Elaboration of Distilled Beverage from Spent Coffee Ground

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Abstract. *Spent coffee ground (SCG) is the solid residue obtained from the treatment of coffee powder with hot water to prepare instant coffee, and constitutes the main coffee industry residue. Finding alternatives for the reuse of this residue is of great interest from economical and environmental viewpoints. The goal of the present study was to use this residue as raw material for the production of a new distilled beverage. The process for elaboration of this beverage consisted in an initial extraction of the aromatic compounds from SCG with water, followed by the fermentation of this extract in a bench bioreactor and subsequently distillation of the fermented broth. The produced drink contained 40% v/v ethanol, and presented mild coffee flavor. Several volatile compounds were identified in this distillate among of which, higher alcohols were quantitatively the most abundant group. Isoamyl alcohol (3-methyl-1-butanol), isobutanol (2-methyl-1-propanol), and 2-methyl-1-butanol were the higher alcohols found in major quantities (810, 269, and 185 mg/l, respectively), contributing thus for the greatest proportion of the total aroma and essential character. Ethyl acetate and acetaldehyde, which are also volatile compounds of large influence on the flavor of alcoholic beverages, were found in SCG distillate in concentrations of 38 mg/l and 80 mg/l, respectively. On the other hand, methanol that is a compound harmful to the health was found at low level (11 mg/l). Considering the flavor, the volatile compounds present, and the ratio between isoamyl alcohol/2-methyl-1-propanol and 2-methyl-1-propanol/1-propanol, which are indicative of the quality of alcoholic beverages and have to be higher than unity, it was concluded that a novel spirit of acceptable organoleptic character can be produced by fermentation using SCG as raw material.*

Keywords. Spent coffee ground, Fermentation, Distilled beverage, Volatile Compounds.

Introduction

In the last years, an increased interest of the distillates' industry on the development of new products from different (non-usual) raw materials has been observed. Such interest is motivated by the different characteristics that these products may present, which made possible to amplify the variety of products present in the market. In this sense, the development of new beverages with natural aroma compounds has merited special attention due to the restriction of using synthetic chemical agents in food and beverages. The market of alcoholic beverages, particularly, requires the use of aroma and flavors extracts free of solvents and toxic compounds (Raventós, Duarte, & Alarcon, 2002). Such compounds may be obtained from several natural sources; and in this case, the quality of the final distillate depends on how much it is able to remind the typical flavor derived from the raw material used for its production (Dürr & Tanner, 1983).

Spent coffee ground (SCG) is the main coffee industry residue, obtained during the process for instantaneous coffee preparation. With a high annual generation in the order of 6 million of tons (Tokimoto, Kawasaki, Nakamura, Akutagawa, & Tanada, 2005), great attention has been given in finding alternatives for its reuse, both from environmental and economical viewpoints. A recent study about the chemical composition revealed that SCG is a residue rich in sugars, which correspond to almost 50% of its composition on a dry weight basis (Mussatto, Carneiro, Silva, Roberto, & Teixeira, 2011). Additionally, the presence of considerable amounts of phenolic compounds was also observed in this material. The extraction of sugars and phenolic compounds from SCG could be an interesting alternative for the valorization of this residue.

Based on the above mentioned concerns, the present study had as objective to use SCG as raw material for the production of a new distilled beverage. Such application constitutes a novelty in terms of product, since there is not any distillate produced from SCG in the market.

Material and Methods

Sugars and phenolic compounds extraction

SCG was mixed with water (1 g/10 ml) and the mixture was transferred to stainless steel reactors, which were dully covered and maintained in bath at 163 ºC during 45 min. After the reaction, the residual solid material was removed by centrifugation (6000 rpm, 15 min) and the liquid fraction was stored at 4-5 ºC for subsequent use as fermentation medium.

Microorganism and inoculum

Saccharomyces cerevisiae RL-11 was the yeast strain used in the experiments. Cultures of this yeast were maintained at 4-5 ºC in malt extract agar medium. For the inoculum preparation, cells of the yeast from the maintenance medium were transferred to 500-ml Erlenmeyer flasks containing 200 ml of the following medium (g/l): glucose (30.0), $(NH_4)_2HPO_4$ (3.0), $MgSO_4 \times 7H_2O$ (1.0), and yeast extract (3.0). The inoculated flasks were incubated at 30 ºC, 200 rpm, for 24 h.

Fermentation

To be used as fermentation medium, the liquid fraction obtained after the SCG extraction with water was supplemented with sucrose (200 g/l) and potassium metabisulphite (175 mg/l), and the final pH was adjusted to 5.5 by the addition of sodium carbonate. Fermentation runs were performed in a 6.5-L bioreactor containing 3.5 L of fermentation medium inoculated with an

initial cell concentration of 1 g/l, at 30 ºC and 150 rpm. After the carbon source exhaustion, the fermented broth was separated from the biomass by centrifugation (6000 rpm, 15 min) and the supernatant was submitted to distillation.

Distillation

During the fermented broth distillation, distilled fractions of about 20 ml were collected at different temperatures, varying between 70 and 90 ºC. All of them were analyzed by HPLC to determine the ethanol concentration present. Fractions containing between 40 and 70% v/v of ethanol were mixed to compose the SCG distillate, being the final ethanol content corrected to 40% v/v by the addition of ultra pure water.

Results and discussion

Chemical characterization of the volatile compounds present in the produced distillate (Table 1) revealed higher alcohols (isoamyl alcohol (3-methyl-1-butanol), isobutanol (2-methyl-1-propanol) and 2-methyl-1-butanol) as the most abundant group, thus being responsible for the greater proportion of the aroma of the distillate. Concentration of these compounds was similar to those found in cheese whey distillate, which contained 887 mg/L of 3-methyl-1-butanol, 542 mg/L of 2-methyl-1-propanol, and 176 mg/L of 2-methyl-1-butanol (Dragone, Mussatto, Oliveira, & Teixeira, 2009a).

Ethyl acetate and acetaldehyde, which are also volatile compounds of large influence on the flavor of alcoholic beverages, were found in SCG distillate in concentrations of 38 mg/l and 80 mg/l, respectively. This concentration of ethyl acetate is in the range (between 50 and 80 mg/L) reported to positively contribute to the final aroma of the beverages (Steger & Lambrechts, 2000). The concentration of acetaldehyde in SCG distillate is also in the range able to promote pleasant characteristics to the beverage, such as aroma of walnuts, sherry and ripe apples (Geroyiannaki, Komaitis, Stavrakas, Polysiou, Athanasopoulos, & Spanos, 2007). This concentration value was higher than that obtained in cheese whey distillate (36.7 mg/L) (Dragone, Mussatto, Vilanova, Oliveira, Teixeira, & Almeida e Silva, 2009b), but was much less than that reported for bagaceiras (600 mg/L) (Silva, Malcata, & de Revel, 1996).

Table 1. Volatile Compounds Present in SCG Distillate.

Compound	Concentration (mg/L)
3-methyl-1-butanol	810 ± 201
2-methyl-1-propanol	269 ± 64
2-methyl-1-butanol	185 ± 47
Acetaldehyde	80 ± 24
1-propanol	44 ± 5
Ethyl acetate	38 ± 9
Acetal	36 ± 7
Methanol	11 ± 3
2-phenylethanol	8 ± 3

Other volatile compounds, including 1-propanol, 2-phenylethanol, acetal, and methanol, were also identified in SCG distillate but at low concentrations. The concentration of 1-propanol can be considered relatively low and unable to affect the odor of the distillate (Fundira, Blom,

Pretorius, & van Rensburg, 2002). Concentration of 2-phenylethanol (8 mg/L) was low, and similar to the values reported for other distillates (Dragone et al., 2009a, Silva et al., 1996). Low acetal concentration in SCG distillate was expected since this compound is most commonly present in the head of the distillate (Silva et al., 1996). Finally, methanol was present in very low concentration in SCG distillate and this is a very positive aspect due to the toxicity of this compound. Methanol can be harmful to human health when present concentrations higher than 4000 mg/L.

Conclusions

Considering that relations between the compounds alcohol isoamílico/2-metil-1-propanol and 2-metil-1-propanol/1-propanol are indicative of the quality of the drink and must be greater than one unit, it can be concluded that the distilled beverage produced from spent coffee grounds has organoleptic quality acceptable for consumption and sale in the market. In addition, the presence of aroma compounds from SCG made possible obtaining a distilled beverage with specific characteristics, aroma and flavor different of those existent in the market.

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