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DIAPAUSE EFFECT ON THE KHAPRA BEETLE, *Trogoderma granarium* EVERTS ELEMENTS CONTENT REARED ON DIFFERENT HOSTS.

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ABSTRACT

The element contents of *Trogoderma granarium* Everts diapaused and nondiapaused larvae reared on three larval hosts and kept at two degrees of temperatures. Analyses of 10 elements Na,Mg,Si,P,S,Cl,K,Ca,Cu and Zn were analyzed by energy dispersive X-ray analyzer (EDX). It was observed that the most abundant light element in (NDLW) and (NDLC) was K. The most abundant light element in NDLP was P. Sodium was disappeared from NDLW and NDLC, while it was appeared in significant values in DLW kept at 25°C and DLW kept at 35°C. Mg disappeared only from NDLW. Heavy metals (Cu and Zn) show relative abundance DLW kept at 25 and 35°C less than their control (NDLW). The same trend was observed in DLC and DLP except those reared on peanut and kept at 25°C.

Abbreviations :

NDLW: nondiapaused larvae reared on wheat
NDLC: nondiapaused larvae reared on cowpea
NDLP: nondiapaused larvae reared on peanut
DLW : diapaused larvae reared on wheat
DLC : diapaused larvae reared on cowpea
DLP : diapaused larvae reared on Peanut

INTRODUCTION

The Khapra beetle, *Trogoderma granarium* Everts is a pest of stored cereals and many other food materials. Diapaused can be defined as an arrest of growth and development which persists in environments favorable for normal growth and development until the insect is subjected to certain well-defined conditions. These conditions permit some physiological change, which enables growth to be resumed as soon as the environment favors it (Burges, 1960). The incidence of diapaused is influenced by temperature, feed, population density and the genotypic composition of the population (Nair and Desai, 1973). At favorable temperatures, some larvae of *T. granarium* pupate about a month after hatching (Burges, 1957), whilst others leave the food when they are apparently fully grown and cluster for long periods in refuges such as the cracks and crannies in the fabric of the food stores (Burges, 1959 b).

Elemental composition differences in insects may arise from physiological state (Bowden *et al.*, 1984). The larval host plant is a significant factor in the element composition of the adults. General relationship was noticed between the mineral content of an insect diet and the tissue accumulation of various metabolic elements from that diet (Levy *et al.*, 1973). This experiment was conducted to know the elemental content of *T.*

granarium fullygrown diapaused larvae reared on three types of food (wheat. Cowpea and peanut) and kept at 2 degrees of temperatures (25°C and 35°C).

MATERIALS AND METHODS

Insect samples :

Insect used in this study came from a basic stock of *T. granarium* maintained on three different diets (wheat, cowpea and peanut) in the laboratory for about 4 years. A standard procedure was allowed to obtain the experimental larvae so as to minimize the risk of accidental loss of any of the diapaused characteristics of the stock. A continual supply of diapaused larvae was insured by placing patches of more than one thousand newly hatched larvae on approximately thirty grams of crushed foods (Nair and Desai, 1973). Culture and experimental larvae were breed according to Rajendran (1982).

Non-diuapaused larvae :

Newly hatched larvae were reared on crushed (wheat, cowpea and peanut) at 34±1°C and 65±5 R.H. When pupation started, the non-diapausedd larvae were attained the full larval growth (18 – 20 day). These larvae were collected and held as control. Each sample was 1 gram for each diet.

Diapausedd larvae :

1- Obtaining diapaused larvae at 35°C.

In crowded cultures (as done by Nair and Desai, 1973) small refuges as described by Burges (1959a) were put on the surface of the food inside the jars. Many last instar larvae tended to hide and cluster inside these refuges. Diapaused larvae were collected 90 days later after all the non-diapaused insects had been removed as pupae. Also one gram from the diapaused larvae were collected from each diet.

2- Obtaining diapaused larvae at 25°C:

Twenty-day old larvae from the culture of different diets used were released on the fresh food and maintained at 25°C. Also, small refuges were put on the surface of the diet. The non-diapaused insects had been removed as pupae, the diapaused larvae were collected from refuges after 90 days of the incubation at this degree (Gothi *et al.*, 1984).

Preparation and analysis of insects :

Samples of non-diapaused and diapaused larvae were oven dried, defatted and analyzed by energy dispersive X-ray analyzer (EDX). This Analyzer was attached to scanning electron microscope model HEOL-JSM 4500. The program software used is OXFORD-ISIS under windows. The detected elements were determined as a percentage existed in the sample.

RESULTS AND DISCUSSION

The analysis of *T. granarium* diapaused and non-diapaused larvae resulted in the identification of the ten elements presented in tables (1-3). The ten analyzed elements are namely : sodium (Na), Magnesium (Mg), silicon (Si), phosphorus (P), chlorine (Cl), potassium (K), calcium (Ca) and two heavy metals, copper (Cu) and Zinc (Zn). Most of these elements are important for maintain of homeostasis of organisms (Schutte, 1964 and Christian and Feldman, 1970). The present investigation showed that the relative abundance of NDL 5 elements which have the greatest values were as follows : Zn>Cu>K>P>S. Levy and Cromroy (1973) determined the concentration of five elements in immature stages of 41 species of insects and found a general trend of concentration as follows : K>Na>Mg>Fe>Cu. El-Orabi and Ghareib (1999) found that arrangement of the five elements detected in *T. granarium* adults reared on three larval hosts, from the greatest to smallest order was as follows : P>K>Cu>S>Cu.It is very important to note that Engelman (1970); Florkin and Scheer (1970) and House (1962) reported that minerals are extremely important in maintaining the ionic balance for the activity of insect cells, as cofactors of some enzyme systems and as an integral part of others.

From the results presented in tables (1,2,3), it was observed that the most abundant light element in nondiapaused larvae reared on wheat (NDLW) and those reared on cowpea (NDLC) was K (14.59 and 17.96%, respectively) (Tables 1 and 2). The most abundant light element in nondiapaused larvae reared on peanut (NDLP) was P (17.72%). (Table 3). The second element, from the most abundance point of view, was p in NDLW (13.96%) and NDLC (14.85%) and S in NDLP (9.19%) (Tables 1,2,3). El-Orabi and Ghareib (1999) found that P came in the first order followed by K in their investigation on *T. granarium* adults reared on three larval hosts. The same trend was observed by El-Orabi (1998) on onion fly *Eumerus amoenus* Loew. Larval host plant is a significant factor in the element composition of adults *Noctua pronula* (Bowden *et al.* 1984) and in *Agrotis segetum* (Sherlock *et al.* 1985).

The relative abundance of the total light elements in NDLC (60.50%) and NDLP (61.35%) was greater than the total heavy ones (39.5%, and 38.65%) respectively (Tables 2,3) , while they approximately equaled in case of NDLW (Table 1). It can thought that is due to the absence of some elements such as Na and Mg in NDLW which reflected on distribution of the percentage on eight elements instead of ten. El-Degwi and Ghareib (2000) reported that the differences observed in mineral concentrations may be attributed to the feeding habits of the insect and the distribution of minerals in host components. In wheat for example minerals are mainly concentrated in the bran portion of the seed (Salunkhe *et al.*, 1985). *Trogoderma granarium* appeared to eat a portion of bran, thus offsetting the increase of mineral composition (Sudesh *et al.*, 1992).

Table (1) Element content (%) of non-diapauaed and diapaused larvae of *T. granarium* reared on wheat.

Element	Non-diapaused Larvae	Diapaused larvae	
		Kept at 25°C	Kept at 35°C
Sodium (Na)	-	17.24	15.80
Magnesium (Mg)	-	3.19	8.27
Silicon (Si)	2.6	0.96	-
Phosphorus (P)	13.96	16.86	15.57
Sulfur (S)	9.30	8.87	8.26
Chlorine (Cl)	7.55	7.17	6.04
Potassium (K)	14.59	11.02	13.06
Calcium (Ca)	2.56	1.69	0.29
Light metals	**50.56**	**66.99**	**67.28**
Copper (Cu)	23.37	18.49	13.97
Zinc (Zn)	26.07	14.52	18.75
Heavy metals	**49.44**	**33.01**	**32.72**

Table (2): Element content (%) of non-diapauaed and diapaused larvae of *T. granarium* reared on cowpea.

Element	Non-diapaused larvae	Diapaused larvae	
		Kept at 25°C	Kept at 35°C
Sodium (Na)	-	11.81	9.83
Magnesium (Mg)	2.10	6.77	3.86
Silicon (Si)	7.15	5.70	2.18
Phosphorus (P)	14.85	11.76	14.94
Sulfur (S)	8.68	7.06	8.24
Chlorine (Cl)	5.27	4.03	5.19
Potassium (K)	17.96	12.71	13.01
Calcium (Ca)	4.47	3.78	4.08
Light metals	**60.50**	**63.61**	**61.33**
Copper (Cu)	19.91	19.72	19.68
Zinc (Zn)	19.59	16.67	18.99
Heavy metals	**39.50**	**36.39**	**38.67**

Table (3): Element content (%) of non-diapauaed and diapaused larvae of *T. granarium* reared on peanut.

Element	Non-diapaused Larvae	Diapaused larvae	
		Kept at 25°C	Kept at 35°C
Sodium (Na)	7.33	14.96	9.57
Magnesium (Mg)	1.21	0.77	7.62
Silicon (Si)	8.59	-	2.63
Phosphorus (P)	17.72	14.62	14.31
Sulfur (S)	9.19	7.51	10.21
Chlorine (Cl)	5.54	5.72	5.37
Potassium (K)	8.16	13.04	12.92
Calcium (Ca)	3.16	1.16	1.97
Light metals	**61.35**	**57.78**	**62.6**
Copper (Cu)	21.35	20.27	18.83
Zinc (Zn)	17.30	21.95	16.57
Heavy metals	**38.65**	**42.22**	**37.40**

From tables, it was observed that Na was disappeared from NDLW and NDLC and appeared again in NDLP in relative abundance of 7.33%. Mg disappeared only from NDLW and appeared in small relative abundances in NDLC (2.10%) and NDLP (1.21%).

In comparing the percentages of Na in diapaused larvae reared on wheat DLW and kept at 25 and 35°C, it can be observed that Na appeared in significant values (17.24 and 15.80%), respectively and disappeared from control (Table 1). The same trend was observed in DLC kept at 25°C (11.81%) and DLC kept at 35°C (9.83%) in comparing to zero in the control treatment. Na again appeared in NDLP but in values (7.33%) smaller than DLP kept at 25°C (14.96%) and DLP kept at 35°C (9.57%), respectively.

Mg shows relative abundance 3.19% and 8.27% in DLW kept at 25°C and DLW kept at 35°C, respectively in comparing to zero in the control treatment, 6.77% and 3.86% in DLC kept at 25°C and DLC kept at 35°C, respectively in comparing to 2.10% in the control treatment and 0.77% and 7.62% in DLP kept at 25°C and DLP kept at 35°C, respectively in comparing to 1.21%. Rahman and Tarafdar (1991) indicated that Na content of *Dermestis maculatus* was lower in newly adult insects and then increased with age. Mg level showed the reverse trend. Levy *et al.* (1973) reported that the lower body concentration of Mg in insect species the greater the resistance to an acute radiation exposure.

Heavy metals (Cu and Zn) show relative abundances in diapaused larvae were less than their corresponding nondiapaused larvae (controls) except those observed in diapaused larvae reared on peanut and kept at 25°C. (Tables 1-3).

From data presented in Table (1), it was seemed that the relative abundance of Cu (23.37%) in NDLW was greater than DLW kept at 25°C (18.49%) and DLW kept at 35°C (13.97%), respectively. The same trend was observed in DLC kept at 25 and 35°C and DLP kept at 25 and 35°C in comparing to their controls (Tables 2,3).

Zinc took the behavior of copper except those that in DLP, its relative abundance (21.59%) was greater than those record in the corresponding control (17.30%). Table (3). VanStraalen and Van Wensem (1986) and Heliovaara *et al.* (1987) reported that mineral concentrations in insects seem to depend on their life style and physiology than its concentration in their food.

To show the effect of diet on the relative abundance of P in diapaused larvae it was observed that the percentage of P in DLW (16.86%) was greater than the corresponding values of DLC (11.76%) and DLP (14.62%) when larvae were kept at 25°C. The same trend was appeared when diapaused larvae was kept at 35°C. The reverse was the case in % K, where its relative abundance was (11.02%) less than those record in DLC (12.71) and DLP (13.04%) in larvae reared on 25°C. Meanwhile no significant changes were observed in % K in DL reared on three larval hosts. The values were 13.01 and 12.92% in larvae reared on wheat, cowpea and peanut, respectively.

Silicon was disappeared from DLW kept at 35°C and DLP kept at 25°C and had the least values in DLW kept at 25°C (0.96%) Table (1).

Generally it can be concluded that there was a relation ship between the differences in the relative abundances of minerals detected in nondiapaused and diapaused larvae on larval hosts and diapaused as a a physiological stage. Levy and Cromroy, (1973) showed that the similarities and differences in some and major trace elements between insects would reflect the ability of an insect to concentrate and utilize specific levels of them from the diet to metabolic or biological activity.

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تأثير طور السكون على محتوى العناصر فى يرقات خنفساء الصعيد المرباة علـــى عوائل مختلفة.

أسامة حامد غريب

المركز القومى لبحوث وتكنولوجيا الإشعاع – ص. ب ٢٩ مدينة نصر القاهرة

أجرى هذا البحث لدراسة محتوى العناصر ليرقات خنفساء الصعيد الساكنة وغير الساكنة المرباة على ثلاثة عوائل نباتية وهى القمح – اللوبيا والفول السودانى .

درست عشرة عناصر هى : الصوديوم، الماغنسيوم، السيليكون، الفوسفور، الكلورين، الكـــبريت، البوتاسيوم، النحاس، الزنك، الكالسيوم.

كان من أهم النتائج المتحصل عليها ما يلى :

- كان أكثر العناصر الخفيفة تواجدا هو البوتاسيوم وذلك فى اليرقات غير الساكنة المرباة علـــى القمح واللوبيا.
- كان أكثر العناصر وفرة فى اليرقات غير الساكنة المرباة على الفول السودانى هو الفوسفور.
- اختفى عنصر الصوديوم فى اليرقات غير الساكنة المرباة على القمح واللوبيا بينما ظهر بقيـــم معنوية فى اليرقات الساكنة المرباة على القمح فى درجات حرارة ٢٥ ، ٣٥ درجة مئوية.
- اختفى الماغنسيوم فقط من اليرقات غير الساكنة المرباة على القمح.
- أظهرت العناصر الثقيلة (النحاس – الزنك) نسبة وافرة فى اليرقات الساكنة المرباة على درجة الحرارة ٢٥ ، ٣٥ درجة مئوية أقل من تلك التى لوحظت فى اليرقات غير الساكنة المرباة علـــى القمح لوحظ نفس الاتجاه فى اليرقات الساكنة المرباة على كل من اللوبيا وفول السودانى ما عـــدا اليرقات الساكنة المرباة على الفول السودانى وفى درجة حرارة ٢٥° م.