ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR – ABEN
2019 International Nuclear Atlantic Conference - INAC 2019
Santos, SP, Brazil, October 21-25, 2019

Agência Brasileira do ISBN
ISBN 978-85-99141-08-3

APPLICATION OF IONIZING RADIATION IN THE COCUNUTS OF "LICURI" SYAGRUS CORONATA (MART.) IN THE CONTROL OF THE *PACHYMERUS NUCLEORUM* BEETLE (FABRICIUS, 1792)

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ABSTRACT

The "licuri" fruit palm (*Syagrus coronata)* is harvested extractively from palm trees that grow in native forests, pastures, and in association with other cultures being part of the regional economy in the hinterland of Bahia. Among the problems related to the "licuri" palm is the insect specie *Pachymerus nucleorum* (Fabricius, 1792), which stands out as a pest of economic importance because it causes direct damages to the "licuri's" almonds. Due to this the objective of the work was to determine the lethal doses of gamma radiation for the phases of egg, larvae and pupae of *Pachymerus nucleorum* aiming at its control in almonds of coconuts of licuri. A Cobalt 60 irradiator, Gammacell-220 type, installed at the Institute of Energy and Nuclear Research - IPEN / CNEN, located in São Paulo / Brazil, at a dose rate of 748 Gy / h, was used to carry out the research with the *Pachymerus nucleorum* biological cycle. Each treatment for all stages of egg, larvae and pupae inside of coconuts consisted of 3 replicates with 12 coconuts each, in a total of 216 coconuts per test that were irradiated in the following doses: 0 (control), 50, 75, 100 and 125 Gy. After irradiation, the samples were stored at a temperature of 25 ± 5 ° C and relative humidity of 70 ± 5%, where the development of egg, larvae and pupae stages until adult transformation in irradiated almonds. From the results obtained it is concluded that the dose of 125 Gy was sufficient to interrupt the development of the phases of the insect. Therefore, this dose of radiation can be used for quarantine treatment of the immature stages of *Pachymerus nucleorum* in the coconuts of "licuri" *Syagrus coronata* palm.

Keyword: Irradiation, coconuts, insect, control

1. INTRODUCTION

In the second half of the 20th century, irradiation application research for food preservation became a new and prospective field of food science and technology [1]. Irradiation is a physical treatment process consisting in subjecting the food to controlled doses of ionizing radiation, for sanitary, phytosanitary and / or technological purposes. In this sense, the irradiation food can be used as a phytosanitary treatment, reducing microbial populations and increasing their shelf-life [2].

Depending on the dose of irradiation absorbed, various effects can be achieved, resulting in reduced storage losses, longer shelf life and improved food safety, reducing the biological load of pathogenic microorganisms possibly present in food [3].

The objective of phytosanitary treatment is the prevention and propagation of regulated pests from infested and non-infested areas. A phytosanitary treatment is required when a production area is considered infested by a regulated pest, and the products to be shipped out of that area are considered capable of being infested by that pest. [4]

Irradiation is one of the many physical processes applied to food, having several practical advantages. The maximum dose absorbed by the food should not exceed 10kGy, except when necessary to achieve the legitimate technological purpose. It is well known that the absorbed dose recommendation applies to any food and implies that any food can be safely treated within the dose limits. [5]

Ionizing irradiation used as a treatment in processed foods for the elimination of insects is well used in the food industry. As a goal of disinfecting and preserving food, it appears as a promising practice, used to reduce pathogenic microorganisms, extending product life and reducing crop loss during product storage. Food irradiation has proved to be an effective tool to eliminate certain pathogens transmitted from food. [5]. The process of irradiating food is quite safe for the environment, as it does not produce any type of residue. In this process, the most used equipments are the Cobalto-60 irradiators. [7]

The licuri palm is scientifically named: *Syagrus coronata* (Martius) Beccari. Botanical family: *Arecaceae,* Subfamily: *Arecoideae,* tribe *Cocoeae,* subtribo *Butineae* [8]. The subfamily gathers 115 genera and 1500 species, being the largest among the *Arecaceae*. Traditional peoples, communities, agro-extractivists, and family farmers baptized him in different ways. There are at least 36 popular names**:** **"***adicuri, alicuri, aricui, aricuí, aricuri, ariri, butiá, butua, cabeçudo, coco-cabeçudo, coqueiro-aracuri, coqueiro-dicori, coqueiro-dicuri, dicori, iricuri, licuri, Iicurizeiro*" and other names [9].

The fruit of the licuri palm (Syagrus coronata), is extracted extractively from palm trees that grow in native forests, pastures and in association with other cultures, being part of the regional economy in the backwoods of Bahia contributing to the generation of jobs, strengthening of social inclusion through income generation, environmental preservation, food security, with direct positive impacts on regional socioeconomic indicators [10] (Figure 1).

To stimulate the consumption of alternative food sources, the substitution of conventional foods for unconventional foods has justified research in the field of nutrition science, public health, food technology and studies on phytosanitary procedures including traceability, necessary for safe consumption of foods that were not part of the diet of the general population. [11]

Source: author' collection
Figure 1: Licuri palm tree and coconut of licuri

Among the problems related to the cultivation of the licuri palm tree, it is worth mentioning the infestation by insect pests which, in addition to attacking different stages of development of the culture in the field, also damages the licuri almond and other palm trees. There are about 80 species of insects that damage coconut of licuri in Brazil [12]. Phytosantary management is a paramount importance for cultivation of licuri palm for producing states. The pests of this fruit represent a problem that limit production once they attack the different stages of their growth and development, causing damage to the different parts of the plant and responding significantly to crop depletion and low productivity. [13]

The species *P. nucleorum* Fabricius, 1792 is a beetle of the Bruchinae subfamily of the Chrysomelidae family, whose representatives are known as vegetable seed borers economically important for man [14], being a natural predator that causes many damages on the chestnuts of babassu and other palm trees. The beetle *P. Nucleorum* is a common insect throughout the north of Brazil, measuring from 12 mm to 15 mm in length by 5 mm to 7 mm in width. It has dark gray color, striated elytra, posterior ovoid and jagged thighs [15].

After oviposition on fruits or seeds, the emergent larvae penetrate and develops and only emerges as an adult, being one of the largest pests of vegetable grains stored in the world [16]. In the babassu, the females deposit their eggs, in the fallen fruits, so the larvae hatch and penetrate through the channels of sap or yarn of the coconut. They feed on the almonds by absorbing oil and protein and weave a cocoon where they stay until they become adults. Attacks of this pest cause several damages to subsisting families of babassu and other palm trees [17].

The study of coleopteran biology is important, since some families have relevance in the economy, allowing to understand the behavior and the ecological importance of this insect [18]. Little is known about the biochemistry of this insect which causes damage to the economy of the babassu, a plant on which many families depend in one of the poorest regions of Brazil [19]. Pests seriously affect the quantitative and qualitative issue of stored products. The quantitative damages are characterized by the loss of weight caused by the galleries opened in the grains; and the degree of hygiene of the product due to the presence of insects, excrements and eggs [20].

The average grain losses in the country estimated by the Ministry of Agriculture, Livestock and Supply (MAPA), and the Food and Agriculture Organization (FAO / ONU), reach approximately 10% of total production annually. In addition, there are qualitative losses which are of the greatest importance, since they compromise the use of all grains produced or classify them for another use of lower added value [21].

Due to this the objective of the work was to determine the lethal doses of gamma radiation for the phases of egg, larvae and pupae of *P. nucleorum* aiming at its control in almonds of the licuri.

2. MATERIAL AND METHOD

2.1. Samples

The samples of licuri almonds infested by the *P. nucleorum* beetle (Figure 2) and stages of egg, larvae, pupae and adult that were obtained from the Boa Sorte site located in the city of Iramaia BA, in the Diamantina plateau region and Linhares-ES, and taken to the food irradiation laboratory of the CTR-IPEN.

2.2. Irradiation of the almonds of the licuri palm

A Cobalt 60, type Gammacell-220 irradiator, installed at the Institute of Energy and Nuclear Research - IPEN / CNEN, located in São Paulo State, Brazil, was used to perform the research with the *P. nucleorum* biological cycle phases. Each treatment for all phases of egg, larvae and pupae inside the almonds consisted of 3 replicates with 12 licuri each, in a total of 216 coconuts of licuri per test that was irradiated in the doses of: 0 control, 50 Gy, 75 Gy, 100 Gy and 125 Gy of gama radiation at a dose rate of 748 Gy / hr.

After irradiation, the coconuts of licuri infested were transferred to 250 ml glass pots with perforated caps so that the gas exchanges occurred within the pots. Mortality, from all stages of development, of eggs, larvae and pupae of *P. nucleorum* was evaluated. This procedure was adopted for all coconuts of licuri samples.

The samples were stored in controlled environment, with temperature of 25 ± 1 ° C and relative humidity of 70 ± 5%. The immature phases mortality and adult emergence of the F-1 generation was evaluated at 30, 60 and 90 days after the irradiation process. Data were subjected by statistic program (SAS) and the means were compared by Tukey test ($p < 0.05$).

Source: author's collection
Figure 2. Phases of biological cycle of *Pachymerus nucleoru*

3. RESULTS AND DICUSSION

Table 1 shows the results obtained with the irradiation of coconuts of licuri infested with eggs and irradiated with increasing doses of cobalt-60 gamma radiation. From the results can see that the effects of the gamma radiation on *P. nucleorum* eggs were proportional to the increase of radiation doses applied in the eggs infesting coconuts. The lethal dose for the eggs was at 75 Gy where there was no adult emergency. These results are in agreement with those found by [22,23,24,25,26].

Table 1: Eggs essays - Average emergency of *P. nucleorum* adults from the licuri infested and irradiated with increasing doses of gamma radiation from Cobalt-60.

Doses (Gy)	Number of coconuts of licuri irradiated	Number of emerged adults insects*
0	12	10^a
50	12	3^b
75	12	0^c
100	12	0^c
125	12	0^c

* Equal letters in the same column do not differ statistically at the 5% level of significance in the Tukey test.

Table 2 shows the results obtained with the irradiation of coconuts of licuri infested with larvae and irradiated with increasing doses of cobalt-60 gamma radiation. From the results can see that the effects of the gamma radiation on *P. nucleorum* larvae were proportional to the increase of radiation doses applied in the larvae infesting coconuts. The lethal dose for the larvae was at 100 Gy where there was no adult emergency. These results are in agreement with those found by [22,23,24,25,26].

Table 2: Larvae essays - Average emergency of *P. nucleorum* adults from the licuri infested and irradiated with increasing doses of gamma radiation from Cobalt-60.

Doses (Gy)	Number of coconuts of licuri irradiated	Number of emerged adults insects*
0	12	9^a
50	12	7^a
75	12	8^a
100	12	0^b
125	12	0^b

* Equal letters in the same column do not differ statistically at the 5% level of significance in the Tukey test.

Table 3 shows the results obtained with the irradiation of coconuts of licuri infested with pupae and irradiated with increasing doses of cobalt-60 gamma radiation. From the results can see that the effects of the gamma radiation on *P. nucleorum* pupae were proportional to the increase of radiation doses applied in the pupae infesting coconuts. The lethal dose for the pupae was at 125 Gy where there was no adult emergency. These results are in agreement with those found by [22,23,24,25,26].

Table 3: Pupae essays - Average emergency of *P. nucleorum* adults from the licuri infested and irradiated with increasing doses of gamma radiation from Cobalt-60

Doses (Gy)	Number of coconuts of licuri irradiated	Number of emerged adults insects*
0	12	8^a
50	12	7^a
75	12	5^b
100	12	2^c
125	12	0^c

* Equal letters in the same column do not differ statistically at the 5% level of significance in the Tukey test.

Figure 3 correlate the effect of applied doses at each stage of the biological cycle of the *P. nucleorum.*

ISPM 18 (Guidelines for the use of irradiation as a phytosanitary measure) establishes dose ranges of ionizing radiation for groups of insects. As far as the Coleoptera group is concerned the range is 50-400 Gy to sterilize actively reproducing adult. [27]

According to [28] it is important to develop generic treatments (a single dose that applies to a group of regulated pests). But also reduce the currently accepted doses (400Gy for the Coleptera group for example), in order to provide additional data to determine more precisely the dose that can be accepted as a commercial treatment for many quarantine pest species.

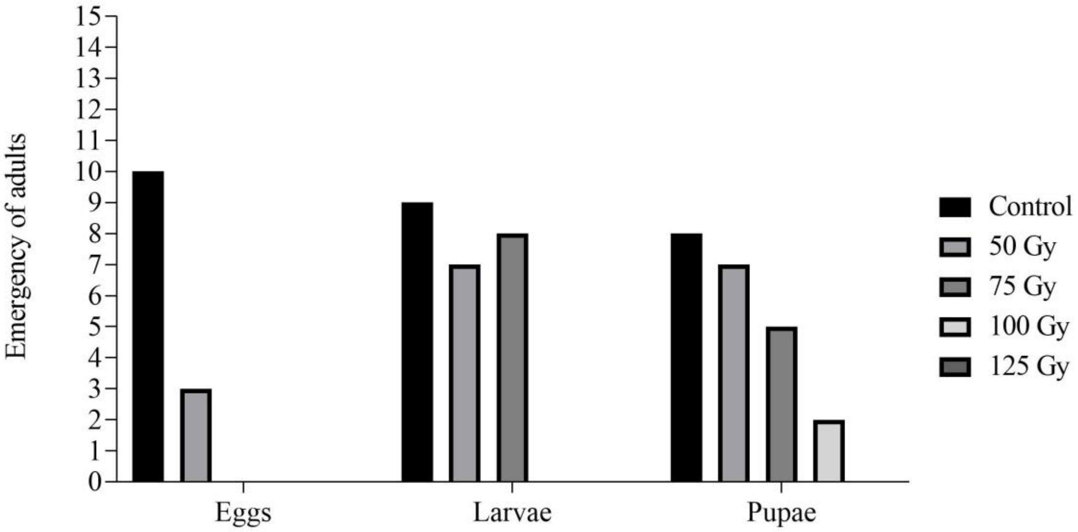

Figure 3: Average adult emergence in eggs, larvae and pupae essays with doses of 50, 75, 100 and 125 Gy

For example, International Plant Protection Convention studied some pests and established a dose of 150 Gy is sufficient to prevent the development of F1 adults of *Euscepes postfasciatus*, 92 Gy to prevent reproduction in adults of *Conotrachelus nenuphar* and 165 Gy to prevent the development of adult F1 *Cylas formicarius elegantulus* [29].

4. CONCLUSIONS

In conclusion, the dose of 125 Gy was effective to inhibit the development of all phases of the biological cycle of *Pachymerus nucleorum*. This study accord the International Standards for Phytosanitary Measures and also establishes the specific dose of ionizing radiation for an insect of great impact in the production of licuri for causing economic losses and post-harvest.

ACKNOWLEDGMENTS

The authors are grateful to IPEN-CNEN/SP, CNPq, FAPESP and CAPES for the financial support.

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