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Maceration time over antioxidant activity, volatile compounds and temporal dominant sensation of fermented jabuticaba

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Abstract

Jabuticaba is a fruit sensory appreciated and has significant nutritional and functional value. However, it is quite perishable, and its use is interesting for the preparation of other products such as fermented jabuticaba, from a nutritional, biological and technological point of view. This study evaluated the interference of maceration time over antioxidant capacity, volatile compounds profile and temporal dominant sensation of fermented jabuticaba. Four different treatments of fermented jabuticaba in different fermentation times were prepared (96, 120, 144 and 168 h). After preparation, total monomeric anthocyanin content, total antioxidant activity by *2,2-azino-bis 3-ethylbenzthiazoline-6-sulfonic acid* and iron reduction method, volatile compounds profile by gas chromatography and sensory analysis of temporal dominance of sensations were performed of fermented jabuticaba. The highest concentration of total anthocyanins (25.81 mg/100 g) and antioxidant activity (78.34 μmol Trolox/g e 84.69 μM $FeSO_4$/g) of jabuticaba is in its skin. Regarding the antioxidant activity by FRAP method, the fermented beverages presented higher value than the whole fruit. However, after 96 h of maceration, the values decreased, followed by an increase after 144 h. In all maceration times the predominant sensation was acidic taste, initially and then astringency, the most persistent sensation in all treatments. However, there was a downward trend in this sensation with the increase in maceration time, as well as isoamyl alcohol content.

Keywords: anthocyanins; antioxidants; bioactive compounds; fermented beverage.

Practical Application: Anthocyanins and antioxidant activity reduced after 96 h of maceration time.

1 Introduction

Jabuticaba fruit is characterized by presenting a black spherical berry with a thin and fragile peel and a gelatinous fruit pulp that has an astringent and sweet flavor due to its high content of sugars and acids (Oliveira et al., 2019). This fruit is highly perishable; therefore, it is interesting to use it in other preparations such as fermented beverages, juices, jam and liqueur (Dias et al., 2016; Hacke et al., 2016; Morales et al., 2016). According to Stafussa et al. (2018), jabuticaba fruits are considered a natural source of the anthocyanins, that represent an important class of flavonoids, total phenolic compounds (TPCs) and antioxidant activity. In addition, its peel is the main source of these components (Stafussa et al., 2018). According to Jideani et al. (2021), these components have antioxidant, anti-inflammatory, antimutagenic, and anticarcinogenic properties.

Jabuticaba has a high nutritional value, rich in fibers, minerals, vitamins such as carotenoids and phenolic compounds such as flavonoids, especially the anthocyanins, with a potent antioxidant activity, antinflammatory, antimutagenic and chemopreventive (Duarte et al., 2010; Plaza et al., 2016; Silva et al., 2014), in which its peel is the main source of these compounds, being responsible for the red-purplish coloration of the fruit (Zhao et al., 2019).

Maceration is a fundamental technique of vinification, and its time is prolonged in the production of red wines, in which occurs alcoholic fermentation, affecting sensorial properties and its aroma. The action of enzymes promotes maceration by increasing the concentrations of alcohols during the process involving ethanolic extraction (Kocabey et al., 2016). In studies with wine has been reported that the increase of the ethanol level after maceration process led to in the better solubilization of pigments such as anthocyanins and tannins (Kocabey et al., 2016; Ouyang et al., 2017). However, excessive maceration can lead to wine with unpleasant flavor (Ouyang et al., 2017). According to Pérez-Navarro et al. (2018), maceration time has a significant impact on the style and quality of red wine.

It has been well documented the effect of maceration time on sensory attributes and antioxidant activity of wine made of grape (Kocabey et al., 2016; Ouyang et al., 2017; Pérez-Navarro et al., 2018). However, such investigations have not been well conducted

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in fermented jabuticaba. Since the fermentation of jabuticaba can potentialize its antioxidant activity, that confers benefits to human health and in the industrial field, this study is necessary to evaluate the fermentation parameters in order to optimize maceration time to produce fermented jabuticaba with better acceptability and nutritional quality (Guergoletto et al., 2017). In addition, acceptability of fermented beverages is influenced by its aroma which is also developed during the maceration process and that plays important roles in determining the organoleptic quality of fermented. In general, the aroma of fermented beverages is the result of the balance of various volatile compounds and its composition is determined mainly by the fruit's genotype and fermentation process (Ouyang et al., 2017). The harmony of these components is critical to maintain the beverage nutritional value and quality (Guergoletto et al., 2017).

Therefore, this study evaluated the interference of maceration time during 96 to 168 h over the antioxidant activity, volatile compounds profile and temporal dominance of sensations of fermented jabuticaba.

2 Materials and methods

2.1 Development of fermented jabuticaba

The fruits were acquired in Cachoeira do Campo district, located in the city of Ouro Preto - MG, Brazil. After the jabuticabas were received, they went through manual selection processes considering the degree of ripeness and injuries, and rachis removal or destemming. This procedure is of great importance to the fermented beverage quality, because its presence negatively impacts on must chemical composition due to low sugar content, acidity and high content of potassium and tannins, which may lead to the appearance of bitter taste and astringency in beverages (Rizzon & Meneguzzo, 2006). The cleaning was performed on treated running water and then the fruits were submerged in 100 ppm chlorinated water for 10 min, completing the sanitization process. For the crushing process, 4.5 kg of jabuticabas for each treatment were placed in polypropylene containers and crushed with a polyethylene plunger for the release of must by rupturing the peel. Then, they were transferred to sanitized polyethylene containers, where 30 g/hL *Saccharomyces cerevisiae var bayanus EC1118* was inoculated (Lallemand, Blagnac, France), according to the manufacturer's recommendations.

The containers with must were closed and this stage of fermentation, also known as maceration or tumultuous fermentation was performed at room temperature (23 ± 3 °C) during 96, 120, 144 and 168 h, determining the four treatments. The must temperature remained between 20 °C and 26 °C in the contact phase with the peel (maceration). After the maceration step, a sieve was used for separating pomace and must and then, must was filtered in organza fabric. The pressing was manually performed through spatulas, avoiding pressing too much so undesirable compounds such as tannins would not be extracted.

After filtering, fermented jabuticaba were placed in closed polyethylene buckets again and left for 21 days under refrigeration (7 ± 2 °C). After this stage (secondary fermentation or maturation) 7.5% sucrose was added to make semi-dry fermented beverage. Olive green glass bottles were filled with the beverages and sealed with cork stoppers. Samples of whole jabuticaba and its fractions (pulp and peel) and fermented beverages after the maturation stage were collected and stored at -80 °C in Ultrafreezer DF8524GL model (Skadi®) for further analysis.

2.2 Chemical analysis

Moisture, ashes, lipids and proteins

The content determination of moisture, protein, lipids and ashes of the whole jabuticaba and its fractions (pulp and peel) were performed according to the AOAC (Association of Official Analytical Chemists, 2012).

Extracts preparation for determination of anthocyanins and antioxidant activity

The extracts were obtained according to the method described by Larrauri et al. (1997). Samples were weighed (10 g) in centrifuge tubes and extracted with 40 mL of methanol/water (50 : 50, v/v) at room temperature for 2 h. The tubes were centrifuged at 25,400 g (15,000 rpm) for 30 min, and the supernatant was recovered. Then, 40 mL of acetone/water (70:30, v/v) were added to the residue at room temperature. The samples were extracted for 2 h and centrifuged at 25.400 g (15.000 rpm) for 30 min. To determine the antioxidant activity as well as anthocyanins content, methanol and acetone extracts were combined and for the final volume of 100 mL were added distilled water.

Total monomeric anthocyanin content

Total monomeric anthocyanin content (TMAC) was estimated using the method of differential pH (Wrolstad, 1993). Each extract was diluted in buffer solutions of pH 1.0 to 4.5 in order to achieve the same dilution. Absorbance was made in spectrophotometer model 600S FEMTO and measured at 510 nm and 700 nm, in both buffers. Then TMAC (expressed as cyanidin-3- glucoside) was calculated using the Equations 1 and 2:

$$A = \left(A_{510} - A_{700}\right)\, pH\, 1,0 - \left(A_{510} - A_{700}\right)\, pH\, 4,5 \quad (1)$$

$$\mathrm{TMAC} = \frac{\mathrm{A} \times \mathrm{MW} \times \mathrm{DF} \times \mathrm{Ve} \times 100}{\varepsilon \times 1 \times \mathrm{M}} \quad (2)$$

Where: A = absorbance in nm; MW = molecular weight of cyanidin-3-glucoside (449 g mol^{-1}); DF = the dilution factor; Ve = extract volume; ε= molar extinction coefficient of cyanidin-3-glucoside, ε = 26,900; M = mass of fruit or fermented beverage in the extract.

The results were expressed in mg of equivalent cyanidin-3-glucoside /100 g of fruit or fermented beverage on a wet basis.

Determination of total antioxidant activity by ABTS free radical capture

The antioxidant activity using *2,2-azino-bis 3-ethylbenzthiazoline-6-sulfonic acid* (ABTS) free radical was determined by the method of Rufino et al. (2010). ABTS was prepared from 5 mL of ABTS aqueous solution (7 mM) and 88 µL of 140 mM potassium persulphate solution. This mixture was stored for 16 h at room

temperature, in absence of light and diluted in methanol to obtain an absorbance of 0.700 ± 0.05 nm to 734 nm. Aliquots of 30 μL were added to 3 mL of the diluted ABTS solution, and the mixture absorbances were recorded after six minutes. The antioxidant activity was calculated using standard Trolox curve (100-2000 μM) and their inhibition percentages, and the test results were expressed in Trolox μmol equivalent per gram of fruit or fermented beverage on a wet basis (μmol/g).

Determination of total antioxidant activity of fruits by iron reduction method (FRAP)

The assay for ferric ion reducing activity was conducted according to the technique described by Rufino et al. (2010). The FRAP reagent was obtained from the mixture of acetate buffer (0.3 M, pH 3.6) *2,4,6-Tris(2-pyridyl)-s-triazine* (TPTZ) solution (10 mM) and ferric chloride solution (20 mM), at a ratio of 100 : 10 : 10. 90 μL aliquots of the extracts were mixed with 270 μL of distilled water and 2.7 mL of FRAP reagent. The absorbance of the mixture was measured at 595 nm after incubation at 37 °C for 30 min. Solutions with known concentrations of ferrous sulphate (500-2000 μM) were used to construct the standard curve. Results were expressed in μM ferrous sulfate per gram of fruit or fermented beverage on a wet basis (μmol/g).

Quantification of volatile compounds

Volatile compounds were determined by gas chromatography according to International Organization of Vine and Wine (2014). The volatiles compounds methanol, 1-propanol, isoamyl alcohol and isobutyl alcohol were quantified. The internal standard used was 4-methyl-2-pentanol (1g/L). The standard solutions were prepared by the reference of evaluated compounds and internal standard. To determine the concentrations of volatile compounds the equation described below was used (Equation 3):

$$C = c\frac{h \times I}{H \times i} \quad (3)$$

Where: C = substance concentration (g/L); c = substance concentration in the reference standard solution (g/L); h = substance peak area in the wine; H = substance peak area in the reference standard solution; i = peak area of the internal standard in the wine; I = peak area of internal standard in the reference standard solution.

Shimadzu gas chromatograph GC-17A Model QP5050 was used, with a flame ionization detector (FID) equipped with a Supelco capillary column with dimensions 30 m x 0.25 mm film thickness x 0.25 μm internal diameter. Synthetic air was used as ignition gas (175 mL/min) and flame maintaining, helium as carrier gas (1 mL/min) and hydrogen gas responsible for the flame detector (20 mL/min). The chromatographic run was carried out as follows: initial temperature (35 °C) was maintained for 5 min and then raised at a rate about 10 °C per minute until reaching 120 °C and continued at that temperature for 10 min. Then, it was again raised at a rate of 10 °C per minute until reaching 180 °C and continued at that temperature for 10 min. To finish the process, it was increased to 200 °C while maintaining the rate of 10 °C per minute.

2.3 Temporal dominance of sensations

The procedure temporal dominance of sensations is a sensory descriptive method according to Labbe et al. (2009). Fifty wine consumers interested in participating were recruited, with available time and no restrictions on the consumption of this product. The sequential method proposed by Amerine et al. (1965). In the triangular tests we used two NaCl solutions (0.08% and 0.15%) and wald chart was built, and judges were selected or rejected according to the number of tests with hits. From the four triangular tests, we selected 14 volunteers. The panel members were selected among students and professors aged between 18 and 35 years, thirteen women and one man (Amerine et al., 1965).

The attributes sweet, sour, bitter, astringent and hot were chosen, previously evaluated by Sokolowsky et al. (2015). Three primary sessions were conducted, as described by Albert et al. (2012). In the first session, panel members were trained regarding the attributes that should be evaluated by the evaluation reference solutions, as follows: sweet - 2% sucrose aqueous solution; acid - lemon juice aqueous solution; bitter - tonic water; and astringent - green banana, evaluated by Sokolowsky et al. (2015). No pattern was presented in relation to the hot attribute, but tasters were informed that "burning" sensation would be attributed to ingestion of certain drinks, such as cachaça. At the same session, the tasters were informed about temporal dominance of sensations and the data acquisition program SensoMaker (Nunes & Pinheiro, 2014) was presented to them. In the second and third sessions, panel members took part in a simulation of a TDS session with several samples of fermented jabuticaba, when questions about the methodology were clarified. Thus, the tasters were able to become familiar with the computer program. Total time of the experiment (60 s) and the time that the fermented beverages samples remain in the mouth (4 s) preceding their evaluation were also defined.

The evaluation was made in monadic order (Macfie et al., 1989) in disposable white plastic cups coded with random three-digit numbers. The SensoMaker software was used for data collection and for calculating the TDS curves. Two lines were drawn in the graphic display, TDS, the "chance level" and "significance level". "Chance level" is the dominance rate that an attribute can obtain by chance and "significance level" is the minimum value of this ratio that should be equal to be considered significantly. It was calculated using the confidence interval of a binomial proportion based on a normal approximation (Equation 4) (Pineau et al., 2009).

$$Ps = Po + 1.645\sqrt{\frac{Po(1 - Po)}{n}} \quad (4)$$

Ps: lower value of significant proportion (p = 0.05) at any point in time for a TDS curve; P_0: is equal to 1/p, where p is the number of attributes; n: number of individual's repetition.

The project was approved by the Ethics committee in Research of Federal University of Ouro Preto following the requirements of the National Health Council Resolution 466/12 under the protocol number 36002014.0.0000.5150.

2.4 Statistical analyses

The results were expressed as mean and standard deviation of the three replicates. Kolmogorov-Smirnov test was applied to test the normality of the data. In case of normal distribution, the results were analyzed using analysis of variance (ANOVA). For analyzes that showed significant results ($p \leq 0.05$), Tukey test was used for the characterization of raw material (whole jabuticaba, pulp and peel) and regression analysis ($p \leq 0.05$) was used to assess the interference of maceration time over the quality parameters of the fermented beverage. Statistical analyzes were performed by SISVAR programs.

3 Results and discussion

In the present study, there was a significant difference in relation to the determination of moisture, lipids and ashes of the whole jabuticaba and its fractions (pulp and peel) (Table 1).

The value of moisture resembles the values reported by Alezandro et al. (2013) who found the moisture value of 82 g/100 g. In relation to the ash content, the peel was statistically different from the whole fruit and pulp. This difference was also found by Inada et al. (2015) (4.0 g/100 g, 3.1 g/100 g, 3.2 g/100 g, respectively). The lipid values present in the peel differed statistically from the whole fruit and pulp. This difference was also observed in the study by Inada et al. (2015). In relation to the protein there was no significant difference between the whole jabuticaba and its fractions.

The analysis of jabuticaba and its fractions revealed that the highest concentration of anthocyanins of jabuticaba is in its peel (Table 1). This result was already expected due to its coloring and this fruit present value closer to those found in red fruit such as raspberry (24.07 ± 0.61 mg/100g) (Stafussa et al., 2018). In addition, the fruits that presented higher anthocyanin content were those with dark-colored peel, from purple to black such as blackberry (54.65 ± 2.96 mg/100 g) and açai (46.12 ± 1.83 mg/100 g) (Stafussa et al., 2018). Which reinforces the importance of these pigments to assign functional properties to the fruits, among them, jabuticaba (Stafussa et al., 2018; Jideani et al., 2021).

The antioxidant activity measured by iron reduction method showed that the peel has highest antioxidant activity when compared the whole fruit and pulp (Table 1). In the study by Inada et al. (2015) also showed that jabuticaba has higher antioxidant activity present in the peel. Rufino et al. (2010) found a higher value antioxidant activity by iron reduction method for jabuticaba when compared with the following tropical fruits found in Brazil: jabuticaba (87.9 ± 1.9 μM $FeSO_4$/g), gurguri (70.4 ± 7.8 μM $FeSO_4$/g), uvaia (38.4 ± 4.1 μM $FeSO_4$/g), jambolão (35.5 ± 1.4 μM $FeSO_4$/g), açai (32.1 ± 6.5 μM $FeSO_4$/g), cashew (22.9 ± 0.7 μM $FeSO_4$/g), mangaba (18.3 ± 1.6 μM $FeSO_4$/g), umbu (17.2 ± 0.3 μM $FeSO_4$/g), carnaúba (15.5 ± 0.4 μM $FeSO_4$/g), cajá (11.8 ± 0.2 μM $FeSO_4$/g). Such comparisons show the high antioxidant potential of jabuticaba.

The antioxidant activity measured by the ability to capture the ABTS radical also showed that the highest amount of jabuticaba antioxidant compounds is concentrated in the peel (Table 1), even so, through this method, the whole fruit had higher values. Rufino et al. (2010) found in their study a higher value for jabuticaba (317 ± 2.7 μmol Trolox/g) when compared to other fruits. Stafussa et al. (2018) found the following values of antioxidant activity by ABTS: acerola (85.11 μmol Trolox/g), açai (40.35 μmol Trolox/g) and jabuticaba (36.58 μmol Trolox/g). These differences may be justified by the type of methodology used to determine the bioactive compound, as well as specific characteristics of each fruit (species, geographic location of the cultivation site, among others) (Rufino et al., 2010).

According to Pérez-Navarro et al. (2018), the maceration time during vinification in red grapes are determining factors for the antioxidant concentration in wine. This step takes place along with alcoholic fermentation in a complex environment subjected to many physical and chemical changes. After the process of crushing the fruit, one of the main efforts of technicians and producers of fruit fermented beverages is to determine the ideal moment when the produced must can extract and provide optimal levels of the present compounds and subsequently, give sensory quality to the drink (Romero-Cascales et al., 2005; Sacchi et al., 2005). Regarding fermented jabuticaba, it can be seen that all showed lower anthocyanin content than those found in the whole jabuticaba (Figure 1A).

Moreover, the longer is maceration time, the smaller are anthocyanin concentrations in fermented beverages. According to Kocabey et al. (2016) the reduction of anthocyanin content may be related to the degradation of this compound and condensation with tannin. Moreover, its decrease may also be linked to the reactions of anthocyanins with proanthocyanins that generate copolymerization products or adsorption of anthocyanins by yeast.

Regarding the antioxidant activity by FRAP method (Figure 1B) after 96 h of maceration there was a decrease in the values,

Table 1. Chemical composition, anthocyanin content and jabuticaba antioxidant capacity and its fractions (pulp and peel).

Analysis	Whole fruit	Pulp	Peel
Moisture (g/100 g)	78.70 ± 0.74^b	84.24 ± 1.21^a	77.89 ± 0.35^b
Ashes (g/100 g)	0.54 ± 0.00^a	0.52 ± 0.02^a	0.47 ± 0.03^b
Ether extract (g/100 g)	0.83 ± 0.06^a	0.84 ± 0.07^a	0.54 ± 0.07^b
Proteins (g/100 g)	0.62 ± 0.29^a	0.81 ± 0.12^a	1.00 ± 0.35^a
Anthocyanins (mg/100 g)	14.34 ± 0.08^b	8.97 ± 0.54^c	25.81 ± 2.33^a
Antioxidant capacity - FRAP (μM $FeSO_4$/g)	71.85 ± 1.47^b	28.77 ± 1.34^c	84.69 ± 3.89^a
Antioxidant capacity - ABTS (μmol Trolox/g)	85.01 ± 3.53^a	21.44 ± 0.56^b	78.34 ± 3.39^a

All determinations are on a wet basis. Means in the same row followed by a letter are equal according to Turkey test at a significance level of 5%.

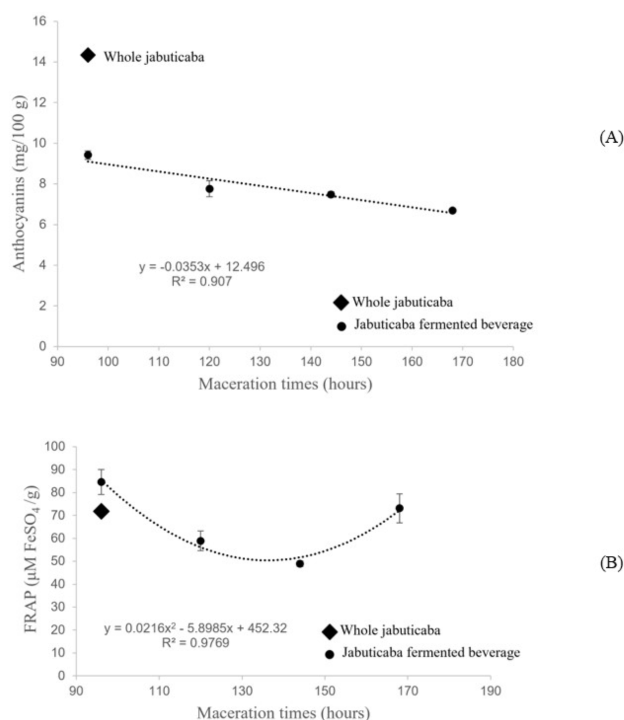


Figure 1. Total monomeric anthocyanin content (A) and total antioxidant capacity by iron reduction method (FRAP) (B) of jaboticaba fruit and of jabuticaba fermented beverage during different maceration times (96, 120, 144 and 168 h).

followed by an increase after 144 h of maceration (Figure 1B). Kocabey et al. (2016) studied the effect of maceration on wine production, a product that is closer to that studied in the present work. They also observed that the lowest antioxidant activity values were after 5 days, and these values increased with increasing maceration duration. The explanation for such phenomenon would be due to changes in the polyphenol content during the vinification process, including maceration that would affect the antioxidant activity of the wine, since antioxidant activity in wine depends on the concentration of some flavonoids such as hydroxybenzoic and hydroxycinnamic acids, flavan -3-ols, flavonols, flavanones and stilbenes.

During alcoholic fermentation a series of smaller metabolites, such as higher alcohols, esters, acids and acetates, and others from the metabolism of sugar and amino acids are produced (Ouyang et al., 2017). Regarding the higher alcohols, these compounds are the main secondary product of yeast metabolism and are synthesized from amino acids at the early stage of alcoholic fermentation which are important in the formation of the flavor and aroma of alcoholic beverages (Ribéreau-Gayon et al., 2006; Ouyang et al., 2017). In the present study, alcohols obtained in the of fermented jabuticaba are described in Table 2.

The presence of 1-propanol in fermented jabuticaba ranged from 52.14 ($mg.L^{-1}$) to 72.13 ($mg.L^{1}$). We can observe the trend for increasing in the content of this alcohol along with increasing in maceration time. In red wines, this concentration is desirable below 68 mg/L (Ribéreau-Gayon et al., 2006)

Table 2. Concentration values of 1-propanol (mg/L), isoamyl alcohol (mg/L), isobutyl alcohol (mg/L) and methanol (mg/L).

Alcohol	Maceration time (hours)			
	96 h	120 h	144 h	168 h
1-Propanol (mg/L)	52.14	56.14	60.72	72.13
Isoamyl alcohol (mg/L)	209.37	193.58	179.98	185.11
Isobutyl alcohol (mg/L)	64.26	62.18	59.43	62.22
Metanol (mg/L)	266.29	131.20	31.61	257.05

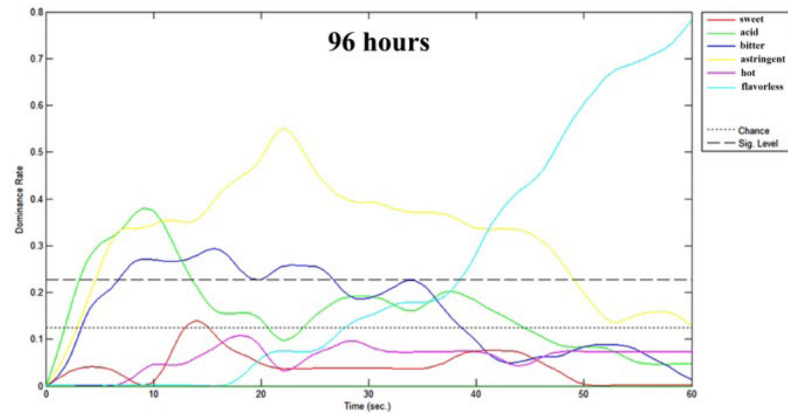
Isoamyl alcohol influences aromatic properties in wines, but in high concentrations, it can negatively affect its sensory characteristics (Jackson, 2008). Its values in fermented alcoholic beverages should not exceed 4 mg/L (Burdock, 2002). Fermented jabuticaba presented high values (between 209.37 and 179.98 mg/L) which can be related to the sense of persistent astringency that was determined in the sensory evaluation (TDS), which will be reported on.

According to Cabanis & Cabanis (2000), isobutyl alcohol concentration in red wines lies between 9.0 mg/L and 148.0 mg/L. In this study, the values found range from 59.43 mg/L to 64.26 mg/L. Methanol concentration ranged from 31.61 mg/L to 266.29 mg/L, below the allowed by Brazilian law (maximum 350 mg/L). This aspect is positive, because in high concentrations it can be toxic.

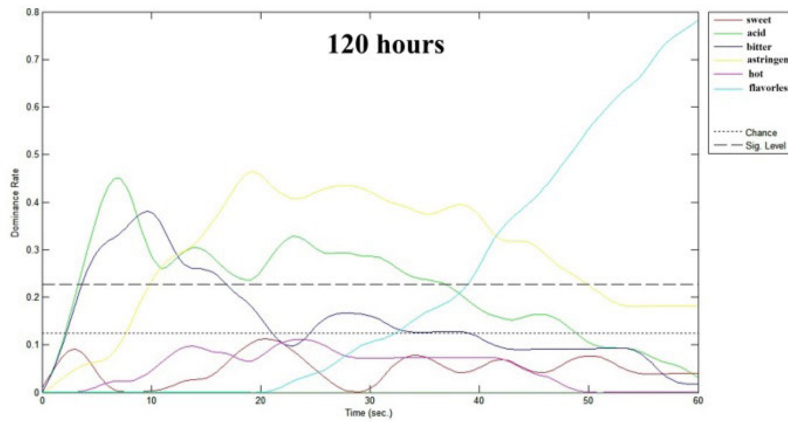
Higher alcohols found in fermented beverages occur as by-products of *Saccharomyces cerevisiae* fermentation. According to Jackson (2008), at concentrations up to 300 mg/L they generally contribute to the aroma of the fermentation, but at higher concentrations, adversely affect their sensory characteristics. The synthesis of higher alcohols is favored by the presence of oxygen, high temperature and materials suspended in the fermenting must. The Figure 2 shows the profile for TDS of four samples of fermented jabuticaba.

Each curve represents the variation in dominance rate of the attributes evaluated over time. The bottom line (dotted) corresponds to the line of chance and below it means the values were labeled randomly, and the upper line (dotted) represents the line of significance, and the results above that line (dotted) indicate the significant perceived sensation (Pineau et al., 2009).

At all maceration times, the first prevailing feeling was acidic taste, and it reduced its persistence over time. Then, bitter taste (about 5s) and astringency sensation, and the latter predominant time was decreasing with increased maceration time, as observed in the behavior of isoamyl alcohol formation in the fermented beverages. From there, neither of the evaluated sensations was significant, and the perception “no taste / flavor” was predominant. The persistence of astringency may be related to the fact that all the time of the fermentation process in the tumultuous phase has occurred in contact with the jabuticaba peel and it contains considerable amounts of tannins (Reynertson et al., 2006).



(A)



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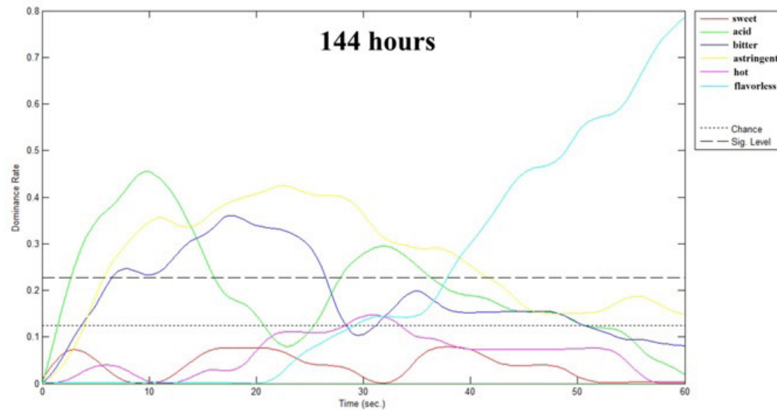
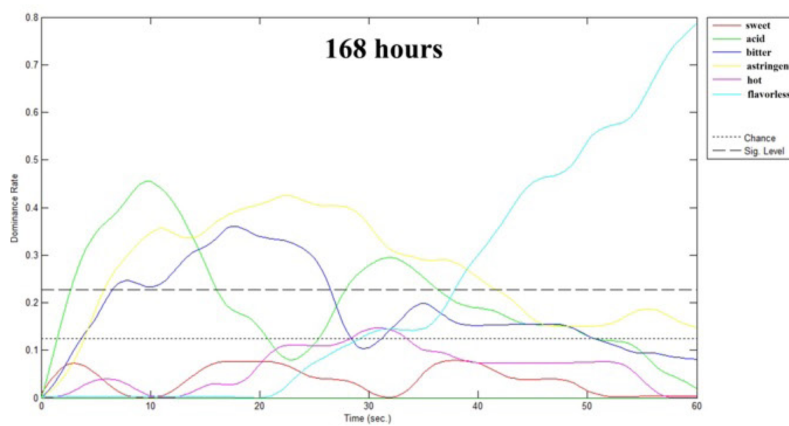


(C)



(D)

Figure 2. Temporal dominance of sensations curves (TDS) of jabuticaba fermented beverages during different maceration times: 96 h (A) 120 h (B) at 144 h (C) and 168 h (D).

4 Conclusion

Most anthocyanin content and antioxidant activity of jabuticaba is concentrated in its peel and this fruit has superior antioxidant activity when compared to many fruits considered significant sources of bioactive compounds. During maceration step to obtain the fermented beverages, part of its anthocyanins migrates to the drink, but this concentration decreases with increased maceration time.

Regarding the antioxidant activity, the best maceration time to obtain fermented jabuticaba must be 96 h; after this time there is decay in the concentrations of anthocyanins and iron ion reducing capacity. Moreover, the increased maceration time favors the reduction of isoamyl alcohol concentration, which can be associated with reduction in temporal dominance of sensations of astringency sensation in the fermented beverages.

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