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ORIGINAL RESEARCH ARTICLE

Effects of *Callosobruchus maculatus* Infestation on the Proximate Composition of Cowpea (*Vigna unguiculata* L.) Sold in Lapai Market

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ABSTRACT
Cowpea damage caused by pest infestation is a major challenge to farmers and traders in Nigeria which request urgent response. This research is aimed primarily to evaluate the proximate composition and degree of infestation effect on cowpea (*Vigna unguiculata* L. Walp) nutrients. The samples of cowpea were randomly collected in the Lapai market, refrigerated for a week to stop insect action and were separated into two categories, non-infestation (sample without exit hole) and infestation (samples with one, two and three exit holes), Samples were subjected to proximate composition and statistical analyses for variation in nutrient. Results show a rise in protein and moisture content in the sample without infestation. But shows a decrease in Carbohydrate, Fat, Fibre and Ash content in non-infested samples. For the infested sample, infestation leads to significant deterioration of nutrients of food products developed from cowpeas. The current result shows that pest infestations reduced nutritional benefits as a protein source in livestock and human diets.

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INTRODUCTION
Cowpea farming is tormented via insect pest infestations causing damages and capital losses. The damages caused by the pest are the fundamental limitation to cowpea grain production in major cowpea-producing countries (Singh & Emden, 1979; N'Gbesso *et al.*, 2013). Cowpea weevil (*Callosobruchus maculatus)* are the leading insects inflicting harm to saved cowpeas in West Africa. Infestation of pest starts from field and after the crop is positioned in storage. The damages continue till the cowpea is destroyed (Bolarinwa, *et al.*, 2022; Profit, 1997).

The cowpea plant is commonly farmed in the West Africa, Latin America, Southeast Asia and the United States. It is a food crop adapted to drought-tolerant as well as a varied range of temperature and soil (Langyintuo *et al.,* 2003; Manda *et al.*, 2019). Nigeria is the leading cowpea producer with more than 60% of the overall production in the world followed by the Niger Republic (FAO, 2017). Over 14.5 million acres are thought to be used for cowpea cultivation globally, with an expected annual production of 7.64 million tonnes. West and Central Africa make up more than 9 million acres and 3 million tonnes of this projection (FAO, 2017). Beans might serve as useful food due to the presence of some bioactive compounds like enzyme active site, lectin, phytic acid, carbohydrates and phenolic substances that could display metabolic activities in human beings as well as fauna that regularly feed from the meals (Diaz-Batalla, *et al.*, 2006). The health benefits of cowpea intake have been associated with, a reduction in cholesterol degree and coronary heart illnesses (Anderson, Smith, Washnock., 1999; Rosa, *et al.,* 1998). Other benefits are resistance to cancer, reduces diabetics, weight problems, high antioxidant capability, and anti-mutagenic as well antiproliferative effects (Paredes, *et al.*, 2009) Nigeria established mortality rate of 10 - 20 times in children of less than 4 years of age compared to the developed countries. This was due to protein energy malnutrition (PEM) observed in the estimation of 800 children that die from malnutrition. Cowpea cultivation

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is suffering from insect pest and disease damage which leads to monetary losses (Singh, et al., 1997). The cowpea weevils, *Callosobruchus maculatus* are the number one insect inflicting losses on saved cowpea in West Africa (Aliyu and Ahmed, 2006).

The use of insecticide exerts a toxic effect on humans as well as animals via inhibiting the enzyme. The effect generated by acute publicity includes nausea, vomiting, diarrhoea, fatigue, headache and many others. In general view, the major factors that are hindering and imposing a high threat on the cultivation of cowpea in Nigeria are weevils, diseases and weeds. The practice of monoculture farming has increased populations of weeds, weevils and diseases for so many years in the country (Bolarinwa, *et al.*, 2022; Emosairue & Ubana, 1998). Habitually, Nigerian farmers depend mainly on pesticides for the inhibition of numerous weeds, cowpea pests and diseases, resulting in the massive importation of these chemicals with exorbitant prices that have made it impossible for local producers to afford (Okrikata and Anaso, 2008). With the demoralizing and damaging effect of insect pests on cowpea in most stages of its development, several methodologies have been accepted for its inhibition. Studies embarked on the prevention of these insects centred principally on the application of these chemicals (Echendu, 1991). Most of those chemicals are Azodrin, Dursban, Dimecron and, Thiodan DDT, which have been noted effective against the leafhoppers. For more than two decades, weevils' chemical has made significant contributions in the protection and preservation of these insects and infections.

Nevertheless, their widespread and continuing use has led to pest resistance and pollution, which has led to import restrictions. Challenges, such as soil and aquatic adulteration with continuous rise of the dangerous chemical deposits in major and derived system agriculture, which are threatened both the habitat and man's health. The projected capital cost of environmental and socio-economic destruction is US$8.1 billion annually (Shen and Zhang, 2000). Broadly, synthetic organic pesticides used in product insect control plans globally have caused significant environmental damage, increased insects revival and resistance to pesticides, and lethal effects on non-targeted species (Alao and Adebayo, 2011). As a result of harmful influence on non-targeted species such as human being, and the ecosystem, organochlorine has been allegedly forbidden in developed nations. This revived the use of botanical insecticides with favourable active components as a substitute to insects control. Botanical insecticides are naturally occurring chemicals derived from plants and easily decompose in the soil without storing any residue in the organism's tissue and with no long-lasting effect as compared to those synthetic pesticides (Isman, 2006). Botanical insecticides are usually pest specific with moderately harmful to non-targeted species. They are decomposable and inoffensive to the ecosystem. Additionally, the risk of pest developing resistance to botanical pesticides is reduced (Schmutterer, 1990). Although more than 2000 plant species are known to have insecticidal active compounds, but only a small number have been thoroughly studied. (Ojo, 1996; Isman, 2000).

Researchers revealed the global challenges of malnutrition popularly known as hidden hunger (Ritchie & Roser 2020) due to unhealthy diet and diseases which leads to impaired growth, fitness and high mortality rate in both developed and underdeveloped nations of the world, responsible for not less than 70% deaths in the year 2015 (Forouzanfar *et al.*, 2015). This malnutrition which may also be considered a nutritional deficiency has become a threat. More than two billion people majorly women, children and infants are suffering from micronutrient malnutrition (Roorkiwal, *et al.,* 2021 & World Health Organization 2017). In the year, 2018, 5.3 million children under the age of five died, with undernutrition being blamed for almost 45% of those deaths, (World Health Organization 2017). Moreover, the National Socioeconomic Development Plan (NSEDP) has been lowered, and there have been more illnesses, disabilities, and mental growth issues (FAO *et al.*, 2017)

Considering the above-listed challenges legumes such as cowpea, pigeon pea, and other beans are cheap sources of protein (20-25%), and minerals and vitamins (50%) available for almost every resource-poor people in west Africa especial Nigeria which is the leading major producer of cowpea in the world. Attention to cowpea production will contribute to reducing the problem of nutritional imbalance in Nigeria and globally. (Jayathilake, *et al.*, 2018 & Sánchez-Chino *et al.*, 2015). This study has determined the variability of the nutritional quality as affected by the cowpea weevil infestation in Nigeria.

MATERIALS AND METHODS

Sample collection

Samples of infested and non-infested beans were obtained from Lapai market of Niger state, Nigeria which is located at latitude 09° 3′ and longitude 06° 3′. To inhibit pest activity, the samples were placed in the refrigerator for a week. They were then dried for Three days. The proximate analysis was carried out in the Biological Science Department, Faculty of Natural Sciences, Ibrahim Badamasi Babangida University, Lapai (IBBUL), Niger State, Nigeria.

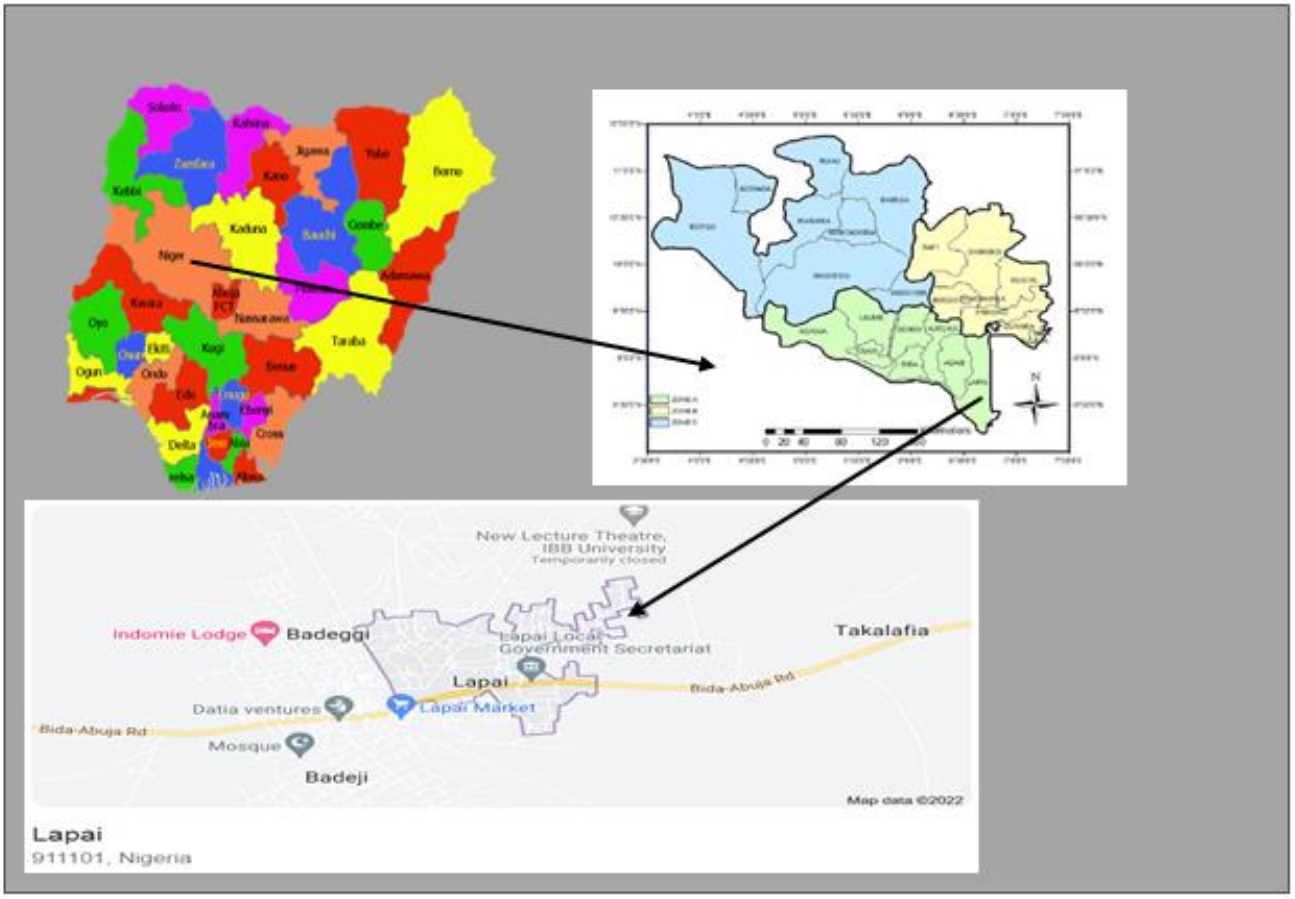

Figure 1: Map of Nigeria showing the study area

Treatment

The cowpea raw matured seeds' nutritious value per 100gram results in the proximate composition of infested and non-infested cowpea seeds. Non-infested cowpea (Sample Check SC) Infested sample with one exit hole (Infestation A, (IA); with two exit holes Infestation B, (IB) and with three exit holes, Infestation C, (IC).

Analysis of Cowpea Proximate Composition

Proximate analysis of cowpea composition such as total carbohydrates, protein, fat, fibre moisture and ash are determined According to Onwuka's, (2005) and AOAC, (1990) methodology. The samples total moisture, ash, crude fibre, and fat were performed in triplicate. Nitrogen was estimated using the Micro-Kjeldahl method and a factor of N×6.25 was used to convert nitrogen content to protein. Crude fat was determined by mining a powder sample of known weight with petroleum ether using a Soxhlet device. Ash content was determined by combustion at 600 ±15°C. The number of total carbohydrates was calculated as a "difference". The proximate standards were defined in percentage (%). Moisture percentage was determined using the oven drying method.

Statistical Analysis

For each determination, the analysis was performed in triplicate, and the mean stander deviations were used to express the results. The Analysis of Variance (ANOVA) and Pearson correlation coefficients were performed using the SPSS 17.0 for Windows Computer Software Package. For ANOVA and Pearson correlation, the significance of the differences was determined at $P < 0.05$ and $P < 0.05$ and 0.01. Duncan's new Multiple Range tests were used to compare the mean differences.

RESULT

The results of the proximate composition of cowpea nutrients (non-infested and infested) are shown in figure 1. The outcome revealed that the protein composition decreases in infested cowpea value when compared to non-infested cowpea value: non-infestation protein 20% while infestation protein 19%. Fat and fibre are equal in non-infestation and infestation percentage of 4% each. While moisture and carbohydrate showed increased in infested cowpea percentage: moisture 5% in non-infestation to 6% in infested cowpea.

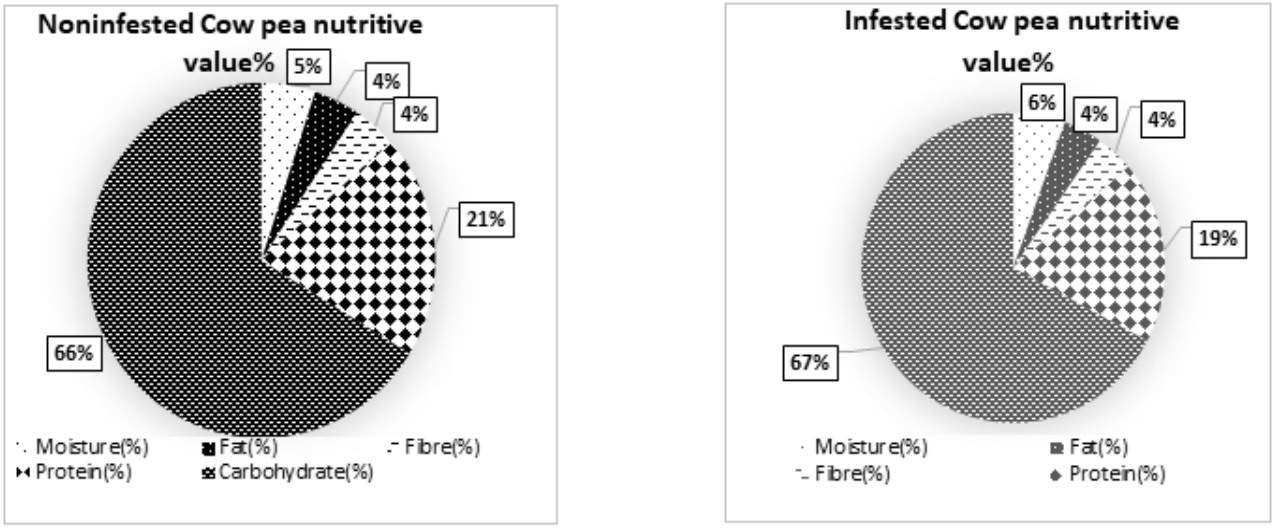

Figure 2: Nutritive value percentage of non-infested and infested cowpea

Table 1 displays the effect of pest infestation on cowpea the parameters determined include Protein, Carbohydrate, Fat, Fibre, Ash as well Moisture which all have three replicates each.

Protein content was observed to be significantly ($P<0.05$) affected by the infestation where cowpea seeds treated as control have revealed greater contents and those seeds with one and two exit holes were observed to contained least protein. Carbohydrate content was found to be not significantly affected by the infestation, since cowpea control revealed less content to the infested cowpea. Fat, fibre and ash content were observed to be less affected where cowpea control seed treatments have their contents less than the infested cowpea. moisture content was observed to be significantly ($P<0.05$) affected by the infestation where cowpea seeds treated as control have revealed greater contents and those seeds with one and two exit holes were observed to contained least moisture.

Table 1. Cowpea sample's Proximate composition.

Parameter	Sample C	Infestation A	Infestation B	Infestation C
Protein	19.25 ± 0.01^{b}	17.49 ± 0.01^{a}	17.25 ± 0.01^{a}	18.52 ± 0.01^{b}
Carbohydrate	62.33 ± 0.01^{a}	64.49 ± 0.01^{c}	66.13 ± 0.01^{a}	63.57 ± 0.01^{b}
Fat	4.02 ± 0.02^{b}	4.50 ± 0.01^{c}	3.50 ± 0.01^{a}	4.02 ± 0.01^{b}
Fibre	3.81 ± 0.01^{b}	4.01 ± 0.01^{b}	3.62 ± 0.01^{a}	3.90 ± 0.01^{b}
Ash	3.51 ± 0.01^{b}	4.01 ± 0.01^{c}	3.01 ± 0.01^{a}	4.00 ± 0.01^{c}
Moisture	7.09 ± 0.01^{c}	5.51 ± 0.01^{b}	4.49 ± 0.01^{a}	5.99 ± 0.01^{b}

Value tend mean ± SD; minimum towards a maximum (range) means carrying superscript letter into the same row tend significantly different at $p\leq0.05$

DISCUSSION

The choice of cowpea as a preferred nutritive substitute crop, in developing countries especially Nigeria is the largest producer, where nutritional deficiency is killing millions of its citizens while the crop is in abundance and affordable for the poor mass. Unfortunately, pest infestation posed a serious constraint on cowpea production. The average nutritive value of Moisture, Fat, Fibre, Protein and Carbohydrate obtained from this study, revealed that despite the reduction in nutrients due to pest infestation, the 100g of these cowpea nutrients are valid to provide a daily nutritive requirement for man. In this study, the protein content recorded is between 19% - 17%. This is in line with what El-Niely, (2007) reported. The protein content decreases with the effect of the weevil's infestation. This is similar to what was reported by Salawu *et al.*, (2014)., Although the value is below what was recorded by (Fatokun, *et al.*, 2000; Ajeigbe, *et al.*, 2008; Mamiro, *et al.*, 2011). Cowpea possesses high-quality protein content and the content disparity depends on the variability (Vasconcelos, 2010)

Carbohydrate recorded in this study is 62.22% – 66.13% and is a little bit higher than what was recorded in other studies (Khalid & Elharadallou, 2013; Kirse & Karklina, 2015). Similar was recorded by other research (Thorne, *et al.*, 1983) with a value between 60% - 70%. Evidence suggests that cowpea and other legume seed's resistant starch and amylose (carbohydrate and fibre) have a significant impact in man's health. The slow pace of digestion of foods high in resistant starch and amylose results in a slow release of glucose into the organism and reduces the amount of glucose that is taken up by the

intestinal cells (Thorne, *et al* 1983; Sajilata, *et al*., 2006). Resistant starch enters the digestive track and aids as a substrate for active probiotics since it is not fully digested by digestive track enzymes. The colonic microorganisms' fermentation of such resistant starches end up in the formation of short-chain fatty acids like butyrate, which have numerous positive health effects in terms of good lipid function and cancer prevention (Key, *et al*., 2004). Cowpea seeds are a low glycemic snack because they have a remarkable quantity of resistant starch and nutritive fibre (Vatanasuchart, *et al*., 2009). Cowpeas are another low-calorie food that can be used as a meal to help diabetics better regulate their blood sugar and aiding obese persons to lose weight (Oboh & Agu, 2010).

In Table 1 sample check (SC) with protein content (19.246±0.01%) has the highest protein content compared to the other samples infested IA, and IB (17.4933±0.01) has the lowest protein content because both have an equal full-size difference in protein content. The findings address the beans' ability to significantly contribute to the daily human protein requirement (Jayathilake, *et al* 2018). The protein constitutes found in pigeon pea has been discovered to range between (18.29%) and as much as 30% described in some closely related *Cajanus* spp (Damaris, 2007). Due to the reduction in some dietary requirements, such as protein and carbs that range between 18 and 29%, the infected cowpea tends to be unviable. Pests have damaged the nutritional content in several ways, but the protein content material's basic pattern has been more severely affected. Additionally, it has been stated that white beans are a traditional cuisine consumed by several individuals in Latin America, Africa (Nigeria), and Asia. They are a great protein source, vital vitamins and minerals, soluble fibre, carbohydrates, phyto-chemicals, and low-fat ingredients (Paredes, *et al*., 2009). There was a considerable difference in the number of carbohydrates in the samples, with the infested cowpea IB having the highest concentration (66.13±0.01d) and the uninfested cowpea SC having the lowest (62±0.01a). Comparable figures (61.29%) were reported by Olapade *et al.* (2004) using cowpea flour. Given that the OAC of the flours similarly reduced with a rise in garage time and an increase in the range of pest, the decrease in the seed's fat content was not a surprise. This assertion is in line with the findings by Ravi and Sushelamma (2005), who ascribed the oil-preserving qualities of dietary items to their composition and protein concentration.

The most crucial factor is the seed moisture content since it controls the seeds' toughness. Better seed moisture increases seed degradation, which ultimately lowers the cost of planting seeds in the area. The moisture content shows the best variety of beans to be SC (7.09±0.01d) and the least variety to be IB (4.49±0.01a), which could have been quite particular. When legume seeds reached physiological maturity, their moisture content material variety produced 40% - 50% of their total weight (Delouche, 1980). Based on my research, pest infestations have been shown to reduce some of the key dietary components, which has led to a reduction in the quality and quantity of cowpea seeds based on the ranges.

CONCLUSION

The findings of the current study clearly show that infestation has an impact on the composition, nutritive value of cowpeas. Dependence on cowpea as a potential protein supply is only worthwhile if it is accompanied by providing enough protection for the seeds against infection.

RECOMMENDATION

Increased efforts should be made to guarantee healthiness and maximize nutrient retention in cowpea even during small-scale storage.

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