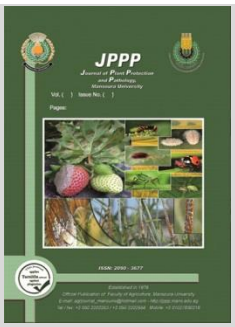
Journal of Plant Protection and Pathology

Journal homepage: www.jppp.mans.edu.eg
Available online at: www. jppp.journals.ekb.eg

Toxicity of Certain Insecticides on *Tuta absoluta* (Lepidoptera: Gelechiidae) with Relation to Carbohydrasis and Phosphatasis Enzyme

Heba A. A. Al-Ghnam* and S. M. Abd El Naby

Plant Protection Research Institute (PPRI), ARC, Dokki, Giza



ABSTRACT

The present work is the studying the toxicities of three insecticides from different groups indoxacarb, emamectin benzoate and methoxyfenozide on *Tuta absoluta*. collected from field. The obtained result showed the toxicity of three insecticides against the third larvae instar of *T.absoluta*, the values of LC_{50} for methoxyfenzoid, indoxacarb and emmamectin benzoate (50.77 ppm. , 2.33 ppm. and 0.022 ppm.), respectively. Emmamectin benzoate and indoxacarb are more effective methoxyfenzoid. The biochemical result showed high increase in activity enzyme trehalase and Acid phosphatase (17.93% , 7.83%), respectively and slight increase in invertase and amylase activities, (2.51%, and 0.039%), respectively, when treated by Indoxicarb comparing with the other two insecticide.

Keywords: *Tuta absoluta*, Indoxicarb, Methoxyfenzoid, Emmamectin benzoat, Insect growth regulators (IGR's), Acid phosphatase (AcP), Alkaline phosphatase (AlP) and Carbohydrates enzyme.

INTRODUCTION

The tomato pinworm, *Tuta absoluta* Meyrick (Lepidoptera: Gelechiidae), is one of the most destructive pest of solanaceae and it prefers tomato *Solanum lycopersicum L.*, becoming a major concern for tomato cultivation in Europe, Africa and the Middle East (Gebremariam, 2015). *Tuta absoluta* (Meyrick) is considered as one of the most important and devastating tomato insect pest (Cuthbertson *et al.*, (2013) and Öztemiz.,(2013). Recording control failure, development of resistance to a wide range of compounds, (Silva *et.al*, 2015). Damages are caused through affecting the plant's photosynthetic capacity and development by all larval instars feeding on leaf mesophyll, stems and the growing tips forming mines and galleries. The fruit rot occurrence by pathogens attack and lowering tomato yield was the source of ' Marketing and processing misplace up to 80–100%, (Desneux *et.al*, 2011). Resistance can be defined as the susceptibility change of the pest population reflects a repeated control failure of proper insecticide used with its label recommendation of application (Gontijo *et.al*, 2013). The effective management needs a durable assessment to any new insecticide by many category of detection to follow and predict its more efficacy information on the proper pest, discovering new additionally resistance mechanisms and reduce the number of insecticides not desirable for control, this was infinitely by using biochemical approaches as well as toxicological measures.

Carbohydrates, protein and lipids are very efficiently utilized by insects and most species derive the main part of their nourishment from these nutrients depends. Amylase, invertase and trehalase were found to be the most important enzymes that play the major role in the digestion and metabolism of carbohydrates in insects (Wigglesworth, 1972; and Wyatt, 1967). These enzymes have received a great deal of attention in concern with digestion and utilization of carbohydrates in insect.

The low enzyme activity may be used as a marker for resistant individual in populations (Van Dyk, 2011). To measure the effect of insecticide it must be measure the inhibition on the carbohydrate hydrolyzing enzyme because it more sensitive to inhibitors than general protein synthesis from 5–20 times (Silva *et.al.*, 2015; and Campos *et.al.*, 2014). There is a relationship between the increase of insecticide resistance and the activity of detoxification enzymes (Xin-Ju and Hui-Min, 2011). Detoxification enzyme, acid phosphatase (ACP) in insects is generally demonstrated as the enzymatic defense against foreign compounds and play significant roles in maintaining their normal physiological functions (Li, and Liu, 2007).

There for, that present study aims to infestigate the changes in the carbohydrate hydrolyzing enzymes amylase, invertase, trehalase, Acid phosphatase & alkaline phosphatase activity after treatment the field strain larvae of *T. absoluta* larvae by the insecticide median lethal concentration (LC_{50}).

MATERIALS AND METHODS

Insects

Collection tomato plant leaves contain different developmental stages of *T. absoluta* were obtained from heavy infested tomato crop (field strain) and transferred to laboratory to study the toxicity and biochemical assay.

Insecticides used

1-The toxicological studies

Insecticides were carried out using filter paper impregnated with one concentration (according to recommended Dose cited in Table1) 1ml of insecticide dissolved in acetone and placed in petri dish, three replicate each one contain 10 larvae of the third larvae instar *T.absoluta* were used for each insecticide. Mortality was

* **Corresponding author.**
E-mail address: heba_beuty_2010@yahoo.com
DOI: 10.21608/jppp.2020.96008

checked every six hour, for two days. Every day larvae were provided with fresh food. Statistical Probit Analysis of Correlated Data, The average mortality was corrected using Abbott's formula (1925).The corrected mortality average of each compound was statistically computed according to Finney (1971). Resistance ratio (RR) and lethal dose causing 50 and 90% mortality (LC_{50} and Lc_{90}) values using LDP-line software, Ehabsoft, (2005) including correction for control mortality.

Table 1. Chemical, Brand names, Mode of action and field dose of insecticides tested

Insecticide	Commercial names	Formulations	Field Dose	Class	Primary mechanism
Methoxyfenzoid	Rano	24% SC	37.5 ml /100L	Diacylhydrazine	chitin synthesis inhibition
Indoxicarb	Camvaal	15% EC	25 ml /100L	Oxadiazine	Na channel blocking
Emmamectin benzoat	Excellent	1.9% EC	75 ml / 100L	Avermectin	GABA receptor blocking

2-The biochemical assay

Bioassays were performed using a method according to (Reyes *et al.,* 2012; Silva *et.al.* 2011 & 2015 and Campos *et.al.* 2014) leaves were dipped for in fresh solutions of the insecticide for 5 seconds in each aqueous concentration of the tested compound then left to dry on room temperature, then two leaves were placed in individually in 9 diameter Petri dish. Elementary controls were dipped in water only, 10 3rd instar larvae were carefully placed on every dish of the three replicate and seven concentrations and kept on controlled conditions at 25 ± 2ºC and 16:8 h light to dark. Mortality was recorded after 24 h from treatment for the faster-acting insecticides indoxacarb and emmamectin benzoate (neurotoxic insecticide) and 48h for the slower-acting insecticides for methoxyfenozide (insect growth regulators) (Silva *et al.*,2011) under a binocular. The larvae were considered dead when it was not able to move normally. Statistical analysis of bioassay data was carried out to estimate the median lethal concentration (LC_{50} and LC_{90} values) using LDP-line (Ehabsoft, 2005), correction for control mortality were performed throughout probit transformations. A number of biochemical indices was measured in the present study to evaluate the physiological and biochemical effects of the tested insecticides against larvae of *T. absoluta*. For that a huge number of larvae were treated with LC_{50} that previously determined for each insecticide and distilled water only for control and about 0.5 g of healthy *T. absoluta* larvae from each insecticide treatment that survived after two days from treatment with the LC_{50} of methoxyfenzoid and after one day treatment with the LC_{50} of indoxacarb and emmamectin benzoate and the control were collected in plastic dishes and kept in a freezer at (- 20°C) until required.

preparation of samples for biochemical studies:

The collected larvae were homogenized in distilled water at 500 rpm using a Teflon homogenizer - (MECHIANIKA PRECYZYJNA Warszawa type MPN-309-Poland) - surrounded with a jacket of crushed ice for 3 minutes. The larvae homogenates of *T. absoluta* were collected in cold tubes (on ice) previously coated with crystals of phenylthiourea to prevent melanization, then centrifuged at 6000 rpm for 10 min at 5°C using (BECKMAN GS-6R Centrifuge). After centrifugation, the supernatant fluid was divided into small aliquots (0.5 ml) and stored at –20 °C until analysis of enzyme activities and determination of main component. Three replicates were carried out for each biochemical determination.

A-Determination of carbohydrate hydrolyzing enzymes activity :

The method was based on the digestion of trehalose, starch, and sucrose by trehalase, amylase, and invertase, respectively, according to the method described by Ishaaya and Swirski (1976).

B- Determination of acid and alkaline phosphatase activities

Acid phosphatase (AcP) and alkaline phosphatase (AlkP) activities were determined according to the method described by Powell and Smith (1954). In this method, the phenol released by enzymatic hydrolysis of disodium phenylphosphate, reacts with 4-aminoantipyrine, and by the addition of potassium ferricyanide, the characteristic brown colour is produced.

Results and Discussion

Toxicological study:

Table (2) show the toxicity effect of three insecticides against the third larvae instar of *T.absoluta* larvae, the values of LC_{50} for methoxyfenzoid, indoxacarb and emmamectin benzoate (50.77 ppm. , 2.33 ppm. and 0.022 ppm.), respectively. The slope values were (1.85, 1.87 and 1.4), respectively. Resistance ratios (RR) for methoxyfenzoid, indoxacarb and emmamectin benzoate were determined using the most susceptible population as reference. RR values were (18.8, 4.12, and 1.83), respectively.

Table 2. Resistance ratio (RR) of the third larvae instar larvae of tomato pinworm *Tuta absoluta* (Meyrick) tested by three different.

Tested insecticides	field strain			Susceptible strain			RR
	LC_{50} (95% FL)	Slope ± SE	χ2(df)	LC_{50} (95% FL)	Slope± SE	χ2(df)	
Methoxyfenzoid	50.77 (37.46 - 67.39)	1.857±0.29	2.805(3)	2.699(20.8- 34.5)	2.2±0.32	2.7(3)	18.88
Indoxicarb	2.33 (1.6 - 3.08)	1.873±0.30	1.057(3)	0.565(0.392-0.759)	1.7±0.29	0.56(3)	4.12
Emmamectin benzoat	0.022 (0.014 - 0.03)	1.400±0.27	1.712(3)	0.012(.009-0 .016)	1.7±0.28	1.67(3)	1.83

The population consider susceptible to insecticides because RR was low (under 5 fold) according to Roditakis *et.al.,* (2013). From the previous results it seems that emmamectin benzoate most efficient than the others, Methoxyfenzoid were less efficient. Contijo *et.al.,* (2013) and Roditakis *et.al.,* (2013) found that LC_{50} of some tested insecticides against *T. absoluta* populations was less than 5 fold except for indoxacarb up to 10 fold of resistance. Gacemi and Guenaoui (2012), reported that three foliar applications of Emamectin benzoate were made at 7 days interval in a tomato greenhouse, showed a good activity on *Tuta absoluta* larvae with a mortality reached 87%. Fanigliulo and Sacchetti (2008), said that Emamectin benzoate has a high control of *H. armigera* more than

indoxacarb and spinosad. Although some searches noted that indoxacarb were potent with other insect pests.

Biochemical study:

Effect on carbohydrate enzymes activity:

As show in table (3), larvae treatment with LC_{50} of methoxyfenzoid caused a significant decrease in trehalase and amylase activity (-20.18 % , 12.85 %), respectively comparative with than control. However, activities of invertase were slightly decreased by -0.35% than the control, respectively. on the other hand treatment by indoxacarb caused a much increase of trehalase activity about 17.93% and slight increase in invertase and amylase activities, (2.51%, 0.039%), respectively. And the treatment of emmamectin benzoate cause a little decrease of trehalase -2.96% and a little increase in invertase activity 0.978% and much decrease in amylase activity -25.42 % than that in untreated larvae.

Amylase enzyme is required to digest carbohydrates into glucose. Invertase enzyme hydrolyzes sucrose, forming fructose and glucose. Trehalase also plays a role in carbohydrate absorption, **Guven 2003**. This note is identical to Ishaaya and Ascher (1977), determine the effect of diflubenzuron on trehalase, amylase and invertase inhibition of *Tribolium castaneum*, and found them essential during molting to generate production of glucose for chitin build-up that might affect the molting process.

Table 3. Enzyme activity for Amylase, Trehalase and Invertase at homogenate of the third larvae instar of *Tuta absoluta* (Meyrick) treatment with LC_{50} of each tested insecticide.

Carbohydratase activities (µg glucose / min /g body weight)												
insecticides	**Trehalase (Mean± SE)**			**%**	**Invertase (Mean ± SE)**			**%**	**Amylase (Mean ± SE)**			**%**
Emmamectin benzoat	445.36	±	0.10	-2.96	611.56	±	0.28	0.98	691.27	±	0.20	-25.42
Methoxyfenzoid	366.31	±	0.41	-20.19	603.49	±	0.21	-0.35	808.00	±	0.25	-12.85
Indoxicarb	541.26	±	0.16	17.93	620.84	±	0.27	2.51	927.77	±	0.25	0.039
Control	458.96	±	0.93	---	605.63	±	0.25	---	928.91	±	0.33	---

*** % (decrease or increase)**

These results are in agreement with previous research verified decrease in amylase, trehalase and invertase was observed in *T. absoluta* exoposed to the seed proteinaceous extracts from non-host plant, found to be 50% inhibition of α-amylase than host plant, Esmaeily, and Bandani, (2015).

Effect on acid and alkaline phosphatase:

The activity of acid and alkaline phosphatase was being (36.09 and 26.05) µg phenol/ml/min, respectively in untreated *T. absoluta* the third larvae instar larvae. Data in table (4), showed the activity of acid phosphatase that was much higher in larvae treated with indoxacarb than treatment with emmamectin benzoate, methoxyfenzoid, 38.92, 31.82 and 24.00 (µg phenol/ml/min), respectively. Alkaline phosphatase activity was reduced to 22.35 (µg phenol/ml/min) in larvae treated with Indoxacarb, making a (-14.2)% decrease. Alkaline phosphatase activity recorded a significant distinguishable increase to 35.42 µg phenol/ml/min (35.9% increases) treatment by methoxyfenzoid when compared with the control.

Phosphatases catalyse the hydrolytic cleavage of phosphoric acid esters called 'acid' or 'alkaline' phosphatases according to their activity related to pH optima and associate with many important physiological processes such as metabolism and cell signaling. It found in the membrane of insect gut plays an important role in insecticide toxicity, Koodalingam *et.al.,* (2012). Gamil *et.al.,* (2011), found a decrease in the acid phosphatase, and content of carbohydrates and lipids increase in the alpha, beta esterase and the total protein was increased in *Spodoptera littoralis* (Boisd.) larvae treated with indoxacarb. Awad *et.al,* 2013, measures the *Schistocerca gregaria* digestive enzymes and chitinase that affected by treatment with farnesol. All insects can be develop resistance to the continuous insecticide exposure in the root of detoxifying variety of poisons with much its body enzymes each of them proper to a specific poison, and this call resistance mechanisms. The fall armyworm had developed multiple/cross resistance to both Bt toxins and conventional insecticides and the reduced alkaline phosphatase prove that the alkaline phosphatase could be a Bt resistance mechanism, Zhu *et.al.* 2015. Furthermore the effect of Vectobar (*Bacillus thuringiensis* (Bt)-based formulations) against *Aedes aegypti* larvae, treated by LC_{50} and the level of alkaline phosphatase decreased (49%), Koodalingam *et.al.* 2012.

Table 4. Phosphatase activities at homogenate of the the third larvae instar of *Tuta absoluta* (Meyrick) treatment with LC_{50} of each tested insecticide.

Phosphatase activities (µg phenol/min/g body weight)								
insecticides	**AcP activity (Mean ± SE)**			**%**	**AlP activity (Mean ± SE)**			**%**
Emmamectin benzoat	31.82	±	0.85	-11.8	26.76	±	0.80	2.73
Methoxyfenzoid	24.00	±	0.46	-33.5	35.42	±	0.91	35.9
Indoxicarb	38.92	±	0.96	7.83	22.35	±	0.49	-14.2
Control	36.09	±	0.92	--	26.05	±	0.52	---

***% (decrease or increase)**

The different mode of action can play the same role on this enzymes inhibition that affect insect's balances. There are two possible explanations to these inhibitions: direct inhibition of enzyme synthesis and inhibition of the mechanism that controls the digestive enzyme secretion into the midguts, Liu *et.al.* 2008. After treatment with insecticides, the secretion and function of insect digestive enzymes becomes imbalanced and normal consumption and digestive processes are affected. When the activity of amylase affected, the degradation of carbohydrates also decreases. This leads to disturbance in chitin building and failure of molting process to insect pests. For example: The activity of trehalase was reduced in *Bradysia odoriphaga* (Diptera treated with benzothiazole, which may explain why the trehalose fraction increased while the carbohydrate content decreased Zhao *et.al.,* (2015). Other organism also can interrupt by the insecticide exposure, for instance endosulfan, Maneb and Mancozeb on *Bacillus subtilis* α-amylase was also seen at very low concentrations (0.048 ppm), Guven 2003.

From the result it showed that most treatment was lower than the control, Bemani *et.al*., (2013)**,** found that the trehalose content in pupae of fruit hull borer *Arimania camaroffi* treated with pyriproxyfen 0.52 mg/g fresh body weight was lower than control with 2.07mg/g. From this study we can say that the inhibited digestive enzyme could be used as biochemical markers and indicators for monitoring pesticide residual present in *T. absoluta*. Also insecticides can be failing to control pest and must be incorporated in integrated pest management (IPM).

REFERENCES

Abbott, W.S. (1925). A method of computing the effectiveness of an insecticide. J. Econ. Entomol.,18: 265-267.

Awad,H.H.; Ghazawy,N.A. and Rahman,K.M.A. (2013). Impact of farnesol on the food consumption and utilization digestive enzymes and fat body proteins of the desert locust *Schistocerca gregaria* Forskal (Orthoptera: acrididae). African entomology vol.21 (1): 126-131.

Bakr, E. M. (2005). New software devoted to calculate probit analyses according to Finney (1971), which used to illustrate the relation between stimulus and response in toxicological and biological studies.

Bemani,M.; Izadi,H.; and Mahdian,K. (2013). Effect of pyriproxyfen on some physiological aspects of the pistachio fruit hull borer, *Arimania camaroffi* Ragonot, pupae. Archives of phytopathology and plant protection vol.46, issue 20:2436-2442.

Campos,M.R.; Rodrigues,A.R.S.; Silva,W.M.; Silva,T.B.M.; Silva,V.R.F.; Guedes, R.N.C.; and Siqueira,H.A.A. (2014). Spinosad and the Tomato Borer Tuta absoluta: A Bioinsecticide, an Invasive Pest Threat, and High Insecticide Resistance. Plos One, (9) 8: 1-12

Cuthbertson, A.S., J. J. Mathers, L.F. Blackburn, A. Korycinska, W. Luo, R.J. Jacobson and P. Northing (2013). Population Development of *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) under Simulated UK Glasshouse Conditions. *Insects* 2013, *4*, 185-197

Desneux,N.; Luna,M.G.; Guillemaud,T. and Urbaneja,A. (2011). The invasive South American tomato pinworm, *Tuta absoluta* continues to spread in Afro-Eurasia and beyond: the new threat to tomato world production. J. Pest. Sci. 84:403–408.

Esmaeily,M. and Bandani,A.R. (2015). Interaction between larval α-amylase of the tomato leaf miners, *Tuta absoluta* Meyrick (Lepidoptera:Gelechiidae) and protinaceous extracts from plant seeds. Journal of plant protection research, 55 (3): 278-286

Fanigliulo, A. and Sacchetti M. (2008). Emamectin benzoate: new insecticide against Helicoverpa armigera. Commun Agric Appl Biol Sci.73(3):651-3.

Finney, D.J. (1971). Probit Analysis. Cambridge University Press, London.

Gacemi, A. and Guenaoui,Y. (2012). Efficacy of Emamectin Benzoate on Tuta absoluta Meyrick (Lepidoptera: Gelechiidae) Infesting a Protected Tomato Crop in Algeria. Academic J. of Entomology 5 (1): 37-40.

Gamil, W.E.; Mariy, F.M.; Youssef, L.A. and Abdel Halim, S.M. (2011). Effect of Indoxacarb on some biological and biochemical aspects of *Spodoptera littoralis* (Boisd.) larvae. Annals of Agricultural Science 56(2): 121–126.

Gebremariam, G. G., (2015). *Tuta Absoluta*: A Global Looming Challenge in Tomato Production, Review Paper Journal of Biology, Agriculture and Healthcare 5 (14): 57-62

Gontijo,P.C.; Picanco,M.C.; Pereira, E.J.G.; Martins,J.C.; Chediak,M. and Guedes,R.N.C. (2013). Spatial and temporal variation in the control failure likelihood of the tomato leafminer, tuta absoluta. Annals of applied biology, 162. 50-59.

Ishaaya, I. and Swirski, E. (1976). Trehalase, invertase and amylase activities in the black scale, Saissetia oleae and their relation to host adaptability. J. Insect Physiol., 22: 1025-1029.

Koodalingam,A.; Mullainadhan,P.; Rajalakshmi,A.; Deepalakshmi,R.; and Ammu,M. (2012). Effect of a Bt-based product (Vectobar) on esterases and phosphatases from larvae of the mosquito *Aedes aegypti*. Pesticide Biochem. and Physiol. 104: 267–272.

Öztemiz S. (2013). Population of *Tuta absoluta* and natural enemies after releasing on tomato grown greenhouse in Turkey. African Journal of Biotechnology 12 (15): 1882-1887

Powell, M.E.A. and Smith M.J.H. (1954). The determination of serum acid and alkaline phosphatases activity with 4-amino antipyrine. J. Clin. Pathol., 7: 245- 248.

Roditakis,E.; Skarmoutsou,K. and Staurakaki,M. (2013). Toxicity of insecticides to populations of tomato borer *Tuta absoluta* Meyrick from Greece. Pest management Science 69 (7) : 834-840.

Roditakis,E.; Vasakis,E.; Grispou,M.; Stavrakaki,M.; Nauen,R.; Gravouil,M. and Bassi,A. (2015). First report of *Tuta absoluta* resistance to diamide insecticides. J Pest Sci, 88:9–16.

Silva,G.A.; Picanco,M.C.; Bacci,L.; Crespo,A.L.; Rosado,J.F., and Guedes,R.N. (2011). Control failure likelihood and spatial dependence of insecticide resistance in the tomato pinworm, Tuta absoluta. Pest management science, 67(8), 913-920.

Silva,W.M.; Berger,M.; Bass,C.; Balbino,V.Q.; Amaral,M.H.P.; Campos,M.R.; and Siqueira,H.A.A. (2015). Status of pyrethroid resistance and mechanisms in Brazilian populations of *Tuta absoluta*. Pesticide Biochem. and Physiol. 122: 8-14.

Van Dyk,J.S. and Pletschke,B. (2011). Review on the use of enzymes for the detection of organochlorine, organophosphate and carbamate pesticides in the environment. Chemosphere 82: 291–307.

wigglesworth, V.B. (1972). The principles of insect physiology 7th ed. Chapman and Hall Ltd.

Wyatt, G.R. (1967). The biochemistry of sugars and polysaccharides in insects Adv. Insect Pysiol. 4, 287-360.

Zhu,Y.C.; Blanco,C.A.; Portilla,M.; Adamczyk,J.; Luttrell,R.; and Huang,F. (2015). Evidence of multiple/cross resistance to Bt and organophosphate insecticides in Puerto Rico population of the fall armyworm, *Spodoptera frugiperda*. Pesticide Biochem. and Physiol. 122: 15–2.

سمية بعض المبيدات الحشرية على حفار أوراق الطماطم (Lepidoptera: Gelechiidae) وعلاقتها بالكربوهيدرات وإنزيمات الفوسفاتيز

هبه عبد الجليل الغنام و سامح مصطفى عبد النبى

معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقى – الجيزة

فى هذه التجارب تم دراسة سمية ثلاثة مبيدات حشرية من مجموعات مختلفة اندوكساكارب، ايمامكتين بنزوات وميثوكسى فينوزيد، على حفار أوراق الطماطم التى تم الحصول عليها من الحقل. وأظهرت النتائج التي تم الحصول عليها ان للمبيدات حشرية ضد العمر اليرقى الثالث *T.absoluta* وكانت قيم (LC_{50}) الجرعة النصفية المميته لميثوكسى فينوزيد، اندوكساكارب و ايمامكتين بنزوات هى (٥٠,٧٧ جزء في المليون، ٢,٣٣ جزء في المليون. و ٠,٠٢٢ جزء من المليون) على التوالي. ايمامكتين بنزوات و اندوكساكارب أكثر كفاءة من ميثوكسى فينوزيد. وأظهرت نتائج التحليل الكيميائي زيادة كبيرة في نشاط انزيم التريهالوز وانزيم لفوسفاتيز الحامضى (١٧,٩٣ ٪ ، ٧,٨٣ ٪)، على التوالي و زيادة طفيفة في نشاط انزيم الانفرتيز و الأميليز (٢,٥١ ٪ ، و ٠,٠٣٩ ٪) على التوالي عندما المعاملة بمبيد اندوكساكارب مقارنة مع المبيدات الاخرى.