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Gamma-ray sanitization of Argentinean dehydrated garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) products

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Abstract

The contaminating microflora of 12 dehydrated garlic and onion products was investigated. The products were presented in powder, chops and flakes, both packed and unpacked, as sold in the Argentinean retail market. Also, the efficacy of gamma rays doses between 5 and 25 kGy to reduce microbial population was investigated. The prevailing microflora were the spores of mesophilic aerobic bacteria (between 1.4×10^3–2.7×10^5 in garlic and 3.5×10^4–4.6×10^5 CFU/g in onion). A dose of 10 kGy for onion was required to reduce the spore counts up to non-detectable levels. Sulfite-reducing clostridia and their spores were detected only in garlic at levels below 30 CFU/g. In all products, *Bacillus cereus* and their spores, moulds and yeasts did not exceed 266 and 6.0×10^3 CFU/g, respectively. Total coliforms predominated in onion with a MPN maximum of 1.1×10^3/g. A dose of 5 kGy was enough to reduce this non-prevailing microflora up to non-detectable limits. As regards public health, the treatment with gamma rays is suggested for garlic and onion products used by Argentinean consumers.

Keywords: Dry garlic; Dry onion; Irradiation; Microflora; Sanitization

1. Introduction

Species are defined as vegetal origin products used as flavoring agents in food and drinks. Some dehydrated plants such as garlic (*Allium sativum* L.) and onion (*Allium cepa* L.) are included in this definition (ICMSF, 1999) and it is believed that they are among the first plants dehydrated by man (Fenwick & Hanley, 1990). In Argentina in particular, *Alliums* are the main products in the dehydration industry and they represent more than 50% of the total production. Considering the volume produced, onion is in the first place and garlic in the second (Belettieri, 1997).

Dried garlic and onion are widely used in food industry in manufactured soups, ketchups, sauces and mayonnaises; they can also be added to more elaborated pre-prepared foods (Brewster, 1994). Today, their consumption as ingredient in domestic cooking has significantly increased, both due to their easy use and their long shelf-life. In the retail market, consumers find them in powder, in chops, or in flakes, and can buy them both packed and unpacked.

As with other agricultural products, they are exposed to a wide range of environmental microbial contamination during collection and processing, including packaging. Researches conducted in several countries confirmed that potential food borne pathogens such as *Salmonella*, *Escherichia coli*, *Clostridium perfringens*, *Bacillus cerus* and toxigenic moulds are found in dry onion and garlic (McKee, 1995). As for microbial count of dehydrated garlic and onion products there is no legislation in Argentina. Considering that these products are often used in

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their raw condition, and that certain pathogenic bacteria can survive up to 10 and 12 years in plant material (Beuchat, 1996), the necessity to adopt highly effective methods for inhibiting undesired microbial growth and thus avoid the occurrence of food transmitted diseases is imperious from the point of view of public health.

Fumigation of dry vegetables with ethylene oxide can effectively reduce the microbial population by up 90%. However, this practice is banned in many countries because of possible human health hazards caused by fumigation by-products (Baxter & Holzapfel, 1982).

The only other known safe and effective technique for dry vegetables is gamma irradiation. This is evidenced by the increasing number of countries adopting irradiation technology to assure the hygienic quality of dry food (IAEA, 1998). Radiation damage of microbial cells is due to the scission of single or double strands of DNA, which essentially is caused by the free radicals formed in the food medium and is influenced by food composition (Diehl, 1990). International safe dose clearance is up to 10 kGy, whereas some countries, including Argentina, have raised this level up to 30 kGy with no harmful effects observed. In addition, as products can be treated directly in commercial containers, irradiation offers the advantage of considerable energy and labor savings.

Previous work (Farkas, 1985) has shown that gamma-rays are a powerful tool to reduce the microbial load of dry onions for use in the food processing industry. Reductions on onion powder microbial load to below detectable levels were reported by Farkas, Beezner, and Ineze (1973) when applying 8.0 kGy and initial microbial count was below 10^4 CFU/g. A reduction of one order of magnitude of microbial contamination in onion powder and flakes resulted from irradiation with 1.0–2.0 kGy (Farkas & El-Nawawy, 1973). Furthermore, according to Galetto et al. (1979), 9 kGy exposure reduced microbial count of 2×10^7 to below 3×10^4 CFU/g in onion powder. In addition, Argentinean workers reported that gamma-rays were suitable for in bulk sterilization of several ingredients, including garlic and onion powder, used by a local food manufacturer (Lescano, Narvaiz, & Kairiyama, 1991).

To date, however, there is lack of data regarding the sanitary conditions of dehydrated garlic and onion commonly available at retail in Argentina and used by local consumers in the preparation of their homemade meals. Then, the necessity exists to evaluate the changes that gamma irradiation may induce on the microbiological status of such products.

Therefore, the aims of the present study were, first, to ascertain the microbiological status of dehydrated garlic and onion available at local retail market in powder, in chops and in flakes, both packed and unpacked; and second, to determine the sanitizing effect of gamma irradiation on these products using doses between 5 and 25 kGy.

2. Materials and methods

2.1. Samples

Garlic and onion dehydrated products were studied, which are available for the consumer at retail stores in the City of Bahía Blanca (Buenos Aires, Argentina). The samples were taken from four of the most popular supermarkets in the city. According to the selling procedure and their presentation, they were classified as follows:

Upg1: unpacked powder garlic 1	Pgch1: packed garlic chops 1
Upg2: unpacked powder garlic 2	Ugf1: unpacked garlic flakes 1
Ppg1: packed powder garlic 1	Uof1: unpacked onion flakes 1
Ppg2: packed powder garlic 2	Uof2: unpacked onion flakes 2
Ppg3: packed powder garlic 3	Pof1: packed onion flakes 1
Ugch1: unpacked garlic chops 1	Pof2: packed onion flakes 2

Numbers 1, 2 and 3 show different commercial trademarks.

2.2. Packaging and treatment

After arriving at the laboratory, the products were immediately divided into samples of 5 g in sterile petri dishes (5 cm diameter) to avoid further contamination. All samples were stored in darkness under laboratory conditions (20–25 °C; RH 50–80%). The four most contaminated products were selected for treatment. As previously reported (Croci, Banek, & Curzio, 1995), the irradiation was carried out at the facilities of the Comisión Nacional de Energía Atómica in Ezeiza Atomic Center, Buenos Aires Province, Argentina. The samples were treated under air conditions at 20 °C with doses of 0, 5, 10, 15, 20 and 25 kGy using ^{60}Co gamma rays. The dose-rate was 0.13 kGy/min as determined by Fricke dosimetry, and the dose uniformity ratio was 1.25.

2.3. Microbiological analysis

The procedures prescribed by the International Commission on Microbiological Specifications for Food (ICMSF, 2000) were followed by determining: mesophilic aerobic bacteria (MAB) and their spores, sulfite-reducing *Clostridia* (SRC) and their spores and *Bacillus cereus* (*B. cereus*) and their spores; moulds and yeasts (M–Y) and total coliforms (TC) of the non-irradiated and irradiated dehydrated onion and garlic samples. For microbial analysis, samples of 5 g each were taken and added to 45 mL of sterile water. This initial dilution was manually