USING MIXED GAMMA AND ULTRAVIOLET RADIATION FOR DISINFESTIATION OF IRAQI DATES FRUIT FROM EPHESTIA CAUTELLA

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ABSTRACT

Fig moth *E. cautella*, considered the most serious pests infest dates and cause economic losses in the field and warehouses in Iraq which produces between 600-700 thousand tons of dates annually. In order to reduce this damage, different pest control methods are used, and mixed radiation considered one of the newest and innovative way to control the Moth that attack stored dates. This research has been done in Nuclear Laboratory of Edu. For pure Sci. / Ibn al-Haitham in 2016, three boxes for each irradiation dose, each one contain 10 date fruits. Dates. Zahdi variety artificially infested by eggs of *Ephestia cautella*. Eggs and larvae of insect exposed to different doses of gamma radiation on 5 periods for each dose separated by 5 min for each period of irradiation along with constant dose of UV radiation, 15min for all treated samples. Irradiated dates stored at 19C^{o} for 40 and 30 day for eggs and larvae respectively. Results showed that the mixed radiation technique were effective for eliminating the insect and keeping the dates preserved with high quality A dose of 106Gy and 298Gy of gamma required for 100% of eliminating eggs and larvaes respectively. Physical and chemical characteristics did not changed as a result of irradiation.

Keywords: Ephestia, Stored dates, Irradiation
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استعمال اشعة كاما والأشعة الفوق البنفسجية المزدوج في تطهير التمور العراقية من عثة التين

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المستخلص

تعد عثة التين *E. cautella* من اخطر الآفات التي تصيب التمور مسببة بذلك خسائر اقتصادية كبيرة في الحقل او المخازن حيث يتراوح انتاج العراق من التمور بين 600–700 الف طن سنويا. لغرض التقليل من تلك الخسائر فأن هذه الآفة تكافح بعدة طرائق حيث تعد طريقة استعمال الإشعاع المزدوج طريقة جديدة ومبتكرة للسيطرة على الآفات التي تصيب التمور المخزونة، تم البحث الحالي في مختبر النووية التابع لكلية التربية ابن الهيثم سنة 2016، حيث عرضت 3 صناديق من التمور لكل جرعة اشعاعية يحتوي الصندوق الواحد منها على 10 حبات من التمر. اختير تمر نوع زهدي وذلك بوضعه في صناديق صغيرة وأصابته اصطناعيا ببيوض العثة التي تم تربيتها في المختبر. عرضت بيوض ويرقات الحشرة لجرعات مختلفة من اشعة كاما وعلى 5 اجزاء لكل جرعة اشعاعية بفاصل زمني مدته 5 دقائق مع جرعة ثابته من الأشعة فوق البنفسجية حيث عرضت جميع هذه الصناديق لهذه الأشعة لمدة 15 دقيقة. خزن التمر المعرض للأشعة لمدة 40 يوما بالنسبة للبيوض و30 يوما بالنسبة لليرقات المعرضة للإشعاع على التوالي وبدرجة حرارة 19 سيليزية وبعد ذلك فتحت هذه الصناديق. وجد ان جرعة 106Gy و298Gy بالإضافة لجرعة الأشعة فوق البنفسجية كانت كافية للقضاء على البيوض واليرقات المعرضة للإشعاع بالترتيب حيث اثبتت هذه الطريقة كفاءتها في حفظ التمر وبقائه بجودة عالية، كما لم يلاحظ اي تغيير في الصفات الكيميائية والفيزيائية للتمر نتيجة تعرضه للإشعاع.

كلمات مفتاحية: عثة، التمور المخزونة، تشعيع
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INTRODUCTION

The date palm (*Phoenix dactylifera L*.) plays an important economic role for Foreign Trade to many countries that are located in arid and semi-arid regions of the world. Dates are rich in certain nutrients and provide a good source of energy, due to their high carbohydrate content (70–80%). Moreover, it contains protein (2.30– 5.60%), fat (0.20–0.50%), dietary fiber (6.40–11.50%), minerals about (0.10– 916 mg/100 g dry weight), and vitamins (C, B1, B2, B3, and A) (7). Iraq is considered as one of the oldest countries cultivating date palms. Palm trees and fruits are subjected to infestation by many pests and insects which can be found wherever these trees are cultivated. (6)(11). The production of dates fruit in 2016 in Iraq was more than 850 thousand tons of known Iraqi dates varieties and 15 million palm trees distributed in all provinces(4). Fig moth (*Ephestia Cautella walk.*) is considered the most important insect pests, which infect the dates in the field when harvest delayed, and during the storage period and it cause large economic losses (14). Stored dates pest and insect control was depending almost entirely on methyl bromide fumigation and it had faced a phase-out worldwide in year 2015 under the terms of the Montreal Protocol (19). Recently, many researchers have been devoted their efforts for seeking an alternative to methyl bromide against insect pests in warehouses. It has been reported that irradiation by gamma radiation could provide an important and effective alternative for the export dates fumigation (4)(17). Generally, ionizing radiation such as gamma rays and X-rays are used for the disinfestations of insects and pests. Treatment with UV-radiation has obviously less penetrating effect than ionizing radiations. The ultraviolet radiation is widely used as germicide, attractant for insects and for the surface disinfection of insect eggs (12). A number of investigators have considered the possibility of using UV-rays to control, or inhibit the development of various species insects of stored products (12). In the present work, we have tested mixed gamma ultraviolet irradiation sensitivity of different life stages of *Ephestia cautella walk*. and the effectiveness of a new innovative way to reduce the risk of exposure to high efficiency radioactive sources and at the same time to get results by less exposing to radiation and with the same efficiency as continuous exposure of gamma radiation to eliminate fig moth (*Ephestia cautella walk.*) and preserve the stored dates with high quality and from infection of this insect again.

MATERIALS AND METHODS

1- Insect rearing

We have used in this work insect *E.cautella* moth style found in Agricultural Research Center laboratories of the Minestry of Science and Technology/Iraq, that bred on artificial food consists of 81% rods wheat, 12% Glycerol, 0.6% dibs and 1% dry yeast putted all in sterile plastic stock with diameter (11cm) and height (30cm). Insect raised in the same way mentioned again until the end of search and placed in the laboratory room under temperature (21 C^o – 25 C^o) and relative humidity (40% - 50%).

2- Treatment and preserve of dates

Date fruits where placed in rectangular boxes were made by hand from Cardboard. The dimensions of its base and sides (5x6 cm^2) and (3x6 cm^2), respectively with artificially insect eggs infestation (25 eggs per 10 fruits), eggs where obtained from the raised insect.

3- Collecting eggs

Eggs were collected by placing (20-30) pair adults of insect *E.cautella* (24-48hr) aged into sterile glass jar; lantern. In the base of the lantern there is a plastic plate ”dish” covered by slight piece of cloth to ensure only the eggs fall into the dish after mating of insect adults, and the top of lantern covered by thick piece of cloth for ventilation, *E.cautella* adults take two days for mating and placing the eggs after that the eggs will distribute on the boxes.

4-Irradiation process and storage conditions

a- Gamma radiation source

Packaged dates were exposed to different doses with different periods. Gamma chamber 900 were used in the irradiation process that containing Co^{60} as irradiation source with activity 4.878 Currie and absorbed dose 42Gy/hr. Eggs of *Ephestia cautella walk.* Moth and Larvae aged 10-15 days and were irradiated. Fragmentation of radiation dose of gamma was used, five periods for each dose with 5min separating each period until reach the required dose.

b- **Ultraviolet radiation source**

A 20W UV germicidal lamp emitting at a wavelength of 254nm (UV-C) was only the source of irradiation. The rectangular boxes containing the dates were placed beneath the lamp for 15min to each gamma radiation dose.

5- Statistical analysis

The data for percentage of alive insect stages, egg hatching and mortality were subjected to one-way analysis of variance; differences between treatment means were determined Duncan's multiple range test at the 5% probability level. Abbott formula used for the correction of mortality for the treated samples (2).

6- Physiochemical characteristics of dates

Date palm (*Phoenix dactylifera*) fruits, zahdi variety were used in the present experiment. The following characteristics were studied before and after the irradiation. Physical characteristics: The main physical of Dates characteristics as weight loss, flavor and color were observed. Chemical analysis: Moisture content, pH-values and total soluble solids were determined as methods of AOAC (8). Total carbohydrates were determined, as glucose by the phenol-sulfuric acid method (15) .The crude protein was determined using Kjeldahl method (1).

RESULTS AND DISCUSSION

1-Irradiation of eggs

Tables 1, shows the effect of combination treatment of gamma with ultraviolet irradiation on eggs. Three replications (boxes) treated with different doses of gamma radiation and then followed by 15min of ultraviolet irradiation after 2-4 days of the infestation, one used for measuring the nutritional values of irradiated dates and the other two were stored the temperature 19 C^o ±1 and unpacked after 40 days of irradiation and average results calculated in Table 1.

2- Irradiation of larvae

Tables 2, shows the effect of combination treatment of gamma with ultraviolet irradiation on larvae. Three replications (boxes) treated with different doses of gamma radiation and then followed by 15min of ultraviolet irradiation on 10-15 days aged larvae of the insect, one used for measuring the nutritional values of irradiated dates and the other two were stored the temperature 19 C^o ±1 and unpacked after 30 days of irradiation and average results calculated in Table 2.

Table 1. Percentage of adults and pupae and Larvae of the insect and eggs hatching compared with the radiation dose due to the irradiation of Eggs by mixed gamma UV radiations.

Dose (Gy)	Pupae % +SE	Adults %+SE	Eggs Hatching %+SE
0.00	76±2.30[a]	12±2.30[a]	92±4.61[a]
53.07	48±2.30[b]	4±2.30[b]	72±4.61[b]
106.15	0[c]	0[b]	0[c]
162.62	0[c]	0[b]	0[c]
198.75	0[c]	0[b]	0[c]

***Means within a column followed by the same letter are not significantly different at the 5% level using Duncan's multiple range tests.**

Table 2. Percentage of adults and pupae and larvae of the insect and deaths compared with the adiation dose due to the irradiation of larvae by mixed gamma UV radiations.

Dose (Gy)	Pupae % +SE	Adults %+SE	Mortality %+SE	Mortality% (Corrected)
0.00	76±2.30[a]	16±2.30[b]	8[d]	0.00
165.62	36±4.61[b]	30±1.15[a]	34±3.46[c]	28.26
198.75	32±2.30[b]	32±2.30[a]	36±4.61[c]	30.43
265.00	12±2.30[c]	20±2.30[b]	68±4.61[b]	65.22
298.12	0[d]	0[c]	100[a]	100

***Means within a column followed by the same letter are not significantly different at the 5% level using Duncan's multiple range tests**

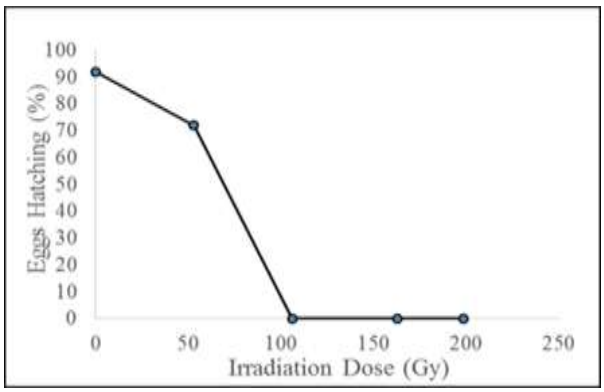

Fig 1. Percentage of eggs hatching compared with the radiation dose due to the irradiation of the eggs by mixed gamma UV radiations

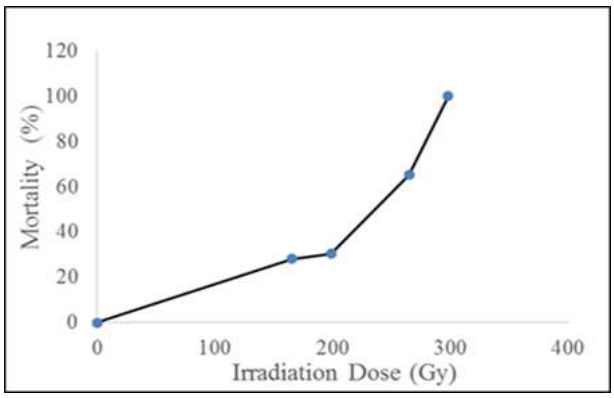

Fig 2. Percentage of mortality compared with the radiation dose due to the irradiation of the larvae by mixed gamma UV radiations.

The results in Tables 1 and 2 shows that a dose of (106Gy) and (298Gy) of gamma with UV is enough to achieve 100% mortality on eggs and larvae respectively. Immediate killing did not happen for the larvae of the insect. The maximum rate of mortality was found after 40 days of irradiation. The results above shows that the eggs are generally the most sensitive stage to radiation. Results also show that the amount of non-lethal irradiation dose has affected the age of larvae and pupae resulting from irradiated eggs and larvae, as the higher radiation dose is the growth period of larvae and pupae increase. For nutritional values of dates and the impact of radiation are showed in Table 3. It's clearly observed from the table below that irradiation by mixed gamma and UV radiation does not made significant changes in nutritional values of dates. Also noticed during the research that there is no physical changes in dates as long as we stored it in lower temperature. In the present study, gamma and ultraviolet radiation used for *E.cautella walk*. Moth. A search of databases for research on mixed gamma and UV radiation did not yield any information on the minimum radiation doses for elimination of this Moth; therefore, we chose radiation doses arbitrarily to evaluate the effect of the mixed radiations on eggs and larvae stages of the insect. We have used constant UV radiation 15min with changed gamma radiation doses. Fragmentation of radiation dose of gamma radiation found to take advantage of the low activity radioactive sources where it has less exposure effect for workers and ease in handling; it also represents a lower economic cost. Disinfestation by using mixed gamma, ultraviolet radiation is a method used to maximize quality and safety standards of fruits and this was observed on the dates in the current experiment.

Table 3. Nutritional values of dates compared with mixed gamma UV irradiation of Dates

Dose (Gy)	moisture content %	pH%	protein%	Total carbohydrate%	Soluble sugars%
0.00	**12.8**	**7.7**	**1.313**	**65.2**	**12**
53.07	**11.4**	**7.8**	**1.323**	**66.23**	**13**
106.155	**12**	**7.25**	**1.563**	**68.01**	**18**
165.625	**11.25**	**7.3**	**1.688**	**68**	**15**
198.75	**12.2**	**7.31**	**1.75**	**65.3**	**15**
265.00	**11.41**	**7.5**	**2.438**	**69.9**	**13**
298.125	**10.9**	**7.43**	**1.92**	**66.19**	**17**

The insect disinfestation depends on several factors, including temperature and radiation dose, giving a number of fractional exposures dose for gamma causes increase in radiation tolerance by giving opportunity to repair the radiation injury between exposures and the same effect can be occurred with very low dose rates (20). But at the same time this method enables us to take advantage of the low activity sources of gamma. For the current source of gamma, we have tested the effect of radiation on eggs and larvae to see the effect

of gamma radiation with ultraviolet radiation. We have concluded that a dose of (106Gy) and (298Gy) was enough for preventing the hatching of eggs, and survival of larvae, so we could see the difference of using mixed radiation method for complete control of the insect despite of using low dose rate of gamma sources. UV radiation can cause damage to DNA indirectly it also induces mutagenic and cytotoxic effects (10). There are advantages to use UV and gamma radiations in pest management. These advantages involve the absence of unwanted residues and a little variation in the nutritive value of foods, also no resistance development by the pest insects (5)(16)(9). In conclusion, mixed gamma and ultraviolet method is effective for controlling the fig moth at minimum radiation doses of gamma and ultraviolet radiations and keep the stored dates preserved through the strengthening of the influence of the gamma for eggs and larvae, and that's what makes it a good alternative to methyl bromide, who was laid off at the beginning of 2015. In addition to, the fragmentation of irradiation process helped to take advantage of minimum radiation doses of gamma, which was influential with dose of (106Gy) for eggs and (298Gy) for larvae and it's less than that reported by (3) and (18) respectively. Hence we can adopt this method to avoid the problems that may occur during the process of disinfestation such as the breakdown of the radioactive source by using multiple radioactive sources has less activity without effecting the production process, also this method can provide more safety and protection from the radiation.

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