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Sterilizing of *Alphitobius diaperinus* (Panzer, 1797) (Coleoptera: Tenebrionidae) irradiated in pupa stage

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ABSTRACT

The use of irradiation process in stored grain may be the solution for the losses caused in these products by insects, as it does not induce resistance in the insects and leaves no toxic residue, and is considered an efficient and safe method of control of insects. The aim of the experiment was to determine the sterilizing dose of ionizing radiation from cobalt-60 to *Alphitobius diaperinus* (Panzer, 1797) (Coleoptera: Tenebrionidae) in peanuts irradiated in pupa stage. The experiment was conducted in the laboratory of Radiobiology and Environment of the Center for Nuclear Energy in Agriculture - CENA / USP., Piracicaba, SP, Brazil. Peanuts samples infested with pupae of *A. diaperinus* were utilized in the experiment that consisted of 8 treatments with 5 repetitions. Each repetition consisted of 20 pupae a total of 100 individuals per treatment. Were irradiated with doses of 0 (control), 25, 50, 75, 100, 125, 150 and 175 Gy, in a source of cobalt-60, Gammacell-220 type, with a rate dose of 381Gy / h. The experiment was conducted in a controlled temperature of 25 ± 5 ° C and relative humidity of 70 ± 5%. After of irradiation process was evaluated of the number of emerged adult insects in each repetition in the treatments. The results showed that the sterilizing dose in F_1 generation was 125 Gy and the pupa lethal dose 150 Gy. The dose of 150 Gy of gamma radiation can be used as phytosanitary treatment to control of immature stages of *A. diaperinus* infested peanuts.

Keywords: **gamma radiation, *Alphitobius diaperinus*, lesser mealworm.**

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1. INTRODUCTION

Worldwide the loss of stored grain is a problem of economic order of importance, in view of the concern of the increased supply of food for a world population increasingly expanding. Associated with this fact, there is the problem of nutritional deficiency due to lack of protein, especially for the less privileged populations in the resources of a country. This lack could be met by adequate supply of grain produced, requiring for it, a system that provides optimum grain storage conditions in securing the quality until the time of consumption. The utilization of ionizing radiation in insects that attack stored grain can resolve the problem of the losses caused in these products, because insects does not get resistance and leaves no toxic residue in the products, and is considered an effective and safe method [1, 2]. The first use of ionizing radiation on insects was performed by [3] when irradiated *Sitophilus oryzae* with X-ray, but did not get satisfactory results.

From 1950 there was a breakthrough in this type of research. Some factors such as the discovery of resistance to certain pests to chemicals, biological imbalance and toxicological problems caused by these products, contributed to this advance. Irradiation of the stored products can solve these types of problems, since it does not induce the emergence of resistance nor residues [4, 5, 6].

Some control measures are adopted to solve the damage and losses caused by insects such as good storage practices, monitoring of pests and chemical treatment, this in turn end up causing some damage, besides the resistance of insects to the active ingredients used in composition of chemicals, and because of these problems, there is a need for more effective methods of control at low cost. Irradiation by numerous factors has been presented as the best solution to control pests [5, 2, 7, 8].

The disinfestation of grain consists of a physical control method, inhibiting reproduction of insects or even killing him. However, for such control is of prime importance to know the lethal doses of ionizing radiation for the different stages of the life cycle of the pest, as the radiosensitivity varies according to several factors, including the stage of development [1, 2].

Postharvest phytosanitary irradiation is growing in commercial application and offers some advantages compared with other treatments for the control of quarantine pests on exported commodities. Irradiation takes less time than fumigation and leaves no undesirable residues, while being at least as effective as any other existing method insect and mite control. Also, while the development of resistance to insecticides and acaricides is a growing problem, resistance to irradiation has never arisen in arthropods [9, 10].

The use of methyl bromide as a fumigant to protect commodities is being phased out; indeed the 1997 Montreal Protocol Agreement stipulated that methyl bromide usage would be completely phased out by 2005 in developed countries and by 2015 in developing countries, (UNEP 2009). Nevertheless, certain uses of methyl bromide are exempt from phase-out, and these include the strictly regulated quarantine and preshipment applications [11].

Studied on the effects of gamma radiations in species of insect have already been done but specifically with the *Alphitobius diaperinus* (Panzer, 1797) (Coleoptera: Tenebrionidae) no paper was found in the literature review. The aim of the experiment was determine the sterilizing dose to this pest insect irradiated in pupa stage by gamma radiation in peanuts *Arachis hypogaea* for their control. Was development in peanuts because this inset is pest in the specie of food.

2. MATERIALS AND METHODS

The experiment was performed in the Laboratory of Radiobiology and Environment, Center for Nuclear Energy in Agriculture (CENA/USP), Piracicaba city, Sao Paulo, Brazil. The insect colony was obtained from cultures that had been maintained in the laboratory for more than 1 year and were utilized peanuts (*Arachis hypogaea*) cv. IAC 8112 samples in flasks with capacity of 200 mL infected with adults of *Alphitobius diaperinus*. The choice of doses was based in works from the literature consulted. The experiment consisted of 8 treatments; each treatment had 5 repetitions, and in each treatment was consisted of 20 individual's pupae, in a total of 100 individuals per treatment. Were irradiated with doses of 0 (control), 25, 50, 75, 100, 125, 150 and 175 Gy, in a source of Cobalt-60, Gammacell-220 type, at a rate dose of 381 Gy/h. (Atomic Energy of Canada, Ottawa, Ontario, Canada) located in CENA/USP.

The intended doses for the irradiated samples were 25-175 Gy. Gammachrome dosimeters with range dose of 0.1-3 kGy were used, and they were read with a Genesy 20 spectrophotometer. Dose certifications were made by the Institute for Energy and Nuclear Research – IPEN. The traceability of dose measurements was maintained by comparison with the international service assurance dose offered by the International Atomic Energy Agency, Vienna, Austria. The 200 mL flasks were centralized inside the irradiator in order not to disrupt the uniformity of the radiation. Six dosimeters were positioned as follows: 1 on top of the flask, 1 at the bottom, and 4 equally spaced at lateral positions. The uncertainty in each flask was ± 1.6%. The variation of measured doses was of ± 1.5% in the Gammacell-220 source.

The experiment was conducted in a room with a relative of 25 ± 5° C temperatures, humidity of 70 ± 5% and a 14:10 h L:D photoperiod, because these conditions are very good to development this specie of insect. After 50 days of the irradiation process time sufficient to pupae if transformed in adults were performed evaluations using the method of counting of the number emerged insects in P and F_1 generations in the treatments. The experimental statistical design was completely randomized in an 8x5x1 scheme (8 treatments and 1 sampling time and 5 repetitions). The results of evaluations of the tests were subjected to variance analysis by F test, and the comparison of averages by 5% Tukey test, using the statistical system SAS.

3. RESULTS AND DISCUSSION

The Table 1 shows the average number of adults emerged in the P and F_1 generations from adults of *A. diaperinus* irradiated in phase pupae with increasing doses of gamma radiation Cobalt-60 of: 0 (control); 25; 50; 75; 100; 125; 150 and 175 Gy in peanuts.

From the results of the Table 1, we can observe that to all the treatments presented significant statistical differences and that the effects of the gamma radiation in the pupae were directly proportional to the increase of the doses.

Doses of 50 Gy to 100 Gy caused a significant reduction in the development of the pupae, which was above of 60% when compared to the control treatment. But these doses were not sufficient to cause total sterility in adults.

The sterility in generation P adults was only obtained with the dose of 125 Gy, where there was no emergence of adults in the F1 generation these results are in agreement with obtained by [5, 8, 9, 12, 13, 14, 15]. The dose lethal ($LD_{100\%}$) to pupae was 150 Gy where there was no adult emergency in the F_1 generation. Based in the criterion of 100% of mortality this dose can also be considered a viable candidate for phytosanitary irradiation of *A. diaperinus* infested peanuts.

Table 1. Mean number of adults (± SE) of *Alphitobius diaperinus* emerged in the P and F_1 generations of pupa in peanuts irradiated with doses of 0 (control), 25, 50, 75, 100, 125, 150 and 175 Gy, with gamma radiation of Cobalt-60 .

	Number of adults emerged		
Doses/Gy	**Mean number of irradiated pupae**	**Mean number of emerged adults in P generation**	**Mean number of emerged adults in F_1 generation**
0	20	$19.4 \pm 2.0^{a*}$	$147.0 \pm 3.0^{a*}$
25	20	13.7 ± 1.5^{b}	97.1 ± 1.0^{b}
50	20	10.2 ± 1.3^{c}	21.4 ± 1.5^{c}
75	20	7.2 ± 1.0^{d}	11.9 ± 1.7^{d}
100	20	3.5 ± 1.7^{e}	3.2 ± 0.7^{e}
125	20	1.3 ± 0.7^{f}	0.0 ± 0.0^{f}
150	20	0.0 ± 0.0^{g}	0.0 ± 0.0^{f}
175	20	0.0 ± 0.7^{g}	0.0 ± 0.0^{f}

*Means followed by the same letter do not differ by Tukey's test at 5%.

4. CONCLUSION

The gamma radiation dose of 125 Gy was sufficient to sterilizing the adults emerged of irradiated pupa.

The lethal dose to pupa irradiated was 150 Gy.

Therefore, the dose of 150 Gy can be indicated for phytosanitary treatment to *A. diaperinus* in peanuts infested in the pupa stage.

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