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COMPARATIVE NUTRITIONAL EVALUATION OF UNINFESTED AND WEEVIL-INFESTED COWPEA (*Vigna unguiculata*) IN IGBOORA

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Abstract

This study was carried out to evaluate the proximate composition (PC), some mineral element contents (MEC) and some functional properties (FP) of cowpea (Vigna unguiculata) sold and consumed in Igboora. Two portions of cowpea samples (uninfested and weevil-infested) were powdered and analysed using standard analytical techniques. The results showed that the uninfested sample and the weevil-infested sample had the following PC (in %): Moisture contents, 11.34 and 9.37; protein, 20.44 and 15.43; ash contents, 3.36 and 2.99; crude fat, 1.67 and 0.99; crude fibre, 1.02 and 1.00 and carbohydrate contents, 62.34 and 70.23, respectively. The results for MEC is as follows (in mg/kg): Ca, 19885 and 19836; Mg, 16133.5 and 16019; K, 49555.5 and 49333.5; Na, 40891.5 and 40425.5; Fe, 50.35 and 39.35; Zn, 30.13 and 26.34; Cu, 0.06 and 0.04, and P, 1123.5 and 1033.5 for uninfested and weevil-infested samples respectively. The results also gave FP (in g mL⁻¹) as follows: Water absorption capacity, 1.31 and 1.23; loose bulk capacity, 0.71 and 0.51; packed bulk capacity, 0.91 and 0.62, and oil absorption capacity, 1.33 and 0.88 for infested and weevil-infested sample respectively. This showed that weevil infestation led to decrease in all the parameters considered and therefore, affected the quality of cowpea negatively. It is recommended that cowpea should be properly stored to prevent infestation by weevils.

Keywords: uninfested, weevil-infested, proximate composition, mineral element contents, functional properties

Introduction

The effects of insect pests on food crop can not be over-emphasized and as viewed by Thomas (1999), insect pests in agricultural systems are one of the major causes of damage to crop production and storage. In tropical countries, pests are believed to cause losses approaching 60–70%, principally in stored products (Thomas, 1999; Nwilene *et al.*, 2008). This affects both the quantities and qualities of food crops. One of such crops is cowpea (*Vigna unguiculata* L. Walp.). The damage is usually colossal and needs prompt attention by scientists, farmers and consumers. The damage could be assessed by analysing the proximate composition, the mineral element composition, functional properties, among others, of the uninfested and weevil-infested seeds and thereby evaluating the damage done to the crop. Cowpea is an important food legume and an essential component of cropping systems in the drier regions of the tropics (Singh and Adu-Dapaah, 1998). The history of cowpea dates to ancient West African cereal farming, 5000 to 6000 years ago, where it was closely associated with the cultivation of sorghum and pearl millet (Singh *et al.*, 2003). In West and Central Africa, cowpea is of major importance to the livelihoods of millions of people providing nourishment and an opportunity to generate income (Latunde-Dada *et al.*, 1999). The bulk of the diet of rural and urban poor Africa consists of starchy food made from cassava, yam, plantain and banana, millet, sorghum, and maize. As stated by Saber and Hussein (1998), the addition of even a small amount of cowpea ensures the nutritional balance of the diet and enhances the protein quality by the synergistic effect of high protein and lysine from cowpea and high methionine and energy from the cereals. Boulter and Evans. (1975), reported that cowpea contains about 24% protein, 62% soluble carbohydrates, and small amounts of other nutrients; so, most of its nutritional value is provided by proteins and carbohydrates. The high protein content represents a major advantage in the use of cowpea in nutritional products, for infant and

children's food, and to compensate for the large proportion of carbohydrates often ingested in African diets. Cowpea storage bruchid *Callosobrochus maculatus* is a cosmopolitan pest of cowpea in the tropics and subtropics of the world. It is commonly referred to as cowpea weevil and well known to deteriorate stored cowpeas (Booth *et al.*, 1990; Bagheri, 1996); its larva infest other grains such as chickpea, bambara groundnut, green gram, lentil, broad bean and green pea and subsequently resulted in physical and nutritional losses. *Callosobrochus maculatus* infestation constitutes a serious threat to the cowpeas growing regions of the world. The infestation may start from the field and continue during storage (Osuji, 1985). Evangelisti *et al.* (1994) reported that previous research also showed that insect pest can affect quality of plant food and negatively alter the chemical composition. The severity of the effects will depend on the stage of the development of the pest and the intensity of the attack.

Some research works had been carried out on the proximate, mineral element compositions and functional properties of cowpea (*Vigna. unguiculata*) in Nigeria. However, none of these works has been carried out in Oyo State, especially in Ibarapaland of Oyo State. The present study is, therefore, aimed at investigating the effect of *Callosobrochus maculatus* infestation on the proximate composition, mineral element contents and some functional properties of a cultivar of cowpea (*V. unguiculata*) commonly sold and consumed in Igboora, Ibarapa Central Local Government Area of Oyo State Nigeria. This will give a scientific touch to some of the damages done by beans weevil to cowpea in this area.

Materials and methods

Experimental site: The study was carried out at the Research Laboratory of Oyo State College of Agriculture and Technology, Igboora, Oyo State, Nigeria.

Samples and sample treatments: Clean non-weevil-infested cowpea sample (the brown type, usually called Ife Brown), in its dried state, was purchased from Towobowo Market, Igboora, Oyo State, Nigeria. The sample was identified and authenticated in the Department of Agricultural Technology (Crop Science Unit), Oyo State College of Agriculture and Technology, Igboora, Oyo State, Nigeria. The cowpea seeds were carefully handpicked to get the viable ones and kept in an air-tight transparent plastic container for two weeks to ascertain their uninfested status. These were then divided into two portions. The first portion was kept in a transparent plastic container, covered properly and labelled "Uninfested cowpea". The second portion was put in another transparent plastic container, artificially infested with *Callosobrochus maculatus* that were harvested from previously infested cowpea seeds, covered properly and labelled "Weevil-infested cowpea". Both samples were kept in a safe place in the laboratory for six weeks after which the infested cowpeas were picked to separate the pest and excretory materials and separately ground to powder using porcelain-made laboratory mortar and pestle and stored in a sealed air-tight containers separately prior analysis.

Proximate analysis: Proximate composition (moisture, proteins, fat, crude fibre, ash and carbohydrates) of infested and uninfested cowpea seed powder were determined by methods of analysis AOAC (1990). The crude protein contents ($N \times 6.25$) of the samples were estimated by the macro-Kjeldahl method; the crude fat was determined by extracting a known weight of powdered sample with petroleum ether, using a Soxhlet apparatus; the ash content was determined by incineration at $600 \pm 15^\circ\text{C}$. Total carbohydrates were calculated by difference.

$$\text{Carbohydrate (\%)} = 100 - (\text{moisture} + \text{ash} + \text{fat} + \text{crude fibre} + \text{protein}) \%$$

Determination of mineral elements: Atomic absorption spectrophotometer (Pye Unicam sp. 9 AAS) was used for the determination of calcium, magnesium, iron, sodium, manganese, phosphorous and potassium. Sample product (2 g) was ashed in a muffle furnace. Fifteen milliliter of 20% (v/v) of nitric acid solution was ashed in the crucible to break up the ash. This was boiled and filtered and acid-washed through Whatman paper. The

residue and the paper were washed 3 times with de-ionized water into a standard 100 mL volumetric flask, then diluted to 100 mL with de-ionized water.

Water absorption capacity of infested cowpea flour

Water absorption capacity (WAC) of the cowpea powder was determined using the methods of Sosulski *et al.*, (1976). One gram of powder sample was mixed with 10ml of distilled water. The mixture was allowed to stand, at room temperature, for 30 minutes and then centrifuged at 2000g for 30 minutes. Water absorption capacity was expressed as gram of water bound per gram of the powder.

Oil absorption capacity of infested cowpea flour

Oil absorption capacity (OAC) of the cowpea powder was determined using the methods of Sosulski *et al.*, (1976). One gram of flour sample was mixed with 10ml of refined soybean oil (sp.gravity 0.9092). The mixture was allowed to stand at room temperature for 30 minutes and then centrifuged at 2000g for 30 minutes; oil absorption capacity was expressed as gram of oil bound per gram of powder..

Bulk densities

The method of Mpotokwane *et al.*, (2008) was adopted for the determination of loose bulk density (LBD) with slight modification. A measuring cylinder (100mL) was filled with the powder to 100mL mark, and the content weighed. Bulk density was calculated as the ratio of the bulk weight and the volume of the container (g/mL). The packed bulk density (PBD) was also obtained by using the same procedure for the LBD, but tapping for 50 times prior to weighing.

Results and discussion

The results of the proximate composition of uninfested and weevil-infested cowpea are shown in Table 1. The results showed that the protein content decreases with respect to infestation of cowpea from 20.44% for uninfested cowpea to 15.43% for weevil-infested cowpea. The decrease in the protein content could be attributed to the utilization of these nutrients by the infesting *Callosobruchus maculatus* as opined by Ojimelekwe, 2002. These results agreed with the findings of Mbah and Silas (2007), Ojimelekwe (2002), Owolabi *et al.*, (2012) and Oyeyinka *et al.* (2013), all of whom reported decreased protein values for weevile-infested cowpea seeds as against uninfested ones. An increasing value was noticed in the carbohydrate contents after *C. maculatus* infestation with carbohydrate contents increasing from 62.34% (uninfested) to 70.23% (weevil-infested). The increasing value of the carbohydrate content may be attributed to the feeding activities of the insect (Owolabi *et al.*, 2012). There was no appreciable difference in the fibre content of the weevil infested and uninfested cowpea, with 1.02% for uninfested and 1.00% for infested cowpea. These results obtained for the fibre content after infestation is similar to previous report by Oyeyinka (2013). The results showed a decreasing value in the moisture contents from 11.34% in uninfested to 9.37% in weevil-infested cowpea, fat 1.67 (uninfested) to 0.99 (weevil-infested) this may be as a result of excretion and other secretion by the insect; The decrease in moisture content observed as a result of infestation could be ascribed to the humidity of the storage facility that promotes infestation. As stated by Mbah and Silas (2007), storage conditions, variety, geographical location and time of the year affect moisture content. The ash contents decreased from 3.36 for uninfested to 2.99 for weevil-infested sample. This is as a result of pest infestation, so this decreased value of the ash content of the infested cowpea could be attributed to the feeding activities of *C. maculatus* generating less residue which amounts to ash.

Mineral element compositions

The results of the mineral element composition of uninfested and weevil-infested cowpea are shown in Table 2. A total of eight (8) Mineral elements namely Calcium(Ca), Magnesium (Mg), Potassium (K), Sodium (Na), Iron

(Fe), Zinc (Zn), Copper (Cu), Phosphorus (P) were analyzed and detected uninfested and weevil-infested cowpea seeds. *Callosobruchus maculatus* infestation led to a reduced concentration of all the mineral elements evaluated in the cowpeas. There were decrease in the values of mineral element concentrations for uninfested and weevil-infested cowpea seeds (in mg/kg) as follows: Ca, 19885 to 19836; Mg, 16133.5 to 16019; K, 49555.5 to 49333; Na, 40891.5 to 40425.5; Fe, 50.35 to 39.35; Zn, 30.13 to 26.34; Cu, 0.06 to 0.04 and P, 1123.5 to 1033.5 for weevil-infested to uninfested cowpea seeds respectively. The observed reductions in the mineral contents after infestation may be due to the feeding activities of the insect and the developmental stages of the insects as stated by Ojimelekwé (2002), during which a high level of minerals were utilized by the infesting pest. Minerals are considered essential to life and form the main electrolyte of the human body, maintain tissue homeostasis and at the same time form the main structural component of bones and teeth. Any condition that leads to the non-availability of these nutrients will affect the body chemistry of humans and other animals

Functional properties of infested cowpea flour

Table 3 shows the the results of analysis of functional properties of uninfested and weevil-infested cowpea. Water absorption capacity (WAC) varied in uninfested and weevil-infested cowpea powder samples: 1.31g mL^{-1} in uninfested and 1.23g mL^{-1} in weevil-infested sample. Falade and Kolawole (2011) and Ngoddy *et al.* (1986) reported higher values of 1.64g mL^{-1} and 4.78g mL^{-1} respectively for cowpea flours while Oyeyinka *et al.*, 2013 reported lower values of 1.25g mL^{-1} and 1.00g mL^{-1} for uninfested and four weeks weevil-infested cowpea flour respectively. The difference in the WAC of the flours may be attributed to the cultivar used and the period of infestation. Since proteins are the major constituents of flours responsible for the bulk of water uptake (Afoakwa 1996), the decrease in the WAC could be attributed to the low protein content of the flours as storage period increased. This observation suggests that the economic values of akara, moin-moin or any other product produced from infested cowpea will be low and hence, there is the need to prevent infestation at all cost. The loose bulk density (LBD) of the powder decreased with value of 0.71g mL^{-1} uninfested cowpea and 0.51g mL^{-1} for weevil-infested sample. Oyeyinka *et al.* (2013) reported lower values ranging from 0.56g mL^{-1} to 0.66g mL^{-1} for infested cowpea flour for four weeks and uninfested cowpea flour respectively. The packed bulk density (PBD) decreased from 0.91g mL^{-1} for uninfested to 0.62g mL^{-1} for weevil-infested cowpea. A lower value of 0.85g/mL for uninfested cowpea and a higher value of 0.75g mL^{-1} for infested cowpea flour for four weeks. Falade and Kolawole (2011) and Olapade *et al.* (2004) reported PBD values of 0.63g mL^{-1} ; 0.713g mL^{-1} respectively. According to Perez (1997), the difference in the bulk densities could be attributed to the difference in the particle size. The oil absorption capacity (OAC) of the powder also decreased significantly from 1.33g mL^{-1} for uninfested sample to 0.88g mL^{-1} for weevil-infested. Oyeyinka *et al.* 2013 reported values ranging from 0.8g mL^{-1} to 1.10g mL^{-1} for infested cowpea flour for four weeks and uninfested cowpea flour respectively. In the words of Henshaw and Lawal (1993), heat denaturation of cowpea protein has been associated with high oil absorption capacity of cowpea. And also as reported by Kinsella (1982) and Sathe *et al.* (1982), the mechanism of oil absorption involves the physical entrapment of oil by food components and the affinity of nonpolar protein side chains for lipids. The OAC of flours is important for the development of new food products as well as their storage stability, particularly for flavour binding and in the development of oxidative rancidity (Oyeyinka *et al.*, 2013)

Conclusion

This study has shown that cowpea weevil (*Callosobruchus maculatus*) infestation affected the nutritional quality of cowpea. The weevil attacks majorly the protein, carbohydrate and mineral element contents of cowpea during storage. The effect on the protein content, in turn, significantly affected some other nutritional and functional properties of the powder made from the infested cowpea. The consumption of products made with the powder will not, therefore, supply sufficient nutrients needed for growth and healthy living of organisms that consume the products. Proper storage of cowpea is necessary to maintain its quantity and quality. Methods that will lead to the eradication of the weevils should also be used to make cowpea free from infestation.



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Table 1: Proximate composition uninfested and weevil-infested cowpea powder

Parameter (%)	Non-infested cowpea	Weevil-infested cowpea
Moisture content	11.34 ± 0.20	9.37 ± 0.05
Crude protein	20.44 ± 0.02	15.43 ± 0.01
Ash content	3.36 ± 0.04	2.99 ± 0.01
Crude fibre	1.02 ± 0.02	1.00 ± 0.00
Crude fat	1.67 ± 0.01	0.99 ± 0.01
Carbohydrates	62.34 ± 0.32	70.23 ± 0.07

Table 2: Mineral element compositions of non-infested and weevil-infested cowpea powder

Parameters (mg/Kg)	Uninfested cowpea	Weevil-infested cowpea
Calcium (Ca)	19885 ± 4.24	19836 ± 2.83
Magnesium (Mg)	16133.5 ± 0.71	16019 ± 0.71
Potassium (K)	49555.5 ± 4.95	49333 ± 1.41
Sodium (Na)	40891.5 ± 0.71	40425.5 ± 3.53
Iron (Fe)	50.35 ± 0.02	39.35 ± 0.21
Zinc (Zn)	30.13 ± 0.00	26.34 ± 0.01
Copper (Cu)	0.06 ± 0.01	0.04 ± 0.00
Phosphorus (P)	1123.5 ± 0.71	1033.5 ± 0.71

Table 3: Functional properties of uninfested and weevil-infested cowpea powder

Parameter (gmL ⁻¹)	Uninfested cowpea	Weevil-infested cowpea
Water absorption capacity	1.31±0.20	1.23±0.22
Loose bulk density	0.71±0.01	0.51±0.02
Packed bulk density	0.91±0.24	0.62±0.44
Oil absorption capacity	1.33±0.10	0.88±0.01