

Anti-Nutritional Status of Uninfested and *Prostephanus truncatus* (Horn) (Coleoptera: Bostichidae) Infested Dried Cassava Chips

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Abstract: This research study focus on the determination of anti-nutritional content status of the uninfested and infested dried cassava chips by *Prostephanus truncatus*. *Prostephanus truncatus*, the larger grain borer, is an alien invasive post harvest pest; with wide spread population all over cassava growing regions. After an infestation period of 10 weeks in the laboratory, proximate analysis revealed increased values for only alkaloids content in the infested dried cassava chips, while all other contents, such as hydrogen cyanide, saponin, tannin, trypsin inhibitor, oxalates and phytate had reduced values when compared to the un-infested dried cassava chips which recorded less anti-nutritional contents.

Keywords: Anti-nutritional factors, hydrogen cyanide and alkaloids, infestation, *prostephanus truncatus*

INTRODUCTION

The larger grain borer, *Prostephanus truncatus* (Horn) is a significant pest of stored products in many parts of Africa. It was introduced from Central America and Mexico in the early 1980's (Dick *et al.*, 1989; Hodges *et al.*, 1983; Krall, 1984; Golob, 1988). *Prostephanus truncatus* (Larger Grain Borer) is a major pest of cassava and other stored products. It causes damage to dried tuber of cassava during its infestation by converting the stored dried cassava tuber to cassava frass and fragment. Dried cassava chips are susceptible to attack by the insect. The structure of the dried cassava root may quickly be reduced to dust (Pingale *et al.*, 1956; Ingram and Humphries, 1972). The insect was for long regarded as a minor pest of only local or occasional importance in dry cassava. In Africa, the larger grain borer has locally been regarded as one of the most damaging pests of stored products such as dried cassava, Africans staple food crop. A weight loss of 70% in dried cassava chips within four months of infestation was recorded in Tanzania (Markham, 1992). Cassava, *Manihot esculenta* (Crantz) is a woody shrub of the Euphorbiaceae, native to South America that is extensively cultivated as an annual crop in tropical and subtropical regions for its edible starchy tuberous root, a major source of carbohydrates. Cassava was introduced to Africa by the Portuguese during the late 16th century (Ekandem, 1964; Agboola, 1968). The root is consumed in a number of forms as flour used for cooking, root slices, root chips, grated root (pan fried, baked or steamed), steamed whole root or tapioca pearls made as a pudding. Cassava is primarily a source of carbohydrate and contains very little fat or protein.

On the other hand, it is relatively rich in calcium and ascorbic acid (Doku, 1969). However, there are risk from cassava chips made from the root because cassava contains potentially toxic compounds called cyanogenic glycosides, primarily linamarin and a small amount of lotaustralin, collectively called hydrogen cyanide. Others include saponin, tannin, oxalate, alkaloid, phytate and trypsin inhibitor. Antinutrients are natural or synthetic compounds that interfere with the absorption of nutrients. One common example is phytic acid, which forms insoluble complexes with calcium, zinc, iron and copper (Cheryan, 1980). Safe human consumption of cassava is dependent on adequate processing to minimize the anti-nutritional content. If cassava is eaten either raw or after inadequate processing, then toxicity may be observed.

Adequate initial drying of any cassava products is required to bring down its moisture content (mc) below the critical water activity level and subsequently suitable packaging and storage facilities have to be provided to prolong the storage life. The package system should offer continued protection against biochemical deterioration, microbial growth and insect infestation which are likely to arise due to any rehydration by the uptake of atmospheric moisture (Stewart and Amerine, 1973). This research work focus on the anti-nutritional content status of the uninfested and *Prostephanus truncatus* infested dried cassava chips in store.

MATERIALS AND METHODS

Test insect collection: A population of 630 test insect's pest, *Prostephanus truncatus* were collected

from a culture stock raised in Entomology Laboratory of the Department of Zoology, University of Ibadan, Ibadan, Nigeria.

Substrate processing and collection: The substrate dried cassava chips used for this experiment was obtained from cassava tubers purchased from a cassava market in Eleyele, Ibadan, South Western Nigeria with latitude 7°26'N and longitude 3°53'E. The cassava tubers were then processed to dried cassava chips. The processing entails, peeling, cutting and soaking to ferment for about 72 h. After which the cassava was firstly air dried and subsequently oven dried at 60°C in Gallenkamp oven of model OV-160 to adequately dry and sterilize the cassava chips from any pre infestation.

Experimental set-up: The processed uninfested dried cassava chips were grinded in mortar to powdery form. A total 700 g was used. Weighed 100 g in seven places were used for the antinutritional factor proximate analyses. On the other hand, a total of 3,150 g of dried cassava chips and 630 *P. truncatus* population were used for the infestation experiment set up of infested dried cassava chips. Weighed 50 g of the dried cassava chips was put into 63 specimen bottles (250 mL) and infested with ten *P. truncatus* each. The specimen bottles were then covered with muslin cloth which was held tight with rubber band and stored in wooden cage to prevent cross infestation and possible insect escape. These set-up were then stored away in the Laboratory for the period of 10 weeks. After, the period of infestation, the frass from the infested chips was sieved and weighed.

The frass from the 63 bottles were grouped into 7 groups. Frass from each of the 7 groups were used to analyze seven anti-nutritional content factors of the infested substrates. Each antinutritional factors analysis was replicated three times. This research work was conducted in the year 2010 in the Department of Zoology University of Ibadan, Oyo State, Nigeria.

Analyzed anti nutritional factors: The anti nutritional factors considered for analyses, were; the cyanogenic glycoside of the cassava frass, which was based on the

automated enzymic method (Rao and Hahn, 1984). Saponin content was analyzed by the modified method of Fenwick and Oakenfull (1983). Trypsin inhibitor was done based on the method described by Kakade *et al.* (1974). Others such as, oxalate was determined using method by Ekeke (2005). Furthermore, phytate was done using the method described by Latta and Eskin (1980). Also, total alkaloid analysis was done. Lastly, tannin was determined based on the method described by Schanderl (1970). Dry to constant weight was employed in measuring moisture content AOAC (1975). Both infested and un-infested dried cassava chips were analyzed for antinutritional content status. These analyses were conducted in the Food analysis Laboratory of International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, in the year 2010.

RESULTS AND DISCUSSION

Table 1 shows the anti-nutritional content status of uninfested dried cassava chips and the percentage moisture content. Seven different antinutritional factors were considered for proximate analysis.

The anti-nutritional factors content status of infested dried frass produced from the experimental set up revealed the mean values shown in Table 2. All the factors analyzed had reduction in their contents after the infestation period of 10 weeks.

The proximate analysis of the dried cassava chips done in the International Institute of Tropical Agriculture (IITA) Ibadan showed the impact of the pest activities on the anti-nutritional status of dried cassava chips. The analysis expressed a considerable difference in the parameters investigated which may be due to the metabolic and boring activities of *P. truncatus* on the dried cassava chips over the period of ten weeks of infestation in the laboratory.

The phytate level of the dried cassava chips which was 7.45 mg/100 g in uninfested chips. This dropped to 5.9 mg/100 g in infested chips, after 10 weeks of infestation with *P. truncatus*. Phytate content in fresh cassava tuber was 624 g/100 g. This was reduced by 88% in processed cassava tuber by fermentation. Marfo and Oke (1988). Beyond processing, insect activities

Table 1: Proximate analysis values of anti-nutritional factors of uninfested cassava dried chips (mg/100 g)

Anti nutritional factors	Phytate	Tanni	Oxalate	Hydrogen saponin	Total cyanide	Tripsin Alkaloids	Inhibitor	Moisture content (MC) %
Anti nutritional values	7.45	2.75	18.25	0.12	5.22	0.16	0.15	10.50

Table 2: Mean±SD Values of anti-nutritional factors of *P. truncatus* infested dried cassava chips (mg/100 g)

Anti nutritional factors	Phytate	Tannin	Oxalate	Saponin	Hydrogen cyanide	Total Alkaloid	Tripsin Inhibitor	Moisture content (MC) %
Total antinutritional values	136.6	8.80	113.70	2.60	65.50	130.10	0.83	
Range of antinutritional values	5.3-6.5	0.2-0.7	04.1-5.9	0.1-0.1	2.5-3.3	4.4-6.7	0.0-0.1	10.50
Antinutritional content Mean±SD	0.3±5.9	0.1±0.4	0.6±4.9	0.0±0.1	0.2±2.8	0.7±5.7	0.0±0.0	

reduced dried cassava chips to frass and this may be implicated in further reduction of the phytate content since the resulting frass has a larger surface area for evaporation of phytate to take place during the infestation period. Furthermore, phytate is a storage form of phosphorus which is found in plant seeds and in many roots and tubers (Dipak and Mukherjee, 1986). Phytic acid has the potential to bind calcium, zinc, iron and other minerals thereby reducing their availability in the body (Davis and Olpin, 1979; O'Dell and Savage, 1960).

In addition, complex formation of phytic acid with proteins may inhibit the enzymatic digestion of the protein (Singh and Krikorian, 1982).

The Hydrogen cyanide reduced from 5.22 mg/100 g to a mean value of 2.8 mg/100 g after the infestation period of 10 weeks. Hydrogen cyanide is a volatile compound; it evaporates rapidly in the air at temperature over 28 C and dissolves readily in water. It is easily lost during transportation, storage and analysis of specimen. Apart from the fact that cassava processing reduces the hydrogen cyanide content, insect boring activity and the ten weeks storage period may contributed to the evaporation of this volatile compound, various authors have suggested different minimal level for toxicity.

Rosling (1987) was of the opinion that an intake of over 20 mg/100 g of cassava is toxic, while Bothius in 1954 set that the toxic level was at an intake cyanide of 50 mg to 60 mg daily from a cassava dominated diet. This has been proposed as a contributing factor in two forms of nutritional neuropathies; tropical adoxie neuropathy in Nigeria and epidemic spastic paraparesis.

The oxalate content also reduced significantly from a pre infestation value of 18.25 mg/100 g to a mean value of 4.9 mg/100 g after 10 weeks of infestation with *P. truncatus*. Previous studies have shown that an anaerobic bacteria which degrades dietary oxalate to CO₂ and formate is present in the colon content of a number of phytophagous species (Argenzio *et al.*, 1987).

P. truncatus is an herbivorous species since it has been found feeding on woods and it contains bacterial flora in its guts to help it digest cellulose. It is therefore suspected that the anaerobic bacteria in the gut of *P. truncatus* may be responsible for the reduction in the oxalate content of the frass. Oxalates may have also evaporated and reduce in concentration over the infestation period. Oxalates in food of man are absorbed much by the gut; it will be metabolized by the flora in the intestines or excreted from the body as stool. The percentage alkaloid content was found to have increased from 0.16 mg/100 g to 5.7 mg/100 g for pre and infestation period respectively. This increase is suspected to be due to the presence of cellulolytic bacteria in the gut of *P. truncatus*. Vazquez *et al.* (1997) isolated and identified 3 bacteria strains with cellulose degrading capacity. The bacteria include *Alcaligenes*

faecoalis, *Chromobacterium violaceum* and *Pseudomonas fluorescens*. Since alkaloids are produced by organisms including bacteria, fungi, plants and animals and the dried cassava chip was properly processed and sterilized to rid it of bacteria and fungi before infestation. It is suspected that the cellulolytic bacteria in the gut of *P. truncatus* were responsible for the increase in quantity of the alkaloids in the cassava frass. Alkaloids produce strong physiological effects on the body (Microsoft® Student 2008) and food materials containing relatively high levels of alkaloids and are not suitable as animal feedstuffs because of their negative effects on intake. Cattle consuming certain Lupin species, a plant with high level of alkaloid during pregnancy may produce calves with multiple congenital deformities (D'Mello, 2000). It is advisable that heavily infested cassava chips and fragments should not be consumed neither should they be used to feed animals since alkaloid content rises in highly infested samples.

The values of saponin and tannin in pre and infested dried cassava chips were 0.12 mg/100 g and 0.10 mg/100 g for saponin, while, tannin was 2.75 mg/100 g and 0.40 mg/100 g. This reduction was suspected to be due to the evaporation of the compounds from frass and the fragment over the 10 weeks infestation period due boring activity of the pest. The quantity of trypsin inhibitor in the cassava was infinitesimal, the value was 0.15 mg/100 g and 0.00 mg/100 g was recorded at the end of the infestation period. Therefore trypsin inhibitor was completely lost during the time of infestation.

The feeding and boring activities of *P. Truncatus* during infestation brings about the exposure of the cassava dried chips when degrade, consequently this increase the surface area of the resulting frass and fragment, which in turn encouraged the reduction of most of the antinutritional factors with an exception of total alkaloid which was increased.

This study shows that infestation of dried cassava chips by *P. truncatus* reduce all anti-nutritional factors except alkaloid content that was increased.

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