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MEANING AND VALUES OF BRAZILIAN ALEMBIC CACHAÇA

SIGNIFICADO E VALORES DA CACHAÇA BRASILEIRA DE ALAMBIQUE

SIGNIFICADO Y VALORES DE LA CACHAÇA BRASILEÑA DEL ALAMBIQUE

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ABSTRACT
Cachaça - the drink obtained by the distillation of fermented must from sugar cane juice – has been manufactured on an artisanal scale by thousands of Brazilian producers since the 16th century. However, in the 1970s, the survival of these producers was seriously threatened, due to the emergence of and competition from industrial cachaça, produced in significantly larger volumes and sold at very low prices. To help them face the situation, a robust project was designed to support small producers, integrating actions from government institutions, universities and producer associations. Since then, cachaça of rural origin has risen in the market as a reference for quality, richness and sensorial diversity – reaching high level of recognition and appreciation. Recently, Brazilian legislation authorized the name “alembic cachaça”, which was conditioned exclusively to batch distillation in copper stills. However, the technological advances introduced go beyond the distillation process, and characterize marked differences in relation to industrial cachaça. The objective of this article is to highlight the paradigms of good production practices for still cachaça – with emphasis on the fact that the origin can be attested using chemical markers.

KEYWORDS: Cachaça. Alembic cachaça. Good production practices. Chemical markers.

RESUMO
A cachaça – bebida obtida pela destilação do mosto fermentado do caldo da cana-de-açúcar – é fabricada em escala artesanal por milhares de produtores brasileiros desde o século XVI. Na década de 1970, porém, a sobrevivência desses produtores ficou seriamente ameaçada, devido ao surgimento e à concorrência da cachaça industrial, produzida em volumes significativamente maiores e vendida a preços muito baixos. Para ajudá-los a enfrentar a situação, foi concebido um projeto robusto de apoio aos pequenos produtores, integrando ações de instituições governamentais, universidades e associações de produtores. Desde então, a cachaça de origem rural cresceu no mercado como referência de qualidade, riqueza e diversidade sensorial – alcançando elevado patamar de reconhecimento e valorização. Recentemente, a legislação brasileira autorizou a denominação “cachaça de alambique”, que ficou condicionada exclusivamente à destilação por bateladas em alambiques de cobre. Contudo, os avanços tecnológicos introduzidos vão além do processo de destilação e caracterizam diferenças marcantes em relação à cachaça industrial. O objetivo deste artigo é destacar os paradigmas de boas práticas de produção de cachaça de alambique – com ênfase no fato de que a origem pode ser atestada por meio de marcadores químicos.

PALAVRAS-CHAVE: Cachaça. Cachaça de alambique. Boas práticas de produção. Marcadores químicos.

RESUMEN
La cachaça – bebida que se obtiene de la destilación del mosto fermentado del jugo de la caña de azúcar – ha sido fabricada a escala artesanal por miles de productores brasileños desde el siglo XVI. Sin embargo, en la década de 1970, la supervivencia de estos productores se vio seriamente amenazada debido al surgimiento y la competición de la cachaça industrial, producida en volúmenes significativamente mayores y vendida a precios muy bajos. Para ayudarlos a enfrentar la situación, se diseñó un proyecto robusto de apoyo a los pequeños productores, integrando acciones de instituciones gubernamentales, universidades y asociaciones de productores. Desde entonces, la cachaza de origen rural ha crecido en el mercado como referencia por calidad, riqueza y diversidad

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sensorial, alcanzando un alto nivel de reconocimiento y apreciación. Recientemente, la legislación brasileña autorizó la denominación “cachaça de alambique”, que estaba condicionada exclusivamente a la destilación discontinua en alambiques de cobre. No obstante, los avances tecnológicos introducidos van más allá del proceso de destilación y caracterizan marcadas diferencias en relación a la cachaza industrial. El objetivo de este artículo es resaltar los paradigmas de buenas prácticas para la producción de cachaza sin gas – con énfasis en el hecho de que el origen puede ser testificado a través de marcadores químicos.

PALABRAS CLAVE: Cachaça. Cachaça destilada. Buenas prácticas de producción. Marcadores químicos

1) INTRODUCTION

Cachaça is the name of the Brazilian distilled beverage produced from sugarcane juice. Its origin, as well as its name, date back to the beginning of Portuguese colonization, in the sixteenth century. Strictly speaking, therefore, cachaça and alembic are practically inseparable. Therefore, the expression "alembic cachaça" may even seem redundant.

To understand its meaning and values, one must go back to the 1970s. Until then, cachaça was produced empirically based on ancestral knowledge that was transmitted from parents to children. Deprived of the scientific basis already incorporated in the production of other spirits, such as whiskey and cognac, the process had a low level of standardization and reproducibility. Anyway, the quality of the drink left a lot to be desired. It was consumed predominantly by the poorest populations, motivated by the inebriating effect of alcohol to cope with daily difficulties. The image of the drink was associated with excessive consumption and the devastating effects of alcoholism – which justified the refusals of research funding agencies to sponsor projects to support the sector.

In 1975, due to the international oil crisis, the Brazilian government created the National Alcohol Program (Pró-álcool) with the aim of reducing Brazil's dependence on imported oil. Since then, there has been a significant investment in research aimed at optimizing the process of producing fuel alcohol from sugarcane. At the same time, developments supported the emergence of the "industrial cachaça", whose production process was linked to the maximization of yield and productivity at all stages. Referred to as "column cachaça", this cachaça began to be marketed at prices far below the cost of production of "rural" cachaça. In addition, it was extolled as the only safe one for the consumer – on the grounds that all possible contaminants were eliminated during the manufacturing process. This movement caused strong oppression on cachaça producers in the agricultural environment, who began to be labeled as clandestine and illegal. Industrial cachaça, produced with fuel alcohol technology, threatened the survival of thousands of producers of cachaça, which pejoratively began to be referred to as "alembic cachaça".

In the 1980s, a group of entrepreneurs from Minas Gerais (who later founded AMPAQ - main Brazilian Association of alembic cachaça producers) realized the urgency of supporting the "alembic cachaça" producers, whose inestimable historical and cultural value was being ostracized. Since then, efforts have been made on several fronts, with an emphasis on raising awareness among universities, technological institutes and research funding agencies. In the academic sphere, still facing prejudice,

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UFMG immediately supported the development of research, which soon led to master's monographs and doctoral theses. Numerous other initiatives and enterprises began to count on government support, especially through Epamig (created in 1974), Fapemig (from 1985), AMPAQ (from 1988) and IMA (from 1992). In 2005, the Cachaça Production Technology Course (IFNMG – Salinas) was created, in academic level.

Currently, the producers of "alembic cachaça" are organized into associations and cooperatives (Fernandes, 2002). They actively participate in academic congresses and symposia. Many brands, from various regions of the country, have been consistently awarded in national and international tasting contest. With a market associated to tasting/fraternization events and conscious/responsible consumption, alembic cachaça is sold at prices far above industrial cachaça and, in several cases, at the level of the most expensive spirits in the world.

This brief historic helps to understand the breadth of the values embedded in the designation "alembic cachaça". And it justifies the importance of periodically reviewing and reaffirming the benchmarks of good practices for the production of alembic cachaça. Which can be compiled into ten topics (Maia *et al.,* 2006; Cardoso, 2021) as summarized in sequence.

2) TYPICAL PROCEDURES IN ALEMBIC CACHAÇA PRODUCTION

2.1) Sugarcane: selection and harvesting

The exclusive use of ripe sugarcane is a privilege of the producers of alembic cachaça, due to the flexibility they have to adapt the harvest period according to the evolution of the sugarcane field itself. To maintain cachaça production at an interval of up to six months each year, producers cultivate varieties with different maturation periods, usually referred to as early, medium and late (Cardoso; Andrade, 2008). This care is very important because, before the optimal point of maturation, in addition to the imbalance between the sugar and acid contents, it has already been shown that important nutrients are sequestered (for example, bound to tannins). That is why they remain in the milling bagasse (Rutherford, 2013).

Another important peculiarity refers to the harvest conditions, which preferably take place at dawn, minimizing the incidence of sunlight. The harvest is selective and is restricted to the amount needed for processing to be done on the same day. At this stage, care includes: the arrangement of the culms on tarpaulins, avoiding contamination by particles, insects and microorganisms in the soil, the assembly of bundles (of parallel culms), the transport of small trailers by trailer, avoiding injuries and mechanical damage until arrival at the factory. In the processing area, the sugarcane is transferred to a covered patio with a wooden grating floor, allowing the application of drinking water jets that clean the surface of the stalks and are quickly drained. The operational feasibility of all these precautions is ensured in view of the daily production limits, which are up to 1000 times lower than industrialized cachaça (Maia; Campelo, 2006].

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2.2) Broth preparation

The extraction of sugarcane juice is done in simple mills equipped with one or two sets of cylinders. The mills are sanitized before and after daily use, which is usually restricted to the early hours of the morning. Although there are ways to increase the efficiency of extraction in these mills (such as the grinding of previously chopped sugarcane or the imbibition of the bagasse between the first and second milling rounds), these resources are generally avoided or employed with reserves in exceptional situations, prioritizing the extraction of pure juice, with minimal dragging of impurities and components of the husk and bagasse.

Soon after extraction, the juice passes through a thin screen that separates fragments of bagasse that may be dragged. Then, already in a specific room, it passes through a continuous flow decanter that retains 99% of the residual particles. The fresh, clear broth is then sent to the brix adjustment tank, where pure water at room temperature is added, in an amount previously calculated to reduce the sugar content to 15% w/w (Cardoso, 2021). This precaution makes it possible to limit the alcohol content of the fermented wort to 8.5% v/v, which is appropriate both for the preservation of the vigor of the yeast (which will be used in subsequent fermentations) and for the sensory quality of the wort (avoiding the risk of extravasation of the contents of cells that would be damaged due to excessive alcohol contents) and good practices in batch distillation in a still.

2.3) Preparation of the yeast

The propagation of wild yeast is a traditional practice in the field of alembic cachaça. In recent decades, however, several yeast options have been developed that are specially selected for the production of cachaça in the agricultural environment. Its use has been widely welcomed in the productive sector, with important gains in the practicality and effectiveness of the yeast propagation stage. As fermentation takes place in successive batches (taking advantage of the yeast deposited at the bottom of the vat, at the end of each cycle), in general there is no need to replace the selected yeast during the harvest. Wild yeasts have been shown to become progressively incorporated into the wort and can be predominant from one to two weeks (Campos *et al.,* 2010; Souza *et al.,* 2012; Ratkovich *et al.,* 2023].

2.4) Fermentation

The most important differential in the fermentation stage consists in the exclusive use of fresh juice – without the introduction of additives or other procedures that are intended to combat the natural microbial flora that accompanies the broth – in which lactic acid bacteria from the environment predominate (Badotti *et al.,* 2012).

Lactic acid bacteria are spontaneously incorporated into sugarcane juice, without the need for intentional inoculation. These bacteria are healthy and GRAS [10]. They are particularly active in the initial phase of fermentation of fresh sugarcane juice, secreting lactic acid by sugar metabolism. Subsequently, with the decrease in the pH of the wort, they become inactive. The lactic acid content

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in wort is an order of magnitude similar to that of acetic acid, which is secreted as a by-product of yeast metabolism (Reid *et al.,* 2020; Maicas, 2021). Lactic acid (secreted by bacteria) interacts with ethanol (secreted by yeasts) to form the ethyl lactate ester, both in the wort environment and during distillation. The action of lactic acid bacteria extends to other sensorially important compounds, especially phenolics, which are not routinely analyzed (Gaur *et al.,* 2023). Lactic acid and ethyl lactate can be routinely analyzed and have high potential as chemical markers: their presence in cachaça allows us to attest that it was produced by fermenting fresh broth and not subjected to antibacterial treatments.

2.5) Batch distillation

In all alembics distillation is conduced by batches. Unlike continuous distillation (typical of the industrial scale) the batch process allows the separation of three fractions of the distillate (Maia; Campelo, 2006; Lukic *et al.,* 2011; Strickland, 2021) as illustrated in Figure 1:

- The initial fraction (head) corresponds to 5% of the total volume of the distillate. It concentrates methanol, acetaldehyde and ethyl acetate. In certain cases, this fraction may have a sharp and unpleasant odor.
- The intermediate fraction (heart) makes up the freshly distilled cachaça and corresponds to about 80% of the total distilled volume. It contains smaller fractions of acetaldehyde and ethyl acetate, in proportions appropriate to the characterization and sensory evolution of the beverage. In this fraction, most of the higher alcohols (important components in the identity of the beverage) and a fraction of the acetic and lactic acids are collected. In particular, this fraction contains all the noble esters, which are formed within the column of the still itself (Pìggott *et al.,* 1989; Spaho, 2017).

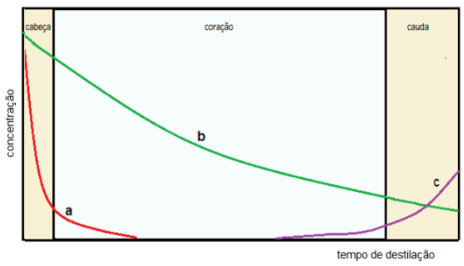

Figure 1 - Typical profiles of the partition of the wort components during batch distillation:
(a) Methanol, acetaldehyde.
(b) Ethanol, higher alcohols.
(c) Volatile acids.

2.6) Copper still

The alembic being made of copper is fundamental for the chemical and sensory quality, not only of cachaça, as any other distilled beverage. This is because copper associates well with a great diversity of functional groups and acts as a catalyst in the formation of numerous compounds. A particularly valuable effect of copper comes from its high reactivity with hydrogen sulfide gas and sulfur compounds in general. It is known that certain strains of yeasts (*Saccharomyces cerevisiae*) release hydrogen sulfide gas, as a residue of the metabolism of sulfur amino acids (methionine, cysteine and cystine) and other sulfur-containing compounds, from the raw material and/or nutritional

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supplements applied to the must (Monk, 1996; Rauhut; Kurbel, 1994). This gas has a very unpleasant smell, reminiscent of rotten eggs, already noticeable at concentrations of 8 µg/L. In steel distillers, hydrogen sulfide gas tends to react with the primary and secondary products of alcoholic fermentation (ethanol, aldehydes and ketones) to generate volatile compounds that, in addition to being cloying, are endowed with detection limits that can reach 0.1 µg/L (Rauhut; Kurbel, 1994).

In alembics, the high electrical conductivity of copper allows hydrogen sulfide gas to be readily converted into cupric sulfide, an odorless and high-density salt that is concentrated in the wine. The valuable functions of copper presuppose the partial conversion of metallic copper into ionic copper, which is soluble in water. Therefore, some copper is transferred to the distilled spirit. At this point, it should be noted that:

- Even in the already distilled beverage, copper still has a beneficial effect on oxidation reactions that are desirable in the maturation and aging stage of the beverage, especially in the conversion of phenolic alcohols and aldehydes into their acids.
- Prior to bottling, the residual copper can be extracted from the beverage by filtration in ion exchange resin. This is necessary when the residual content exceeds 5 mg/L, which is the limit allowed in Brazilian legislation.
- In appropriate proportions, far from being poisonous, ionic copper is indispensable in the daily human diet, acting as a cofactor of enzymes that act inside and outside the cells of all living organisms. In humans, the rate of absorption is adjusted to metabolic demand: intakes above the need lead to lower absorptions, which can be up to ten times lower than the daily normal. The rest is secreted, without accumulation in the body (Davis; Mertz, 1987; Linder, 1991; Collins, 2014).

2.7) Distillate storage

The alembic cachaça produced during the harvest is not intended for consumption. The entire volume is sent to barrels, which can be made of wood or stainless steel, composing mixtures from several distillation batches during the harvest. From these barrels, part of the cachaça is sent to storage in wooden barrels for aging purposes. Another part is intended for larger barrels and selected woods, for maturation purposes. All barrels and barrels are numbered and refer to a record of the production history. Storage is done in a secluded and cool place, equipped with natural ventilation and away from sunlight (Maia; Marinho, 2018).

2.8) Beverage standardization

It is the final step before bottling, in many cases conducted by third-party specialists (*master-blenders*). The cachaça stored in the barrels is transferred to larger barrels in order to make up a traceable fraction of the volume to be standardized. The volumes of the selected barrels are mixed in specific proportions that, after being sensorially approved, are sent for analysis in a third-party laboratory, in order to certify compliance with legal requirements. The mixture, as sensorially

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standardized and approved in the chemical analysis, takes place in stainless steel tanks, whose contents characterize the specific batch number informed on the label of the bottles. This ensures the traceability of each bottle sold (Oliveira *et al.,* 2005; Maia; Marinho, 2018).

2.9) Bottling and labelling

Once pumped into the tank intended for bottling, the cachaça descends by gravity and passes through at least two polishing filters, with porosities of 5 and 0.5 μm, respectively. Bottling and labeling are conducted manually (Figure 2). Prior to labeling, each bottle is visually observed against an indirect white light source, for clarity and absence of any particles.

Figure 2 – Typical environment of the still cachaça labeling area (Google)

Producers reserve two to three bottles of each batch, to witness their quality and sensory evolution over time. After all, the drink can be kept by the consumer for many years and even pass as a relic from one generation to another.

2.10) Absence of color and flavor correctives

Almost all (if not all) producers of alembic cachaça abstain from practices that, although permitted, they consider to be discrediting good production practices. In particular (Maia; Marinho, 2018):

- The legislation allows the addition of caramel coloring to adjust the color of the cachaça, when the contact time with the wood is not sufficient to achieve the desired tonality; the practice does not need to be mentioned on the label. This practice is also accepted in spirits from other countries [26]. However, the spontaneous development of the tonality is an indicator of the level of phenolic components extracted from the wood. If the color needs to be corrected by adding dye, it should be noted that the drink will have inferior quality: the phenolics extracted from the wood, in addition to being nutraceuticals (potent antioxidants) introduce peculiar and highly valued touches of aroma and astringency, as references of sensory nobility.
- The current legislation authorizes the addition of sugar to cachaça up to a limit of 6 g/L, without the need for this information to appear on the label; it also authorizes the addition of sugar in the range of 6 to 30 g/L, characterizing the "sweetened cachaça". In any case, the addition is intended to cover up sensory flaws, such as excess astringency or bitterness, which can be avoided through good manufacturing practices.

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3) QUALITY CONTROL

On a day-to-day basis, process control is carried out in small laboratories at the own factory, by means of appropriate resources to control the sugar content in the juice and must (by refractometry and alcoholometry), alcohol content, pH and total acidity in the wort and in the drink, and copper content in the drink. After standardization (by sensory criteria) and before bottling, producers send a sample from each batch for chemical and chromatographic analysis, when the identity and contaminant parameters (MAPA, 2022) are examined (Table 1). The analysis and approval reports for each batch are obligatorily kept on the factory premises, available to the inspection entities.

Table 1- Parameters monitored in the analysis of each batch of alembic cachaça [MAPA, 2022]

IDENTITY PARAMETERS	CONTAMINANTS
Alcoholic degree	Methanol
Volatile acidity, in acetic acid	
Total esters, in ethyl acetate	Ethyl carbamate
Total aldehydes, in acetaldehyde	2-Propenal
Furfural + Hydroxymethylfurfural	
Total higher alcohols (1-propanol + isobutanol + isoamyl alcohol)	1-Butanol
Coefficient of congeners	2-Butanol
Total phenolic compounds (for aged cachaça)	
Total sugars	Copper

4) CONCLUSION

The designation "alembic cachaça" has become a relevant indicator of refined and high-quality beverage. And it gave rise, within the scope of the legislation (25) to the differentiation between "cachaça" and "alembic cachaça", being:

- "Alembic cachaça: that which is produced exclusively and in its entirety in a copper still and obtained by the distillation of the fermented must of the raw sugarcane juice".
- "Cachaça: when it is produced by another distillation method or by the mixture of cachaças from different distillation methods."

However, the legal concept needs to be improved. Clearly, the differentiation between beverages from the two scales of production is not restricted to the distillation process. To certify the origin, it is essential to recognize that the alembic cachaça is produced from the pure and fresh juice of raw sugarcane – preserving the lactic acid bacteria that accompany the stalks from the moment of harvest. For this reason, it contains relevant levels of lactic acid and ethyl lactate, unlike industrial cachaça, whose production process includes the thermal pre-sterilization of the broth, making lactic acid bacteria unviable.

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