Rum production: elaboration and chemical characteristics

ALMEIDA, Lara Solange Bastos de
OLAYA, Rafaela Couto
NASCIMENTO, Daniela Defavri do

Abstract

Among the beverages produced based on alcoholic fermentation and distillation, Rum stands out. The distillate is produced from the fermentation of sugarcane molasses, going through two distillation processes, and proceeding to the aging stage. In this project, production was carried out followed by chromatographic, microbiological analyzes and a market research analysis. Through Chromatographic analysis the presence of alcohol content, acetaldehyde, ethyl acetate, N-propanol, isoamyl alcohol and isobutanol were quantified, presenting variable results when compared to the literature. Cell viability of the yeast used in fermentation process was carried out using a Neubauer chamber, totaling a percentage of 84.2% of viable cells, which potentiates the microorganism. The market research presented information where it is observed that the issue of alcoholic beverage consumption is well divided between beers, distillates and mixed drinks, which shows the change in consumer habits over time.

Keywords: physicochemical analysis, fermentation, distillation and market research.

Resumo

Dentre as bebidas produzidas a partir da fermentação alcoólica e destilação, destaca-se o rum. O destilado é produzido a partir da fermentação do melaço de cana-de-açúcar, passando por dois processos de destilação e seguindo para a etapa de envelhecimento. Neste projeto, a produção foi realizada seguida de análises cromatográficas, microbiológicas e uma análise de pesquisa de mercado. Através da análise cromatográfica foram quantificados a presença do teor alcoólico, acetaldeído, acetato de etila, N-propanol, álcool isoamílico e isobutanol, apresentando resultados variáveis quando comparados à literatura. A viabilidade celular da levedura utilizada no processo fermentativo foi realizada utilizando-se câmara de Neubauer, totalizando um percentual de 84,2% de células viáveis, o que potencializa o microrganismo. A pesquisa de mercado apresentou informações onde se observa que a questão do consumo de bebidas alcoólicas está bem dividida entre cervejas, destilados e bebidas mistas, o que mostra a mudança nos hábitos de consumo ao longo do tempo.
Palavras chave: Análise físico-química, fermentação, destilação e pesquisa de mercado.

Resumen

Entre las bebidas producidas a partir de la fermentación alcohólica y la destilación, destaca el ron. El destilado se produce a partir de la fermentación de la melaza de caña de azúcar, pasando por dos procesos de destilación y pasando a la etapa de envejecimiento. En este proyecto, la producción se llevó a cabo seguida de análisis cromatográficos y microbiológicos y un análisis de investigación de mercado. Mediante análisis cromatográfico se cuantificó la presencia de contenido alcohólico, acetaldehído, acetato de etilo, N-propanol, alcohol isoamílico e isobutanol, presentando resultados variables en comparación con la literatura. La viabilidad celular de la levadura utilizada en el proceso de fermentación se realizó utilizando una cámara de Neubauer, totalizando un porcentaje del 84,2% de células viables, lo que potencia el microorganismo. La investigación de mercado presentó información donde se observa que el tema del consumo de alcohol está bien dividido entre cervezas, licores y combinados, lo que muestra el cambio en los hábitos de consumo a lo largo del tiempo.

Palabras clave: Análisis fisicoquímico, fermentación, destilación e investigación de mercados.

INTRODUCTION

Among the beverages that can be produced based on alcoholic fermentation, rum is particularly interested, a simple distillate produced from the alcoholic fermentation of molasses, the mixture of sugarcane and molasses broth, aged in whole or in part, in an oak container or equivalent wood, preserving its peculiar sensory characteristics (Brasil, 2020).

It is worth remembering that the drink originated in the West Indies and was first recognized in Barbados, around 1650. As for its industrial production, it dates back to the 17th century, in the context of the expansion of sugar production in America promoted by the West India Company. The origin of the word rum is uncertain. Possibly, it could derive: (1) from the Latin word "saccharum" (sugar), (2) from the spanish word "rumbullion", which means great turmoil, as well as the word "rumbostion", both used by vendors from Eastern countries for the Caribbean and (3) from the Spanish "ron", distillate produced by the Spanish in the Indies, previously the arrival of the English in the Caribbean (Nicol, 2003 quoted by Souza, 2006 p. 16). In this period, rum did not have a good reputation due to the effects that alcohol had on its connoisseurs.

Rum is a drink known for having refined characteristics and mild aroma, which should have an alcohol content of 35% to 54% and sweet taste (Brasil, 2020). The drink is more than 500 years old, having as the largest rum consumer Jamaica, with 90% sales. In addition, rum has molasses as its main raw material, while cachaça uses sugarcane as a fundamental ingredient. Another characteristic of rum is to be a distilled beverage whose fermentation was spontaneous and distillation performed in stills, where several distillations were made before the product was commercialized, being carried out in Jamaica, Barbados, Virgin Islands and São Domingos (Clutton, 1974 cited by Magnani, 2009).

In the production of rum, the result will depend on the fermentation time of the molasses. If it is white, it takes between 24 and 48h of fermentation, while for a darker color this procedure takes about weeks. It is worth remembering that according to Brazilian legislation, the main types of rum are: Light, Heavy and Aged (Brazil, 2020).

It is called Light Rum when you have a coefficient of congeners of the drink of less than 200 mg/100 mL in anhydrous alcohol, while Heavy Rum has a range of 200 to 500 mg/100 mL, obtained exclusively from molasses. And if stored for a period of at least 2 years, it becomes Aged Rum (Brasil, 2020).

The reason for the use of molasses as raw material, is that the product of easy access has

a low cost, in addition to its residues, after fermentation processes can without discarded in nature and of great abundance in our region.

The objective of the work was to produce rum, a by-product derived from sugar cane, in which the parameters evaluated referred to microbiological, physical-chemical analyzes and also the consumer profile in relation to data collection from reserch on market realized.

MATERIAL AND METHODS

Rum was produced from an exclusive base of cane molasses. Molasses acquired from molasses Brasileiros (Saltinho-SP) in buckets of food polypropylene previously sanitized and sanitized with 70% ethanol and peracetic acid.

As molasses is normally acquired in a concentrated form (70-80 ºBx), it was diluted with heated filtered water (50ºC) for the preparation of the must at a volume of 20 liters, standardizing it at 18 ºBx (using a digital Brix refractometer), in addition to having been transferred to a polypropylene fermenting bucket.

The liquid yeasts acquired from the company Smart Yeast (Piracicaba - SP) were used to inoculate the must to be fermented, using the strain *Saccharomyces cerevisiae* SYL-200 at a final inoculation rate of approximately 1×10^{7} cells/mL (corresponding to 4×10^{11} total cells in 20 L) and there was the use of capsules that serve as nutrients for yeasts, which aids in their best performance.

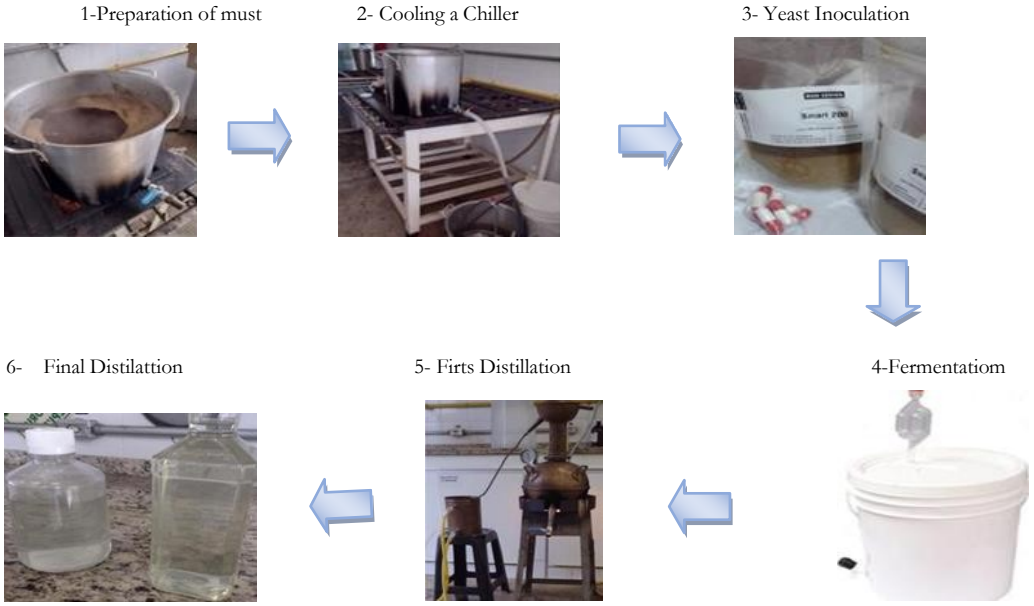
Fermentation was conducted in a polypropylene fermenting bucket and accompanied by brix measurement at the beginning of the fermentation process, using a refractometer to accompany sugar attenuation. The end of fermentation was weighted when it was noticed that there was no more bubble formation in the must, thus considering that the brix measurement was close to zero and no activity was observed in the system (detachment of gases or agitation of the must).

The clarified wine went into the copper still with deflegmador. The system is heated directly tothe fire link and the controlled temperature between 90-92ºC. The distilled product was obtained by two sequential distillations:

a) Distillation A: the wine was styled with phase separation, following the steps: 'Head' (1% of the total volume, to be discarded), 'heart' (product obtained after the separation of the 'head' and until the distillate presents an alcoholic graduation between 36 and 38 % v/v) and 'tail' (product obtained after the separation of the head and which was also discarded).

The validated distilled product is the 'heart' fraction. A sample was taken to determine the alcohol content by densitometry in AntoonPaar densimeter after distillation of the sample in an alcohol microdistiller.

b) Distillation B: In this second stage, the product obtained in distillation "A" was fully distilled, and with this, there being the elimination of congeners that do not add essential characteristics to the beverage.



Chromatographic analysis

After distillation, a chromatographic analysis was performed in the perkin elmer equipment, Clarus 600, choromatograph gas that has an ELITE WAX capillary chromatographic column (30 m × 0.25 mm × 0.25 µm) and flame ionization detector (FID). The automatic sampler employed is combipal brand, CTC Analytics model, Pal System, with the oven for headspace. The drag gas used was N2, with flow of 1.2 mL min-1, hydrogen was 45 mL min1 and synthetic air was 450 mL min-1, all with a high purity (99.999%). The injector temperature was 150 °C and the column temperature was programmed to 45 °C for 1.5 min, with heating at a rate of 9°C min-1, up to 153 °C, remaining at this temperature for 1.5 min. The temperature of the detector was 300 °C. The optimized conditions of the headspace were: volume of the decarbonated sample in the vial = 5 mL, heating time = 5 minutes, oven temperature = 80 °C and volume of collection and injection = 1.5 mL at a speed of 250 µL $^{s-1}$, using the "split" of 50:1 (Bortoleto; Gomes, 2021).

For this, 3 tubes were separated, determined as Ethanol, VOC A and VOC B, and VOC (A and B) are two duplicate samples containing volatile compounds. Respectively, in the first one, 1mL of the sample and 10mL of water were placed, and in the other two, 50uL of acetone and 5 mL of the sample were placed, and then inserted in the chromatograph, where the results of alcohol content; upper alcohols, presence of acetaldehyde and ethyl acetate were obtained.

Microbiological Analysis

To perform the syl-090 yeast cell viability count, a serial dilution was prepared in ten times of the sample, representing 100 uL in a total of 900 uL of distilled water. Then, this same genetic content along with the methylene blue dye, which aims to mark the dead strains, were placed in the Neubauer chamber.

The method performed by this chamber consists of counting the four lateral quadrants and the cells present in the central quadrant, a procedure used by Lucarani; Silva and Bianchi (2011).

The equipment used was the Zeiss Axioskop 40 ergonomic trinocular microscope with 1.25x - 4x - 10x - 40x - 100x, with camera output for documentation; 23 mm wide-plane eyepieces. Zeiss lenses have the following planes: 1.25x NEOFLUAR; 4x ACHROPLAN; 10x ACHROPLAN; 100x NEOFLUAR with Condenser Zeiss 0.9 NA; 35 W halogen lighting, with filter support on the base.

Market Research

Exploratory market research was conducted on Google Forms, a tool provided by Microsoft, in which the choice of this type of data survey was due to the best undertanding of the consumer profile, and obtaining insights and ideas that can contribuite to the study.

The questions contained in this form aimed to collect information about the Rum drink through the six questions asked, obtaining 121 answers at the end of the research (it is attached at the end of the paper).

RESULTS AND DISCUSSION

From molasses were produced 20 liters of fermented, resulting in a yield of 2 liters of Rum.

Chromatographic Analysis

The values found in the determination of alcohol and distillate volatiles are presented in Table 1, being performed in gas chromatography with the method according to Bortoletto *et al* (2021).

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Table 1. Ethanol determination and volatiles

Analyte	Concentration in % (v/v) andmg/L
Ethanol	39,2%
Acetaldehyde	162,5 mg/l
Ethyl acetate	121,6 mg/l
N. Propanol	148,5 mg/l
Isobutanol	255,8 mg/l
Isoamílico alcohol	982,5 mg/l

Source: Author.

According to mapa regulations, the parameters for alcohol content is 35 to 54%, so the rum produced is in accordance with current legislation.

According to the data presented in the previous table, there is a comparison of the compounds in relation to the values shown by Lea and Pigott (2009) in the book Fermented Beverage Production, where variations in the results can be observed.

Acetaldehyde values; Ethyl acetate and isoamyl alcohol found in the table are higher when compared to the literature, respectively: 95 mg/L; 39 mg/L; 479 mg/L. On the other hand, the isobutanol content presented by Lea and Pigott (2009) reaches 445 mg/L, being lower than that of the analysis performed, and the authors do not determine the presence of N-propanol. For this reason, it is hypothesized that the difference in the contents of chromatographic analysis and the authors' information is related to the aging of the beverage.

The importance of superior alcohols besides giving aroma and flavor are solvents on other aromatic substances, such as isobutanol (Moreira *et al*., 1912).

The concentration of acetaldehyde depends on the strain used during the fermentation

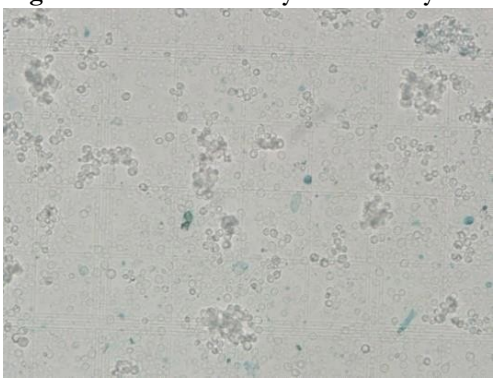
process and ethyl acetate is the main congener found in distilled beverages, giving pleasant flavor and aroma (Nascimento, 2007).

In question of isoamyl alcohol, it is characterized by providing sweetness and fruity aroma, however, these aspects will depend on its volatile fraction. (Moreira *et al.*; 2012).

N-propanol distills during the first distillation due to its characteristics with a high degree of uniformity (Almeida *et al.*, 1984 cited by Moreira *et al.* 2012).

Microbiological Analysis

Figure 1. Observation of yeast viability



Source: author.

The viability of live yeast cells is one of the essential parameters for analyzing a fermentation process, since the yeast strains used can be reused. In the literature by Garcia (2016), viability values were 80.18-84.78 for unclarified musts at the beginning and end of the fermentation process. In the present work, live cells resulted in 84.2%, in which the quadrants counted to carry out this survey were R1, R5, R13, R21, R25, presenting the number of viable cells respectively: 65,43,52,54 and 58, this contributes to the similarity in the fermentation process and performance of the strains for both works.

Market Research

The Google Forms search resulted in 121 responses to Rum. The following are the graphs of some questions.

Figure 2. Rum Knowledge Chart

- Do you know the Rum drink?

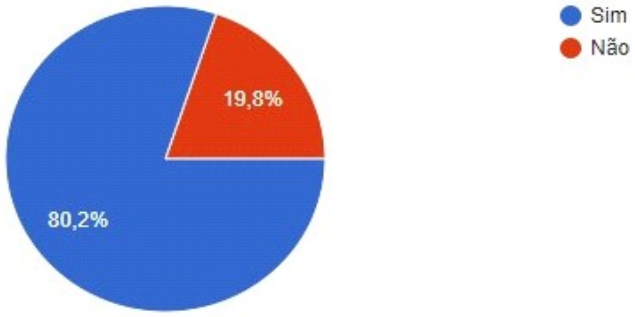


Figure 3. Beverage consumption

- What kind of alcoholic beverage do you consume the most?

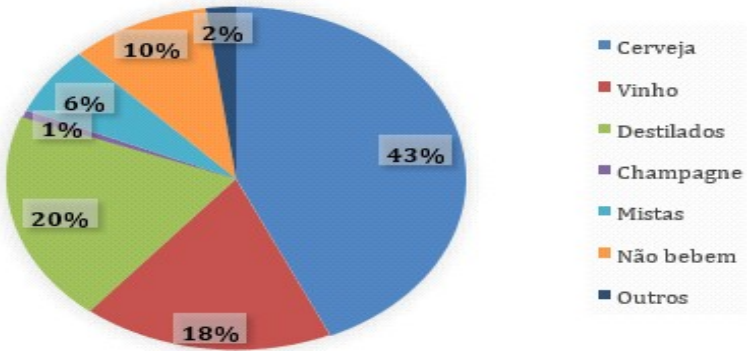


Figure 4. curious to try the rum drink

- If you had the opportunity to taste the handmade Rum, would you prove it?

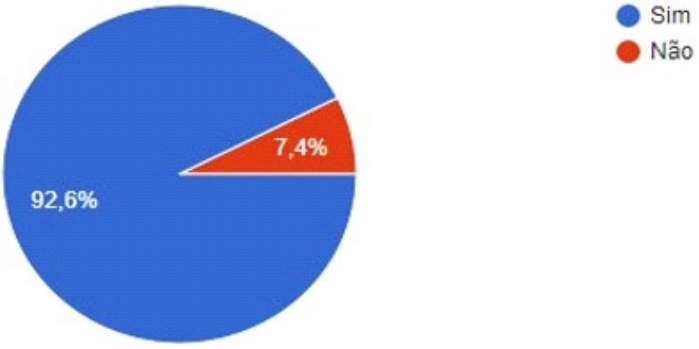


Figure 5. Graph representing the percentage of how many people know the difference between rum and cachaça

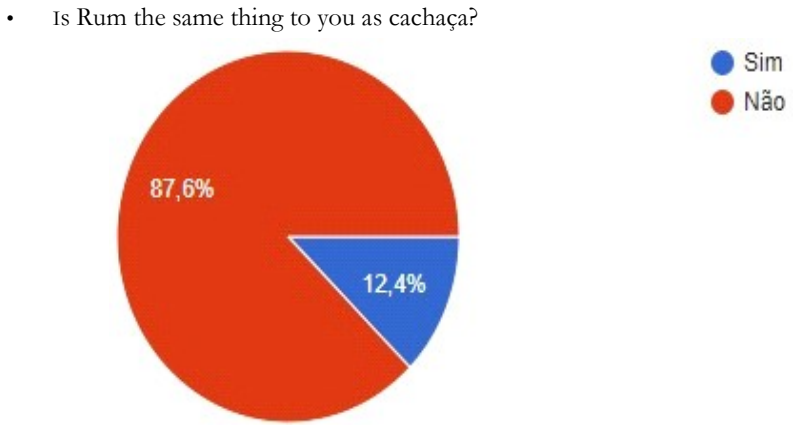


Figure 6. Graph showing the percentage of how many people think Rum is a sweet and bitter drink

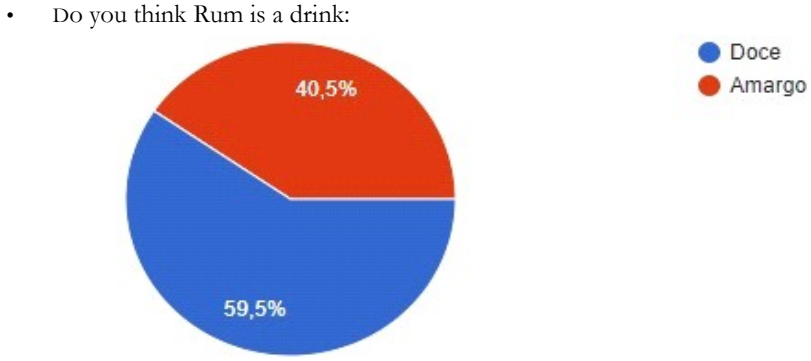
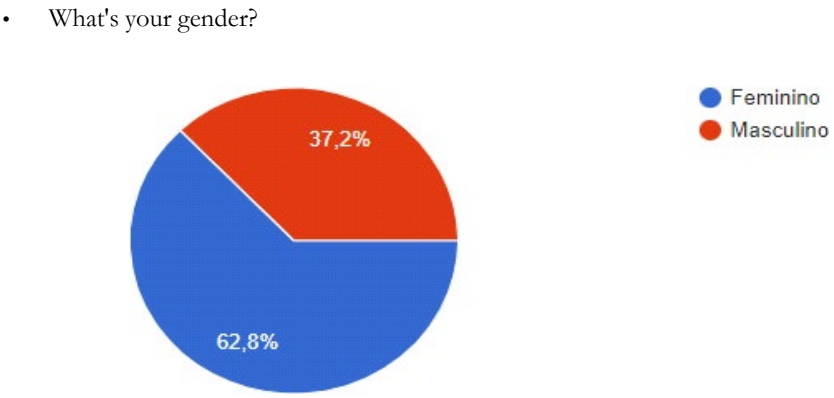


Figure 7. Gender of people interviewed



In the research parameter of alcohol consumption, we reached the following results: of the 121 people, 28 of them consume distilled beverages such as cachaça, whisky and vodka, in relation to wines and beers, respectively, were a total of 25 and 61 people. Mixed drinks such as gines, beats, consumption was 9 people; for champagne only one person consumes and finally, 14 people do not consume alcoholic beverages. The category "others" was due to answers that did not provide specified drink. It is worth remembering that rum is presented in the spirits category in the alcoholic beverage parameters.

It is important to mention that about 62.8% of the people who responded to the survey are female, which can be related to the consumption of beverages other than beer. It is worth remembering that some people answered more than one drink, so this generated a higher result in all people who responded to the survey.

CONCLUSION

Through the methodology used in this rum production project, it can be concluded that the beverage produced presented alcohol content according to the legislation.

In the microbiological analysis, the result obtained from yeast cells was expected, presenting a viability of 84.2% of live strains.

According to the data of the market research conducted, about 80.2% know the distillate and 92.6% would prove it if they had the opportunity. In question of the consumption of alcoholic beverages, the public consumes beer more, totaling about 43%, in addition, it is worth mentioning that 87.6% know the difference between Rum and cachaça, however 12.4% think they are the same thing, due to the fact that Rum is not frequently consumed in Brazil, which suggests a better

dissemination of the drink to grow its market potential.

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ALMEIDA, Lara Solange Bastos de. Graduada em Tecnologia dos Alimentos pela Faculdade de Tecnologia (FATEC), campus Piracicaba, Estado de São Paulo, Brasil. Durante 16 (dezesseis) meses atuou como estagiária produzindo meios de culturas, preparando mostos de melaço para propagar leveduras, assim como análises Físico-Químicas de bebidas alcóolicas na startup Smart Yeast incubada na Escola Superior de Agricultura Luiz de Queiroz (ESALQ) da Universidade de São Paulo (USP). Atualmente atua como mestranda em Química na Agricultura e no Ambiente no Centro Nuclear na Agricultura (CENA/USP), no qual está sendo desenvolvido um projeto que visa no reaproveitamento de cascas de café como carga de reforço no desenvolvimento de filmes biodegradáveis, além de possuir licenciatura em Química R2. Faculdade de tecnologia (FATEC) de Piracicaba Deputado Roque Trevisan, Tecnologia em Alimentos, Av. Diácono Jair de Oliveira, 651 - Santa Rosa Ipês, 13414-141 Piracicaba, São Paulo, 551934131702: larabastosalmeida@gmail.com

OLAYA, Rafaela Couto. Acadêmica do Curso Superior em Tecnologia em Alimentos pela FATEC Piracicaba Dep. "Roque Trevisan" e Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ/USP), Açúcar e álcool, Av. Pádua Dias, 11 - Agronomia, 13418-900 Piracicaba, São Paulo. rcoutoolaya@gmail.com

NASCIMENTO, Daniela Defavri do. Possui graduação em Engenharia Agronômica pela Universidade de São Paulo (1997), graduação em Licenciatura Em Ciências Agrárias pela ESALQ/USP (1998), mestrado em Fisiologia e Bioquímica de Plantas pela ESALQ/USP (2000) e doutorado em Agronomia (Genética e Melhoramento de Plantas) pela ESALQ/USP (2005). Especialista (MBA) em Agronegócios pelo PECEGE/ESALQ/USP (2012). Tem experiência na área de Agronomia e Fermentações, com ênfase em Bioquímica e Biologia Molecular, atuando principalmente nos seguintes temas: desenvolvimento e análise de cervejas especiais, cultura de tecidos, micropropagação de plantas, clonagem gênica, transformação genética de plantas (Tabaco, Arabidopsis, Eucalipto e cana-de-açúcar), análises moleculares. Desde 2010 é professora concursada por prazo indeterminado para as disciplinas: Biotecnologia e Bioetanol do curso de Graduação em Biocombustíveis; e Biotecnologia e Bioquímica de Alimentos do curso de Graduação em Alimentos, todos da FATEC Piracicaba "Deputado Roque Trevisan".