THE EFFECTS OF JUVENILE HORMONE ANALOGUE ON THE DEVELOPMENT OF THE TSETSE FLY, GLOSSINA MORSITANS MORSITANS WESTWOOD

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SUMMARY

In insects, egg maturation, growth, development and metabolic processes are known to be controlled by hormones secreted by the neuroendocrine system. The insect neuroendocrine system consists of the antero-medial neurosecretory cells of the brain, Corpus cardiacum (or the neurohaemal organ), corpus allatum and prothoracic glands. During development the brain neurosecretory cells produce neurosecretory material (or the brain hormone) which is stored in the Corpus cardiacum from where it is released into the general circulation and stimulates the endocrine glands which respond by secreting their respective hormones that control various processes. Thus the prothoracic glands secrete ecdysones and Corpora allata secrete juvenile hormone. After the prothoracic glands are activated, ecdysones appear in the insects body and these ecdysones cause the insect to moult.

The type of cuticle secreted by the epidermal cells at each moult is affected by the juvenile hormone secreted by the Corpora allata. As long as juvenile hormone is secreted, larvae maintain larval characters at each moult. However, at the end of the last larval instar, juvenile hormone concentration falls rapidly as growth and moulting hormone titre rises and at the next moult larvae of exopterygote insects such as Rhodnius give rise to adults, and the larvae of endopterygote insects such as the cecropia moth, Tenebrio

and Drosophila moult into pupae and the latter into adults. Thus, when larval epidermal cells are stimulated by ecdysone, in the presence of high concentrations of juvenile hormone, they secrete a larval cuticle, whereas in the presence of low concentrations of juvenile hormones or in its absence, they secrete a pupal or adult cuticle.

Juvenile hormone analogues (JHA) are substances of different chemical compositions with biological effects similar to those of the true juvenile hormone of the insect Corpus allatum. They are either extracts from animal and plant sources or synthetic materials.

The history of the discovery of substances of this type started with the discovery by Williams (1956) that the abdomen of the mature Hyalophora cecropia male contained a large amount of a substance whose effects corresponded with those of juvenile hormone. These extracts were found to be active in Pieris brassicae as well as in Tenebrio molitor and Rhodnius prolixus. Later Williams and Law (1956) isolated a highly active fraction from the cecropia moth. Meyer, Schneiderman and Gilbert (1965) also isolated the cecropia moth fraction, having a molecular weight of 294 and the empirical formula $C_{18}H_{30}O_3$. Slama and Williams (1966) tested extracted Juvabione from balsam fir and found it to be potent for pyrrhocorid bugs. Farnesol was also identified as the substance from Tenebrio excrement and Yeast (Slama, 1972).

To test the concept that juvenile hormone analogues would have some future potential in insect control, I have decided to investigate the effects of one synthetic JHA on the development of Glossina morsitans morsitans in the laboratory.

Juvenile hormone analogue, 4-Ethylphenyl-6, 7-epoxy geranyl ether, manufactured by Hoffmann-La Roche, was serially dissolved in acetone to make the required concentrations. The hormone analogue solutions were then topically applied to:

(a) 1-3 days old pupae;

(b) 15-17 days old pupae

(c) females day '0' after first larvipositions;

(d) females day '4' after first larvipositions.

Each specimen was topically treated with 1-µl of hormone solution using microcapillary applicator. The controls were treated with acetone alone. Pupae were treated on the anterior half while for females the hormone solution was applied on the venter of the abdomen.

The following observations were carried out:

(i) morphogenetic effect of the JHA on the pupae;

(ii) embryonic effect of the JHA on the females in their second and third pregnancy cycles;

(iii) the periods after pupation when the application of the hormone analogue would be effective;

(iv) the period after the first larviposition of the female when the application of the hormone analogue would be effective;

(v) abortions or successful larvipositions.

Topical application of JHA to 1-3 and 15-17 days old pupae resulted into morphological deformities in adult Glossina morsitans morsitans which emerged. This ranged from an increasing degree of wing deformity of an otherwise normally emerged adults to an attempted emergence. Such deformations or abnormalities involved mainly the wings that at the time of emergence were usually curled up or wrinkled or never expanded at all. The deformities were found to occur at all concentrations of the JHA used.

The results of applying graded concentrations (0.1; 0.05; 0.025; 0.0125; 0.0063; 0.0031; 0.0016; 0.0008; 0.0004; 0.0002; 0.0001; 0.00005; 0.00002; 0.00001; µg/µl) of JHA to 1-3 days old pupae showed that the hormone affected the pupae in six categories:-

1. It caused some pupae to emerge into adults with fully expanded wings of which some (22.8%) of the flies fed normally but others (4.3%) failed to do so;
2. Some pupae emerged with deformed wings of which 2.7% adults fed, but 36.6% which did not feed died within twenty four hours of emergence;
3. 5.1% pupae were caused to emerge into intermediate forms in which most of the adult characters were inhibited;
4. It caused still other pupae to undergo partial emergence whereby puparia remained attached to wings and/or abdomen;
5. In a few pupae, JHA caused only the anterior parts of the emerging flies to come out of the puparia with the posterior parts and wings still remaining inside the puparia;

6. It caused inhibition of adult emergence to some of the treated pupae.

It was found that the graded per cent score (obtained by pooling together the effects of a dose of JHA on pupae) rose as the concentrations of the JHA increased.

However, following topical application of JHA to 15-17 days old pupae, it was found that at the concentrations (0·1; 0·05; 0·025; 0·0125; 0·0063 µg/µl) used over 50% adults which emerged were normal. On the other hand, the same concentrations prevented normal adult emergence in 1-3 days old pupae. Increasing the dose concentrations resulted in high percentage of inhibition of adult emergence (43% – 93·3%). The results showed that 1-3 days old pupae were more susceptible to the hormone analogue than 15-17 days old pupae. ED_{50} (dose needed to affect 50% of the treated pupae) for 1-3 days old pupae was found to be 0.55 µg per ml pupa whereas the same dose was ineffective to 15-17 days old pupa. ID_{50} (dose expected to produce 50% inhibition of adult emergence) was 10.33 µg per ml per pupa in 1-3 days old pupae whereas the same dose caused even less than 20% inhibition of adult emergence to 15-17 days old pupae.

The results of treating females '0' day after their first larvipositions with the JHA showed that some of the doses used caused abortion and toxicity to flies. As the dose increases, the effects of JHA becomes pronounced in that the number of aborted larvae increased, and that the JHA became toxic.

The increase in the number of aborted larvae and toxicity of the JHA to the flies occurred during the second pregancy cycle. 12.5 µg per ml/1 female caused 50% of the treated flies to abort, while 25 µg per ml/1 female killed all the flies before any could deposit a second larva. Most of the aborted larvae were the second instars though some were also aborted in the third instars. More abortions occurred during the second pregancy cycle than in the third cycle.

However, the results of treating females 4 days after their first larvipositions showed that lower doses of the JHA did not cause abortion. Higher doses, however, caused abortion. Toxicity of the doses tested were less marked in 4 days old females than in day '0' females.