Journal of Applied Sciences

ISSN 1812-5654

science alert

ANSInet
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Journal of Applied Sciences 5 (10): 1735-1738, 2005
ISSN 1812-5654

Studies on Effects of Artificial Diets on Pre-oviposition, Oviposition Period, Fecundity and Longevity of *Atherigona orientalis* (Schiner) (Diptera, Muscidae)

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Abstract: The study on the effects of artificial diets on some aspects of the biology of *Atherigona orientalis* was undertaken in order to establish a rearing diet for the dipterous pest of peppers and tomatoes in Nigeria. Establishing a rearing diet for the pest will lead to having a detailed study of other aspects of the biology of the pest. Two artificial diets (3% honey solution and a diet mixture of dry baker's yeast, sugar and water) were used to assess their effects on pre-oviposition, oviposition periods, fecundity and longevity of *Atherigona orientalis*. Mean pre-oviposition period was shortest for flies fed on the diet mixture with an average of 1.77±0.2 days (range: 1-3 days), whereas mean pre-oviposition periods for adults fed on 3% honey solution was longer (2.8±0.2; range: 2-5 days). A total of 2465 eggs were recorded for 21 mated females fed on the diet mixture as against 1204 from 21 mated females fed on 3% honey solution. A very loose relationship ($\hat{y} = 9.43 + 0.04\ x$; $r = 0.35$) was observed between longevity and fecundity of females of *A. orientalis*.

Key words: Artificial diets, oviposition, longevity, *Atherigona orientalis*

INTRODUCTION

The Niger Delta ecological zone where this study was conducted is the humid geographical region of Nigeria and the relative high humidity of the area predisposes most of the vegetables and fruits to insect and fungal attacks even from the field to the store. Different cultivars, shapes and colours of peppers are available in the region but the production levels expected is not realized due to insect pests notably the dipterous pests which include *Atherigona orientalis, Ceratitis capitata* and *Megaselia* sp. Their larvae bore through the fruits and feed within destroying the placenta, ovules and seeds affecting their germinability. They leave a papery and transparent epicarp with frass, larval skins and pupae within the fruits causing them to lose their market values as well. The dipterous pests attack peppers and tomatoes mostly during the rainy seasons

A number of researchers have described methods of rearing and managing insects in the field and laboratories. Ogbalu[1] reported on the management of *Atherigona orientalis* during oviposition in the laboratory. Previous studies showed that oocyte maturation and oviposition in the some insects were accelerated when the adult females were fed on diets containing proteins[1].

Apart from the incorporation of artificial diet formulations in insects food, most dipterous insects can still thrive on natural diets however, the inclusion of artificial protein, vitamins and other minerals enhances oocyte maturation , larval growth and adult emergence[2]. Ogbalu[3] formulated a diet of 10% sugar solution; a mixture of dry baker's yeast, sugar and water and 10% honey solution and assessed their effects on the fecundity of the females of *Acraea eponina* adults. Other studies on the infestation of fruits by flies include the reports of Pelz *et al.*[4] and Umeh *et al.*[5]. *A. orientalis* females oviposit on pepper and tomato fruits in nature[6].

Available literature on the fecundity of *A. orientalis* or its rearing on artificial diets is scanty; one of the few studies available include the reports of Ogbalu *et al.*[2,7,8] on the ovipostion site preference of A. orientalis on peppers and tomatoes. This study was therefore undertaken to establish a rearing diet for *A. orientalis* to help in having further detailed study on other aspects of the biology of the pest.

MATERIALS AND METHODS

This study was carried out from July-September, 2003 in the Entomology Unit Laboratory of the Department of Applied and Environmental Biology, Rivers State University of Science and Technology, Port Harcourt, Nigeria (at a temperature range of 26-28°C; relative humidity, 82-88%) using two different diets. Freshly

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emerged males and females were collected from the laboratory and from the field. The experimental design was a Randomized Complete Block Design. On emergence, the adults (while still in perforated plastic petri dish) were transferred on to a flat basin containing ice-blocks for temporary knock-off. After the knock-off, the adults were quickly transferred to another petri dish and viewed under stereo-microscope for the selection and separation of males and females for pairing. Selected paired adults flies were kept in individual plastic containers which were cut open at the two sides into rectangular shapes and gauzed with the aid of fine mosquito net. Pepper fruits were washed and kept in watch-glass for oviposition. A total of 21 pairs of adult flies were used for this study. Each pair was kept in a separate container.

Two different diets were used in feeding the adult flies: one was a combination of dried Baker's Yeast, ordinary sugar and water (1:1:5) and the other was a 3% honey solution.

A 3% honey solution was chosen after series of tests were conducted on different percentages (in the range 0.5%-10%). These various combinations were absorbed in cotton wool and suspended inside the plastic container with the aid of a string. Water absorbed in cotton wool was constantly available in each of the containers. A fresh cotton wool soaked in Baker's Yeast diet or a 3% Honey solution was supplied every 24 h. Each of the diets was offered to 21 pairs of adults and replicated 5 times.

The fruits were observed twice daily to record the number of eggs laid. The pre-oviposition period was taken to be from the first day of emergence of adult females to the first day of oviposition. Eggs laid on each day were collected with the aid of a wet black Painter's brush, counted and kept on moist cotton cloth (kept at the base of the disposable petri dish) for hatching. If a male fly died before the female, a replacement was made by introducing a freshly emerged virgin male. The experiment was terminated when the female died and both longevity and fecundity were calculated.

Analysis of variance was used to analyze variation between treatments and diets and mean separations were done using Duncan Multiple Range Test at 5% level of significance.

RESULTS AND DISCUSSION

From Table 1, a total of 1740 eggs were recorded from the four pepper varieties when the adults were fed with a diet mixture of dry baker's yeast, sugar and water and this was significantly different from 1050 eggs observed under the 3% honey solution diet ($p=0.05$). The number of eggs deposited on Nsukka Yellow variety (i.e for females fed on dry baker's yeast diet) were also significantly different from the rest at 5% level of significance. The same was observed in the 3% honey solution diet. Assessing the percentage contribution of both diets and varieties to oviposition, Nsukka yellow alone contributed more than half of the total eggs (992) observed under Baker's yeast, sugar and water diet and only 453 eggs were observed for flies fed with 3% honey solution diet. Atarugu variety attracted 265 eggs out of the total eggs deposited under the Baker's yeast, sugar and water diet and 206 eggs on 3% honey diet.

Under both diets, Bird's eye chilli variety recorded 313 eggs under Baker's yeast, sugar and water diet and 248 eggs under 3% honey solution diet. Tatashi variety had the lowest number of eggs; 170 when fed with the mixture diet and 134 when fed with 3% honey. The test of significance showed that there was significant difference in the number of eggs laid under different diets and that the total number of eggs laid was dependent on varieties and diets.

Fecundity: Mean pre-oviposition period was shortest for flies fed on a diet mixture of baker's yeast, sugar and water and was 1.7±0.2 days (range: 1-3 days) and 14.3% of flies fed on this diet laid eggs at one day old, while 42.8% laid eggs at two days old. Mean pre-oviposition periods for adults fed on 3% honey solution were longer 2.8±0.2 days (range: 2-5 days). No flies on 3% honey concentration laid eggs on the first day after emergence.

Under laboratory conditions, a total of 2465 eggs was recorded when the adults were fed on the diet mixture of Baker's yeast, sugar and water by 21 mated females. The mean number of eggs for 21 mated flies fed on the diet mixture was 117.4±7.0 (Table 2). The total number of eggs when the 21 mated flies were fed on 3% honey solution was 1204 with a mean number of 57.3±1.7 eggs. Mean number of eggs laid as well as the maximum fecundity were highest in the flies fed on the diet mixture.

Longevity: A loose relationship was observed between longevity and fecundity of females *A. orientalis* when fed on Baker's yeast, sugar and water diet mixture ($y = 9.43+0.04x$; $r = 0.35$). The non-significance of r is confirmed by the loose relationship between longevity and fecundity. Some dead females were found to contain eggs and in some cases eggs were found adhering to their ovipositors.

Fecundity, longevity, pre-oviposition and oviposition periods and rate of oviposition were affected by the nature of diet of the adult insects and the adult food is an

Table 1: Distribution of eggs on the fruits of five varieties of pepper

Treatments	Baker's yeast, sugar and water	Diets 3% honey solution	Total
C. annum var. Atarugu	265c	206c	471c
C. annum var. Nsukka Yellow	992a	453a	1445a
C. annum var. Tatashi	170d	134d	304d
C. frutescens var. Bird's eye chilli	313b	248b	561b
Total eggs	1740a	1041b	

Figures in the same column with different letter (s) are significantly different from each other at 5% level of significance (DMRT)

Table 2: Fecundity, longevity, pre-oviposition and oviposition periods of *A. orientalis* females

Diets	No. of insects	Pre-oviposition period (days)	eggs/female/day	Total No. of Eggs/21 female	Longevity of Females (days)	Oviposition periods (days)	Longevity of males (days)
Baker's yeast sugar and water	21	1.7±0.2 (1-3)	13.0±0.6	2465	14.5±0.6 (6-21)	8.9±0.3 (6-11)	7.4±0.2 (6-9)
3% honey solution	21	2.8±0.2 (2-5)	7.6±0.5	1204	12.2±0.4 (4-16)	7.2±0.5 (3-8)	6.6±0.3 (4-9)

Values in parenthesis shows range

important factor which determines the realization of the full reproductive potential of *A. orientalis*. The result of the experiments on the choice of honey concentration level for the adult insects showed that egg production did not increase with increasing concentration of honey solution, hence 3% honey solution gave a total egg-output of 1050 eggs. In the preliminary trials conducted for the choice an optimum level of honey, ten percent honey concentration may be supra optimal and most flies died when fed on this level of honey concentration. Concentration much higher than 3% honey concentration would be detrimental to the insects and even if the insects lived to lay a few eggs, their longevity would probably have been impaired. This speculation remains to be investigated further.

From the result of the experiments, a mixture of Baker's yeast, sugar and water is a very good diet for the laboratory rearing of pepper fruit flies. Fruit flies maintained on this diet under laboratory conditions had shorter pre-oviposition period (1.7±0.2 days) and over 14.3% of adults fed on this diet laid eggs as 1-day-old and 42.8% laid eggs as two-day-olds. The pre-oviposition period (2.8±0.2 days) of adults maintained on 3% honey concentration was longer. This goes to show that although autogeny is not uncommon in Diptera, protein-feeding is essential for egg-production in *A. orientalis*. It was confirmed that the same holds in *A. acerata*[3]. Protein-feeding is also imperative for egg-production in A. acerata and other fruit flies[3]. Fecundity in *A. orientalis* is low when fed on carbohydrate diet alone (3% honey solution): 57±1.2 eggs were laid by 21 mated females fed on honey as compared to 117.4±7.0 eggs laid by the same number of females fed on dry Baker's yeast, sugar and water diet; showing that fecundity is much higher in flies fed on the latter.

Feeding *Drosophila* on Baker's yeast instead of brewer's yeast increased the number of eggs laid. Under the conditions of the experiment, the longevity of female was 14.5±0.6 (range: 6-21) when reared on Baker's yeast, sugar and water diet compared to 12.2±0.4 (range: 4-16 days) of flies fed on 3% honey solution. The longevity of the females on both diet mixture and 3% honey solution was longer than that of the males. The relationship between fecundity and longevity of females on Baker's yeast, sugar and water diet was not a strong one and the weak relationship is confirmed by the non-significance of r. High fecundity does not necessarily imply higher longevity and vice versa. Mean daily oviposition rate per female was 13.0 with a maximum of 34 eggs (Baker's yeast, sugar and water diet). Difference in pre-oviposition, oviposition periods and longevity could be partly attributed to the influence of both larval and adult diets.

Generally, food ingested and digested by any insect is expected to fulfil its nutritional requirements for normal growth and development. Apart from carbohydrates, that are required for energy, amino acids required for tissue and enzyme production, a direct source of sterols is needed especially as they lack the ability to synthesize these compounds. Also, the type of diet an insect is exposed to can result in differential pre-oviposition periods of females fed on different diets[1,8]. *Acraea acerata* females reared on diet mixtures of dry baker's yeast + sugar + water were more fecund than those bred on honey indicating that the protein diet must have been nutritionally adequate as the females laid higher number of eggs, had shorter incubation periods and heavier larvae and pupae in *A. acerata* diet studies.

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