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Orchid flowers tolerance to gamma-radiation

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Abstract

Cut flowers are fresh goods that may be treated with fumigants such as methyl bromide to meet the needs of the quarantine requirements of importing countries. Irradiation is a non-chemical alternative to substitute the methyl bromide treatment of fresh products. In this research, different cut orchids were irradiated to examine their tolerance to gamma-rays. A 200 Gy dose did inhibit the *Dendrobium palenopsis* buds from opening, but did not cause visible damage to opened flowers. Doses of 800 and 1000 Gy were damaging because they provoked the flowers to drop from the stem. *Cattleya* irradiated with 750 Gy did not show any damage, and were therefore eligible for the radiation treatment. *Cymbidium* tolerated up to 300 Gy and above this dose dropped prematurely. On the other hand, *Oncydium* did not tolerate doses above 150 Gy. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Orchid; Gamma-radiation; Quarantine treatment

1. Introduction

There are about 20,000 orchid species around the world and they grow mainly in tropical regions. Brazil has a huge quantity of beautiful orchids and the species which are commercialized as cut flowers include some genera as *Cattleya, Cymbidium, Dendrobium, Oncidium* and *Phalaenopsis*. The exportation of Brazilian orchids is still modest, but may penetrate a potentially promising international market as floriculture has grown significantly in our country.

Cut flowers are fresh products subject to many plagues. Quarantine treatment is therefore a requisite for fresh flowers intended for export/import. Methyl bromide is a very effective fumigant but it is a potent depleting substance for the ozone layer. Consequently, it will be banned until 2015 and it is imperative to find alternatives to this kind of treatment (EPA, 1996; Marcotte, 1998).

Radiation is one of the methods that can be used to disinfest fresh products, on the condition that the doses used do not damage the product. The use of radiation for post-harvest and quarantine commodity control is cited by the Environmental Protection Agency of the United States (EPA) as being effective for disinfesting fruits and other vegetables, including cut flowers (EPA, 1996).

Flowers do not differ from other biological organisms and can be damaged by radiation and other agents. This depends on the dose which is used, keeping in mind that each organism possesses a different sensitivity. Some authors irradiated cut flowers with gamma-radiation (Haasbroek et al., 1973; Piriyathamrong et al., 1985; Wit and van de Vrie, 1985; Kikuchi et al., 1995, 1998; Hayashi and Todoriki, 1996), while others did the same with elec-

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tron beam (Tanabe and Dohino, 1993, 1995; Hayashi et al., 1998) for disinfestation purposes and for the study of the tolerance of the flowers to radiation.

This paper deals with the tolerance and sensitivity of some orchid flowers to gamma-radiation, focusing on those more suitable to be disinfested by radiation.

2. Materials and methods

The cut orchid flowers were obtained on the São Paulo flower market, about 4 km away from the IPEN laboratory. The flower stems were cut and soaked in filtered tapwater for about 15 h before the irradiation in order to recover their turgidity.

The following orchids were irradiated: *Cattleya* sp. (white and lilac), *Cymbidium* sp. (dark rose), *Dendrobium* sp. (white), *Dendrobium phalaenopsis* (white and lilac), *Oncidium flexuosum* (gold) and *Phalaenopsis amabilis* (white).

The irradiation was carried out in a panoramic cobalt-60 source (Yoshizawa Kiko Co Ltd) with 0–1000 Gy (176–123 Gy/h) doses in 1997 and 1998. Orchid flowers were exposed at 30 cm from the cobalt-60 source, in air and with the flower stems soaked in filter water. After the irradiation, the flowers were weighed and maintained in a preservative solution composed of 0.005% of 8-hydroxyquinoline hemisulfate salt (Sigma), 1 ppm of ampicillin sodium salt (Sigma) and streptomycin sulfate (Sigma). All the samples were maintained at room temperature, varying from 18 to 25°C, and were exposed to electric light for 9–10 h.

The flowers were considered not viable when the first withering or coloration change symptoms appeared or the flower dropped from the stem. The inflorescence non-viability was considered when half of the flowers withered, dropped or showed some other damage signal.

3. Results and discussion

A summary of the results is shown in Table 1.

Cattleya sp. — tolerant. The vase-life of the white flowers was the same both for the control and the irradiated flowers. The vase-life was only 5 days and the probable damaging effects of radiation did not have time to appear. Lilac flowers had also a short vase-life and were tolerant to a 750 Gy dose.

Cymbidium sp. — not tolerant. The doses from 300 to 1000 Gy caused the flowers to drop 7 days after irradiation.

Dendrobium sp. — tolerant. The vase-life of these flowers was short, 5 days, and there was no difference among the control and the irradiated samples.

Dendrobium phalaenopsis— not tolerant. The white influorescences were damaged with doses of 300–1000 Gy, presenting flowers withering and drop. The vase-life of the control was between 12 and 19 days and the 200 Gy sample vase-life was between 11 and 19 days. The flowers irradiated with 300–1000 Gy had less than 1 week vase-life. The lilac influorescences also presented tolerance only to 200 Gy. The doses of 800 and 1000 Gy were definitely damaging, causing a severe flower drop that began 5 days after the irradiation.

Oncidium flexuosum — not tolerant. There was a severe flower drop in the irradiated inflorescences with doses from 200 to 1000 Gy.

Phalaenopsis amabilis — moderately tolerant. The dose of 400 Gy or more caused subsequent petal withering and flower drop.

Orchids are relatively sensitive to gamma-radiation. The flower withering and drop shortened the vase-life of some irradiated flowers. Our results are in accordance to Piriyathamrong's research which observed that *Dendrobium* Pompadour had its vase-life shortened by gamma-radiation with 500 Gy (Piriyathamrong et al., 1985). Tanabe and Dohino (1995) observed that *Dendrobium* Pramot irradiated in an electron beam was not tolerant to 400 Gy, presenting slight abscission

Table 1
Summary of the results

Orchid flower	Damaging dose (Gy)	Damaging symptoms of irradiated flowers	Control vase-life (days)
Cattleya sp. (white)		Without damage	5
Cattleya sp. (lilac)		Without damage	4
Cymbidium sp. (dark rose)	$\geqslant 300$	Flower drop	14–16
Dendrobium sp. (white)		Without damage	5
Dendrobium phalaenopsis (white)	$\geqslant 300$	Petal withering, flower drop, vase-life shortened to 6 days	12–19
Dendrobium phalaenopsis (lilac)	$\geqslant 400$	Flower drop, vase-life shortened to 6 days	12–20
Oncidium flexuosum (gold)	$\geqslant 200$	Flower drop	6–7
Phalaenopsis amabilis (white)	$\geqslant 400$	Petal withering, flower drop, vase-life shortened to 5 days	15–17

and withering of flowers and vase-life shortening. In our case, two species of *Dendrobium* were irradiated and the short vase-life flowers were tolerant to doses up to 750 or 1000 Gy, while long vase-life orchid, *Dendrobium phalaenopsis*, were sensitive to gamma-rays. Tanabe and Dohino (1995) also observed that *Oncidium* Gower Ramsey showed withered petals when irradiated with a 600 Gy electron beam as we observed with the dose of 200 Gy on *Oncydium flexuosum*.

Some orchids we irradiated, as *Cattleya* and *Dendrobium*, met the criteria to be irradiated. But some of them were intolerant to doses above 300 Gy, which is necessary to sterilize insects, other than fruit-fly. It would then be necessary to adapt or project an irradiation procedure to avoid the irradiation of the product with higher doses than 300 Gy.

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