ISSN 1984-3011

ABRAN
ASSOCIAÇÃO BRASILEIRA DE NUTROLOGIA

International Journal of Nutrology

Ano 3 - Nº 1
Janeiro/Abril
2010

Órgão oficial de divulgação da Associação Brasileira de Nutrologia

International Colleges for the Advancement of Nutrition - ICAN/USA

Sociedad Argentina de Nutrición - SAN/Argentina

ARTIGO ORIGINAL

Stability of vitamin E content of γ-irradiated powder milk

Estabilidade do teor de vitamina E do leite em pó γ-irradiada

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ABSTRACT

Background: The technology of food irradiation is seen by the industry as a means of ensuring food safety, since it exposes foods to ionizing radiation that kills insects, moulds and bacteria. Vitamin E (α-tocopherol) is one of the most potent natural lipophilic antioxidants commonly present in the human diet. As it is considered a free radical scavenger there is a growing concern that irradiation might reduce the vitamin E content of food products prepared with ingredients rich in any of the dietary source of the vitamin. **Objective**: To describe the effects of ionizing radiation on the vitamin E content of powder milk commercially found in the market. **Material and Methods:** Three lots of the powder milk were studied. Irradiation was performed in a ^{60}Co Gammacell 220 source, dose rate of about 3.5kGy/h at doses of 1kGy and 3kGy. **Results:** There was no loss of α-tocopherol activity as a result of irradiation of the milk powder with the doses of 1 and 3kGy in all the three lots assayed, with the average perceptual activity retentions of 99.2 and 99.9 respectively **Conclusion:** We concluded that there was a notorious stability of the vitamin content of the powder milk submitted to γ-irradiation at the assayed doses.

Key words: Vitamin E; irradiation; milk.

INTRODUCTION

Vitamin E (a family of eight natural structurally related tocopherols and tocotrienols compounds expressed as α-tocopherol) is essential for human nutrition and is required for the preservation of lipids in stable form in biological systems and also in foods.[1] In commonly consumed foods vitamin E appears among the main antioxidants together with vitamins A and C and minerals like copper, zinc and selenium.[2] Antioxidants neutralize free radicals formed in the normal process of oxidation in the human body. Although the body can cope with some free radicals and needs them to function properly, an overload of them has been linked to the variety of chronic degenerative diseases. Then, a diet rich in antioxidants has an important role in the prevention of diseases related to oxidative stress.

Increased dietary vitamin E had been shown to reduce serum lipid peroxides.[3,4] A diet rich in foods containing vitamin E may help to protect against Alzheimer´s disease, cancer and coronary heart disease.[5,6,7]

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 fortificated foods.[1,8]

Under inadequate hygienic conditions, opportunistic bacteria may multiply in powedered infant formula and cause severe, often fatal neonatal infections. *Enterobacter sakasakii,* for instance, has obtained public health relevance as the agent causing neonatal meningitis, bacteremia and necrotizing enterocolitis.[9] Also, there are reports in the literature that samples of spray-dried milk powder presented *Bacillus licheniformis* and *Bacillus subtilis*.[10] The possibility of using gamma irradiation to improve the microbiological quality of different foods has been studied and is presently applied commercially in USA and France among other countries. The

need to eliminate bacterial pathogens from read-to-eat food products must always be balanced with the maintenance of product quality. In addition to determining the effective ionizing radiation doses required for pathogen elimination the effects of irradiation on product chemistry, nutritional value and organoleptic quality must also been determined.[11] The role of reactive oxygen species in ionizing radiation injury and the potential of antioxidants to reduce these deleterious effects have been studied for several decades. Naturally occurring antioxidants are considered able to behave as radioprotectors.[12] Radiation protecting properties of vitamin E has been described.[13,14]

Being the vitamin E a free radical scavenger there is a growing concern that irradiation might reduce their content on food products prepared with ingredients rich in any of the dietary source of the vitamin. Thus the objective of the present study was to determine the effects of ionizing radiation on the vitamin E content of powder milk commercially found at Brazilian drugstores.

Table1. Vitamin E content of irradiated milk powder, means (X) and standard deviations (σ), and % of activity retention

Sample	Vitamin E (mg/100g)				
1st lot	0kGy*	1kGy**	% Retention	3kGy***	% Retention
1	11.46	11.65		11.82	
2	11.46	11.46		10.97	
3	11.46	11.31		11.25	
X ± σ	11.46±0	11.47±0.17	100.11	11.34±0.4	99.01
2nd lot					
4	11.82	11.65		11,82	
5	12.15	11.47		11,47	
6	12.15	12.15		12,52	
X ± σ	12.04±0.19	11.5±0.35	97.65	11,93±0,5	99.14
3th lot					
7	12.25	12.25		12.70	
8	12.25	12.10		12.55	
9	12.25	12.37		12.04	
X ± σ	12.25±0.0	12.24±0.13	99.91	12.43±0.3	101.47

0kGy*: no gama radiation; 1kGy**: radiation dose = 1 kGy; 3kGy***: radiation dose = 3kGy. The differences between the three gama radiation doses were not statistically significant

MATERIALS AND METHODS

Material

Fortificated powder milk commercially found at Brazilian drugstores in 400 g tin can was employed. The powder contained the following ingredients (as described by the producer): light powder milk, sugar, whole powder milk, maltodextrin, shoyu, lecithin and flavoring. Three different lots of fortificated powder milk were used, kept at a refrigerator (4-7°C) before and after irradiation.

Irradiation

Irradiation was performed in a ^{60}Co Gammacell 220(AECL) source, dose rate about 3.5kGy/h at doses of 1kGy and 3kGy, dose uniformity factor, 1.13. Dosimetric mappping was previously performed by Fricke dosimetry.

Vitamin E measurement

The methodology of vitamin E determination (expressed as α-tocopherol) established by the Instituto Adolfo Lutz was followed.[15] The method consisted of a saponification applied to 3-g samples 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 520 nm and a previously prepared calibration curve was used.

Statistical analysis

The data were analysed using Anova and the significance level was set at $p < 0.05$.

RESULTS

Table 1 presents the results of vitamin E content determination of the irradiated powder milk with the gamma radiation doses of 0 (non irradiated), 1 and 3 kGy.

DISCUSSION

The present results show that there was no loss of á-tocopherol activity as a result of irradiation of the milk powder with the doses of 1 and 3kGy in all the three lots assayed, with the average perceptual activity retentions of 99.2 and 99.9 respectively in spite of vitamin E is known as the most radiation-sensitive of the fat-soluble vitamins being oils and dairy products the main sources of this vitamin.[16]

Brandstetter *et al.* (2009)[17] studying antioxidative properties of some herbs found similarly that the impact of 10kGy gamma-irradiation was insignificant and although ionizing radiation is known to generate oxygen radicals which destabilize organic molecules, radiation was unable to decrease system's antioxidant potential.

Diverse authors studied radiation effects on vitamin E containing foods. They found different results depending of the system assayed, the water activity and the radiation

conditions. Fresh skinless turkey breasts packaged in air or nitrogen gas were either irradiated (2.4 to 2.9 kGy) or not and stored at 2° C. Samples of raw and cooked turkey were evaluated by a descriptive panel. Irradiation affected color, odor, flavor, and levels of α-tocopherol levels by 33%.[18] Treatment of minced pork with a dose of 50kGy in the presence of air at ambient temperature destroyed α–tocopherol completely. When irradiation was carried out at 0°C the loss was 75%, and at 30°C it was 55%.[19] (Diehl, 1990)

In another works, no significant difference was found between vitamin E degradation in air and in nitrogen at dose rates between 1 kGy e 100kGy. No significant differences were observed in α-tocopherol loss from the irradiation of sunflower oil at total dose of 1kGy[20]. Irradiating α-tocopherol in the presence of air at 10, 50, or 100kGy produced a 51%, 78%, or 95% loss of tocopherol activity, respectively. The loss of tocopherol in oatmeal steadily increased as the irradiation temperature increased from 7% at 18°C to 46% at 50°C.

The vitamin E content of wheat was decreased by irradiation at ambient temperature in the presence of air. Oats that were packaged, irradiated at 1 kGy, and stored for 8 months under nitrogen lost only 5% of their tocopherol content compared with a 56% loss in oats irradiated and stored in air. The irradiation of hazel nuts at 1 kGy produced an 18% loss of α-tocopherol, while baking produced a 13% loss.[21]

CONCLUSIONS

There was a notorious stability of the vitamin E content, expressed as α-tocopherol, of powder milk submitted to γ-irradiation at 1 and 3kGy doses.

REFERENCES

1. Wagner KH, Kamal-Eldin A, Elmadfa I. Gamma-tocopherol - an underestimated vitamin? Ann Nutr Metab. 2004;48(3):169-88.
2. Wu X, Beecher GR, Holden JM, Haytowitz D, Gebhardt SE, Prior RL. Lipophilic and hydrophilic antioxidant capacities of common foods in the United States. J Agric Food Chem. 2004;52(12):4026-37.
3. Avula CPR, Fernandes G. Effect of dietary vitamin E on apoptosis and proliferation of murine splenocytes. Nutrition Research. 2000; 20:225-36.
4. IOM-Institute of Medicine. DRI. Dietary references intakes for vitamin C, vitamin E, Selenium and carotenoids. Washington, D.C: Academy Press, 2000, p. 186-283.
5. National Institutes of Health. Diet rich in foods with vitamin E may reduce Alzeimer's Disease Risk. NIH News Release, [2002, n. 301, p. 496-1752], http://www nia.nih gov.
6. Ferreira PR, Fleck JF, Diehl A, Barletta D, Braga-Filho A, Barletta A, *et al.* Protective effect of alpha-tocopherol in head and neck cancer radiation-induced mucositis: A double-blind randomized trial.Head Neck. 2004;26(4):313-21.
7. Maguire LS, O'Sullivans M, Galvin K, O'Connor TP, O'Brien NM. Fatty acid profile, tocopherol, squalene and phytosterol content of walnuts, almonds, peanuts, hazelnuts and the macadamia nut. Int. Int J Food Sci Nutr. 2004;55(3):171-8.
8. Ohio State University. Ohio State University Extension Fact Sheet: Human Nutrition. [Acesso: 24 ago. 2004]. Disponivel em: http://ohioline.osu.edu/hyg-fact/5000/5554.html.
9. Friedemann M. Enterobacter sakazakii in powdered infant formula. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2008;51(6):664-74.
10. Ronimus RS, Rueckert A, Morgan HW. Survival of thermophilic spore-forming bacteria a 90(+) year old milk powder from Ernest Shackelton's Cape Royds Hut in Antarctica. J. Dairy Res. 2006;73(2): 235-43.
11. Sommers C, Fan XT, Niemira B, Rajkowski K. Irradiation of ready-to-eat foods at USDA Eastern Regional Research Center-2003 update. Radiation Physics and Chemistry. 2004;71(1-2):511-4.
12. Wiess JF, Landauer MR. Radioprotection by antioxidants. Reactive Oxygen Species: From Radiation to Molecular Biology. Annals of the New York Academy of Sciences. 2000;899:44-60.
13. Kammerer C, Czernak I, Getoff N. Radiation protecting properties of vitamin E-acetate and beta-carotene. Radiation Physics and Chemistry. 2001;60:71-2.
14. Manzi FR, Boscolo FN, Almeida SMD *et al.* Morphological study of the radioprotective effect of vitamin E (dl-alpha-tocopherol) in tissue reparation in rats. Radiol. Bras. 2003;36(6):367-71.
15. Instituto Adolfo Lutz. Normas analíticas do Instituto Adolfo Lutz. Métodos químicos e físicos para análise de alimentos. IV ed. São Paulo: IAL, 2005, p.645-682.
16. Kilcast D. Effect of Irradiation on vitamins. Food Chem. 1994; 49:157-64.
17. Brandstetter S, Berthold C, Isnardy B, Solar S, Elmadfa I. Impact of gamma-irradiation on the antioxidative properties of sage, thyme, and oregano. Food Chem Toxicol. 2009;47(9):2230-5..
18. BagorogozaK, Bowers J, Okot- Kotber M. The effect of irradiation and modified atmosphere packaging on the quality of intact chill-stored turkey breast. J Food Sci. 2001;66(2):367-72.
19. Diehl JF. Safety of irradiated foods. New York, NY: Marcel Dekker,1990, p. 95-199.
20. Singh H. Dose rate effect in food irradiation: A review. L´ Effect debit de dose en irradiation des aliments: Un examen. Pinawa, Manitona: Whistshell Laboratories, Aug. 1991. (AECL-10343).
21. Thayer DW, Fox JB., Lakritz L. Effect of ionizing radiation on vitamins. In: Thorne S. Food irradiation. London: 1991, p. 286-314.

Recebido:02/01/2010
Revisado: 02/03/2010
Aceito: 06/03/2010

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