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Research Article

Formulation, Proximate Composition and Quality Evaluation of Cocoyam-Wheat Cake Enriched with Edible Palm Larvae (*Rhynchophorus phoenicis*)

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Abstract

This study investigated some quality attributes of cocoyam-wheat flour blends enriched with edible palm weevil (*Rhynchophorous phoenicis*) in the production of cake samples. The nutrient composition, antinutrient, sensory and functional properties of the cake samples and composite flour blends were evaluated using standard methods. There were significant ($p < .05$) differences in the various attributes analyzed. The crude protein and crude lipid contents of the cake samples increased as the level of addition of cocoyam flour increased (7.83 – 9.71%) and (15.36 – 19.85%) respectively. The carbohydrate values (44.54 – 50.89%) of the composite cake samples decreased as the rate of addition of cocoyam increased with addition of the edible palm weevil powder. The antinutrients determined had low values and poses no risk to human health. The result of the functional properties shows that the flour blends increased in values as the rate of addition of cocoyam flour increased in the oil absorption capacity (1.72 – 1.83g/g), emulsion capacity (43.51 – 47.85%) and swelling index (1.08 – 1.24%). The bulk density values were in the varied range of 0.61 – 0.68g/cm^3. The cake samples produced from sample 0:100:0 (cocoyam: wheat: edible palm weevil) also recorded higher mean score of 8.10 than others in the taste attribute. There were no significant differences in the taste and mouthfeel attributes of the cake samples. In all the attributes, the values were above 6 which translates to like moderately, like very much and extremely liked in the hedonic scale. The study paves way for enhanced utilization of composite flour blends of cocoyam-wheat flour enriched with edible palm weevil and the resulting rich protein of the samples can help fight protein-energy malnutrition.

Keywords: Cocoyam; Wheat; Edible Palm Eeevil; *Rhynchophorous phoenicis*

Introduction

Food security remains one of the most fundamental challenges for human welfare and economic growth in Africa. Many people on the continent are unable to acquire and effectively utilize at all times the food they need for a healthy life. In many countries, sufficient food to meet the needs of all citizens is not even available at a national level [1]. Entomophagy; the practice of using insects as a part of the human diet [2,3], has played an important role in the history of human nutrition in Africa, Asia and Latin America [4,5]. Insects link biodiversity conservation and human nutrition in a way that many other food sources do not. Insects often contain more protein, fat, and carbohydrates than equal amounts of beef or fish, and a higher energy value than soybeans, maize, beef, fish, lentils, or other beans [6,7]. Although the consumption of edible insects is now reported in Africa [8,9] further studies are still needed to provide their nutritional value for efficient promotion of their utilisation [10]. Edible palm larvae (Rhynchophorus phoenicis) are known to be rich in protein content like other meat products. In addition, palm larvae are cheap, contain less fat and are reported to have high levels of essential amino acids [11,12].

Cakes are used as snacks in many festivities and in fast food industries [13]. Several cake recipes are available and are classified based on their ingredients, accompaniment and/or cooking techniques [14]. They are produced by baking butter with flour, beaten eggs with or without shortenings and baking powders [13]. Wheat is mostly used as cereal of choice for production snacks, however, due to climatic conditions, it is not grown in tropical regions including Nigeria. Thus, for production of baked foods in regions where wheat supply is limited, people depend on importation or exclude it from diets [15].

Cocoyams (*Xanthosoma sagittifolium*) are used as local staples in Nigeria. Their utilization in the production of cakes would result in the reduction of imported wheat, promote its utilization for improved health and help fight nutritional deficiencies in the region. It is acknowledged that, a combination of flours made from legumes, tubers or cereal have higher nutritional value when compared to flour produced only from one of the them [16]. Furthermore, flours made from combination of tubers and legumes are known to contain high protein and caloric value [17]. This study was therefore carried out to determine the nutrient composition and suitability of Rhynchophorus phoenicis in the production of cocoyam-wheat cakes.

Materials and Methods

The edible palm larvae larva (*Rhnchophorus phoenicis*) were obtained from palm wine tappers in Umuariaga community in Ikwuano local government area of Abia State. Cocoyam (*Xanthosoma sagittfolum*) cormels were supplied by the Cocoyam Program of National Root Crops Research Institute, Umudike, Abia State, Nigeria. Wheat and other ingredients used in cake production were purchased from Umuahia main market (Ubani Ibeku) in Abia State, Nigeria. Reagents used were of high analytical grade.

Production of edible palm larvae powder

The method described by Ogbuagu., *et al*. [18] was used in the production of raffia palm larvae powder. Live larvae of the raffia palm larvae were properly washed with water. The heads and the alimentary tissues were removed and squeezed out, respectively. Larvae were then cut open longitudinally, dried in an oven for 72 h, and finally milled to obtain a powdery sample.

Production of cocoyam flour

The method described by Oti and Akobundu [19] was used to process cocoyam into flour. Briefly, cocoyam cormels, cultivar Ede ocha were peeled, sliced and washed with water. The slices were blanched at 75°C for 15 minutes in portable water. The blanched slices were oven dried at 60°C for 9 hours and milled to obtain flour which was subsequently sieved to yield flour of fine texture.

Production of wheat flour

The method of Ndife., *et al.* [20] was used in the production of wheat flour. The whole wheat seeds were cleaned, washed and oven dried. The attrition mill with 2 mm mesh sieve was used to sieve wheat into fine flour powder. The flours were then packed into airtight containers.

Production of cocoyam-wheat cake enriched with edible palm larva

The method described by Sheikh., *et al.* [21] with little modification was used in the production of the cake samples. Cakes were prepared using wheat-mushroom flour blends at different level of substitution.

Determination of proximate composition of the composite cake samples

Protein, fat, moisture, fibre and ash were determined using methods described by AOAC [22]. Carbohydrate content was determined by difference.

Determination of antinutrient composition of the composite cake samples

The tanin, oxalate, saponin and phytate were determined using the method reported by Onwuka [23] alkaloid test was done using the method by Harborne [24].

Determination of Mineral and Vitamin contents

The mineral components (calcium and sodium) were analyzed using an Atomic Absorption Spectrophotometer (AAS, Model SP9, Pychicham UK) while Vitamin A and C contents were determined spectrophotometrically using the standard methods of AOAC [22] and Vitamin B1 was determined using the colorimetric method [25].

Determination of functional Properties of the composite flour blends

Bulk density, swelling index, foam capacity and emulsion capacity were determined using methods described by [22]. while water and oil absorption capacities were determined according to the methods described by Onimawo and Akubor [26].

Sensory evaluation of the cake samples

The sensory evaluation was carried out using twenty semi-trained panelists comprising of staff and students of the College of Applied Food Science and Tourism, Michael Okpara University of Agriculture, Umudike who were regular consumers of cake. Samples were scored based on the following attributes: appearance, taste, aroma, mouthfeel and general acceptability; based on a 9-point hedonic scale with 1 representing dislike extremely, 5, neither like nor dislike and 9 like extremely [27].

Statistical analysis

All data collections were subjected to Analysis of variance (ANOVA), using SPSS (Version 15, 2007). Duncan multiple range test was used to determine the significant difference.

Results and Discussion

Proximate composition of cocoyam-wheat cakes enriched with edible palm larvae

Addition of edible palm larvae powder to composite flours of cocoyam and wheat for the production of cakes improved the crude protein of the cake samples (Table 1). Significant differences ($p \leq 0.05$) were recorded in the protein contents of the cake samples produced from African yam bean-wheat flour blends enriched with edible palm larvae powder. The crude protein level increased

from 7.83% to 9.71% which were significantly different at ($p \geq 0.05$) level of probability. The protein content of the cake samples increased with the increase in the level of cocoyam flour added as well as the inclusion of the edible palm larvae powder. Sample 45:45:10 (cocoyam: wheat: edible palm larvae) had the highest protein content of 9.71%; higher than the 100% wheat flour which is the control (sample 0:100:0). This is in agreement with Chinma., *et al.* [17]. High level of protein imply that insects can replace high animal protein which is not available to majority in rural areas in the developing regions [28]. The fiber content increased as the percentage inclusion of cocoyam flour increased. This shows that the composite flour blends are good sources of fiber. It has also been reported that consumption of high fiber food products is linked to reduction in hermorrhoids, diabetes, high blood pressure, and obesity [29].The moisture content of the cakes ranged from 23.22% (sample 45:45:10) to 24.78% (sample 30:60:10). High moisture content as a result of substitution of cocoyam would attribute water absorption to protein. This observation is in agreement with the work of Eke., *et al.* [14]; who reported a range of moisture content from 21.1 to 23.2% for cakes consumed in Nigeria. The carbohydrate content decreased progressively from 50.89% (sample 0:100:0) to 44.54% (sample 45:45:10). This decrease in carbohydrate is attributed to the cocoyam flour used in the production of the cake samples and high level of carbohydrate observed in the cake samples agrees with the report by FAO [30] that the main nutrient supplied by cocoyam as with other root and tuber crops, is dietary energy provided by the carbohydrates [31].

Antinutrient composition of cocoyam-wheat cakes enriched with edible palm larvae

The results of the antinutrients composition of the cake samples are presented in table 2. Evaluation of the antinutritional factors in the cakes produced from cocoyam-wheat flour blends

Table 1: Proximate composition of cocoyam-wheat cake samples enriched with edible palm larvae (%).

Samples Cocoyam: wheat: Palm larvae	Moisture	Dry matter	Ash	Crude protein	Crude lipids	Crude fibre	Carbohydrate
0:100:0	$23.44^{bc} \pm 0.02$	$76.57^{ab} \pm 0.02$	$1.24^{e} \pm 0.00$	$7.83^{e} \pm 0.01$	$15.36^{f} \pm 0.08$	$1.25^{b} \pm 0.00$	$50.89^{a} \pm 0.07$
10:80:10	$23.85^{b} \pm 0.01$	$76.15^{b} \pm 0.01$	$1.26^{e} \pm 0.02$	$8.66^{d} \pm 0.05$	$17.62^{e} \pm 0.02$	$1.22^{cd} \pm 0.00$	$47.39^{b} \pm 0.07$
20:70:10	$24.54^{a} \pm 0.08$	$75.46^{c} \pm 0.08$	$1.29^{cd} \pm 0.00$	$8.93^{c} \pm 0.03$	$18.44^{d} \pm 0.01$	$1.18^{e} \pm 0.00$	$45.60^{c} \pm 0.04$
30:60:10	$24.78^{a} \pm 0.02$	$75.42^{c} \pm 0.25$	$1.33^{bc} \pm 0.00$	$9.18^{b} \pm 0.02$	$18.87^{c} \pm 0.04$	$1.20^{de} \pm 0.00$	$44.65^{d} \pm 0.09$
50:40:10	$23.82^{b} \pm 0.02$	$76.38^{ab} \pm 0.31$	$1.36^{b} \pm 0.00$	$9.24^{b} \pm 0.01$	$19.56^{b} \pm 0.05$	$1.23^{c} \pm 0.00$	$44.80^{a} \pm 0.08$
45:45:10	$23.22^{c} \pm 0.03$	$76.78^{a} \pm 0.39$	$1.40^{a} \pm 0.02$	$9.71^{a} \pm 0.01$	$19.85^{a} \pm 0.01$	$1.29^{a} \pm 0.01$	$44.54^{d} \pm 0.44$

*Means with the same superscripts within the column are not significantly different ($p \geq 0.05$)

enriched with edible palm larvae show that there were significant increases in the antinutritional factors determined. The increase could be as a result of increased substitution of wheat flour with cocoyam flour; though the values are low and occur within acceptable safe limit. Application of heat during processing of flour blends into cakes may bring respite to consumers who may entertain concerns over the presence of antinutritional factors in cocoyam. There were significant differences in the oxalate contents of the composite cake sample. Sample 45:45:10 (cocoyam: wheat: edible palm larvae) had the highest oxalate content of 1.08 mg/100 g. The oxalate contents increased as the rate of addition of cocoyam flour increased. The major limiting factor in the utilization of cocoyam is the presence of oxalates which cause irritation when foods are prepared from it (impart an acrid taste), because, they interfere with bioavailability of calcium [32,33]. Other problems associated with processing and utilization of cocoyam, among others include low storage and bulkiness. It has been reported that washing reduced the concentration of oxalate by 9.2% [34], while Akpan and Umoh [35] reported that the peel of tubers has high level of oxalate unlike the peeled tubers, Buntha., *et al*. [36] suggested that, acridity of oxalate cultivars of cocoyam can be removed or reduced by grating, fermentation, peeling and soaking.

The phytate content varied from 0.48 - 0.90 mg/100 g with sample 45:45:10 (cocoyam: wheat: edible palm larvae) having the highest value of 0.90mg/100g. Luo., *et al.* [37] reported that phytic acid binds minerals which are necessary as cofactors, and hence interfering many metabolic processes including protein utilization. Olaoye., *et al.* [38] reported that phytic acids usually form insoluble salts with mineral elements such as zinc, calcium and iron to prevent their utilisation in the body. Phytate are reported to limit availability of minerals such as calcium, iron, magnesium, phosphorous [39]. Furthermore, the saponin contents of the cake samples were very low (0.65 - 0.88 mg/100 g) suggesting that in this regard, they pose no threat to human consumption. Saponins have been reported to lower plasma cholesterol concentrations (Topping., *et al*., 1980). The tannin content of the cake samples was in the range of 0.60 to 1.11 mg/100 g. Tannin are associated to form complexes with protein and hence limiting the availability of protein [39].

Table 2: Antinutrient composition of cocoyam-wheat cake samples enriched with edible palm larvae (mg/100mg).

Samples Cocoyam: Wheat: Palm larvae	Oxalate	Phytate	Alkanoid	Saponin	Tannin
0:100:0	$0.78^{f} \pm 0.00$	$0.48^{f} \pm 0.00$	$0.31^{f} \pm 0.00$	$0.65^{f} \pm 0.00$	$0.60^{f} \pm 0.02$
10:80:10	$0.82^{e} \pm 0.00$	$0.62^{e} \pm 0.00$	$0.40^{e} \pm 0.00$	$0.72^{e} \pm 0.00$	$0.74^{e} \pm 0.01$
20:70:10	$0.88^{d} \pm 0.00$	$0.67^{d} \pm 0.00$	$0.45^{d} \pm 0.00$	$0.76^{d} \pm 0.00$	$0.82^{d} \pm 0.00$
30:60:10	$0.93^{c} \pm 0.00$	$0.73^{c} \pm 0.00$	$0.51^{c} \pm 0.00$	$0.82^{c} \pm 0.00$	$1.04^{c} \pm 0.00$
50:40:10	$0.98^{b} \pm 0.00$	$0.83^{b} \pm 0.00$	$0.63^{b} \pm 0.02$	$0.85^{b} \pm 0.00$	$1.08^{b} \pm 0.01$
45:45:10	$1.08^{a} \pm 0.00$	$0.90^{a} \pm 0.00$	$0.67^{a} \pm 0.00$	$0.88^{a} \pm 0.01$	$1.11^{a} \pm 0.00$

**Means with the same superscripts within the column are not significantly different ($p \geq 0.05$)*

It is now reported that processing techniques can reduce or remove anti-nutritional factors. Several studies have investigated on the effects of using simple processing techniques such as soaking, cooking, germination, frying, blanching and fermentation for reduction of anti-nutritional factors in many places in including Nigeria [40].

Mineral and vitamin composition of cocoyam-wheat cakes enriched with edible palm larvae

Table 3 shows the result of some mineral and vitamin contents of the cocoyam-wheat cakes enriched edible palm larvae powder. Minerals play an important role in physiological and metabolic process [41]. There were significant differences ($P \leq 0.05$) in all the mineral components analyzed. Cake samples were found to have high mineral content, calcium content of the samples increased from 382.72-395.39 mg/100 g with sample 45:45:10 (cocoyam: wheat: edible palm larvae) having the highest value of 395.39 mg/100 g. In most cases, minerals are susceptible to leaching into the processing or cooking water, however, they are not sensitive to heat. Calcium has been known to aid in strong bone and teeth formation. Lack of proper consumption of micronutrients can lead to rickets, scurvy and osteoporosis. Calcium intake in diabetics had been shown to be beneficial and likely to reduce osteoporosis in older diabetics [42]. The sodium contents also increased as the rate of addition of cocoyam flour increased; ranging from 184.71 mg/100 g (sample 0:100:0; 100% wheat flour) - 195.82 mg/100 g (sample 45:45:10). Sodium helps to maintain osmotic pressure and regulate acid based balance in the body though not good when taken in high quantities. Prolonged consumption of foods high in sodium as well as sodium intake above the recommended value has been associated with high blood pressure and stiffening of arterial walls and, therefore, is a risk factor for cardio-vascular heart disease (CHD), which is a major cause of death in Europe [43,44].

There were significant differences in the vitamin components analyzed for the cake samples. Sample 45:45:10 (cocoyam: wheat: edible palm larvae) was significantly higher than the other samples with mean value of 1.76 IU /100 g in vitamin A followed closely by sample 50:40:10 (cocoyam: wheat: edible palm larvae) with 1.70 IU /100 g. Sample 0:100:0 (100% wheat flour) had the lowest mean value of 1.24 IU /100g of vitamin A. Vitamin A promotes skeletal growth, normal tooth structure, healthy membrane, healthy skin, eyes and hair, it is also essential for good night vision [45]. Sample 45:45:10 (cocoyam: wheat: edible palm larvae) had the highest vitamin C content of 7.22mg/100g while sample 0:100:0 (100% wheat) had the lowest vitamin C value of 3.41mg/100g. Vitamin C is an essential micronutrient needed for metabolic and physiological functioning of the body. Vitamin C is

Table 3: Mineral and vitamin composition of cocoyam-wheat cake samples enriched with edible palm larvae (mg/100g).

Samples Cocoyam: wheat: Palm larvae	Calcium	Sodium	Vitamin A (IU/100g)	Vitamin B_1	Vitamin C
0:100:0	$382.72^{f} \pm 0.03$	$184.71^{f} \pm 0.26$	$1.24^{f} \pm 0.02$	$2.07^{e} \pm 0.01$	$3.41^{f} \pm 0.01$
10:80:10	$386.00^{e} \pm 0.09$	$187.62^{e} \pm 0.24$	$1.28^{e} \pm 0.00$	$2.11^{d} \pm 0.00$	$3.63^{e} \pm 0.02$
20:70:10	$389.52^{d} \pm 0.01$	$190.83^{d} \pm 0.00$	$1.33^{d} \pm 0.00$	$2.02^{f} \pm 0.01$	$4.61^{d} \pm 0.00$
30:60:10	$390.82^{c} \pm 0.02$	$192.46^{c} \pm 0.05$	$1.50^{c} \pm 0.02$	$2.13^{c} \pm 0.00$	$5.78^{c} \pm 0.00$
50:40:10	$392.34^{b} \pm 0.08$	$193.96^{b} \pm 0.48$	$1.70^{b} \pm 0.01$	$2.16^{b} \pm 0.00$	$6.84^{b} \pm 0.01$
45:45:10	$395.39^{a} \pm 0.04$	$195.82^{a} \pm 0.02$	$1.76^{a} \pm 0.01$	$2.20^{a} \pm 0.00$	$7.22^{a} \pm 0.02$

*Means with the same superscripts within the column are not significantly different ($p \geq 0.05$)

known to improve iron bioavailability. Ascorbic acid is heat labile and minimal cooking (steaming or stir-frying) is recommended to maximize its bioavailability

Functional properties of the cocoyam-wheat flour blends enriched with edible palm larvae

The results of the functional properties of the composite flour blends are presented in Table 4.

Table 4: Functional properties cocoyam-wheat flour blends enriched with edible palm larvae.

Sample Cocoyam: Wheat: Palm larvae	Bulk density (g/cm^3)	Oil absorption capacity (g/g)	Water absorption capacity (g/g)	Emulsion capacity (%)	Foam capacity (%)	Swelling index
0:100:0	$0.68^{a} \pm 0.00$	$1.72^{d} \pm 0.00$	$1.76^{d} \pm 0.00$	$43.51^{f} \pm 0.00$	$39.43^{a} \pm 0.01$	$1.08^{f} \pm 0.00$
10:80:10	$0.64^{bc} \pm 0.00$	$1.75^{cd} \pm 0.00$	$1.53^{e} \pm 0.01$	$44.78^{e} \pm 0.02$	$38.52^{b} \pm 0.10$	$1.12^{e} \pm 0.00$
20:70:10	$0.63^{d} \pm 0.00$	$1.73^{d} \pm 0.00$	$1.69^{b} \pm 0.00^{b}$	$45.82^{d} \pm 0.02$	$35.51^{c} \pm 0.12$	$1.15^{d} \pm 0.00$
30:60:10	$0.64^{cd} \pm 0.00$	$1.76^{d} \pm 0.00$	$1.67^{b} \pm 0.00$	$46.57^{c} \pm 0.04$	$32.76^{e} \pm 0.05$	$1.18^{c} \pm 0.00$
50:40:10	$0.65^{b} \pm 0.00$	$1.78^{d} \pm 0.02$	$1.63^{c} \pm 0.00$	$47.23^{b} \pm 0.00$	$33.62^{d} \pm 0.02$	$1.21^{b} \pm 0.00$
45:45:10	$0.61^{e} \pm 0.00$	$1.83^{a} \pm 0.00$	$1.59^{d} \pm 0.00$	$47.85^{a} \pm 0.01$	$32.78^{e} \pm 0.02$	$1.24^{a} \pm 0.00$

*Means with the same superscripts within the column are not significantly different ($p \geq 0.05$)

Water absorption capacity values of the composite flour blends ranged from1.53 to 1.76 g/g but the highest value of 1.76 g/g was recorded in sample 0:100:0 (100% wheat flour). The values obtained in this work for the flour blends suggest that the flours would be useful functional ingredients in bakery products. Water absorption capacity is an important processing parameter and has implications for viscosity. It is also essential in bulking and consistency of products, as well as in baking application [46]. The composite flour blends displayed stronger affinity for oil than water. This could be attributed to the percentage oil in edible palm larvae which has been reported to be 37.12% [47]. There were significant differences in the oil absorption capacity of the composite flour blends and wheat flour. Oil absorption capacity of the samples were ranged from 1.72 g/g to 1.83 g/g with sample 45:45:10 (cocoyam: wheat: edible palm larvae) having the highest value of 1.83 g/g. Oil absorption capacity is of great importance since fat as a flavor retainer and increases the mouth feel of foods [48].

Emulsion capacity of the samples ranged from 43.51% to 47.85%. Sample 0:100:0 (100% wheat flour) had the lowest value of 43.51%. Samples 50:40:10 (cocoyam: wheat: edible palm larvae) and 45:45:10 (cocoyam: wheat: edible palm larvae) had emulsion capacity values of 47.23% and 47.85% respectively. Emulsifiers are important in baked foods as are known for prolonging shelf life [49]. Bulk density of the flour samples ranged from 0.61 to 0.68 g/cm3. Sample 0:100:0 from 100% wheat had the highest value of 0.68g/cm^3 while sample 45:45:10 (cocoyam: wheat: edible palm larvae) had the least value of 0.61g/cm^3. Bulk density gives an indication of the relative volume and type of packaging material required [50]. Low bulk density of flour is important for physical attributes which determine storability and transportation [51,52].

Sensory properties of cocoyam-wheat cakes enriched with edible palm larvae

Results of sensory evaluation of the cocoyam-wheat cakes enriched with edible palm larvae indicate that sample 0:100:0 (100% wheat) and sample 10:80:10(cocoyam: wheat: edible palm larvae) had mean scores of 8.15 and 8.00 respectively in appearance. Similar observation was made in the mouthfeel attribute where mean scores of 7.75 were recorded for cake samples produced from samples 0:100:0 (cocoyam: wheat: edible palm larvae) and 10:80:10 (cocoyam: wheat: edible palm larvae) respectively. The cake samples produced from sample 0:100:0 (cocoyam: wheat: edible palm larvae) also recorded higher mean score of 8.10 than others in the taste attribute. There were no significant differences in the taste and mouthfeel attributes of the cake samples. In all the attributes, the values were above 6 which translates to like moderately, like very much and extremely liked in the hedonic scale (Table 5).

Conclusion and Recommendation

The study paves way for enhanced utilization of composite flour blends of cocoyam-wheat flour enriched with edible palm larvae. This study shows that the composite flour blends enriched with edible palm larvae are rich in protein and as such produced cake samples that can also be used to fight protein-energy malnutrition.

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