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Total phenolic compounds of irradiated chia seeds

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ABSTRACT

Chia seeds (*Salvia hispanica* L.) is a good source of oil, protein, dietary fiber, minerals and polyphenolic compounds. In order to study the influence of the processing methods on the content of phenolic compounds, the objective of this work was to evaluate the effect of gamma radiation, doses 0 (control), 5, 10 and 20 kGy, on the total phenolic compounds extracted from chia seeds. Seeds were first defatted and extracts produced with proper solvents. Total phenolic content was determined according to Folin-Ciocalteu's method and the extraction solvents applied were ethanol 100%, ethanol 70%, ethanol 50%, methanol 100%, methanol 70% and methanol 50%. When using ethanol 100%, ethanol 70 %, ethanol 50%, methanol 100% and methanol 70%, the extraction yield was independent of the absorbed dose. With methanol 50%, the irradiation process affected positively the total phenolic yield from of chia seeds. In general, the absorbed dose as well as the nature of the solvent affected the extraction yield, although in a limited manner.

Keywords: **Chia (*Salvia hispanica* L.), phenolic compounds, food irradiation.**

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1. INTRODUCTION

Chia (*Salvia hispanica* L) is an herbaceous plant of Lamiaceae family and that grown semiannually. Native from Southern Mexico and northern Guatemala [1, 2], chia is currently grown in Australia, Bolivia, Colombia, Guatemala, Mexico, Peru and Argentina. In Brazil, the regions of western Paraná state and northwestern Rio Grande do Sul state are the main producers. Inclusion of chia in the human diet contribute to human health due to their high content of essential fatty acids, dietary fiber and proteins. The chemical composition of chia seeds was reported as 15 to 25% protein, 30 to 33% oil, 18 to 30% dietary fiber, 26 to 41% carbohydrates and 4 to 5% vitamins and minerals. Most of the oil content is linolenic acid (ω-3), about 60% of total oil content, and about 20% linoleic acid (ω-6) oil [3, 4, 5].

Chia seed contain a rich pool of natural antioxidants [6, 7]. Among them, tocopherols, phytosterols, carotenoids and phenolic compounds, being the most common compounds present caffeic acid, rosmarinic acid, myricetin, quercetin, kaempferol, chlorogenic acid and 3,4-DHPEA-EDA [8, 9].

The treatment of food by ionizing radiation to promote microbiological safety and conservation is one of the most extensively studied technology, being no questions about the safety and nutritional adequacy of irradiated foods [10, 11]. Irradiation can also be used to obtain technological improvements in food materials [12].

The objective of this work was to evaluate the effect of gamma radiation, in doses of 0-20 kGy, on total phenolics extracted with two solvents in different compositions from chia seeds.

2. MATERIALS AND METHODS

2.1. Material

Chia seeds were supplied by Casa Forte Distribuidora de Produtos Alim. Ltda.

2.2. Irradiation

About 600 g of chia seeds were submitted to irradiation process in simple polyethylene bags, in a ^{60}Co source Gammacell 220, Atomic Energy of Canada Ltd (AECL), with doses of 0 (control), 5, 10 and 20 kGy. The nominal dose value in the experiments corresponds to the expected dose calculated with the certificated dose rate (Fricke dosimetry) and the radioactive decay law. The dose rate was 0.6 kGy h^{-1}. The irradiated seeds were stored at room temperature.

2.3. Chia extracts

The chia extracts were grounded in a conventional mill. The seeds were defatted by mixing with n-hexane in a proportion of 1:15 (w/v) and mechanically shacked for 6 h at room temperature. The samples were vortexed and the supernatants discarded. Extraction of phenolic compounds was carried out according Marineli et al [8] with some modifications. The phenolic compounds of chia defatted flour were extracted with ethanol/ water and methanol/ water (1 g of defatted chia flour/ 10 mL of solvent extract) in different proportions (Tab 1). The suspensions were mechanically shacked for 3 h at room temperature. The mixture was centrifuged at 3000 x g for 15 min at 25ºC ± 1ºC. The supernatant was pipetted and maintained in dark at – 18ºC ± 1ºC.

Table 1: Water solution proportions of phenolic compounds extraction solvents.

Sample	Ethanol	Methanol	Water
A	100	0	0
B	70	0	30
C	50	0	50
D	0	100	0
E	0	70	30
F	0	50	50

2.4. Total phenolic compounds

The total phenolic content of chia seed extract was determined in triplicate, by Folin-Ciocalteu's method, based on Marineli et al [8], with some modifications, using gallic acid as a standard. In a vial, 50 µL of extract, 800 µL of distilled water and 25 µL (0.25 N) of Folin-Ciocalteu's reagent

were mixed and incubated at room temperature for 3 min in the dark. Then, 100 µL of sodium carbonate solution (75 g/L water) was added and further incubated for 2 h at room temperature. The absorbance was read at 725 nm in a microplate reader SpectraMax I3, Molecular Devices. A calibration curve was made using gallic acid (5 – 1000 µg gallic acid/L water) and the results were expressed in µg of gallic acid equivalent/ mL of sample extract (µgGAE/mL).

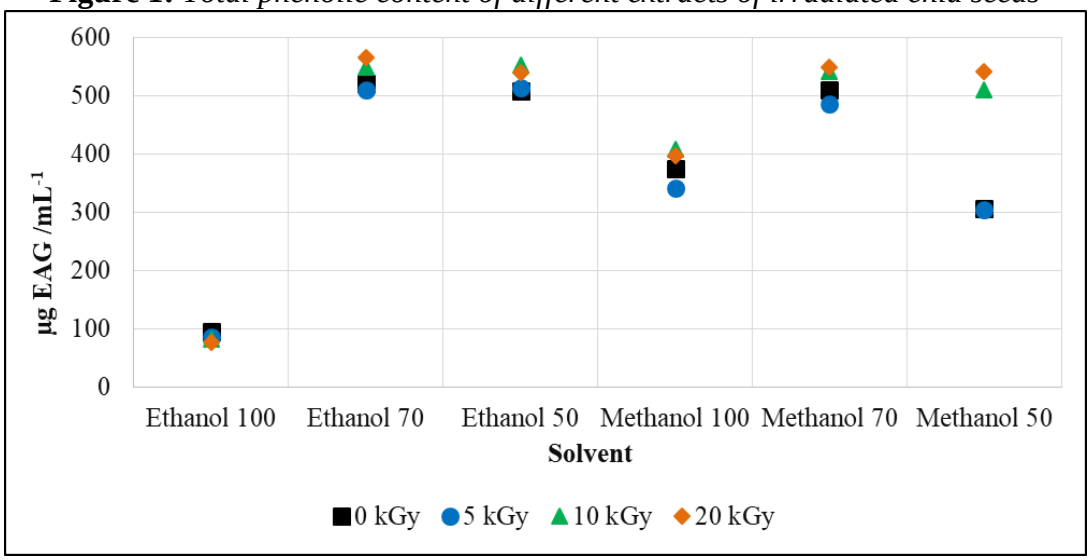
2.5. Statistical Analysis

For the statistical analysis a software GraphPad Prism 8 was employed, using ANOVA followed of Turkey's test with significance of $p \leq 0,05$.

3. RESULTS AND DISCUSSION

Phenolic compounds exhibit free radical-scavenging activities, then, stability of polyphenols is crucial for the nutritional value of foods and is directly associated with their chemical structures. In order to evaluate the effect of gamma radiation on total phenolics from chia seeds, extracted with different compositions of solvents, a calibration curve, absorbance as a function of gallic acid concentration was prepared. The values of polyphenols were expressed in Fig 1 (µg of gallic acid equivalent/ mL of sample extract).

Figure 1: *Total phenolic content of different extracts of irradiated chia seeds*



Analyzing the present results, irradiation treatment did not produce any decrease in total phenolic content extracted from defatted chia flour. Only methanol 50 % was affected positively by the absorbed irradiation dose. The values of μgGAE/mL were not affected by the absorbed irradiation dose on ethanol 100 %, ethanol 70 %, ethanol 50 %, methanol 100% and methanol 70 %.

Although standard solutions of phenolic compounds present relative thermal stability, few reports can be found in the literature trying to establish the effects of gamma and electron beam radiation on the chemical antioxidant profiles of different food products. Matsuda & Mastro [13] reported that were significant difference on irradiated polyphenol-rich propolis extracts when compare with unirradiated sample.

The methanol 50 % solvent increased total phenolic extraction when doses of 10 and 20 kGy were applied. Even though there was difference among applied doses only on methanol 50 %, aqueous dilutions showed higher efficiency when compared with undiluted methanol or ethanol. Barbi [14] obtained similar results in terms of extraction solvents for chia defatted flour extracts. Independently of the solvent employed, results of increase of total phenolic content with increasing absorbed dose are also reported on literature in variety of samples such as, stored irradiated almond hull [15], fenugreek and spinach [16] or even on medicinal plants such *Malva sylvestris* L. [17]. Alcântara et al. [18] reported a higher efficient extraction of phenolic antioxidant compounds of chia samples with a mixture of solvents.

4. CONCLUSION

The total phenolic compounds extracted from irradiated chia seeds were not affected by irradiation when using as extraction solvents: ethanol 100 %, ethanol 70 %, ethanol 50 %, methanol 100% and methanol 70 %. On the other hand, a significant increase in polyphenolics was obtained with methanol 50 %, with highest doses; then, the nature of solvents affects the extraction yield from irradiated chia seeds. Water solutions showed higher extraction yield. Irradiation did not

reduce the extraction yield in any of the systems assayed. In the present work a synergistic effect of radiation and the extraction process seems to appear.

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