Chemical design and bioefficacy screening of new insect growth regulators as potential insecticidal agents against *Spodoptera littoralis* (Boisd.)

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**A B S T R A C T**

The 13 new compounds were chemically synthesized and their spectroscopic analysis was done to determine their chemical structure. All the compounds were screened for their insecticidal potential against *Spodoptera littoralis* (Boisd.). Among the tested compounds, the compound 13 was found to be the most potent. It displayed one fold more activity than a reported insect growth regulator, fenoxycarb. The other target compounds demonstrated weak to strong toxicological activities against *Spodoptera littoralis* (Boisd.).

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1. Introduction

*Spodoptera littoralis* (Boisd.) is considered one of key insect that reason incredible harm to cotton plants and other different plants in Egypt [1,2] the instar larvae of this insect can feed on about ninety economically plant kind belonging to 40 families. To battle the insect growth, producers utilize prepared organic insecticides [3] and some biorational operators, for example, *Bacillus thuringiensis* is Berliner, however the accomplished control isn't successful enough because high ability to create opposition toward of the majority of conventional compounds. Consequently, researchers and producers are looking for elective materials that are viable against this insect, safe to people, natural well disposed, and good inside focused bug the board (IPM) practices [4]. The elective control strategies that is promising as a potential instrument in *S. littoralis* safe administration projects is the utilization of biorational control specialists, for example, synthetic insect growth regulators (IGRs) and those dependent on normally inferred product [5,6]. IGRs are professed to be more secure for valuable creatures than customary items, and they have been effectively utilized in IPM programs against many tree and little fruit insects [7]. There is a need for different insecticides having different modes of action. We found while searching at the desired and synthesis of juvenile hormone analogs [8,9] of pests to be evaluate against the *S. littoralis* (Boisd.). The prepared compounds displayed a variable level of action activity against this pests, and a number of them were most dynamic activity than the normally juvenile hormones [10–13]. Considering that the pests, after treatment with JHAs, were less defenseless to characteristic contaminations with the *S. littoralis* than normal non treated insects [14]. Shockingly, they demonstrated a changeful level of activity, some of them being very active in inhibiting cell expansion of this pests [15]. Toward the start, the well-known insect growth regulator fenoxycarb was utilized as standard control since it carried on as an exceedingly active operator against larvae of *S. littoralis* [10]. Be that as it may, some adjusted chemical structures have the 4-phenoxan carbamate were observed to be more active than fenoxycarb in investigations against *S. littoralis* cells [16]. The mode of action of these compounds have been studied and there is evidence that there is a restrain sterol biosynthesis inside the cells [17].

2. Materials and methods

Estimating of the MP, for all prepared target compounds was completed on a Fisher-John mechanical technique. By utilizing a Vario EL C, H, N, S analyzer, basic examinations (C, H, N, and S) were elucidated. On a Pye-Unicam SP3-100 spectrophotometer IR spectra were gotten by utilizing the KBr disc technique. $^1$H NMR and $^{13}$C NMR spectra were estimated on Bruker 400 MHz spectrometers utilizing tetramethylsilane (TMS) as a source of perspective and concoction movements were accounted for as

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ppm. By utilizing a Jeol JMS-400 mass spectrometers were completed. Fenoxycarb juvenile hormone analogues as an insect growth regulators insecticide was buyform Sigma-Aldrich. The numbers of *S. littoralis* insects were gathered from cotton leave worm, fields of Assiut University. Toxic activity of the thirteen compounds comparing with fenoxycarb as reported insecticide was tested against the instar larvae of *S. littoralis*.

3. Result and Discussion

3.1. Chemistry

As following our project in prepared and toxicity evaluate the biological activity of juvenile hormones analogues, here in thirteen tested compounds where shown in (Fig. 1) to determined their toxicity as insecticides. The thirteen compounds, namely, N-[4-(orixin-2-ylmethoxy)phenyl]benzamide 1, ethyl[4-(orixin-2-ylmethoxy)phenyl]carbamate 2, 2-chloro-N-[4-(orixin-2-ylmethoxy)phenyl]acetamide 3, N-[4-(orixin-2-ylmethoxy)phenyl][furan-2-carboxamide 4, 4-(furan-2-carboxamido)-2,6-bis(phenylcarbamoyl)phenyl]benzamide 5, N-[4-(2-hydroxy-3-[piperidine-1-y1]propoxy)phenyl]benzamide 6, N-[4-(2-hydroxy-3-[morpholin-4-yl]propoxy)phenyl]benzamide 7, Ethyl[3,5-bis(phenylcarbamoyl)[(phenyl carbamoyl]oxy][phenyl]carbamate 8, 2-chloro-N-[4-(2-hydroxy-3-[piperidin-1-y1])propoxy][phenyl]acetamide 9, 2-chloro-N-[4-(2-hydroxy-3-[morpholin-4-y1]propoxy][phenyl]acetamide 10, N-[4-(2-hydroxy-3-[piperidin-1-y1]propoxy)phenyl][furan-2-carboxamide 11, N-[4-(2-hydroxy-3-[morpholin-4-yl])propoxy][phenyl][furan-2-carboxamide, N-[4-(2-hydroxy-3-[morpholin-4-yl]propoxy)[propoxy]phenyl][furan-2-carboxamide 12 and N-[4-(2-hydroxypthoxypropoxy)phenyl]benzamide 13.

3.2. Experimental

A Fisher-Johns instruments were practiced to register the melting points of every prepared compounds. Infra-red and elemental analyses (C, H, N, and S) were achieved through a PyeUnicam SP3-100 spectro-photometer utilizing the KBr disk strategy and a Vario EL C, H, N, S analyzer, separately. A Bruker 400 MHz spectrometer was utilized to measure DEPT 135 spectra and the $^1$H and $^{13}$C NMR spectra within the TMS as an interior standard. Reaction headway and perfection of the prepared sections were checked by thin layer chromatography.

**General procedure of synthetic oxirane ring (1-4)** By reaction of 4-hydroxyphenyl acetamide derivatives (0.04 mol) with epichlorohydrin (0.12 mol) in presence of sodium hydroxide 25 %in water was stirred in ice bath for 4 h, compounds (1-4) were prepared. The formed precipitate was filtered off and recrystallized from methanol.

3.3. N-[4-(orixin-2-ylmethoxy)phenyl]benzamide (1)

Pale red crystals. Yield: 83 %; MP: 102–104 °C. IR (ν) (KBr) cm$^{-1}$: 3328 (NH), 3050, 3027 (C=H aromatic). 2922, 2827 (C=H aliphatic)$^1$. H NMR (DMSO-d$_6$): δ 10.11 (s, 1H, NH), 6.19 – 7.99 (m, 9H Ar-H), 4.33 (s, 1H, CH), 3.8 (m, 2H, CH$_2$), 2.8 (s, 1H, CH), 2.7 (s, 1H, CH). $^{13}$C NMR (DMSO-d$_6$): δ 165.61, 153.02, 135.54, 133.07, 132.66, 131.82, 128.80, 128.00, 122.44, 69.60, 50.22, 40.69. Dept 135: δ 131.80, 128.78, 127.99, 122.49, 124.47, 115.01, 114.91, 69.63(CH$_2$), 44.24(CH$_3$). Elemental analysis calculated for C$_9$H$_9$NO$_3$ (% Calcld. /found; C: 71.36/71.34, H: 5.61/5.60, N: 5.20/5.21.

3.4. Ethyl [4-(orixin-2-ylmethoxy)phenyl]carbamate (2)

White crystals. Yield: 90%; MP: 86–89 °C. IR (ν) (KBr) cm$^{-1}$: 3322 (NH), 3059, 3018 (C=H aromatic). 2901, 2880 (C=H aliphatic) 1710 (C=O)$^1$. H NMR (DMSO-d$_6$): δ 9.35 (s, 1H, NH), 7.36 – 7.38 (s, 2H Ar-H), 6.80 – 6.90 (s, 2H Ar-H), 4.27 (s, 1H, CH), 4.26 (s, 2H, CH$_2$), 3.95 (s, 1H, CH), 3.31 (s, 1H, CH)$_2$, 2.83 (s, 1H, CH), 2.84 (s, 1H, CH), 1.3 (s, 3H, CH$_3$)$^{13}$C NMR (DMSO-d$_6$): δ 157.01 153.31, 149.82, 136.04, 119.12, 89.22, 39.44, 38.14, 28.22, 27.69. Elemental analysis calculated for C$_9$H$_9$NO$_4$ (%) Calcd. /found; C: 60.75/60.74, H: 6.37/6.35, N: 5.90/5.89.

3.5. 2-Chloro-N-[4-(orixin-2-ylmethoxy)phenyl]acetamide (3)

White crystals. Yield: 72%; MP: 146–148 °C. IR (ν) (KBr) cm$^{-1}$: 3267 (NH), 3093 (C=H aromatic). 2920 (C=H aliphatic), 1660 (C=O)$^1$. H NMR (DMSO-d$_6$): δ 10.10 (s, 1H, NH), 7.50 – 7.52 (s, 2H Ar-H), 6.93 – 6.95 (s, 2H Ar-H), 4.30 (s, 1H, CH), 4.27 (s, 2H, CH$_2$), 3.85 (s, 1H, CH), 3.31 (s, 1H, CH), 2.85 (s, 1H, CH), 2.82 (s, 1H, CH)$^{13}$C NMR (DMSO-d$_6$): δ 158.02, 153.41, 143.12, 133.59, 126.12, 117.03, 38.14, 27.22, 28.01. Elemental analysis calculated for C$_9$H$_9$ClNO$_3$ (%) Calcd. /found; C: 54.67/54.55, H: 5.00/4.98, N: 5.80/5.78.

3.6. N-[4-(orixin-2-ylmethoxy)phenyllfuran-2-carboxamide (4)

Brown powder. Yield: 69 %; MP: 166 – 168 °C. IR (ν) (KBr) cm$^{-1}$: 3346 (NH), 3185 (C=H aromatic). 2941 (C=H aliphatic), 1661 (C=O)$^1$. H NMR (DMSO-d$_6$): δ 10.03 (s, 1H, NH), 6.69 – 7.90 (m, 7H Ar-H), 4.32 (s, 1H, CH), 3.33 (s, 2H, CH$_2$), 2.85 (s, 1H, CH), 2.71 (s, 1H, CH)$^{13}$C NMR (DMSO-d$_6$): δ 158.43, 156.31, 143.44, 131.59, 129.63, 127.22, 126.12, 120.17, 117.03, 114.33, 38.13.

Fig. 1. Purposed compounds that tested against *S. littoralis*. 
3.7. 4-\{(Furan-2-carboxamido)-2,6-bis(phenylcarbamoyl)phenyl\}phenylcarbamate (5)

White powder. Yield: 70%; MP: 143–146 °C. IR (v) (KBr) cm⁻¹: 3288 (NH), 1716 (C=O), 1648 (C=O). ¹H NMR (DMSO-d₆): δ 10.22 (s, 1H, NH), 10.14 (s, 1H, NH), 8.61 (s, 2H, 2NH), 6.71 – 7.93 (m, 20H Ar-H). ¹³C NMR (DMSO-d₆): δ 156.43, 153.31, 150.44, 130.01, 127.32, 127.19, 119.63, 118.22, 118.02, 112.92. Elemental analysis calculated for C₃₂H₄₄N₄O₆ (%): C 75.15, H 10.01, N 10.04. Found: C 74.97, H 10.04, N 10.01.

3.8. N-4-\{(2-hydroxy-3-(piperidin-4-yl)propoxy)phenyl\}benzamide (6)

White powder. Yield: 62%; MP: 155–158 °C. IR (v) (KBr) cm⁻¹: 3496, 3395 (NH, OH), 3055 (C=H aromatic), 2924 (C=H aliphatic), 1627 (C=O). ¹H NMR (DMSO-d₆): δ 10.11 (s, 1H, NH), 7.50 – 7.97 (m, 9H Ar-H), 5.52 (s, 1H, OH), 4.00 (m, 3H, CH), 3.8 (m, 9H, 4CH₂+CH), 2.2 (s, 2H, CH₂). ¹³C NMR (DMSO-d₆): δ 158.03, 155.32, 140.44, 136.01, 128.39, 127.19, 118.22, 118.02, 112.9, 77.20, 56.15, 39.22, 31.13, 29.15. Elemental analysis calculated for C₁₉H₂₅NO₆ (%): C 67.40, H 7.86, N 10.40. Found: C 67.35, H 7.88, N 10.38.

3.9. N-4-\{(2-hydroxy-3-(morpholin-4-yl)propoxy)phenyl\}benzamide (7)

White powder. Yield: 73%; MP: 205–208 °C. IR (v) (KBr) cm⁻¹: 3277 (OH), 3115 (C=H aromatic), 2930 (C=H aliphatic), 1689 (C=O). ¹H NMR (DMSO-d₆): δ 10.11 (s, 1H, NH), 7.50 – 7.97 (m, 9H Ar-H), 5.52 (s, 1H, OH), 4.00 (m, 3H, CH), 3.8 (m, 9H, 4CH₂+CH), 2.2 (s, 2H, CH₂). ¹³C NMR (DMSO-d₆): δ 157.03, 145.70, 137.15, 127.39, 127.19, 119.55, 118.15, 111.09, 81.20, 75.15, 35.22, 33.13, 27.15 27.32. Elemental analysis calculated for C₂₀H₂₂N₂O₄ (%): C 67.40, H 7.86, N 10.40. Found: C 67.35, H 7.88, N 10.38.

3.10. Ethyl-3,5-bis\{(phenylcarbamoyl)oxy\}phenyl carbamate (8)

White crystals. Yield: 83 %; MP: 186–189 °C. IR (v) (KBr) cm⁻¹: 3326 (NH), 3194 (C=H aromatic), 2978 (C=H aliphatic), 1733, 1694, 1645 (C=O). ¹H NMR (DMSO-d₆): δ 10.13 (s, 1H, NH), 9.63 (s, 1H, NH), 8.64 (s, 1H, NH), 6.96 – 7.56 (s, 17H Ar-H), 4.18 (s, 2H, CH₂), 1.3 (s, 3H, CH₃). ¹³C NMR (DMSO-d₆): δ 157.32, 157.03, 156.70, 147.15, 140.89, 139.25, 137.25, 130.00, 123.23, 122.13, 121.58, 119.68, 119.05, 117.23, 116.35, 59.93, 12.3. Elemental analysis calculated for C₂₀H₁₆N₂O₆ (%): C 66.91, H 66.90, 7.48, 9.88. Found: C 66.91, H 66.90, 7.48, 9.88.

3.11. 2-Chloro-N-4-\{(2-hydroxy-3-(piperidine-1-yl)propoxy)phenyl\}acetamide (9)

Brown powder. Yield: 44 %; MP: 158 – 160 °C. IR (v) (KBr) cm⁻¹: 3267 (NH), 3093 (C=H aromatic), 2920 (C=H aliphatic), 1658 (C=O). ¹H NMR (DMSO-d₆): δ 10.10 (s, 1H, NH), 7.50 – 7.52 (m, 4H Ar-H), 4.30 (s, 1H, OH), 4.27 (s, 1H, CH), 3.85 (m, 4H, 2CH₂), 2.85 (s, 8H, 4CH₂). ¹³C NMR (DMSO-d₆): δ 157.20, 154.81, 129.69, 127.21, 126.77, 126.92, 119.2, 107.25, 71.78, 55.32, 26.19, 24.64. Elemental analysis calculated for C₁₉H₂₂Cl₂N₂O₂ (%): C 68.50, H 58.78. Found: C 68.70/69.07, 7.0, 8.57/8.55.

3.12. 2-Chloro-N-4-\{(2-hydroxy-3-(morpholin-4-yl)propoxy)phenyl\}acetamide (10)

White powder. Yield: 72 %; MP: 146 – 148 °C. IR (v) (KBr) cm⁻¹: 3267 (NH), 3093 (C=H aromatic), 2920 (C=H aliphatic), 1660 (C=O). ¹H NMR (DMSO-d₆): δ 10.13 (s, 1H, NH), 7.98 (s, 2H Ar-H), 7.82 (s, 2H Ar-H), 4.90 (s, 1H, OH), 3.29 (s, 1H, CH), 3.85 (s, 2H, CH₂), 3.12 (s, 2H, CH₂), 2.20 (m, 8H, 4CH₂), 1.82 (s, 2H, CH₂). ¹³C NMR (DMSO-d₆): δ 157.45, 139.69, 127.19, 127.17, 119.2, 107.25, 71.78, 67.25, 55.02, 25.29, 23.44. Elemental analysis calculated for C₁₉H₂₂Cl₂N₂O₂ (%): C 68.50, H 58.78. Found: C 54.79/54.77, 7.44/7.41, N: 8.52/8.50.

3.13. N-4-\{(2-Hydroxy-3-(piperidine-1-yl)propoxy)phenyl\}furan-2-carboxamide (11)

Yellow crystals. Yield: 63 %; MP: 196 – 198 °C. IR (v) (KBr) cm⁻¹: 3326 (NH), 3178, (C=H aromatic), 2925 (C=H aliphatic), 1694, (C=O). ¹H NMR (DMSO-d₆): δ 10.01 (s, 1H, NH), 6.98 – 7.90 (s, 7H)

Table 1

| Comp. | LC₅₀(ppm) | slope | Toxic ratio | LC₅₀ (ppm) | slope | Toxic ratio |
|-------|----------|-------|-------------|----------|-------|-------------|
| 1     | 5.941    | 0.298 ± 0.0808 | 0.684 | 50.914 | 0.225 ± 0.0870 | 0.954 |
Fig. 2. Compounds 1–13 and reference juvenile hormone analogue fenoxycarb as insecticidal activities against the 2nd and 4th instar larvae of S. littoralis after 72 h of treatment.
Ar-H), 4.72 (s, 1H, OH), 3.9 (m, 3H, CH + CH2), 2.4 (s, 2H, CH2), 2.3 (s, 2H, CH2), 1.4 (m, 8H, 4CH2). 13C NMR (DMSO-d6); δ 157.33, 150.03, 159.70, 149.15, 147.89, 146.25, 140.25, 128.63, 128.23, 127.23, 52.36, 44.99, 28.98, 18. 23, 16.35. Elemental analysis calculated for C18H22N2O5 (%) Calcd.; found: C: 66.26/66.23, H: 7.02/7.00, N: 8.13/ 8.15.

3.14. N-[4-(2-Hydroxy-3-napthoxypropoxy)phenyl]furan-2-carboxamide (12)

White powder. Yield: 26 %; MP: 218-220 °C. IR (ν/KBr) cm⁻¹: 3326 (NH), 3302 (OH), 3078, (C=H Aromatic), 2909 (C–H aliphatic), 1653, 1653 (C=O). 1H NMR (DMSO-d6); δ 10.10 (s, 1H, NH), 6.90 – 7.63 (s, 7H Ar-H), 4.72 (s, 1H, OH), 3.72 (s, 1H, CH), 2.5 (m, 4H, 2CH2), 1.3 (m, 8H, 4CH2). 13C NMR (DMSO-d6); δ 157.83, 159.70, 148.15, 148.89, 128.85, 128.65, 128.01, 172.93, 127.23, 52.36, 48.23, 38.98, 17. 23, 16.33. Elemental analysis calculated for C18H22N2O5 (%) Calcd.; found: C: 62.42/62.40, H: 6.40/6.38, N: 8.09/8.09.

3.15. N-[4-(2-Hydroxy-3-napthoxypropoxy)phenyl]benzamide (13)

White crystals. Yield: 81 %; MP: 220-222 °C. IR (ν/KBr) cm⁻¹: 3320 (NH), 3051 (C=H Aromatic), 2922 (C–H aliphatic), 1645 (C=O). 1H NMR (DMSO-d6); δ 10.13 (s, 1H, NH), 6.90 – 7.98 (s, 16H Ar-H), 4.33 (s, 1H, OH), 4.1 (m, 5H, CH). 13C NMR (DMSO-d6); δ 166.39, 157.16, 154.75, 148.39, 139.68, 134.78, 129.74, 128.95, 127.96, 127.12, 126.82, 123.99, 119.25, 111.15, 111.27, 107.10, 105.79, 67.61, 61.33. Elemental analysis calculated for C30H26N4O6 (%) Calcd.; found: C: 66.91/66.90, H: 4.87/4.88, N: 10.40/10.38. Elemental analysis calculated for C30H26NO4 (%) Calcd.; found: C: 75.53/75.50, H: 6.61/6.53, N: 3.39/3.40.

4. Laboratory bioassay

The method that measure toxicity of the target compounds was tested by leaf dipping bioassay [18]. Results of research facility screening to discover the suitable concentrations of the objective target compounds which are deformation in the insect to kill half 50 % LC50 of instar larvae were proclaimed here. Five concentrations of arrangement of each synthesized compound in addition to 0.1 % Triton X-100 as a surfactant were used. The number of ten 2nd instar larvae and 4th instar larvae of insects, nearly have the same size, plates (9 cm, distance across) of castor bean leaves in which dunked in the objective treatment concentrations for 10 s then left to dry and offered to larvae, which starved for 4 – 6 treatment were reproduced multiple times (10 larvae for each). Control was dunked in distilled water only. The larvae were permitted to benefit from treated plates for 48 h, then transferred to the untreated ones. Mortality percentages were recorded after 72 h. for all insecticides. Mortality was redressed by Abbott’s formula [19]. The doses mortality relapse lines were statistically investigated by probit analysis [20]. Toxicity Index and Relative Potency determined by Sun equations [21]:

Toxicity ratio = \( \frac{LC_{50}}{LC_{90}} \) or \( \frac{LC_{50}}{LC_{90}} \) of the most efficient compound × 100

\( \frac{LC_{50}}{LC_{90}} \) or \( \frac{LC_{50}}{LC_{90}} \) of the other compound

Slope esteem and middle deadly focused concentrations LC50 of the title target compounds were determined through a Probit relapse investigation program and recorded in (ppm) [20]. Were inundated for 10 s in each concentration multiple times (3 times). Pests which treated were left to dry at room temperature for about half hour. Control clumps of utilized pests were likewise used. The insecticidal action trial of each compound was rehashed multiple times (2 time) and the gotten data were rectified by Abbott’s equation [19]. By utilizing a modernized probit relapse investigation program, middle deadly fixations (LC50) and incline estimations of objective target compounds were figured and revealed as (ppm) [20].

5. Insecticidal activity

The objective tested compounds have been used for insecticidal activity as explained beneath:

5.1. Toxicological activity of compounds against 2nd instar larvae

As shown in (Table 1) target compounds were tested of their activity as insecticides in which shown beneath. Thirteen previously mentioned compounds displayed strong to weak toxic action against the 2nd instar larvae in light of the fact that various of them were active than fenoxycar after 72 h. of the test with LC50 qualities differ from 4.066 ppm for 2nd instar larvae, while fenoxycar LC50 was 5.943 ppm for 2nd instar larvae. For example, LC50 values of compounds 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13 were 26.546, 12.505, 57.622, 25.414, 15.720, 20.478, 21.424, 8.032, 37.445, 37.495, 13.885, 14.106 and 4.066 ppm, respectively in a specific order, and LC50 of fenoxycarb was 5.943 ppm. From outcomes in over, the toxicity of compound 13 against the 5. litoralis larvae 4.066 ppm after 72 h of the test on the grounds that LC50 estimation of reported fenoxycarb was 5.943 ppm.

5.2. Toxicological activity of compounds against 4th instar larvae

As shown in (Table 1) target compounds were tested for their activity as insecticides and this is shown beneath. Thirteen previously mentioned compounds displayed strong to weak toxic action against the 4th instar larvae in light of the fact that various of them were active than fenoxycar after 72 hs of the treatment in which LC50 values changed from 57.170–254.471 ppm, while fenoxycar LC50 was 59.914 ppm. Compounds 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 and 13 gave a high toxicity with LC50 values of 145.369, 67.908, 254.471, 128.376, 81.406, 91.360, 113.203, 67.670, 148.565, 152.260, 68.670, 68.670 and 57.170 ppm. Comparing with fenoxycarb compound 13 showed that the highest toxicity while compounds 8, 11, 12 and 5 give a very good activity in which LC50 values are 67.670, 68.670, 68.670 and 81.406 ppm, respectively.

6. Structure-activity relationship

As a resumé of our search, the structure-activity relationships were accounted for here as indicated by the poisonous activity peaks in Table 1 underneath and (Fig. 2) too. It is demonstrated that the 4-aminophenol derivatives 13 is progressively active against of S. litoralis than different compounds that prepared. The large activity related with compounds 8 and 5 might be because of the closeness of the carbamate and fuoryl group moiety independently in their chemically structure and the general qualities of the synthesized compounds.

7. Conclusion

A chain of 4-alkoxyphenyl amide derivatives which are analogues to fenoxycarb juvenile hormone in which contain phenoxy group were chemically synthesized. The toxic activity of the tested target compounds was assessed against 2nd and 4th instar larvae demonstrated that some of the synthesized target compounds have great toxicological activity, though some of them uncovered sensible aphidical activity. Particularly, compound 13 was the most toxic action since it surpassed the aphidical activity of a reference juvenile hormone analogue fenoxycarb. The activity concerning compound 13 might be because of the presence of the ethers group joined to the aminophenol in its atomic structure.
examination showed that the new aminophenol analogues containing ethers group moiety could successfully control of *S. littoralis*. These results are lively and gainful for additional work on the improvement of new and strong insecticides.

**Declaration of Competing Interest**

We are declared that there is no conflict of interest including any financial, personal or other relationships with other people or organizations within five years of beginning the submitted our paper that could inappropriately influence, or be perceived to influence, our work

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**Appendix A. Supplementary data**

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.btre.2019.e00394.

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