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Physicochemical Properties of Wheat-Cocoyam Composite Flour Enriched with Palm Weevils (*Rhynchophorous phoenicis*) and Sensory Qualities of Cakes Produced from the Composites

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Abstract
This study investigated some quality attributes of cake produced with cocoyam-wheat flour blends enriched with edible palm weevils. Flours were produced from wheat, cocoyam and palm weevils and proportioned and designated as 100:0:0 (AA), 90:10:0 (AB), 90:5:5 (AC), 80:15:5 (AD), 70:20:10 (AE), 60:30:10 (AF) and 50:40:10 (AG). The proximate composition and functional properties of the wheat-cocoyam-palm weevil flour blends as well as the proximate composition, antinutrients and sensory properties of the cakes were evaluated using standard methods. The result of the functional properties depicted a significant ($p<0.05$) increase in the emulsion capacity (29.02 – 32.15 %), swelling index (1.26 – 1.45) and gelation temperature (70.0 – 83.5°C), and reduction in bulk density (0.714 – 0.619 g/ml) as the level of addition of cocoyam and palm weevils flours increased. Proximate analysis of the wheat-cocoyam-palm weevil flour blends yielded a significant ($p<0.05$) rise in moisture, ash, fat, crude fibre, and protein and a decrease in carbohydrates. The cakes recorded a significant ($p<0.05$) increase in protein, fat, crude fibre, ash, and reduction in carbohydrate contents with increased addition of cocoyam and palm weevil flours. The anti-nutrients were determined to have low values and posed no risk to human health. Sensory evaluation results showed that cakes produced from flour blends were accepted by panellists. Therefore the addition of cocoyam flour and palm weevil powder to wheat flour products is recommended for boosting the nutrient density as well as enhancing the nutrition status and health of consumers.

Keywords: Cakes, wheat, cocoyam, palm weevil, enrich

Introduction

Cakes are convenient food products which are highly cherished by women and children. Cakes are soft bakery products made by baking batter containing flour, baking powder and beaten eggs with or without shortenings (Atef *et al*., 2011). Other ingredients such as flavourings, nuts, chocolate and dried fruits are also added according to the desired final products. The cake is a complete food that is rich in fat and proteins and serves as a major snack in the fast-food industry and the highlight of many celebrations (Kiin-kabari and Banigo, 2015). Cakes are made from wheat flour because of the unique properties of its protein (gluten) (Onwuka, 2014) which enhances the texture of the product. Regrettably, wheat cannot grow in Nigeria since the weather condition is not suitable for its cultivation and scarce foreign exchange is used for its importation. The concept of using composite flour in the production of cakes and other baked goods is not new and has been subject to numerous studies (Ezeocha *et al*., 2022; Arukwe *et al*., 2022). The use of composite flour confers some advantages which include the reduction of wheat flour importation, encouragement of the use of locally grown crops (Hasmadi *et al*., 2014) and saving some foreign exchange which could be used to develop other areas of the economy (Nwanekezi, 2013).

Cocoyam is an underutilized tropical crop even though the literature abounds with its nutritional and health benefits (Onyeka, 2014). Cocoyam is among the world's six most important root crops (FAO, 2012). Africa is the major producer of cocoyam with Nigeria, Ghana and Cameroon contributing to over 60 % of the total African production (Onyeka, 2014). Studies have shown that cocoyam contains thiamin, riboflavin, and niacin (Adeyanju *et al*., 2019). Because of its small size and ease of digestion, cocoyam is a perfect source of carbohydrates for anyone with digestive issues, especially the elderly (Ubalua *et al*., 2016). Compared to cassava and yam, cocoyam contains a reasonable amount of potassium, zinc and folate (Hunter, 2012). Cocoyam can be eaten boiled, roasted, baked, fried in oil, milled, and/or crushed. The palm weevil is a very precious delicacy in western Nigeria and the Niger

Delta, where they are either eaten raw, boiled, baked or fried, and some are used for medical purposes (Opara *et al*., 2012). Palm weevil larva possesses 45.00 mg/kg potassium, 22.00 mg/kg calcium, 201.00 mg/kg magnesium, 99.00 mg/kg iron, 4.00 mg/kg manganese, 43.00 mg/100g phosphorus, 11.00 mg/kg zinc (Abdel-Moniem *et al*., 2017). It is a rich source of vitamins, essential amino acids and unsaturated fatty acids and hence may be explored as an economical source of food, particularly in the developing world (Okunowo *et al.*, 2017).

The importation of wheat, a key component in the making of cakes, into Nigeria, involves significant foreign exchange costs, which drive up the price of cakes (Bibian *et al*., 2014). Also, the increased attention to the consumption of functional foods by World nutritional bodies prompted the blending of wheat flour with cocoyam and palm weevil flours for cake production since palm weevils have some nutritional and health benefits. Furthermore, cocoyam flour is not yet a commercially traded product in Nigeria despite its abounding nutritional advantages. Production of cake using cocoyam and palm weevil flours as a wheat replacement will go a long way in reducing the nation's over-reliance on wheat, saving foreign exchange, improving food security, enhancing food uses of cocoyam and palm weevil, and helping in checking protein-energy deficiency in developing nations like Nigeria. The main objective of this work was to evaluate the proximate composition, functional, anti-nutrient, and sensory properties of wheat-cocoyam cake enriched with palm weevils.

Materials and Methods

Source of Raw Materials

Fresh edible palm weevil larvae were purchased directly from palm wine tappers in Uyo, Akwa Ibom State, Nigeria. Cocoyam corms, wheat grains, and baking ingredients like shortening, eggs, baking powder, powdered milk, vanilla, nutmeg, lime, and sugar were purchased from *Orie Ugba* market in Umuahia, Abia State, Nigeria.

Sample Preparation

Processing of wheat flour

The method described by Bello *et al*. (2020) was used in the processing of wheat flour. Wheat grains were weighed, sorted, washed with tap water, drained and oven dried at 60°C for 20 h. The dried wheat grains were milled into flour with the hammer mill, sieved through 150 µm mesh and packaged in airtight Ziploc bag and kept for further use.

Processing of cocoyam flour

The method described by Kabuo *et al.* (2018) was used in the processing of cocoyam into flour. The fresh corms of cocoyam were sorted, washed with water, peeled with the stainless steel knife, re-washed, and shredded into thin slices. The slices were spread thinly on drying trays and placed in the oven. It was then dried at a temperature of 65°C for 9h. The dried samples were removed from the oven, milled, and sieved using a 150-um mesh sieve. The cocoyam flour was packaged in airtight Ziploc bag, labelled and kept in a cool dry place for further use.

Processing of palm weevil powder

The method described by Koffi *et al.* (2017) was used in the processing of palm weevil powder. Fresh larvae of palm weevil were cleaned with salt water, then drained and oven dried at 65°C for 72 h. The dried larvae were ground using a blender (Kenwood blender) to obtain palm weevil powder and packaged in airtight Ziploc bag for further use.

Formulation of composite flours

Wheat flour, Cocoyam flour and palm weevil larvae powder used in cake production were proportioned into seven samples (100:0:0, 90:10:0, 90:5:5, 80:15:5, 70:20:10, 60:30:10 and 50:40:10) and labelled AA, AB, AC, AD, AE, AF, and AG, respectively. A sample made with 100 % wheat flour (AA) served as the control.

Production of cakes

The cake was processed using the method described by Ceserani and Kinton (2008) with slight modifications in the quantity of egg and milk used. The ingredients used were composite flour (400 g), sugar (150 g), margarine (250 g), baking powder (10 g), egg (250 ml), vanilla (10 ml) and milk (150 ml). The margarine and sugar were manually creamed for 10 minutes in a stainless-steel bowl until light and fluffy. The eggs were beaten for three minutes before adding vanilla essence. Then, the mixture of egg and vanilla essence was added to the creamed mixture while beating continued. Flour samples from various composite blends were separately sieved and added, and salt and baking powder were gradually folded into the mixture with a metal spoon. Milk was added and mixed thoroughly until a soft consistency batter was formed. The batter was then transferred to a six-inch greased baking pan and baked in a preheated oven at 200 ºC for 30 minutes and a further 20 minutes at a reduced temperature of 170 ºC. A skewer was inserted into the centre of the cake to ascertain that it was cooked. The baked cakes were allowed to cool for three minutes before packaging.

Functional Properties Analysis

Bulk Density (BD): A 10ml capacity graduated measuring cylinder was weighed and the sample was gently filled into the cylinder. The bottom of the cylinder was gently tapped on the laboratory bench severally until there was no diminution of the sample level after filling to the 10ml mark. Bulk density (g/ml) was then calculated as the weight of the sample (g) / volume (ml) according to Onwuka (2018).

Swelling Index (SI): This is the ratio of the swollen volume to the original volume of a unit weight of the flour. The method reported by Onwuka (2018) was used. One (1) gram of the flour sample was weighed into a clean dry measuring cylinder. The height occupied by the sample was recorded (H_1) and then 5ml of distilled water was added to the sample. This was left to stand undisturbed for 1h, after which the height was observed and recorded again (H_2). The swelling index was calculated using the equation:

$$\text{Moisture}(\%) = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

where: W_1 = initial weight of empty can,
W_2 = weight of empty can + sample before drying,
W_3 = final weight of empty can + sample after drying.

Ash content: The method described by Onwuka (2018) was used to determine the ash content of the cakes. Porcelain crucibles were dried and cooled in desiccators before weighing. Two millimetres of the samples were weighed into the crucible and the weight was taken. The crucible containing the samples were placed into the muffle furnace and ignited at 550°C. This temperature was maintained for 3h. The muffle furnace was then allowed to cool; the crucibles was then brought out, cooled and weighed. The ash content was calculated as follows:

$$\text{Ash}(\%) = \frac{W_2 - W_1}{\text{Weight of sample}} \times 100$$

Where: W_2 = weight of crucible + ash,
W_1 = weight of empty crucible.

Fat content: The fat content of the samples was determined using solvent extraction in a soxhlet apparatus as described by Onwuka (2018). Two millimetres of each of the samples were wrapped in filter paper and placed in a soxhlet reflux flask which is connected to a condenser on the upper side and to a weighed oil extraction flask full of 200ml of petroleum ether. The ether was brought to its boiling point, and the vapour was condensed into the reflux flask immersing the samples completely for extraction to take place by filling up the reflux flask siphons over carrying the oil extract back to the boiling solvent in the flask. The process of boiling, condensation, and reflux was allowed to go on for four hours before the defatted samples were removed. The oil extract in the flux was dried in the oven at 60˚C for 30min and then weighed.

$$\text{Fat}(\%) = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

Crude Fibre content: The crude fibre of the snack samples was determined according to the Onwuka (2018) method. Two millimetres of each of the cakes were boiled under reflux for 30min with 200ml of a solution containing 1.25g of tetraxosulphate (vi) acid (H_2SO_4) per 100ml of solution. The solution was filtered through linen on a flaunted funnel and washed with water until the washing is no longer acidic. The residue was then transferred to a beaker and boiled for 30min with 100ml of solution. The final residue was filtered through a thin but closer pad of washed and ignited asbestos in a Gosh crucible. The residue was then dried in an electric oven and weighed. The residue was incinerated, cooled and weighed. The crude fibre content of the cake was then calculated as follows:

$$\text{Crude fibre}(\%) = \frac{W_2 - W_3}{W_1}$$

Where: W_1 = weight of sample used
W_2 = weight of crucible plus sample
W_3 = weight of sample crucible

Crude Protein content: Crude protein of the samples was determined using the Kjedahl method as described by Onwuka (2018). One millimetre of the sample was introduced into the digestion flask. Kjedahl catalyst (selenium tablets) was added to the sample. Twenty millilitres of concentrated sulphuric acid were added to the sample and fixed to the digester for 8h until a clear solution was obtained. The cooled digest was transferred into a 100ml volumetric flask and made up to the mark with distilled water. The distillation apparatus was set and rinsed for 10m after boiling. Twenty milliliters of 4% Boric acid was pipetted into the conical flask. Five drops of methyl red were added to the flask as an indicator and the sample was diluted with 75ml distilled water. Ten millilitres of the digest were made alkaline with 20ml of sodium hydroxide (NaOH) (20%) and distilled. The steam exit of the distillatory was closed and the change of colour of the boric acid solution to green was timed. The mixture was distilled for 15min. The filtrate was then titrated against 0.1N Hydrochloric acid (Hcl).
The total percentage of protein was calculated:

Protein(%) = % nitrogen x conversion factor (6.25).

Carbohydrate content: The carbohydrate content of the cake samples was determined by using the formula described by Onwuka (2018).

Carbohydrate(%) = 100 − % (protein + fat + fibre + ash + moisture content)

Antinutritional Factors Analysis
Saponin: The colourimetric method of AOAC (2012) was employed to determine the saponin content. The sample (0.5g) was weighed and put into a test tube followed by the addition of 10ml of distilled water. The mixture was shaken and allowed to stand for 1h. the formation of stable foaming froth was observed. One millilitre of the mixture was pipette into another test tube with 5ml of distilled water added to the extract. This was followed by the addition of a drop of olive oil. The test tube with its content was shaken and it became cloudy. The absorbance was measured at 620nm using a spectrophotometer. The quantity of saponin contained in each cake was estimated from the standard saponin curve obtained from plotting the concentration of the standard concentration against the absorbance and calculated as:

%Saponin = Ab x S x Df x 100
Where: Ab = absorbance
S = slope
Df = dilution factor

Tannin: The method described by Nwosu (2014) was used to determine the tannin content of the cake. One gram of each sample was weighed into a different centrifuge tube with 2ml of distilled water. It was centrifuged at 1500rpm for 10 minutes. The centrifuge samples were then poured out into a beaker and the supernatant (extract) dispersed. One millilitre of sodium carbonate and Folin Denis reagent were added to the beaker and allowed to settle. The absorbance of the developed colour was measured at 760nm wavelength with the reagent blank at zero. The tannin content was calculated as;

$$\%Tannin = \frac{AU \times C \times VF}{W \times AS \times VA}$$

Where: W = weight of sample analyzed
AU = absorbance of the test sample
AS = absorbance of the standard solution
C = concentration of the standard in mg/ml
VF = total volume of filtrates
VA = volume of filtrates analyzed

Phytate: The spectrophotometric method described by AOAC (2012) was used to analyze the phytate content. One gram of the sample was extracted in duplicate for 4h with 20 ml of 0.1M nitric acid with constant agitation. The tubes were stoppered and placed in a boiling water bath for 20 minutes and allowed to cool. Five millilitres of amyl alcohol were added to each tube followed by 1.0ml of ammonium thiocyanate (100g/l). The tubes were shaken thoroughly and centrifuged at 2000rpm and then absorbance of the amyl alcohol layer was determined at 465nm against amyl alcohol exactly 15 minutes after the addition of the ammonium thiocyanate using a spectrophotometer. One millilitre of the extract was pipette into a test tube fitted with a ground glass stopper together with 1ml of ferric solution. A ferric solution was prepared by dissolving 0.2g hydrated ammonium iron (III) sulphate in 100ml 2N HCl and made up to 1000ml with diluted water and the absorbance was measured at 519nm against distilled water using a spectrophotometer. A standard solution was also prepared for the analysis. Per cent phytic acid was then calculated using the absorbance of the test sample and that of the standard solution.

Hydrogen cyanide: The method of Onwuka (2018) was used for hydrogen cyanide determination. Five grams of the cake was mixed in 50ml of distilled water in a conical flask. The mixture was allowed to stay overnight and the solution was filtered. Two millilitres of the filtrate were mixed with 4ml of alkaline pyrite solution and incubated in a water bath for 5 minutes for colour development (reddish brown) and absorbance was at 490nm. A blank was prepared using 2ml distilled water. The hydrogen cyanide content was extrapolated from the cyanide standard curve in duplicate and the hydrogen cyanide was calculated as:

$$HCN = \frac{Vf \times 100}{Va \times W}$$

Where: Vf = total volume of cake extract (ml)
Va = volume of cake extract used (ml)
W = weight of sample used (g)

Sensory Attributes Evaluation
The sensory evaluation of the cake was carried out according to the method described by Iwe (2014). A total of 20 semi-trained panellists from the Department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike performed the sensory test to determine the appearance, taste, aroma, texture, and general acceptability of the cake on a 9-point Hedonic scale (1 = dislike extremely and 9 = like extremely). All cake samples were separately coded before presenting them to the panellists on a tray in individual booths to avoid bias. A questionnaire describing the quality attributes of the cake was given to each panellist. The panellists were provided with portable water to rinse their mouths between evaluations.

Experimental Design
The experimental design was used for this study. The experimental design used was a completely randomized design.

Statistical Analysis
One-way analysis of variance (ANOVA) was carried out on the data generated in this research using the Statistical Package for Social Sciences version 23.0 software. The analyzed data were expressed as mean ± SD (standard deviation). The Duncan Multiple Range Test (DMRT) method was used to compare the means of experimental data at a 95 % confidence interval.

Results and Discussion
Functional Properties of Wheat-Cocoyam Flour Enriched with Palm Weevils
Table 1 depicts the functional properties of the wheat-cocoyam flours enriched with palm weevils. The bulk densities of the samples increased from 0.728 g/ml to 0.619 g/ml with a rise in the addition of cocoyam-palm weevils flours with the control (sample AA) recording the highest value (0.728 g/ml). The values recorded for bulk density were lower than the range (0.78 to 0.82 g/ml) reported by Ezeocha *et al*. (2022) for wheat-bambara nut-velvet tamarind flour blends. The moderate values of bulk densities reported in this work make the flours suitable for baby food production that requires high nutrient density. The swelling index was also found to increase significantly ($p<0.05$) from (1.20 to 1.45) as the proportion of cocoyam and palm weevil flours in the blends increased. The high swelling index is a pleasant indicator in baking (Arukwe and Onugha, 2020). The result showed enhanced emulsion capacity (28.32 to 32.15 %) as the level of substitution of wheat flour with cocoyam and palm weevil flours increased with wheat flour recording the least value. The emulsion capacity values for this study are within the range of 26.80 – 29.68 % reported for wheat-sorghum-African yam bean

composite flours (Arukwe *et al*., 2021). The gelation temperature (67.5 to 83.5°C) of the samples was found to increase significantly ($p<0.05$) as the proportion of cocoyam flour and palm weevils powder increased. Gelation temperature is the point at which the swelling and bursting of starch granules in a hot aqueous solution occur. Hence, starch granules of the wheat-cocoyam-palm weevil flour blends would require higher temperatures for disruption of the starch structure while those of the control, (sample AA) will require lesser temperature.

Proximate Composition of Wheat-Cocoyam Flour Enriched with Palm Weevil
The result of the proximate composition of the cocoyam-wheat flour enriched with palm weevils is presented in Table 2. The moisture content of the samples decreased (11.80 to 10.90 %) with the rise in the addition of cocoyam-palm weevil flours to wheat flour with sample AG having the least moisture content. This might be due to the lower water absorption capacity of the flours with the increase in supplementation of cocoyam-palm weevil flours. Sample AG had moisture content close to 10% moisture level recommended for safekeeping of flour by SON (2014) which suggests that it will have longer shelf life compared with others. Supplementation of wheat flour with cocoyam and palm weevil flours increased the ash content of the flour blends from 1.30 % in sample AA (control) to 2.90 % for sample AG. This could be a result of the higher mineral content of palm weevils and cocoyam flour. A similar finding was reported by Alozie and Chinma (2015) on the higher ash content (1.86 %) of cocoyam flour compared to that of wheat flour (1.54 %). Hence consumption of foods produced from flour blends of wheat-cocoyam-palm weevils might furnish the body with adequate minerals. The result also revealed that fat content increased (1.10 to 2.45 %) as the percentage of cocoyam and palm weevils flour increased. This result differed from that of Alozie and Chinma (2015) who reported a higher fat content (19.77 %) for wheat flour and (18.15 %) for cocoyam flour. Therefore, the observed increase in fat content of the wheat-cocoyam-palm weevil flours could be attributed to the presence of palm weevils. The low-fat content recorded flours implies that they will be less vulnerable to rancidity. The crude fibre content of the samples significantly ($p<0.05$) increased (1.05 to 1.90 %) with increased inclusion of cocoyam-palm weevil flours to wheat flour. This could be due to the higher fibre content of cocoyam relative to wheat (Alozie and Chinma, 2015). Thus, enrichment of wheat flour with cocoyam and palm weevils flours could be useful in cases where high-fibre diets are desirable. Fibres are substances in foods which help in absorption during the digestion process (Ubbor *et al*., 2022). The protein content of sample AA (control) was found to be 10.87 % but it was observed to vary significantly ($p<0.05$) in the composite flours which ranged from 10.02 to 13.02 % with sample AD recording the least value while sample AE had the highest value. The result indicates that the addition of palm weevil powder to wheat and cocoyam flour at a 10 % level improved the protein content of the flours, thus will increase the protein intake of the consumers. The carbohydrate content of sample AA (control) was 73.97 % and it was observed to significantly ($p<0.05$) decrease (74.15 to 69.95 %) in the composite flours as the proportion of cocoyam and palm weevil flours increased. The high carbohydrate content of the flours in this work indicates that they are good sources of energy.

Antinutrient Content of Wheat-Cocoyam Cake Enriched with Palm Weevils
The anti-nutrient content of the wheat-cocoyam cakes enriched with palm weevils is presented in Table 3. The level of tannin in the cakes ranged from 1.29 to 2.11 mg/100g with the control having the lowest value. It was also observed that an increase in the level of inclusion of cocoyam-palm weevil flour resulted in a significant ($p<0.05$) increase in tannin concentrations of the cakes. Tannins adversely affect the digestibility of proteins (Arukwe and Arukwe, 2021). However, the levels of tannins found in the enriched cakes were lower than the lethal dose of 3 mg/100 g reported by Rathod and Valvi (2011). Hence consumption of the wheat-cocoyam-palm weevil cakes would not have any adverse effect on protein bioavailability. The result also showed that an increase in the proportion of cocoyam-palm weevil flours resulted in a significant ($p<0.05$) increase (0.73 to 2.90 mg/100g) in oxalate concentrations. Oxalates irritate and a scratching sensation in the mouth and throat when consumed (impart an acrid taste). Akpan and Umoh (2004) reported that the peel of tubers has a high level of oxalate, unlike the peeled tubers. The acridity of oxalate in cocoyam can be removed or reduced by grating, fermenting, peeling, soaking or boiling (Igbabul *et al*., 2014). The oxalate concentrations obtained in the enriched cakes were lower than the reported toxic level of 2 to 5 g in men (Onwuka, 2018). The phytate content of the cakes ranged from 1.20 to 1.93 mg/100g and significantly increased ($p<0.05$) with the increased addition of cocoyam-palm weevils flour. High concentrations of phytate in foods can bind a significant amount of minerals and decrease their bioavailability. However, the phytate concentrations in the enriched cakes were lower than the safe level of 10 – 60 mg/g (Suree *et al*., 2004). The concentration of saponin in the enriched cakes ranged from 0.43 to 0.91 mg/100g with the control (sample AA) recording the least value. The results indicated a significant ($p<0.05$) increase in saponin with the rise in the addition of cocoyam-palm weevil flour. Saponins can lower plasma cholesterol concentrations (Umaru *et al*., 2007) by binding cholesterol and making it unavailable for the body's absorption. Therefore, the low values recorded for saponin content of the enriched cakes would not cause any adverse effect associated with saponin ingestion. The concentration of hydrogen cyanide in the cakes ranged between 0.15 mg/100 g and 0.61 mg/100 g. The result suggests that an increase in the proportion of cocoyam-palm weevil flours resulted in a corresponding increase in the hydrogen cyanide concentration of the enriched cakes. However, the enriched cakes in this work had very low concentrations

of hydrogen cyanide below the safe level of 10 to 20 mg/kg (Sanni *et al*., 2005), hence, safe for consumption.

Proximate Composition of Wheat-Cocoyam Cake Enriched with Palm Weevil

The proximate composition of the wheat-cocoyam cake enriched with palm weevils is presented in Table 4. The moisture content of the cakes significantly ($p<0.05$) and decreased (20.90 to 19.75 %) with increasing proportions of palm weevils and cocoyam flours with the control (sample AA) having the highest value and sample AG recording the least (19.75 %) moisture content. This result is in agreement with that obtained for cakes from wheat-unripe plantain-Bambara groundnut (Kiin-Kabari and Banigo, 2015). The shelf life of food products has a direct connection with their moisture content, which is an index of water activity and a measure of stability and susceptibility to microbial contamination (Ayensu *et al*., 2019). The low moisture content of between 1% and 5% renders snacks less perishable (Ayensu *et al*., 2019). This implies that the cakes produced from wheat-cocoyam-palm weevil flours could be stored for a shorter time if packaged and stored under appropriate conditions of temperature and relative humidity. The ash content of the cakes significantly ($p<0.05$) increased (1.50 to 2.95 %) with a rise in the proportions of palm weevils and cocoyam flours. The ash content of a food material is an estimate of the total minerals present in it (Agoreyo *et al*., 2011). This implies that the addition of palm weevils and cocoyam flour enhanced the mineral content of the cakes. This result is in consonant with the report of Ezeocha *et al*. (2022) for cakes made with wheat-bambara nut-velvet tamarind. Minerals are essential for life and the optimal functioning of the body. Thus, the cakes in this study might help to combat the micronutrient deficiencies in Nigeria. The fat content of the wheat-cocoyam-palm weevil cakes differed significantly ($p<0.05$) and increased (14.80 to 18.40 %) as the level of inclusion of cocoyam-palm weevil flours increased. The fat content obtained in this work was lower than (19.89 to 20.63) reported for cakes produced from wheat-bambara nut-velvet tamarind (Ezeocha e*t al*., 2022). Fat supplies essential fatty acids (Arukwe, 2020) and imparts on the sensory attributes of food products. The crude fibre content (0.70 %) of the 100 % wheat cake (sample AA) was significantly ($p<0.05$) lower than those of the wheat flour-cocoyam-palm weevils (1.00 to 1.85 %), with the highest inclusion level (sample AG) having the highest value. These values were higher than the range (0.59% to 0.87%) reported for wheat, Bambara groundnut and velvet tamarind cakes by Ezeocha *et al*. (2022). The protein content of the samples ranged from 10.62 to 14.62 % and the samples differed significantly ($p<0.05$). The highest value (14.62 %) was recorded in sample AD while the least value was observed for sample AB. The protein content of the enriched cake samples recorded an increment with the rise in proportions of palm weevil inclusion. The increase in protein due to palm weevil addition indicates that insects can be used in place of animal protein to check the protein malnutrition in Nigeria and other developing countries. The carbohydrate content (44.90 to 50.95 %) of the enriched cakes decreased with increment in the proportion of cocoyam flour and palm weevils with sample AB having the highest value of 50.95 % while sample AA (control) had the second highest value (50.22 %). The lower values of carbohydrates observed for most of the enriched cakes could be due to an increase in proportions of palm weevil flour inclusion since palm weevil is rich in protein. Ezeocha *et al*. (2022) had similar findings for cakes produced from wheat-Bambara nut-velvet tamarind.

Sensory Attributes of Wheat-Cocoyam Cake Enriched with Palm Weevil

The sensory attributes of the wheat-cocoyam cakes enriched with palm weevils are presented in Table 5. The preference for the appearance of the wheat-cocoyam-palm weevil cakes by the panellists was significantly ($p<0.05$) reduced as the addition of cocoyam flour and palm weevil powder increased. However, the scores for appearance score for the control (sample AA) were not significantly different ($p<0.05$) from samples AB and AC. It was observed that the aroma, taste, texture and general acceptability followed the same trend of reduction with increased inclusion of cocoyam-palm weevil flour into wheat flour. The decrease in likeness for the texture of the samples with the increase in cocoyam-palm weevil flour addition might be due to high fibre content which made the texture less tender and unacceptable (Sengev *et al*., 2015). In terms of overall acceptability, the control sample had the highest score. Among the test samples, sample AB was preferred while sample AG was the least preferred by the panellists. This suggests that the increased addition of cocoyam-palm weevil flour resulted in a decrease in the level of preference for enriched cakes.

Conclusion

From the findings of this study, it can be concluded that the nutrient composition of the wheat-cocoyam-palm weevil cakes was higher compared to the cake produced from 100% wheat flour. The trend observed was that increasing the percentage of cocoyam flour and palm weevil powder resulted in a corresponding increase in the nutrient content of the enriched cakes as well as improved functional properties of the composite flours. The results of the anti-nutrients were very low and within permissible limits for man, so consumption of the enriched cakes would not pose any threat to the health and well-being of consumers. The study also revealed that acceptable cakes of high nutritional value can be produced with wheat-cocoyam-palm weevil flour blends. It is therefore recommended that the amino acid profile of the wheat-cocoyam-palm weevil composite cakes be investigated owing to their high protein content. Also, the use of palm weevil powder for complementation of cocoyam and wheat flour products should be encouraged as this would boost the nutrient density of the products resulting in enhanced nutrition and health of consumers. Furthermore, the cultivation of cocoyam and harvesting of palm weevils should be encouraged throughout Nigeria to generate high income for local farmers and improve their utilization both industrially and domestically.

References

Abdel-Moniem, A. S. H., El-Kholy, M. Y. and Elshekh, W. E. A. (2017). The red palm weevil, *Rhynchophorus ferrugineus*olivier, as edible insects for food and feed a case study in Egypt. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 8(3): 1653.

Adeyanju, J. A., Babarinde, G. O., Abioye, A. O., Olajire, A. S. and Bolarinwa, I. D. (2019). Cocoyam processing: Food uses and industrial benefit. *International Journal of Scientific and Engineering Research*, 10(9): 1658-1663.

Agoreyo, B.O., Akpiroroh, O., Orukpe, A., Osaweren, R. and Owabor, C.N. (2011). The Effects of Various Drying Methods on the Nutritional Composition of *Musa paradisiaca*, *Dioscorea rotundata* and *Colocasia esculenta*. *Asian Journal of Biochemistry*. 1: 1-7.

Akpan, E. J. and Umoh, I. B. (2014). Effect of heat and tetracycline treatments on the food quality and acridty factors in cocoyam (*Xanthosoma sagittifolium* (L) Schott). *Pakistan Journal of Nutrition*, 3(4): 240-243.

Alozie, Y. E. and Chinma, C. E. (2015). Proximate composition, physical and sensory properties of wheat and cocoyam flour blends. *Journal of Food Research*, 4(5): 181-188.

AOAC (2012). Official Methods of Analysis of the Association of Official Analytical Chemists. 20th Ed. Washington D.C., USA.

Arukwe, D. C. (2020). Proximate composition, physical properties and sensory evaluation of wheat-cocoyam-pigeon pea biscuits. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 14(7): 47-51.

Arukwe, D. C. and Onugha, F. C. (2020). Comparative evaluation of processing treatments on the functional and pasting properties of two cocoyam varieties. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 14(8):37-44.

Arukwe, D. C. and Arukwe, J. A. (2021). Quality assessment of azama-a toasted African yam bean (*Sphenostylis stenocarpa*) seed snack in Abia State, Nigeria. *International Journal of Theoretical & Applied Sciences*, 13(1): 26-31.

Arukwe, D. C., Ezeocha, V. C. and Ubbor, S. C. (2021). Production and evaluation of cookies from composites of sprouted wheat, sorghum and African yam bean seed flours. *Nigerian Agricultural Journal*, 52(2): 277-283.

Arukwe, D. C., Offia Olua, B. I. and Ike, E. A. (2022). Evaluation of the proximate composition, functional and sensory properties of mungbean-cooking banana composite flours and biscuits. *Uniuyo Journal of Gender Studies*, 4: 148-164.

Atef, A. M. A, Mostafa, T. R. and Samia A. A. (2011). Utilization of faba bean and cowpea flours in gluten free cake production. *Australian Journal of Basic and Applied Sciences*, 5(12): 2665-2672.

Ayensu, J., Larbie, C., Annan, R. A., Lutterodt, H., Edusei, A., Loh, S. P. and Asiamah, E. A. (2020). Palm weevil larvae (*Rhynchophorus phoenicis* Fabricius) and orange-fleshed sweet potato-enriched biscuits improved nutritional status in female wistar Albino Rats. *Journal of Nutrition and Metabolism*, 1: 8061365.

Bello, F. A., Akpan, E. E. and Ntukidem, V. E. (2020). Development and quality characteristics of cookies from sprouted sorghum, pigeon pea and orange fleshed sweet potato flour blends. *European Journal of Nutrition and Food Safety*, 12(2): 11-21.

Bibiana, I., Num, G. and Amove, J. (2014). Quality evaluation of composite bread produced from wheat, maize and orange fleshed sweet potato flours. *American Journal of Food Science and Technology,* 2(4): 109-115.

Ceserani, V. and Kinton, R. (2008). Practical Cookery (10th ed). John Wiley and Sons, New York.

Ezeocha, V. C., Arukwe, D. C. and Nnamani, M. U. (2022). Quality evaluation of cake from wheat, bambara groundnut (*Vigna subterranean*) and velvet tamarind (*Dalium guineense*) flour blends. *FUDMA Journal of Science*, 6(4): 88-94.

FAO - Food and Agriculture Organization of the United Nations (2012). Roots, tubers, plantains and bananas in human nutrition. (E-book) Rome: FAO Corporate Document repository, 12.

Hasmadi, M., Siti-Faridah, A., Salwa, I., Matanjun, P., Abdul Hamid, M. and Rameli, A. S. (2014). The effect of seaweed composite flour on the textural properties of dough and bread. *Journal of Applied Psychology,* 26: 1057-1062.

Hunter, A. S., Lam, S. Y., Nakayama, T. M. and Lin, H. (2012). Microbiological and chemical changes in poi stored at 20ºC. *Journal of Agriculture and Food Chemistry*, 42(1): 45-48.

Igbabul, B., Amove, J. and Twadue, I. (2014). Effect of fermentation on the proximate composition, antinutritional factors and functional properties of cocoyam (*Colocasia esculenta*) flour. *African Journal of Food Science*, 5(3): 67-74.

Iwe, M. O. (2014). Current trends in sensory evaluation of foods. Revised Edition Rojoint Communication Services Ltd. Uwani Enugu, Nigeria. Pp. 144-145.

Kabuo, N.O., Alagbaoso, O.S., Omeire, G.C., Peter-Ikechukwu, A.I., Akajiaku, L.O. and Obasi, A.C. (2018). Production and evaluation of biscuits from cocoyam (Xanthosoma sagittifolium Cv Okoriko)-wheat composite flour. *Research Journal of Food and Nutrition*, 2(2): 53-61.

Kiin-kabari and Banigo, E. B. (2015). Quality characteristics of cakes prepared from wheat and unripe plantain flour blends enriched with bambara groundnut protein concentrate. *European Journal of Food Science and Technology,* 3(3): 1-10.

Koffi, D., Cisse, M., Koua, G. and Niamke, S. (2017). Nutritional and functional properties of flour from the palm (*Elaeis Guineensis*) weevil *Rhynchophorus phoenicis* larvae consumed as protein source in South Côte D'Ivoire. *Annals of the*

University Dunarea de Jos of Galati, Fascicle VI: *Food Technology*, 41(1): 9-19.

Nwanekezi, E. C. (2013). Composite flours for baked products and possible challenges – A Review. *Nigerian Food Journal*, 31(2): 8-17.

Nwosu, U. L., Elochukwu, C. U. and Onwurah, C. O. (2014). Physical characteristics and sensory quality of bread produced from wheat/African oil bean flour blends. *African Journal of Food Science*, 8(6): 351-355.

Onwuka, G. I. (2014). Food Science and Technology. Naphtali Prints. Nigeria, 231pp.

Onwuka, G. I. (2018). Food Analysis and Instrumentation. Theory and Practice. Revised edition, Naphtali Prints, Lagos, Nigeria.

Opara, M. N., Sanyigha, F. T., Ogbuewu, I. P. and Okoli, I. C. (2012). Studies on the production trend and quality characteristics of palm grubs tropical rainforest zone of Nigeria. *Journal of Agricultural Technology*, 8(3):851-860.

Okunowo, W. O., Olagboye, A. M., Afolabi, L. O. and Oyedeji, A. O. (2017). Nutritional value of *Rhynchophorus phoenicis* (F.) larvae, an edible insect in Nigeria. *African Entomology*, 25(1):156-163.

Onyeka, J. (2014). Status of cocoyam (*Colocasia esculenta* and *Xanthosoma spp*) in West and Central Africa: Production, household importance and the threat from leaf blight. Lima (Peru). CGIAR Research Program on Roots, Tubers and Bananas (RTB), 1-39.

Rathod, V. S. and Valvi, S. R. (2011). Antinutritional factors of some wild edible fruits from Kolhapur District. *Recent Research in Science and Technology*, 3(5): 68-72.

Sanni, A. I., Asiedu, M. and Ayenor, G. S. (2005). Influence of processing conditions on the nutritive value of Ogi-Baba, a Nigerian fermented sorghum gruel. *Plant Foods for Human Nutrition*, 56(3): 217-223.

Sengev, I.A., Gernah, D.I. and Bunde-Tsegba, M.C. (2015).Physical, Chemical and Sensory Properties of Cookies Produced from Sweet Potato and Mango Mesocarp Flours. *African Journal of Food Agriculture, Nutrition and Development*, 15 (5): 10428-10442.

Suree, N., Surat, K. and Akekacha, N. (2004). Phytate and fiber content in Thai fruits commonly consumed by diabetic patients. *J. Med. Assoc. Thai*, 87(12): 1444-1446.

Ubalua, A. O. (2016). Cocoyam (taro and tannia): Staples with untapped enormous potentials-A review. *Plant Knowledge Journal*, 5(1): 27-35.

Ubbor, S. C., Arukwe, D. C., Ejechi, M. E. and Ekeh, J. I. (2022). Physiochemical and sensory evaluation of cookies produced from composite flours of wheat, bambara nut and orange fleshed sweet potato. *Journal of Agriculture and Food Sciences*, 20(1): 60-77.

Umaru, H. A., Adamu, R., Dahiru, D. and Nadro, M. S. (2007). Levels of antinutritional factors in some wild edible fruits of Northern Nigeria. *African Journal of Biotechnology*, 6(16): 1935-1938.

Table 1: Functional Properties of wheat-cocoyam flour enriched with palm Weevils

Sample W:CY: PW	BD (g/ml)	Swelling Index (ml/g)	Emulsion Capacity (%)	GT (°C)
(AA) 100:0:0	$0.728^{a}\pm0.000$	$1.20^{f}\pm0.02$	$28.32^{e}\pm0.60$	$67.5^{d}\pm2.1$
(AB) 90:10:0	$0.714^{a}\pm0.001$	$1.26^{e}\pm0.00$	$29.02^{d}\pm0.10$	$70.0^{cd}\pm0.0$
(AC) 90:5:5	$0.716^{a}\pm0.002$	$1.31^{d}\pm0.00$	$29.45^{cd}\pm0.00$	$72.5^{c}\pm0.7$
(AD) 80:15:5	$0.690^{b}\pm0.005$	$1.35^{c}\pm0.02$	$29.90^{c}\pm0.01$	$75.5^{b}\pm0.7$
(AE) 70:20:10	$0.672^{c}\pm0.000$	$1.37^{c}\pm0.00$	$30.92^{b}\pm0.07$	$78.0^{b}\pm0.0$
(AF) 60:30:10	$0.658^{d}\pm0.005$	$1.41^{b}\pm0.01$	$31.70^{a}\pm0.00$	$81.0^{a}\pm1.4$
(AG) 50:40:10	$0.619^{e}\pm0.012$	$1.45^{a}\pm0.00$	$32.15^{a}\pm0.01$	$83.5^{a}\pm0.7$

a-g: Values are means ± standard deviations of duplicate determinations and two means within the same column with different superscripts are significantly different (p<0.05).

Key: W = Wheat, CY = Cocoyam, PW = Palm weevil. AA=100% wheat flour, AB=90% wheat flour and 10% cocoyam flour, AC=90% wheat flour, 5% cocoyam flour, and 5% palm weevil powder, AD=80% wheat flour, 15% cocoyam flour and 5% palm weevil powder, AE=70% wheat flour, 20% cocoyam flour and 10% palm weevil powder, AF=60% wheat flour, 30% cocoyam flour and 10% palm weevil powder, and AG=50% wheat flour, 30% cocoyam flour and 10% palm weevil powder.

Table 2: Proximate Composition of wheat-cocoyam flour enriched with palm weevils

Samples W:CY:PW	Moisture (%)	Ash (%)	Fat (%)	Crude fibre (%)	Protein (%)	Carbohydrate (%)
(AA) 100:0:0	$12.10^{a}\pm0.14$	$1.30^{g}\pm0.14$	$0.90^{g}\pm0.14$	$0.85^{g}\pm0.07$	$10.87^{e}\pm0.01$	$74.97^{a}\pm0.00$
(AB) 90:10:0	$11.80^{b}\pm0.00$	$1.55^{f}\pm0.07$	$1.10^{f}\pm0.14$	$1.05^{f}\pm0.07$	$10.35^{f}\pm0.02$	$74.15^{b}\pm0.00$
(AC) 90:5:5	$11.50^{c}\pm0.14$	$1.75^{e}\pm0.07$	$1.30^{e}\pm0.00$	$1.25^{e}\pm0.07$	$10.95^{d}\pm0.01$	$73.25^{d}\pm0.04$
(AD) 80:15:5	$11.35^{d}\pm0.07$	$2.00^{d}\pm0.00$	$1.55^{d}\pm0.07$	$1.45^{d}\pm0.07$	$10.02^{g}\pm0.03$	$73.62^{c}\pm0.00$
(AE) 70:20:10	$11.20^{e}\pm0.14$	$2.30^{c}\pm0.14$	$1.85^{c}\pm0.07$	$1.60^{c}\pm0.00$	$13.02^{a}\pm0.01$	$70.02^{e}\pm0.04$
(AF) 60:30:10	$1.10^{f}\pm0.00$	$2.55^{b}\pm0.07$	$2.25^{b}\pm0.04$	$1.75^{b}\pm0.00$	$12.37^{b}\pm0.03$	$69.82^{g}\pm0.00$
(AG) 50:40:10	$10.00^{g}\pm0.14$	$2.90^{a}\pm0.14$	$2.48^{a}\pm0.07$	$1.90^{a}\pm0.00$	$11.09^{c}\pm0.00$	$69.95^{f}\pm0.04$

a-g: Values are means ± standard deviations of duplicate determinations and two means within the same column with different superscripts are significantly different (p<0.05).

Key: W = Wheat, CY = Cocoyam, PW = Palm weevil. AA=100% wheat flour, AB=90% wheat flour and 10% cocoyam flour, AC=90% wheat flour, 5% cocoyam flour, and 5% palm weevil powder, AD=80% wheat flour, 15% cocoyam flour and 5% palm weevil powder, AE=70% wheat flour, 20% cocoyam flour and 10% palm weevil powder, AF=60% wheat flour, 30% cocoyam flour and 10% palm weevil powder, and AG=50% wheat flour, 30% cocoyam flour and 10% palm weevil powder.

Table 3: Anti-nutrient Content of wheat-cocoyam cakes enriched with palm weevils

Sample W:CY:PW	Tannin	Oxalate	Phytate	Saponin	Hydrogen Cyanide
(AA) 100:0:0	$1.29^{g}\pm0.15$	$0.73^{g}\pm0.00$	$1.20^{g}\pm0.04$	$0.43^{g}\pm0.02$	$0.15^{g}\pm0.00$
(AB) 90:10:0	$1.40^{f}\pm0.00$	$1.12^{f}\pm0.01$	$1.29^{f}\pm0.02$	$0.51^{f}\pm0.00$	$0.18^{f}\pm0.01$
(AC) 90:5:5	$1.61^{e}\pm0.14$	$1.41^{e}\pm0.04$	$1.39^{e}\pm0.00$	$0.59^{e}\pm0.01$	$0.28^{e}\pm0.01$
(AD) 80:15:5	$1.83^{d}\pm0.09$	$1.70^{d}\pm0.00$	$1.46^{d}\pm0.01$	$0.67^{d}\pm0.00$	$0.33^{d}\pm0.02$
(AE) 70:20:10	$2.00^{c}\pm0.25$	$2.15^{c}\pm0.01$	$1.58^{c}\pm0.00$	$0.73^{c}\pm0.00$	$0.42^{c}\pm0.00$
(AF) 60:30:10	$2.06^{b}\pm0.00$	$2.60^{b}\pm0.00$	$1.71^{b}\pm0.01$	$0.83^{b}\pm0.02$	$0.51^{b}\pm0.01$
(AG) 50:40:10	$2.11^{a}\pm0.04$	$2.90^{a}\pm0.01$	$1.93^{a}\pm0.00$	$0.91^{a}\pm0.04$	$0.61^{a}\pm0.03$

a-g: Values are means ± standard deviations of duplicate determinations and two means within the same column with different superscripts are significantly different (p<0.05).

Key: W = Wheat, CY = Cocoyam, PW = Palm weevil. AA=100% wheat flour, AB=90% whea t flour and 10% cocoyam flour, AC=90% wheat flour, 5% cocoyam flour, and 5% palm weevil powder, AD=80% wheat flour, 15% cocoyam flour and 5% palm weevil powder, AE=70% wheat flour, 20% cocoyam flour and 10% palm weevil powder, AF=60% wheat flour, 30% cocoyam flour and 10% palm weevil powder, and AG=50% wheat flour, 30% cocoyam flour and 10% palm weevil powder.

Table 4: Proximate Composition of wheat-cocoyam cake enriched with palm weevils.

Samples W:CY:PW	Moisture (%)	Ash (%)	Fat (%)	Crude fibre (%)	Protein (%)	Carbohydrate (%)
(AA) 100:0:0	$20.90^{a}\pm0.14$	$1.50^{g}\pm0.14$	$14.80^{e}\pm0.00$	$0.70^{g}\pm0.14$	$11.87^{f}\pm0.01$	$50.22^{b}\pm0.03$
(AB) 90:10:0	$20.70^{b}\pm0.00$	$1.70^{f}\pm0.14$	$15.02^{e}\pm0.03$	$1.00^{f}\pm0.00$	$10.62^{g}\pm0.24$	$50.95^{a}\pm0.35$
(AC) 90:5:5	$20.65^{b}\pm0.07$	$1.90^{e}\pm0.00$	$15.20^{e}\pm0.00$	$1.20^{e}\pm0.14$	$12.12^{e}\pm0.10$	$48.92^{c}\pm0.03$
(AD) 80:15:5	$20.45^{c}\pm0.07$	$2.20^{d}\pm0.14$	$16.50^{d}\pm0.14$	$1.35^{d}\pm0.07$	$13.40^{b}\pm0.10$	$46.10^{d}\pm0.17$
(AE) 70:20:10	$20.20^{d}\pm0.00$	$2.35^{c}\pm0.07$	$17.97^{c}\pm0.24$	$1.50^{c}\pm0.00$	$14.62^{a}\pm0.17$	$43.36^{g}\pm0.53$
(AF) 60:30:10	$19.95^{e}\pm0.07$	$2.80^{b}\pm0.00$	$18.20^{ab}\pm0.00$	$1.70^{b}\pm0.14$	$12.67^{c}\pm0.00$	$44.67^{f}\pm0.10$
(AG) 50:40:10	$19.75^{f}\pm0.07$	$2.95^{a}\pm0.07$	$18.40^{a}\pm0.14$	$1.85^{a}\pm0.07$	$12.15^{d}\pm0.00$	$44.90^{e}\pm0.20$

a-g: Values are means ± standard deviations of duplicate determinations and two means within the same column with different superscripts are significantly different (p<0.05).

Key: W = Wheat, CY = Cocoyam, PW = Palm weevil. AA=100% wheat flour, AB=90% whea t flour and 10% cocoyam flour, AC=90% wheat flour, 5% cocoyam flour, and 5% palm weevil powder, AD=80% wheat flour, 15% cocoyam flour and 5% palm weevil powder, AE=70% wheat flour, 20% cocoyam flour and 10% palm weevil powder, AF=60% wheat flour, 30% cocoyam flour and 10% palm weevil powder, and AG=50% wheat flour, 30% cocoyam flour and 10% palm weevil powder.

Table 5: Sensory Scores of cocoyam-wheat cakes enriched with palm weevils

Sample W:CY:PW	Appearance	Aroma	Taste	Texture	General acceptability
(AA) 100:0:0	$8.86^{a}\pm0.35$	$8.80^{a}\pm0.56$	$8.80^{a}\pm0.41$	$8.66^{a}\pm0.81$	$9.00^{a}\pm0.00$
(AB) 90:10:0	$8.53^{a}\pm0.51$	$8.00^{b}\pm0.65$	$8.13^{b}\pm0.74$	$7.73^{b}\pm0.70$	$8.53^{ab}\pm0.51$
(AC) 90:5:5	$8.13^{a}\pm0.91$	$7.40^{bc}\pm1.50$	$7.46^{c}\pm1.18$	$7.46^{b}\pm1.12$	$7.93^{b}\pm1.09$
(AD) 80:15:5	$7.06^{b}\pm1.16$	$6.73^{cd}\pm1.03$	$6.00^{d}\pm0.84$	$6.46^{c}\pm0.74$	$7.13^{c}\pm0.91$
(AE) 70:20:10	$6.13^{c}\pm0.83$	$6.00^{de}\pm1.06$	$5.73^{d}\pm0.88$	$6.46^{c}\pm1.06$	$6.26^{d}\pm1.27$
(AF) 60:30:10	$5.86^{cd}\pm1.35$	$5.86^{e}\pm1.30$	$5.53^{de}\pm0.63$	$6.00^{cd}\pm1.19$	$6.00^{d}\pm1.13$
(AG) 50:40:10	$5.33^{d}\pm1.23$	$5.26^{f}\pm1.16$	$5.30^{e}\pm0.79$	$5.60^{d}\pm1.50$	$5.60^{d}\pm0.82$

a-g: Values are means ± standard deviations of duplicate determinations and two means within the same column with different superscripts are significantly different (p<0.05).

Key: W = Wheat, CY = Cocoyam, PW = Palm weevil. AA=100% wheat flour, AB=90% whea t flour and 10% cocoyam flour, AC=90% wheat flour, 5% cocoyam flour, and 5% palm weevil powder, AD=80% wheat flour, 15% cocoyam flour and 5% palm weevil powder, AE=70% wheat flour, 20% cocoyam flour and 10% palm weevil powder, AF=60% wheat flour, 30% cocoyam flour and 10% palm weevil powder, and AG=50% wheat flour, 30% cocoyam flour and 10% palm weevil powder.