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APPLE PORRIDGE SUBMITTED TO GAMMA RADIATION FOR SHELF-LIFE EXTENDED

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ABSTRACT

Among various apple products, apple porridge is a much consumed product, not only for babies, but also for adults. It is a practical, healthy and tasty product that can be consumed throughout the day. However, it is an extremely perishable product. Therefore, the aim of this work was to evaluate the shelf-life period of apple porridge after the application of gamma radiation as a conservation technology. After the formulation of apple porridge was developed, which was subjected to gamma radiation at the dose of 1kGy in a dose tax of 0.356kGy.hour^{-1} and compared this treatment with the control (0kGy). From the results presented, it can be concluded that the period of conservation of apple porridge submitted to gamma radiation is 30 days. From the 60th day, the samples showed microbial growth, not being accepted for consumption. In comparison to the control, the use of gamma radiation was promising, since the standard sample showed contamination before 30 days. By the results it can be concluded that the dose used was adequate for the conservation of this product for the period evaluated.

1. INTRODUCTION

The cultivated apple tree is a complex hybrid, whose scientific name is *Malus domestic* belongs to the family of Rosaceae, subfamily Maloidae (Pomoidae). Apples should be harvested when they reach the commercial maturation stage, characterized by the stage of development in which the fruit has the desired quality characteristics for consumption [1].

The center of origin is in the Caucasus region, the mountain chain of Asia and the east of China who is the higher producer in world [1]. However, high production still faces problems such as deficiency in storage and transportation, especially in the post-harvest period, which promotes increased losses and manufacturing is a good option to promote increase of shelf life [2].

The apple is one of the most appreciated fruits in the world; in addition to 85% water, contains 12% sugar, organic acids, pectin, tannin, vitamins B1, B2, PP, C, E and provitamin A. Its pleasant aroma is the result of an essence in the bark. Refreshing by its abundant juice, slightly acidic, stimulates the digestive glands and protects the gastric mucosa. It is an excellent complementary food that especially favors the assimilation of calcium. The apple, for its recognized antioxidant properties, has numerous uses [3].

According to the same author, the apple contains a type of complex carbohydrate, the pectin, which forms the fibers of the fruit and which, once dissolved in water, produces a gelatinous, viscous mass that absorbs the bile acids in the digestive tract, decreasing them together with the feces. Thus, since bile acids are not recycled into the digestive tract, the body mobilizes cholesterol to form new bile acids, which are essential in the metabolism of fats and cholesterol, thereby reducing the body's cholesterol level [3].

The fruit processing becomes an interesting option to minimize this situation, because when elaborating pulps; juices and/or nectars applying conservation treatments and a suitable packaging, it increases the shelf life of the product, besides unifying the facilitate storage, distribution and consumption [2].

Some studies have shown an increase in the consumption of juices and fruit products in recent years, due to factors such as practicality, nutritional value and health concern, there is still a shortage of fruit products in the market. However, due to the diversity of fruits in the country and cultural miscegenation, there is demand for diversified flavors [4].

There is no regulation in Brazil that predict porridge production, but there is a regulation for fruit pulp that is defined like the non-fermented, non-concentrated, undiluted product obtained from pulpy fruits, using a suitable technological process, with a minimum total solids content, from the edible part of the fruit. The minimum content of total solids will be established for each specific fruit pulp. [5].

For MAPA (Ministry of Agriculture Livestock and Food Supply) there is a definition for apple juice that is the product defined in art. 18 of Decree No. 6.871, 2009, obtained from the edible part of the apple (*Pyrus malus* L.), by means of an appropriate technological process, obtained from the ripe and healthy fruit or vegetable part of origin, by means of an appropriate technological process of color, aroma and flavor characteristic of the fruit, submitted to treatment that ensures its preservation and presentation until the moment of consumption [6].

Conservation method is the set of standards or processes with a view to prolonging the durability of products and maintaining their characteristics.

Irradiation is an excellent method of food conservation, as well as reinforces the action of other applied processes for the same purpose. Irradiation satisfies completely the objectives of giving food nutritional stability; sanitary conditions and along shelf life [7, 8].

The great advantage of the process is the elimination of pathogens and other microorganisms that deteriorate the food, and can be used to eliminate insects and delay the germination process in plant products [9].

In a research, Harder et al. (2009) concluded that the irradiation did not induce significant alterations in the physicochemical and sensorial characteristics of kiwi nectar, with the exception for total ascorbic acid at doses of 1.0 and 2.0 kGy [10].

The shelf life definition is derived from stability studies that provide evidence of how the quality of a product varies over time under the influence of various factors such as microbial contamination or physicochemical instability [11].

Because of this, the aim of this work was to evaluate the shelf-life period of apple porridge after the application of gamma radiation as a conservation technology by changes in microbiologic and physicochemical quality attributes.

2. MATERIAL AND METHODS

2.1. Porridge preparation

The apple used for the experiment was obtained in the local commerce of Piracicaba.

The fruits were forwarded at Food Technology laboratory at Fatec Piracicaba and which before the despoliation occurred the sanitization of the fruit, then undergoing the process of cutting and removing the inedible parts and taken to the blender, where it was processed until homogeneous.

The apples were cleaned with chlorine, peeled and chopped into cubes, the peels were separated to make jelly and the apples were weighed on the scale, peeled and chopped. The apples were cooked in water and added rice flour to thicken. The bottles and lids were sanitized for packaging.

And after, for the preparation of the apple porridge, 2,500 kg of apple pulp was used and mixed with water and 12% of sugar, adapted of [12].

Then the porridge was bottled in sterilized glass bottles (150 ml) in boiling water and the vessel was subjected to steam exhaustion to keep the vessels hermetically sealed and subjected to vacuum.

2.2. Porridge irradiation

The apple porridge samples were submitted to gamma radiation by the used of the Gammacell 220 Excel irradiator, MDS, Nordion, by Cobalt 60 source (60Co), located at the Center for Nuclear Energy in Agriculture (CENA/USP) was used to treat the samples. The doses 0 and 1kGy were used, under a dose rate of $0.712 kGy.h^{-1}$.

Dosimetry was performed using 5-mm-diameter alanine dosimeters (Bruker Instruments, Rheinstetten, Germany), and the free radical signal was measured with Bruker EMS 104 EPR Analyzer.

The actual dose was within 0.02 of the target dose. Samples were turned 360° continuously during the irradiation process to achieve uniform target doses and the non-irradiated control was placed outside the irradiation chamber to have the same environmental temperature effect as that of their radiated sample.

The samples were analyzed at 2 different times 0 and 120 days after irradiation with (60Co).

Both analysis were realized according to normative instruction no. 37/2018 and RDC 12/2001 [6, 13].

2.3. Counting of mold and yeast

The counts of molds and yeasts were carried out using growing medium sabouraud agar and incubation at 21° C for 3 to 5 days [14].

2.4. Determination of coliform group (MPN)

For the MPN (most probable number) determination, was used a fermentation method in multiple tubes. In the first series of 3 tubes of lactose broth 1 ml of the 10-1 dilution was inoculated and in the second and third series 1 ml of the dilutions 10-2 and 10-3, respectively.

The tubes were incubated at 35° C for 48 hours. Tubes with positive results should be inoculated in lactose broth - bright green-bile 2% and incubated at 35° C for 48 hours. The determination of the MPN of coliform bacteria was made from the number of positive tubes with the aid of the Hoskins Table [14].

2.5. Physicochemical analysis

Analyzes of pH, total acidity and tenor of soluble solids were performed according to AOAC methodology (1995) [15].

3. RESULTS AND DISCUSSION

Table 1 shows the results data obtained in the MPN analysis of the apple porridge samples with increasing doses of gamma radiation (60Co).

Table 1: Results of coliform bacteria (MPN) and total counting mold and yeast of apple porridge sample

Dose (kGy)	Coliform (MNP)	Total mold and yeast (CFU)
Time 0		
0 kGy (Control)	$<1.0 \times 10^{-1}$	2 CFU
1 kGy	$<1.0 \times 10^{-1}$	< 1 CFU
Time 120 days		
0 kGy (Control)	Deteriorated sample	Deteriorated sample
1 kGy	$< 1.0 \times 10^{-1}$	2 CFU

The apple porridge samples was being in accordance with the microbiological standards established by RDC 12/2001 at the last day, that did not occurred with the control [13].

These results obtained were presented higher values than the values obtained by Cubas and Torres (2019), who found 10 CFUs in yellow dragon fruit nectar that be submitted to UV irradiation for increased shelf life, showed that the gamma radiation high efficiency [16].

Using gamma radiation to treat raspberries, Gimarães et al. (2013) found that irradiation reduces weight loss and filamentous fungi and yeast count with doses of 1.0 and 2.0 kGy. This conclusion confirm the results of this research that found the control of these microorganisms with 1.0 kGy dose [17].

Table 2 shows the average data obtained in the analysis of hydrogenionic potential (pH); total acidity and tenor of soluble solids, in samples of apple porridge samples with increasing doses of gamma radiation (60Co).

By the results of the Table 2 we can observed that values practically did not differ between the control and the sample irradiated.

Table 2: Average values found for analyzes of pH, Total acidity and Tenor of Soluble solids in apple porridge irradiated samples

Dose (kGy)	pH	Total acidity ($g.100g^{-1}$ expressed in citric acid)	Tenor soluble solids (°Brix)
Time 0			
0 kGy (Control)	3.04	0.1	11.8
1 kGy	3.17	0.1	12.5
Time 120 days			
0 kGy (Control)	Deteriorated sample	Deteriorated sample	Deteriorated sample
1 kGy	3.27	0.11	11.9

The results obtained meet the requirements described in Brazilian normative instruction 37/2018, which presents a minimum values of 4.0 for pH; 0.1 for Total acidity (g.100g^{-1} expressed in citric acid) and 9.0 for tenor of soluble solids [6].

But these values did not allowing with Cubas and Torres (2019) that found values like 3.6 for pH; 0.18 g.100g^{-1} for total acidity and 13.0 for tenor of soluble solids, that they are a little discrepant with the values found in this research [16].

And the results are in disagree too with Harder et al. (2009), for kiwi nectar irradiated they found values of 3.0 for pH; 8.8 g.100g^{-1} for total acidity and 16.7 for tenor of soluble solids [10].

Even so all values are in according with Brazilian normative instruction that regulate the norms and standards for this kind of product like nectars and juices.

3. CONCLUSIONS

By the results it can be concluded that the dose used was adequate for the conservation of this product for the period evaluated reaching the aim.

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