

## PHYSICAL CHEMICAL EVALUATION OF SUGARCANE SPIRIT WITH ANATTO SUBJECTED TO GAMMA IRRADIATION FOR AGING

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### ABSTRACT

The sugarcane spirit beverage has economic and cultural importance in Brazil, and is produced by distilling the fermented sugarcane juice. The aging process, generally done in oak barrels, consists of chemical reactions which occur slowly and continuously, leading to richer and more complex flavours. Annatto, a native fruit from tropical America is used in the production of natural dyes, in the replacement for artificial colorants, especially by the food industry. Also, the beverage industry uses it to make products resembling the natural aged ones. Nowadays, modern methods use irradiation to accelerate the aging process. There are many reasons to use it in sugarcane spirit production: sterilizing the wort, changing sensory characteristics of sugarcane liquor and aging speedup. For this study, samples of sugarcane spirit were obtained at FATEC Piracicaba and annatto was added at a ratio of 3%, when using annatto seeds, and 0.25%, when using annatto extract. The samples, except the controls, were directly irradiated in polyethylene containers with doses of 200Gy and 300Gy at a rate of 0.406Gy/h. The evaluation parameters were soluble solids, pH, acidity and ashes content. For statistical purposes, the Tukey test was used with a 5% significance level. From the obtained results, the gamma radiation ages the sugarcane spirit and parameters as soluble solids and acidity can be used for aging determination. Annatto addition is allowed in the process.

## 1. INTRODUCTION

The sugarcane spirit is the first distilled drink from Latin America; it is the third distilled beverage most consumed worldwide and the first in Brazil. It is exclusively made in Brazil and produced by distilling the fermented sugarcane juice [1, 3]. The alcohol content normally is between 38% to 48% by volume at 20°C [4]. It is formed by ethanol (main component), water and other organic compounds. The secondary compounds are responsible for characteristics associated with taste and smell of drinking [2].

The sugarcane spirit aging process, usually made in oak wood, consists on chemical reactions that occur slowly and continuously, leading to richer and more complex flavours. Changes occur in the smell and taste, among other factors, due to the extraction of compounds from the wood casks. Tannins, also present on it, are responsible for darkening the beverage. In Brazil, the aging stage is not mandatory, but adds value to the final product [5].

The annatto (*Bixa orellana L.*) is a fruit from tropical America that belongs to the Bixacea family and can be used, among other activities, on the production of natural colorings. Industries, including the food industry, are using annatto as a replacement for the artificial coloring. Also, the beverage industry uses it to make products resembling the natural aged ones. For sugarcane spirit, a parameter of aging is the rich presence of tannins and annatto. Lima et al. (2006) [6] analyzed the aqueous solution from the fruit, and high concentrations of hydrolyzed tannins were detected by phytochemicals and spectroscopy tests.

The gamma irradiation has been used to accelerate the aging of distilled spirits, improve their sensory characteristics, sterilizing the wort, among others [7]. According to Miranda et al. (2006) [8] the process of sugarcane spirit aging was accelerated; which was confirmed by sensory analysis on irradiated sugarcane spirit and/or irradiated cask, with a higher approval rate.

## 2. MATERIAL AND METHODS

### 2.1. Material

Sugarcane spirit samples were obtained in FATEC Piracicaba. They were subjected to two types of treatment: 3% increment of annatto seeds and 0.25% increment of annatto extract. After it, the samples were irradiated inside polyethylene bottles with doses of 200Gy and 300Gy, at a dose rate of 0.406 Gy/h, except the control samples.

### 2.2. Methods

It was evaluated the following physical chemical parameters: soluble solids, pH, acidity and ashes content. For statistical purposes, it was used the Tukey test at 5% significance.

#### 2.2.1. Physical chemical analysis

##### 2.2.1.1. Soluble solids concentration

Measured in refractometer RT-30ATC and expressed in degrees Brix, in agreement with methodology described by AOAC [9].

### 2.2.1.2. pH

It was certain by using pHmeter MB-10, according to the recommendations of AOAC [9].

### 2.2.1.3. Acidity

It was calculated by using the potentiometric titration, according to the methodology proposed by AOAC [9], to express the acidity in tartaric acid percentage.

### 2.2.1.4. Ashes

It was used muffle furnace to incinerate the samples, which were expressed by gray content percent, according to AOAC [9].

## 3. RESULTS AND DISCUSSION

### 3.1. Physical chemical analysis

Table 1, 2 and 3 shows the statistical results obtained from soluble solids concentration, pH, acidity and ashes content values.

#### 3.1.1. Sugarcane spirit analysis

From what is shown on Table 1 it is possible to observe that the applied doses within the sugarcane spirit samples has changed the concentration of soluble solids with significant difference.

**Table 1: Means obtained in sugarcane spirit for soluble solids, pH, acidity and ashes content with increasing gamma radiation doses**

Sample	Tenor of soluble solids (°Brix)	pH	Acidity (tartaric acid (%))	Ashes (%)
Control	13.84±0.03 <sup>1a2</sup>	6.33±0.02 <sup>a</sup>	0.006±0.000 <sup>b</sup>	0.11±0.39 <sup>a</sup>
200Gy	13.50±0.06 <sup>b</sup>	5.12±0.04 <sup>b</sup>	0.060±0.000 <sup>a</sup>	0.27±0.23 <sup>a</sup>
300Gy	13.60±0.06 <sup>b</sup>	6.18± 0.26 <sup>a</sup>	0.050±0.020 <sup>a</sup>	0.13±0.11 <sup>a</sup>

<sup>1</sup> Media ± Standard Deviation

<sup>2</sup> media with different word(s) in the vertical they differ significantly at the level of 5%.

Evaluating the same table, it can be observed that pH measurement did not present relevant information. The control showed the highest value while the 200Gy sample showed the lowest statistical value. However between doses of 300Gy and control there were no

significant changes. Souza (2000) [7] reports that pH value can decrease by gamma radiation in sugarcane spirit and it may be considered an aging factor.

According to Karasz et al. (2005)[10] the aging process leads to acidity values increment. As reported (Table 1) the gamma radiation has promoted significant changes in the sugarcane spirit acidity. So, this is evaluated as a possible characteristic of aging.

For the ashes there was not significance between the treatments.

### 3.1.2. Sugarcane spirit with 3% of annatto seeds analysis

On Table 2 it is possible to observe that with the gamma radiation doses used in the samples, the concentration of soluble solids was significantly altered by it.

**Table 2: Means obtained in sugarcane spirit with 3% of annatto seeds for soluble solids, pH, acidity and ashes content with increasing gamma radiation doses**

Sample	Concentration of soluble solids (°Brix)	pH	Acidity (Tartaric acid (%))	Ashes (%)
Control	14.08±0.25 <sup>1a2</sup>	4.57±0.16 <sup>a</sup>	0.006±0.000 <sup>b</sup>	0.10±0.00 <sup>a</sup>
200Gy	13.63±0.00 <sup>b</sup>	4.67±0.22 <sup>a</sup>	0.080±0.017 <sup>a</sup>	0.13±0.23 <sup>a</sup>
300Gy	13.55±0.34 <sup>c</sup>	4.57±0.33 <sup>a</sup>	0.110±0.017 <sup>a</sup>	0.10±0.10 <sup>a</sup>

<sup>1</sup> Media ± Standard Deviation

<sup>2</sup> medias with different word(s) in the vertical they differ significantly at the level of 5%.

The pH values did not presented significant changes and regarding the acidity, the samples were in agreement with other results and Karasz et al. (2005)[10].

The ashes were maintained similar to the ordinary sugarcane samples, which did not presente difference between the samples.

### 3.1.3. Sugarcane spirit with 0.25% of annatto extract analysis

According to Table 3, it is possible to observe that the results are similar to the ones presented on Table 2.

**Table 3: Means obtained in sugarcane spirit with 0.25% of annatto extract for soluble solids, pH, acidity and ashes content with increasing gamma radiation doses**

Sample	Concentration of soluble solids (°Brix)	pH	Acidity (Tartaric acid (%))	Ashes (%)
Control	13.93±0.34 <sup>1a2</sup>	6.90±0.43 <sup>a</sup>	0.003±0.000 <sup>b</sup>	0.12±0.15 <sup>a</sup>
200Gy	13.69±0.06 <sup>b</sup>	8.82±1.50 <sup>a</sup>	0.120±0.000 <sup>a</sup>	0.17±0.06 <sup>a</sup>
300Gy	13.69±0.06 <sup>b</sup>	8.80±1.30 <sup>a</sup>	0.110±0.030 <sup>a</sup>	0.17±0.11 <sup>a</sup>

<sup>1</sup> Media ± Standard Deviation

<sup>2</sup> medias with different word(s) in the vertical they differ significantly at the level of 5%.

The pH grows significantly when compared to others treatments, however the values do not display significant differences between them.

#### 4. CONCLUSIONS

By the showed, we conclude that the gamma radiation ages the sugarcane spirit. Parameters as soluble solids and acidity can be used for aging determination. Besides, annatto addition is allowed in the process.

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