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Original article

EVALUATION OF STEM BORERS TENERAL RESERVE CONCENTRATION AND THEIR EFFECTS ON PROXIMATE COMPOSITION AND YIELD PARAMETER OF MAIZE IN AGRO-ECOLOGICAL ZONE B, NIGER STATE, NIGERIA.

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ABSTRACT

Maize is a major source of carbohydrate and other beneficial nutrients in the diet of the consumers, and with the ever increasing demand in its production, it is not without constraints from insect pest infestation attributing to low yields with great economic importance. Hence, the need to assess the yield, compare the proximate composition of stems and grains from plants not infested and infested by stem borers, as well as nutrient reserve in the stem borer insect pest. The study was carried out in four localities namely; Beji, Chanchaga, Paiko and Shanu in Agro-Ecological Zone B of Niger State. At harvest, borers found on cobs and stems were collected, counted and preserved in 70% alcohol. The cobs were weighed, shelled and the grains weighed. Proximate analysis was done on the maize seeds and stems, while teneral reserve was done on the stem borer larvae, following standard experimental procedures. The proximate composition of the maize stems was highest in the non-infested stems except the crude fibre (73.26%) that was highest in the infested stems. Also, the proximate composition of the non-infested seeds had highest values except for moisture content (10.87%) that was highest in the infested seeds. Productivity was highest at the Shanu site with values of 183.95g and 154.45g, and lowest in Beji with 53.80g and 40.85g for a cob and grains, respectively. Aggregate teneral reserve of the terminal larval stage of the stem borer species were 61.67μg per stem borer for glycogen, 40.10 μg/stem borer for glucose, 106.64 μg/stem borer for lipid and 97.46 μg/stem borer for protein. The study revealed significant effects of stem borers on the maize plants and grains, which may further result to damage economically and nutritionally.

Key words: Maize, Stem Borer, Yield, Proximate Composition, Teneral Reserve

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INTRODUCTION

In Nigeria, specifically in the North central part of the country, cereal provides a major food resource with several nutritional benefits [1]. Maize production and its status in determining food security, economic growth and poverty reduction, has received a major focus in the past few decades. The plant can be used as raw material for manufacturing many food products both in industries and homemade meals [2]. The ever increasing number of Nigeria citizen has resulted to high demand for more maize production [3], even though majority of the cultivators are still house hold farmers.

Maize is categorized as an important cereal grown in Niger state, alongside sorghum, sugarcane, rice and millet [4]. However, maize annual crop production outputs remains very low, as compared to the State's potentials [4], due to several challenges such as abiotic and biotic components. Among the biotic components are the insect pests which are considered key pests, causing havoc with great economic importance. The most devastating of the insect pests of maize belong to the Order Lepidoptera [5].

The lepidopterans can be both maize ear/cob borers and stem borers such as *Busseola fusca*, *Eldana saccharina*, *Chilo partellus* and *Sesamia calamistis* that contributes majorly to maize crop yield reduction [6]. The damages caused by stem borers reduce the yield and quality of harvested maize and its products as, most of the maize plant parts at different agronomic stages of the maize life cycle are vulnerable to insect feeding from the time of sowing till harvesting. Extensive stem borer attack on maize plants can result to complete death of plant leading to enormous losses of up to 90% post-harvest and during storage [7].

The immature and mature stages of these stem borers can cause mechanical damage due to consistent feeding by boring and tunneling into stems or sucking fluid saps from stems and grains. The injury from feeding leads to damage of plant vascular bundles causing breakage and lodging [8]. This causes ultimate losses in crop value which are in economic returns and nutritional composition of up to 70% in areas with severe borer problems [9]. Stem borers cause 10-100% loss in maize grain yield [10, 11]. [12, 11], reported that within Africa, damage to maize varies with locations/regions, with sub-Saharan Africa recording the highest population of stem borers; being directly correlated with damage and grain yield

The nutritional composition of most edible insects have been studied by several authors [13, 14, 15], where most reports are on *Cirina forda* (Lepidoptera) which has been found to have protein and fats in high amounts. Similar information are, however, scanty for other Lepidoptera such as the stem borer even though, they are serious agricultural pests. Stem borers may have nutritional compositions that could be beneficial for other purposes such as poultry feed formulation.

Therefore, in order to make the production of cereals and maize crops, in particular, more attractive to farmers and boost subsistence and export needs of the country, there is need to estimate the extent of damage on yield by stem borers, as it is essential for determining the potential effect the pest has on maize crop production, which may warrant control measures [16]. This study was, therefore, aimed at assessing the yield, determine the proximate composition of stems and grains/seeds from infested and non-infested maize plants by stem borers, as well as, evaluate the teneral reserves in the stem borer insect pests.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out in Agro-Ecological Zone B of Niger state. The Capital city of the state Minna is situated within the zone. Four localities: Beji, Chanchaga, Paiko and Shanu where selected randomly for stem borer sampling. In each sampling site, 2 (two) farms where further selected not more than 5km apart for easy and quick accessibility.

Beji is located North-West along Minna – Maikunkele – Kagara road. The Sampling station is located on latitude 9°41'12.15"N and longitude 6°28'16.32"E. it is about 8.63km from Federal University of Technology (FUT) Minna and the inhabitants of Beji Community are dominantly Gbayis and mainly farmers. The settlement is popularly known for its food stock and cattle market.

Chanchaga is located North-East of Agro-Ecological Zone B, and the sampling station is situated 11.01km away from FUT Minna, the central reference point of this study in Minna metropolis. It falls on latitude 9°31'56.63"N and longitude 6°34'37.67"E, with the majority of the inhabitants being of mixed tribes, of farmers and Civil Servants that are also into small scale farming.

Paiko sampling station has a distance of 24.16km from FUT Minna, located North-East of Agro-Ecological Zone B, which also falls on latitude 9°27'4.78"N and longitude 6°38'4.91"E. Most of the inhabitants are known to be yam farmers but cereal farmers are also commonly found, alongside small scale business owners. The Paiko farm site applied the insecticide Promethrin (Profenofos-40%, Cypermethrin-04%, inert ingredient-56%) during the vegetative stage (three weeks post emergence of the maize plant).

Shanu site is located on latitude 9°38'7.76"N and longitude 6°30'3.42"E with about 4.45km from FUT in Minna metropolis. Inhabitants are predominantly house-hold farmers as well with high number of them being Civil Servants. The site is located North-South of the agro-ecological zone. The farm at Shanu planted Apron plus pretreated maize seeds (20% thiamethoxam, 20% methalaxyl-M, and 2% difenoconazole).

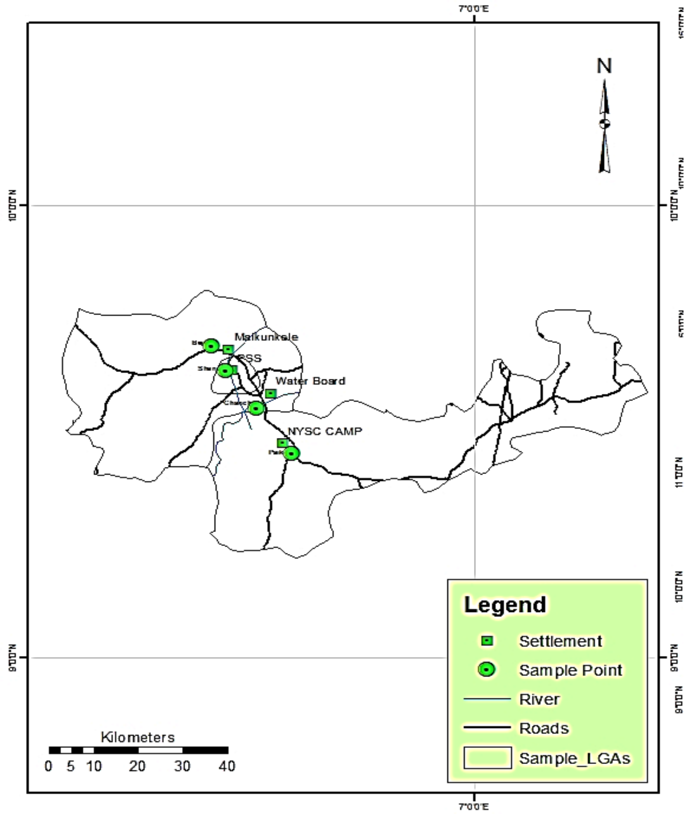

Figure 1: Map of the study area, showing the sampling sites
Source: Remote Sensing and GIS Laboratory, Department of Geography FUT, Minna.

Specimen Collection, Processing and Preservation

Sampling of maize plants for damage by stem borers was from vegetative to harvest stages. At harvest, borers found on the cobs were collected, counted and preserved in 70% alcohol, according to farms and sites [9, 16]. Identification of the stem borers was done following the methods and taxonomic aids described by [17] and also based on the morphology as proposed by [18].

The cobs (stem borer infested and non-infested) were first weighed, then shelled to weigh the total grains per cob. Proximate analysis was then carried out on the maize seeds (stem borer infested and non-infested seeds) and maize stalks (stem borer infested and non-infested). All samples to be analyzed were in triplicates, after the sample was sufficiently dried to be finely ground and following the procedures of Association of Official Analytical Chemist (AOAC) [19, 20, 21]. Determination of teneral reserve was done on the terminal larval instar of the stem borers recovered, following standard methods [22, 23, 24, 25, 26].

Proximate Analysis

Moisture content was estimated by drying triplicates 10g weight of the sample at 105^oC for 24hr and then reweighing after cooling in a desiccator [21, 27, 1]. Ash content was obtained as described by [20, 28]. Crude fibre content was determined as described by [20, 15, 28]. The lipid (oil) content was obtained by extracting 5 g of the powdered sample with 200ml of petroleum ether as described by [20, 1, 28]. Crude protein content was determined by the micro- Kjeldahl method and obtained by using a Nitrogen Protein conversion factor of 6.25 [21, 27, 28]. Percentage Nitrogen Free Extract (Carbohydrate) was obtained by difference applying the formula: 100 % - (% protein + % lipid + % ash + % fibre) [19, 20, 28].

Yield Assessment of Crops at Harvest Stage

During harvest in all the sampling sites, 5 maize plants from each plot were randomly selected for counts of plants with ears and the number of ears on each maize plant. Making a total of 20 maize plants from each farmer's field. Ears from the 20 (twenty) selected plants were collected, stored separately according to plot, sun-dried for 7 days and weighed individually. These were then threshed individually and all the seeds weighed. These data were used to calculate average weight of all seeds per plant for plants with ears [29,3]

Quantification of Teneral Reserves for Terminal Larval Stage of Stem Borer Species

At the terminal larval stage, one (1) stem borer in three (3) replicates were selected, randomly, from each representative of affected fields and analyzed for teneral components (i.e., lipid, glycogen, glucose and protein). Teneral reserve mobilization was carried out as adapted from [22, 23, 24], described by [26, 25] and modified by [30].

Lipid, glucose and glycogen standard preparations

For lipid:

Soya bean oil (100 mg) was mixed with chloroform (100 ml), and in triplicates, 50, 100, 200 and 400 µl of the solution was added to glass tubes and placed on a heating block (at 100°C) to evaporate the solvent. Sulphuric acid (0.2 ml) was added and heated for 10 minutes at 100°C. Vanillin-phosphoric acid reagent [vanillin (600 mg) + hot Distilled water (100 ml) + 85% phosphoric acid (400 ml)], stored in a dark place was added to 5 ml level and mixed. This was removed from the heating block and allowed to cool until reddish color was formed. Optical density (OD) was determined at 625 nm and µg lipid plotted against OD [23].

For glucose and glycogen:

Anhydrous glucose (100 mg) was dissolved in distilled water (100 ml), and in triplicates, 25, 50, 100, 150 and 200µl of glucose solution was added to glass tubes. Anthrone reagent [95-98% sulphuric acid (385 ml) + distilled water (150 ml) + anthrone (750 mg), stored at 4°C was added to 5 ml level and mixed. This was heated for 17 minutes (at 100°C), and allowed to cool. OD was read at 625 nm and a graph of µg glucose plotted against OD [22].

For protein:

Fifty micro-litres (50 µl) of serial concentrations containing 10, 20, 40, 80 and 100 µg bovine serum albumin were pipetted into test tubes. The volume in the test tube was adjusted to 1 ml with phosphate buffer (0.1 M, pH 6.6). Five millimetres of protein reagent (Coomassie

Brilliant Blue G-250 (100 mg) + 95% ethanol (50 ml)) were added to the test tube and the contents mixed, and OD read at 595 nm [26].

Lipid, glycogen and glucose quantitative extraction fractions from stem borer larvae

Sodium sulphate solution (2%, 0.2 ml) was added to the stem borer sample in a glass centrifuge tube and homogenized with glass rod until no identifiable parts remained. The glass rod was washed with equal volumes of chloroform/methanol solution (0.8 ml) into centrifuge tube and centrifuged at 3000 rpm for 1 minute. The supernatant was transferred to a clean centrifuge tube, while the pellets retained for glycogen analysis. Distilled water (0.6 ml) was added to the supernatant, mixed, and also centrifuged at 3000 rpm for 1 minute. The top fraction (containing water/methanol) was separated for sugar analysis, while the bottom portion (chloroform) was used for lipid analysis [25, 30].

Lipid analysis:
The portion for lipid analysis was placed in a tube (with a marking at the 5 ml level), and heated (at 100°C) to evaporate the solvent. Sulphuric acid (0.2 ml) was then added, and heated for 10 minutes at 100^{o}C. Vanillin reagent was added to 5 ml level and mixed. This was removed from heating block and allowed to cool, for the development of reddish colour and was stable up to 30 minutes. OD was determined at 625 nm [25, 30].

Sugar analysis:
Portion for sugar analysis was placed in a tube (with a marking at the 5 mL level), and heated (at 100°C) to evaporate the solvent down to 0.15 ml. Anthrone reagent was then added to 5 ml level and mixed. This solution was heated (for 17 minutes at 100°C), removed to cool. OD was determined at 625 nm [25, 30].

Glycogen analysis**:**
Anthrone reagent was added (to 5 ml level) and mixed. The solution was heated (for 17 minutes at 100°C), removed and allowed to cool. OD was determined at 625 nm [25, 30].

Protein quantitative extraction from stem borers

Total proteins were determined by the method of Bradford (1976). Briefly, Ice-cold saline buffer (0.9% NaCl) was added to the stem borers placed in a centrifuge tube, homogenized and centrifuged at 4000 r.p.m. (for 20 minutes at 4°C). Supernatants were stored at -20°C until used. Phosphoric acid (85%, 100 ml) was then added to the protein reagent. The resulting solution made up to a final volume of 1 litre, by diluting with distilled water. Sample solution (50 µl) was pipetted into test tubes, and adjusted to 1 ml with phosphate buffer (0.1 M, pH 6.6). OD at 595 nm was measured after 2 minutes and before 1 hour against the blank prepared from 1 ml of phosphate buffer and 5 ml protein reagent [26, 31, 30].

Data Analysis

Data obtained were subjected to analysis of variance (ANOVA), and the means were separated with Duncan Multiple Range Test (DMART). Analyzed results were considered significant at P value of ≤ 0.05. Analysis were carried out using Microsoft excel 2010 and statistical package for social science, 20^{th} version.

RESULTS

Plate 1 (a) showed the activity of borers on a maize cob from a standing maize plant on the field. Frass was noticed as a symptom of extensive feeding done by the stem borer. The damage done to the maize cob by borers was further revealed in plate 1 (b), as formation of dusts due to extensive feeding on the grains was observed. Plate 1 (c) indicated the extent to which the borer feeds on a cob, as it was found in a dissected maize cob.

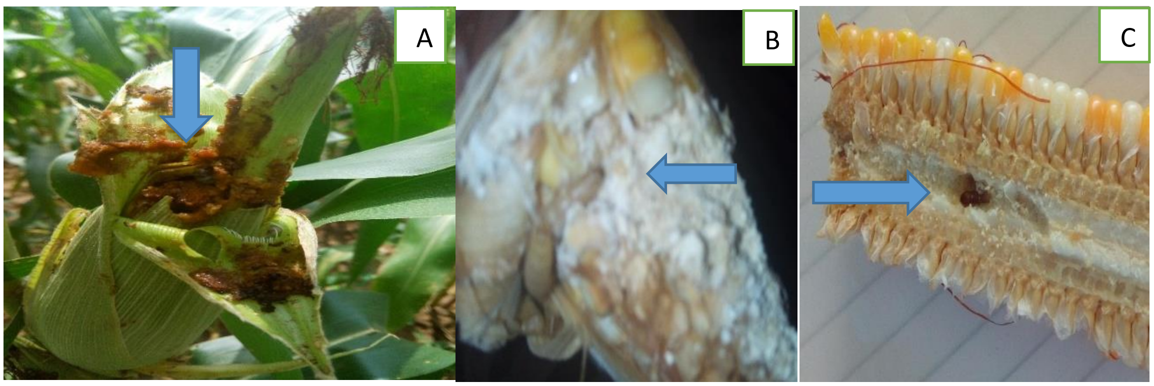

Plate I: (A) Borer damage to fresh maize cobs on maize stand, (B) Borer damage to harvested maize cob and (C) presence of borer in dissected maize cob.

Mean weight of sundried corn at harvest stage in agro-ecological zone B, Niger state

Mean weight of sundried corn, at harvest stage, in agro-ecological zone B, Niger state is represented in Table 1. In all parameters measured, Shanu site consistently had the highest weight values of 183.95 g, 154.45 g and 29.50 g for cobs, grains and core, respectively. It was followed by Paiko, then Chanchaga and Beji with the least values of 53.80 g, 40.85 g and 12.95 g for cobs, grains and cores, respectively. Furthermore, there was significant difference among the weigh means ($p < 0.05$) across all the sampling sites for cobs, grains and core.

Table 1: Mean weight of sundried corn at harvest stage in agro-ecological zone B, Niger state

Sampling sites	Stem borer infestation per plant	Cob (g)	Total Grains/Cob (g)	Core (g)
Beji	$6.60 \pm 0.34^{a*}$	53.80 ± 4.42^{d}	40.85 ± 3.49^{d}	12.95 ± 1.06^{d}
Chanchaga	6.68 ± 0.23^{a}	66.35 ± 5.95^{c}	49.55 ± 4.52^{c}	16.80 ± 1.88^{c}
Paiko	4.89 ± 0.08^{b}	123.80 ± 11.96^{b}	100.10 ± 10.51^{b}	23.70 ± 1.75^{b}
Shanu	2.98 ± 0.49^{c}	183.95 ± 7.15^{a}	154.45 ± 6.30^{a}	29.50 ± 1.42^{a}

*Values followed by the same superscript alphabets in a column are not significantly different at $P \leq 0.05$ Values are represented in mean ± standard error of their replicates

Proximate composition of stem borer infested and non-infested maize seeds and stems

Table 2 showed the proximate composition of maize seeds from stem borer infested and non-infested maize plant in agro-ecological zone B, Niger state. There was no significant difference ($p > 0.05$), between the ash content of the infested maize seeds (1.05%) and the non-infested maize seeds (1.16%). Carbohydrate content (CHO) was significantly higher in the non-infested seeds than the infested seeds (77.76% and 71.55% respectively). Fibre content was also significantly higher in the non-infested seeds (1.75%) than the infested seeds (1.42%). However, Moisture content was significantly higher in the infested seeds (10.87%) when compared with the non-infested seeds (9.71%). Furthermore, the values obtained for lipid and protein contents in the non-infested maize seeds were higher, at 5.10% and 1.63% respectively, than the infested maize seeds with 4.49% and 5.10% for lipid and protein contents, respectively. There was significant difference between the infested and non-infested maize seeds, at $p < 0.05$, for lipid and protein contents.

The proximate composition of stem borer infested and non-infested maize stems in Agro-Ecological Zone B, Niger state was also presented in Table 2. The results indicated that the ash content of the infested stem was significantly ($p < 0.05$) higher than the non-infested stem. While the carbohydrate (CHO) content in the non-infested stems (7.65%) was significantly higher than that of infested stems. Fibre content was 73.26% for the infested stems, which was not only higher but also significantly different ($p < 0.05$) from that of the non-infested stems (70.62%). Moisture content was more in the non-infested stems (6.01%) than the infested stems (5.05%) and there was significant difference at $p < 0.05$. There was no significant difference ($p > 0.05$) between the lipid content of the infested stems and non-infested stems with 0.84% and 0.95% respectively. Crude protein content was significantly higher ($p < 0.05$) in the non-infested stems (8.75%) than the infested stems (4.42%).

Table 2: Proximate composition of stem borer infested and non-infested maize seeds and stems in agro-ecological zone B, Niger state, Nigeria

Samples	Infested seeds (%)	Non-infested seeds (%)	Infested stem (%)	Non-infested stem (%)
Ash	$1.05 \pm 0.03^{a*}$	1.16 ± 0.01^{a}	6.93 ± 0.06^{a}	6.01 ± 0.04^{b}
CHO	71.55 ± 0.89^{b}	77.76 ± 0.09^{a}	4.52 ± 0.20^{b}	7.65 ± 3.17^{a}
Fiber	1.42 ± 0.32^{b}	1.75 ± 0.01^{a}	73.26 ± 0.21^{a}	70.62 ± 0.36^{b}
Moisture	10.87 ± 0.31^{a}	9.71 ± 0.02^{b}	5.05 ± 0.03^{b}	6.01 ± 0.04^{a}
Oil	4.49 ± 0.21^{b}	5.10 ± 0.06^{a}	0.84 ± 0.03^{a}	0.97 ± 0.01^{a}
Protein	5.73 ± 0.06^{b}	11.63 ± 3.29^{a}	4.42 ± 0.09^{b}	8.75 ± 0.12^{a}

*Values followed by the same superscript alphabets, in a row, are not significantly different at $P \leq 0.05$ Values are represented in mean ± standard error of their replicates

Teneral reserve of terminal larval stage of stem borer species (µg) from maize plants.

Teneral reserve of terminal larval stage of stem borer species (µg) for maize plants of heavily infested maize fields in agro-ecological zone B, Niger state is detailed in Table 3. There was significant difference ($p < 0.05$) in the teneral reserve accumulated by the terminal larval stage of stem borers across all the sampling sites with the exception of Shanu and Paiko that had no significant difference at $p > 0.05$ for glycogen reserve. There was also no significant difference ($p < 0.05$) in the glucose reserve across the sampling sites. With the exception of Beji, there was no significant difference among Chanchaga, Shanu and Paiko for lipid reserve. Furthermore, there was no significant difference in the protein reserve between the terminal stage of the stem borer species in Beji, Chanchaga and Paiko, except for stem borers in Shanu.

The highest values of glycogen reserve was from the larvae in Beji (70.53 µg/stem borer) and the least was in the larvae from Paiko (55.03 µg/stem borer). Glucose reserve was also highest in the larvae from Beji and lowest in larvae from Shanu with 43.67 µg/stem borer and 38 .99 µg/stem borer, respectively. The highest and lowest values for lipid reserve was in the larvae of Beji (130.18 µg/stem borer) and Chanchaga (98.85 µg/stem borer). Finally, the protein reserve of the terminal larval stage also had the highest values in Beji with 106.69 µg/stem borer and least value of 88.84 µg/stem borer in Shanu.

Table 3: Teneral reserve of the terminal larval stage of stem borer species (µg) from maize plants in agro-ecological zone B, Niger state, Nigeria

Sampling sites	Glycogen (µg/stem borer)	Glucose (µg/stem borer)	Lipid (µg/stem borer)	Protein (µg/stem borer)
Beji	$70.53 \pm 1.95^{a*}$	43.67 ± 0.01^{a}	130.18 ± 0.01^{a}	106.69 ± 5.14^{a}
Chanchaga	62.35 ± 1.00^{b}	41.25 ± 1.21^{a}	94.85 ± 5.02^{b}	100.93 ± 2.93^{a}
Shanu	58.75 ± 3.87^{c}	38.99 ± 4.26^{a}	98.33 ± 0.33^{b}	88.84 ± 8.25^{b}
Paiko	55.03 ± 3.07^{c}	40.07 ± 0.96^{a}	103.19 ± 1.85^{b}	93.44 ± 3.78^{a}
Aggregate	61.67 ± 2.47	40.10 ± 1.61	106.64 ± 2.88	97.46 ± 5.03

***Values followed by the same superscript alphabets in a column are not significantly different at $P \leq 0.05$. Values are represented in mean ± standard error of their replicates**

DISCUSSION

Stem borer feeding on maize kernels at maturity has been reported, by Musore [32], to produce higher effect on grain by reducing its weight. [16], reported that increase in stem borer infestation causes decrease in grain yield. Sylvain and Tuarira [8] reported that yield loss estimated at 10 – 43% are expected to occur at small holder farm plots, where suppression of insect pests by chemicals is generally not practiced. The relationship between stem borer and grain weight as reported by [33], revealed that percent cob damage was reduced, thereby having higher cob and grain weight in fully protected maize plots than non-fully protected plots. According to [34], insecticides application doubled the yield of maize grain, when applied 4 and 6 weeks after crop emergence.

In the present study, percentage ash content of the infested seeds (1.05%), non-infested seeds (1.16%), infested stems (6.93%) and non-infested stems (6.01%); contradicted the values of 2.19% ash content reported for maize by [28]. The author did not specify if the seeds were new or old seeds; and this may be the reason for disparity; as seeds used in the current study are newly harvested seeds that have been reported by [1] to have lower ash contents. Meanwhile the ash content values obtained in this study fell within the ranges reported by [35], who reported a range of 0.70 – 1.20% for different maize varieties, and the results of [1] who reported 1.10 – 2.95% for maize seeds and maize products. .

The carbohydrate content of maize from stem borer infested seeds (71.55%), non-infested seeds (77.76%), stem borer infested stem (4.52%) and non-infested stem (7.65%) that were obtained in this study were not in agreement with the findings of [35] (69.66 -74.55%) and [1] (44.8 – 69.6%), as the values obtained in the present study were higher than the values obtained by the authors. However, the values of carbohydrate content were also similar to 77.46% reported by [28]. The similarity and dissimilarity of results obtained by the authors may be due to the composition of maize starch which may be genetically controlled.

The crude fibre range observed in this study (1.42 – 1.75%) for the maize seeds samples and 70.62-73.26% for the maize stems samples, were not in agreement with the findings of the following authors; [36] who reported fibre content range of 2.07 -2.97% for maize variety grains in Nigeria; [35] 0.89 – 2.90% for different varieties of maize; [1], reported a range of 2.10 – 26.77% for maize and maize products and [28] reported fibre content of 2.04% for maize seeds.

The moisture content of the stem borer infested seeds (10.87%) and non-infested maize seeds (9.71%) in the current study was consistently in the same range with reports of [35], who reported moisture content of maize to be in the range of 9.20 – 10.91%. Although the moisture content was slightly lower than the earlier research on maize and maize products of 11.6 – 20% by [1] and higher than the results of 7.16% obtained by [28]. This slight variation may be attributed to the maize variety used, environmental factors and agronomic practices. The lower moisture content is of importance as it enables longer storage with minimal fungal contamination and spoilage of the maize seeds. Moisture content of maize stalk of 6.30% obtained by [37] is similar to the value of 5.05% for stem borer infested maize stem and 6.01% for stem borer non-infested stem in the current study.

The percentage lipid obtained for stem borer infested seeds (4.49%) and non-infested seeds (5.10%) in this study was slightly different from the findings of other researchers [35, 1] that found higher fat content as against the range of 4.49 – 5.10% obtained in the present study. Furthermore, this result was higher than the 3.10% obtained by [28].

The percentage protein range of (5.73%-11.63%) maize in this study was found closely related to those reported on different maize varieties by several notable authors. [36] Reported the protein contents of three maize varieties grown in Nigeria to be within the range of 10.67 – 11.25%, [35] reported a range of 7.71 –

14.60% protein content on maize, [1] had a range of 4.5 – 9.87% of maize/maize products and [28] obtained 8.75%.

The average values of teneral reserve obtained in the current study on the terminal larvae stage of the stem borers for glucose (40.10 µg /stem borer), lipid (106.64 µg /stem borer), and protein (97.46 µg /stem borer) were higher than the range of values of 7.66-13.62 for glucose, 12.05-23.95 for lipid and 20.19-38.30 for protein, with the exception of 38.06-61.97 for glycogen (µg /mosquito); where the values (61.67 µg /stem borer) in this study fall within the range obtained by [30] whose report was on the teneral reserve of mosquito larvae. The disparity in the values maybe as result of the differences in insect species and also the weight of the stem borer sample, which were larger than mosquito larvae. The crude protein content from the larva of the emperor moth (*Cirina forda*) was reported to fall within the range of 15 – 60%, as a lepidopterous edible insect [38]. [39] Reported a protein content of 33.12% dry matter for *Cirina forda*. Carbohydrate content of 28.66% was found in the moth caterpillar [15].

Although the results of the above mentioned authors were not similar to those obtained in this study, which may be due to differences in the methods by which the nutritional composition was obtained. It did however, revealed high nutritional composition in protein, lipids and carbohydrate (glycogen and glucose) that was similar to their results. Since the Lepidoptera stem borer had high reserve in teneral composition they could serve as good nutrient source contributing significantly to the nutritional requirement, if of course the quality of the protein, lipid and carbohydrate (glycogen and glucose) found has been established.

CONCLUSION

The study revealed that non-infested maize seeds were richer in nutritional compositions than the infested maize seeds. Except for the fibre and ash contents which were higher in the infested stems, the non-infested maize stems were richer in other nutritional composition, which maybe more preferable for use in livestock feed. Maize cobs and grains of sampling sites with lesser stem borer infestation had higher productivity than sampling sites with higher stem borer infestation.

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