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Studies on the mechanism of action of insecticides in insects

Inhibition of the Acetylcholinesterase activity

With 3 graphs

Introduction

The presence and kinetics of acetylcholinesterase activity in *Musca domestica nebulo* Fabricius has been described and worked out in detail by Srivastava (1964). Its maximum activity takes place at 7 pH and 37 °C. A number of workers have reported that after the DDT poisoning there is an increase in the amount of the acetylcholine in the ventral nerve cord of the American roach and housefly (Tobias et al. 1946, Lewis 1953 and Srivastava et al. 1963). Richards & Cutkomp (1946) reported that DDT did not inhibit the cholinesterase of the nerve cord. DDT may also act by indirect blocking of cytochrome oxidase and succinic dehydrogenase in insects and rat muscles (Lauger et al. 1944 and 1946, Sacktor 1950 and Anderson et al. 1954). As regards the specific action of DDT on the cholinesterase enzyme there has been a great controversy. The present investigation has been undertaken to determine the effect of p,p′-DDT on the acetylcholinesterase activity of the house flies, *Musca domestica nebulo* Fabricius.

Material and Technique

The details of technique employed for the determination of acetylcholinesterase activity has been described in an earlier paper (Srivastava 1964).

In all these experiments 3 c.c. of buffer at 7 pH, 0.6 c.c. of substrate (acetylcholine bromide at 0.11 M) and 3 c.c. of brei (either 10 heads or thorax or abdomen or whole flies or 20 thoracic ganglia) have been used and incubated at 37 °C for one hour.

Results

Inhibition of acetylcholinesterase activity

Whole fly (Graph 1): The houseflies have been treated with 1% solution of p,p′-DDT in acetone. The cholinesterase enzyme has been determined in the treated and untreated flies at intervals of 1, 2, 4, 6 and 24 hours after insecticidal treatment, data are given in graph 1. The inhibition of the enzyme is 15.4%, 35.3%, 53.4%, 71.4% and 89.8% after 1, 2, 4, 6 and 24 hours respectively. The maximum inhibition of the enzyme takes place after 24 hours of application of p,p′-DDT.

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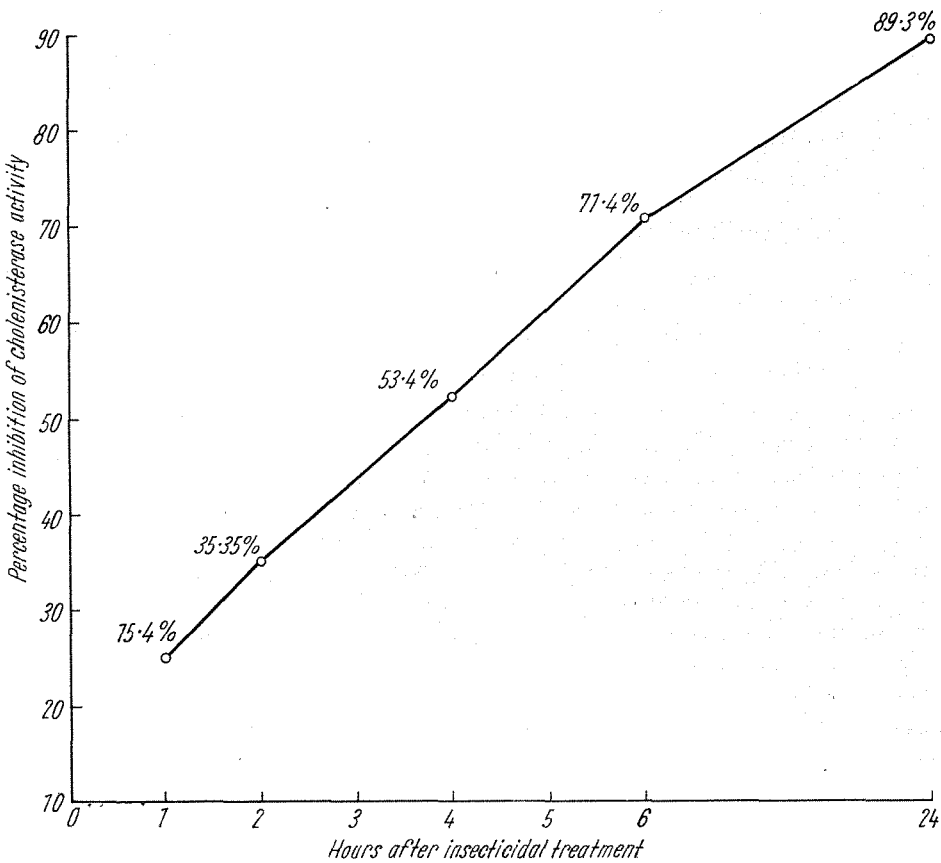

Graph 1. Percentage inhibition of the Acetylcholinesterase activity in the whole fly after treatment with 1% solution of p,p'-DDT in acetone. — Buffer — 3 cc (7 pH); Brei — 3 cc (10 flies); Substrate — 6 cc Acetylcholine bromide (11 M); Incubation period — 1 hour at 37 °C

Head, thorax and abdomen (Graph 2): The activity of cholinesterase enzyme has been determined in the head, thorax and abdomen of the treated flies after one and two hours with 1%, pp'-DDT in acetone. The data is presented in the graph 2. The inhibition of this enzyme is 9.3% and 15.5% in the heads and 11.5% and 22.7% in the thorax after one and two hours of insecticidal application respectively. The cholinesterase activity in the abdomen is very low and there is practically no inhibition of the enzyme.

Throraciaganglia (Graph 3): The anti-cholinesterase activity in the thoracic ganglia of the DDT treated flies showed the maximum inhibition after 24 hours i.e., 86.4% but after 2 and 4 hours the inhibition is 56.7% and 57.7% respectively. The data is presented in the graph 3.

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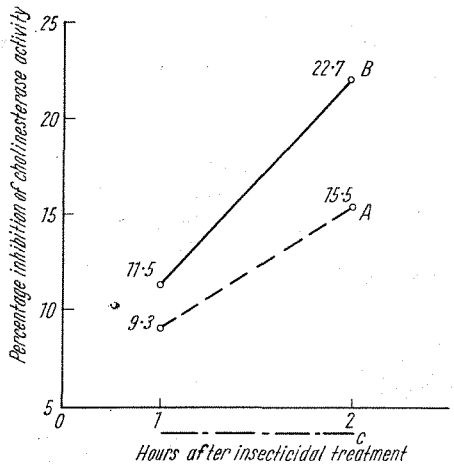
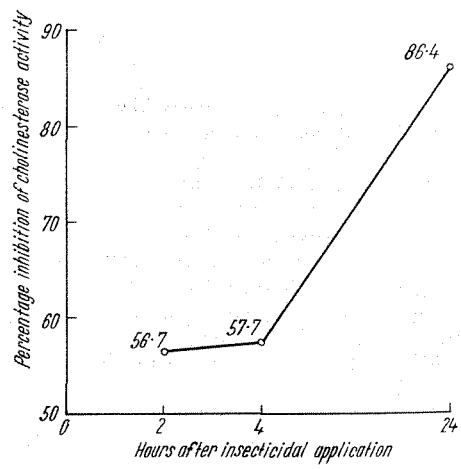


Graph 2. Percentage inhibition of the Acetylcholinesterase activity in the head (A), thorax (B) and abdomen (C) of house flies after treatment with 1% solution of DDT in acetone. — Buffer — 3 cc (7 pH); Brei — 3 cc (10 heads or thorax or abdomen); Substrate — 6 cc Acetylcholine bromide (11 M); Incubation period — 1 hour at 37 °C



Graph 3. Percentage inhibition of the Acetylcholinesterase activity in the thoracic ganglia of flies after treatment with 1% solution of DDT in acetone. — Buffer — 3 cc (7 pH); Brei — 3 cc (20 thoracic ganglia); Substrate — 6 cc Acetylcholine bromide (11 M); Incubation period — 1 hour at 37 °C

Discussion

The effect of DDT on the acetylcholinesterase enzyme in the houseflies is a very significant fact. It has been shown that p,p′-DDT inhibits this enzyme in the head and thorax, but in the case of abdomen the enzyme activity is very low and, therefore, there is practically no inhibition. In the whole fly DDT inhibits this enzyme gradually and maximum inhibition of 89.8% takes place after 24 hours of application. In the case of thoracic ganglia the anti-cholinesterase activity is very much pronounced i.e., after two hours of treatment the inhibition is 56.7% and maximum is 86.47% after 24 hours.

Summary

p,p′-DDT inhibits the cholinesterase enzyme in the head and thorax of house flies *Musca domestica nebulo* Fabricius, but in the abdomen there is practically no inhibition.

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In the whole fly DDT inhibits this enzyme gradually, showing its maximum inhibition (89.3%) after 24 hours of application. In the case of thoracic ganglia the anti-cholinesterase activity is very much pronounced, i.e. 56.7% and 86.4% after 2 and 24 hours respectively.

Zusammenfassung

p,p′-DDT hemmt das Cholinesterase-Enzym in Kopf und Thorax der Hausfliege *Musca domestica nebulo* FABRICIUS, während im Unterleib praktisch keine Hemmung eintritt. In der ganzen Fliege behindert DDT dieses Enzym allmählich, wobei die größte Wirkung (89,3%) 24 Stunden nach Anwendung zu verzeichnen ist. In den Ganglien des Thorax ist die Anti-Cholinesterase-Wirkung sehr deutlich, das heißt 56,7% nach 2 Stunden und 86,4% nach 24 Stunden.

Резюме

p,p′-DDT задерживает энцим Холинестераз в голове и в груди у *Musca domestica nebulo* FABRICIUS, в то время, как в брюшке почти не возникает задерживание. В целом насекомом DDT задерживает постепенно этот энцим, самое высокое влияние (89,3%) отмечается 24 часов после применения. В ганглиях груди влияние анти-Холинестераза очень яркое — 56,7% после 2 часов и 86,4% после 24 часов.

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