THE EFFECTS OF 2-HYDROXY CHALCONE AND ITS DERIVATIVE ON THE LARVAE AND ADULTS OF TRIBOLIUM CONFUSUM

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ABSTRACT:
2-Hydroxy Chalcone and its derivatives (compounds 1 and 2) were used in a toxicity test on the larvae and adults of confused flour beetle Tribolium confusum (Du Val). Mortality tests were done by applying different concentrations (0.01, 0.02 and 0.04 ppm) on 2-Hydroxy Chalcone and its derivatives which were exposed by topical application with 5 μL of each compound and the data were recorded after 24 h of treatments. The mortality % of [7-Hydroxy-9-(pyridine-4-yl)-6H-benzo[C]chromen-6-one] in (compound 2) were 26.6, 50 and 76.67% and 16.67, 36.67 and 63.3% and 13.3, 23.3 and 36.6 % to 3rd, 5th instar larvae and adults, respectively. While in [3-thiinyl-1-(2-hydroxynaphthyl) -1-propene] (compound 1), the mortality % were 23.3, 40 and 66.6% and 13.3, 30 and 56.6% and 6.6, 16.6 and 26.6 % to 3rd, 5th instar larvae and adults, respectively. The results indicated that (comp.2) was the most toxic one and (comp.1) was the least toxic to confused flour beetle when applied singly. The calculated LC50 values to (compound 2) were 0.019, 0.028 and 0.074 ppm to 3rd, 5th instar larvae and adults, respectively. While to (compound 1), the LC50 values were 0.025, 0.034 and 0.106 ppm to 3rd, 5th instar larvae and adults, respectively. The order of toxicity of the chemical compounds was 2 > 1. These chemical compounds can be used to control confused flour beetle.

KEYWORDS: Tribolium Confusum, Toxicity, Chalcones and its Derivatives.

1. INTRODUCTION

Tribolium confusum (Du Val) is considered as a suitable insect species for bioassays since it exhibits moderate tolerance to most insecticides (Champ and Campbell-Brown 1970). In this investigation, 2 chemical compounds (1 and 2) were used to evaluate their action on the confused flour beetle, Tribolium confusum (Du Val).

Confused flour beetle Tribolium confusum is one of the worldwide insect pests of mills, food warehouses, retail stores, and urban homes (Park, 2002 and Esraaili, et al. 2013). The pest can cause damage to stored-products by feeding and hence severely reducing the quality of crops due to product excrement and larval feces. This pest makes serious damage on flour and crush cereal particularly at larval and adults stages. Also, the pest causes damage to the seeds containing high humidity (usually above 12%) converting flour color to gray and creates bad smell see table2. The continuous exposure of the grain and flour to this pest encourages mold growth (Weston, and Rattinggoud 2000 and Park, 2002).

Recently, chlorinated hydrocarbons were replaced in confused flour beetle control program by pesticides of other chemical groups, especially by certain organophosphorous (O-P) insecticides (Pedigo, 1989). The O-P compounds selected are safer to humans and environment where it can effectively replace the chlorinated hydrocarbon (Smith, 1970 and Zettler & Arthur, 2000).

Chalcones are one of the most popular compounds in plants, such as vegetables, fruits, tea, and have various pharmacological activities; as anti-inflammatory, antifungal, antimarial, cytotoxic, anti-tumor, and anti-oxidant (Zhuang, 2017). In addition, it is a basic moiety of many heterocyclic systems containing O, S and N. N with heterocyclic derivatives synthesized from chalcones which exhibited anti-inflammatory, antioxidative, anti-tubercular and anti-bacterial activities. Naphthylchalcone and 2-hydroxy chalcones derivatives were proved to have activity and toxicity against mycobacterium tuberculosis at low concentrations with low cytotoxicity against human cells (Macaev, et. Al. 2014). Simplicity of their synthesis at low cost is an advantage of chalcones as potential anti-tuberculosis. An attempt has been made to synthesize chalcone (comp.1) by the reaction of 2-acetyl thiophene with 2- hydroxy naphthaldehyde. In addition, one of the chalcones derivatives was prepared as follow [pyridine-2-yl-6H-benzo[c] chromen-6-one] (comp. 2). The synthesized compounds have been characterized by physical properties, IR, 1HNMR data.

2. MATERIALS AND METHODS

1. Insect rearing

The confused flour beetle adults were obtained from a laboratory colony of Department of Biology, Faculty of Science/ Zakho University. The pest was reared in 1000 ml glass container. The insects were fed on flour containing 5% powdered dry yeast (Park, and Frank, 1948; Park, 1962; and Zyromska-Rudzka, 1966). The glass containers were maintained in the dark incubator (LAB TECH. Korea) at 30 ± 1 °C, 70 ± 5% RH conditions. The 3rd and 5th instars larvae of T. confusum were used in the present experiments, whereas the adults age were 1 week after emergence.

2. Chemistry

Melting points were determined in an open capillary tube and were uncorrected. IR spectra were recorded on a Bruker -Alpha with Platinum-ART spectrometer (Germany). 1H- NMR spectra were recorded on a Bruker BioSpin GmbH 100.65-MHz instrument in DMSO as solvent and TMS as an internal standard.

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Table 1. Physical properties and IR-spectra of compounds 1 and 2.

<table>
<thead>
<tr>
<th>n</th>
<th>Nomenclature</th>
<th>Chemical formula</th>
<th>Color</th>
<th>M. P.</th>
<th>Solubility</th>
<th>C=O</th>
<th>C=C</th>
<th>-OH</th>
<th>C-O</th>
<th>=C-H</th>
<th>Aromatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3-thinyl-1-(2-hydroxynaphthyl)-1-propene</td>
<td>C₃H₂₇SO₂</td>
<td>Brown</td>
<td>96-98</td>
<td>Ethanol</td>
<td>1630</td>
<td>1586</td>
<td>3180</td>
<td>1160</td>
<td>2882</td>
<td>1458-741</td>
</tr>
<tr>
<td>2</td>
<td>7-Hydroxy-9-(pyridine-4-yl)-6H-benzo[c]chromen-6-one</td>
<td>C₃H₁₇NO₃</td>
<td>White solid</td>
<td>160-162</td>
<td>Ethanol</td>
<td>1649</td>
<td>-----</td>
<td>3362</td>
<td>1236</td>
<td>1151</td>
<td>C-O-C</td>
</tr>
</tbody>
</table>

Table 2. ¹HNMR-spectra of compounds 1 and 2.

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1H,7.87,d</td>
<td>1H,8.12,d</td>
<td>9H,7.20-7.61,m</td>
<td>1H,12.05,s</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>2</td>
<td>-----</td>
<td>-----</td>
<td>4H,7.60-7.81,m</td>
<td>1H,8.8,s</td>
<td>4H,8.40-8.73,m</td>
<td>2H,7.10-7.20,dd</td>
</tr>
</tbody>
</table>

3. Bioassay
Three different concentrations 0.01, 0.02 and 0.04 ppm were used for 3rd, 5th instars larvae and adults of confused flour beetle. Compounds 1 and 2 were diluted with ethanol; 10 larvae and 10 adults were exposed by topical application (the solution was injected over the insect's thorax by 50 capacity microliter syringe) (Galdino, 2011) with 5 µL of different compounds concentrations and covered by a Petri dish to prevent the escaping of the insects. The treatments were replicated 3 times and each replicate consisted of 10 3rd, 5th instar larvae and 10 adults, the control group received 5 µL of 50% ethanol. The bioassay containers were maintained in a glass door incubator at 30 ± 1 °C and 70% ± 5 relative humidity throughout the experimental. The mortality % for larvae and adults was recorded after 24 h. The mortality was corrected according to Abbott's (1925).

4. Determination of lethal concentration (LC50)
Deadly dose values were determined for 50% of the tested insects and Upper and lower confidence limits using a system called MS-DOS according to Probit. Exe, probit. Statistical analysis of the results of toxicological tests were calculated according to Finney (1971). So as to get low doses of the pesticide to kill 50% of the experiment insects.

5. Statistical analysis
All statistical analyses were performed with the Graph Pad Prism program (Version 6.01) (GraphPad Software, Finland) by a Newmanns-Keuls of one-way analysis of variance (ANOVA) and the data were expressed as means ± standard error of mean (SEM). In all tables the letters (a, b and c) are representing significant differences in the means at the 0.05, respectively.

3. RESULTS AND DISCUSSION
1. Larvicidal activity of compounds 1 and 2.
Table (3) shows the results of exposing the 3rd instar larvae of T. confusum to compounds concentrations of 0.01, 0.02 and 0.04 ppm. Larval mortality was significantly different (P<0.05) among the 3 doses and control which were 26.6 ±3.33, 50.0 ± 0.08 and 76.67 ±3.33 % with compound 2, and 23.3 ±3.33, 40.0 ±14 and 66.6 ±3.33% with compound 1, respectively. These results indicated that a concentration dependent mortality for both compounds were obvious. Also, Table (3) shows that the LC50 of compound 2 (0. 019 ppm) was more toxic than that of compound 1 (0.025 ppm) on the 3rd instar larvae of confused flour beetle. The present study revealed that compound 2 possesses a high level of potency as larvicide against T. confusum. Such a phenomenon was noticed in the 70% mortality of 3rd instar larvae of compound 2 treatment with 0.04 ppm, while the mortality % reached 63.3% with 5th instar larvae indicating a higher instar resistant with increasing larvae age.

Martin, et. Al. (2000) showed that the 1st instar larvae of the Helicoverpa Armigeria were very sensitive to the chemical pesticide and then the sensitivity decreased significantly in subsequent successive larval stages, where sensitivity decreased with advancement of larval instar.
Table 3. Mortality %, concentration value of LC50 for different concentrations of compounds 1 and 2 on the 3rd instar larva of T. confusum.

<table>
<thead>
<tr>
<th>Concentrations Ppm</th>
<th>Control (% Mortality)</th>
<th>Compound 2 (%)</th>
<th>Compound 1 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>2.6±3.33</td>
<td>23.3±3.33</td>
<td>0.01</td>
</tr>
<tr>
<td>0.02</td>
<td>50.0±0.08</td>
<td>40.0±0.14</td>
<td>0.025</td>
</tr>
<tr>
<td>0.04</td>
<td>76.6±0.33</td>
<td>66.6±0.33</td>
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</tbody>
</table>

Table 4. Mortality %, concentration value of LC50 for different concentrations of compounds 1 and 2 on 5th instar larva of T. confusum.

<table>
<thead>
<tr>
<th>Concentrations ppm</th>
<th>Control (% Mortality)</th>
<th>Compound 2 (%)</th>
<th>Compound 1 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>16.6±3.33</td>
<td>13.3±3.33</td>
<td>0.03</td>
</tr>
<tr>
<td>0.02</td>
<td>36.6±3.33</td>
<td>30.0±1.32</td>
<td>4</td>
</tr>
<tr>
<td>0.04</td>
<td>63.3±3.33</td>
<td>56.6±3.31</td>
<td></td>
</tr>
</tbody>
</table>

Cassida (1970) and Sun & Johnson (1972) revealed that the basic mechanism of chemical action is to inhibit various oxidation enzymes. This confirms our conclusion about insect susceptibility to pesticides, which is mainly due to the different levels of metabolizing enzymes in the insecticide; this conclusion is consistent with the findings of Cassida, 1966 and Franklin, 1972 as the rate of inhibition depends on the chemical concentration.

The compounds containing hydroxy and methoxy substituents showed antioxidant activity. Chalcones showed a good insect antifeedant activity against the 4th instar larvae Achoea Janata L. with castor leaf disc bio-assay method (Thirunarayanan, 2014).

4. CONCLUSION

In conclusion, the results of the present study revealed that 7-Hydroxy-9-(pyridine-4-yl)-6H-benzo[C] chalcone-6-one (compound 2) showed significantly larvicidal and adulticidal against T. confusum than the 3-thyl-1-(2-hydroxyanaphyl)-1-proline (compound 1) effects.

REFERENCES


