



The effects of gamma irradiation on the vitamin E content and sensory qualities of pecan nuts (*Carya illinoensis*)

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ABSTRACT

Pecan nuts (*Carya illinoensis*) were treated with gamma irradiation and evaluated for changes in vitamin E content and sensory properties. Irradiation at 1 and 3 kGy resulted in no changes in vitamin E content measured as α -tocopherol equivalents by a colorimetric method. A trained sensory panel found that irradiation at 1 kGy produced no significant changes in appearance, aroma, texture and flavor attributes. The vitamin E content of irradiated pecan nuts remained stable, but from the point of view of sensory quality a dose of merely 1 kGy can be considered as recommendable.

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1. Introduction

In Brazil, the cultivation of pecan tree was brought by North-American immigrants and it is produced in a few States, among them Amazonia. The cultivation of pecans is considered to be one way to preserve and reforest the region. Pecan nuts are rich in proteins, vitamins, especially E vitamin, carbohydrates and oil containing non-saturated fatty acids, calcium, magnesium, potassium, zinc, fibers and antioxidants.

Vitamin E (a family of eight natural structurally related tocopherols and tocotrienols compounds expressed as α -tocopherol) represents an essential antioxidant component in human nutrition required for the preservation of lipids in stable form in biological systems and also in foods. Naturally occurring antioxidants like vitamin E are considered able to behave as radioprotectors, *i.e.*, to reduce radiation deleterious effects (Weiss and Landauer, 2000; Kammerer et al., 2001).

Most individuals are believed to obtain sufficient vitamin E from dietary sources, although individuals with very low-fat diets or intestinal malabsorption disorders may require supplementation. The Brazilian Agency for Sanitary Surveillance consider 10 mg as the dietary reference intakes (DRI) for adults for vitamin E provided in Alpha-tocopherol equivalents (ATE) to account for the different biological activities of the various forms of vitamin E (ANVISA, 2005).

The possibility of using gamma irradiation to improve the microbiological and fungal quality of different foods has been studied and is presently applied commercially in USA and France among other countries. The need to eliminate undesired patho-

gens from food products must always be balanced with the maintenance of product quality. In many cases, food irradiation is limited due to fatty acid decomposition and subsequent off-flavor formation in the foodstuff (Desmots, 1997). Then, in addition to determining the effective ionizing radiation doses required for a proposed objective, the effects of irradiation on product chemistry, nutritional value and organoleptic quality must also been determined (Sommers et al., 2004).

Sensory analyses must be used to assess sensory attributes in foods that were subjected to irradiation processes. A multiple comparison or control difference test can be used for checking significant differences among samples which were subjected to different treatments when compared to a control.

In this work, data on the effects of ionizing radiation on the vitamin E content of pecan nuts commercially found in the Brazilian market are reported as well as the sensory evaluation of the irradiated samples about appearance, odor, texture and flavor.

2. Material and methods

2.1. Material

Commercially available 500 g packages of pecan nuts were used in this study. Three different lots of pecan nuts were used, kept at a refrigerator (4–7 °C) before and after irradiation.

2.2. Irradiation

Irradiation was performed in a ⁶⁰Co Gammacell 220 (AECL) source, dose rate about 3.5 kGy/h at doses of 1 and 3 kGy.

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2.3. Vitamin E measurement

For vitamin E (as α -tocopherol) determination a method based on colorimetric measurements was employed (IAL, 2005). The samples were initially crushed in a blender and then submitted to a saponification and solvent extraction. Five-grams samples were saponified with ethanolic potassium hydroxide (50 mL ethanol, KOH 1g) in the presence of pyrogalic acid (100mg) and the vitamin E extracted into petroleum ether (50 mL). The extracts were thoroughly washed with water. Absorbance measurements were made in a Hewlett Packard spectrophotometer at 520 nm using a previously prepared calibration curve.

2.4. Sensory evaluation

The multiple comparison procedure was used to evaluate sensory differences of irradiated nuts (ABNT, 1995). Thirteen trained panelists analyzed sensory attributes using a 9-point hedonic scale from 1 = none difference to 9 = extreme difference from control. The sensory profiles of non-irradiated samples were firstly judged being 1.00 in the first rank of the hedonic scores. Nuts appearance was assessed in white china plates, glass-covered, under white artificial illumination. Other attributes were evaluated in climate-controlled individual cabinets illuminated with red artificial light. Analysis of variance was applied and mean comparisons by Dunnett test, at error of 5%.

3. Results and discussion

Table 1 shows the vitamin E content for the three different samples of Brazilian pecan nuts, non-irradiated and irradiated with 1 and 3 kGy. Means within a row did not differ significantly ($p < 0.05$). The total amount of tocopherol expressed as α -tocopherol was found to be about 15 mg/100 g. As can be seen, there was no loss of its content in pecan nuts as a result of gamma irradiation with neither 1 nor 3 kGy. The literature reports discrepancies about pecan nuts vitamin E content according to different sources. Total tocopherol content of pecan nuts was described as being about 20 mg/100 g (Scherz and Senser, 2000) or 26.7 mg/100 g (USDA, 2006).

Studies on the E vitamers content in foods emphasize the vast differences of bioactivities of individual E vitamers (Franke et al., 2007). Warner et al. (2008) found that oils with the best oxidative stabilities are those which high γ -tocopherols contents. As already published (Thomas and Gebhardt, 2006), the predominant tocopherol in pecan oil is γ -tocopherol ranging up to 24 mg/100 g according to that study based on USDA (2006) data. Then, the high- γ -tocopherol content of the samples could have contributed to the present results.

Table 2 displays the sensory evaluation of irradiated pecans. Sensory panelists found no significant differences ($p < 0.05$)

Table 1
Vitamin E content of irradiated pecan nuts.

Sample	Vitamin E (mg/100 g)				
	0 kGy	1 kGy	% Retention	3 kGy	% Retention
1st lot	14.66 ^a ±0.32	14.68 ^a ±0.13	100.13	15.20 ^a ±0.67	103.62
2nd lot	16.46 ^a ±0.20	16.27 ^a ±0.22	98.86	16.57 ^a ±0.41	100.65
3rd lot	15.32 ^a ±0.29	15.52 ^a ±0.12	101.27	15.27 ^a ±0.56	99.61

Means ± standard deviations and % of activity retention.

Means within a row with common superscript not differ ($p < 0.05$).

Table 2
Sensory evaluation of irradiated pecan nuts.

Sensory attribute	Irradiation dose			LSD
	0 kGy	1 kGy	3 kGy	
Appearance	1.54 ^b ±0.10	1.62 ^b ±0.15	2.00 ^a ±0.14	0.34
Texture	1.46 ^b ±0.12	1.69 ^b ±0.19	2.13 ^a ±0.16	0.38
Odor	1.66 ^b ±0.17	1.64 ^b ±0.15	2.18 ^a ±0.16	0.40
Flavor	1.56 ^b ±0.13	2.03 ^b ±0.21	3.77 ^a ±0.21	0.48

Means ± standard deviations and the least significant differences (LSD).

Means within a row with no common superscript differ ($p < 0.05$).

between the non-irradiated and the 1 kGy-irradiated samples and “slightly different” in comparison with the 3 kGy-irradiated ones for texture, odor and flavor. The attribute flavor fostered a higher difference degree.

Investigations conducted in our laboratory have shown that gamma irradiation was highly effective against spoilage fungus of cashew nuts like *Aspergillus*, *Cladosporium*, *Penicillium*, *Curvularia* and *Emericella* (Freire and Mastro, 2000) being the reduction of fungus populations depending of the radiation dose applied and the initial load. On the other hand, radiation processing as a post-harvest quarantine control for raisins, dried figs and dried apricots showed that a dose of 1 kGy was effective with no effects on sensory (marketing) attributes (Cetinkaya et al., 2006).

As vitamin E is known as the most radiation-sensitive of the fat-soluble vitamins diverse authors had studied radiation effects on tocopherols containing foods. They found different results according to the system assayed, the water activity and the radiation conditions (WHO, 1994; Sanches-Bel, 2005). Thayer et al. (1991), for instance, reported an 18% loss of α -tocopherol of hazel nuts after irradiation with 1 kGy. Comparing with data from the literature, present results can be considered important example of retention of nut vitamin E content after irradiation.

4. Conclusions

Gamma irradiation of pecan nuts with doses of 1 and 3 kGy maintained their original vitamin E content. Overall sensory ratings for the attributes tested appear to be affected by the amount of ionizing irradiation. For pecan nuts treated under 1 kGy, there was no significant difference in relation to the control for none of the assessed sensory attributes. On the other hand, the radiation dose of 3 kGy adversely affected sensory attributes.

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