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Development and characterization of the tangerine peel liquor with different alcoholic bases

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ABSTRACT. This study aimed to produce and characterize a liquor of tangerine peel with three alcoholic bases (grain alcohol, sugar cane spirit and tangerine spirit). The physical and chemical analyses were performed relative to volatile acidity, dry extract, density and alcohol degree. The density in all samples was 1.13 g mL⁻¹, volatile acidity 48.54 g 100 mL⁻¹ for the treatment with grain alcohol, 28.43 g 100 mL⁻¹ with spirit sugar cane and 22.09 g 100 mL⁻¹ for the tangerine spirit treatment. The dry extract ranged from 431 g L⁻¹ for grain alcohol treatment, 446.26 g L⁻¹ for sugar cane spirit treatment and 443.84 g L⁻¹ for the tangerine spirit treatment, the alcohol degree ranged from 18.84, 20.01 and 19.67 °GL among the treatments. We accomplished an acceptance test through sensory analysis of the following attributes: alcoholic taste, fruit flavor, sweetness and overall impression. The liquor based on grain alcohol produced the highest mean regarding all attributes (6.32, 6.66, 6.34 e 6.26 for taste alcoholic, fruit flavor, sweetness and overall impression, respectively), but without significant difference among the treatments. In conclusion, the tangerine peel liquor made using the own fruit spirit is a viable alternative for the total use of the fruit and can be a source of income for small farmers. Nevertheless, further studies are necessary to develop of this product.

Keywords: liquor, sugar cane spirit, tangerine spirit, grain alcohol.

RESUMO. Desenvolvimento e caracterização de licor de casca de tangerina com diferentes bases alcoólicas. O presente estudo foi desenvolvido com o objetivo de produzir e caracterizar um licor de casca de tangerina com três bases alcoólicas (álcool de cereais, aguardente de cana-de-açúcar e aguardente de mexerica). Realizaram-se análises físicas e químicas em relação à acidez volátil, extrato seco, densidade e grau alcoólico. A densidade em todas as amostras foi de 1,13 g mL⁻¹, acidez volátil de 48,54 g 100 mL⁻¹ para o tratamento com álcool de cereais, 28,43 g 100 mL⁻¹ para aguardente de cana-de-açúcar e 22,09 g 100 mL⁻¹ para a aguardente de mexerica. O extrato seco variou de 431 g L⁻¹ para o tratamento com álcool de cereais, 446,26 g L⁻¹ para o tratamento com aguardente de cana-de-açúcar e 443,84 g L⁻¹ para a aguardente de mexerica, o grau alcoólico variou de 18,84; 20,01 e 19,67 °GL entre os tratamentos. Realizou-se o teste de aceitação por meio da análise sensorial dos atributos sabor alcoólico, sabor frutal, sabor doce e impressão global. O licor à base de álcool de cereais obteve as maiores médias (6,32, 6,66, 6,34 e 6,26 para sabor alcoólico, sabor frutal, sabor doce e impressão global, respectivamente) em todos os atributos, porém estatisticamente não foi encontrada diferença entre os tratamentos. Concluiu-se que o licor de casca de mexerica, fabricado com a aguardente da própria fruta, pode ser uma alternativa viável para a utilização de todas as partes da fruta, podendo ser fonte de renda para o pequeno produtor. Sendo, contudo, necessários mais estudos para o desenvolvimento deste produto.

Palavras-chave: licor, aguardente de cana, aguardente de mexerica, álcool de cereais.

Introduction

The tangerine 'Ponkan', originated in Asia, is one of the most cultivated in the world, very common in China, Japan, Philippines, India and also the most popular in Brazil (PIO et al., 2006). Brazil has designed much of the production of citrus

juice processing and although considered the largest worldwide producer of citrus with 15.9 million tons, just less than 1.3 million tons correspond to tangerines and hybrids (AGRIANUAL, 2009).

An alternative that has been developed from the early 1970 is the use of waste (mainly peels) of

certain fruit as raw material for the production of some foods perfectly able to be included in human meal. Certainly, these wastes represent an extraordinary source of materials considered strategic for some Brazilian industries (OLIVEIRA et al., 2002).

In Brazil, the waste industrialization progressed especially with vegetables, highlighting the fruit sector. The waste emergence does not only occur in the operation of the raw material (benefit) but also in various stages of canned production. The residuals compounded by peels and lump, seeds, branches etc. should be employed to produce a new product for human use (EVANGELISTA, 2003).

The craft production of liquor is an interesting alternative to provide increased household income, because the preparation requires simple technology, the final product is sold at room temperature, extending shelf-life (TEIXEIRA et al., 2005). In this context, liquor is a drink with alcohol from fifteen to fifty-four percent in volume, at twenty degrees Celsius, and a percentage of sugar more than thirty grams per liter, prepared with drinking alcohol of agricultural origin, or distilled alcohol from simple home agricultural or alcohol drinks, added to the extract substances of plant or animal origin, flavors and other additives allowed by administrative decree complement (BRASIL, 1997).

Instead of drinking alcohol in the liquor formulation we can employ simple spirit deodorized. The alcohol must be from 15 to 54% by volume (AQUARONE et al., 2001). Sugar cane spirit is defined as the alcoholic drink obtained through distilling the sugar cane or by distilling the fermented mash (wine) of sugar cane, with graduation from 38 to 54% by volume. *Cachaça* is the name of the typical and unique sugar cane spirit produced in Brazil, obtained by distilling the fermented must of sugar cane with peculiar sensory traits, with alcoholic graduation from 38 to 48% by volume (BRASIL, 2005).

This study aimed to develop tangerine peel liquor using three different alcoholic bases, check the acceptance of the products and characterize it through physical and chemical analyses.

Material and methods

Materials

Tangerine spirit production

We used the Ponkan tangerine at advanced stage of maturity purchased in Ceasa (Central Supply of Goiás SA) from Goiânia and the tangerine variety of "*fuxiqueira*" at early maturity stage purchased in the

city of Goiânia. In order to produce the pre-inoculum, we used the magnesium sulfate and ammonium sulfate, cornmeal (Paulistas Products, Brazil), wheat bran (Jasmine, Brazil), instant dry yeast (AB, Brazil Industry and Commerce) and lemon variety of China. All these ingredients were acquired in local trades of Goiânia, Goiás State, Brazil.

Liquor production

For the liquor production, we used the tangerine spirit produced in the Laboratory of Vegetables of the Federal University of Goiás (UFG) - Brazil, industrial spirits (DECAL distillery, Brazil) and grain alcohol hydrated (Celeste Farma, Brazil) refined sugar (Union, Brazil) and potable water.

Methods

Preparation of the pre-inoculum

The formulation of inoculum was 15 g of instant dry yeast, 10 g of ammonium sulfate, wheat bran, cornmeal, 2 g of magnesium sulfate, 15 mL lemon juice and 1 L of concentrated tangerine juice 7°Brix, and left to rest for 24 hours to occur the fermentation. The experiment was performed in duplicate (LIMA, 1999).

Production of the tangerine spirit

For the production of the tangerine spirit, 48.33 kg of Ponkan tangerine were weighed and washed in chlorinated water (100 ppm), peeling, liquefied and filtered into sieves. At each preparation of the fermented pre-inoculum we added 5.85 L of juice and the concentrate °Brix was adjusted from 12.5 to 14°Brix with the addition of 200 g of sugar. Twenty-four hours after the fermentation, we dropped out a total 10 L for the first distillation. The extraction of "head", "heart" and "tail" was carried out in their respective volume of 92.5, 1,020 and 92.5 mL. The procedure was performed in duplicate until getting to the final production of 2.04 L of heart, which was used as a tangerine spirit, with a 44% alcohol concentration by volume at 20°C.

Standardization of alcohol samples

Samples of tangerine spirits were produced with the standard of 44% alcohol by volume at 20°C.

The industrial spirit presented 47% alcohol by volume and the grain alcohol, 95% alcohol by volume, which were standardized with the same alcoholic degree of the tangerine spirits before using for the liquors production. The standardization was made by mass balance adding distilled water to grain alcohol.

Elaboration of liquor

Figure 1 shows the flow of liquor production.

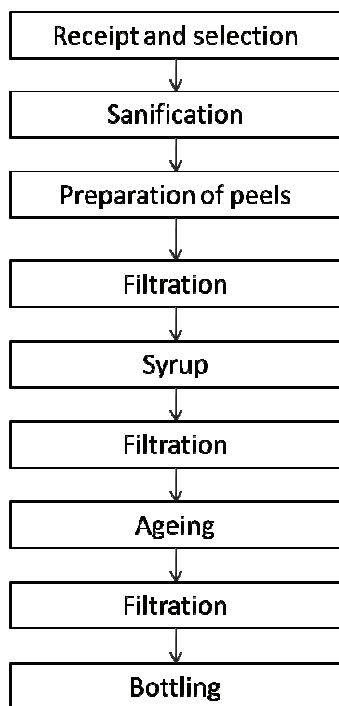


Figure 1. Flow adapted for the liquor production.

The tangerine variety of "*fuxiqueira*" at early stage of maturity were received at Laboratory of Vegetables Technology in the School Engineering of Food, Federal University of Goiás, and removed the rot and defects in the peels. They were washed to remove the soiling and then immersed in a solution of chlorinated water (100 ppm) for 30 min. to sanitization.

After the sanitization of the tangerine, the peels were manually removed and weighed in batches of 200 g to the immersion in the alcoholic bases. Triplicates were prepared for each alcohol base. To the peels batches we added 533 mL of alcoholic bases. The peels remained in infusion for 16 days.

At the end of the infusion, the volumes were filtered in cotton to remove the peels. The syrup formulation was 3 kg of sugar and 1.5 L of water, which were mixed and taken to the heating for dissolution of all the sugar and obtainment of the desired viscosity (BUSS, 1993).

After filtration, the physical-chemical analyses (volatile acidity, density, dry extract and alcohol) were performed for the three treatments and their repetition. Due to the pronounced taste of alcohol, the aging process lasted two months. The liquor was stored at pots of transparent glass, protected from

sunlight and humidity. After the aging period, the liquors were filtered to obtain a clear and pure product. The liquor was bottled in bottles of glass labeled and transparent.

The liquor made with a base of grain alcohol was called GA, liquor prepared on the basis of sugar cane sugar was called SC and liquor prepared on the basis of tangerine spirit was called TA.

Physical and chemical analyses

The physical and chemical analyses of volatile acidity, relative density and dry extract were determined in triplicate. The alcohol analysis was made in duplicate. The analyses were performed in the Laboratory of Physical Chemistry of the Federal University of Goiás, according to the methodology of the Ministry of Agriculture Livestock and Supply (MAPA, 2005). The statistical analyses applied were the analysis of variance (ANOVA) and Tukey's test, using Excel 2003 software.

Sensory analysis

The procedures were performed in the Laboratory of Sensory Analysis of the School of Agricultural and Food Engineering, Federal University of Goiás. The tasters were not trained, students and teachers, totaling 50 tasters.

The samples were served individually in disposable plastic cups of 50 mL, containing 7 mL of sample. The tasters were asked to wash the mouth after tasting each sample.

They accomplished the test of acceptance using the 9-point hedonic scale, ranging from "extremely disliked" to "extremely like" for taste alcoholic, fruit flavor, sweetness and overall impression. We asked the tasters if they appreciate liquor and if they would consume the product that was served, in case of "yes", the sample should be specified (DUTCOSKY, 1996). Statistical analyses applied were the analysis of variance (ANOVA) and Tukey's test, using Excel 2003 software.

Results and discussion

Physical and chemical analyses

The Table 1 presents the results of density, volatile acidity, alcohol and dry extract.

Concerning the density, regardless the alcoholic base, none of the treatments was different amongst themselves, probably because all alcoholic bases are not aged, since the ageing influences the enrichment of beverage components with higher density (CHAVES, 2002).

Table 1. Results of density, volatile acidity, dry extract and alcohol.

Treatment	Density (g mL ⁻¹)	Volatile acidity (g 100 mL ⁻¹)	Dry extract (g L ⁻¹)	Alcohol (% vol)
GA	1.13 ^a ± 0.01	27.09 ^a ± 13.21	430.66 ^b ± 11.26	20.12 ^a ± 1.26
SC	1.13 ^a ± 0.01	35.07 ^a ± 12.95	427.13 ^b ± 13.16	18.74 ^b ± 1.09
TA	1.13 ^a ± 0.01	36.92 ^a ± 10.56	465.30 ^b ± 22.41	19.66 ^{a,b} ± 0.70

^{a, b}equal letters in the last column means that the treatments did not differ among themselves ($p > 0.05$), by Tukey's test. The treatments: GA - tangerine peel liquor based on grain alcohol; SC - tangerine peel liquor based on industrial spirits; TA - tangerine peel liquor based on tangerine spirit.

In relation to volatile acidity, despite the difference between the samples, there was no significant difference among the treatments. This is probably because all the alcoholic bases are strong; hence we have the formation of volatile acids from the reaction of alcohols with acids, forming esters responsible for the aromatic compounds of the beverage.

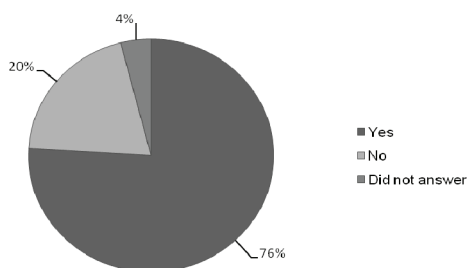
Teixeira et al. (2005) reported lower values of density and volatile acidity in the banana liquor, which was expected by the difference between the fruits (tangerine and banana).

The content of dry extract represents the mineral and organic material obtained from the evaporation of water and volatile substances, using a water-bath and posterior drying, and can be expressed in grams per liter of solution (BRASIL, 2005). The sample C (liquor with base of tangerine) presented the highest mean of dry extract probably because during the spirit distillation we added the tangerine peel that increased the extraction of dense compound of the beverage.

Despite the initial standardization of the alcohol content for all sources of alcohol used in the experiment, we observed that the alcohol content of the liquor from the industrial spirit and grain alcohol were significantly different ($p \leq 0.05$), but not different ($p > 0.05$) from the tangerine spirit.

Sensory analysis

The results were compared using an analysis of variance. For the results, we only considered the responses from tasters who appreciate liquor, from a total of fifty tasters, about 76% (thirty-eight) responded that like liquor, as shown in Figure 2.

**Figure 2.** Answers to the question: Do you like the liquor?

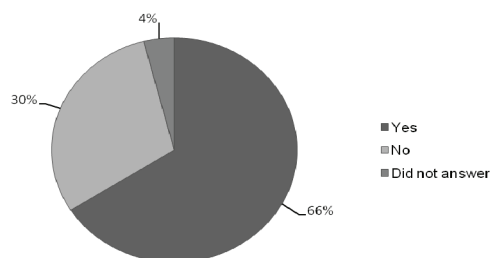
The means of the notes used for data analysis are expressed in Table 2.

Table 2. Means of the results by judges for the attributes - alcohol flavor, fruit flavor, sweetness and overall impression.

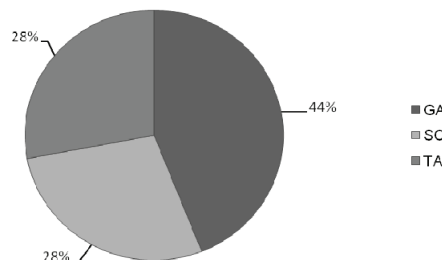
Sample	Alcohol flavor	Fruit flavor	Sweetness	Overall impression
GA	6.32	6.66	6.34	6.26
SC	6.05	5.74	5.84	5.68
TA	5.84	5.89	5.89	5.68

GA - Liquor based on grain alcohol; SC - Liquor based on sugar cane spirits; TA - Liquor based on tangerine spirit.

Figures 2 and 3 highlight the product acceptance, since 76% of consumers responded that like liquor and 66% replied that would consume one of the liquors.

**Figure 3.** Answers to the question: Would you consume any of these products?

The other results of sensory evaluation are shown in Figure 4. For these results, we regarded the responses of fifty judges who participated in this experiment. Figure 4 also indicates the greater acceptance of the sample "GA", formulated with grain alcohol, 44% of consumers responded that they would consume the sample "GA".

**Figure 4.** Answers to the question: Which of the samples would you consume?

Alcohol flavor

The samples were not statistically different concerning the alcohol flavor ($F < F_v$); at 5% level of significance. The sample with the highest mean was "GA" (6.32) and the lowest, "TA" (5.84).

According Penha et al. (2003), the judges in sensory analysis may not distinguish the taste of liquor with a variation of only 1 °GL and the variation in this study was lower than ± 0.70 °GL.

Considering that 68.42% of the answers to the sample "GA", 76.32% for the sample "SC" and 63.16% for the sample "TA", were scored above 5, or between "I liked slightly" and "I liked very much", we can infer that the samples had a good acceptance by the public regarding this attribute.

Fruit flavor

The attribute of fruit flavor also presented no significant difference among the samples ($F < F_v$), at 5% level. Treatment with the higher mean was the "GA" (6.66) and the lowest, "SC" (5.74).

We expected that the treatment "TA" produced with tangerine spirit would reach the highest mean among the three treatments, because of the additional aroma of fruit from the tangerine spirit. The sample "SC" presented the lowest mean, and this is explained by the fact that the treatment is performed with the industrial sugar cane spirit, which has its own aroma and flavor that inhibit fruit aroma.

For this attribute 71.05% of the answers to the sample "GA", 63.16% for the sample "SC" and 60.53% for the sample "TA", were scored above 5, corroborating the good acceptance of the product considering this attribute.

Sweetness

For the sweetness attribute, the results were similar to the previous results, with no significant difference ($F < F_v$), at 5% level, among treatments. The sample with the highest mean was the "GA" (6.34), and the sample "SC" had the lowest mean (5.84).

For this, 71.05% of the answers to the sample "GA", 55.26% for the sample "SC" and 65.79% for the sample "TA" was above 5.

Many judges mentioned the sweetness in excess in all the liquors, emphasizing the need to improve the product.

Overall impression

The samples presented no significant difference amongst themselves in relation to this attribute, considering the confidence level of 5%. And the sample with the highest mean was again the "GA" with 6.26, and the other samples obtained an average of 5.68.

For the overall impression, 68.43% of the notes to the sample "GA" were over 5. For the "SC" sample, 57.89%, and for the sample "TA", 50% of the scores were above 5, between "I liked slightly" and "I liked extremely."

Conclusion

The preparation of tangerine peel liquor using different alcoholic bases results in a product with particular traits, especially in relation to the dry extract, alcohol and fruit flavor.

Regarding the sensory analysis of the liquors, there is no significant difference at 5% level of significance.

The liquor based on the grain alcohol base presented the greater mean of acceptance.

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