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Mediate gamma radiation effects on some packaged food items

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ABSTRACT

For most of prepackaged foods a 10 kGy radiation dose is considered the maximum dose needed; however, the commercially available and practically accepted packaging materials must be suitable for such application. This work describes the application of ionizing radiation on several packaged food items, using 5 dehydrated food items, 5 ready-to-eat meals and 5 ready-to-eat food items irradiated in a ^{60}Co gamma source with a 3 kGy dose. The quality evaluation of the irradiated samples was performed 2 and 8 months after irradiation. Microbiological analysis (bacteria, fungus and yeast load) was performed. The sensory characteristics were established for appearance, aroma, texture and flavor attributes were also established. From these data, the acceptability of all irradiated items was obtained. All ready-to-eat food items assayed like manioc flour, some pâtés and blocks of raw brown sugar and most of ready-to-eat meals like sausages and chicken with legumes were considered acceptable for microbial and sensory characteristics. On the other hand, the dehydrated food items chosen for this study, such as dehydrated bacon potatoes or pea soups were not accepted by the sensory analysis. A careful dose choice and special irradiation conditions must be used in order to achieve sensory acceptability needed for the commercialization of specific irradiated food items.

1. Introduction

Food packaging is a common and standard tool for retailers and product manufacturers. Methods of food preservation are fundamental for conserving the integrity of a product and protecting the consumer health (Coles et al., 2003). Packaged product quality and shelf life issues are the main concerns for product stability and consumer acceptability, as there are many ways in which a packaging material may influence a product during storage (ASTM E-460., 2004).

As stated in documents from the World Health Organization (WHO, 1988, 1994) one of the objectives of processing food with ionizing radiation is to destroy pathogenic and spoilage microorganisms without compromising the safety, nutritional properties and sensory quality of the product. As with any other food processes, physical and chemical changes are produced, but the extent of these changes differs significantly. Although the radiolytic changes in irradiated food are known in general terms, when packaged food is irradiated, the packaging material itself must be suitable for this purpose and so must any adhesive used for sealing. For that reason, a 10 kGy dose was considered the maximum dose for most commercial packaging materials for use during irradiation of prepackaged foods (USA, 1985).

Commercial, shelf stable packaged foods can be used anywhere: at home, for sports practitioners or eventually as military rations. A variety of test procedures are available for measuring product differences, perceived characteristics, quality and acceptability.

This work describes the application of gamma ionizing radiation on several packaged food items and their mediate effects in terms of microbial counts and sensory evaluation.

2. Material and methods

2.1. Material

Three kinds of industrialized food samples were employed: 5 dehydrated food items (dehydrated coffee/milk/sugar mixture, cocoa/milk/sugar mixture, packaged Brazilian corn pudding, bacon potatoes or pea soups), 5 ready-to-eat meals (meatballs, chicken with legumes, spaghetti in tomato sauce, ravioli and sausages) and 5 ready-to-eat food items (manioc flour, ham and chicken pâtés, honey and blocks of raw brown sugar). Each one of the different kinds of samples was divided into 2 groups of 15 units each: unirradiated and irradiated (3 kGy). The samples were evaluated at the 2nd and 8th month after irradiation.

2.2. Gamma irradiation

A completely self shielded irradiator, dose rate about 7 kGy/h, as well as a panoramic ^{60}Co source, dose rate about 0.05 kGy/h

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were employed, being an average dose of 3 kGy applied. Dosimetric measurements were previously performed using Fricke dosimetry. The self shielded irradiator is referred to have a dose uniformity factor of 1.13. On the other hand, when the panoramic irradiator was employed, the dose range was 1.2–4.8 kGy.

2.3. Microbial analyses

The quality evaluation of the irradiated and non-irradiated samples was performed 2 and 8 months after irradiation. To determine the microbiological profile, conventional methods of plating, Colony Forming Units (CFU) and Most Probable Number (MPN) by the multiple tubes technique were used following the Norms of the American Public Health Association (2001) and national and international legislations (BRASIL, 2001; APHA, 2001), that specify maximum tolerances for different kind of foods. In general terms, samples are considered contaminated when the microorganism counts are higher than 1.0×10^3 CFU/g or MPN/g or presence/25 g, in the case of *Salmonella* spp., positive coagulase for staphylococci, or sulfite reducing for clostridia.

Counts of aerobic mesophiles, yeast and molds, NMP of total coliforms, NMP of fecal coliforms, presence/25 g for *Salmonella* spp., *Clostridium perfringens*, *Bacillus cereus*, spored mesophiles and thermophiles and *Staphylococcus aureus* were investigated.

2.4. Sensory evaluation

The characterization of the perceived sensory attributes, appearance, aroma, texture and flavor was made by qualified panelists, who were requested to judge their pleasantness by means of a 5-point hedonic scale. The panelists judged the sensory attributes, ranging from '1 Dislike Very Much' to '5 Like Very Much' to indicate their preference. The known sample that provided a reference point upon which to base results was the corresponding non-irradiated one. Sensory acceptability of control (non-irradiated) samples and irradiated ones was determined 2 and 8 months after irradiation.

3. Results and discussion

The tolerance for moisture content in packaged dehydrated food items is 10%. All samples used in this work presented moisture content around 3–4%.

Even the non-irradiated samples were free of pathogen contamination. All the samples, whether irradiated or not, presented bacteria, fungus and yeast counts below the maximum permitted by the legislation and in none of the samples were fecal coliforms, *Bacillus cereus* or *Staphilococcus aureus* present.

The acceptability of different food samples was restricted to the sensory evaluation. As texture and appearance remained like those of the unirradiated ones 8 months after irradiation, the sensory parameters evaluated were actually flavor and aroma.

Data of the acceptability coming from the sensory scores for all irradiated and non-irradiated items were obtained. The non-irradiated samples scored always 4 and 5 in the 5-point hedonic scale used in the study.

The results for dehydrated food items: coffee/milk/sugar mixture, cocoa/milk/sugar mixture, Brazilian corn pudding, dehydrated potatoes soup and dehydrated pea soup, showed that none of the irradiated products, except the Brazilian corn pudding, after two months of storage, had been judged 'acceptable'.

The sensory analysis results for ready-to-eat meals: meat balls, spaghetti in tomato sauce, sausages, chicken with legumes and ravioli, showed that only irradiated ravioli after 8 months were not acceptable.

For ready-to-eat food items: honey, blocks of raw brown sugar, manioc flour, ham pâté and chicken pâté, all products were accepted for both microbial and sensory characteristics.

Some authors irradiated with doses up to 5 kGy ground beef and frankfurters and found that the changes in *trans* fatty acid content and fatty acid composition due to irradiation were negligible (Fan and Kays, 2008). Johnson and Resurreccion (2009) found that the storage time had a more significant effect on poultry frankfurters than irradiation dose up to 3 kGy being aroma but not texture significantly affected by irradiation.

Mechanical properties of polyethylene, polypropylene, polystyrene, polyamides and laminates such as polyester-polyethylene and polyethylene aluminum-polyester-polyethylene are considered unaffected up to a dose of 10 kGy. Using suitable stabilizers, changes in mechanical properties of certain polymers e.g. polyethylene can be minimized when subjected to even higher doses of radiation (Buchalla et al., 1993).

All irradiated samples presented an expected decrease in microbiological counts for yeast, molds and total coliforms. As no further contamination occurred, it can be said that the packaging of all the irradiated samples endured the processing up to the time of analysis, 8 months after gamma irradiation.

Ionizing irradiation from an electron beam accelerator in dose of 5 and 10 kGy was able to decrease or eliminate microbiological risks when applied on packaged fiber rich cookies, fruit cereal bars, instant dehydrated asparagus soup and instant Brazilian corn pudding, although the microflora of these irradiated packaged dried food items is extremely low or below the detection limit. But in that case, mean sensory ratings for all irradiated samples were considered 'non-acceptable' (Mastro and Mattiolo, 2010).

4. Conclusion

This work presents the results for radiation effects on industrialized food items packaged in regular packaging material. All ready-to-eat food items assayed like manioc flour, some pâtés and blocks of raw brown sugar and most of ready-to-eat meals like sausages and chicken with legumes, were acceptable for their microbial and sensory characteristics. On the other hand, the dehydrated food items chosen for this study, such as dehydrated bacon potatoes or pea soups were not accepted by the sensory analysis. A careful dose choice, special irradiation conditions and the suitability of the packaging material must be considered in order to achieve sensory acceptability needed for the commercialization of specific irradiated food items.

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