2009 International Nuclear Atlantic Conference - INAC 2009
Rio de Janeiro,RJ, Brazil, September27 to October 2, 2009
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
ISBN: 978-85-99141-03-8

EFFECTS OF γ-RADIATION ON WHITE TEA VOLATILES

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ABSTRACT

Tea is the second most widely consumed beverages in the world and is processed from two and a bud of *Camellia sinensis* (L.). Depending on the processing may give rise to four mainly teas (green, black, oolong and white tea). The white tea is the one that has recently awakened interest in scientific community due the fact that this tea has more antioxidant property and activity than green tea. A further industrialization and commercialization of these plants become a problem of public health. The presence of potentially toxigenic fungi can be found in these products, indicating a great potential for the presence of mycotoxins that can cause acute and chronic effects in different organs and systems of the human body. Ionizing radiation is one of the most effective means disinfecting dry food ingredients. This treatment can inhibit cellular life division, like microorganisms, promoting a molecular structural modification. The aim of this study was evaluate the effects of radiation on volatile formation in white tea. Samples were irradiated in room temperature at ^{60}Co source Gammacell 220 (A.E.C. Ltda) at doses of 0, 5, 10, 15 and 20kGy. The volatiles organic compound was extracted by hydrodestilation and the extract was separated and identified by gas chromatography–mass spectrometry (GC–MS) analysis. The results show that the quantities of volatiles formations are directly proportional to the increase of radiation dose. About 37.86% of the compounds were stable at all radiation doses and 47.53% of new compounds were identified after irradiation.

1. INTRODUCTION

Tea is the most consumed beverage in the world after water. Annual production of dried tea leaves is estimated at 1.8 million tons, providing 40L of tea beverage per capita worldwide [1]. Tea is a significant commercial crop that grows in both tropical and sub-tropical regions, where growing conditions can be very different. Tea is processed from tender shoots (two and bud) of *Camellia sinensis* (L.) O. Kuntze. Depending on the processing may give rise to four mainly teas (green, black, oolong and white tea) [2].

The white tea is obtained by newly leaves and shoots of the plant and not suffers any processing beyond drying by the sun. Few studies have been conducted with white tea, but these studies have shown that this type of tea may have greater antimutagenic activity than green tea, due to higher concentrations of some antioxidants [3-4].

People enjoy tea for its taste and flavor. Therefore, most studies conducted on tea were investigations of taste and flavor. In the 1970s and 1980s, many researchers analyzed the flavor constituents of various tea extracts [5].

Flavor comprises principally taste and aroma. Non-volatile components are generally responsible for the taste, while volatile components give the aroma. In tea, volatile organic compounds (VOC) are present in minimum quantities, i.e. 0.01% of the total dry weight, but these have high impact on the flavor of the products due to their low threshold value and resulting high odor units. VOC of tea are classified into two groups, Group I consisting of mainly non-terpenoids, which imparts fresh green flavor and Group II of terpenoids, which imparts sweet flowery aroma to tea, viz, monoterpene alcohols such as linalool and geraniol. The presence of group II compounds is highly desirable [6-7].

The past decade had a significant increase in the use of herbal medicine. Despite lots of studies on the mycoflora in agricultural products, only a few were concerned with spices and medicinal herbs that are more and more common in our daily diet and play an important role in the economy, as green tea [8]. Some investigators reported the presence of moulds in medicinal plants, herbs and natural drugs that are widely consumed as home medicine and raw materials used for the pharmaceutical industries [9-11].

In some kinds of medicinal plants analyzed, the percentage of contamination in packed samples was higher than those non-packed and this may be due to other factors, such as, humidity inside the pack and also unsuitable methods of keeping and storing the pack [9].

Ionizing radiation is one of the most effective means to disinfecting dry food ingredients. This treatment can inhibit cellular life division, like microorganisms and promoting a molecular structural modification [12-13]. The aim of this study was evaluate the effects of radiation on volatile formation in white tea.

2. EXPERIMENTAL

2.1 Samples

The white tea was donated by HERBARIUM LABORATÓRIO BOTÂNICO LTDA. (Paraná, Brazil). The samples were packed in polyethylene bags, labeled and identified with its respective radiation doses.

2.2 Irradiation

Samples were irradiated at room temperature in a ^{60}Co source Gammacell 220 (A.E.C. Ltda) at doses of 0, 5, 10, 15 and 20kGy (dose rate of 2.38kGy/h). Harwell Amber 3042 dosimeters were used to measure the radiation dose.

2.3 Extraction of VOC by Hydrodistillation

100g of green tea plus 10µL (1µg/µL ethanol) of timol (standard) was placed in a round-bottom flask with 700mL of boiling distilled water. The contents were distilled for 60min. to collect the volatile oil. The essential oil was separated from the aqueous phase by dichloromethane (10mL) for 60min, dried over pure nitrogen flow, re-suspended with 1mL of dichloromethane and stored in a freezer (-4°C) [6].

2.4 Gas chromatography–mass spectrometry (GC–MS) analysis

The concentrated extracts were analyzed on a HP 5973 MSD detector coupled to a HP 6980 GC. A HP-5MS column (30m/0.25mm id, film thickness 0.25µm) was used with helium as a carrier gas. The injector temperature was 200°C in splitless mode. The GC oven temperature was programmed to hold at 50°C for 0.5min. and then increasing to 250°C at 5°C/min, finally holding at 250°C for 0.5min. Column flow rate was 1mL/min. Ion source temperature was 230°C and the interface temperature was set at 200°C. The MS was scanned at 70eV over 30–550a.m.u. Sample injection volume was 1.0µL.

2.5 Statistical analysis

Principal Components Analysis (PCA) was performed using the Win-Das software [14].

3. RESULTS AND DISCUSSION

A total of 103 VOC were identified after the irradiation. The white tea had a large influence from radiation, increasing 47.53% of volatiles identified in relation to control sample. From total identified volatiles, the major VOC were the compounds founded on non-irradiated samples (n=54). The dose of 15kGy produced 16.50% of new compounds, being the dose that formed more volatiles, followed by 10kGy (11.65%), 20kGy (10.68%) and 5kGy (8.74%) (fig. 1).

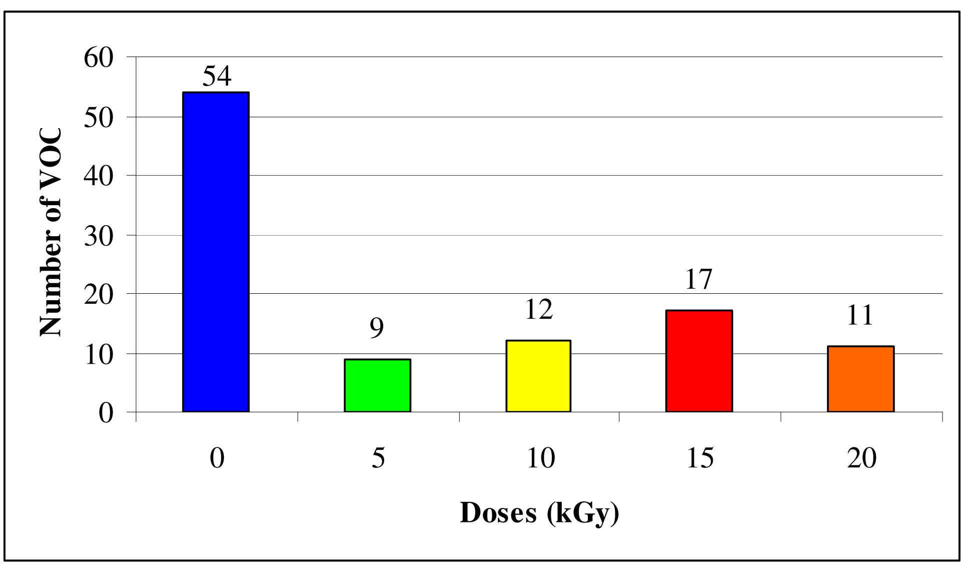

Figure 1. Number of identified VOC in white tea at different radiation doses.

The majority compounds founded on unirradiated samples were also stable when applied the radiation treatment. The major of 54 VOC founded on non-irradiated white tea, 39 VOC were stable when applied the radiation treatment. The dose of 5kGy was the dose that degraded more compounds, totalizing 18.52%, following by 20kGy (9.26%). The doses of 10 and 15kGy had no influence on VOC degradation (Fig.2).

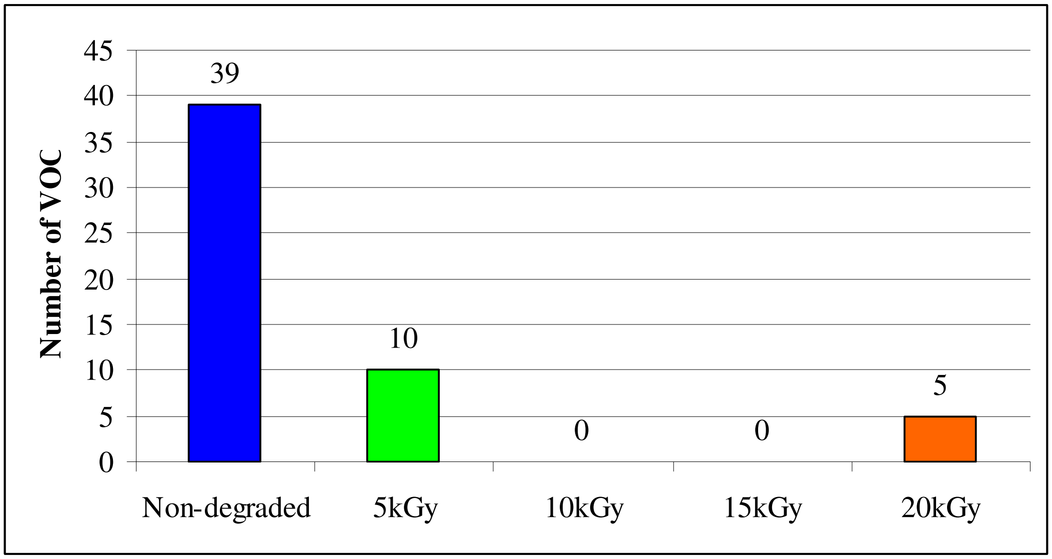

Figure 2. Number of VOC non-degraded and degraded founded at different radiation doses.

Each VOC had a different behaviour when submitted to radiation treatment. The table 1 shows this conduct of ten volatiles founded naturally in this kind of tea at different radiation doses.

Table 1. Quantity of ten volatiles organic compounds, in µg/100g of white tea leaves, identified on unirradiated and irradiated samples.

Volatile Organic Compound	Quantity (µg/100g) Doses (kGy)					Odor
	0	5	10	15	20	
2-Pentadecanone, 6,10,14-trimethyl	33,59	105,36	481,07	186,39	17,95	Fat [15]
β-Ionone	372,38	984,77	1146,59	787,04	1046,96	Seaweed, Violet, Raspberry [16]
Caffeine	5,68	22,02	47,70	142,26	362,91	-
Actinidiolide, dihydro-	217,97	428,53	596,09	534,78	641,33	-
Phenylethyl Alcohol	23,93	59,62	96,09	63,62	131,70	Honey, Spice, Rose [17]
Phytol	52,00	7,16	38,14	84,21	94,37	Flower [18]
Geranyl acetone	436,32	558,90	636,09	406,58	646,21	Magnolia, Green [15]
Linalol	174,97	294,14	389,28	210,22	485,15	Flower, Lavender [19]
Nonalactone	8,74	25,69	48,70	32,57	59,51	Coconut, Peach [20]
trans-Geraniol	115,45	120,70	258,40	89,93	60,60	Rose, Geranium [16]

Among the VOC that had its concentration increased with the radiation, the 2-Pentadecanone, 6,10,14-trimethyl showed an increase of 1,432.18% between control and irradiated sample with 10kGy as trans-Geraniol (223.82%). To β-Ionone the increase was 281.15%, as Actinidiolide, dihydro- (294.23%), Phenylethyl Alcohol (550.36%), Phytol (181.48%), Geranyl acetone (148.10%), Linalol (277.28%) and Nonalactone (680.89%) the higher increase happened between the control and 20kGy. The Caffeine compound was the volatile that had the greater increase, 6,389.26% between the control and 20kGy sample.

The increase on quantity of these volatiles is due to the fact of most VOC comes from large molecules as glycosides, while some came from products of lipids and carotenoids degradation (*2*).

The PCA showed a slight deviation from the control and 20kGy sample for the other doses. However this variation can not be considered as difference among the radiation doses and control samples (fig. 3).

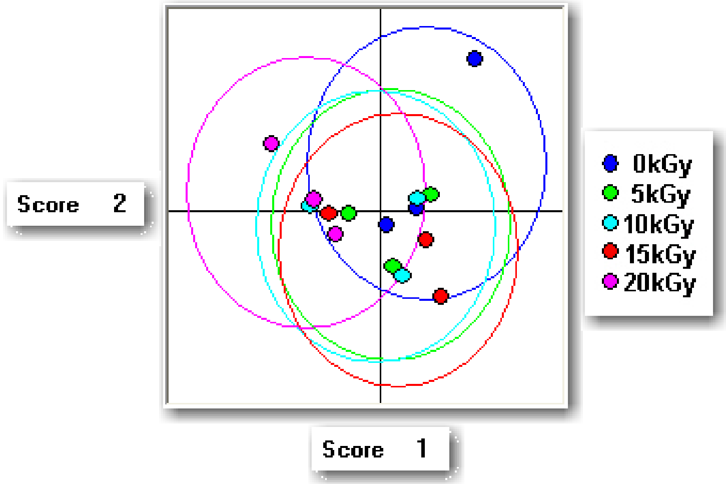

Figure 3. Principal components analysis from white tea irradiated with different doses.

Jo *et al.* (2003) irradiated green tea leaves extracts at dose up to 20kGy and showed that the extract had enhanced its colour proportional to increase dose, but there was no difference between irradiated and non-irradiated physiological activity.

Gyawali *et al.* (2006) articulated that doses up to 10kGy increased volatile organic compounds formation in onion, although observed that with 20kGy, VOC decreased 5,12% in comparison with 10kGy. Seo *et al.* (2007), using the maximum dose of 20kGy, demonstrated that the profile of volatiles composition of *Angelica gigas* (a medicinal plant) did not change with irradiation.

Furgeri *et al.* (2007) studying the sensorial analysis in maté (*Ilexis paraguariensis*) irradiated at doses up to 10kGy demonstrated that was no difference between the irradiation and non-irradiation samples. Salum *et al.* (2007) shows in their sensorial analysis that the participants had difficulties among to define the differences on odor between irradiated and the control cinnamon and nut meg.

4. CONCLUSION

The gamma irradiation had a directly influence on volatiles compounds, increasing the quantity of greater VOC, however, there was no statistical difference among irradiated and non-irradiated samples.

ACKNOWLEDGMENTS

We are thankful for IPEN, CNEN, CNPq for financial support and Herbarium Laboratório Botânico for samples donation.

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