ISSN:
Print - 2277 - 0593
Online - 2315 - 7461

Journal of Natural Science, Engineering and Technology

INFLUENCE OF SEX RATIO ON THE NUTRIENT COMPOSITION OF THE ACCESSORY GLAND AND FEMORAL MUSCLE OF ADULT MALE *Zonocerus variegatus*

O. A. OKE*, K. O. ADEMOLU AND O. A. OLUWO

Department of Biological Sciences, Federal University of Agriculture, Abeokuta. Nigeria
***Corresponding Author:** olubodeoke@yahoo.com

ABSTRACT

Zonocerus variegatus (L.) is the main grasshopper pest of crops in over twenty countries which occupy the extensive forest and savannah areas of West and Central Africa. It feeds on many plant species, including a wide range of plantation and subsistence crops (Notably cassava, *Manihot esculenta leaves*) and horticultural plants. Male grasshoppers are smaller than females, and size varies greatly between species-from a length of 0.4 in (1cm) to more than 5.9 in (15 cm). a male grasshopper has a pair of adjacent testes, which appear to be a single structure along the dorsal midline. The testes are made up of many follicles collected by tiny tubes to either the right or left vas deferens. The vas deference carry sperm to the ejaculatory duct. A pair of tiny seminal vesicles produces a liquid that combines with the sperm produced in the testes. During mating, there is transfer of secretion from the male to the female, such secretion include protein, lipids and glucose, others may be amino acids, peptides and prostaglandins. *Zonocerus variegates* is very high in protein concentration and these proteins are transferred during copulation from males to females. The analysis of the mineral concentration of the femoral muscle and accessory glands shows that sodium ion (Na^+) has the highest concentration in the femoral muscle and accessory gland of Adult male *Z. variegates*. Chloride ion ($C1^-$) also has relative high mineral content when compared to other mineral found in the femoral muscle and accessory gland of *Z. variegatus.*

Key words: *Zonocerus variegatus;* Sex ratio; Accessory gland; Femora muscle; Nutrient.

INTRODUCTION

Zonocerus variegatus, like some other members of the family Pyrgomorphidae, is aposematically colored, sequesters toxic chemicals from plants, and commonly lives in dense groups (Chapman *et al. 1986).* The insect feeds on a wide range of crops from plantain crops such as coffee and banana as well as a wide variety of subsistence crops, notably cassava and some weed plants (Chapman *et al,* 1986). *Zonocerus variegatus* begins feeding in the morning when the temperature reaches about 26°C (Okere 1980) or 23°C with a slowing down at temperature over 35°C (Kaufmann, 1965). Modder (1983) found out that confined nymphs of *Zonocerus variegatus* have the ability to start active feeding in the morning at a temperature as

low as 17°C and extreme massive feeding was recorded at 34°C. Later in the day (mostly in the evening), they have the ability of ascending to the tops of their food plants to root.

Zonocerus variegatus undergo incomplete metamorphosis. Eggs are laid in egg pods and then buried in the soil (Toye, 1982). The eggs undergo diapauses (resting stage) in the soil for 3 months before the developments of the embryo. The eggs later hatches into nymph, which climb on stem of vegetation (Youdeowei, 1974). There are usually 6 nymphal stages before the adult stage (Youdeowei, 1974). However, these nymphal stages are referred to as instars. Chapman reported 5 instars in 1986 and Anya (1973) mentioned only 4.

Manihot esculenta (Cassava) and *Vernonina amygdelina* have been discovered to support growth and development in *Zonocerus variegatus* (Bernay *et al, 1974;* Idowu, 2004). The early stages of development of *Zonocerus variegatus* notably the first, second and third instars, survive on weeds (Toye, 1974). Among the weeds, *Chromolena odorata* was regarded noteworthy since its ever increasing spread in southern Nigeria appears to account for the increased abundance of *Zonocerus variegatus* in the country (Toye, 1974). It was reported by Idowu and Sonde (2004) that cassava is the most preferred and most consumed food plant of all diets of *Zonocerus variegatu.* However, Bernay *et al.*, (1975) reported that early instars (1st – 4th) do not feed on cassava leaves on the field; it is the later instars (5th – adult) that are responsible for damage.

Male and female *Z. variegatus* live for up to 15 weeks in the laboratory, which gives the spaces ample time for egg maturation, oviposition and remating. The length of life could, however, be reduced by male:male:male:female interaction and oviposition. Mating triggers ovarian development in several species of insects owning to transfer of sperm and/or secretion of the male reproductive system (Davey, 1985). Sex isolation also reduces risk of predation on expenditure of energy and time by males while securing mate. (Kuba and Ito, 1993).

Male accessory gland of insects secrete protein and hormones whose function include stimulation of oviposition, inhibition of female receptive, activation and nourishment of sperm and formulation of spermatophores (Loher, 1984). The reproductive system of a male *Zonocerus variegatus*, a cassava pest in West and Central Africa, contains eleven pairs of mesodermally derived accessory gland tubules (Muse and Balogun, 1992).

There has been some work on *Zonocerus variegatus*, however, few work has been done on nutrient composition in the femoral muscle and accessory gland. Hence the objective of this study is to examine the influence of sex ratio on the nutrient composition on some tissues of the adult male *Zonocerus variegatus.*

Femoral Muscle Enzymes

The femoral muscle of all developmental stages of *Zonocerus variegatus* exhibited the presence of α-glucosidase, lipase, amylase, proteinasee and cellulose, suggesting their ability to metabolise their substrate. These enzymes have been reported to be common in the tissues of phytophagus insects like grasshopper (Morgan, 1976). Similarly, these enzymes are present in the gut of *Zonocerus variegatus* (Balogun, 1972; Modder, 1983). It was reported by that food substances were converted to utilizable substances prior to or during transport to the muscles.

The activity of these enzymes increased as the insect moved from the first instar to the adult stage. The increase in the weight and length of the hind femur as the insect advanced in age actually increased the amount of various substrates in the muscle, thereby increasing the activities of the enzymes. An increase in food consumption during post-embryonic development (Idowu and Edema, 2001) might have increased the activities of these enzymes in the muscle, suggesting an increasing hopping capacity as the insect move from younger to older instar.

MATERIALS AND METHODS

Collection and Maintenance of Insects

6th instars stage of *Zonocerus variegatus* were collected from the University of Agriculture, Abeokuta farmland. The 6th instars were allowed to mature into adult stage before being paired. The insects were kept in cages made of wood and mosquito net (30x40x45) cm^2, and were fed daily with fresh cassava (*Manihot esculenta* leaves). The adult *Z. variegatus* were separated and placed into four (4) different cages according to this grouping;

1 male and 5 females
5 males and 1 female
5 males and 5 females
10 males only

After four (4) weeks the adult male *Z. variegatus* were separated from the female.

Measurement of the Body Weight

The weights of *Z. variegatus* were taken after the pairing experiment was carried out, using electric balance manufactured by METTLER-TOLEDO A.G

Dissection of Insects

The hind legs and abdominal region of adult male *Z. variegatus* paired in groups of; 1M:5F, 5M:1F, 5M:5F, 10M:0F were dissected with sharp razor as described by Youdeowei (1974). The femoral muscle and accessory gland of the insects were collected and put into a test tube containing 0.05M KCl. The homogenate was centrifuged at 500rpm at 5°C for 30 minutes. The supernatant was collected in 30ml centrifuge bottle and stored in a deep freezer until further analysis.

Proximate and Mineral Analysis in the Femoral Muscle and Accessory Gland of Adult Male *Z. variegatus*

Proximate analysis for protein, glucose and lipid content in the femoral muscles and accessory gland of the paired and unpaired adult male *Z. variegatus* was determined by standard method (AOAC 1990). Protein was determined by the Biuret micro method.

Mineral analysis for Calcium, Sodium, Potassium, Chloride and Phosphate content of femoral muscles and accessory gland of the paired and unpaired adult male *Z. variegatus* was determined by standard method . Sodium, Potassium, Calcium, Chloride and Phosphate were determined in diluted serum using polarized atomic absorption spectrophotometry.

Statistical Analysis

The results of all analysis in the tables were subjected to statistical analysis to know if there were significant differences in the result. This was done using ANOVA.

RESULTS

Glucose Concentration in the Femoral Muscles of Adult Male *Zonocerus variegatus* (Mg/Dl)

The result of glucose concentration carried out on the femoral muscle of adult male *Z. variegatus* was illustrated in the different sex ratio, shown in the figure below

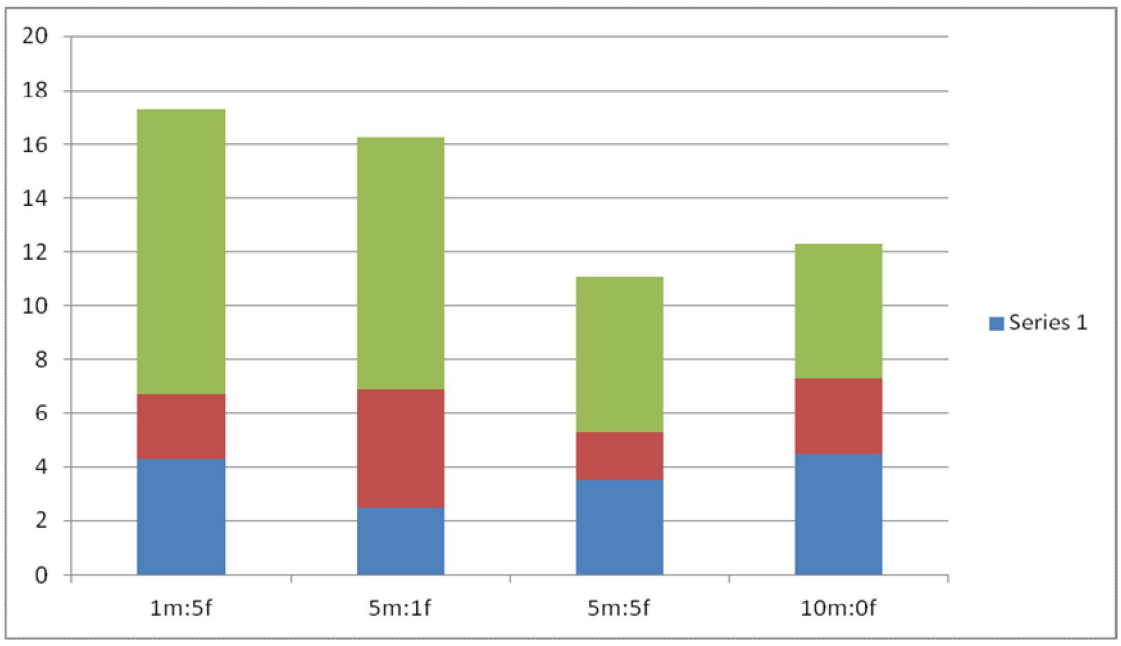

Fig. 1: The concentration of glucose (mg/dl) in the femoral muscles of adult male *Zonocerus variegatus*

Protein Concentration in the Femoral Muscles of Adult Male *Zonocerus variegatus* (Mg/Dl)

The result of protein concentration carried out on the femoral muscle of adult male *Z. variegatus* was illustrated in the different sex ratio, shown in the figure below.

Figure 2 shows that there were high levels of protein concentration in paired group compared to Figure 5.

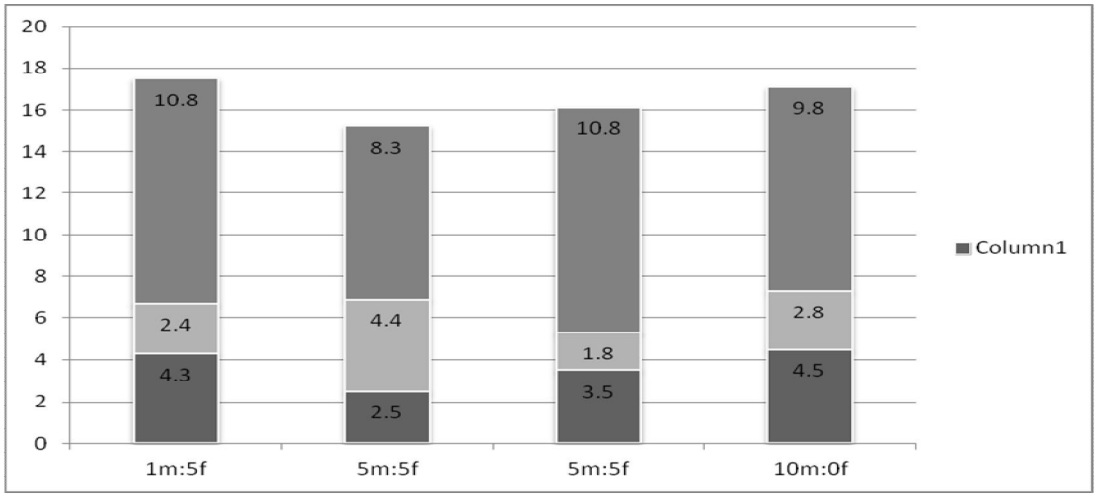

Fig 2: The concentration of protein (g/l) in the femoral muscles of adult male *Zonocerus variegatus*

Lipid Concentration in the Femoral Muscles of Adult Male *Zonocerus variegatus* (mg/dl)

The result of lipid concentration carried out on the femoral muscle of adult male *Z. variegatus* was illustrated in the different sex ratio, shown in the figure below.

Figure 3 shows a high concentration of lipids (mg/) in the femoral muscle of adult male *Z. variegatus* contain only 10M:0F.

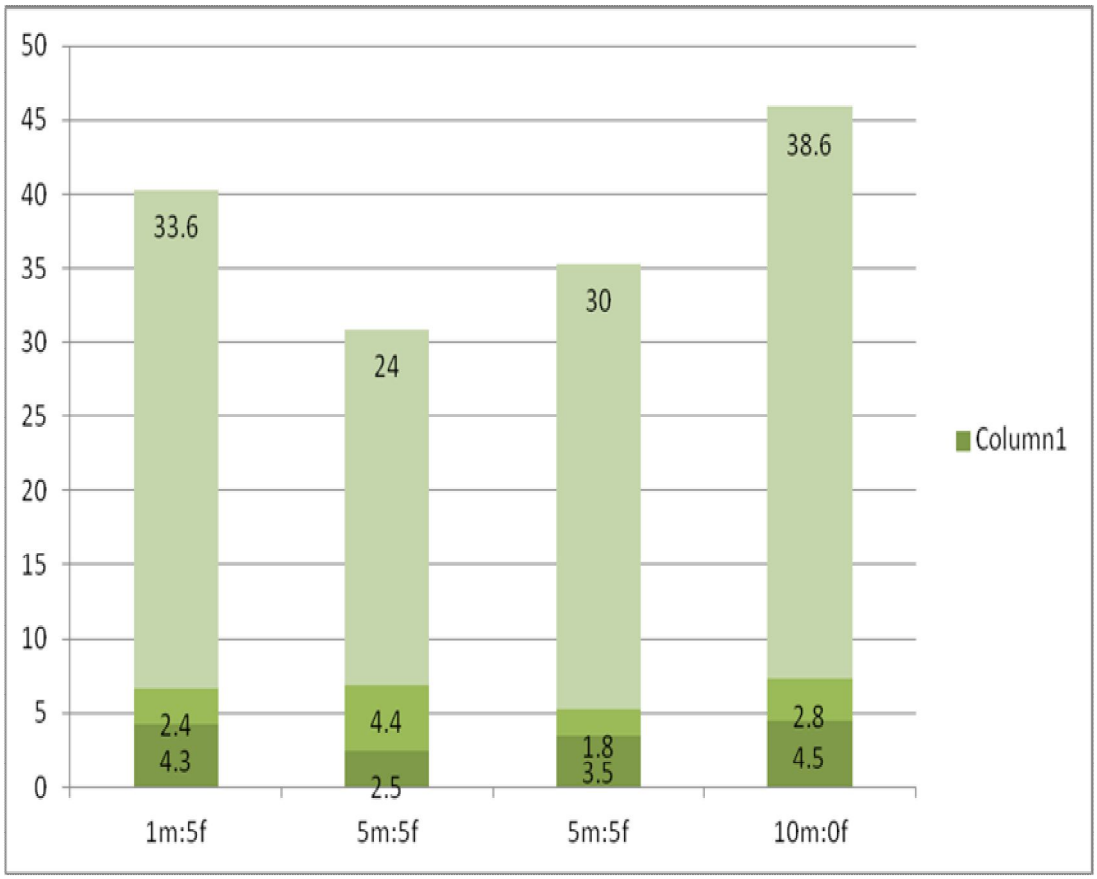

Fig 3: The concentration of lipid in the femoral muscles of adult male *Zonocerus variegatus*

Glucose Concentration in the Accessory Gland of Adult Male *Zonocerus variegatus* (mg/dl)

The result of glucose concentration carried out on the accessory gland of adult male *Z. variegatus* was illustrated in the different sex ratio, shown in the figure below.

Figure 4 shows that there was high level of glucose concentration in paired group 1M:5F

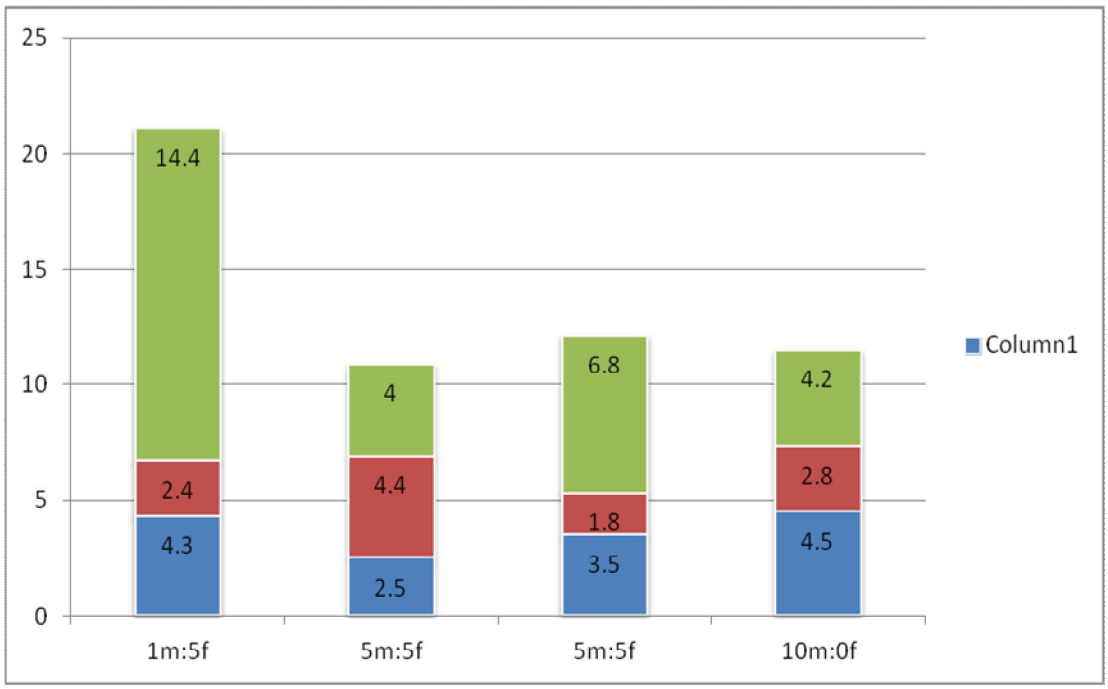

Fig 4: the quantities of glucose (mg/dl) in the accessory gland of adult male *Zonocerus variegatus*

Protein Concentration in The Accessory Gland of Adult Male *Zonocerus variegatus* (mg/dl)

The result of protein concentration carried out on the accessory gland of adult male *Z. variegatus* was illustrated in the different sex ratio, shown in the figure below.

Figure 5 shows that there were high levels of protein concentration in all the groups.

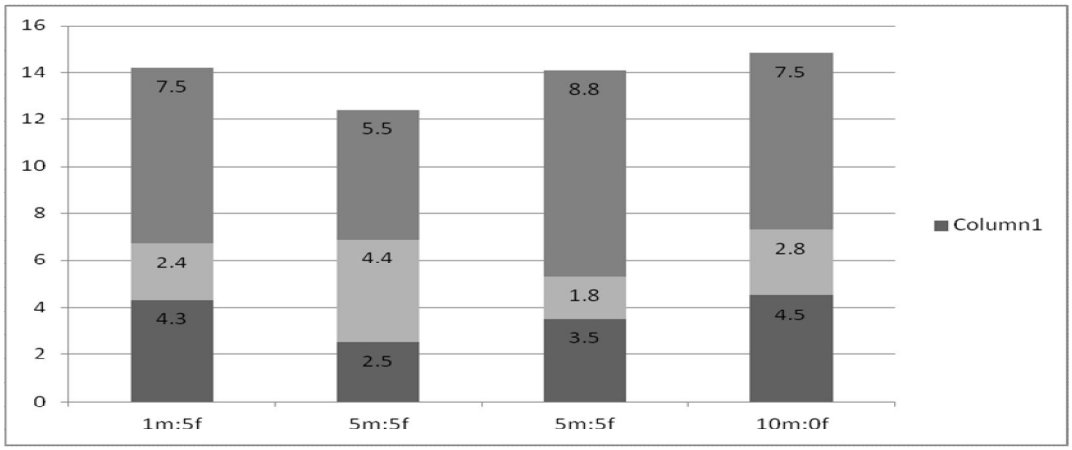

Fig 5: The quantities of protein (g/l) in the accessory gland of adult male *Zonocerus variegatus*

Lipid Concentration in the Accessory Gland of Adult Male *Zonocerus variegatus* (mg/dl)

The result of lipid concentration carried out on the accessory gland of adult male *Z. variegatus* was illustrated in the different sex ratio, shown in the figure below.

Figure 6 shows a high concentration of lipid (mg/dl) in the accessory gland of adult *Z. variegatus* contain in only 10M:0F

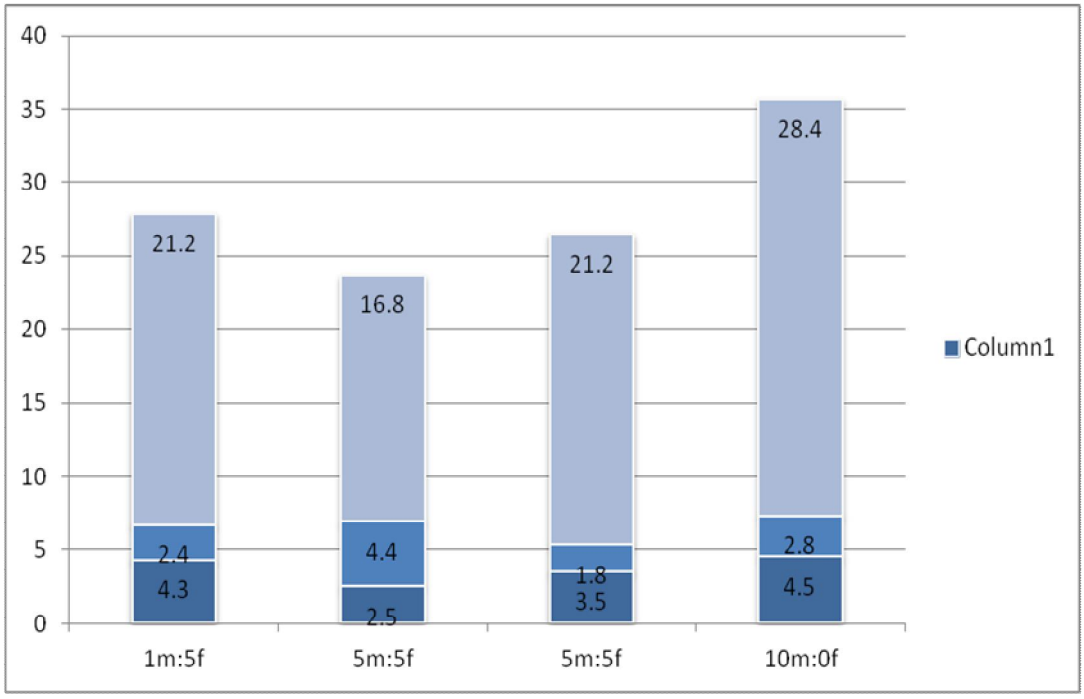

Fig 6: The quantities of lipid (mg/dl) in the accessory gland of adult male *Zonocerus variegatus*

The concentration of Calcium, Sodium, Potassium, Chloride and Phosphate present in the femoral muscles in the adult male *Zonocerus variegatus*

The result of concentration of minerals in the femoral muscles of adult male *Z. variegatus* showed the presence of the following minerals; Calcium, Sodium, Potassium, Chloride and Phosphate (Table 1).

There was no significant difference (P>0.05) in the concentration of Calcium in the femoral muscles of adult male *Z. variegatus* (1M:5F and 10M:0F)

There was significant difference (P<0.05) in the concentration of Sodium in the femoral muscles of adult male *Z. variegatus*

There was significant difference (P<0.05) in the concentration of Potassium in the femoral muscles of adult male *Z. variegatus*

There was significant difference (P>0.05) in the concentration of Chloride in the femoral muscles of adult male *Z. variegatus*

There was significant difference (P>0.05) in the concentration of Phosphate in the femoral muscles of adult male *Z. variegatus*

TABLE 1: The concentration of Calcium, Sodium, Potassium, Chloride and Phosphate present in the femoral muscles in the adult male *Zonocerus variegatus*

	Calcium g/L	Sodium Mmol/L	Potassium Mmol/L	Chloride Mmol/L	Phosphate Mg/dl
1M:5F	1.62aa	142.2a	5.4b	60.6b	1.30a
5M:1F	1.68	81.4	4.0	89.0	1.41
5M:5F	1.55	74.0	4.1	69.1	1.11
10M:0F	1.61a	160.0b	7.0a	79.5a	1.30aa

The concentration of Calcium, Sodium, Potassium, Chloride and Phosphate present in the accessory gland in the adult male *Zonocerus variegatus*

The result of concentration of minerals in the accessory gland of adult male *Z. variegatus* showed the presence of the following minerals; Calcium, Sodium, Potassium, Chloride and Phosphate (Table 2). There was significant difference (P<0.05) in the concentration of Calcium in the accessory gland of adult male *Z. variegatus* (1M:5F and 10M:0F)

There was no significant difference (P>0.05) in the concentration of Sodium in the accessory gland of adult male *Z. variegatus*

There was significant difference (P<0.05) in the concentration of Potassium in the accessory gland of adult male *Z. variegatus*

There was significant difference (P<0.05) in the concentration of Chloride in the accessory gland of adult male *Z. variegatus*

There was significant difference (P<0.05) in the concentration of Phosphate in the accessory gland of adult male *Z. variegatus*

TABLE 2*:* The Concentration of Calcium, Sodium, Potassium, Chloride and Phosphate present in the accessory gland in the adult male *Zonocerus variegatus*

	Calcium g/L	Sodium Mmol/L	Potassium Mmol/L	Chloride Mmol/L	Phosphate Mg/dl
1M:5F	1.61b	106.6a	4.3a	71.3a	1.25a
5M:1F	1.77	73.8	3.2	56.9	1.39
5M:5F	1.63	88.4	3.7	52.7	1.20
10M:0F	1.95a	106.6aa	3.5b	71.3aa	1.25aa

Weight of *Z. variegatus*

The result showed that the paired adult *Z. variegatus* (1M:5F and 5M:5F) except for 5M:1F, recorded loss of weight, and the adult female *Z. variegatus* of all the paired groups recorded an increase in weight.

TABLE 3: **The weight of adult male and female** *Zonocerus variegatus* (g) after being isolated from the female *Z. variegatus*

Samples / Weight	1M : 5F		5M : 1F		5M : 5F		10M : 0F	
Final Weight	3.9	11.4	5.8	4.1	12.3	6.8	12.3	-
Initial Weight	4.0	11.0	5.6	3.1	10.9	5.3	12.0	-

DISCUSSION AND CONCLUSION

The accessory gland of adult male *Z. variegatus* of the present study showed the presence of glucose, lipid and protein as reported by Muse (1993). During mating, there was transfer of secretion from the male to the female, such secretion include protein, lipids and glucose. Others included amino acids, peptides and prostaglandis as reported by Davey (1985). The result in figure 2 and figure 5 showed that there was an increase in the protein concentration in all groups of adult male *Zonocerus variegatus* both in the femoral muscle and the accessory gland. Olusola *et al,* (2003) reported that *Zonocerus variegatus* was very high in protein concentration and these proteins were transferred during copulation from males to females. Insects in general are to be involved in double mating, this enhance female's fecundity and longevity by obtaining non-sperm resources from males (Ramaswamy *et al,* 1997).

In figure 1 and figure 4, glucose concentration was higher in the femoral muscles and accessory gland of adult male *Z. variegatus* in the group containing only one male, this might be due to its requirement for mating more females (5 females and repetition of mating the same female frequently as reported by Ramaswamy *et al,* (1997).

The mineral content analysis of the femoral muscles and accessory gland of adult male *Zonocerus Variegatus* reported the presence of Calcium ion (Ca+), Sodium ion (Na+), Potassium (K+), Chloride (Cl-) and Phosphate (PO4) in the femoral muscle and accessory gland. The analysis of the mineral concentration of the femoral muscle and accessory gland showed that Sodium ion (Na+) has the highest concentration in the femoral muscle and accessory gland of adult male *Z. variegatus*. Chloride ion (Cl-) also has relatively high mineral content when compared to other mineral found in the femoral muscle and accessory gland of *Z. variegatus*. Concentration of Sodium and Chloride has been reported to be higher in phytophagus insects (Chapman, 1990). Mating in *Zonocerus variegatus* has significant effect on the nutritional composition in adult male *Zonocerus variegatus.*

REFERENCES

Anya, A. O. (1973). Ecology of variegated grasshopper, *Zonocerus Variegatus* (Orthoptera: Acridoidae, Pygomorphidae) on Nsukka Plateau, Nigeria: *Entomolgia Experimentalis et Applicata.* 16: 64-70.

Balogun, R. A. (1972). Digestion Carbohydrase and nature of amylase in the gut homogenates of *Zonocerus variegatus* (L). *Bulletin of the Entomological Society of Nigeria.* 3: 91-94.

Bernay, E. A., Chapman, R. F., Cook, A. G., Mcveigh, L. J., Page, W. W., (1974). Food plants in the survival and development of *Zonocerus variegatus* (L.). *Acrida. Bulletin of Entomological Research.* 4: 33-46.

Chapman, R. F., Page, W. W.,and MaCaffery, A. R. (1986). Bionomics of the variegated grasshopper Zonocerus variegatus in west and central Africa. *Ann. Rev. Entomol.* 31: 479-505.

Harshman, L. G., Prout, T. (1994). Sperm displacement without sperm transfer in *Drosophila melanogaster. Evolution.* 48: 758-766.

Idowu, A. B., Edema, M. O. (2001). The microbial flora of different gut region of *Zonocerus variegatus* (L.) (Orthoptera: Pyrogomorphidae). *Nigerian Journal of Plant Protection.* 620: 19-30.

Idowu, A. B. Sonde, O. A. (2004). The contribution of food plants to the growth development and fecundity *of Zonocerus variegatus* (L.). *Nigerian Journal of Entomology.* 21: 24-28.

Kaufmann, T. (1965). Observations on aggregation, igration and feeding habits of *Zonocerus variegatus* in Ghana (Orthoptera: Acrdidae). *Ann. Entomol. Soc. Ann.* 58: 426-436.

Kuba, H., Ito, Y. (1993). Remating inhibition in the melon fly, *Bactrocera curcbitae* (Diptera: Tephritidae): copulation with sperm less males inhibit female. *J. Ethol.* 11: 23-28.

Lai Fook, J. (1982). Structure of the accessory glands and duplex of the internal male reproductive system of *Calpodes ethlius* (Hesperiidae; lepidoptera). *Can. J. Zool.* 60: 1202-1215.

Loher, W. (1984). Behavioral and Physiological changes in cricket female after mating. *Adv. Invertebr. Re-prod.* 3: 189-201.

Modder, W. W. D. (1983). Diurnal Variation in feeding and gut activity in nymphs of the African pest, grasshopper Zonocerus variegates. *Insects. Sci. Appl.* 5: 527-531.

Morgan, M. R. J. (1976). Gut Carbohydrase in locust and grasshopper. *Insects biochemistry*. 5: 251-531.

Muse, W. A., Balogun, R. A. (1992). Morphology and histology of accessory glands of malevariegated grasshopper, *Zonocerus variagatus* L. (Orthoptera, Pyrgomorphidae). *Nig. J. Entomol.* 12: 134-146.

Ramaswamy, S. B., Park, Y. I., Zeng, F. (1997). Dynamics of juvenile hormone mediatedgonadotiopism in the Lepidoptera Archives of Insects. *Biochemistry and Physiology.* 35: 539-558.

Toye, S. A. (1982). Studies on the biology of grasshopper pest *Zonocerus variegatus* (L.) (Orthoptera: Pyrgomorphidae) in Nigeria. *Insect Science and its Application.* 3 (9): 1911-1981.

Youdeowei, A. (1974). *Dissection of the variegated Grasshopper, Zonocerus variegates*. Oxford University Press, Ibadan, Nigeria.

(Manuscript received: 09 November, 2011; accepted: 25th June, 2014).

ISSN:
Print - 2277 - 0593
Online - 2315 - 7461

Journal of Natural Science, Engineering and Technology

COMPOSITION AND SENSORY QUALITY OF SWEET POTATO CRISPS AS INFLUENCED BY PRE-FRYING TREATMENT

G. O. FETUGA*[1], A. O. ODULAJA[1] AND A. O. ADELEKAN[2]

[1]Department of Food Science & Technology, Federal University of Agriculture, Abeokuta. Postcode 110001. Abeokuta. Nigeria.

[2]Department of Food Science & Technology, Bells University of Technology, Ota.

***Corresponding author**: ganolfet@gmail.com.

ABSTRACT

The effect of some pre-frying treatments on the composition and sensory attributes of sweet potato crisps were evaluated. Five pretreatment conditions were studied. Moisture, protein, fat, ash, reducing sugar and vitamin C content of the sweet potato crisps were determined. Sensory attributes of colour, taste, flavor and crispness, as well as overall consumer acceptability of the crisps were analyzed. Pearson correlation coefficient between composition and sensory scores were calculated. Composition of sweet potato crisps varied significantly with pretreatment ($p<0.05$). Drying pretreatment gave sweet potato crisps with the least moisture and fat contents while blanching gave the highest values. The use of NaCl solution for blanching resulted in a significantly higher value of fat in the crisps. Crisps produced by drying before frying was the most acceptable, although crisps from all the pretreatments were generally acceptable. The lower the moisture, protein and fat content, the higher the acceptability.

Keywords: sweet potato, pre-frying treatment, oil content, moisture content, crispness, food quality

INTRODUCTION

Nutritional composition and sensory attributes of food products are among the quality factors that are of utmost importance to consumers. Nutritional composition is important because of health concerns while sensory attributes are important for consumer acceptance and enjoyment. These quality factors have been known to be influenced by processing conditions which includes pretreatments, as well as chemical composition of the final product among other factors. For fried products such as sweet potato crisps, oil content, texture (crispness), taste, colour and flavour have been reported to be important quality attributes for an acceptable product (Singh *et al.,* 2003). With respect to nutritional quality, Odenigbo *et al.* (2012) reported that cultivars of sweet potato gave French fries with low to moderate glycaemic index values.

Sweet potato crisps are thin slices of sweet potato roots processed by deep-fat frying. The deep –fat frying process can be defined as a drying, cooking or fast dehydration process, in which the water is removed from the food by means of immersion into oil at a temperature of 120 to 180 °C (Vitrac *et al.,* 2000). During the process of deep-fat frying, oil is incorporated into the food, occupying the space left by the water, thereby increasing its palatability. These results in development of sensory characteristics such as aroma, flavour, colour and texture which are appreciated by all categories of consumers