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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 0-20 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.

1. INTRODUCTION

Chia (*Salvia hispanica* L) is an herbaceous plant of Lamiaceae family and that grown semi-annually [1]. Native from Southern Mexico and northern Guatemala [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

The 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, 5, 10 and 20 kGy. The dose rate was 0.6 kGy h^{-1}. The irradiated seeds were stored at room temperature.

2.3. Chia extracts

The chia seeds were ground in a conventional miller. 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 [13] 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: Extraction solvents ratio

Ethanol : water	100 : 0	70 : 0	50 : 50
Methanol : water	100 : 0	70 : 0	50 : 50

2.4. Total phenolic content

The total phenolic content of chia seed extract was determined in triplicate, by Folin-Ciocalteu's method, with some modifications, using gallic acid as a standard. In a vial, 50 mL of extract, 800 mL distilled water and 25 mL (0.25 N) Folin Ciocalteu's reagent were mixed and incubated at room temperature for 3 min. Then, 100 mL 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 (1.6 – 225 g gallic acid/L water) and the results were expressed in grams of gallic acid equivalent/ gram of sample (gGAE/g).

2.4. Statistical analysis

For the statistical analysis a software GraphPad Prism 8 was employed, and Turkey's multiple comparisons test to check significant difference between results.

3. RESULTS AND DISCUSSION

In order to evaluate the effect of gamma radiation on total phenolics extracted with different composition of solvents from chia seeds, a calibration curve, absorbance as a function of concentration of gallic acid was prepared (Figure 1). The values of polyphenols were expressed in terms of gallic acid equivalent (gGAE/g) and are presented in Figure 2.

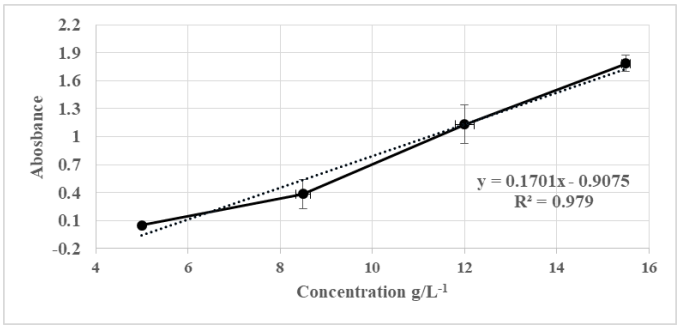

Fig 1. Absorbance vs of gallic acid concentrations g. L^{-1}.

Phenolic compounds exhibit considerable free radical-scavenging activities, then, stability of polyphenols is crucial for the nutritional value of foods and is directly associated with their chemical structures.

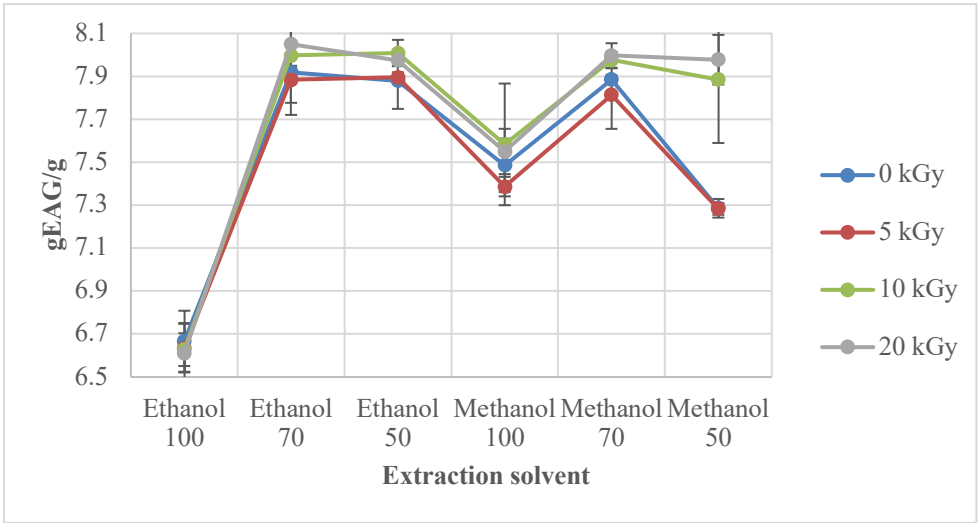

Fig 2. Total phenolic content of different extracts of irradiated chia seeds

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 gGAE/g were not affect 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 not 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 phenolics content with increasing absorbed dose are also reported on literature in a 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 high efficient extraction of phenolic antioxidant compounds of chia samples with a mixture of solvents.

4. CONCLUSIONS

The total phenolic compounds extracted from chia seeds were not affect by irradiation when using as extraction solvents ethanol 100%, ethanol 70 %, ethanol 50%, methanol 100% and methanol 70 %; on the other hand, a significantly increase in polyphenolics was obtained with the methanol 50%; then, the nature of the solvents affected 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 appeared.

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