particularly in processed foods. In this research work the values obtained for copper were below the maximum permissible limit of 2 mg/kg recommended by the Standard Organization of Nigeria (NIS, 1995) as indicated in table 5. The copper concentrations varied between 0.32 and 0.57 mg/kg while none of the tested samples contained lead at all. This is encouraging sign that the production process of the products did not result into production of metallic ions that are dangerous for human health. Similar observation was made by Adebowale *et al*., (2013) in his study on cowpea-based snacks and concluded that the level of heavy metals was within acceptable limits and hence the products are suitable for human consumption.

The fact that no lead at all has been characterized in all the samples is crucial because of the dangers attributed to lead, particularly they affect children. This contaminative metal is dangerous in food as it causes developmental delay and cognitive deficits (WHO, 2018). The outcomes of this study reveal that correct procurement of raw materials and Compliance with safe methods of processing helps largely reduce metallic contamination as well endorsed FAO (2016) guidelines regarding food safety in developing nations.

2.2.3 Sensory Attributes

With regards to the sensory analysis on chin-chin and biscuit samples, results showed that the 20% cowpea inclusion sample, hence CTWP for chin-chin and BTWP for biscuit had the best results on overall acceptability, color, texture/tenderness and taste. This accords with Ayo et al. (2007), who found that adding cowpea flour in a proportion of about 20% in baked products has the greatest positive effect on the sensory properties of the products. The panelists chose this level of cowpea flour incorporation because its taste remained relatively unchanged and whose intensity is known to increase with increasing concentrations of legume flour.

In the present investigation, the 30% cowpea inclusion sample or the CTTP and BTTP were given least preference due to the increased beany flavour and firmness associated with legume enriched products even though they were richer in protein. This tallies with Akubor (2004) and Adegunwa et al. (2014) studies where improved legume contents reduced the sensory appeal because of the beany taste – less preferred by most consumers. Nevertheless, this formulation is useful in that it provides an improved nutritional profile especially in situations where the focus is not so much on the sensory properties of the food as it is on protein content.

Some of the quality characteristics such as crispiness seen in both chin-chin and biscuits were relatively retained in all samples. These authors also pointed out that crispiness of baked snacks is associated with moisture content and fat content. A low moist content in the samples was favorable for maintaining crispiness, and moderate fat content influenced mouth feel and overall acceptability of the products. The results also indicated that the to the extent that the legume content is not greatly elevated, the sensory properties of composite flour products acceptable to consumers.

2.2.4 Nutritional and Consumer Implications

The implication of the present study is that rice-cowpea composite flour could be utilised for preparing improved snacks such as chin-chin and biscuits. As observed in many Nigerian and other developing countries, these fortified snacks could provide an important source of protein and energy, especially to children and other special groups (Chaudhary, F, Khokhar, 2018). Because of the high protein content, cowpea-enriched snacks would help reduce the protein intake gap in many Nigerian households where carbohydrates are frequently overindulged (UNICEF, 2021).

In addition, the sensory evaluation results show that it is possible to retain consumer acceptability with moderate levels of incorporation of cowpea flour thereby providing a good outlook for the commercialisation of these products. Intervention programmes that aim at educating the consumers together with awareness creation, on the health efficiency of consuming legume-enriched snacks have been reported in earlier literature as effective strategies toward enhancing the market acceptability of the products (Adebowale et al., 2013; FAO, 2016). From the above it can be concluded that failed attempts at getting people to buy such products should entail both the nutritional values of the product and the sensory attributes, to create the necessary appeal.

1.3 Conclusion

The outcome of this study has therefore shown that biscuits and chin-chin prepared from rice-cowpea composite flours which incorporated varying quantities of the legume flour can enhance the nutritive value of these snacks without undesirably affecting their sensory characteristics. The formulation of up to 20% of cowpea flour gave a right balance between improved nutritional quality and consumer acceptance. The existence of these possibilities proves previous research of composite flour products which indicate that they may help to decrease PEM in developing countries due to fortification (Oluwole & Kosoko, 2012; Iwe & Onadipe, 2001). Other legumes can be used in the formulation, or the formulation might be further improved to address other nutritional requirements, such as in gluten-free diets or diets higher in protein.

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