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The effect of gamma irradiation on the nutrional properties of sunflower whole grain cookies

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Abstract

Bakery and intermediate moisture food products like breads, dried fruit, cereals, cookies and crackers can benefit from irradiation processing. However, irradiated lipid - rich products must be assayed carefully in terms of safety, nutrition and acceptability. In the integral biscuits, the ready-to-eat industrialized sunflower whole grain cookies, the sources of vitamin E are oils, seeds, nuts and cereal grains and also, the ready- to-eat sunflower whole grains. Vitamin E represents an essential component in human nutrition required for the preservation of lipids in stable form in biological systems and also in foods. The possibility of using gamma irradiation to improve the microbiological and fungal quality of different foods has been studied and is nowadays applied commercially. Usually, macro and micronutrients, essential amino acids, essential fatty acids, minerals, trace elements and most vitamins not suffer significant losses in irradiated food process. In this work, data about on the effects of ionizing radiation on the vitamin E content and nutritional analysis (carbohydrate, proteins, lipids, alimentary fiber, volatile substances and ashes) of sunflower whole grain cookies. These samples were treated with gamma irradiation and their changes evaluated in vitamin E content and physicochemical analysis. Irradiation was performed in a ^{60}Co Gammacell 220 source at doses of 3kGy. For vitamin E (as σ-tocopherol) determination a method based on colorimetric measurements was used. The physicochemical analysis were performed by standard methods. Irradiation at 3 kGy resulted no changes in vitamin E content. Also, no significant difference was observed between the biscuits irradiated and non – irradiated for the physicochemical analysis. From the obtained results it is possible to conclude that there is a significant stability of the vitamin E content at assayed γ-irradiation dose. And also there is no considerable difference for physicochemical properties contents of sunflower whole grain cookies.

Keywords: food irradiation; food safety; ready-to-eat food.

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1.INTRODUCTION

Bakery and intermediate moisture food products like breads, dried fruit, cereals, cookies and crackers can benefit from irradiation processing. However, irradiated lipid - rich products must be assayed carefully in terms of safety, nutrition and acceptability. Bread types enriched with combinations of whole oilseeds have been readily accepted by consumers [1], their importance is related to their high content of polyunsatured fatty acids, vegetal protein, phosphorus, iron, magnesium, vitamin E, niacin, folate and phytoestrogens.

The sources of vitamin E in the diet are oils (soybean, corn, linseed, cotton, rapeseed, palm, sesame, wheat-germ, peanut, sunflower, olive), margarines (corn, soybean, sunflower), seeds (sesame, sunflower), nuts (almonds pecan, peanuts, Brazil nuts) and cereal grains (corn, rice) and also, the ready- to-eat industrialized sunflower whole grains [2][3].

Vitamin E (a family of eight natural structurally related tocopherols and tocotrienols compounds expressed as α-tocopherol) represents an essential component in human nutrition required for the preservation of lipids in stable form in biological systems and also in foods. In commonly consumed foods vitamin E appears among the main antioxidants together with vitamins A and C and minerals like copper, zinc and selenium [4]. A diet rich in antioxidants has an important role in the prevention of diseases related to oxidative stress such as Alzheimer, cancer ,among others [5].

Food irradiation has been identified as a safe technology to reduce the risk of foodborne illness as part of high-quality food production, processing, handling and preparation. Certainly, the most important benefit of gamma irradiation is improve the microbiological and fungal quality of different foods. Nowadays is applied commercially in the USA and France among other countries. The need to eliminate bacterial pathogens from ready-to-eat food products must always be balanced with the maintenance of product quality [6][7][8].

Whole grain cereals are related to good health [9]. Sunflower seed oil ranks among the best vegetable oils, typically up to 90% of their fatty acids are unsaturated and more than 90% of their vitamin E family of compounds is α-tocopherol [10]. In this work data about on the effects of ionizing radiation on the vitamin E content and nutritional analysis (carbohydrate, proteins, lipids, alimentary fiber, volatile substances and ashes) of sunflower whole grain cookies commercially found at the Brazilian market are reported.

2.MATERIALS & METHODS

In the integral biscuits, the ready-to-eat industrialized sunflower whole grain ring cookies (200 g pouches) were employed. Three different lots of biscuits were used for vitamin E (as α-tocopherol) determination and one lot for physicochemical analysis of biscuits, kept at a refrigerator (4-7ºC) before and after irradiation.

2.1 Irradiation

Irradiation was performed in a ^{60}Co Gammacell 220 (AECL) source, dose rate about 3.5 kGy/h at doses of 3kGy, dose uniformity factor, 1.13. Dosimetric mappping was previously performed by Fricke dosimetry.

2.2 Vitamin E measurement

For vitamin E (as α-tocopherol) determination a method based on colorimetric measurements [11] was chosen as recommended in the literature [12][13]. The method consists of a saponification step applied to 2-g samples of biscuits with ethanolic hydroxide potassium in the presence of pyrogalic acid, followed by a petroleum ether extraction. The extracts were thoroughly washed with water. Absorbance measurements were made at 520nm and a previously prepared calibration curve was used.

2.3The physicochemical analyses

The physicochemical sample analyses were carried out in conformity with the methodologies described in IAL (2005) [11], with the following determinations: volatile substances, ashes, lipids, proteins, total carbohydrates and total alimentary fiber. The caloric value was calculated. This value was obtained from Atwater conversion factors, with calculation of the nutrients energy: g% lipids x 9 kcal; g% proteins x 4kcal and g% carbohydrates x 4 kcal [14]. A non-parametric analysis of variance (ANOVA) was applied with mean comparisons By Dunnet test, at error of 5%.

3. RESULTS & DISCUSSION

Table 1 shows the results of vitamin E content determination in irradiated industrialized sunflower whole grain cookies for the 3 different lots of samples, non-irradiated and irradiated with 3 kGy. The total amount of tocopherol expressed as α-tocopherol was found to be about 10 mg/100 g for all samples. As can be see there was no loss of vitamin E content as result of gamma irradiation at 3 kGy.

Table 1. Effects of irradiation on the vitamin E content of sunflower whole grain cookies, Means (X) ± standard deviations (sd), and % of activity retention

Sample	**Vitamin E (mg/100g)**		
1st lot	0 kGy	3 kGy	% Retention
1	11.62	11.15	
2	12.27	12.15	
3	11.77	11.35	
X	11.88	11.55	100.31
σ	0.34	0.53	
2st lot			
4	8.95	8.80	
5	9.92	8.78	
6	7.95	9.45	
X	8.94	9.01	102.53
σ	0.98	0.38	
3st lot			
7	8.32	8.27	
8	9.85	9.5	
9	9.95	11.1	
X	9.37	9.62	102.47
σ	0.91	1.41	

In Table 2 are displayed the results for the irradiated and non – irradiated cookies with the following determinations: volatile substances, ashes, lipids, proteins, total carbohydrates and total alimentary fiber and these values did not differ over 10% from the nutritional information values at the analyzed products

labels, i.e., varying from 2% in relation to the caloric value to 9.3% for the food fiber. No significant difference was observed between the samples irradiated and non – irradiated

Table 2. The physicochemical analysis of sunflower whole grain cookies irradiated and non – irradiated

Nutritional Compositional (g/100 g)	**Sunflower whole grain cookies**		
	0 kGy	**3 kGy**	**p**
Carbohydrates	55.6[a] (0.13)	56.00[a] (0.11)	0.071
Proteins	10.96[a] (0.34)	11.15[a] (0.18)	0.597
Lipids	19.19[a] (0.11)	19.19[a] (0.04)	0.891
Alimentary Fiber	7.12[a] (0.07)	6.51[a] (0.13)	0.133
Volatile substances at 105ºC	2.11[a] (0.01)	2.14[a] (0.00)	0.074
Ashes	5.08[a] (0.08)	5.07[a] (0.00)	0.500
Caloric value (kcal)	4.39[a] (2.12)	4.41[a] (0.00)	0.103

n = duplicate

[a] Medium values followed by the same letters, on the same line, do not differ significantly from the control- sample at 5% significance (error 5%), (Dunnett Test).

( ) standard deviations

Some authors also reported that no significant differences were observed in α–tocopherol loss from the irradiation with different dose rates of pure sunflower oil, total dose of 1 kGy [15]. Studies on the E vitamer content in foods emphasize the vast differences of bioactivities of individual E vitamers confirming the need for analyse of food consumed in specific studied populations [16]. Also, there are substantial differences in calculated /measured vitamin E content of foods, explained by intrinsic variability (breeding, season, country of origin, ripeness, freshness), and should be taken into account when interpreting data of dietary intervention studies [17].

There is general agreement that the metabolizable energy of macronutrients(carbohydrates, lipids, proteins) is unaffected by radiation doses up to 10 kGy and even considerably beyond. Usually, macro and micronutrients, the essencial aminoacids, essencial fatty acids, minerals, trace elements and most vitamins undergo suffer no significant losses in food irradiated under conditions of actual or potential commercial application [18][19]. The findings of this study corroborate data from literature.

When whole-grain cereals (wheat, rice and rye) were irradiated at 0.1 - 1 kGy, no losses of unsaturated fatty acids were observed. Only small losses were found even at the very high dose of 63 kGy [20].

4.CONCLUSION

Irradiation at 3 kGy resulted no changes in vitamin E content, measured as σ-tocopherol equivalents by a colorimetric method. From the obtained results it is possible to conclude that there is a significant stability of the vitamin E content at assayed γ-irradiation dose. And also there is no considerable difference for physicochemical properties contents in the Brazilian ready-to-eat sunflower whole grain cookies.

REFERENCES

- [1] Skrbic, B. & Filipcev, B. 2008. Nutritional and sensory evaluation of wheat breads supplemented with oleic-rich sunflower seed. Food Chemistry, 108, 119-129.
- [2] USDA NUTRIENT DATABASE FOR STANDARD REFERENCE, RELEASE 19. 2006. Nuts pecan. Available in: <http://www.nal.usda.gov/fnic/foodcomp/search/> Access in: 27 ago. 2007.
- [3] Scherz, H & Senser, F. 2000. Food composition and nutrition tables. Boca Raton CRC, Fl, USA.

- [4] Wu, X.; Beecher, G.R.; Holden, J.M.; Haytowitz, D.; Gebhardt, S.E; Prior, R.L. 2004. Lipophilic and hydrophilic antioxidant capacities of common foods in the United States. Journal Agricutural Food Chemistry. 52, 4026-4037.
- [5] NIH - National Institute of Health. 2002. Diet rich in foods with vitamin E may reduce Alzeimer`s Disease Risk. NIH News Release. 301, 496-1752. http://www.nia.nih.gov.
- [6] Desmonts. M H. 1997. Les modifications organoleptiques des aliments traités par ionization. Annales des Falsifications de l'Expertise Chimique et Toxicologique, 90, 347-353.
- [7] Wood,O.B.; Bruhn, C.M. 2000. Position of the American Dietetic Association: Food irradiation (Statistical Data Included). Journal American Dietetic Association, 100 (2), 246-253.
- [8] Sommers, C.; Fan, X.T.; Niemira, B, RajkowskI, K. 2004. Irradiation of ready-to-eat foods at USDA Eastern Regional Research Center-2003 update. Radiation Physics and Chemistry, 71 (1-2), 511-514.
- [9] Knudsen, K.E.B.; Laerke, H.N. 2008. Whole grain cereals and gut health. Agro Food Industry Hi-Tech, 19 (2), 6-8,
- [10] Skoric, D.; Jocic, S.; Sakac, Z.; Lecic, N. 2008. Genetic possibilities for altering sunflower oil quality to obtain novel oils. Canadian Journal of Physiology and Pharmacology, 86 (4), 215-221.
- [11] IAL - INSTITUTO ADOLFO LUTZ. Métodos físico-químicos para análise de alimentos. IV ed., Ministério da Saúde, Brasília: ANVISA, 2005, p. 1018.
- [12] Deustsh M J. 1995. Vitamins and Other Nutrients. In: Cuniff, P. (Eds). Official Methods of Analysis of International AOAC. 16. Ed. Arlington, VA, chapter 45.
- [13] Amin, A.S. 2001. Colorimetric determination of tocopheryl acetate (vitamin E) in pure form and in multivitamin capsules. European Journal Pharmaceutics Biopharmaceutics, 51, 267-222.
- [14] De Angelis, R.C. 1997. Fisiologia da nutrição: fundamentos para nutrição e desnutrição v.1. São Paulo: EDART/Ed., Universidade de São Paulo.
- [15] Singh H . 1991. Dose rate effect in food irradiation: A review. L´ Effect debit de dose en irradiation des aliments: Un examen. Pinawa, Manitona: Whistshell Laboratories. (AECL-10343).
- [16] Franke A A,; Murphy S P.; Lacey R, Custer L J. 2007. Tocopherol and tocotrienol levels of foods consumed in Hawaii Journal Agricutural Food Chemistry. 55, 769-778.
- [17] Sundl, I.; Murkovic, M.; Bandoniene, D.; Winklhofer-Roob, B.M. 2007. Vitamin E content of foods: Comparison of results obtained from food composition tables and HPLC analysis. Clinical Nutrition, 26, 145-153.
- [18] Diehl, J. F.; Josephson, E.S. 1994.Assesment of wholesomeness of irradiated foods. Acta Alimentary, 23 (2), 195-214.
- [19] FDA- Food and Drug Administration. 1998. Food Irradiation: The treatmants of foods with ionizing radiation. available in em: http⁄⁄ www.cfsan.fda.gov⁄~dms ⁄opa-fdir.html,. Access in: 8 abr. 2009.
- [20] WHO - WORLD HEALTH ORGANIZATION. 1994. Safety and nutricional adequacy of irradiated food. Geneva, p. 138.