Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(3): 455-458
© 2020 JEZS
Received: 16-03-2020
Accepted: 18-04-2020

Md. Abdul Bari
Insect Biotechnology Division, Institute of Food and Radiation Biology, Bangladesh Atomic Energy Commission, Dhaka 1349, Bangladesh

Shakil Ahmed Khan
Insect Biotechnology Division, Institute of Food and Radiation Biology, Bangladesh Atomic Energy Commission, Dhaka 1349, Bangladesh

Kajla Seheli
Insect Biotechnology Division, Institute of Food and Radiation Biology, Bangladesh Atomic Energy Commission, Dhaka 1349, Bangladesh

Md. Forhad Hossain
Insect Biotechnology Division, Institute of Food and Radiation Biology, Bangladesh Atomic Energy Commission, Dhaka 1349, Bangladesh

Corresponding Author:
Md. Abdul Bari
Insect Biotechnology Division, Institute of Food and Radiation Biology, Bangladesh Atomic Energy Commission, Dhaka 1349, Bangladesh

Use of ionizing, non-ionizing radiation and their combination as an alternative phytosanitary treatment for fresh cucumber and bitter gourd

Md. Abdul Bari, Shakil Ahmed Khan, Kajla Seheli and Md. Forhad Hossain

Abstract
90 Gy and 100 Gy Gamma radiation doses alone and along with 180 watt microwave energy (10 seconds) were applied to know the effects on pupation and adult emergences of *Zeugodacus cucurbitae* (Coq.) from artificially infested cucumber and bitter gourds. The percentage of pupation at 90 Gy, 100 Gy, 90 Gy and 100 Gy followed by microwave energy (180 watts for 10 seconds) and Control were 86.33%, 74.66%, 41.33%, 33.66%, 99.66% respectively from cucumber and 79.66%, 67.33%, 36.66%, 21.33%, 97.66% from bitter gourd respectively. The percentage of adult emergence at 90 Gy, 100 Gy, 90 Gy and 100 Gy followed by microwave energy (180 watts for 10 seconds) and Control were 45.33%, 33.66%, 0.87%, 0%, 98.66% respectively from cucumber and 43.33%, 29.66%, 0.59%, 0%, 95.66% respectively from bitter gourds. Present findings revealed that 100 Gy gamma radiation dose in combination with 180 watt microwave energy (10 seconds) may be applicable instead of 150 Gy as a quarantine treatment for *Z. cucurbitae*.

Keywords: Phytosanitary treatment, cucumber, bitter gourd, ionizing, non-ionizing radiation, *Zeugodacus cucurbitae*

1. Introduction
Zeugodacus cucurbitae (Coq.) (Diptera: Tephritidae) commonly called Melon fly is a Polyphagous fruit fly that has 39 to as many as 125 host plant species especially under the family Cucurbitaceae and Solanaceae. Vegetables in the affected regions may partly or wholly perish in a commercial point of view, that's why this species is known as one of the major pests and subjected to quarantine. Nowadays, the Phytosanitary treatments are being applied to prevent the invasion of harmful organisms. The betterment in this treatment process which is cost-effective, easy to implement and also ensures the efficacy and good quality of the products is the expected goals [15]. Ionizing radiation can be applied as a Phytosanitary treatment in many fresh produces [3]. This treatment is the process used to kill, inert, sterile, weaken or dispel the pests [17]. The word quarantine is usually used to mean a procedure which is driven to the agricultural products for inhibiting further developmental activities of invaded insect pests. The treatment of food commodities using radiation is an eco-friendly quarantine method. Many countries including Australia, USA, New Zealand have fixed irradiation doses as generic in the case of some pest (450 Gy generally). The generic irradiation dose suggested for fruit flies is 150 Gy [10].
The cucumber, *Cucumis sativus* L. is a very common vegetable throughout the world belonging to the Cucurbitaceae family [7, 23]. The cucumber has been being consumed for about three thousand years and spread over Europe by Romans and Greeks. This vegetable was started to cultivate in France, England and North America in the 9th, 14th and mid-16th century respectively [25]. About 40,000 tons of cucumber is produced throughout the world per year and the highest produceder is China [8].
The Bitter gourd, *Momordica charantia* L. is another familiar vegetable which is also originated from the Indian subcontinent. It has been being used for producing various herbal medicines throughout the Asian and African regions for a long time [6, 22]. Turkish uses this vegetable in different diseases especially in stomach problems. Indian use various parts of bitter gourd to get remedy from different diseases [24] and this also acts as anti-diabetic vegetable [18].

Cucurbit vegetables suffer a considerable loss every year. Some rapid initiatives are essential to mitigate the loss due to the melon fly thinking the quarantine importance and also the economical point of view [11, 13]. The infestation of the melon fly causes 10 to 30% damages of agricultural products per year [21]. To get rid of the fungal attack at the storage condition of vegetable heat treatments have been widely used [20]. Hot water or vapor has been used to destroy the eggs and also different instars of larvae of pests [19]. The heat treatments in a selected fruit or vegetable have been used to destroy the fungal and bacterial attacks, desensitize fruits to the injury, mitigate the physiological abnormalities after harvesting, lower the percentage of ripening and prolong the self-life [2]. Hot water treatment along with radiation can be applied to control the physical loss of fruits [4]. Controlled temperature and other conditions affect the standard of cucumbers [22].

As microwave energy has minimal effect on the ecosystem and also produces no harmful residues on the fruits and vegetables it has been increasingly applied in food technology. After harvesting the vegetable pests can be destroyed by applying the radio frequency and microwave energy. Scientists reported on the use of microwave energy to destroy different pests on many food products [5, 12] which may be good for the disinfestations [14]. Many fruit and vegetable varieties could not tolerate radiation dose that is appropriate for a particular insect pest species. Therefore a study plan was designed to analyze whether non-ionizing radiation can be used either alone or in combination with ionizing radiation. The main purpose of the present work was to reduce the radiation dose below the generic dose in combination with non-ionizing radiation (microwave energy). The effect of microwave energy to the commodities were also be analyzed. Melon fly, *Z. cucurbitae* (Coq.) were used as model insect in this experiments.

2. Materials and Methods

2.1 Stock rearing of insect

Rearing of *Z. cucurbitae* was maintained in the laboratory of the Insect Biotechnology Division (IBD), Institution of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment (AERE), Savar, Dhaka. *Z. cucurbitae* used in the present study originated from a population collected from infested cucumber, and sponge gourd respectively, and continued for several generations on respective hosts for laboratory adaptation. Larvae were fed on a locally developed semi-solid artificial diet. About 6000-9000 and 4000-6000 adult melon flies were stocked in stainless steel framed large cages (183×76×38 cm) and small cages (120×120×90 cm) respectively. The insects were usually supplied with laboratory-developed diets both in solid and liquid form *viz*., 1) casein: sugar: yeast extract at 1:2:1 ratio and 2) baking yeast: sugar: water at 1:3:4 ratio along with soaked cotton. The average temperature and relative humidity (RH) of the rearing room were 28±2℃ and 70±10% respectively.

2.2 Egg Collection

To collect a huge number of eggs the mature flies in the cage were provided with some ripens and fresh pieces of greenish cucumber and bitter gourd were cut into several pieces and were placed inside the *Z. cucurbitae* adult rearing cages for oviposition separately. After half an hour all the pieces of cucumber and bitter gourd were collected and put into two separate plastic bowls spread with sawdust bellow for further development of *Z. cucurbitae* on cucumber and bitter gourd up to early 3rd instar larvae. Fresh cucumbers and bitter gourds were supplied as food from time to time for the proper culture.

2.3 Collection and Storage of cucumbers and bitter gourds

15 mature fresh greenish cucumbers and 15 mature fresh greenish bitter gourds were collected from local farmers at the time of harvesting. Cucumber and bitter gourd were wiped with a soft cloth to clean and then packed in a perforated polythene bag for carrying out to the laboratory.

2.4 Storage conditions

All the treated and untreated fresh cucumbers and bitter gourds were stored at 25ºC temperature and 80-90% RH during the entire period of experiments. Cucumber and bitter gourds used for treatments were selected by uniform size and free from any blemishes, physical damage and fungal decay.

2.5 Infestation of Larvae

50 early 3rd instar larvae of *Z. cucurbitae* were infested to every 15 samples of cucumbers and bitter gourds separately. 12 infested cucumbers and 12 infested bitter gourds were packed into four (two + two) different perforated polythene bags containing 6 samples for each bag and 3 infested samples of cucumber and 3 infested samples of bitter gourd were packed into other two perforated polythene bags as a control to compare with the treated samples and kept them at room temperature for 24 hrs.

2.6 Ionizing and Non-ionizing Radiation Treatment

After 24 hrs two different perforated polythene bags with 6 infested cucumbers for each fruit were irradiated separately at 90 and 100 Gy using gamma-rays emitted from Co^{60} at the Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Savar. Following irradiation, 3 + 3=6 cucumbers were removed from two different treated packets and were taken into a Micro-wave oven (Model M1975N T.D.S. Samsung) for non-ionizing radiation at 180 Mw for 10 Seconds for each. Then each treated sample and 3 control samples were placed on different Petri plates (9cm) and all the Petri plates were placed on 15 plastic bowls within the sawdust and were observed for Pupation and adult emergence in the laboratory condition. After 6-8 days the sawdust of 15 experimental bowls was sieved properly and collected dust-free pupae and then was placed on another 15 labeled Petri dishes (9 cm) to observe the adult emergence, the no. of male and female was also observed. The experiments were repeated at thrice. For bitter gourds, the same and similar procedure has been followed for ionizing and Non-ionizing radiation treatment.

In both cases, the percentage of the adult emergence was calculated by using the following formula:

$$\% \text{ of the adult emergence} = \frac{\text{No. of adult emergence}}{\text{No. of pupae obtained}} \times 100\%$$

3. Results and Discussion

The Combined treatment of irradiation and microwave energy on the percentage of pupation and adult emergence *Z. cucurbitae* has been shown in Fig.1. The highest percentage of pupation and adult emergence found at 90Gy (0 Mw), was 86.33% and 45.33% and lowest at 100Gy (180 Mw for 10 seconds), was 33.66% and there is no adult for cucumber

respectively. But in the control batch, the pupation percentage and adult emergence percentage were 99.66% and 98.66% for Cucumber respectively (Fig.1)

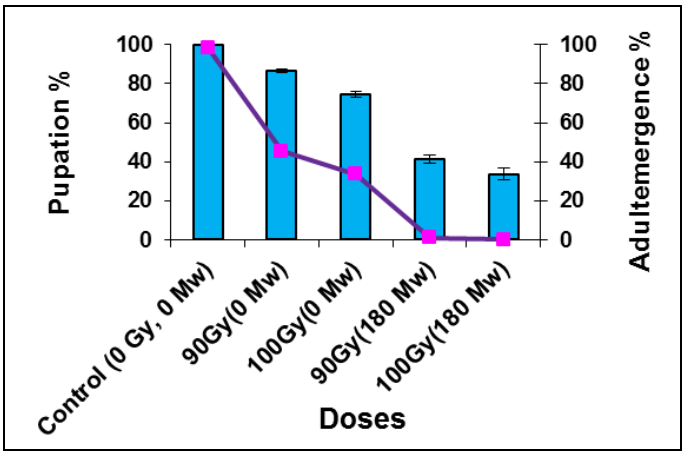

Fig 1: Combined Effect of Ionizing and Non-ionizing radiation on pupation and adult emergence of *Z. cucurbitae* (Coq.) for Cucumber

The highest pupation percentage and adult emergence percentage for bitter gourds were found at 90 Gy (0 Mw) 79.66% and 43.33%) and lowest at 100Gy (180 Mw for 10 seconds) 21.33% and 0% respectively. But in the control batch, the pupation percentage and adult emergence percentage were 97.66% and 95.66% respectively as shown in Fig.2.

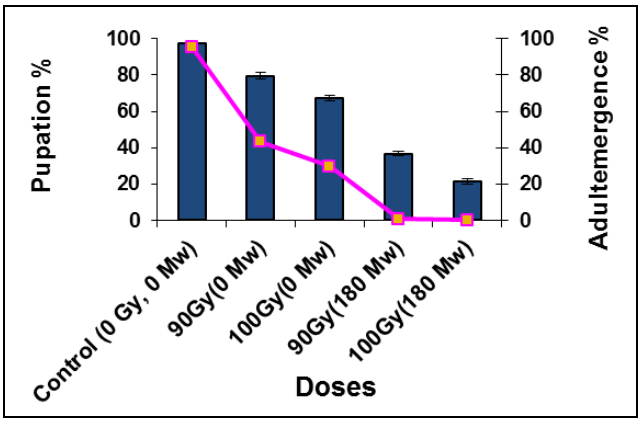

Fig 2: Combined Effect of Ionizing and Non-ionizing radiation on pupation and adult emergence of *Z. cucurbitae* (Coq.) for Bitter gourd

The ICGFI (International Consultative Group on Food Irradiation) proposed a dose of 150 Gy for fruit flies and 300 Gy for other insects [16] though earlier it was not accepted worldwide as USDA Animal Plant Health Inspection Service (APHIS) approved irradiation doses of 210, 225, and 250 Gy to control the Melon, Oriental and Mediterranean fruit fly species [1, 11] and Hawaii reported earlier that higher doses required to kill the three Tephritids species. Our data support the findings of Follet PA and Armstrong JW [9, 10] who reported no adult could emerge after applying 100 Gy from papaya even they found no adult emergence at the dose of 85.7 Gy and 84.5 Gy for wild and reared *Z. cucurbitae* though in another experiment they found one adult survived at 124 Gy dose in Papaya. Our experiment was set to know the effect of lower doses from the minimum generic dose applying in the Cucumber and Bitter gourds and found 100Gy irradiation dose in combination of microwave energy (180 Mw for 10 seconds) could be quarantine secured. This would be cost-effective and also save time, thus would enhance the treatment capacity.

4. Conclusion

Combined treatment of irradiation and microwave generated non-ionizing radiation (180 watt, 10 seconds) seems to be promising for quarantine security. This study revealed that microwave-generated non-ionizing radiation along with ionizing gamma radiation both could be used in combination to reduce the generic dose for Melon fly, *Z. cucurbitae*. Experiments were repeated for several times for the confirmation of the reduction of the generic dose of fruit fly and found that 100 Gy could be used in combination with microwave energy instead of 150 Gy irradiations only. Hence, this combined approach may reduce the gamma radiation dose for fruit flies.

5. References

1. Anonymous. Papaya, carambola, and litchifrom Hawaii. FEDERAL REGISTER. Rules and Regulations. 1997; 62(132):36967-36976.
2. Bard ZJ, Kaiser C. Post-harvest vapor heat shock treatments of fuerte avocado fruit. South African Growers' Association Yearbook. 1996; 19:116-118.
3. Bari MA, Khan SA. Effects on the Quality of Fresh Cucumber (*Cucumis sativas* L.) Treated with Ionizing, Non-ionizing Radiations and their Combined Treatments. Asian Journal Agriculture and Food Science. 2015; 3(1):13-18.
4. Barkai-Golan R, Padova R, Ross I, Lapidot M, Davidson H, Copel A. Combined hot water and radiation treatments to control decay of tomato fruits. Ientia Horticulture. 1993; 56(2):101-105. doi:10.1016/0304-4238(93)90011-E
5. Bedi SS, Singh M. Microwaves for control of stored grain insects. National Academy of Science Letter. 1992; 15(6):195-197.
6. Beloin N, Gbeassor M, Akpagana K, Hudson J, De Soussa K, Koumaglo K et al. Ethnomedicinal uses of *Momordica charantia* (Cucurbitaceae) in Togo and relation to its phytochemistry and biological activity". Journal of Ethnopharmacology. 2005; 96(1, 2):49-55. doi:10.1016/j.jep.2004.08.009. PMID 15588650.
7. Doijode SD. Seed storage of horticultural crops. Haworth Press. ISBN 1-56022-901-2. 2001, 281.
8. FAO (Food and Agriculture Organization) of the United Nations. Production quantity (1000 tons)/ cucumbers and gherkins. 2005. http://faostat.fao.org/site/336/DesktopDefault.aspx?PageID=336.
9. Follet PA, Armstrong JW. New irradiatin doses to control Hawaii's fruit flies: towards a generic dose for Tephritids. In: Proceedings of the 6th International Symposium on fruit flies of economic importance, Stellenbosch, South Africa, 6–10 May 2002, eds. Barnes BB. Isteg Scientific Publications, Irene. 2002, 237-240.
10. Follet PA, Armstrong JW. Revised irradiation doses to control melon fly Mediterranean fruit fly and oriental fruit fly (Diptera: Tephritidae) and a generic dose for trphritid fruit flies. Journal of Economic Entomology. 2004; 97(4):1254-1262.
11. Hallman GJ, Loaharanu. Generic ionizing radiation quarantine treatments against fruit flies (Diptera:

Tephritidae) proposed. Journal of Economic Entomology. 2002; 95:893-901.
12. Hallman GJ, Sharp JL. Radio frequency heat treatments. In: Sharp JL, Hallman GJ. (Eds.) Quarantine treatments for pests of food plants. Westview press, san Francisco. 1994; 165-170.
13. Hallman GJ. Irradiation as a quarantine treatment. In: Molins R. (Eds.) Food irradiation. Wiley and Sons. New York. USA. 2001, 113-130.
14. Hansen J. Heating curve models of quarantine treatments against insect pests. Journal of Economic Entomology. 1992; 85:1846-1854.
15. Heather NH, Hallman GJ. Pest management and phytosanitary trade barriers, CAB International, Oxfordshire OX108DE, UK, 2008, 132-152.
16. ICGF (International Consultative Group on Food Irradiation). Irradiation as a quarantine treatment of fresh fruits and vegetables. ICGFI Document 13. International Atomic Energy Agency, Vienna, Austria, 1991.
17. IPPC (International Plant Protection Convention). International Standards for Phytosanitary Measures (ISPM) No. 5, Glossary of phytosanitary terms, FAO, Rome, 2017.
18. Krawinkel MB, Ludwig C, Swai ME, Yang RY, Chun KP, Habicht SD. Bitter gourd reduces elevated fasting plasma glucose levels in an intervention study among prediabetics in Tanzania. Journal of Ethno pharmacology. 2018; 216:1-7.
19. Le TN, Shiesh CC, Lin HL. Effect of vapor heat and hot water treatments on disease incidence and quality of Taiwan native strain mango fruits. International Journal of agriculture and Biology. 2010; 12:673-678.
20. Mansour FE, Abd-El-Aziz SA, Helal CA. Effect of fruit heat treatment in three mango varieties on incidence of post-harvest fungal disease. Journal of Plant Pathology. 2006; 88:141-148.
21. Naqvi MH. Management and quality assurance of fruits and vegetables for export-needs for product to market approach, In: Use of irradiation for quarantine treatment of fresh fruits and vegetables. Proceedings of the first national seminar held at atomic energy centre, Dhaka, Bangladesh, 2005.
22. Paul A, Raychaudhuri SS. Medicinal uses and molecular identification of two *Momordica charantia* varieties- a review. Electronic Journal of Biology. 2010; 6(2):43-51.
23. Renner SS, Schaefer H, Kocyan A. Phylogenetics of Cucumis (Cucurbitaceae): Cucumber (*C. sativus*) belongs in an Asian/Australian clade far from melon (C. melo). BMC Evolutionary Biology. 2007; 7:58. doi:10.1186/1471-2148-7-58. PMC 3225884. PMID 17425784.
24. Wang CY, Qi L. Controlled atmosphere storage affects quality and chilling susceptibility of cucumbers. Journal of Food Quality. 1997; 20:559-566.
25. Zhuang FY, Chen JF, Staub JE, Qian CT. Taxonomic Relationships of A Rare *Cucumis* Species (*C. hystrix* Chakr.) and Its Interspecific Hybrid with Cucumber. Horticultural Science. 2006; 41(3):571-574. doi:10.21273/HORTSCI.41.3.571