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Using Laser Energy For Controlling Some Stored Product Insects

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Abstract

In this study the effect of visible laser 405nm at four exposure times on survival of adults and fourth instar larvae of *Tribolium castaneum* and *Trogoderma granarium* as well as the development period of larva to adults were investigated.Results showed that adults of the two pests significantly affected with laser irradiation at all exposure times,there was 100% mortality was observed in adults of *T.castaneum* at 30 and 40 min respectively compared with control treatment,while 30 and 40 min of laser irradiation caused 70% and 83.3% mortality respectively compared with control treatment in adults of *T.granarium*. Results also showed that mortality percent of *T. castaneum* larva was 40%,46.6%,76.6,and 100% at 10,20,30,40 min respectivelly compared with 0% in control treatment,while larva of ***T. granarium*** significantly affected with laser irradiation at 20,30,and 40min as mortality percent was46.6%, 53.3%,and 66.6% respectively compared with 0% at control treatment.It has been found that increase in exposure times showed an increase moulting to adults by larva of *T. granarium* ,the longer period appeared was 22.6 and 23.2 day at 30 and 40 min respectively compared with 17 day in control , there was no adult emergence from the larva of *T. castaneum* irradiated at all exposure times as pupal recovery was seen but the pupa died and there was no adult emergence. In conclusion the results demonstrate the adverse effects of laser irradiation on the survival of adults and larvae of *T.granarium* and *T. castaneum* , the present study suggests the potential for a safe pest-control technique that can easily kill insect pests simply by laser radiating .

Introduction

As concerns about the safety of our foods increase along with concerns about the impact of agricultural chemicals on our environment.Insecticides are used in pests control ,rising problems about residues on products,contamination of non-target areas,and the rising problems with respects to resistance require new strategies.One of the alternative methods is the biotechnical treatments[1]. The main advantage of these methods is an increase of the selectivity leading to areduced effects on non-target animals and the environment[2)]Current technology has led to investigations in the application of energy to control infesting pests,these treatments include ionizing radiation,microwaves,ultraviolet,infrared radiations,radio frequency,x-ray and electricity[3] The high doses needed to cause immediate death of all insect stages are rarely practical because product qualitysuffers ,for this reason,radiation treatments are designed to reduce product damage by inhibiting insect feeding and development and preventing pest population growth by sterilizing adults[4]

The first time that laser light has been used in applied entomology was that on adults of five types of stored product insect pests[5]. [6] investigated laser-based pest control of beetle species in stored foods. [7] used the effect of laser irradiation for the control of fruit flies (*Drosophila melanogaster*). [8] has been exposed eggs of *T. castaneum* and *T.confusum* to uv radiation with 254 nm wavelength and they found no adults emerged from eggs of two insects when exposed to 24 min of uv radiation.[9] found that blue light has teathal effect on fruit fly,mosquito, and flour beetles.[10] has been studied effect of gamma radiation on growth and development of rust flour beetles and they found that development of pests period increased compared with control.[11] found that there is a complete mortality of *S.zeamais* and *T.castaneum* larva and adults when exposed to microwave energy, and [12] used the effect of laser irradiation for the control of fruit flies (*Drosophila melanogaster*). [13] has been found that doses to prevent reproduction of stored product insects ranged from 0.05 KGY for *Tenebrio molitor* to 0.45 KGY for *Sitotroga cereallela* . [14] has been pointed that there is a hight reduction in percent of egg hatching for *E. cautella and S.cerealella* respectively when treated with ultraviolet radiation.

Because of the very few studies that use physical methods especially laser radiation to control pests in Iraq ,the objective of this study came to examine

suitability of laser radiation as an alternative pesticide for controlling of two important insect pests *T.castaneum* and *T. granarium* .

Materials and Methods

1.Insect Rearing

T.granarium (Evert.)(Coleoptera:Dermestidae) and *T.castaneum* (Herbest.)(Coleoptera:Tenebrionidae) were reared for three years on food consisting of wheat flour and yeast(10gm:1gm) at 30±2ºc and 70±5% R.H.[15]in laboratories of Biology Dept./ Collage of Science for Women/Babylon University

2.Laser Application

2.1.Laser effect on mortality of larvae and adults of *T.granarium* and *T.castaneum*

Avisible laser model(supetek) of 405 nm and 110 watt was used in the irradiation expirement.The laser beam was focoused to 10 cm on a tube cotaines larvae or adults of *T.granarium* and *T.castaneum*.30 larvae of the fourth instar and 30 adults were transferred in to the tube and were exposed to laser radiation at four periods 10,20, 30 ,and 40 min respectivelly , three replicates were run for each exposure time and for each instar(10 larva and10 adults for each replicate).At the end of each exposure time ,the treated and untreated(control) insects were transferred into the containers with the food media and put in the incubater at the same conditions.The dead individuals for each pest and for each treatment were counted after 24hr and compared with control treatment(untreated insects). The mortality counts were corrected by using Abbott formula [16]

2.2.Effect of laser irradaiation on development period of larvae to adults.

A laser beam was focoused on 10 cm on a tubes contains 10 fourth instar larvae ,those larvae were exposed to laser irradiation at four times 10,20,30,and 40 min.Each treatment was repeated three times, the period of larval development to adults was counted for each exposure time and compared with control treatment(the larvae untreated with laser beam) .

All data were analyzed by using Analysis of variance (ANOVA) and least significant differences (LSD).

Results and disscusion

1.Laser effect on mortality of adults of *T.granarium* and *T.castaneum*

Effect of 405nm laser irradiation on mortality of adults of *T. granarium* and *T.castaneum* is presented in Table(1), it has been found that the survivability of adults decreased along with increase in exposure time ,results showed that all exposure times caused significant mortalities in adults of the two pests compared with control treatment,the table also showed that the mortality of adults was 100% in *T.castaneum* at 30 and 40 min respectively compared with control treatment,while 30 and 40 min of laser irradiation caused 70% and 83.3% mortality respectively compared with control treatment in adults of *T.granarium*.

2.Laser effect on mortality of larvae of *T.granarium* and *T.castaneum*

All larvae of the two pests treated with laser significantly affected at all exposure times as shown in Table(2).Results in Table (2) has been shown that mortality percent of *T. castaneum* larvae were 40%,46.6%,76.6,and 100% at 10,20,30,40 min respectivelly compared with 0% in control treatment,while larvae of *T. granarium* significantly affected with laser irradiation at 20,30,and 40min as mortality percent were 46.6%, 53.3%,and 66.6% respectively compared with 0% at control treatment .

3.Effect of laser irradaiation on age of larvae .

Effect of laser radiation on fourth instar larvae on period required to develop to adults is given in Table(3).The table showed that increase in exposure times showed an increase moulting to adults by larvae of *T. granarium* ,the longer period appeared was 22.6 and 23.2 day at 30 and 40 min respectively compared with 17 days in control treatment .The development period of larvae irradiated at 10 and 20 min showed no significant differences compared with control. There was no adult emergence from the larvae of *T. castaneum* irradiated at all exposure times as pupal recovery was seen but the pupa died and there was no adult emergence.

The study showed gradual decrease in survival of adults and larva of the two pests with increase in exposure times ,these results are similar to those of [11]when they treated larvae and adults of three pests with microwave energy they found significant mortalities with increasing exposure time.[17] has been found that the effect of laser nitrogen on pupa of *Drosophila melanogaster* was directly propotional to exposure of time . With increasing the exposure time , the dose of the laser radiation increases , since the dose equal to: fluence (energy density) , the most probable mechanism of interaction of the laser light with the living cells is a photochemical interaction, taking into account the term of absorbing chromophore or Photoacceptor that have high absorbance at the wavelength of the applied laser light[18].Radiation may indirectly

damage lipids ,proteins and DNA by inhancing production of reactive oxygen species(ROS)[19]

As the statistical analysis showed there were significant differences in mortalities between the studied pests ,the adults of *T. castaneum* was more affected with laser radiation at longer exposure times 30 and 40 min than *T. granarium* as the mortality percents were 100% and 100% respectively, the fourth instar larvae of *T. castaneum* were also more susceptible at all exposure times than those of *T. granarium* , [9] has been investigated that leathal effect of radiation differed among the insect species as they studied effect of uv light on eggs ,larvae, pupa and adults of *Drosophila melanogaster, Culex pipiens and Tribolium confusum* they supposed that leathal effect of radiation seemed to be species-spicific ,it means that the light absorption by tissues of insects is wavelength specific as species-specific chromophores or photosensitizers in insect tissues absorp specific wavelengths of light, then generating free radicals insects subsequently die from tissue damage caused by formation of free-radicals[20].

It has been found that moulting of larvae to adult was delayed as exposure time increase these results were similar to those of [21] when they studied effect of uv irradiation on the the red cotton bug, *Dysdercus koenigii* nemphs at three durations[22] observed that cocconing of *Bombyx mori* larvae was significantly decreased as duration with uv laser irradiation increases [23] have also been found that Adult emergence was significantly decreased when larvae of *T. castaneum*) were irradiated with uv radiation .

As shown in Table (3) the period required for developing to adults by fourth instar larvae of *T.granarium* affected significantly at 30 and 40 min while no adults emerged from *T. castaneum* larvae treated with laser radiation at all exposure times this reveals that the laser irradiation sensitivity varies according to species, the genetic variation among insect species may be the reason [24] [25] suggested that radiation decreases the rate of cellular processes during gonad development in insects. [26] supposed that the possible target molecule for the laser radiation is a catecholic compound secreted into the cuticle in the late stage of larvae, which is responsible for the transformation of cuticle into the puparial stage by crosslinking of and protein, mechanism could be the absorption of radiation by a catacholic compound with the generation of free radicals ,these can diffuse and readily reach the muscles and nerves which are attached immediately below the epidermis.

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Table(1) Effect of laser irradiation 405nm on adults of *T.granarium* and*T.castaneum* at different exposure times

Exposure time/min	%of adults mortality	
	T.granarium	*T.castaneum*
control	20	0
10	36.6*	30*
20	50*	50*
30	70*	100*
40	83.3*	100*

$LSD_{(0.05)for\ pest}=7.318$

$LSD_{(0.05)for\ instar}=7.311$

$LSD_{(0.05)for\ time}=11.572$

$LSD_{(0.05)for\ interference}=23.144$

Table(2) Effect of laser irradiation 405nm on larva of *T.granarium* and*T.castaneum* at different exposure times

Exposure time/min	Developmental period/day	
	T.granarium	*T.castaneum*
control	17	21
10	17	0
20	20	0
30	22.6*	0
40	23.2*	0

$LSD_{(0.05)for\ pest=0.538}$

$LSD_{(0.05)for\ time=1.203}$

$LSD_{(0.05)for\ interference=1.702}$

*significant differences

Table(3)Effect of laser irradiation 405nm on development period of larva at different exposure times

Exposure time/min	%of larva mortality	
	T.granarium	*T.castaneum*
control	0	0
10	23.3	40*
20	46.6*	46.6*
30	53.3*	76.6*
40	66.6*	100*

*significant differences

References

1. Marx,C.;Kiesow,T.;Husted,M.; Kaierle,s.; Poehling,H.M.and Rath,T: Application of NIR-lasers for the control of aphids and whiteflies. DGG-Proceedings, 3(12) p. 1-5.(2013)
2. Neven,Lisa,G:Physiological effects of physical postharvested treatments on insects.Hortechnology 13(2):272-275.(2013)
3. Johanson,J.and Marcotte,M: Irradiation control of insect pests of dried food and walnuts.Food technology 35(6) 46-51.(1999) Diaz B.M.,Fereres A.: Ultraviolet-blocking materials as a physical barrier to control insect pests and plant pathogens in protected crops. Pest Technology 1 (2), pp. 85-95(2007)
4. Conconi,J..R.E.;De; Hernada,M.L.;Ramirez,M.M.,and Siqeiros,B.:Laser ray effect on *Tribolium confusum* Duv.*Tribolium* information Bulletin.21:120-31.(1978)
5. Conconi R.E.J. De.: Laser light as a new potential method for pest control in preserved foods. Biodeterioration 5 Conference Proceedings, pp. 592-608.(1983)
6. Zhang J.: Biologic effects on the *Drosophila melanogaster* by laser radiation.Yingyong Jiguang/Applied Laser Technology 17(6), pp. 273-275.(1997)
7. Faruki S.I.; Das, D.R.; Khan A.R.;and Khatun, M.: Effects of ultraviolet (254nm) irradiation on egg hatching and dult emergence of the flour beetles, *Tribolium castaneum*, *T.confusum* and the almond moth, *Cadra cautella*. J Insect Sci 7:1-6.(2007)
8. Hori.M.;Shibuya,S.;Sato,M.and Saito,Y.: Lethal effects of short wavelength visible light on insects.Scientific reports (4) pp.12.(2014)

9. Tandon,S.;Singh,A.and Kanaujia.S.:Effect of gamma radiation on growth and development of rest red flour beetles *T.castaneum* (Herbest.) Journal of plant protection research.49(3).280-282.(2009)
10. Vadivambal,R.;Deji,O.F.;Jayas,D.S.and White, N.D.G.:Disinfestation of corn using microwave energy .Aric. Biol.J..N Am.1(1)18-26.(2010)
11. Ren K.;Tu, K.and Li, H.W. :Control effects of semiconductor laser on *Drosophila melanogaster*. Zhongguo Jiguang/Chinese Journal of Lasers 33(8), pp 1148-1152 .(2006)
12. Hallman,G.J.: Control of stored product pests by ionizing radiation.J.Stored products research 52:36-41. (2013)
13. Shawkit,M.A.;Obaid,R.H.and Hady,A.K.: Effect of Ultraviolet Radiation on the Eggs of the Fig moth, *Ephestiacautella*, Angoumis Grain moth, *Sitotroga cerealella* andCowpea Beetle, *Callosobruchus maculatus*. Iraq J.for Science and Technology.3(3) 169-173.(2012)
14. Ubaid,J.: Fumigant toxicity of *Ricinus communis* L.oil on adults and larva of some stored product insects **.** j.natural sciences research 4(4) :26-29. (2014)
15. Abbott, W.S.: A method of computing the effectiveness of insecticide. J.Econ. Entomol, 18: 265 - 267.(1925)
16. Anwer ,A.G.: Effect of nitrogen laser on the pupa of *Drosophila melanogaster* . Tikrit Journal of Pure Science .11(1) :1-3 .(2006)
17. Chernova, G.V.and Vorsobina, N.V. :Effect of low intensity pulsed laser radiation of basic parameters of aging in Drosophila melanogaster. Radiats Biol Radioecol. May-Jun;42(3):331-6. (2002)
18. Meng, J. Y.; Zhang, C. Y.; Zhu, F.; Wang, X. P. and Lei, C. L.: Ultraviolet light-induced oxidative stress: Effects on antioxidant response of *Helicoverpa armigera* adults. *J. Insect. Physiol.* **55**, 588–592 .(2009)
19. Kuse, Y.; Ogawa, K.; Tsuruma, K.; Shimazawa, M. and Hara, H. Damage of photoreceptor-derived cells in culture induced by light emitting diode-derived blue light. *Sci. Rep.* 4(2014) doi:10.1038/srep05223
20. Mohan,S. and Kumar,D. :Effects of UV irradiation on the survival of the red cotton bug, *Dysdercus koenigii* (Heteroptera: Pyrrhocoridae).Australian journal of agricultural research. 1(4):132-135 (2010)
21. Hosagoudar, S.R.and Manjunatha, H.B.: Picosecond UV laser induced morphological,biochemical and biological changes in *Bombyx mori.* Iran. J. Radiat. Res. 9(2): 127-137.(2011)
22. Faruki S.I. : Effects of UV-radiation on the growth and development of malathion-susceptible and multi-resistant strains of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *Bangladesh Journal of Entomology* 25: 55-63. (2005)
23. Gomez, F. H., Loeschcke, V. and Norry, F. M: QTL for survival to UV-C radiation in *Drosophila melanogaster*. *Int. J. Radiat. Biol.* **89**, 583–589 (2013).
24. Dimitris, J.: Effect of GSM 900- MHz Radiation on the Reproductive Capacity of Drosophila melanogaster .Electromagnetic Biology and Medicine. 23(1).pp29 – 43.(2004)
25. Sugumaran. M:Molecular mechanism s of sclerotisation. In Bennington K,Retnakaran A(eds): Physiology of the insect epidermis.Canberra, Australia: CSIRO Publications, Inc.pp 141-168.(1991)