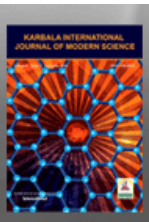

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The Effect of Diode Laser on The Life and Appearance of White Ant (Psammotermes hypostoma)

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Abstract

This work focused on studying effect of diode laser on external appearance of white ants, and finding the percentage of mortality resulting from this beam of (650nm),(5mW),exposure times (60,70,80,90,100)sec at (3,5)cm for each exposure. The results recorded showed a clear increase in death rates, and increase in deformations as laser exposure times increased (higher percentage at lower distance), where laser was used to capture results of this therapeutic effect after passage time periods (12,24,48,72)hours. These results, show laser thermal effects resulting from its interaction with tissues, thermal propagation leads to ravage to the structures, thus to an increase death rates.

Keywords

diode laser, white ants, biophysics, thermal effect

1. Introduction

One of the important topics that cover many and wide fields in physics and biology is the topic of biophysics, and the efforts of scientists specialized in this topic have led to its development by focusing on the main aspects that have developed many applications, techniques, and researches [1]. The most effective technique in this aspect is the laser, due to the important applications of its [2]. Humans live alongside insects, which in turn affect our lives in many different ways [3]. White ants (termites) are social insects that live in tropical, subtropical, and temperate regions of the world [4,5]. They are harmful insects due to their ability to destroy all cellulose-containing materials [4,6]. Serious economic damage may occur due to termites that feed on wood [4,7], the damage and dangers caused by this insect are known to people, where everyone knows that they are omnivores of wood and walls in homes, crops, live trees, or any material that contains cellulose, where it is one of the main pests of wood used for construction purposes [4,8]. They are classified as major pests with annual management costs estimated at millions of dollars [7,8], and therefore the consequences of various control measures must be considered. Chemical agents (it as pesticides) were used to control it, as it is of great importance in controlling termites. However, widespread reliance on pesticides for their control eventually led to a rise in pest resistance which could render many pesticides ineffective [7]. Pesticides are meant to eliminate pests, but many of them can harm humans as well. Pesticides have different health consequences depending on the type, with some compounds affecting the nervous system and others irritating the skin or eyes. Some pesticides may cause cancer, while others may affect the body's hormones or endocrine system [9,10], As a result, we can identify it as one of the few hazardous compounds purposely put into the environment to destroy living organisms such as insects, fungus, and rodents [11]. Current pest control methods, which are frequently dependent on chemical or biological agents, have unfavorable consequences [12]. Moreover, growing concerns about potential product residues, contamination of non-target areas, and growing problems regarding resistance require new strategies that lead to the search for alternative pest control methods that focus on biological methods or biotechnical measures. The main advantage of these methods is the increased selectivity which leads to less impact on non-target insects and the environment. The technique of using the laser to directly damage treated lesions is more selective [13]. The primary purpose of this technique is to study how cells function after being exposed to laser light in a specific area of it, as well as the mutual influence of matter and light, and how the energy generated by this impact can be very exact channeled via biomaterials [14]. The approximated curves of net absorption of laser of the components of various tissue are shown in Fig. 1 [15].

Diode lasers are the most efficient lasers and cover a broad spectrum of wavelengths. They are classified as lasers that are made of solid-state. It is utilized in numerous approaches to benefit from its interaction with matter and to induce quick changes because of its multiple characteristics [16]. It has been used in medicine for a long time and its effect has been proven in many studies [17,18], it provides promising results on cells level [17], effective in killing harmful insects [19,20]. The diode laser structure is shown in Fig. 2 [21].

The optical effect is dependent on the wavelength of the light source used, the extent of its interaction with the matter, and its agreement with it in terms of absorption. And the other effect is the thermal effect, which is the instantaneous effect of energy [16], where laser-generated light interacts with tissue in four different ways: transmission, reflection, scattering, and absorption [17]. Absorption is the most essential factor in the biological effects of laser light. The tissue absorbs photon energy, which can be reemitted or converted into heat as radiation, raising the tissue's interior temperature [17,22]. Interaction mechanisms occur when laser light is shed on biological tissues, and the specific characteristics of the laser, as well as, the parameters of the laser contribute to this diversity [16,23]. There is no effect in the tissue, if it is penetrated by the radiation or there is a reflection. The wavelength, exposure period, energy density, spot size, and the distance of the laser all affect its interaction with tissue [16]. Fig. 3 depicts a straightforward example of laser thermal effects on the living tissue [1].

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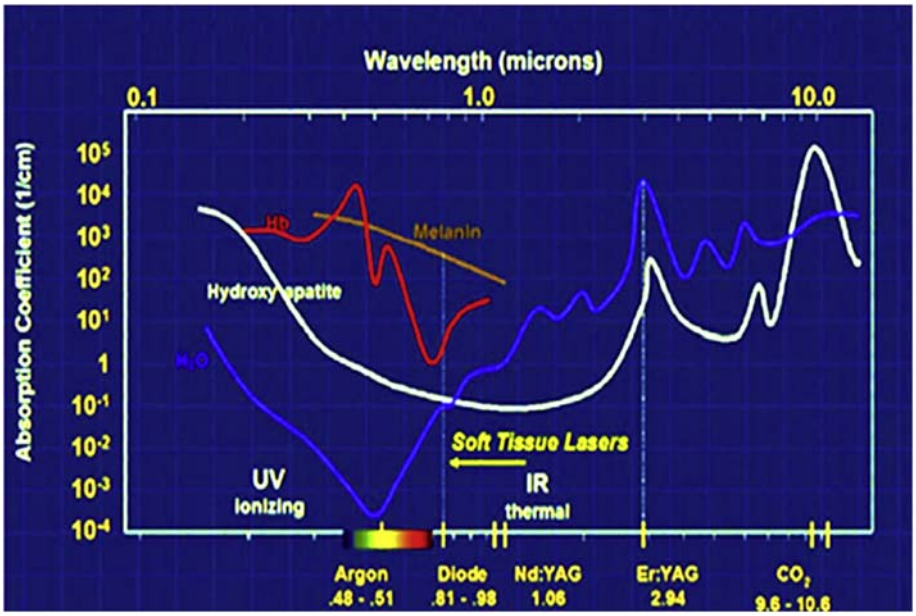

Fig. 1. Approximate net absorption curves of various tissue components.

2. Experimental

Domestic termite samples were collected in Petri dishes. The work was done with a diode laser (wavelength (650 nm) and energy (5 mW)), which was used to expose the termites and their environment to radiation, to see the effect of changing the time and distance of exposure to this laser on its external appearance as well as its ability to kill this insect. Petri dishes were divided into two groups, each containing five dishes, and all were laser irradiated at distances (3 and 5) cm, at five exposure periods (60, 70, 80, 90, 100) sec for each distance. Then they were examined by a microscope with a zoom camera (Sony) (12 MP) after (12, 24, 48, 72) hours.

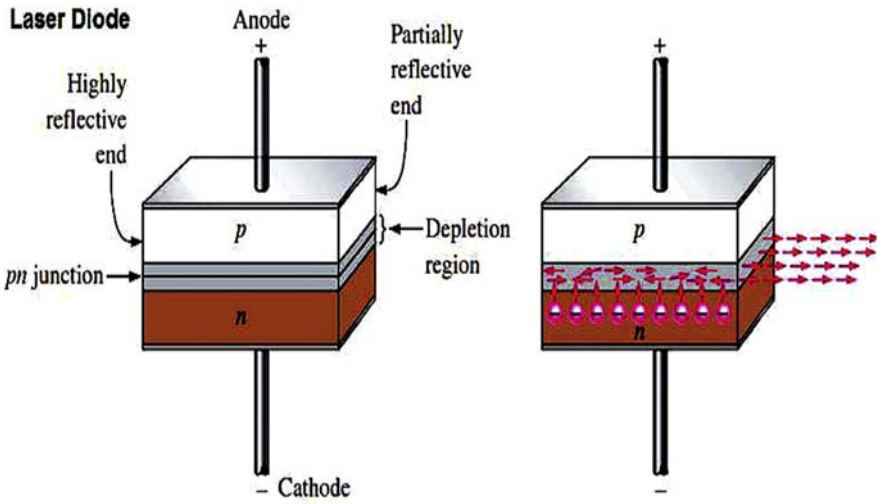

Fig. 2. Structure of diode laser.

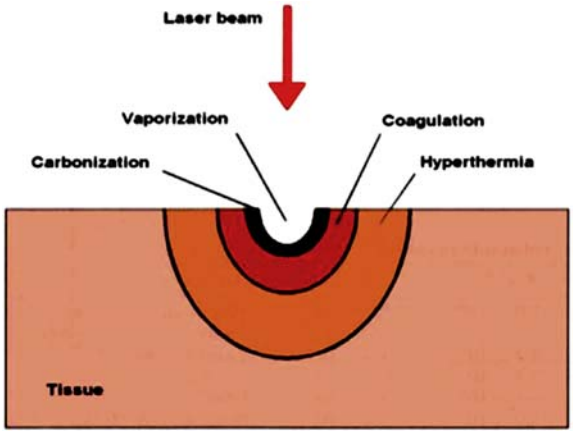

Fig. 3. Example of a figure caption (*figure caption*).

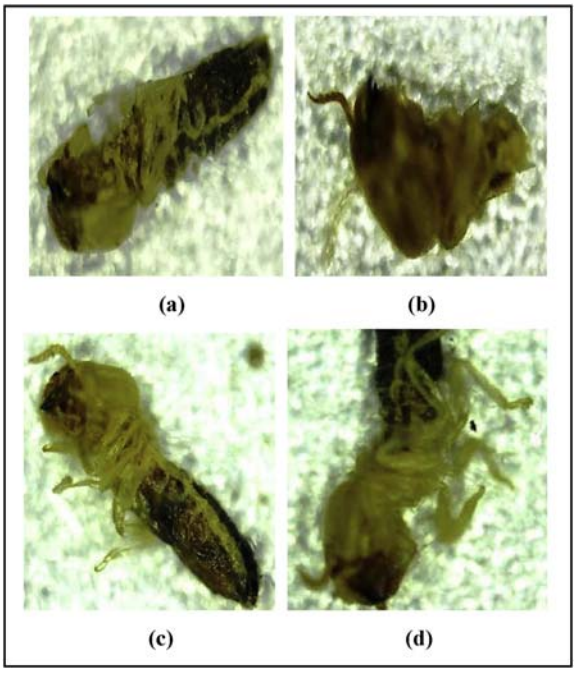

Fig. 4. Ant white insect exposed to laser show: (a) loss of sensor horns, (b) breaking legs, (c) change of cuticle color, (d) blackening of the head and crash in the body.

3. Results and discussion

3.1. The effect on the shape and appearance of white ant (termite)

For both irradiation distances, microscopic examination revealed variations in the exterior of termites subjected to the radiation and at all exposure periods, and the largest changes were at the highest time of exposure. The results of the phenotypic effects of the insect as shown in Fig. 4-(a, b, c, d) included changing the shape of the head, abdomen, and dorsal side, as well as breaking legs and tearing the sensor horns, addition to blackening the head and the abdomen area. As the interaction of the laser with the different tissues here is considered as a thermal effect, which is an instant effect resulting from the ability of these tissues to absorb radiation, which led to melting in the exposed areas and then evaporation by continuous exposure and thus shrinkage and damage to the parts as a result of fluid loss in them and thus burning, and this effect appeared through damage to the chest, back and legs areas, color difference and loss of horn sensors.

3.2. The effect on the life of white ant (termite)

The results of the laser's effect on the life of the insect under study indicated a direct increase in the death rate of the insect with the increase in the exposure time of the laser beam and for both distances, in general, to reach its highest levels at the exposure duration (100 s), as seen in Fig. 5-(a,b).

The samples at (3 cm) were more affected than those that were at a distance (5 cm), meaning that the approximation of the distance between the sample and the source gives better results, and this was shown by Fig. (6)–(9). All figures show that the calculated killing rates after the passage of the specified periods (12, 24, 48, and 72)hours; increased with the increase in these periods, and this is due to the changes that occur inside the insect's body from a continuous loss of fluids and nutrients in its body as a result of its thermal impact as due to its exposure to the laser, and these results are consistent with the previous studies of the effect on the insects[1].

Signaling, cognition, and behavior are all influenced by the availability of an energy substrate to the central nervous system. Carbohydrates are the neurological system's primary source of energy. The main carbohydrate in the blood (hemolymph) of insects is trehalose. Glucose and fructose are also present, however in modest and highly variable amounts depending on the animal's nutritional state. Glycogen is found in the nervous system of insects, however, it is mostly restricted to glial cells [24]. The death of termites can be attributed to the insect's nervous system being

[1] Special description of the title. The footnote can be dispensable.

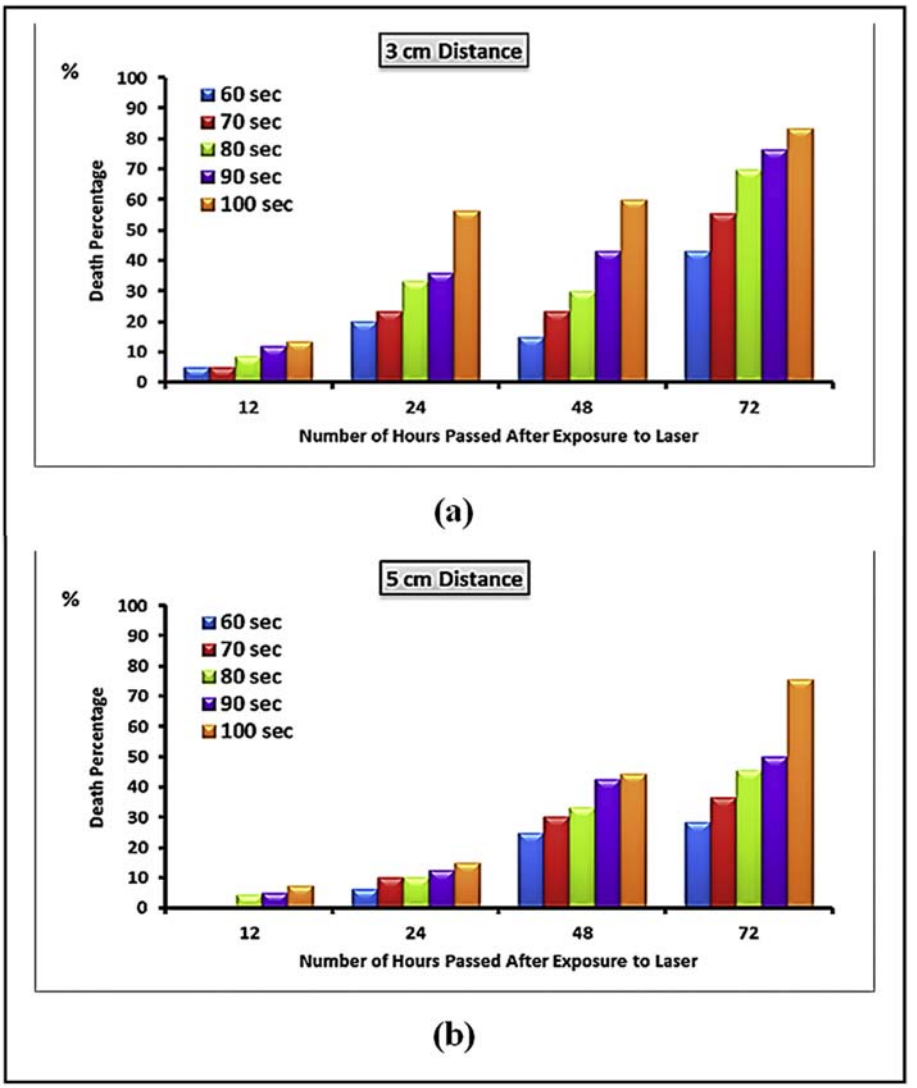

Fig. 5. Death percentage at distance: (a) 3 cm, (b) 5 cm.

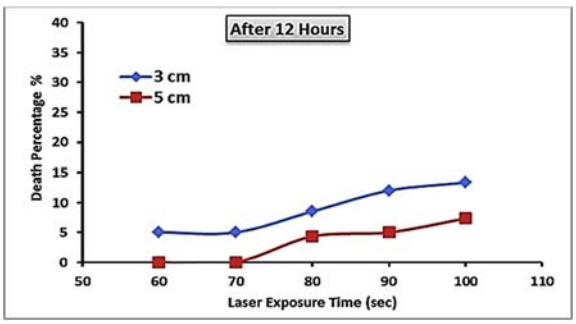

Fig. 6. Death percentage after (12 h) of treatment.

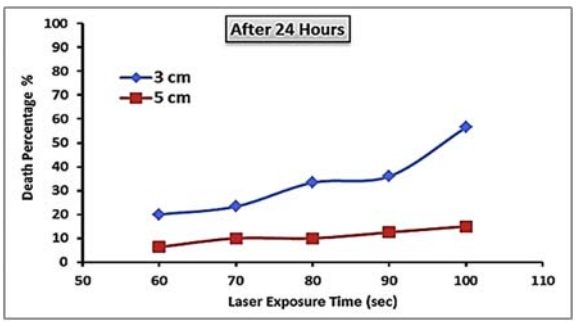

Fig. 7. Death percentage after (24 h) of treatment.

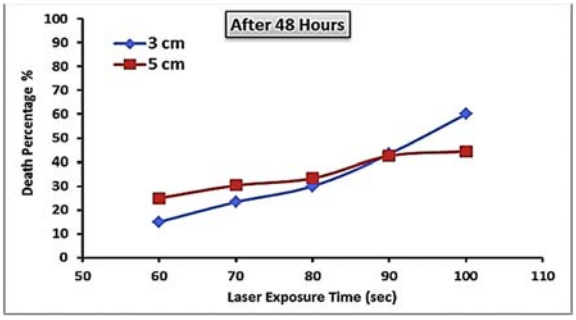

Fig. 8. Death percentage after (48 h) of treatment.

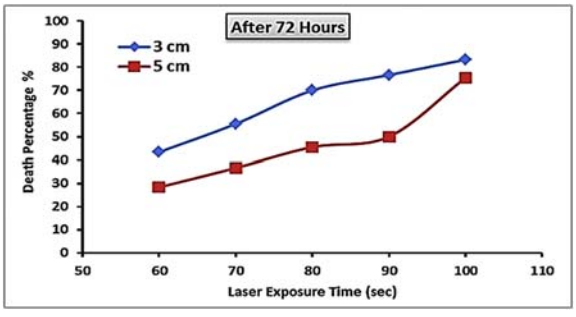

Fig. 9. Death percentage after (72 h) of treatment.

influenced by the laser radiation as soon as it occurs, as it influences the nerve and ventral ganglion responsible for the insect's nervous reactions, as the beam influence the brain, rendering the insect is unable to manipulate the injured limb's muscles., after a certain amount of time, the insect loses its capacity to be moving or walking, and hence its ability to find nutrition, leading to its death [1,25].

4. Conclusions

The capability of a diode laser to impact white ants (termites) was examined in this study. The findings suggest that lasers could be a viable alternative to pesticides for pest control. This straightforward procedure holds promise for the versatile implementation of lasers to a variety of pests. It is a good replacement for typical pest-removal or pest-reduction procedures. Additional research may be required for direct application in this subject. Comprehension of the ecological boundaries of exposure to the laser as well as the major constraints of insect disposal by the laser is among the topics being researched.

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