NUTRITIONAL COMPOSITION AND SENSORY EVALUATION OF COOKIES MADE FROM WHEAT AND PALM WEEVIL LARVAE FLOUR BLENDS.

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Abstract
The study developed cookies using wheat flour supplemented with varying proportions of palm weevil larvae flour with the view to introducing novel forms of palm weevil larvae consumption as against the usual. The larvae were cleaned, gutted and oven dried before being milled into flour. The palm weevil larvae flour was then mixed with wheat flour in proportions of 10-50% before being made into cookies. The cookies were subjected to proximate content determination and sensory evaluation. Data obtained were analyzed using inferential statistics. Proximate composition values of the cookies increased with increasing levels of palm weevil larvae substitution while consumer acceptability increased with decreasing level of palm weevil larvae substitution. Amongst the blends, cookies containing 10% palm weevil larvae flour had the highest energy content and the protein content also increased by 86.7% as compared with cookies made from 100% wheat flour. The carbohydrate content of the enriched cookies decreased while crude fibre content increased. There was no significant difference ($p<0.05$) in the taste, appearance, texture and overall acceptability of cookies made from 100% wheat flour and 10% palm weevil larvae substitution. The study concluded that wheat flour can be supplemented with at most 10% palm weevil larvae flour to give an enriched snack of good quality and acceptability.

Keywords: Entomophagy, Supplementation, Insects, Malnutrition, Snack

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Introduction

Due to increasing cases of malnutrition in most developing and under-developed countries as a result of difficulties in providing sufficient food, most especially protein (Aylward and Morgans, 1995), insects are being presented as an attractive alternative protein source as they are natural foods of many vertebrates, human inclusive (DeFoliart, 1999). Insects are not a traditional food in Western culture, but there is a growing public interest in their nutritional importance. The cultural practice of entomophagy (use of insect as food) is an old and well-established custom in non-industrialized regions of the world. It is exercised traditionally in 113 countries all over the world and more than 2,000 insect species that are considered edible have been counted to date (MacEvilly, 2000; Jongema, 2012). The practice of Entomophagy in Nigeria has significantly reduced protein deficiency in the country (Omotoso, 2006).

According to Mwizenge (1993), insects are valuable sources of animal protein in Zambia since meat from domestic and wild animals are scarce. Edible insects have been reported to be part of the traditional cuisine of many nations (Bednarova *et al.*, 2013) and because they are easy to breed, reproduce rapidly, have low environmental footprints, they have become an important and valuable source of nutrition not only in the developed countries as well (Kinyuru *et al.*, 2013). They have been discovered to be a rich source of various nutrients such as iron, zinc and calcium. Insects commonly consumed in Nigeria are locust, termites, ants, grasshoppers, weevils, beetles, crickets and caterpillars. Although most of these insects have been reported to contain phytic acid an anti-nutrient, its concentration is greatly reduced during processes such as frying, roasting and boiling (Ekop, 2004). Generally, edible insects have been found to be good sources of proteins, fat, energy, vitamins and minerals. According to Agbidiye *et al.* (2009), consumption of 100 g of caterpillars provides 76 % of the daily required amount of proteins in adults.

In South-western Nigeria, grubs of palm weevil are roasted or fried and hawked by the roadside. The larvae is a delicacy served as snacks or taken with carbohydrate foods (Omotoso, 2006). The larvae of the African Palm Weevil (*Rhychophorus phoenicis*) live and feed on the trunk of the raffia palm. They burrow in the crown of the palm and feed on the young tissues and sometimes destroy the growing point till the palm dies. The adult palm weevils have a plump, yellowish-cream body with a soft ridged texture and a hard shelled head (Beckerman, 1977; Bedford, 1980 and DeFoliart, 1993). In light of this, they are regarded as pests but the grubs are highly valued delicacies in the rain forest regions of Nigeria. Forms of utilization include boiling, roasting, frying or eaten raw (Onyeike *et al.*, 2005). In a study by Opara (2012), December to May have been reported as the peak season for Palm Weevil Larvae (PWL) production while June to November are off-peak periods in the rain forest zones of Nigeria.

Owen (1973) attributed the aversion to insect as human foods by Europeans as, a result of custom and prejudice. Whether or not insects are eaten depends not only on taste and nutritional value but also on customs, ethnic preferences or prohibitions. Since there is the likelihood of the traditional practice of insect eating disappearing as food regions westernize (Aguilar-Miranda *et al.,* 2012), efforts are being made to merge the traditional practice with more popular foods such as tortillas being enriched with yellow mealworms. More so, as the consumption of cereal foods has become very popular globally, there is an increase in the replacement of wheat flour with other food sources. Aqu and Okoli (2014) reported on biscuits made from wheat four improved with beniseed and unripe plantain. Gbadamosi *et al.* (2011) also produced cookies using wheat and African oil bean flour blends. This study therefore sought an alternative to insect consumption by using it as a supplement in snack production with a view to eliminating the disgust that may likely be felt by some consumers when they are otherwise presented with roasted PWL as it is.

Methodology

Palm Weevil Larvae Flour (PWLF) Preparation

Fresh and live larvae of the palm weevil were purchased from a local market in Igbokoda, Ondo State, Nigeria. The larvae were gutted using a sharp knife, washed in salt water and dried in a Gallenkamp oven at 60 ^{o}C until constant weight was achieved. The dried larvae was then milled using a hammer mill into fine powder. The powder was sieved and the flour kept for future use.

Preparation of Cookies

The PWLF was blended with Wheat Flour (WF) in the following proportions 0:100, 10:90, 20:80, 30:70, 40:60 and 50:50. The composite flour was then used to produce cookies using the modified formulation of Ihekeronye and Ngoddy (1999). The ingredients were mixed using a Russell Hobb's hand held mixer for 5 mins. The dough was kneaded and cut into circular shapes of 5cm diameter and uniform thickness. Baking was done in a gas oven at 185 ^{o}C for 20 ± 5 min. The cookies were cooled at room temperature (28 ± 2 ^{o}C) and packaged in polyethylene bags until needed.

Proximate Composition Determination

The moisture content, crude protein, crude ash, crude fat and crude fibre contents of the cookies were determined by the methods of AOAC (2005). Carbohydrate was calculated by difference. Energy value was calculated using the Atwater factor.

Sensory Evaluation

The cookies were presented to a 20-member trained panellists who were asked to evaluate the following parameters: taste, appearance, crispiness, aroma, texture and overall acceptability on a 9-point hedonic scale with 1= dislike extremely, 5 = neither like nor dislike and 9 = like extremely (Gbadamosi *et al.,* 2011). The panellists were provided with water to rinse their mouths in between sample evaluation.

Statistical Analysis
All experiments were conducted in triplicates and the data subjected to appropriate descriptive and inferential tests. Significance of mean difference was accepted at p $\geq$ 0.05.

Results and Discussion

From Table 1, the nutritional values for cookies made from 100% WF agree with the findings of Aderinola and Allikura (2015). It was observed that cookies made from 100% PWLF had higher nutritional value than cookies made from 100% WF and this led to a significant increase in the values of the nutritional components of the cookies as PWLF substitution increased. This phenomenon agrees with the findings of Akubor and Badifu (2004); Gbadamosi *et al.*, (2011) who also reported an increase in nutritional composition of supplemented cookies. The moisture content of the supplemented cookies were higher than those made from 100% WF and 100% PWLF, nevertheless the values still indicate the shelf stability of the cookies without the danger of microbial deterioration and eventual spoilage. The high values also imply that the baking time needs to be increased to ensure adequate moisture removal. It also indicates that the PWLF has hydrophilic properties which resulted in a reduced ability of the cookies to lose water under the same drying/baking conditions as cookies made from 100% WF. Crude protein content increased with increasing levels of substitution. Previous studies by (Banjo *et al*., 2006; Adesina, 2012) have shown that PWLF has a protein content of 50.01%, hence an addition of this to eggs which is the principal source of protein in cookies will result in a protein rich snack as compared to cookies which are usually carbohydrate packed. In this study, as minimal as 10% supplementation with PWLF yielded an 86.7% increase in the protein content of supplemented cookies. Also, carbohydrate decreased while crude fibre increased. According to Salvin (2005) and Yusufu *et al.* (2015), cookies having increased fibre and low carbohydrate content have health benefits such as reduced constipation and ease in colon digestion. There was also an observable decrease in the crude ash content but it increased at higher levels (40 and 50%) of PWLF substitution. Energy content of the supplemented cookies was higher than cookies made from 100% WF with that of 10% substitution having the highest (484.15 kcal/g) amongst the blends. This increase is due to the high fat content of Palm Weevil Larvae and agrees with the findings of Gbadamosi *et al*., (2011).

The sensory scores are shown on Table 2 with an observable decrease in the scores as PWLF substitution increased. Amongst the supplemented cookies, cookies made from 10% PWLF substitution had the highest scores for all attributes evaluated. There was no significant difference (p<0.05) in the taste, appearance, texture and overall acceptability of cookies made from 100% WF and cookies with 10% PWLF. As the levels of PWLF substitution increased, the cookies became softer and very dark in colour since the PWLF is naturally dark brown in colour. At 10% substitution level, the aroma of palm weevil larvae was distinctly noticeable thus leading to reduced scores for the supplemented cookies as indicated by the significant difference observed between the supplemented cookies and cookies made form 100% WF.

Table 1: Proximate Composition of Cookies made from Wheat Flour and Palm Weevil Larvae Flour Blends

Sample Code	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate (%)	Energy (kcal/g)
100% WF	3.21±0.02a	10.89±0.23b	19.82±0.34a	2.54±0.99c	0.28±0.09a	63.26±0.13f	474.98±0.71b
90:10	7.05±0.02c	20.33±0.35d	25.87±0.15e	2.17±0.01b	2.08±0.07c	42.51±0.28c	484.15±0.11c
80:20	7.60±0.10d	9.74±0.11a	25.75±0.05e	1.61±0.01a	3.27±0.08e	52.03±0.15de	478.83±0.50b
70:30	8.99±0.01f	15.02±0.12c	24.47±0.01d	2.40±0.02c	1.09±0.03b	48.03±0.58d	472.43±0.77b

60:40	7.59±0.03d	15.01±0.04c	22.99±0.02c	3.04±0.08d	0.52±0.12a	50.85±0.03e	470.35±0.07b
50:50	8.05±0.01e	25.06±0.16e	26.47±0.06f	3.08±0.01d	2.51±0.01d	34.83±0.21b	477.79±0.28b
100% PWLF	6.61±0.03b	52.77±0.38f	20.42±0.16b	3.22±0.09e	6.67±0.30f	10.31±0.01a	436.10±0.10a

Table 2: Sensory Scores of Cookies made from Wheat Flour and Palm Weevil Larvae Flour Blends

Sample Code	Taste	Appearance	Crispiness	Aroma	Texture	Overall Acceptability
100% WF	8.20±0.77	7.35±0.93	7.05±0.68	6.95±0.89	6.90±1.17	7.75±0.71
90:10	7.15±1.04	6.60±1.19	6.25±1.02	5.90±1.12	6.30±1.13	7.25±1.02
80:20	6.15±1.09	5.60±1.27	5.45±1.05	5.25±1.37	5.05±1.43	6.20±1.58
70:30	4.85±1.42	4.75±1.80	4.80±1.15	4.65±1.42	4.40±1.43	5.20±1.44
60:40	4.30±2.22	4.15±2.25	3.90±1.37	3.50±1.82	4.05±1.61	4.55±1.79
50:50	3.30±2.58	3.55±2.56	3.45±1.57	3.05±1.82	3.80±1.61	3.60±2.01

Conclusion

Wheat flour can be substituted or enriched with 10% Palm Weevil Larvae flour without any adverse effect on the quality of the snack made from it. PWLF is without doubt a protein rich snack and this study confirmed the possibility of its inclusion in carbohydrate rich foods to give products of acceptable quality. Attention should therefore be given to the cultivation or production of palm weevil larvae in large quantities so that protein isolates can be produced and used in production of other foods. Further studies may also investigate the effect of removal of vegetable shortening as a raw material in production of PWLF supplemented cookies since PWLF has a high fat content.

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