DEVELOPMENT OF CRAFT CATHARINA SOUR BEER USING KOMBUCHA AND PINEAPPLE PULP

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ABSTRACT

In Brazil, the specialty beer market points to an expansion in the consumption of styles that stand out for their acidity, such as Sour. In this sense, there is an increase in innovation, creativity and authenticity aimed at exploring and improving the potential of the drink. One of these innovations is the Catharina Sour beer, a Brazilian style that aims to unify fruit flavors with the acidity of the Sour style. With this, aiming to maintain the beer's flavor characteristics associated with the health benefits of kombucha, interest is growing in producing an acidic and potentially probiotic beer. Given the above, the objective of this work was to develop and evaluate the physical-chemical composition of a Catharina Sour beer using kombucha and pineapple pulp, with the aim of obtaining a product with sensorial quality and possible probiotic effects. The kinetics of primary fermentation was monitored in terms of parameters: pH, total titratable acidity, soluble solids and alcohol content for 192 hours. The final beer produced was analyzed for the following parameters: pH, total titratable acidity, total soluble solids, alcohol content, vitamin C and total sugars. It was observed that the final beer produced had an appearance, color, aroma, flavor and carbonation consistent with the proposed style and probiotic potential, where all parameters were within the legislation and available literature. It is concluded that kombucha scoby is a great option for acidifying the must for the production of the Catharina Sour style.

Keywords: Alcoholic beverage, *Ananas comosus*, adjunct, malt.

1 INTRODUCTION

The production of craft beer in Brazil has been expanding considerably, with different beer styles increasingly attracting consumers seeking innovative and distinctive flavors[2]. Among these styles, sour beers have been gaining interest due to their smooth taste, characterized by low bitterness and higher acidity. The Catharina Sour is the first beer style recognized by the BJCP (Beer Judge Certification Program), created in 2015 and commercially produced since 2016. Its main characteristics are its acidity and the addition of fruits, which have been appealing to consumers worldwide.

Kombucha is a fermented beverage that has been gaining popularity in the Brazilian market in recent years. It is produced by adding a cellulosic biofilm, composed of bacteria and yeast, to sweetened base tea. Kombucha has specific characteristics that are highly appreciated, such as acidity, carbonation, and mild alcohol content[5]. The consumption of kombucha-fermented products is widespread due to the recognized probiotic effects of these colonies, which promote well-being and help in the treatment and prevention of various diseases[9]. Besides the use of kombucha, Catharina Sour beer allows for the incorporation of fruit juices or pieces, such as pineapple juice, in its formulation.

Pineapple has long been the most popular non-citrus fruit in tropical and subtropical countries, mainly due to its attractive taste and aroma, and it contains a wide variety of vitamins and minerals. Although pineapple has a low vitamin C content, it enjoys high sensory acceptance from consumers and is rich in fiber, water, and carbohydrates.

In light of this, the objective of this study was to develop and evaluate the physicochemical composition of Catharina Sour beer using kombucha and pineapple pulp, aiming to produce a beer with sensory quality and potential probiotic properties.

2 MATERIAL & METHODS

The experiments were conducted at the laboratories of the Academic Unit of Food Engineering (UAEAli) of the Federal University of Campina Grande (UFCG), Campus Campina Grande/PB. Base malt and hops were sourced from a brewery supply store in Natal-RN, while pineapple pulp was obtained from a local market in Campina Grande-PB. Microorganisms used included kombucha, a consortium of fungi and bacteria sourced from a scientific research project at the institution, and brewer's yeast (Saccharomyces cerevisiae) obtained from a brewing supply store. The pineapple pulp was characterized for pH, soluble solids (ºBrix), and acidity following the methodology of Instituto Adolfo Lutz (2008), with all analyses conducted in triplicate.

Beer production commenced with the preparation of wort using pilsner malt and wheat from a specialized store. Ground malts were added to 20 liters of mineral water and subjected to a temperature ramp of 65°C for 60 minutes, followed by 76°C for 10 minutes. After filtering and washing the malt husks with an additional 10 liters of water at 76°C, the wort was boiled at 100°C for 60 minutes with the addition of hops. The wort was then cooled to a temperature between 20°C and 28°C and transferred to a fermentation bucket to initiate fermentation. In the first stage, activated kombucha was added to ferment, acidify, and impart probiotic characteristics to the wort, maintained at 25°C for 3 days. After removing the kombucha, yeast was added, initiating the second fermentation at 22°C for 5 days. Subsequently, pineapple pulp was added, starting beer maturation at 5°C for 7 days, followed by a Cold Crash at 0°C for 2 days to settle out the yeast. Finally, carbonation and bottling in amber glass bottles were conducted.

Throughout the 192 hours of primary fermentation, pH, acidity, soluble solids, and alcohol content were regularly analyzed according to Instituto Adolfo Lutz (2008) methodology. Fermentation kinetics were monitored in duplicate using two 15-liter plastic bioreactors.

The produced beers were analyzed for the following parameters: pH, total acidity, soluble solids (°Brix), alcohol content, total sugars, and vitamin C. All analyses were performed in triplicate.

3 RESULTS & DISCUSSION

3.1 Characterization of pineapple pulp

Table 1 Physicochemical parameters of pineapple pulp.

	pH	**Soluble Solids** (Brix°)	**Acidity** % of acidity
Pineapple pulp	3.58 ± 0.02	13.45° ± 0.00	0.6 ± 0.01

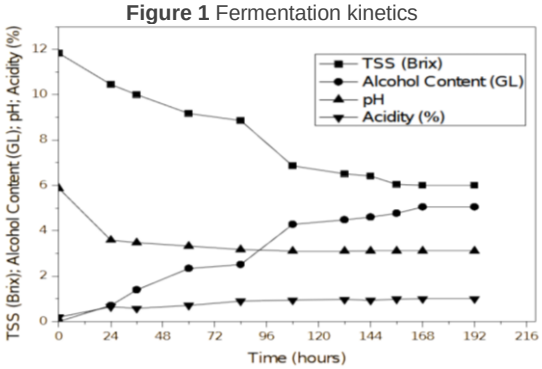
The pineapple pulp, with a pH of 3.58, shows a value similar to that of the fresh fruit (pH = 3.80), indicating that pineapple is an acidic fruit. The soluble solids content is also within legal standards (minimum of 11°Brix) and close to values reported in the literature. A soluble solids content of 14°Brix was observed by[10].

The acidity value observed in the pineapple pulp indicates it meets a good quality standard, as it is also within the minimum value established by regulations (minimum 0.3).

3.2. Fermentation kinetics

In Figure 1, the values of TSS (°Brix), alcohol content, pH, and acidity during the 192-hour period (primary fermentation) are shown.

Figure 1 Fermentation kinetics



The decrease in soluble solids during beer production is due to the fermentation process, crucial for alcohol production, which reduces the concentration of soluble sugars in the liquid. This reduction occurs as yeast cells multiply and consume substrates, converting them into ethanol and other compounds. As depicted in Figure 1, initial soluble solids (°Brix) in the reactors were around 12, dropping to 6 °Brix after 192 hours, similar to[9], who reported values of 10 and 4.5 respectively.

Alcohol formation in beer occurs during fermentation, where yeast converts sugars into alcohol and carbon dioxide. Alcohol content varies primarily due to initial sugar levels, yeast type, and fermentation duration. Lower alcohol content results from less sugar and/or yeast strains with lower alcohol tolerance, while higher content involves more sugar and/or alcohol-resistant yeast. Controlling these factors adjusts the desired alcohol content in beer.

The substrate conversion to ethanol in the analyzed samples, as seen in Figure 1, significantly increases in the first 168 hours of fermentation and stabilizes thereafter. This behavior can be explained by high cellular growth rates followed by a maintenance phase, with fermentation process inhibition noted in the final stage, as explained by[1]. As substrate concentration progressively declines, ethanol concentration rises over fermentation time, maintaining soluble solids content around 5% until fermentation completion.

Initial pH around 5.7 is crucial, as optimal pH ranges are necessary for yeast and scoby action. Initial pH values between 5.0 and 6.0 are ideal for malt worts, as cited by[11]. Proper pH control maintains optimal conditions for microbial growth in beer production, directly influencing taste and final quality. During fermentation, initial pH acidification depicted in Figure 1 decreased from 5.7 to 3.3 within three days, highlighting kombucha scoby efficiency in beer wort. This decrease results from acids produced by microorganisms consuming wort, including acetic, formic, pyruvic, and lactic acids, as described by[7].

Over the 192 hours of fermentation shown in Figure 1, acidity in wort increased from 0.2% to 1.0%. These values are lower than those reported by[4], who noted a final acidity of 3.27%, possibly due to variations in malts, yeasts, and kombucha scoby used. Increased acidity is expected as fermentation progresses, leading to higher ester levels and reduced diacetyl, acetaldehyde, and hydrogen sulfide, enhancing beer stability against spoilage microorganisms. Acidity is crucial for flavor balance, stability, and beer quality, primarily associated with lactic acid from Lactobacillus and acetic acid produced by kombucha scoby. pH, measuring hydrogen ion activity, typically decreases with increasing acidity.

3.3. Physicochemical analyses of catharina sour style beer

Table 2 Physicochemical parameters of packaged beer.

Analysis	pH	Soluble solids (Brix°)	Acidity (%)	Alcohol content (%)	Vitamin C (%)	Total sugars (g/100g)
Packaged beer	3.1 ± 0.02	6.0 ± 0.05	1.01 ± 0.01	5.0 ± 0.05	0.008 ± 0.0	0.92 ± 0.006

The study investigated the production of Catharina Sour beer with added pineapple pulp, focusing on key quality parameters. The pH value of 3.1 ± 0.05 aligns with the ideal range for Catharina Sour beer, as suggested by[6] (between 3.0 and 3.5). The total soluble solids (Brix°) of 6.0 ± 0.05 indicate efficient sugar consumption by the Scoby and yeast, contributing to good carbonation. The alcohol content of 5.0 ± 0.05% conforms to[3], falling within the 4.0% to 5.5% range specified. The beer exhibited negligible vitamin C content (0.008 ± 0.0), reflecting the pineapple pulp's role primarily in aroma and flavor enhancement. Total sugar content was measured at 0.92 ± 0.006 g/100g, consistent with findings by[8] across various beer types, highlighting residual non-fermentable sugars. Overall, the beer demonstrated sensory characteristics typical of Catharina Sour as per BJCP guidelines, with the added benefit of potential probiotic properties due to the incorporation of kombucha.

Figure 2 Catharina sour style beer.

4 CONCLUSION

According to the results obtained, it can be observed that kombucha scoby is an excellent option for acidifying wort in the production of Catharina Sour style beer, where all parameters were within the expected range for the style. The yeast also underwent excellent fermentation in the acidified medium, requiring 16 days for the beer to be ready. The produced beer exhibited appearance, color, aroma, flavor, and carbonation consistent with Catharina Sour style, potentially being probiotic due to the use of kombucha. All parameters including pH, soluble solids, acidity, alcohol content, and total sugars met regulatory standards and literature benchmarks.

It was noted that the use of pineapple pulp serves primarily to impart aromas and certain flavor characteristics to the beer, with its vitamin C content being negligible to the final product.

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