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Evaluation of phenolic compounds in maté (*Ilex paraguariensis*) processed by gamma radiation

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ABSTRACT

The radiation food processing has been demonstrating great effectiveness in the attack of pathogenic agents, while little compromising nutritional value and sensorial properties of foods. The maté (*Ilex paraguariensis*), widely consumed product in South America, generally in the form of infusions with hot or cold water, calls of chimarrão or tererê, it is cited in literature as one of the best sources phenolic compounds. The antioxidants action of these constituent has been related to the protection of the organism against the free radicals, generated in alive, currently responsible for the sprouting of some degenerative illness as cancer, arteriosclerosis, rheumatic arthritis and cardiovascular clutters among others. The objective of that work was to evaluate the action of the processing for gamma radiation in phenolic compounds of tererê beverage in the doses of 0, 3, 5, 7 and 10 kGy. The observed results do not demonstrate significant alterations in phenolic compounds of tererê beverage processed by gamma radiation.

1. Introduction

The maté (*Ilex paraguariensis*) herb is widely consumed in South America countries (Brazil, Argentina, Paraguay and Uruguay) and its consumption has been growing all around the world markets. The dried leaves and twigs of this tree are used to prepare the two main kinds of beverages: chimarrão (infusion with hot water) and tererê (infusion with cold water). The consumption of maté in the South America reaches approximately 30% of the population which drinks more than 1 L/day of this beverage (Bastos et al., 2006a, b).

The phenolic compounds have been studied due to their influence on food quality. They are constituted by a large amount of substances, among them the phenolic acids which have antioxidant properties, as a result of their chemical structure. The maté is considered in literature as one of the best antioxidant sources. It contains substances like phenolic compounds, very active for human health. The action of these constituent has been related to the protection of the organism against the free radicals, generated *in vivo*, that they are involved in the appearance of some degenerative illnesses, as cancer, atherosclerosis, rheumatic arthritis and cardiovascular clutters among others (Bastos et al., 2006a, b; Lunceford and Gugliucci, 2005).

Radiation processing has been employed in several countries as a mean of treatment to assure microbiological safety of food. The food radiation processing has demonstrated great effectiveness against pathogenic agents with minimal nutritional and sensorial changes (Villavicencio et al., 2007; Morehouse, 2002).

The utilization of this technique has been improved in the last years. Safety and efficiency of food irradiation has been approved by several authorities as World Health Organization (WHO), Food and Agriculture Organization (FAO) and International Atomic Energy Agency (IAEA). The aim of this study was to evaluate the effect of ionizing radiation treatment on phenolic compounds of "tererê" beverage.

2. Material and methods

2.1. Material

The maté (*I. paraguariensis*) used in this work was supplied by Industry Mate Leão Junior S.A. (Paraná, Brazil) as a mixture of milled, dried green mate leaves and branches. A total of 500 g of maté was packed in polyethylene plastic bags, labelled and identified with its respective radiation dose.

2.2. Irradiation

Samples were irradiated using a multi-purpose ^{60}Co gamma ray facility installed at Instituto de Pesquisas Energéticas e

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Nucleares-IPEN/CNEN (São Paulo, Brazil). The applied doses were 0, 3, 5, 7 and 10 kGy. The dose rate was 5.0 kGy/h. Amber 3042 Batch R dosimeters were used for radiation dose measurement.

2.3. Analysis

2.3.1. Preparation of the infusions (extracts)

The extracts of tererê beverage were prepared as an infusion. A quantity of 50 mL of distilled water (10 °C) was added to 1.0 ± 0.1 g of maté. After five minutes, this mixture was filtered under vacuum into a new recipient, as adapted from Mazzafera (1997).

2.3.2. Determination of total phenolic

The total phenolic was carried out according to the method of Vinson et al. (2001). The total phenolic content was determined using the Folin-Ciocalteau reagent. Results were expressed using 5-caffeoylquinic acid as standard. Phenolic compounds were quantified by spectrophotometry (Shimadzu UV 1650-PC) at 750 nm.

2.3.3. Statistical analysis

Data were analyzed by ANOVA and Tukey's test (at significance level of 95%) using the GraphPad software.

3. Results and discussion

The total phenolic compounds content are showed in Table 1. We could observe that increasing radiation doses had no impact in phenolic compounds losses, indeed there was a slight increase in quantity of these compounds at doses of 3 and 7 kGy compared to control sample.

Despite the dose of 5 kGy also increased the concentration of phenolic compounds compared to non-irradiated samples, statistically this increase was not significant. The same happened to 10 kGy irradiated samples, where a slight decrease was detected.

The increased phenolic content in gamma-irradiated samples with 3 and 7 kGy could be attributed to the release of phenolic compounds from glycosidic components and the degradation of larger phenolic compounds into smaller ones by gamma irradiation, as described by Harrison and Were (2007).

Bastos et al. (2005) quantified the phenolic composition of 5-caffeoylquinic acid in chimarrão and tererê beverages, through the HPLC method and described a lower amount of phenolic compounds present in the tererê in relation to chimarrão. It was exhaustively explained by several authors (Bixby et al., 2005; Lunceford and Gugliucci, 2005; Menini et al., 2007) because the hot water used to make an infusion (chimarrão) extracts more compounds than cold water (tererê).

Mishra et al. (2006) using radiation doses up to 10 kGy in *Camellia sinensis* leaves, obtained similar results as this study, suggesting that irradiation treatment has a variable effect on phenolic compounds depending on radiation doses applied. Other studies that evaluated phenolic compounds in irradiated plants, also showed no significant loss of these compounds (Harrison and Were, 2007; Lee et al., 2009; Villavicencio et al., 2000).

Jo et al. (2003) irradiated green tea leaves extracts with doses up to 20 kGy and showed that this extract enhanced its color proportionally to increasing doses, but there was no difference between irradiated and non-irradiated antioxidant activity. Kim et al. (2000) showed that gamma irradiation treatment up to 10 kGy was an effective method to improve extract yields as well as reducing microbial contamination of Korean medicinal herbs.

Al-Bachir et al. (2004) demonstrated that taste, flavor, texture and color characteristics of licorice were unaffected by gamma irradiation treatment with doses up to 20 kGy. Farkas (1988) reported that the organoleptic changes on basil, dill, oregano, sage, tumeric, caraway, celery seeds, cinnamon, cloves, curry, fennel, ginger, juniper, mustard seed, nutmeg and thyme were not detectable by sensory panels up to 10 kGy.

Furgeri et al. (2007) studying the sensorial analysis in the same kind of maté samples, irradiated at doses up to 10 kGy, demonstrated that there was no difference between irradiated and non-irradiated samples.

Table 1
Total phenolic compounds present in beverage tererê.

Samples[a] (kGy)	Total phenolics (mg/mL)
Control	$2.11^{b} \pm 0.001$
3	$2.31^{c} \pm 0.001$
5	$2.18^{b} \pm 0.005$
7	$2.29^{c} \pm 0.002$
10	$2.10^{b} \pm 0.001$

Different superscripts (b and c) indicate significant difference ($p<0.05$). (Curve $y = 4.130+0.100$ $R^2 = 0.996$).

[a] Number of samples (n) = 3.

4. Conclusion

In this study, it was possible to determine that irradiation processing promoted a slight increase on total phenolic compounds at doses of 3 and 7 kGy and had no effects on total phenolic compounds concentration of 5 and 10 kGy irradiated samples.

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