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Technical note

Gamma and electron-beam irradiation of cut flowers ☆

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Abstract

Fresh cut flowers are commodities that require quarantine treatment for export/import. In the present work some cut flowers were irradiated in a gamma panoramic source and in an electron beam accelerator with doses up to 800 Gy, and the results for the radiation tolerance of the flowers are presented.

Keywords: Cut flower; Gamma radiation; Electron beam; Quarantine

1. Introduction

Fresh cut flowers are vegetable products subjected to phytosanitary inspection when exported. Many plagues attack flowers and other important agricultural cultures. The disinfestation of cut flowers is being done currently with methyl bromide that is a very effective fumigant, but it is also a potent depleting agent for ozone layer. Methyl bromide will be banned until 2015 and it is necessary to find other alternatives to substitute it (Marcotte, 1998).

Carbonyl sulfide can be an option in some cases (Chen and Paull, 1998). Phosphine is not very effective against some insects and high dosages can damage some flowers (Karunaratne et al., 1997; Weller et al., 1998). Heat treatment is proposed also as a possibility with some restrictions (Lurie, 1998).

The treatment with radiation is another alternative to substitute chemical fumigation with methyl bromide (Marcotte, 1998). The post-harvested vegetables can be irradiated with gamma rays or electron beam to attend the phytosanitary requirements. Some previous researches indicate the effectiveness of the radiation for disinfestations of flowers (Hayashi et al., 1998; Kikuchi, 2000; Seaton and Joyce, 1992; Tanabe and Dohino, 1995; Wit and Van de Vrie, 1985). The dose of 300 Gy is considered enough to cause sterility to all stages of insects and mites.

This paper deals with the tolerance and sensitivity of some cut flowers, comparing the gamma and electron-beam radiation effects.

2. Materials and methods

The cut flowers were obtained on the Sao Paulo flower market, about 4 km away from the IPEN laboratory. The flower stems were cut and soaked in filtered tap water to recover their turgidity and then irradiated.

The irradiation was carried out in a panoramic cobalt-60 source (Yoshizawa Kiko Co Ltd.) and in an electron-beam accelerator (Radiation Dynamics Inc., 0.5–1.5 MeV). The dose rates in the gamma source varied from 147 to 159 Gy/h and in the EB accelerator the dose rate was 133 Gy/s. After the irradiation the flowers were maintained in a preservative solution composed of 0.005% of 8-hydroxyquinoline hemisulfate salt (Sigma), 1 ppm of ampicilim sodium salt (Sigma) and streptomycin sulfate (Sigma). All the samples were maintained at room temperature, varying from 18°C to 25°C, and exposed to electric light for 9–10 h.

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Table 1
Cut flower tolerance to radiation

Flower	Gamma radiation	Electron beam
Lilium speciosum (Liliaceae)	Up to 500 Gy	Up to 300 Gy
Alpinia purpurata (Zingiberaceae)	Up to 400 Gy	Up to 300 Gy
Curcuma alismatifolia (Zingiberaceae)	Up to 500 Gy	n.t.[a]
Lisianthus sp. (Gentianaceae)	Up to 700 Gy	Up to 300 Gy
Eustoma grandiflorum (Gentianaceae)	Up to 400 Gy	n.t.
Zingiber spectabile (Zingiberaceae)	n.t.	n.t.
Gerbera sp. (Compositae)	n.t.	Up to 300 Gy
Strelitza reginae (Musaceae)	n.t.	n.t.
Heliconia psittacorum (Musaceaea)	n.t.	n.t.
Heliconia rostrata (Musaceae)	n.t.	n.t.
Dendrobium phalenopsis (Orchidaceae)	n.t.	n.t.
Matthiola incana (Brassicaceae)	n.t.	n.t.
Bouvardia spp (Rubiaceae)	n.t.	n.t.

[a] n.t.: not tolerant to 300 Gy.

The dose of 300 Gy was considered as the minimum value for tolerance of the flowers to both kind of radiation. When the flower was damaged by 300 Gy it was considered as not tolerant.

3. Results and discussion

Table 1 shows the tolerance of the irradiated flowers to gamma rays and electron beam.

Lilium speciosum (Liliaceae)—tolerant to gamma and e-beam radiation. High doses caused bud opening inhibition. E-beam was more damaging than gamma rays.

Alpinia purpurata (Zingiberaceae)—tolerant to gamma and e-beam radiation. Browning symptoms appeared with high doses.

Curcuma alismatifolia (Zingiberaceae)—tolerant to gamma rays, but not tolerant to e-beam. The damage that appeared was the browning symptom.

Lisianthus sp. (Gentianaceae)—tolerant to gamma and e-beam radiation. High doses caused bud opening inhibition and petal withering.

Eustoma grandiflorum (Gentianaceae)—tolerant to gamma rays, but not tolerant to e-beam. The damaging symptom was the petal withering.

Zingiber spectabile (Zingiberaceae)—not tolerant to gamma and e-beam radiation. The dose of 300 Gy caused browning process.

Gerbera sp. (Compositae)—not tolerant to gamma-rays, but tolerant to 300 Gy of e-beam. The gamma radiation caused the bent stem and curling petal symptoms. Even with 500 Gy of e-beam the flowers did not present the bent stem and only a slight petal curling symptom.

Strelitza reginae, *Heliconia psittacorum* and *Heliconia rostrata* (Musaceae)—not tolerant to gamma and e-beam radiation. The most evident damage caused by irradiation was the browning, followed by drying up.

Dendrobium phalenopsis (Orchidaceae), *Matthiola incana* (Brassicaceae) and *Bouvardia* spp (Rubiaceae)—not tolerant to gamma and e-beam radiation. The petal withering and flower drop were the undesirable symptoms.

It seems that there are no visible parameters to establish which variety of flower is tolerant or not to gamma and/or e-beam radiation. It is not possible to classify the radio-resistant flowers according to the plant family or to the structural aspect. The Musaceae family flowers we irradiated for example are very radio-sensitive in spite of the rigid aspect. Among the Zingiberaceae family, the *Zingiber* has a strong structure but is radio-sensitive, while *Alpinia* and *Curcuma* that have a more delicate appearance are relatively radio-resistant. The high water content of those flowers can be one indication to the radio-sensitivity due to the water radiolysis occurrence caused by the radiation. The color also cannot be used as a reference to indicate if the flower is tolerant to radiation. *Alpinia*, *Curcuma*, *Eustoma* and *Gerbera* present some grade of petal discoloration with damaging doses of both kinds of radiation and this symptom can be a result of direct or indirect effects of radiation on pigments (Tanabe and Dohino, 1993). Unfortunately, in the absence of an efficient method to classify the radio-resistant flowers, it is necessary to continue verifying the tolerance of each kind of flower that was not irradiated yet.

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