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Short Communication

Nutritional and functional properties of *Cirina forda* larva from Ado-Ekiti, Nigeria

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Proximate composition, mineral content and functional properties of the flour obtained from larvae of *Cirina forda* were evaluated. The proximate analysis revealed the crude protein to be 20.0 ± 0.2%, crude fat 12.5 ± 0.4%, moisture 4.5 ± 0.1%, ash 8.7 ± 0.1% and total carbohydrate 54.3 ± 0.2%. The mineral evaluation in mg/100g dry weight showed K (47.6 ± 0.1) > P (45.9 ± 0.6) > Na (44.4 ± 0.1) > Mg (43.8 ± 0.4) > Zn (24.2±0.2) > Ca (12.9 ±0.2) > Fe (1.3). Cu and Mn were not detected. The functional properties showed water absorption capacity, oil absorption capacity and emulsion capacity to be 248.3 ±2.4%, 178.7 ± 0.0% and 135.7 ± 2.3%, respectively. The least gelation concentration was 14.0 ± 0.1% (w/v). It had high solubility in both acidic and basic pHs suggesting that *C. forda* flour will be useful in the formulation of both acidic and basic foods. The protein solubility profile also revealed that the protein content of *C. forda* is least available in a neutral medium. This study revealed that *C. forda* is a good source of protein and fat. The result of the mineral analysis will make *C. forda* useful in the formulation of human foods which may however need to be fortified with iron and calcium.

Key words: *Cirina forda*, protein solubility profile, minerals, functional properties.

INTRODUCTION

Insects and other related invertebrates have served as food for people for thousands of years all over the planet. Insects commonly consumed include: locusts, termites, grasshoppers, weevils and various caterpillars (Ene, 1963). Today, insect eating is rare in the developed world, but insects remain a popular food in many developing regions of the Central and South America, Africa, and Asia. In fact, insects are preferred to meat in some of these regions. For example, the Yukpa people of Colombia and Venezuela and the Pedi of South Africa prefer certain of their traditional insect foods to fresh meat (DeFoliart, 1992).

Different studies have shown that edible insects contain appreciable amount of proteins (Olaofe et al., 1998), (Ramos-Elorduy et al., 1997) and (Fashoranti and Ajiboye, 1993). It has also been reported that the dried form of insects commonly found in village markets of the developing world are very high in crude protein in which some species have values above 60% (DeFoliart, 1992). Insects are rich in protein; however, studies have shown that whole insects as a source of protein are somewhat of lower quality than vertebrate animals because of the indigestibility of chitin (Phelps et al., 1975). Insects are also found to be rich in fat. Among insects, Isoptera (termites) and Lepidoptera have been ranked among the highest in fat (DeFoliart, 1992). Oliveira et al. (1976) and DeFoliart (1992) have reported that insects like caterpillars (Saturmiidae), winged termites, and palm weevil larva are rich in Cu, Fe, Mg and Zn. Considering the fact that most edible insects are rich in protein, fat and minerals, research into the nutritional quality of insects will not only encourage the consumption of insects but also help in achieving some of the United Nations Millennium Development Goals such as eradication of hunger and extreme poverty, reducing child mortality and improving maternal health.

Cirina forda, a Lepidoptera, is a pest of sheabutter tree; its larvae resemble silk worm caterpillars except that they do not spin cocoons. Instead, they dig into the soil at the base of the host tree to pupate. Hence they are called 'konni wole' in the south western part of Nigeria; 'konni'

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Table 1. Proximate Composition of *C. forda*, from Ado-Ekiti, Nigeria.

Component	Percentage composition
Moisture content	4.5 ± 0.1
Protein	20.0 ± 0.2
Crude fat	12.5 ±0.4
Ash	8.7 ± 0.1
Total carbohydrate	54.3 ± 0.2

Table 2. Mineral Composition of *C. forda*, from Ado-Ekiti, Nigeria.

Element	Concentration (mg/100 g)
Fe	1.3 ± 0.0
Zn	24.2 ± 0.4
Ca	12.9 ± 0.2
Na	44.4 ± 0.1
K	47.6 ± 0.1
Mg	43.8 ± 0.4
Cu	ND
Mn	ND
P	45.9 ± 0.6

ND = Not detected.

means *C. forda* while 'wole' means to enter soil. The larvae of this insect are processed into the dried form which is widely marketed and consumed as an essential ingredient in vegetable soups (Fasoranti and Ajiboye, 1993).

The larvae are usually boiled and dried in the sun before they are sold. *C. forda* is reported to be one of the most important and widely eaten insects in some parts of Nigeria (Fasoranti and Ajiboye, 1993) and (Agbidye et al., 2009). This study is an attempt aimed at elucidating the nutritional quality of *C. forda* widely consumed in some parts of Africa.

MATERIALS AND METHODS

Dry larvae of *C. forda* were purchased in Oba's Market Ado-Ekiti, Nigeria. They were dry milled after the screening of the bad ones and impurities. The flour was used for the various analyses carried out. All analyses were done in the research laboratory of Chemistry Department, Federal University of Technology, Akure, Nigeria.

Proximate analysis

The moisture content, ash, crude fat and crude protein contents were determined using the methods of the Association of Official Analytical Chemists (AOAC, 1990). The total carbohydrate content was obtained by difference.

Mineral analysis

The mineral elements were determined using Atomic Absorption Spectrophotometric method (Olaofe et al., 1998). Potassium and sodium were determined by flame photometry while phosphorous level was determined using the phosphovanado molydbdenate method (AOAC, 1990).

Functional properties

The method reported by Beuchat (1997) was used to determine the oil absorption, water absorption and emulsion capacities of the sample. The methods of Coffman and Garcia (1977) as modified by Sathe et al. (1982) were used to determine the foaming capacity and the least gelation concentration. The effect of pH on the flour protein solubility was determined as described by Oshodi and Ekperigin (1989). The crude protein content of the supernatants was determined using AOAC (1990) method. All determinations were in triplicates.

RESULTS AND DISCUSSION

The chemical composition of *C. forda* flour is shown in Table 1. The table reveals the moisture content of *C. forda* flour to be 4.5% ± 0.1. This low value suggests that dry *C. forda* larvae are not likely to be susceptible to micro- organism attack. This value is in agreement with reported value of 4.4% for *C. forda* (Banjo et al., 2006). The crude protein content (20.0 ± 0.2) is high compared to the reported value of 12.5% (Uddoh, 1980) for pork. It is also within the range of 15 to 60% reported for various forms of Lepidoptera edible insects from the state of Oaxaca Mexico (Ramo- Elorduy et al., 1997). It is low compared with 55.0% recorded for grasshopper (Oloafe et al., 1998) and 33.12% recorded for *C. forda* (Akinawo et al., 2000). The disparity between this result and Akinawo's might be due to the differences in processing methods; only oven- drying at 60°C was involved in Akinawo's method. Boiling and sun-drying the larvae before marketing might have denatured some of the protein molecules.

Table 2 shows the mineral composition of *C. forda* flour. It reveals that potassium was the most abundant mineral in the flour of *C. forda*. This observation is in close agreement with the observation of Olaofe et al. (1998) for *Zonocerus variegatus*. The least abundant mineral in the flour of *C. forda* was Fe with a value of 1.3 mg/100g. This value is close to the results (mg/100g) 0.68, 1.56 and 1.79 obtained for *Brachy trupes*, *Anaphe* spp and *C. forda* respectively (Banjo et al., 2006).The general order of the distribution of these minerals is K >P>Na> Mg>Z>Ca>Fe. The values of some functional properties of *C. forda* are presented in Table 3. The water absorption capacity (248.3 ± 2.4%) is high compared with the one reported for fluted pumpkin seed flour by Akintayo (1997). The least gelation capacity is comparable with those reported for pigeon pea Oshodi and Ekperigin (1989), fluted pumpkin (Akintayo, 1997)

Table 3. Functional properties of *C. forda*, from Ado-Ekiti, Nigeria.

Functional property	Percentage
Water absorption capacity	248.3 ± 2.4
Foaming capacity	0
Emulsion capacity	135.7 ± 2.3
Least gelation concentration	14 ± 0.1 w/v
Oil absorption capacity	178.7 ± 0.0

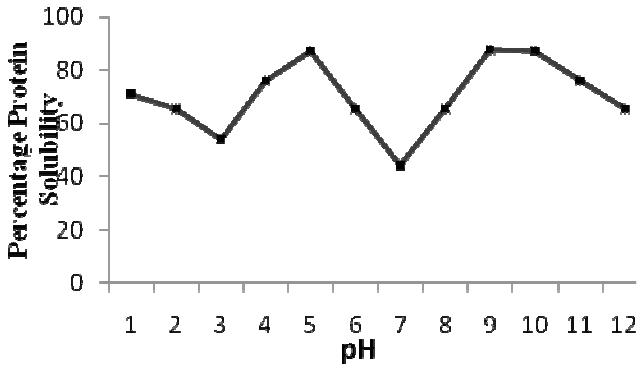

Figure 1. Variation of Protein Solubility of *C. forda* Flour with pH.

and for lupin seed by Sathe et al. (1982). The inability of the sample flour to produce foam can be attributed to the extent to which the protein has been denatured during processing – drying, storing, etc.

The effect of pH on the protein solubility is shown in Figure 1. The Figure shows that *C. forda* flour showed high solubility in both acidic and basic media. Two iso-electric points can be observed in the figure – at pH of about 3 and pH of about 7.1. Its high solubility in both acidic and basic media indicates that *C. forda* powder may be useful in the formulation of acid foods (like milk analogue products and protein rich carbonated beverages) (Kinsella, 1979) and basic foods (like meat products and biscuit) (Olaofe et al., 1998). The two peaks shown by the profile indicate that the sample flour has two major protein constituents.

Conclusion

This study showed that *C. forda* is a good source of protein and fat but a poor source of calcium and iron; it can be recommended for pregnant women and be used in the formulation of infant foods but must be fortified with calcium and iron minerals. Therefore it is a good source of food for men or women (who are in menopause). *C. forda* flour could be useful in the formulation of viscous food like baked foods due to its high water absorption capacity. It could also find application as a flavour retainer and to improve the mouth feel of foods due to its high oil absorption capacity.

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