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IRRADIATION AS A DECONTAMINATION PROCESSING FOR RICE PAPER SHEET

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ABSTRACT

Starch is one of the most important plant products to man. The major sources of this compound for man's use are the cereals, but roots and tubers are also important. The starch industry comes in recent years growing and perfecting it self, leading to the necessity products with specific characteristics that take care the requirements of the market, it makes possible through processing raw material, still seldom explored. Rice paper sheet is an edible product derived from potatoes and rice, being commonly used to cover cakes, pies, and sweets in confectioner's shop. A microbiological control is necessary to give a high quality and to guarantee the security of this food. Irradiation would be a safe alternative as a decontamination method without adverse effects on the physical properties in the final products. The aim of this study was to investigate the best dose used as a decontamination method as well as discover the most prevalent fungi found in this product and changes on physical properties. Samples of rice paper sheet were irradiated with 2.5, 5.0 and 10.0 kGy using a ^{60}Co irradiator. Irradiation appeared as a safe alternative as a decontamination method without adverse effects on the physical properties in the final products.

1. INTRODUCTION

Starch is one of the most important plant products to man. The major sources of this compound for food production are the cereals, but roots and tubers are also important. Starch in rice endosperm is composed of two different glucan chains, amylose and amylopectin. These polymers have the same basic structure, but differ in their length and degree of branching, which ultimately affects the physicochemical properties of these polymers with specific functionality [1].

Starch has been used in both food and non-food products for centuries. The starch industry comes in recent years growing and perfecting it self, leading to the necessity products with specific characteristics that take care the requirements of the market, it makes possible through processing raw material, still seldom explored. Rice paper sheet is an edible product made of starch, being commonly used to cover cakes, pies, and sweets in confectioner's shop [2].

Food irradiation has been successful used to inactivate food spoilage microorganisms, including bacteria, moulds and yeasts. Filamentous fungi development in food and feed could result in the production of toxins, known as mycotoxins; mycotoxigenic fungi associated to food chain comprises basically three genera: *Aspergillus*, *Penicillium* and *Fusarium* [3,4,5].

Irradiation can be applied through packaging materials including those, which cannot withstand heat. Among food preservation methods, nowadays food irradiation is considered the most versatile and effective treatment, causing practically no temperature raise in the product. [6,7]. Safety and efficiency of food irradiation has been approved by several authorities (FDA, USDA, WHO, FAO, etc.) and scientific societies based on extensive research [8,9].

Differences in radiation sensitivities among the microorganisms are related to differences in their chemical and physical structure, as well as in their ability to recover from radiation injury. The mechanism of microbial inactivation by ionizing radiation is mainly due to the damage of nucleic acids, direct damage or indirect damage, affected by oxidative radicals originating from the radiolysis of water [8].

The aim of this study was to investigate the best radiation dose applied as a decontamination method as well as to find out the most prevalent fungi and changes on physical properties of this product.

2. MATERIAL AND METHODS

2.1. Samples

Edible rice paper sheet were purchased from local retail market in São Paulo, Brazil. Each individual rice paper sheet consisted of an unique sample. This sample was fractioned under aseptic conditions in a set of 33 pieces (1x1cm) which was placed into sterile Petri dishes, labeled and identified with its respective radiation doses. Assay was performed in triplicate of a total amount of five samples.

2.2. Water Activity (*Aw*) Determination

Water activity (*Aw*) values from random samples were obtained using a Aqualab CX-2 device (Decagon Devices Inc.) with an accuracy of ± 0.003.

2.3. Irradiation Treatment

Samples were irradiated at room temperature using a ^{60}Co gamma ray facility (Gammacell 220) installed at Instituto de Pesquisas Energéticas e Nucleares - IPEN/CNEN (São Paulo, Brazil). The applied doses were 0 (control), 2.5, 5.0 and 10.0 kGy. The dose rate was of 2.85 kGy/h with uncertainly of ± 1.7%. Harwell Amber 3042 dosimeters were used for the measurement of radiation dose.

2.4. Fungal Growth and Identification

After irradiation process, samples were placed over agar Sabouraud medium with chloranphenicol (0.01% w/v) plates. From a set of 33 pieces of sample, three agar Sabouraud medium plates with 11 pieces (1x1cm) each were plated for each irradiation dose and incubated at 25 ºC for 5 days, adapted from Berjak method [10]. Assay was performed in triplicate and results were expressed as percentage of fungal contamination. Colonies from different morphological types were isolated in agar Sabouraud medium with chloranphenicol (0.01% w/v) and classified until genera.

2.5. Physical Assay

2.5.1 Burst strength

A Texture Analyser (Stable Micro Systems Ltd., England, Model TA.XT2) with a 25 kg-capacity compression load cell and a 6 mm stainless steel cylinder probe (P/6) were used for measurement of the burst strength of samples in terms of g force (g). Texture profile analysis was conducted with a test speed of 1.0 mm/s, until a 5.0 mm distance. All measurements were done in triplicate.

2.5.2 Color measurement

The colour of paper was measured with spectrophotometer (Hunterlab, USA, Model ColorQuest XE). Twelve samples for each radiation dose were scanned to determine *L* (lightness), *a* (redness), and *b* (yellowness) values.

2.5. Statistical Analysis

Statistical analysis for burst strength and colour measurement were developed using a GraphPad Prism, 4.00 version, GraphPad Software for both tests. Differences between mean numbers were determined by analysis of variance, followed by the Dunnett test.

3. RESULTS AND DISCUSSION

Water activity (*Aw*) was measured for control and irradiated samples and values were around 0.56 at 25 ºC. Considering it is a product extremely dry, little microorganisms could grow over it. However filamentous fungi because of its resistance structures could stand in the product until favorable nutritional and physical conditions allow its development [11]. At present of use, an edible gel is applied by both side of paper and following is placed over cakes and pies. This procedure enables a significant increase in *Aw* which reached values around 0.83 at 25 ºC.

Fungal loads of control and irradiated samples of rice paper are shown in table 1. The initial fungal loads determined in non-irradiated samples were 15.15%. Gamma irradiation at 2.5 kGy and 5.0 kGy reduced this percentage two times fold, respectively to 6.06% and 3.03%. After irradiation to 10.0 kGy, no contamination was detected in these samples. Irradiation at low and medium doses (2.5 kGy and 5.0 kGy) was ineffective to promote total fungal decontamination. Although a 10.0 kGy radiation dose inhibited completely fungal growth. Related to fungal contamination diversity, the most prevalent genera found were *Cladosporium* and *Penicillium*, respectively with 50% and 30%. The remaining contamination comprised of non-sporulated fungi (NSF). While *Cladosporium* spp. is just a food deteriorating microorganism, *Penicillium* spp. could produce mycotoxins, depending on species and storage conditions. These mycotoxins, depending on the ingested amount could be harmful to human health, with carcinogenic or hepatotoxic properties [12,13].

Table 1. Percentage of fungal contamination and yellowness[a] (*b*-value) of rice paper sheet (control and irradiated samples).

Dose (kGy)	0	2.5	5.0	10.0
Fungal Contamination (%)	15.15%	6.06%	3.03%	0.0%
Yellowness (*b*-value)	1.97 ± 0.05c	2.20 ± 0.07c	2.47 ± 0.06d	2.87 ± 0.03d

[a] Mean ± standard deviation (n=12). Values followed by different letters have a significative difference by Dunnett test (P<0.05).

Colour of rice paper changed from white to yellow after irradiation. Increasing radiation doses resulted also in an increase of yellowness (*b*-value) (Table 1). The *b*-value of non-irradiated rice was 1.97. After irradiation, the lowest dose (2.5 kGy) did not differ significantly to control. A significant increase was detected ranging from 2.47 to 2.87, respectively for 5.0 kGy and 10.0 kGy. Few studies were performed with irradiated rice paper sheet, however some authors such as Sirisoontaralak and Noomhorm (2006) and Roy et al. (1991) have already reported changes of colour in gamma irradiated rice. Some studies suggested that the cause of yellowing would be due to breakdown of glycosidic and peptidic linkages promoted during irradiation (breakdown products such as carbonyl and amino compounds react - Maillard reaction - and then coloured compounds are formed), as well as melanoidins formed due to oxidation of phenols [15].

Burst strength measurement detected slightly differences between control and irradiated samples (Figure 1). Mean values for the burst strength of rice paper were: 362±25 g, 371±28 g, 359±26 g and 345±16 g, respectively to control, 2.5 kGy, 5.0 kGy and 10.0 kGy. Samples irradiated with 2.5 kGy showed a slight increase in the burst strength, however these values were still close to those obtained in control samples. In general, increasing radiation doses promoted a decrease in the force measured. No significant differences were observed between non-irradiated and irradiated samples (P>0.05). Sung (2005) have also already reported a decrease of firmness of rice curd due to gamma irradiation with doses up 1.0 kGy. Even so, irradiation process did not change negatively this property.

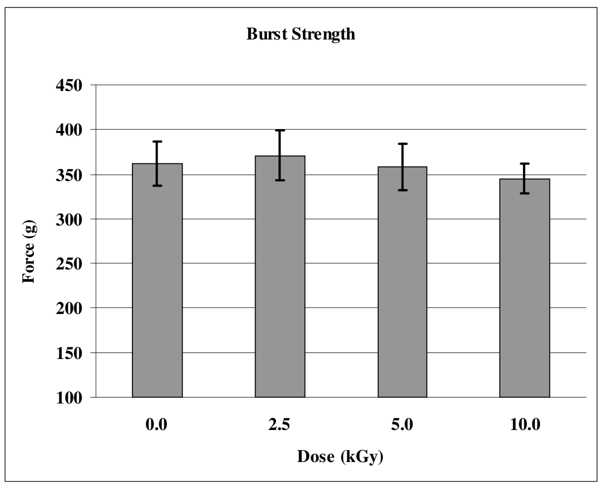

Figure 1. Influence of different radiation doses on burst strength of rice paper sheet.

4. CONCLUSION

From this study, we concluded that gamma irradiation could be applied as a successful decontamination method assuring total fungal elimination. Minimal adverse changes in physical characteristics were found. Burst strength remained similar under the conditions assayed and color measurement indicated a significant difference with 5.0 kGy and 10.0 kGy. Additional studies with an intermediate dose between 5.0 kGy and 10.0 kGy could verify the same effect on fungal control, reducing processing costs and preventing undesirable changes on physical features.

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