PRODUCTION AND KINETIC ANALYSIS OF CRAFT BEER ADDED RED GUAVA

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ABSTRACT

Craft beers have a higher nutritional value than other alcoholic beverages, which is why they are increasingly gaining ground in the domestic market. The addition of other ingredients in the brewing process, such as fruit, adds bioactive compounds, increasing the nutritional value of the drink. The aim of the study was to produce fruit beer-style craft beer using red guava fruit, evaluating physicochemical parameters and fermentation kinetics. To monitor the process and determine the kinetic parameters, aliquots were collected for analysis in triplicate of pH, total soluble solids (ºBrix) and cell concentration ($g.L^{-1}$), in order to determine cell growth, substrate consumption and ethanol production. The process yield and growth rate parameters were calculated. The production of craft beer with the addition of red guava pulp and oat flakes proved to be relevant, as the parameters relating to pH and alcohol content were similar to those found in the literature. Fermentis US-05 yeast showed good compatibility with the medium and operating conditions, resulting in good productivity and higher formation rates than those found by other researchers.

Keywords: Fermentative Process. Kinetic Parameters. *Saccharomyces cerevisiae*. Craft Beer. Guava.

1 INTRODUCTION

Beer is the product of the alcoholic fermentation of brewer's wort, basically made up of barley malt, drinking water, yeast and hops, with or without the addition of brewing adjuncts such as fruit and spices.[1]. Craft beers have a higher nutritional value than other alcoholic beverages, which is why they are increasingly gaining ground in the domestic market. It contains mineral salts such as potassium, magnesium, calcium and sodium, as well as significant amounts of B vitamins.[2].

The search for healthier foods is a common concern for people, which has led to a significant increase in the consumption of fruit-based drinks and/or plant extracts. The addition of other ingredients in brewing adds bioactive compounds, increasing the nutritional value of the drink. The use of fruit incorporates various sensory characteristics into beer, altering its taste, aroma and color.[3].

The guava tree (Psidium guajava L.) is a tropical plant that belongs to the Myrtaceae family and occupies a prominent place among Brazilian fruits, due to its pleasant aroma, flavor and high nutritional value, such as vitamins A, B and C, such as thiamine and niacin, as well as phosphorus, iron and calcium content, it is also rich in fiber, riboflavin and ascorbic acid, and is rich in carotenoids, especially lycopene, an important pigment in the prevention of some types of cancer.[4,5]. The aim of this study was to produce a fruit beer style craft beer using red guava fruit, evaluating physicochemical parameters and fermentation kinetics.

2 MATERIAL & METHODS

The beer was brewed in the Food Technology Laboratory and the analyses were carried out in the Cellular and Molecular Biology Laboratory, both located in the Semi-Arid Sustainable Development Center – CDSA, of the Federal University of Campina Grande – UFCG. For this experiment, 2 kg of pilsen malt, 10 g of Hallertau Blanc hops and 11.5 g of Fermentis US-05 yeast were used. 500 g of oat flakes and 1 kg of red guava pulp were used as brewing adjuncts, for a production of 15 L of the drink.

In order to monitor the process and determine the kinetic parameters, 10 mL aliquots of the must were collected throughout the fermentation period. On the first day of fermentation, 8 samples were collected at 30-minute intervals, followed by 8 more samples at 1-hour intervals, and 4 more samples every 3 hours. Subsequently, 4 samples were taken every 24 hours. For each aliquot, pH, total soluble solids (ºBrix) and cell concentration ($g.L^{-1}$) were analyzed in triplicate to determine cell growth, substrate consumption and ethanol production.[6].

The process yield parameters were defined through kinetic studies, as a function of fermentation time, obtaining the factors that relate cell concentration and the amount of substrate ($Y_{X/S}$), cell concentration and product ($Y_{X/P}$) and product concentration to substrate ($Y_{P/S}$).[7]. Using the data collected, it was possible to calculate the speed of growth or reproduction of the microorganism (r_x) for a period of time (*t*), considering only the exponential growth period.

3 RESULTS & DISCUSSION

In the kinetic analysis of the process, shown in figure 1, it was possible to observe that the lag phase occurred in the first 4 hours; this same behavior was observed in beers with the addition of small red fruits.[8]. Then there was an exponential increase in the concentration of cells, and it was possible to observe the conversion of the fermentable sugars present in the medium. At this stage, the soluble solids content in the wort began to decrease and the ethanol content began to increase. The formation of ethanol in beer basically takes place in two stages: the first consists of the hydrolysis of starch, forming glucose and fructose, and in the second stage, glucose is converted into ethanol and CO_2 in an enzymatic reaction.[9].

It can be seen from the substrate conversion curve that when the fermentable sugars are consumed, their concentration decreases, and the product ethanol begins to be formed, with an increase in its concentration in the medium. The fermentation took a total of 100 hours and with regard to alcohol content, The product had an estimated concentration of 5.29% (ABV%), similar values were observed in craft beers with the addition of mango pulp, with an alcohol content of 5.2% to 6.5%,[10], and in beers added with passion fruit pulp from 5.0% to 5.3% and with guava pulp from 5.6% to 6.0%.[11].

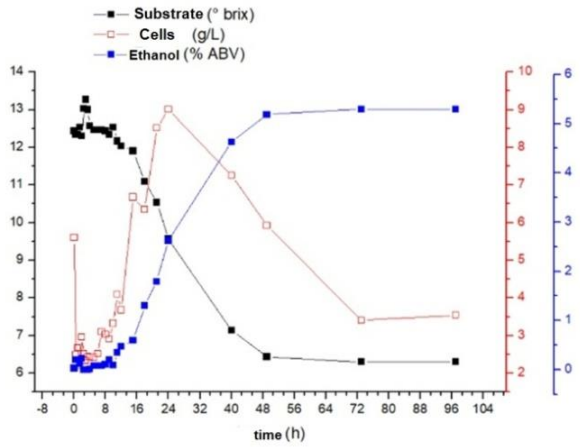

Figure 1 Fermentation kinetics for the production of craft beer with the addition of guava pulp using the yeast *Saccharomyces cerevisiae* US-05.

With regard to pH, it can be seen that in the first 16 hours the level dropped slightly from 5.57 to 4.61, and after 50 hours from the start of analysis the level remained practically constant, with a final value of 4.24. In craft beers with the addition of fruit pulp, the pH value can increase significantly depending on the acidity of the fruit, which adds a greater degree of acidity to the product.[8]. The ideal standard pH values for beer are 4.0 to 4.2,[12], so it can be deduced that the addition of guava pulp at the start of the boil gave good results in terms of this parameter.

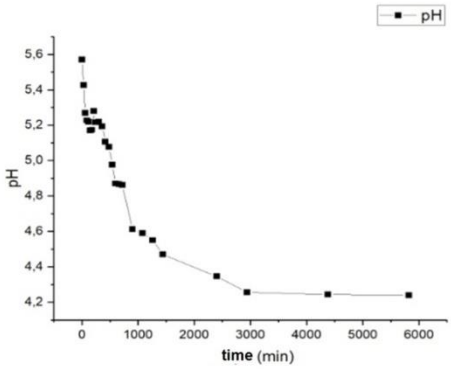

Figure 2 Graphical reproduction of the variation in pH levels .

For the substrate yield parameter in cells, the times from 4 to 24 hours were used, the period corresponding to exponential growth, and the yield achieved was 2.196 g.L^{-1}/°brix, i.e. for each unit of °brix reduced, 2.2 g of cells per liter of must were generated. The cell growth rate found was 0.363 g. L^{-1}.h, higher when compared to other Fermentis yeasts, with the rate found for Fermentis SafAle S-33 being 0.2191 g.L^{-1}.h and for Fermentis SafAle S-04 being 0.1954 g. L^{-1}.h.[13].

Regarding the cell productivity parameters, the maximum and minimum time for the interval corresponding to the exponential phase of growth were considered, thus the biomass productivity was 0.33 g. L^{-1}.h, this value is also higher than the Fermentis SafAle S-33 and Fermentis SafAle S-04 yeasts, with productivity of 0.22 g. L^{-1}.h and 0.18 g. L^{-1}.h.[13]. In order to obtain the value of the specific cell growth rate (µx), the range of data obtained between 4h and 24h of fermentation was also taken into account, and a µx value of 0.074 h^{-1} was observed, with a generation time (tg) of 9.635 hours for the *saccharomyces cerevisiae* yeast US-05.

4 CONCLUSION

The production of craft beer with the addition of red guava pulp and oat flakes proved to be relevant, as the parameters relating to pH and alcohol content were similar to those found in the literature. The Fermentis US-05 yeast showed good compatibility with the medium and operating conditions, resulting in good productivity and higher formation rates than those found by other researchers.

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