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*Full Length Research*

# Production and quality characteristics of African yam bean–wheat cake enriched with edible palm weevil (*Rhynchophorus phoenicis Fabricius*).

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**The use of African yam bean and wheat blended flours enriched with edible palm weevil (*Rhynchophorus phoenicis* ) powder in the production of composite cake samples were studied. The composite cake samples were analyzed for their nutrient, anti nutrient and organoleptic properties using standard methods. The nutrient composition of the composite cake samples showed that the protein contents increased with increasing supplementation with African yam bean flours from 5.65% in sample 0:100:0 (100% wheat flour) to 21.40% in sample 40:50:10 (African yam bean-wheat-palm weevil). Similar trends were observed in the carbohydrate contents which decreased from 60.39% in sample 0:100:0 (100% wheat flour) to 47.94% in sample 40:50:10 (African yam bean-wheat-palm weevil). The organoleptic evaluation carried out on the different composite cake samples showed that sample 0:100:0 (100% wheat flour) which was the standard was the most acceptable by the members of the panelist with a value of 8.60 and this was followed by sample 20:70:10 (African yam bean-wheat-palm weevil) with a value of 7.15 which translates to 'like moderately' and 'like very much' in the hedonic scale. Cake of acceptable quality were produced from African yam bean flour blends enriched with *Rhynchophorus phoenicis.***

**Keywords:** cake, African yam bean, palm weevil.

## INTRODUCTION

Malnutrition is a major public healthconcern and Protein Energy Malnutrion (PEM) remains a significant contributing factor to highchild and maternal mortality.The world population is continuously increasing with a growing requirement for food (Belluco *et al.,* 2013). Growing pressure on the worlds' livestock production sector and enduring protein undernourishment, persuade the search for alternative protein sources. Entomophagy which is human consumption of insects has been practiced since mankind first made an appearance on planet earth (Anankware *et al.,* 2015). Insects are widely consumed in many parts of the world and are evaluated as food or supplement. However, an ever-increasing world population, combined with a steadily rising economic growth and urbanization results in increasing demand for high-value protein which will consequently augment the pressure on the worlds' livestock production sector. This development almost certainly has a negative impact on the environment, considering carbon emissions, land and water use, public health risks etc. (Alston *et al.,*2009; FAO, 2006). Considering that protein energy malnutrition remains a widespread problem, insect consumption represents an inexpensive method of alleviating the food shortage crisis (DeFoliart, 1999).

Edible insects are a well-appreciated food consumed in various regions in Asia, Africa and America. It has been estimated that nearly 1800 insect species are used for human consumption globally (Jongema, 2011). Insects are comparable to conventional livestock meat in terms of nutritive content. The crude protein content of insects ranges from 40% to 75% on dry weight basis, largely dependent on species and stage in the life cycle (Verkerk*et al.,* 2007, Anankware *et al.,* 2016). Apart from nutritional benefits, advantages of insects include their lower emission of greenhouse gases and ammonia per kg mass gain compared with regular livestock such as pigs and cattle (Oonincx*et al.,* 2010). In commercial insect farming, insects reproduce much faster than traditional livestock, have higher feed conversion efficiency, and need far less breeding space than larger animals (Payne *et al.,* 2015).

The majority of the insects consumed are still collected from natural environments, where availability is seasonal and restricted to certain localities (Nonaka, 2009). Only recently, commercial insect farming has evolved as a livelihood in certain countries, in the vicinity of concentrations of customers (suburban farming). In principle, there are three ways insects could be consumed. First as whole insects, recognizable as such; second, whole insects processed in some powder or paste; third, as an extract such as a protein isolate. Whole, recognizable insects are often consumed as a fried snack or as part of the daily meal as well as live or boiled insects are often sold at local markets. As non-recognizable form, farmed insects could be processed into a dried form, e.g. insect powder, suitable for protein enrichment of a variety of low-nutrient foods or feed.

Edible insects have received considerable attention. Insect consumption, which is generally regarded as safe, has been documented for thousands of years in many parts of the world (Verkerk*et al.,* 2007). Studies have reported that insects are good sources of proteins and minerals and contribute to the daily requirements of these nutrients in certain developing countries (Banjo *et al.,* 2006, Elemo*et al.,* 2011, Anankware *et al.,* 2015). Additionally, insects have a high biodiversity with a higher feed conversion efficiency than cattle (Finke and Winn, 2004).

The larva of *Rhynchophorus phoenicis Fabricius*, a Coleopteran of Curculionidae family is used as traditional food in several countries. Among the insect species, *R. phoenicis*larvae are considered the major sources of dietary lipids and proteins. They are consumed worldwide, especially in developing and under developed countries where consumption of animal protein may be limited because of economic, social, cultural or religious factors (Cerda *et al*., 1999).

African yam bean (*Sphenostylis stenocarpa*) is an important legume in Africa with duo food product (seeds and tubers). It is a lesser-known legume of the tropical and sub-tropical areas of the world which has attracted research in recent times (Azeke*et al.,* 2005). African yam bean is rich in protein, carbohydrate, vitamins and minerals (Iwuoha and Eke, 1996). The protein of African yam bean is made up of over 32% essential amino acids, with lysine and leucine being predominant (Onyenekwee*et al.,* 2000). Thus, using it in conjunction with wheat for snacks production would provide the lysine lacking in wheat. Presently, African yam bean is underutilized and rarely consumed in urban areas which are attributed to its elaborate preparation method. The use of African yam bean in composite flour for snack production will make it readily available for consumption by all persons.

Cakes are convenient food products. They are usually sweet and often baked, prepared from flour, sugar, shortening, baking powder, egg, and essence as principal ingredients (Atef*et al*., 2011).Sanful*et al.*(2010) reported that cakes made from wheat-soya beans flour were more acceptable than whole wheat flour cake and the nutrient contents increased as the amount of soya beans increased. The production of cake from wheat, soya beans and cassava flour has also been reported by Ugwuonaet al. (2012). These authors reported that cakes produced from composite flour blends were higher in protein, carbohydrates and fat contents than those made of 100% wheat flour. This study seeks to develop and analyze the quality characteristics of African yam bean-wheat cake enriched with edible palm weevil.

## MATERIALS AND METHODS

Live larvae of edible palm weevil (*Rhynchophorus phoneicis)* were supplied from Amaiyi Okpo Arochukwu Abia State while the African yam beans were purchased from Bende market in Abia State. Reagents used were of high analytical grade.

### Production of edible palm weevil powder

The modified method of Womeniet al. (2012) was used in processing *Rhynchophorus phoenicis* into powdery form for composite cake production.

**Production of African yam bean flour**

The method described by Eneche (2006) with little modification was used in processing African yam bean into flour.

**Production of wheat flour**

The method described by Ndife et al. (2014) was used in the production of wheat flour.

**Production of African yam bean-wheat cake enriched with edible palm weevil**

The method of production of cake described by Sheikh et al. (2010) was used.

**Nutrient analysis of composite cake enriched with *Rhynchophorus phoneicis***

The cake samples were analyzed for moisture, ash, protein and fat contents according to the method of AOAC (2000). Carbohydrate content was determined by difference.

**Evaluation of anti nutritional factors of the composite cake samples.**

The oxalate and phytate determinations were done using the methods described by (Onwuka, 2005). The Tannin content of the samples were determined by Folin Denis Colometric method (Krik and Sawyer, 1998) while saponin test were performed using the double solvent extraction gravimetric method (Harborne, 1973).

**Determination of functional Properties of composite wheat-African yam bean flour blends enriched with edible palm weevil**

Bulk density, gelatinization temperature, swelling index and emulsion capacity were determined using methods described by Onwuka (2005) while water and oil absorption capacities were determined according to the methods described by Onimawo and Akubor (2005).

### Sensory evaluation

The sensory attributes: colour, taste, texture, flavour, aroma, appearance and general
acceptability of the cake samples were evaluated by twenty member semi-trained panelist using a 9- point hedonic scale with 1 representing the least score (dislike extremely) and 9 the highest score (like extremely) (Ihekoronye and Ngoddy, 1985).

### Statistical Analysis

Analysis of Variance (ANOVA) was performed on the data gathered using SPSS (version 15) to determine differences, while Duncan multiple Range test was used to determine the least significant difference.

## RESULTS AND DISCUSSION

### Proximate composition of African yam bean-wheat cake enriched with edible palm weevil

Table 1 shows the result of the proximate composition of African yam bean-wheat cake enriched with edible palm weevil. The protein content of the cake samples ranged from 5.65 – 21.40% with sample 40:50:10 (African yam bean-wheat-palm weevil larvae) having the highest protein content value of 21.40%.The protein content of the African yam bean-wheat cake enriched with edible palm weevil powder cake samples increased with addition of African yam bean flour and edible palm weevil powder. It has been reported that edible palm weevil in its delipidated form, contains over 80% of high quality protein with high content of essential amino acids (USDANAL, 2005).The fibre and fat content of the cake samples were in the range of 2.10 – 3.40% and 6.50– 8.70%, respectively with sample 40:50:10 (African yam bean-wheat-palm weevil) cake having the highest fibre and ash contents. Sample 0:100:0 (100% wheat flour) cake sample had more carbohydrate content than the other samples. Composite flours produced from legumes and tubers have been reported to have higher protein content and caloric value (Chinma*et al.,* 2007).Significant($p$ <

**Table 1:** Proximate composition of African yean bean- wheat cake enriched with edible palm weevil (%)

| Sample: African yam bean:wheat:palm weevil | Ash | Carbohydrates | Crude fibre | Fat | Moisture | Protein |
|---|---|---|---|---|---|---|
| 0:100:0 | 1.75$^{d}$± 0.071 | 60.39$^{a}$± 0.361 | 2.10$^{d}$± 0.141 | 6.50 $^{e}$± 0.000 | 23.62$^{a}$± 0.078 | 5.65$^{e}$± 0.212 |
| 10:80:10 | 2.00$^{c}$± 0.071 | 56.00$^{b}$± 0.354 | 2.60$^{c}$± 0.141 | 7.05$^{d}$± 0.071 | 20.60$^{b}$± 0.566 | 11.75$^{d}$±0.071 |
| 20:70:10 | 2.20$^{cb}$± 0.00 | 52.35$^{c}$± 0.014 | 2.95$^{bc}$± 0.071 | 7.80$^{c}$± 0.000 | 19.20$^{c}$± 0.057 | 15.50$^{c}$±0.000 |
| 30:60:10 | 2.35$^{b}$± 0.071 | 49.42$^{d}$± 0.339 | 3.20$^{ba}$± 0.000 | 8.15$^{b}$± 0.07 | 17.48$^{d}$± 0.085 | 19.40$^{b}$±0.283 |
| 40:50:10 | 2.60$^{a}$± 0.000 | 47.94$^{e}$± 0.057 | 3.40$^{a}$± 0.000 | 8.70$^{a}$± 0.000 | 15.06 $^{e}$± 0.057 | 21.40$^{a}$±0.000 |

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

**Table 2:** Antinutrient composition of African yam bean-wheat cake enriched with edible palm weevil (mg/100g)

| Sample: African yam bean:wheat:palm weevil | Phytate | Oxalate | Saponin | Tannin |
|---|---|---|---|---|
| 0:100:0 | 1.35$^{e}$± 0.026 | 0.65 $^{e}$± 0.000 | 0.45$^{d}$± 0.000 | 0.48$^{e}$± 0.000 |
| 10:80:10 | 1.53$^{d}$± 0.003 | 0.72$^{d}$± 0.000 | 0.58$^{c}$± 0.000 | 0.76$^{d}$± 0.000 |
| 20:70:10 | 1.73$^{c}$± 0.008 | 0.78$^{c}$± 0.000 | 0.64$^{b}$± 0.000 | 1.00$^{c}$± 0.071 |
| 30:60:10 | 1.87$^{b}$± 0.000 | 0.84$^{b}$± 0.000 | 0.69$^{b}$± 0.000 | 1.20$^{b}$± 0.000 |
| 40:50:10 | 1.96$^{a}$± 0.011 | 0.94$^{a}$± 0.021 | 0.77$^{a}$± 0.028 | 1.43$^{a}$± 0.042 |

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

0.05) differences existed in the fat content of the composite cake samples (6.50 – 8.70%). Opara et al. (2012) reported high lipid content of 54.20% for larva of *R. phoenicis*. High levels of fat are undesirable in food products because they could lead to rancidity in foods leading to the development of unpleasant and odorous compounds (Ihekoronye and Ngoddy, 1985). The moisture content of the cakes ranged from 15.06% (sample 40:50:10) to 23.62% (sample 0:100:0) control. The moisture content increased with increase in the levels of substitution with African yam bean and edible palm weevil. This observation is in agreement with the work of Kiin-Kabariand Banigo (2015) who reported moisture content range of 19.2 – 22.4% in cakes produced from wheat and unripe plantain flour blends enriched with bambara groundnut protein concentrate. Eke et al. (2008) also reported a range of moisture content from 21.1 to 23.2% for cakes consumed in Nigeria.

**Anti nutrient composition of African yam bean-wheat cake enriched with edible palm weevil**

The result of the anti nutrient composition of composite cake samples produced from African yam bean-wheat flour blends enriched with edible palm weevil are shown in Table 2. There were significant ($p < 0.05$) differences in the phytate, oxalate ,saponin and tannin contents of the composite cake samples. The tannin values which ranged from 0.48 mg/100 g to 1.43 mg/100 g increased as percentage of addition of African yam bean flour increased. Tannins are polyhydric phenols present in virtually all parts of plants and are known to inhibit trypsin, chymotrypsin, amylase, and lipase activities (Inyang and Ekop, 2015). The observed presence and quantity of tannins in all the samples can be of great medical importance since tannins serve as good antioxidant. The phytate content which varied from 1.35mg/100 to 1.96

mg/100 g also increased as addition of African yam bean flour increased. Similar trends were observed in the saponin contents (0.45 – 1.43mg/100g). Reduction in anti nutrientional factors in the composite cakes is in agreement with the findings of Ikpeme et al. (2012) who reported that though anti nutrientional factors were found in baked products, their contents were lower than in raw flours. This shows that heat application does not completely remove the anti nutrientional factors, but could reduce them significantly to safe and acceptable level not harmful for human consumption.

**Functional properties of African yam bean-wheat flour blends enriched with edible palm weevil**

Presented in Table 3 is the result of the functional properties of African yam bean-wheat flour blends enriched with edible palm weevil. The water absorption capacity of the composite flour samples ranged from 1.50 - 2.40 g/g with wheat flour having the lowest value of 1.50 g/g.

The ability of the composite flour blends to absorb water increased as the level of incorporation of African yam bean flour increased. Carbohydrates and proteins are the major chemical composition that enhances the water absorption capacity of flours, since they contain hydrophilic parts such as polar or charged chains (Lawal and Adebowale, 2004). It has been reported by Shittu et al. (2008) that baking quality is a function of water absorption capacity of the flour. The composite flour blends showed favorable water absorption capacity thereby being suitable materials in the development of ready-to-eat food products, soups, gravies, and baked products (Ohizua*et al.,* 2017). The emulsion capacity ranged from 24.10 to 31.20% with sample 40:50:10 (African yam bean-wheat-palm weevil) having the highest value. Emulsion capacity plays a significant role in many food systems where protein has the ability to bind to fat such as in butter and dough (Sathe, 2001). Emulsion capacity measures the maximum amount of oil emulsified by protein in a given amount of flour. Sathe and Diphase

**Table: 3 :**Functional properties of wheat-African yam bean -edible palm weevil flour blends

| Sample: African yam bean:wheat:palm weevil | Bulk density ($g/cm^3$) | Water absorption capacity (g/g) | Oil absorption capacity(g/g) | Swelling index (%) | Emulsion capacity (%) | Gelatinization temperature ($^oC$) |
|---|---|---|---|---|---|---|
| 0:100:0 | $0.77^a \pm 0.001$ | $1.50^d \pm 0.141$ | $1.80^a \pm 0.000$ | $1.20^d \pm 0.000$ | $24.10^d \pm 0.000$ | $78.00^e \pm 0.000$ |
| 10:80:10 | $0.71^b \pm 0.007$ | $1.80^c \pm 0.000$ | $2.00^a \pm 0.000$ | $1.34^c \pm 0.283$ | $28.25^c \pm 0.354$ | $80.00^d \pm 0.000$ |
| 20:70:10 | $0.69^b \pm 0.000$ | $2.10^b \pm 0.000$ | $2.10^a \pm 0.000$ | $1.38^{bc} \pm 0.000$ | $29.20^b \pm 0.000$ | $82.50^c \pm 0.707$ |
| 30:60:10 | $0.67^c \pm 0.005$ | $2.20^{ba} \pm 0.000$ | $2.25^a \pm 0.071$ | $1.42^b \pm 0.000$ | $30.70^a \pm 0.000$ | $85.00^b \pm 0.000$ |
| 40:50:10 | $0.65^d \pm 0.004$ | $2.40^a \pm 0.000$ | $2.80^a \pm 0.707$ | $1.49^a \pm 0.014$ | $31.20^a \pm 0.000$ | $87.60^a \pm 0.707$ |

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

**Table 4**: Sensory properties of African yam bean- wheat cake samples enriched with edible palm weevil

| Sample: African yam bean :wheat:palm weevil | Taste | Aroma | Appearance | Texture | General acceptability |
|---|---|---|---|---|---|
| 0:100:0 | $8.75^a \pm 0.44$ | $8.00^a \pm 73$ | $8.45^a \pm 0.69$ | $7.70^a \pm 1.08$ | $8.60^a \pm 0.75$ |
| 10:80:10 | $6.55^b \pm 1.67$ | $6.60^b \pm 2.01$ | $6.35^b \pm 1.23$ | $6.10^b \pm 1.65$ | $6.90^b \pm 1.48$ |
| 20:70:10 | $6.40^b \pm 1.27$ | $6.75^{ab} \pm 1.45$ | $6.65^b \pm 1.53$ | $6.35^b \pm 1.81$ | $7.15^b \pm 1.09$ |
| 30:60:10 | $6.65^b \pm 1.66$ | $6.90^{ab} \pm 1.59$ | $6.85^b \pm 1.31$ | $7.20^{ab} \pm 1.51$ | $6.95^b \pm 2.11$ |
| 40:50:10 | $5.75^b \pm 2.02$ | $5.65^b \pm 1.31$ | $5.05^c \pm 1.99$ | $6.40^{ab} \pm 2.16$ | $6.30^b \pm 2.11$ |

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

(1981) reported that high emulsification capacity may be due to the globular nature of the major protein and sample 40:50:10 (African yam bean-wheat-palm weevil) had the highest protein content of 21.40%.

The bulk density of the composite flour blends ranged from 0.65 – 0.77g/cm$^3$ with sample 40:50:10 (African yam bean-wheat-palm weevil) having the least bulk density value of 0.65g/cm$^3$. The bulk density of the flour blends decreased as the level of incorporation level of African yam bean flour increased. Ibeanu et al. (2016) reported bulk density of 0.64 – 0.82g/cm$^3$ in plantain flour samples. The result of bulk density is used to evaluate the flour heaviness, handling requirement and the type of packaging materials suitable for storage and transportation of food materials (Oppong*et al.,*2015).

**Sensory properties of African yam bean-wheat cake enriched with edible palm weevil**

The result of the organoleptic properties of the composite cake samples produced from flour blends of African yam bean, wheat and edible palm weevil powder is shown in Table 5. The evaluated sensory attributes show that sample 0:100:0 (100% wheat) performed best compared to the other cake samples in all the sensory properties determined. In terms of the taste, sample 30:60:10 (African yam bean-wheat-palm weevil) is the second preferred after sample 0:100:0 (100% wheat) with value 6.65. Similar trends were observed in aroma, colour and texture attributes. Samples 20:70:10 (African yam bean-wheat-palm weevil) and 30:60:10 (African yam bean-wheat-palm weevil)were preferred after sample 0:100:10 (100% wheat) in terms of general acceptability with values 7.15 and 6.95 respectively and this translates to 'like moderately' in the hedonic scale.

## CONCLUSION

Composite cakes of acceptable quality were prepared from African yam bean-wheat flour blends enriched with edible palm weevil (*Rhynchophorus phoenicis* ) powder. From the study, it was observed that the composite cake samples enriched with edible palm weevil generally had higher protein, ash and fibre contents than that prepared from 100% wheat flour. The enrichment of composite cake formulations with edible palm weevil would improve their nutritive quality and make them meet the protein – energy needs of people especially children in the regions where protein-energy malnutrition is prevalent. This flour can also be used in preparing weaning formulae for kids. Further study should be conducted to ascertain the iron content since most insects are known to have high iron contents. Knowledge from this will help in combating the injuriousness caused by iron-deficiency anaemia; which is a leading cause of mortalities in developing countries.

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