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COMPARISON OF THE ALCOHOL CONTENT OBTAINED IN THE FERMENTATION OF DWARF CAVENDISH BANANA AND ITS PEEL FOR THE PURPOSES OF BRANDY PRODUCTION

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Abstract

Brandy is one of the most consumed alcoholic beverages in Brazil, being produced with sweet vegetables, cereals, sugar cane and fruits that have fermentable sugars. This drink is confused with cachaça, from which it is distinguished by the alcoholic degree and typically Brazilian productivity. Banana stands out in Brazil and in the world as the second fruit in productivity, behind only orange, being an accessible raw material for the production of brandy. This processing is advantageous due to the rapid ripening of this fruit, which can often make it impossible to fresh to the consumer. This study aimed to carry out the fermentation through the inoculation of the yeast *Saccharomyces cerevisiae* separately for pulp and skins of Dwarf Cavendish bananas to verify the alcohol content produced. The banana pulp brandy reached an alcohol content of 39,5° GL, within the stipulated by the current legislation, the peel, however, did not allow adequate alcohol levels (7,5° GL). It is concluded that the pulp of Dwarf Cavendish banana is viable for the production of brandy.

Keywords: distillation; *Musa* spp.; *Saccharomyces cerevisiae*.

COMPARAÇÃO DO TEOR ALCÓOLICO OBTIDO NA FERMENTAÇÃO DE BANANA NANICA E DE SUA CASCA PARA FINS DE PRODUÇÃO DE AGUARDENTE

Resumo

A aguardente é uma das bebidas alcoólicas mais consumidas no Brasil, sendo produzida com vegetais doces, cereais, cana-de-açúcar e frutas que possuem açúcares fermentescíveis. Esta bebida é confundida com a cachaça, da qual é diferenciada pelo grau alcoólico e produtividade tipicamente brasileira. A banana possui destaque no Brasil e no mundo como a segunda fruta em produtividade, atrás apenas da laranja, sendo uma matéria-prima acessível para a produção de aguardente em razão do processo de amadurecimento rápido, o que acaba muitas vezes por inviabilizar a venda *in natura* para o consumidor. Este estudo objetivou realizar a fermentação através da inoculação da levedura *Saccharomyces cerevisiae* separadamente para mostos da polpa e cascas de bananas nanica para

verificar o teor alcóolico produzido. A aguardente de polpa de banana atingiu teor alcoólico de 39,5° GL, dentro do estipulado pela legislação vigente, a casca, contudo, não permitiu níveis alcóolicos adequados (7,5° GL). Conclui-se que a polpa da banana nanica é viável para a produção de aguardente.

Palavras-chave: destilação; *Musa* spp.; *Saccharomyces cerevisiae*.

Introduction

Cachaça and brandy are very admired drinks in Brazil and around the world, the fermentation and distillation process started in Brazil during slavery, and is very often stigmatized, currently it has greater appreciation, conquering the taste of a large part of Brazilians, thus earning the status of a noble drink both in Brazil and in the world, however, if you compare the number of informal producers, the export index is still low, having great growth potential (PARDO, 2021; MAPA, 2021; PAIVA *et al*., 2017).

In the year 2020, cachaça and brandy production in Brazil showed an increase of 4.14%, with 1,131 producers compared to 2019, in which were 1,086, but when analyzing only the registered establishments able to produce it, there was a decrease of 3.48% compared to 2019, with 345 establishments now. It should be noted that these are official numbers and do not cover the number of informal producers that are quite relevant, covering 89% of producers not registered with the Ministry of Agriculture. It is estimated that this productive sector employs more than 600 thousand direct and indirect workers, having a high economic potential for the country (MAPA, 2021; IBRAC, 2021). The Brazilian Micro and Small Business Support Service (SEBRAE) highlights the economic potential of the country and encourages the formalization of small entrepreneurs (SEBRAE, 2022).

In this context, the differences between cachaça and brandy should be highlighted, because all cachaça is brandy, but not all brandy is cachaça. According to Decree 4062 of December 21, 2001, the "name "cachaça", a word of exclusively Brazilian origin and use, constituting a geographical indication for art. 22 of the Agreement on Trade-Related Aspects of Intellectual Property Rights" (BRASIL, 2001), thus, MAPA Normative Instruction No. 13 of June 29, 2005, defines that cachaça:

> is the typical and exclusive denomination of the sugarcane spirit produced in Brazil, with an alcohol content of 38% vol (thirty-eight percent by volume) to 48% vol (forty-eight percent by volume) at 20 °C (twenty degrees Celsius), obtained by the distillation of the fermented must of the sugarcane juice with peculiar sensorial characteristics, being able to be added sugars up to 6g/l (six grams per liter), expressed in sucrose (BRASIL, 2005).

Brandy, on the other hand, by Decree 6,871 of June 4, 2009 in its article 51, highlights that it is a drink with an alcoholic strength of 38% to 54% by volume, at 20 °C, that is, brandies are distilled drinks from different musts (molasses, cereals, vegetables, fruits, etc.), which has an alcohol content higher than that of cachaça or beverages that are not produced in Brazilian territory with the proper specifications when it comes to sugarcane, since the "cachaça" is configured as a Heritage of Brazil (BRASIL, 2009a).

When analyzing the productivity of spirits and other distilled beverages from 2017 to 2021, we can see a growth in production in liters since in 2017 there were 1,617,130 liters and in 2021 a total of 2,502,538 liters, a lower value than in 2020, when production reached 2,510,069 liters, however, due to the Pandemic scenario (VIANA, 2022).

New growth is in this scenario, the production of alcoholic beverages through fermentation and distillation processes, using fruits as raw material, is a promising market, because in addition to being appreciated all over the world for having a sensorial pleasant aroma and flavor, the use of fruits that do not have ideal visual conditions for sale to the final consumer, can be a source of income through this reuse.

In 2021, Brazil produced around 6,811,374 tons of bananas, and the states with the highest production are São Paulo (1 million tons) and a 14.9% share of total production, followed by the state of Bahia (869 0 thousand/ton), Minas Gerais (791.7 thousand/ton) and Santa Catarina (708.9 thousand/ton) (EMBRAPA, 2021; IBGE, 2021). Being the second most preferred fruit for Brazilians, in first place is the orange, the annual per capita consumption of bananas can reach twenty-five kilograms in all layers of the population, unfortunately during the harvest, losses can reach 60% of production, and most of it is lost even in the plantation, because depending on the harvest, the price does not stimulate the harvest (NERIS *et al.,* 2018).

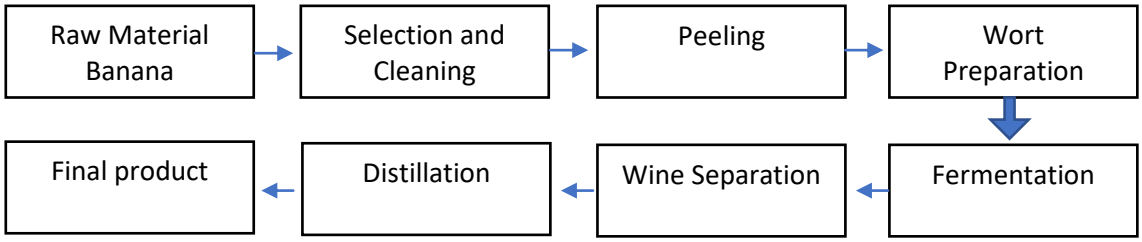
Given this context, this study aims to verify the alcohol content obtained through the must of the pulp of the banana (Dwarf Cavendish) and its peel separately, in order to verify the viability of the production of brandy. As it is a fruit that has a very fast ripening process and contains a significant amount of sugars, its use as raw material for the manufacture of brandy means obtaining a product from reuse, with significant added value.

Thus, the objective is to analyze the alcohol content of the product obtained from the distillation of the must, however, not only the internal mass of the banana will serve as a base, but also its peel, identifying the productivity of both, and for the fermentation the yeast *Saccharomyces cerevisiae* meets comfortably all specs. To verify the feasibility of this process, analyzes of Brix, alcohol content and pH of the distilled liquid will be carried out.

Material and Methods

The banana used, it is popularly known as nanica banana (D. Cavendish), one of the most cultivated in Brazilian soil (CNA, 2021). Figure 1 shows the steps of the process that was performed to obtain the distillate.

Figure 1. Flowchart of the brandy production process through fermentation and distillation of wort made with nanica banana.



Source: Os autores (2021)

After selecting the raw material that was stipulated by the type of banana to be used in the process, the fruit was asepsised in running water in order to remove any dirt that was present, and after washing the bananas with the peels still on, they were placed in a container with water for 10 minutes, in which for every 1 L of water 10 mL of 2.5% bleach was added, aiming to obtain better performance in the fermentation quality, thus avoiding contamination by wild yeasts and bacteria from the medium itself.

The bananas were washed again in running water and the pulp was separated from the peel. For the preparation of the must, 3 kg of banana pulp and 2 kg of banana peel were used separately, in both samples 30% of the weight was inserted in water so that they could be crushed, then the masses were taken to heating for 1 hour at 90 °C in a stainless steel container, in order to disperse the mass and reduce the amount of contaminating microorganisms, in addition to performing the inactivation of enzymes that also act in the browning process. At the end of heating, the broth was cooled to a temperature of 40 °C for the inoculation of the yeast (GUIMARÃES FILHO, 2003).

To correct the loss of water by evaporation and adjust the °Brix of the solution, the juice containing only the banana pulp (18 °Brix) was measured and 600 mL of water was added to obtain 15 °Brix and proceed with fermentation, for the broth that contained only the skins, it was not necessary to carry out this dilution due to the °Brix not being above the stipulated.

The formula (Equation 1) used in the dilution was described by Teixeira (2021).

Equation 1: $Va = \frac{Vc \quad x \quad (Bi - Bf)}{Bf}$

being:

Va = volume of water to be added to the broth, in liters;

Vc = volume of broth, in liters;

Bi = Initial Brix of the broth, in degrees Brix;

Bf = Final wort Brix, in degrees Brix .

After preparing the musts, they were placed in polypropylene basins for fermentation to take place, simulating the "fermentative vats" which are large tanks used for fermentation in industrial processes, then 0.04 Kg of biological yeast for breadmaking (a strain of *Saccharomyces cerevisiae*), at the base of the vat for later insertion into the must. When mixing, the vats were left to rest for 72 hours, this waiting time was based on and determined for the fermentation cycle to occur completely, as highlighted by Araújo (2012).

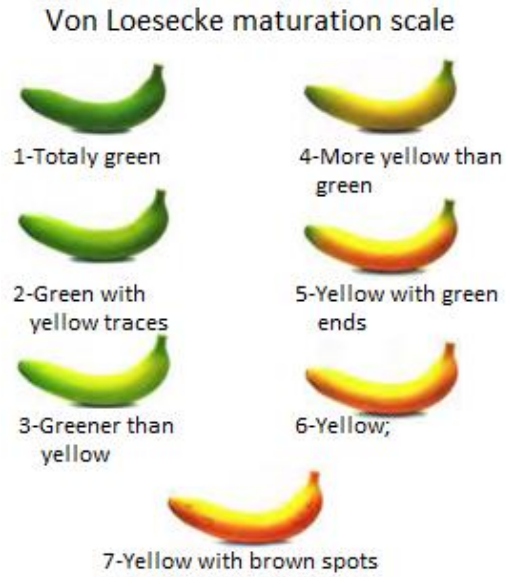
The distillation system used is called a simple distillation system and was monitored to separate the three fractions which consist of a “head” in which 10% of the distilled volume is separated, being rich in methanol and acids and for this reason it should not be consumed; “heart”, which are the following 80% of the distilled volume and it is in this fraction that the main compounds desirable to brandy are collected; and “tail”, which includes the remaining 10% of the distilled volume, this fraction being discarded because it contains fusel oil (mixtures of toxic compounds) (ALCARDE *et al*., 2012; OLIVEIRA *et al*., 2005).

To verify the soluble solids content, including sucrose, the Brix (% of soluble solids in a sugar solution) of the samples was measured, using an equipment called Atago Brix Refractometer model Rx-500000x. After fermentation and subsequent distillation, the alcohol content was verified using an Anton Paar digital densimeter, model DMA-4500 specific for alcohol, and the pH before and after distillation with a Digimed benchtop pHmeter model DM-20.

Results and Discussion

The raw material used in this process was included in the “7” classification of the Von Loesecke maturation advancement scale (PBMH; PIF, 2006), this scale being used to determine the maturation stages, which is composed of seven stages based on shell color: 1) completely green; 2) green with yellow strokes; 3) more green than yellow; 4) more yellow than green; 5) yellow with green tip; 6) yellow; 7) yellow with brown areas, as shown in Figure 2.

Figure 2. Von Loesecke maturation scale



Source: (PBMH; PIF, 2006).

According to Mota *et al.* 1997, significant biochemical changes occur during the ripening process of bananas, the most pronounced being starch hydrolysis and sugar accumulation, in which approximately 20 to 25% of the fresh weight of the unripe fruit pulp (Scale "1" Von Loesecke) is starch and which during the maturation stages is hydrolyzed, leaving only 1-2% in the fully ripe fruit (Scale "7" Von Loesecke), whereas the sugars present in the fresh weight of the pulp of unripe fruits (Scale "1"), increase from 15 to 20% in the mature fruit (Scale "7"), and may vary according to the cultivar. Thus, the selection of the raw material for this study selected the fruit on Scale "7" (FIGURE 3), with the aim of obtaining the highest possible sugar content.

Figure 3. Nanica banana at stage seven of maturation on the Von Loesecke scale, used as raw material in the process of obtaining brandy.



Source: Os autores (2021).

Table 1 shows the volume obtained in the distillation of the wine, both from the banana pulp and its peel, showing the separation of the distillate from the head and the tail, which were

separated and discarded. The volume obtained from the distillation, called the heart, was separated and the analysis of Brix, Alcohol content and pH was carried out (TABLE 2).

Table 1. Volume of distillate obtained in the process.

Distilled wine	Head (mL)	Heart (mL)	Tail (mL)	Total (mL)
Bananal pulp	50.0	407.0	45.0	502.0
Peel pulp	36.0	320.0	30.0	386.0

Source: Os autores (2021).

Table 2. Analytical results before and after fermentation/distillation.

	°Brix		pH		Alcohol level INPM e °GL (20 °C)	
	Pulp	**Peel**	**Pulp**	**Peel**	**Pulp**	**Peel**
Before fermentation (word)	18.0	4.3	4.87	5.71	----*	----
After fermentation (wine)	5.28	1.62	5.35	5.15	----	----
After distilation (distilled)	---	---	---	---	34.68 – 39.5	6.20 – 7.5

INPM – Instituto de Pesos e Medidas; °GL – Gay-Lussac; * Not applicable;

Souce: Os autores (2021).

When analyzing the °Brix values, it can be seen that the banana pulp had a higher concentration of soluble solids, requiring the addition of water to start the fermentation process at 15 °Brix, this dilution is necessary so that the yeasts can act on this solution (CARNEIRO, 2017; GUIMARÃES FILHO, 2003), the banana peel showed much lower °Brix than necessary for fermentation, indicating that the sugars present were not available to the yeasts, highlighting the need for further analyzes that characterize the type of sugar present in this substrate.

When observing the pH results before and after fermentation, it appears that for the banana pulp there was a slight increase in its value, but within the expected for a discontinuous fermentation process, where there is no cell recirculation (CRUZ, 2022), even so, the range is close to the ideal (4.5 to 5.1), as bacterial proliferation occurs much higher, which will compete with the

yeasts for the available fermentable sugars and produce other metabolites such as malic acid , glycerol, not being of interest and making the process unfeasible (FURLANI, 2014). However, when observing the pH of the peel, the change was minimal, which suggests when comparing the alcohol content obtained that fermentation did not occur as expected, since despite having sugars in its constitution (NERIS *et al*., 2018) the presence of other inhibitory compounds, such as the phenolic compounds present in the husks, can significantly affect ethanol productivity (FURLANI, 2014; PEREIRA, 2014).

For the results of alcohol level, as the volume of samples was small, it was not possible to perform the analysis with an alcoholometer, so a digital alcohol densimeter was used that required less sample volume, after taking the readings in °INPM, these were converted to °GL, the difference between these measurement units is that the first works with a percentage mass ratio and the other with a percentage volume ratio. Therefore, when observing the results of the alcohol content, it is verified that the fermentation of the banana pulp is within the parameters required by the legislation, according to Decree 6871, which defines that fruit brandy must have an alcohol content of 36 to 54% v/v at 20 °C (BRASIL, 2009a; BRASIL, 2009b), the banana peel sample had a very low yield and cannot be classified in this category.

Conclusion

The results pointed out that within the proposed, fermentation in banana pulp brings significant results for the alcohol content present, being within the parameters studied, since the banana peel did not meet expectations, so more studies should be carried out on the possibility of fermentation of this raw material, for example, the combined fermentation with the pulp, verifying if the substances present in the peel could or could not interfere in the yield.

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