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Evaluation of low-dose irradiation on microbiological quality of white carrots and string beans

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ABSTRACT

The minimally processed food provided the consumer with a product quality, safety and practicality. However, minimal processing of food does not reduce pathogenic population of microorganisms to safe levels. Ionizing radiation used in low doses is effective to maintain the quality of food, reducing the microbiological load but rather compromising the nutritional values and sensory property. The association of minimal processing with irradiation could improve the quality and safety of product. The purpose of this study was to evaluate the effectiveness of low-doses of ionizing radiation on the reduction of microorganisms in minimally processed foods. The results show that the ionizing radiation of minimally processed vegetables could decontaminate them without several changes in its properties.

1. Introduction

The minimally processed vegetables are those submitted to simple operations aiming to preserve their freshness, sensorial properties and nutritional quality (Cruz et al., 2006). In addition to health aspects, minimal processing addresses consumers' expectations for safe food (Jacxsens et al., 2010).

Minimally processed vegetables have a variety of microorganisms, most of them related to the spoilage of the product and possible contamination with pathogens, such as *Salmonella* and *Escherichia coli*.

The white carrot is a plant eudicots, Umbellales order, family Apiaceae (Umbelliferae), Arracacia genus, species *Arracacia xanthorrhiza* Bancroft. The family of Apiacás also includes carrots, parsley, coriander, celery and fennel, among others (Alasalvar et al., 2001).

Phaseolus vulgaris L. is an annual plant, originally from Central America and belongs to the family Fabaceae. It contains an appreciable amount of fiber and vitamins (Philippi, 2006).

Food irradiation is an economically viable technology for the extension of shelf life of perishable commodities, improvement of hygienic quality of foods and elimination of pathogenic bacteria: *E. coli*, *Salmonella* and *Listeria monocytogenes* from vegetables (Fan et al., 2003).

The use of irradiation to increase the microbiological safety of foods as well as to extend their shelf-life has already been proved (Farkas, 1998; Radomyski et al., 1994; Santos et al., 2003).

The gamma irradiation improves the safety, efficiency, and is suitable for disinfestation, microorganism load reduction or sterilization, and increases the shelf- life of food (Sommers, 2004).

The ionizing radiations do not cause any significant alteration. The important sensory properties of most food are not influenced at low radiation doses (Farkas, 2006).

The purpose of this study is to evaluate the effect of low-dose radiation to control bacteria and fungi in minimally processed white carrot (*A. xanthorrhiza*) and string beans (*P. vulgaris*).

2. Material and methods

2.1. Sample

The minimally processed white carrot and string beans were purchased from the local market in São Paulo, Brazil. The samples were peeled, sliced into small pieces and packaged in polyethylene bags with 100 g.

2.2. Irradiation

The samples were irradiated at Nuclear and Energy Research Institute—IPEN/CNEN (São Paulo, Brazil) using a ^{60}Co Gammacell 200 (MDS Nordion Ottawa, Canadá) at doses of 0, 0.5, 1.0, 1.5 and 2.0 kGy, and each study included three samples per dose. The applied dose rate was 1.67 kGy/h and Harwell Amber 3042

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dosimeters were used to measure the radiation dose. After irradiation, the samples were stored for 1 day at 10 °C ± 1.

2.3. Microbiological analysis

The analysis was performed to determine *Salmonella* spp. (Fig. 1) and presence of coliforms (Fig. 2) in irradiated and non-irradiated was measured according to the method described by Andrews et al. (2001). The results of *Salmonella* spp. and coliforms were obtained as presence or absence in the food.

The analysis of fungi was performed by counting the colony forming units (CFU) by surface plating, using the dilution of 25 g of product in 225 ml of 0.1% peptone water (1:10) (HIMEDIA, Mumbai, India). The dilution was taken and transferred as 0.1 ml aliquots to Petri dishes with medium Potato Dextrose Agar (HIMEDIA, Mumbai, India). The plates were kept in incubator for 5 days at 25 °C ± 1, and subsequently counted within existing colonies (Pitt and Hocking, 1997).

Fungi counts were below detectable limits for all samples (data not shown). Isolated colonies were observed at samples treated up to 1.5 kGy.

2.4. Statistical analysis

Statistical analysis was performed by ANOVA, with a $p > 0.05$, in order to evaluate significant differences among irradiation doses analyzed.

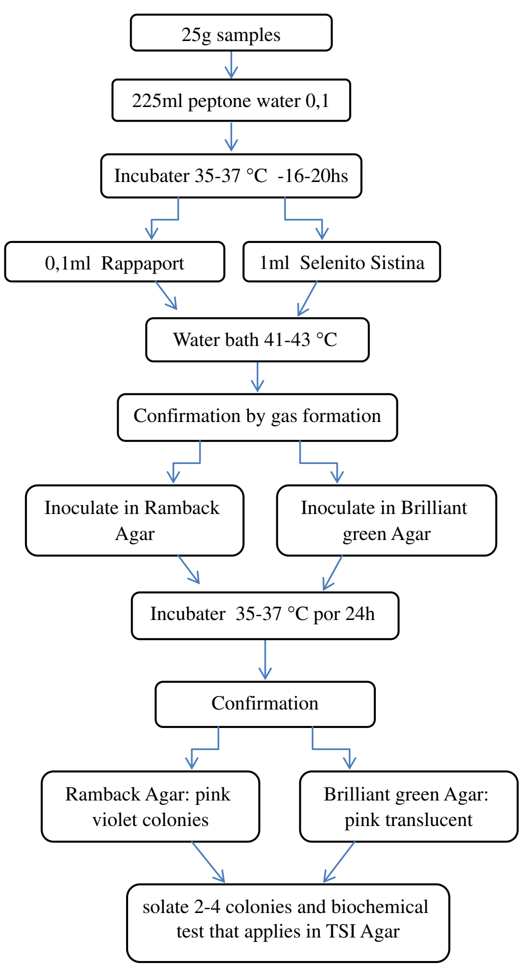

Fig. 1. Analysis for determination of *Salmonella* spp.

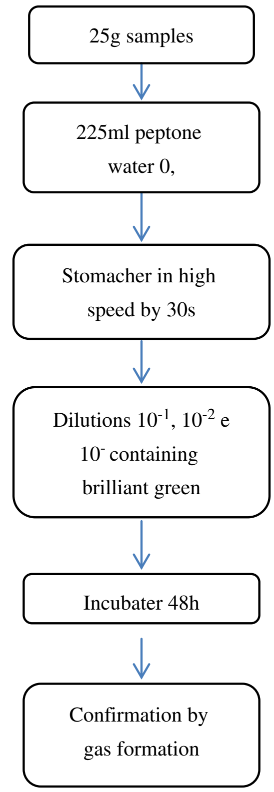

Fig. 2. Analysis for determination of coliforms.

Table 1
Salmonella spp. and coliforms' presence in minimally processed white carrot and string beans.

Dose	White carrot		String beans	
	Salmonella spp. (CFU/g)	Coliforms (CFU/g)	*Salmonella* spp. (CFU/g)	Coliforms (CFU/g)
Control	Absence	110^a	Absence	105^a
0.5 kGy	Absence	75^b	Absence	55^b
1.0 kGy	Absence	Absence	Absence	Absence
1.5 kGy	Absence	Absence	Absence	Absence
2.0 kGy	Absence	Absence	Absence	Absence

Means followed by same letter do not differ according to the Tukey test at 5% significance.

3. Results and discussion

The microbiological analysis showed a decrease in the development of populations of microorganisms with increasing doses of radiation. The results in minimally processed white carrot (*A. xanthorrhiza*) and string beans (*P. vulgaris*) were determined both for bacteria and fungi. Complete absence of *Salmonella* spp. and *E. coli* in samples' doses irradiated at 1.0, 1.5 and 2.0 kGy (see Table 1) was observed.

There was a reduction of microbial fungi in the samples irradiated at 1.5 kGy dose while those irradiated at 2 kGy dose showed complete absence of microorganisms.

Martinsa et al. (2004) obtained the results that combination of minimal processing and exposition to a dose of 1.7 kGy gamma-irradiation resulted in a reduction of *Salmonella* spp. population in watercress.

Trigo et al. (2009) observed that the radiation dose necessary for reduction of the population of *E. coli* was 0.55–0.8 kGy and for *Listeria innocua* it was 0.95–1.55 kGy.

Chaudry et al. (2004) observed that the dose of irradiation of 2.0 kGy was effective in maintaining the quality, texture, sensory and microbiological properties in minimally processed carrots for 14 days at 5 °C.

4. Conclusion

The results show that the ionizing radiation of minimally processed vegetables may be a viable alternative in reduction of the population of microorganisms. A dose of 1.0 kGy decreases the bacterial count and 2.0 kGy destroyed the microbial fungi. The combination of irradiation with minimum processing could improve the safety and quality of minimally processed vegetables.

Acknowledgments

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