PROSPECTING THE GASTRONOMIC POTENTIAL OF "ERVA-BALEEIRA" (Varronia curassavica JACQ.)

PROSPECÇÃO DO POTENCIAL GASTRONÔMICO DE "ERVA-BALEEIRA" (Varronia curassavica JACQ.)

PROSPECCIÓN DEL POTENCIAL GASTRONÓMICO DE LA "ERVA-BALEEIRA" (Varronia curassavica JACQ.)

Maria Luiza da Silva CORDEIRO[1]
e-mail: maludasilva19@gmail.com

Liz Cristina Camargo RIBAS[2]
e-mail: lizribas@ifsc.edu.br

Patrícia Matos SCHEUER[3]
e-mail: patricias@ifsc.edu.br

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[1] Federal Institute of Santa Catarina (IFSC), Florianópolis – SC – Brazil. Gastronomy Technologist.
[2] Federal Institute of Santa Catarina (IFSC), Florianópolis – SC – Brazil. Professor of Basic, Technical, and Technological Education, Department of Teaching, Research, and Extension (DEPE).
[3] Federal Institute of Santa Catarina (IFSC), Florianópolis – SC – Brazil. Professor of Basic, Technical, and Technological Education, Department of Teaching, Research, and Extension (DEPE).

ABSTRACT: The study evaluated the gastronomic potential as a seasoning of the Brazilian native plant known as "*erva-baleeira*" (*Varronia curassavica*), focusing on its aroma, by analyzing its acceptability and purchase intention, as well as the influence of pre-processing (drying) and cooking temperature on maintaining aromatic intensity. Only 3.4% of the judges (n=86) effectively recognized the plant, while 86% reported never having used it (the few uses mentioned were medicinal). Suggestions for gastronomic use were described by 94% of the judges, especially for meats (64%), sauces (26%), pasta and pizza (22%). There was no significant difference in aroma intensity between fresh and dried leaves, but the acceptability of the dried leaves was significantly higher, as well as the purchase intention (76% for dried leaves and 54% for fresh leaves). Evaluating the influence of cooking temperature on aromatic maintenance directed the gastronomic use of the species under temperatures below 100º C, especially at 60º C.

KEYWORDS: Biodiversity. Seasoning. Flavor. Unconventional food plants.

RESUMO*: O trabalho avaliou o potencial gastronômico como tempero da planta autóctone brasileira conhecida por erva-baleeira (Varronia curassavica), com foco em seu aroma, a partir da análise da sua aceitabilidade e intenção de compra, bem como da influência do pré-processamento (secagem) e da temperatura de cocção na manutenção da intensidade aromática. Apenas 3,4% dos juízes (n= 86) reconheceram efetivamente a planta, enquanto 86% relataram nunca a terem utilizado (os poucos usos mencionados foram medicinais). As sugestões de uso gastronômico foram descritas por 94% dos avaliadores, com destaque para carnes (64%), molhos (26%), massas e pizzas (22%). Não houve diferença significativa da intensidade do aroma entre folhas frescas e secas, mas a aceitabilidade das secas foi significativamente superior, bem como a intenção de compra (76% para folhas secas e 54% para in natura). A avaliação da influência da temperatura de cocção na manutenção aromática direcionou o uso gastronômico da espécie sob temperaturas abaixo de 100 °C, especialmente a 60 °C.*

PALAVRAS-CHAVE*: Biodiversidade. Tempero. Aroma. Plantas alimentícias não convencionais.*

RESUMEN*: El trabajo evaluó el potencial gastronómico como condimento de la planta nativa brasileña conocida como"erva-baleeira"(Varronia curassavica), con foco en su aroma, a partir del análisis de su aceptabilidad e intención de compra, así como de la influencia del pre-procesamiento (secado) y de la temperatura de cocción en el mantenimiento de la intensidad aromática. Sólo el 3,4% de los jueces (n= 86) reconocieron efectivamente la planta, mientras que el 86% declaró no haberla utilizado nunca (los pocos usos mencionados fueron medicinales). Las sugerencias de uso gastronómico fueron descritas por el 94% de los jueces, destacando la carne (64%), las salsas (26%), la pasta y la pizza (22%). No hubo diferencias significativas en la intensidad del aroma entre las hojas frescas y secas, pero la aceptabilidad de las hojas secas fue significativamente mayor, así como la intención de compra (76% para las hojas secas y 54% para las frescas). La evaluación de la influencia de la temperatura de cocción en el mantenimiento aromático orientó el uso gastronómico de la especie bajo temperaturas inferiores a 100º C, especialmente a 60º C.*

PALABRAS CLAVE*: Biodiversidad. Condimento. Aromas. Plantas alimenticias no convencionales.*

Introduction

In terms of plants, approximately 391 thousand species of vascular plants are identified worldwide (RBG KEW, 2016), of which 75 thousand have food potential, often with superior nutritional qualities compared to widely cultivated species (WILSON, 1997). Out of all this potential, only 5.5 thousand (BFN, 2018; RBG KEW, 2016) to 7 thousand species (WILSON, 1997) have been used as food by humanity throughout history.

Currently, due to standardization and reduction of food diversity in agriculture and diet, 90% of the world's food comes from only 20 species (KELEN *et al*., 2015; KINUPP; LORENZI, 2014; VILANI *et al*., 2019). According to the Food and Agriculture Organization of the United Nations, only 12 plant species (combined with 5 animal species) provide 75% of the world's consumed food, and only three of them (rice, maize, and wheat) are responsible for 50% of the globally consumed calories (FAO, 2005).

On the other hand, Brazil is a megadiverse country, holding about 10% to 20% of the world's biodiversity (LEWINSOHN; PRADO, 2005; MITTERMEIER; GIL; MITTERMEIER, 1997; MMA, 2019), which corresponds to approximately 200 thousand species (LEWINSOHN; PRADO, 2005; MMA, 2019), counting on a potential of autochthonous food resources on a proportional scale.

However, it is observed that among the four most important food species for humans (rice, potato, maize, and wheat), none are native to Brazil, and among the 15 most important crops consumed globally, only cassava and peanut are native to Brazilian territory (LEITE; CORADIN, 2011). Despite being the country with the greatest biological diversity in the world, Brazil still presents a highly simplified diet and is dependent on external genetic resources (CORADIN, 2011), with all the food potential coming from its biodiversity still underutilized, neglected, or even unknown.

According to the Secretariat of Biodiversity and Forests of the Ministry of the Environment of Brazil (MMA, 2013), 90% of the country's native flora is not part of the Brazilian diet, even though they reproduce spontaneously. According to Coradin and Camilo (2018), the lack of knowledge about the potential use of native species by the population can not only lead to the disappearance of these species even before the recognition of their real value but also waste the opportunity to use this heritage and the socio-environmental benefits it could generate.

According to Filho (2016), cultivating minor species, currently known as "*Plantas Alimentícias não Convencionais*[4]" (PANC), signifies a new conception of sustainable and ecologically based agriculture. Typically, these plants exhibit characteristics of high hardiness, are minimally affected by pests and diseases, and easily adapt to organic and agroecological cultivation. It is emphasized that the term UFP, proposed in 2008 by biologist and professor Valdely Ferreira Kinupp, can be applied to native or exotic plants, wild or cultivated, that are not commonly used in people's diets but are present in various regions, often occurring in a semi-spontaneous manner and frequently influencing local or regional food culture (FILHO, 2016; KINUPP; LORENZI, 2014).

Among the unconventional native Brazilian plants with food (aromatic) potential is *Varronia curassavica* Jacq., popularly known as "*erva-baleeira*" (Figure 1). A shrub plant belonging to the Boraginaceae family (PIMENTEL *et al*., 2012), it is native to South America and is also recorded in Central America and Mexico (JBRJ, [21--]; LEAL-COSTA; 2017). ccording to the Rio de Janeiro Botanical Garden (JBRJ, [21--]), *V. curassavica* has the following synonyms: *Cordia verbenacea*, *C. curassavica* and *C. salicina*.

Figure 1 – Erva-baleeira or *Varronia curassavica Jacq*. (Florianópolis/SC)

Source: Authors' collection.

[4] Unconventional Food Plants.

In Brazil, it naturally occurs in the coastal sandbanks of almost the entire coastline (DE OLIVEIRA, 2017). Depending on the region where it is found, the species receives popular names such as: *catinga-de-barão*, *cordia*, *erva-baleeira*, *maria-rezadeira*, *camarinha*, *maria-milagrosa*, *balieira*, *baleeira*, *balieira-cambará* (BOLINA, 2015; BRISTOT, 2014), *caramona* or *salicina* (HOELTGEBAUM *et al*., 2015) and *miji-grilo* (LEAL, 2015). According to Montanari Júnior (2011), the name *erva-baleeira* is associated with whale hunting carried out on the coast of Santa Catarina, related to its use by native fishermen during hunting to heal wounds, due to its anti-inflammatory activity.

It is a plant that has been used for years by traditional coastal communities in the treatment of muscular pain, bruises, and inflammations (GONELI *et al*., 2014). Because of this, some scientific studies have been conducted, confirming essential active ingredients with pharmacological functions of interest, especially as anti-inflammatory agents (COUTINHO; MUZITANO; COSTA, 2009).

It is noteworthy that this plant presents a unique, peculiar aromatic potential, with the possibility of use as a food condiment. Therefore, in Florianópolis (SC), the species is also contemporarily referred to as "*erva-caldo-knnor*", compared to the aroma of the industrialized seasoning of the mentioned brand or similar. Although there are studies related to its medicinal use (BOLINA, 2015; GONELI *et al*., 2014; HOELTGEBAUM *et al*., 2015), scientific or even popular references to its gastronomic use are practically nonexistent.

Due to the interest of the pharmaceutical industry in the species' anti-inflammatory action, some studies on its chemical composition have already been published (GOMES, 2010; MICHIELIN, 2009; QUEIROZ *et al*., 2016), focusing on compounds such as tannins, flavonoids, and essential oils. It is emphasized that the plant's essential oil, composed of different substances, is mainly responsible for its characteristic aroma, with potentially relevant gastronomic importance. According to Queiroz *et al.* (2016), the main compounds of this oil are: *α-pineno*, *trans-cariofileno*, *elixeno*, *aloaromadendrene* and *γ-muuroleno*.

Toxicological studies support the safe use of the species in food. According to a literature review on the plant's *in vivo* toxicology, conducted by Gilbert and Favoreto (2012) from the Drug Technology Institute of FIOCRUZ:

> In the series of studies on the pharmacology of *Cordia verbenacea*[5] in laboratory animals, significant levels of acute toxicity were not observed in the extracts or isolated substances, either orally or topically administered

[5] Synonym for *V. curassavica*.

> (SERTIÉ *et al*., 1988, 1990, 1991 e 2005; BAYEUX *et al*., 2002; BASILE *et al*., 1998; PASSOS *et al*., 2007; ROLDÃO *et al*., 2008). Sertié *et al*. (2005) demonstrated that the lyophilized hydroalcoholic extract administered orally to female rats during pregnancy did not affect the female's cycle, normal fetal development, bone structure, sexual maturation, or fertility (GILBERT; FAVORETO, 2012, p. 21-22, our translation).

Within this context, aiming to promote the use of Brazilian biodiversity in regional or national gastronomy, the present study aimed to analyze the gastronomic potential of *erva-baleeira* (*Varronia curassavica* Jacq.), focusing on its aroma, considering its acceptability, aroma intensity, purchase intention, pre-processing, and cooking temperature.

Materials and Methods

Materials and Pre-processing

The leaves of *erva-baleeira* (*V. curassavica*)[6] in late August 2019 from a coastal area used as pasture in the south of Santa Catarina Island (Florianópolis/SC), where the species occurs spontaneously. The leaves were collected from six (6) specimens (distinct individuals) from the exact location, mixed to obtain uniform and similar samples. To obtain the dried leaves, the leaves were plucked from their branches and stored in plastic bags until the drying process.

After transportation, the leaves underwent a screening process before drying to remove impurities and elements not selected for the research, such as flowers from the plant itself, branches, and even leaves outside the standard (dry, showing signs of herbivory, etc.). The leaves were then divided into four (4) 100 g samples (replications) and placed on paper towels on the internal shelves of a conventional oven (*DeLeo®, Modelo A3SEDZ, Brasil*). They were kept for 36 hours at a constant temperature of 40°C until completely dry. This drying temperature was selected based on Gasparin *et al*. (2014), which indicates a temperature below 50°C to obtain the maximum yield of the essential oil present in the plant and minimal leaf color degradation.

Additionally, the DIN 6174 Standard (GASPARIN *et al*., 2014) stipulates that at specifically 40°C, it is possible better to distinguish the color difference between fresh and dried leaves. Concurrently with the literature justification, the temperature of 40°C was selected

[6] The research has a registration certificate in the SISGEN (National System for Management of Genetic Heritage and Associated Traditional Knowledge) – No A7DCE9C, in compliance with the provisions of Law No. 13.123/2015 and its regulations.

because it is the minimum temperature used in the aroma intensity test in infusions, and drying could not be done at a higher temperature to avoid causing issues in the analysis. Immediately after drying, the yield assessment was carried out.

For the comparative sensory analysis between fresh and dried leaves, the dried leaves were stored in hermetically sealed glass jars in a ventilated environment for one (1) week, while the fresh leaves used were harvested 1 hour before the test to maintain their organoleptic characteristics. For the experiment analyzing aroma intensity as a function of temperature, the dried leaves were stored for three (3) weeks under the same conditions. For this latter analysis, the leaves were ground in a blender (*Walita®, Model BLSTMG-RD0-057*) for use in the proposed infusions.

The drying of the leaves for conducting the experiments, as well as the yield analysis, was performed in the Research Laboratory of the Florianópolis-Continente Campus of the Federal Institute of Santa Catarina (CTE/IFSC).

Yield

The yield in weight of dried *erva-baleeira* leaves from fresh leaves was calculated as a percentage, based on the following formula, from four (4) repetitions, meaning four samples of 100g of fresh (initial) leaves each.

$$\text{Yield (\%)} = \left(\frac{peso\ folhas\ secas}{peso\ folhas\ frescas}\right) \text{ x } 100^{7}$$

Acceptability Test, Purchase Intent, and Aroma Intensity of Leaves

According to ISO 11136:2013, "Acceptability tests are used to measure the intensity of pleasure in consumption or degree of liking of the product through scale tests, i.e., ranking tests" (DUTCOSKY, 2013, p. 296, our translation). The analyses took place in the Beverage Laboratory of CTE/IFSC, applied to a group of untrained evaluators (n= 86). The evaluating audience was composed of an open invitation to the internal community of the institution (CTE/IFSC), with voluntary participation and prior signing of an informed consent form, characterized by 71% female and 27% male participants, with 2% not responding to this

[7] Translation of the text above: weight of dried leaves; Translation of the text below: weight of fresh leaves.

criterion. Most evaluators were aged between 21 and 35 years (40%), with 10% aged up to 20 years, 37% between 36 and 50 years, and 13% aged over 51 years.

The acceptability test, purchase intent, aroma intensity of the leaves, species recognition and uses, as well as suggestions for gastronomic use, were evaluated through a specific semi-structured questionnaire. For species recognition, the plant was presented to the judges in the form of a branch approximately 30 cm long (Figure 2).

Acceptability

In this study, an acceptability test of the aroma for gastronomic use of fresh and dried leaves of *V. curassavica*, was conducted through a questionnaire, with the aim of identifying whether the evaluators would accept the plant's aroma under both forms of presentation (fresh and dried leaves). Normally, acceptability testing is conducted with foods or aromas already known to the judges. However, as the present study was a survey of a raw material not used in food, the test was used to evaluate the acceptability of a new aroma in gastronomic terms.

Figure 2 - Species recognition, acceptability test for gastronomic use, purchase intention, and analysis of aroma intensity of fresh and dried leaves of *erva-baleeira* (*V. curassavica*)

Source: Authors' Collection.

In this analysis, sample 1 consisted of three (3) to four (4) dried leaves of the plant per evaluator, while sample 2 consisted of 1 fresh leaf per evaluator (Figure 2). Each judge was instructed to manually compress and/or macerate/tear sample 1 (dried) with one hand, followed

by sensory analysis of the aroma and acceptability test. A similar procedure was performed for analysis of sample 2 (fresh), but the opposite hand was used to avoid aroma mixing. Between each olfactory analysis, judges were instructed to inhale the aroma of roasted coffee beans to neutralize previous aromas.

To assess the acceptability of the plant's aroma, a structured verbal hedonic scale of 5 points was used (1 - disliked very much; 2 - disliked; 3 - indifferent; 4 - liked; 5 - liked very much), based on the methodology described by Dutcosky (2013).

Purchase intention and suggestions for gastronomic use

In conjunction with the acceptability test, an analysis of the intention to purchase the plant for food use was conducted based on the analyzed aroma, highlighting the preference between the use of fresh or dried leaves. The questionnaire evaluated purchase intention through a closed-ended question, while suggestions and indications of gastronomic uses with the plant were assessed in an open-ended question, allowing more than one response per evaluator.

The aroma intensity of the leaves

For this test, the assessor evaluated the aroma intensity using a scale based on the application form of Dutcosky's single-sample test (2013) and the quantitative descriptive analysis form proposed by the same author, using a scale with ratings from 1 to 4 (1 - nonexistent; 2 - weak, 3 - medium; 4 - strong).

Influence of cooking temperature on the maintenance of *V. curassavica* aroma

The influence of cooking temperature on the plant's aroma was assessed in a specific sensory analysis because preliminary tests indicated that *erva-baleeira*, exhibited excessive or total loss of aroma when exposed to high temperatures. Therefore, a sensory analysis of the plant's aroma in infusions under different initial temperatures (40°C, 60°C, and 100°C) was conducted to evaluate the ideal temperature for maintaining its aroma in culinary applications. For this purpose, a specific questionnaire was applied along with the analysis.

This test was also conducted in the Beverage Laboratory of CTE/IFSC, involving a group of untrained judges (n=49). The assessor audience was also invited from the internal community of the institution (CTE/IFSC), with voluntary participation and prior signature of

an informed consent form, consisting of 69% female and 27% male participants, with 4% not responding to this criterion. Regarding age, 8% of the assessors were up to 20 years old, 37% were between 21 and 35 years old, 37% were between 36 and 50 years old, and 16% were over 51 years old (2% did not respond).

The infusions were prepared only from dried leaves of *erva-baleeira* (***V. curassavica)***, as they showed greater acceptability and purchase intention in the preliminary test described. Another reason for their use, instead of fresh leaves, was because the test focused only on one variable aspect, namely temperature.

For the preparation of each infusion, 12 grams of crushed dried plant material (approximately 70 ml) were used in 400 ml of water (concentration: 30 g/l) at initial temperatures of 40°C (sample 376), 60°C (sample 126), and 100°C (sample 824), as shown in Figure 3A. The samples were coded with three random numbers, as recommended by Dutcosky (2007).

For aroma evaluation, the infusions were served in transparent glass cups (Figure 3B), with 50 ml of each sample per participant, identified by the three pre-established random numbers. The presentation order of the infusions to the assessors was: sample 126 (60°C), sample 824 (100°C), and sample 376 (40°C). The samples were not arranged in ascending order of temperature to avoid inducing responses.

The assessors evaluated whether it was possible to perceive the aroma of the plant in the specific infusion, also analyzing its intensity using a scale based on Dutcosky's single-sample test application form (2013) and the quantitative descriptive analysis form proposed by the same author.

Before the analysis, a sample of dried leaves of *erva-baleeira* was presented to each assessor, aiming to educate the olfactory sense (recognition) about the aroma to be perceived, excluding all other aromas that differed from the aroma in question. Each assessor was instructed to manually compress and/or macerate/tear the leaves with their hands, followed by sensory analysis of the aroma. Between samples, they were also instructed to smell roasted coffee beans to neutralize previous aromas.

Figure 3 – Sensory analysis of the influence of infusion temperature (cooking) on the maintenance of the aroma (intensity) of *erva-baleeira* (*V. curassavica*)

Source: Authors' collection.

The sensory analysis of the aroma intensity of the infusions was conducted based on Dutcosky (2013), following the methodology already described in previous tests, using a scale with scores ranging from 1 to 4.

Statistical Analysis

To analyze the yield of dried leaves from fresh leaves, the mean yield of the four samples (replicates) was calculated, as well as the standard deviation (α) for statistical analysis of data dispersion.

The sensory analysis of the first experiment (recognition of the plant, uses, aroma intensity, acceptability, and intention to purchase fresh and dried leaves) was conducted by 86 untrained judges (n = 86), while the analysis of aroma intensity as a function of infusion temperature was conducted by 49 judges (n = 49).

The means of the scores provided for acceptability and aroma intensity (in both experiments) were compared using analysis of variance of the means (ANOVA), which were further compared by Tukey's test ($p < 0.05$). Other parameters were analyzed by relative frequency (percentage).

Results and Discussion

Yield

The commercial use of a plant is facilitated by its prior drying, allowing for storage. Conversely, fresh plant material has a short and quick commercialization chain because its high-water content facilitates the proliferation of microorganisms and enzymatic reactions, which can lead to its deterioration (FARIAS, 2003; RODRIGUES *et al*., 2011).

In the case of *Varronia curassavica*, the yield of dried leaves obtained in a conventional oven from fresh leaves was 30.9 ± 1.18%. This suggests a moisture content in the fresh plant of 69%, although the gravimetric method in an oven, one of the most commonly used methods to measure moisture content in plant samples (BORGES *et al*., 2005), was not performed since the aim was to analyze the yield of dried leaves from fresh ones (generating proportionality), rather than moisture content per se. Furthermore, the gravimetric method recommended by the Brazilian Pharmacopoeia (BRASIL, 2010) specifies that samples should be dried between 100°C and 105°C, which could render the use of the plant unfeasible due to evaporation or deterioration of its essential oils responsible for its characteristic aroma.

This calculated moisture content for fresh leaves of *V. curassavica* is relatively low compared to other aromatic or medicinal plants already widely used by the population, resulting in a higher yield of dry raw material. This is because the leaf of erva- is not succulent, being quite resistant and with a high content of organic matter. In comparison, basil (*Ocimum gratissimum*) and oregano (*Origanum vulgaris*) have moisture contents of 78% and 73%, respectively (BORGES *et al.,* 2012).

It is noteworthy that the temperature in the drying process can interfere with the concentration of volatile compounds such as essential oils, especially in aromatic herbs. In this regard, temperatures should not be too high in this process for *erva-baleeira*, as there is evidence that temperature affects its aroma. Farias (2003) emphasizes that drying methods in ovens determine not only the loss of water but also of other constituents volatilized along with the water. Therefore, the first sensory analysis conducted involved fresh and dried plants, precisely to analyze the intensity of the aroma in both presentations of the plant, as well as their modifications.

Species recognition and use

In terms of species recognition, 17.4% of the evaluators described knowing the plant, while 72.1% mentioned being unfamiliar with it. Additionally, 10.4% claimed to know it but incorrectly identified it, confusing it with other species: basil (1), lemon balm (1), "seed herb" (1), fennel (1), chamomile (2), lemon balm (2), and myrrh (1).

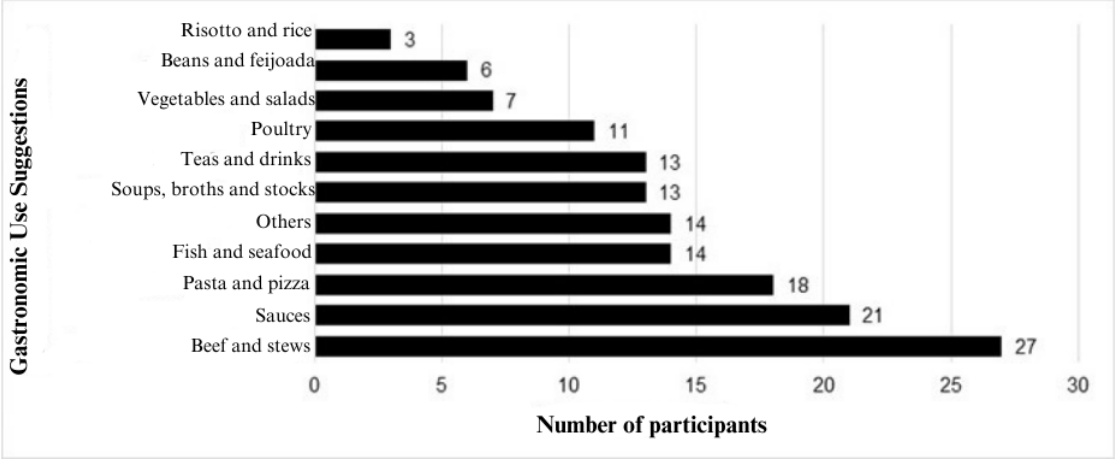
It is worth emphasizing that although 17% of the participants claimed to know the plant, only 3.4% of them remembered or knew its name. There is a possibility of confusion in this recognition (as evidenced by the erroneous names given), since many evaluators relied solely on the aroma for recognition, which can resemble that of other plants and even industrialized spices.

The recognition names described by the judges for the plant were: *erva-baleeira* (3), *Cordia* (1) and *mijo-de-grilo* (1). It is worth noting that the term "*erva-baleeira*" or simply "*baleeira*" is a popular term used in Brazil and along the coast of Greater Florianópolis for the species (BOLINA, 2015; BRISTOT, 2014; HOELTGEBAUM *et al*., 2015), while the term "*Cordia*" refers to the plant's former classification genus, indicating a certain scientific knowledge of the judge. On the other hand, the term "*mijo-de-grilo*" or "*miji-grilo*" is another popular identification term for the plant, especially in the south of Santa Catarina Island (LEAL, 2015).

Regarding usage, 3.4% of the participants claimed to have already used the plant for some purpose. In terms of medicinal use, they mentioned its use as an anti-inflammatory and for muscle pain relief, which is already proven by scientific studies (BOLINA, 2015; BRISTOT, 2014; GILBERT; FAVORETO, 2012). The few mentions of the species' use in gastronomy were as tea and seasoning for rice. It is worth noting that 86% claimed to have never used it.

When asked about suggestions for using the plant in gastronomy, based on the perceived aroma, 94% of the participants suggested its use in various preparations (Figure 4), with emphasis on beef and derivatives (33%), sauces (26%), pasta and pizzas (22%), as well as fish and seafood (17%).

Figure 4 – Gastronomic indications for *erva-baleeira* (*V. curssavica*) based on aroma



* Based on 81 respondents for this criterion.
Source: Compiled by the authors.

It is noteworthy that the use of the plant for seasoning various types of meat (beef, poultry, fish, and seafood) was significantly mentioned by 64% of the evaluators who responded to this criterion, highlighting the potential of the plant for this purpose.

Intensity and acceptability of the plant's aroma

In order to evaluate the gastronomic potential of *erva-baleeira* as a seasoning, the acceptability, and intensity of its aroma were analyzed, based on both fresh and dried leaves, aiming to determine which form is more accepted and better indicated.

Considering Table 1 and the scale used, the aroma intensity was rated as medium to strong for both fresh and dried leaves. This intensity was statistically similar for both forms of presentation of the plant.

Table 1 – Analysis of intensity and acceptability of the aroma of dried and fresh leaves of *erva-baleeira* (*V. curassavica*) for gastronomic use

Leaf	Intensity	Acceptability
Dry	$3,24^{a} \pm 0,049$	$4,02^{a} \pm 0,89$
Fresh	$3,17^{a} \pm 0,049$	$3,51^{b} \pm 1,10$

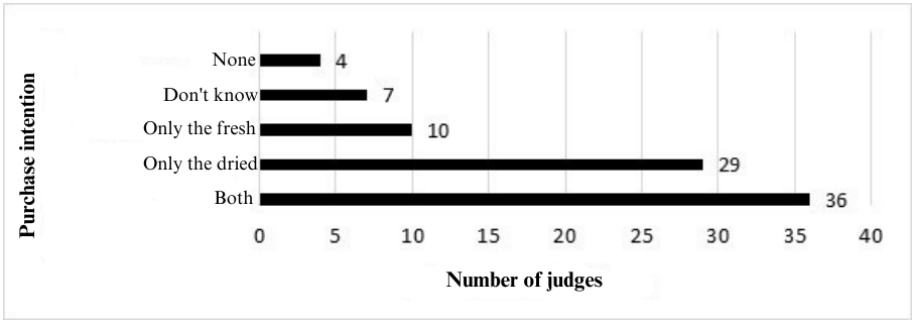
* Values are means ± standard deviation, based on 86 participants. Different letters after the mean values in each column indicate significant differences between the mean ratings, according to Tukey's Test ($p < 0.05$).
Source: Compiled by the authors.

Regarding the acceptability of the aroma, as shown in Table 1, the dry leaf was rated between "liked" (4) and "liked very much" (5) on average, while the fresh leaf received an average rating between "indifferent" (3) and "liked" (4). It is also observed that the acceptability of the dry leaf is significantly higher than that of the fresh leaf. Based on this sensory analysis, there is a greater potential for gastronomic use of the dry plant, which favors its commercial logistics due to its longer shelf life.

Purchase intention

When analyzing the purchase intention of fresh and dry leaves of *erva-baleeira*, only 4.6% of the participants mentioned that they would not buy the plant in any form for gastronomic use, demonstrating great commercial potential for the plant in this regard (Figure 6).

Figure 6 - Purchase intention of fresh and dry leaves of *erva-baleeira* (*V. curassavica*), for gastronomic use



*Based on 86 evaluators.
Source: Developed by the authors.

It is also observed in the figure that 76% of the evaluators would purchase the dried leaves of the plant, and 54% would buy its fresh version. These data corroborate the aroma acceptability results, directing the recommendation of dried leaves for gastronomic use.

Intensity of aroma according to temperature

Preliminary tests for this study indicated aromatic loss of the *erva-baleeira* at high temperatures (such as 150°C), which in some cases appeared to be total. Therefore, an analysis of aroma intensity according to infusion temperature was conducted, aiming to indicate ideal cooking temperatures for the best use of this potential seasoning's aroma.

Analyzing the results from Table 2 and based on the hedonic scale used, it was observed that all infusions (at 40°C, 60°C, and 100°C) received intensity ratings ranging from weak to moderate, despite being made with a relatively high percentage of dried plant (30 g/l).

Although the average aroma intensity of the 60°C infusion was numerically higher than that of the 40°C infusion, both were statistically equal. It was expected that the lower the temperature, the greater the perception of the aroma. However, substances must volatilize for olfactory perception. Considering that the initial water temperature of the infusion of sample 376 was 40°C and that the ambient temperature was lower (around 20°C to 25°C), it is presumed that there was a cooling of the infusion until its evaluation by the evaluators, resulting in the reduction of volatile compounds present, consequently decreasing their perception.

Table 2 – Analysis of aroma intensity of dried leaves of *erva-baleeira* (*V. curassavica*) according to infusion water temperature

Temperature	Aroma intensity
40°C	$2,55^{ab} \pm 0,89$
60°C	$2,96^{a} \pm 0,86$
100°C	$2,39^{b} \pm 1,00$

* Values are means ± standard deviation, based on 49 participants. Different letters after the mean values in the column indicate significant differences between the mean scores, according to Tukey's test ($p < 0,05$).
Source: Developed by the authors.

The aroma intensity in the 60°C infusion received practically average or moderate scores. This aroma was statistically evaluated as more intense than the 100°C aroma, leading to corroborating preliminary tests that high temperatures may affect reducing the aroma of the species. Further studies are needed for conclusive statements, especially using trained participants. However, as previously described, preliminary tests with the plant, conducted in ovens at 150-180°C, found that the characteristic aroma of the plant became imperceptible, leading to infer that the essential oils would have volatilized or destabilized with the temperature.

In Table 1, the main substances constituting the essential oil of *erva-baleeira*, responsible for its aroma, as well as their boiling and flash points, have been systematized[8].

Table 1 – Main substances present in the essential oil of *erva-baleeira* (*V. curassavica*) e and their boiling and flash points

Substance	Percentage in the plant's essential oil	Boiling point	Flash point
α-Pineno	**29,69 %** (QUEIROZ *et al.,* 2016)	**155-163 °C** (CHEMÉO, 2019) **154-156°C** (CHEMSPIDER, 2019)	**31 °C** (SIGMA-ALDRICH, 2019) **32-33°C** (CHEMSPIDER, 2019)
Trans-cariofileno (β-Cariofileno)	**22,6 a 27,4 %** (QUEIROZ *et al.,* 2016)	**262-264 °C** (SIGMA-ALDRICH, 2019) **268±10 °C** (CHEMSPIDER, 2019)	**101°C** (PUBCHEM, 2019) **105±14°C** (CHEMSPIDER, 2019)
Elixeno	**14,9 a 17,2%** (QUEIROZ *et al.,* 2016)	**284º C** (CHEMÉO, 2019) **258±40 °C** (CHEMSPIDER, 2019)	**101±22 °C** (CHEMSPIDER, 2019)
Biciclogermacreno	**13,8 %** (SANTOS *et al*. 2006)	**267- 268 °C** (TGSC, 2019)	**104 °C** (TGSC, 2019)
β-pineno	**13,1 %** (SANTOS et. Al 2006)	**166 °C** (PUBCHEM, 2019) **163-166 °C** (CHEMSPIDER, 2019)	**36 °C** (SIGMA-ALDRICH, 2019) **43 °C** (CHEMSPIDER, 2019)
α-Humuleno (***α*-**Cariofileno)	**12,4 %** (SANTOS *et al.,* 2006)	**166-168 °C** (SIGMA-ALDRICH, 2019) **276±40 °C** (CHEMSPIDER, 2019)	**90º C** (SIGMA-ALDRICH, 2019) **110±22 °C** (CHEMSPIDER, 2019)
Aloaromadendreno	**10 %** (QUEIROZ *et al.,* 2016)	**258±7.0 °C** (CHEMSPIDER, 2019) **261-267 °C** (SIGMA-ALDRICH, 2019)	**106±6 °C** (CHEMSPIDER, 2019)
γ-muuroleno (gama-muuroleno)	**9,1% a 9,8%** (QUEIROZ *et al.,* 2016)	**271°C a 272°C** (CHEMSPIDER, 2019; TGSC, 2019)	**107 °C** (CHEMSPIDER, 2019; TGSC, 2019;)

Source: Compiled from Cheméo (2019), ChemSpider, (2019), PubChem (2019), Queiroz *et al.* (2015), Santos *et al*. (2006), Sigma-Aldrich (2019) and TGSC (2019).

[8] The lowest temperature at which a substance releases vapor in sufficient quantity, which, when mixed with atmospheric air, initiates inflammation upon contact with a source of heat (NICHETTI, 2010).

It is observed that the boiling points of major compounds are below 156°C, suggesting the use of the plant at temperatures lower than this to preserve its characteristic aroma. On the other hand, the flash points of all analyzed substances are between 30°C and 100°C, indicating that the recommended cooking temperature in ovens and stoves (heat sources) can be even lower.

It is emphasized that the highest number of "non-existent" aroma notes (score 1) was precisely attributed to the infusion at 100°C (20.4%), followed by the infusion at 40°C (10.2%) and 60°C (6.1%). On the other hand, the highest scores for aroma intensity (scores 3 and 4 - moderate and vigorous) were attributed to the infusion at 60°C (44.9% and 28.6% of the evaluations, respectively), as presented in Table 3.

Table 3 – Analysis of aroma intensity of aqueous infusions of dried leaves of *erva-baleeira* (*V. curassavica*) as a function of temperature

Aroma Note (Intensity)	**TEMPERATURE**		
	40º C	**60º C**	**100º C**
1 (non-existent)	10,2%	6,12%	20,4%
2 (weak)	40,81%	20,4%	36,73%
3 (moderate)	32,65%	44,9%	26,53%
4 (strong)	16,32%	28,6%	16,32%

* Based on 49 evaluators.
Source: Compiled by the authors.

Considering the three temperatures evaluated and the results obtained, as well as the chemical nature of the constituents of the plant's essential oil, it is suggested that the culinary use of the *erva-baleeira* does not involve temperatures close to or higher than 100°C, with an ideal temperature at 60°C.

Additionally, when the aroma of the plant was not detected in the infusion, participants were asked to indicate a similar aroma for comparison. Among the few responses, the aroma of "mate" (5), which appeared for all three infusions, stood out. For the infusion at 100°C (sample 824), the highest number (5) of distinct aromas was suggested compared to the analyzed plant, including the aroma of chamomile (2), which is very different from *baleeira*, evidencing that the high temperature significantly altered the composition of the essential oils present, changing the characteristic aroma.

Final considerations

The work carried out has identified the high culinary potential of *baleeira* as a seasoning, based on the acceptability of its aroma, both from fresh and dried leaves. However, the superior acceptability of the dried leaves enables longer storage and commercialization chains.

It is worth noting that the aromatic potential of *V. curassavia* as a seasoning was verified not only by its acceptability and purchase intention but also by the number of formulations suggested by 94% of the judges, especially for meats in general (64% of respondents).

The evaluations indicated, in general terms, that high temperatures, close to or above 100°C, should not be employed for *erva-baleeira (V. curassavica)*, with an ideal temperature at 60°C, aiming to maintain its aromatic integrity. However, further studies are suggested using trained aroma evaluators, as well as more temperature scales. Other studies, involving the use of the plant in culinary preparations, can help consolidate the species in the food sector.

Finally, it is noteworthy that the culinary use of this plant can contribute socio-environmentally, encouraging the use of Brazilian biodiversity and underutilized plants, expanding not only the number of species used in gastronomy but also nutritional and organoleptic diversity, as well as fostering local and small-scale production chains.

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Data and material availability: The undergraduate thesis that originated the article is available for access in the IFSC institutional repository (https://repositorio.ifsc.edu.br/). The raw data collected are under the authors' domain and available for further consultation if necessary.

Authors' contributions: **Maria Luiza da Silva Cordeiro:** is the main researcher and student who conducted the research as part of her bachelor's degree in Gastronomy at IFSC, which originated the article. **Liz Cristina Camargo Ribas:** research supervisor; assisted in defining the research topic and objectives; made contributions to the text and corrections, as well as assisted and guided in the experimental development and analysis. **Patrícia Matos Scheuer**: research co-supervisor; in addition to contributions to the text, was responsible for guiding the guidelines of the conducted sensory analysis.

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