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Nutritional composition of green banana flour irradiated (gluten-free)

M.S. Taipina[a,]*, M.L. Garbelotti[b], L.C.A. Lamardo[b], C.S. Balian[c]

[a]*Energy Research Institute and Nucleares-CNEN/SP. Rua Fradique Coutinho 781apt 122 CEP 05416-011.*
[b]*Institute Adolfo Lutz - BQ. Av. Dr. Arnaldo, 355, São Paulo, SP, Brazil.*
[c]*Faculty of Veterinary Medicine and Animal Science --FMVZ São Paulo, Av professor Dr. Orlando Marques de Paiva, São Paulo, SP, Brazil.*

*Corresponding author; Energy Research Institute and Nucleares-CNEN/SP. Rua Fradique Coutinho 781apt 122 CEP 05416-011.

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ABSTRACT

The green banana flour (Musa spp.) was treated with gamma irradiation at doses 1.0 and 3.0 kGy and its changes were evaluated in relation to vitamin B1 and C content, besides nutritional properties. Vitamin B1 was determined using fluorescence quantification produced by thiochrome compound. Vitamin C was determined by UV/VIS spectrophotometric method. The physicochemical analyses were performed by standard methods. No loss of vitamins B1 and C was found at assayed γ-irradiation doses. Also, there is no considerable difference for physicochemical properties of the Brazilian green banana flour. As it was showed, the nutritional value of irradiated food is preserved. Then, the application of the irradiation technology for food may be recommended.

1. Introduction

Banana fruit is one of the economically most important fruits produced and consumed in the world. In addition, it has a high energetic value, in the range of 90–100 kcal per 100 g edible. However, the fruit composition strongly depends on the cultivation (Arias et al, 2003; Davey et al., 2007). The green banana flour or green banana is a complex – carbohydrates, mainly of resistant starch (40 g ⁄100g to 60 g ⁄100g on dry basis (d.b), minerals, vitamins, fiber, total phenolics (campesterol, stigmasterol, β-sitosterol). It is a new alternative for gluten –free products used in ready to eat foods such as spaghetti with up to 15% of banana starch addition. It is well known that this fruit contains various antioxidants, such as vitamins B1, B2, C, E, and β-carotene (Lii, et al 1982; Farange&Zandoni, 2013; Haslinda, et al, 2009; Hernandez-Nava, 2009; Taipina et al, 2008; Tribess, et al 2009; Someya et al, 2002). The presence of these functional components makes regular consuption of green banana flour beneficial to the human health. It might be used the purpose of prevent or reducing high levels of cholesterol, constipation and even color cancer. The treatment for celiac disease (CD) consists of complete exclusion from the diet .That is a complicated task because wheat and the other cereals that contain gluten are widely consumed around the world and gluten -free products may be difficult to find (Farange&Zandoni, 2013).

Thiamin (B1) is essential in the carbohydrate metabolism and neural function. It is widely distributed in vegetables, fruits, yeasts, liver and cereal grain (Combs, 2008).

Vitamin C is the generic descriptor for all compounds exhibiting, qualitatively, the biological activity of ascorbic acid (L- ascorbic acid). Fruits, vegetables and meats are generally the best sources (Combs, 2008).

The literature reports, that the vitamin C content in green banana flour (cultivar Prata) is 15.12 mg/100g (Borges et al, 2009).

The presence of these functional components makes regular consuption of green banana flour beneficial to the human health. It might be used the purpose of prevent or reducing high levels of cholesterol, constipation, diabetes (rich in indigestible carbohydrates that cooperate with adequate glycemic response), and even color cancer.

Gamma irradiation is considered to be an alternative method for food preservation. It has been performed due to the need of extending the shelf - life of foods, whilst maintaining their safety and avoiding one of the main concerns: the nutrient loss. Gamma irradiation process has been compared to pasteurization, since it destroys harmful bacteria. Since irradiation does not, raise the temperature of the food being processed, nutrient losses are small and often, substantially lower than other methods of preservation, such as canning, drying, heat pasteurization and sterilization (Wood & Bruhn, 2000).

The energy of macronutrients which can be metabolized (carbohydrates, lipids, proteins) is unaffect by irradiation at doses up to 10 kGy and even considerably beyond (Wood & Bruhn, 2000; Diehl & Josephson, 1994).

Also, essential amino acids, essential fatty, minerals and most vitamins suffer no significant losses in foods irradiated under conditions of present or potential commercial application (Wood & Bruhn, 2000; Diehl & Josephson, 1994).

Vitamins have varying sensitivity to irradiation treatments and are the only components of foods that need be considered from a dietary impact standpoint (WHO, 1999).

A few vitamins especially vitamin B1 in the green banana flour, are partially lost. In general, nutrients most sensitive to heat treatment, such as the B vitamins and ascorbic acid are sensitive to irradiation (Diehl, 1994; Wood & Bruhn, 2000). Then, in addition to determining the effective ionizing radiation doses required for a proposed objective, the effects of irradiation on product chemistry and nutritional value, must also been determined (Agundez-Arvizu et al, 2006; Desmonts, 1997; Sommers et al, 2004).

In this work, the green banana flour (Musa spp.) was treated with gamma irradiation and their changes were evaluated in relation to vitamin B1 and C content, and on the physicochemical properties.

2. Material and Methods

Industrialized flour green banana found in the market, in 200g pouches were employed. Three different samples in pouches of green banana were used for vitamins B1 and C (triplicate), kept at a refrigerator (4-7ºC), before and after irradiation.

2.1. Irradiation

Irradiation was performed in a 60Co Gammacell 220 (AECL) source, dose rate about 1.96kGy/h, at doses of 1kGy and 3kGy, dose uniformity factor, 1.13. Dosimetric mappping was previously performed by Fricke dosimetry.

2.2. The physicochemical analyses

The physicochemical sample analyses were carried out in conformity with the methodologies described in IAL (2005), with the following determinations: total carbohydrates, proteins, lipids, total alimentary fiber, volatile substances and ashes. The caloric value was calculated. This value was obtained from Atwater conversion factors, with calculation of the nutrients energy: g% lipids x 9kcal; g% proteins x 4kcal and g% carbohydrates x 4kcal (De Angelis, 1977). Analysis of variance was applied and mean comparisons by Dunnett test, at error of 5%.

2.3. Vitamin b1 measurement

The determination of water soluble vitamins (B1, C) of this study was performed according to the Institute Adolfo Lutz standard methods.

The method for determination of vitamin B1 in foods was based on the quantification of fluorescence produced under standard conditions of the thiochrome compound, which originates from oxidation of thiamine in alkaline solution of potassium ferricyanide (IAL, 2005).

2.5. Vitamin C Measurement

To quantify vitamin C, the visible spectrophotometric method was used, based on the reduction of cupric ions (CONTRERAS-GUZMÁN et al., 1984).

3. Results and discussion

In the present work, the table 1 shows the results of the contents of vitamins B1 and C, for different samples of one variety of Brazilian green banana flour (Musa spp), non-irradiated (0kGy) and irradiated with 1 and 3kGy. Medium values of vitamins B1 and C followed by the same letters, on the same line, do not differ, significantly, from the control-sample, at 5% significance (error 5%). From the analysis of the present results there was no loss of vitamins B1 and C activity as a result of irradiation of green banana flours with the doses of 1 and 3kGy.

In Table 2, the results the physicochemical analysis for the irradiated and non - irradiated of green banana flour are displayed, with the following determinations: total carbohydrates, proteins, lipids, total alimentary fiber, volatile substances, ashes and caloric value (calculate). No significant difference was observed between the samples irradiated and non - irradiated concerning volatile substances, ashes, lipids, proteins, and total alimentary fiber. Only, a small difference was observed between the samples irradiated and non – irradiated, on the carbohydrates.

Also, these values did not differ over 15 % from the nutritional information values about total carbohydrates and caloric value at the analyzed products labels, i.e., varying below from 27% in relation of protein to 15% for the Alimentary fiber. This can be explained by intrinsic variability (season, country of origin, ripeness, freshness) (Sundl, 2007).

The findings of this study corroborate data from literature. Usually, macronutrients and micronutrients are preserved under certain conditions (temperature, exclusion of air, radiation dose applied) (Diehl & Josephson, 1994; WHO 1994).

Green bananas Musaacuminata (AAA Cavendish) were processed in order to obtain flour and extract starch. The flour was subjected to gamma radiation doses of 0 (control); 1; 2; 5 and 10 kGy and the starch to doses of 0 (control); 0.5; 1.0; 1.5 and 2.0 kGy. The assessment of only irradiated flours showed that with the increase of radiation dose, there was an increase in levels of reducing sugars and total reducing sugar, water solubility index (WSI). There was also a reduction in resistant starch (RS) levels.

There was an increase in the levels of total dietary fiber (TDF) at doses above 2 kGy (Modenesei, 2011). As opposed this work, the total alimentary fiber (TDF) the values obtained are similar to the irradiated samples compared to the control sample.

Table 1

Effects of the irradiation on the vitamins B1 and C contents of green banana flour. Means (X) standard, deviations (sd) and % of activity retention.

Vitamin (mg/100 g)	0 kGy	1 kGy		3 kGy	
	Mean ± SD	Mean ± SD	Retention (%)	Mean ± SD	Retention (%)
B1	0.046 a ± 0.01	0.05 a ± 0.01	117.77	0,046 a ± 0.01	100
C	15.75 a ± 0.04	15.63 a ±0.13	99.19	15.69 a ± 0.10	99.57

n= triplicate-Means ± standard deviations and % of activity retention; Medium values followed by the same letters, on the same line, do not differ, significantly, from the control- sample, at 5% significance (error 5%).

Table 2
The physicochemical analysis of green banana flour, irradiated and non – irradiated

Nutritional Composition (g/100 g)	**0kGy**	**1 kGy**	**3kGy**
Carbohydrates	87.22a ± 0.03	87.01b± 0.01	87.06b± 0.07
Proteins	0.61a ± 0.00	0.60a ± 0.02	0.57a ± 0.02
Lipids	0.07 a± 0.00	0.07a± 0.00	0.07a± 0.00
Alimentary Fiber	1.42a± 0.04	1.45a± 0.07	1.42a ± 0.03
Volatile substances at 105ºC	10.38a ± 0.22	10.56a ± 0.11	10.4a± 0.01
Ashes	0.28a± 0.03	0.31a ± 0.02	0.44a± 0.007
Caloric value (kcal)	351.97a± 0.03	351.03a± 0.04	351.89a± 1.27

n = duplicate; a bMedium a bMedium values followed by the different letters, on the same line, differ significantly from the control-sample, at 5% significance (error 5%).

There are few experiments described so far in the literature using similar products. No work has been found regarding the variability of the content of vitamins (B1 and C) in this product, using the process of radiation.

The C vitamin content has been compatible with the values found in other flours (Borges et al, 2009).

Thiamin content in fortified corn flour (FCF) and non fortified corn flour (NFCF) showed a significant ($p < 0.05$) decrease (24% and 37%, respectively) after 90 days of storage. Storage time was slightly affected the stability of thiamin in FCF while the cooking process produced considerable losses of this vitamin (Rosado et al, 2005).

Macronutrients in irradiated foods undergo little change, and as a consequence, the normal nutritional values of proteins, lipids and carbohydrates of foods are maintained (WHO, 1981; WHO, 1994). A few vitamins, especially vitamin B1 among the water soluble vitamins, are partially lost. In general, the B vitamins and ascorbic acid, are sensitive to irradiation. This loss can be minimized by choosing the appropriate conditions, particularly the exclusion of air during irradiation and storage (Wood & Bruhn, 2000; Diehl & Josephson, 1994).

To study the effect of gamma radiation on the shelf- life extension of bananas, in the present study, the fruits were treated with three radiation doses of 0.30 kGy; 0.40 kGy and 0.50 kGy respectively and then they were stored in a dry place under room temperature conditions. (25Â±2Â°C/ 80Â± 5% RH). Total Sugar content of gamma-irradiated banana was found to be decreased abruptly due to inversion of sugar in presence of acid during storage. The fat content of gamma irradiated banana remained almost unaltered as compared to the control banana and ranged from 0.1-0.25% during the storage period (Zaman et al, 2007).

The vitamins B1 and C are known as the most radiation-sensitive of the hydro - soluble vitamins (Diehl, 1992; Wood & Bruhn, 2000).

Some authors have studied radiation effects on macronutrients in several kinds of foods. In the literature reports, that a new organic radical was induced in the conjugated protein portion of wheat flour by the gamma-ray irradiation. This indicates that a new organic radical was induced in the conjugated protein portion of wheat flour by the gamma-ray irradiation (Shymoyama et al, 2006).

Taipina, et al (2011) reported that no significant differences were observed on the nutritional properties of industrialized cookies between the samples non – irradiated and irradiated with 3 kGy. There was a significant decrease in the ascorbic acid levels on irradiated pequi fruits, proportional to the applied dose (0.4; 0.6;1kGy) compared to control (Santos, 2008).

Wheat was submitted to irradiation under different doses (0.0; 0.5; 1.0 and 2.0 kGy) and flour produced underwent physicochemical, rheological, thermal and microbiological analyses. None of the physicochemical, rheological or thermal parameters was influenced by irradiation (Singer, 2006).

4. Conclusion

From the obtained results, it is possible to conclude that no loss of vitamins B1 and C were found at assayed γ-irradiation doses. There is, also, no considerable difference for physicochemical properties of the Brazilian green banana flour, when comparing irradiated and non-irradiated samples. As it can be seen, the nutritional values of irradiated food are preserved. Considering the results obtained, the application of the irradiation technology may be recommended.

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