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Effects of electron-beam and gamma irradiation on the antioxidant compounds of edible flowers species

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1. Introduction

The market of Unconventional Food Plants (UFP), especially the edible flowers is a niche in expansion in Brazil and in the world, due to the increasing use of flowers in gastronomy, translating into an increase of varieties and economic growth. It is a market in full expansion worldwide, besides being a source of phytochemicals, improving the nutritional aspects when added to food products, ensuring the maintenance in the consumers' health and wellbeing.

Several studies have reported that flowers are rich in bioactive compounds and contain numerous phytochemicals that have antioxidant activity. The consumption of foods that present substances with antioxidant potential is important because such substances are able to act in the prevention of chronic diseases, such as cardiovascular, cancer, age-related, and degenerative diseases [1-3].

Phytochemicals present in flowers are responsible for health promoting properties such as antioxidant, hypoglycemic, anticancer, antimicrobial activity, antiinflammatory and hepatoprotective [4-6].

However, flowers are very perishable, which demands the research of emerging technologies for their conservation and food safety. The application of ionizing radiation with the purpose of avoiding production losses, guaranteeing longer shelf life and quality of flowers such as the species *Rosa chinensis* Jacq., and *Phalaenopsis*.

The purpose of this study was to analyze the effects of ionizing radiation with ^{60}CO sources and electron accelerators at doses of 0.5, 0.8, 1.0 kGy and control on the antioxidant capacity present in the species *Rosa chinensis* Jacq., and *Phalaenopsis*.

2. Methodology

The edible flowers were purchased from a local market in São Paulo, Brazil, presenting different phenotypes and irradiation processing was carried out at the Nuclear and Energy Research Institute – IPEN/CNEN (São Paulo, Brazil). Samples were irradiated using an electron beam accelerator (IBA Industrial Inc., Edgewood, NY, USA) and a ^{60}Co source Gammacell 200 (Nordion Ltd., Ottawa, ON, Canadá), at room temperature, at doses 0.5, 0.8 and 1.0 kGy. Non-irradiated samples were used as a control and after irradiation, the samples were lyophilized (Solab SL404, São Paulo, Brazil).

The antioxidant activity was evaluated through Oxygen Radical Absorbance Capacity assay (ORAC), 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging and Ferric Reducing Ability of Plasma (FRAP).

The methanol / water (80:20, v/v) extract was prepared from the powdered flower. Samples (≈0.5 g) were stirred with 20 mL of the solvent's mixture, at room temperature, 150 rpm for 1 h. The extract was filtered through Whatman No. 4 paper and the residue was re-extracted with 20 mL of methanol / water 80:20 (v/v).

The DPPH (2,2-diphenyl-1-picryl-hydrazyl) radical scavenger activity was evaluated according to previous authors [7]. The samples of different concentrations of the extract solutions were added to the wells of a 96 well microplate with the methanolic solution (160 µL) containing DPPH radicals (6×10-5 mol/L). The absorbance was measured at 517 nm at 25 °C every 5 minutes for 30 minutes by using a microplate reader. The Trolox® standard curve was used as a positive control.

The antioxidant capacity analysis method by the FRAP method was evaluated according to a methodology described [8]. This methodology was performed using the Microplate Reader described above and measuring the absorbance at 593 nm at 37 °C with an incubation period of 4 minutes. The different concentrations of the extracts were added in the 96-well microplate with FRAP reagent. The extraction solvent was used as blank and the extraction solvent and FRAP reagent as control. The standard curve was prepared with Trolox® (6-hydrox-2,5,7,8-tetramethylchroman-2-carboxylic acid).

The ORAC assay was evaluated according to a method previously described [9] with modifications. The reagents were prepared in 75 mM phosphate buffer (pH 7.4), using fluorescein at concentration 40 mM and the AAPH (2,2'-azobiis(2-amidinopropane) dihydrochloride) solution at 153 nM. Sample extracts were added in 96-well microplate (black color). It was measured fluorescence microplate reader, where 150 µL of fluorescein was automatically injected and then incubated for 30 min at 37 °C. Subsequently, 25 µL of the AAPH solution was injected, triggering the reaction. Fluorescence was read at 493 nm excitation and 515 nm emission every 1 minute for 1 hour at 37 °C. Trolox® was used as standard and phosphate buffer as blank.

3. Results and Discussion

Irradiation technology is a commercial feasible alternative method in effective to prolong shelf-life, improving hygiene and safety of edible flower [10, 11]. As well as researches on the antioxidant activity in petals of edible flowers were reported that the bioactivity of edible flowers is highly related to the content of polyphenolic compounds [12, 13].

The results showed that irradiation treatment did not negatively affect the antioxidant activity of processed edible flowers compared to the control, independently of irradiation technology. Similar effects were observed in studies of influence of the irradiation process on antioxidant substances present in foods. Indeed, antioxidant activity, flavonoids content and total phenolic of methanolic extracts of *Tropaeolum majus* were also reported e antioxidant activity was higher for irradiated samples. Flowers of *Bauhinia variegata* were exposed irradiation with dose up to 1 kGy and the results showed at a samples irradiated antioxidant activity was increased. [14, 15].

The same was reported by in studies of influence of the irradiation process on antioxidant substances present in foods which described a significant increase in the phenolic content, and the favoring of the its antioxidant capacity of samples of *Cammellia sinensis,* and *Viola tricolor* [16, 17].

4. Conclusions

According to the results presented in this work, it was concluded that the radiation treatment did not affect the antioxidant activity in the species of edible flower studied and can be alternative ensured the properties of edible flowers. Thus, the radiation process has proven to be a viable technology to preserve the quality of edible flowers, offering also the possibility of its application in the extension of useful life.

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