academicJournals

Vol. 10(33), pp. 3271-3280, 13 August, 2015
DOI: 10.5897/AJAR2015.9728
Article Number: BCB79BD54926
ISSN 1991-637X

http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Obtaining physical-chemical analysis of the alcoholic distillate of cajarana (Spondias sp) in semiarid Paraiba

Ednaldo Queiroga de Lima[1]*, Elisabeth de Oliveira[1], Hedilberto de Oliveira Alves[2] and Carla Fernanda de Silva Leite[3]

[1]Federal University of Campina Grande – CSTR. Avenida Universitaria s/n, Santa Cecília, Patos-PB 58708-110 Brazil.
[2]Autonomous. Rua Moacir Leitão 850, Jardim Lacerda, Patos-PB 58704-330, Brazil.
[3]Forest Science at Federal University of Campina Grande – CSTR. Avenida Universitaria s/n, Santa Cecília, Patos-PB 58708-110 Brazil.

Received 19 March, 2015; Accepted 16 July, 2015

This study aimed to produce, and consequently create physical-chemical analysis of alcohol distilled from the fruits *of Spondias* sp. The study was carried out at the Federal University of Campina Grande - Campus de Patos-PB (UFCG). 36.85 kg of cajarana and 1100 ml (869 g) of distilled alcohol, with a yield of 2.36% were collected, the cajarana used for this study presents equal 11.02° brix. This occurs with pH (2.74), being the necessary correction of the pH, to 4.5. During the production process of alcoholic distillate, the fermentation was achieved in vats steel with a capacity of 30 L using commercial mark Fleischman containing yeast of *Saccharomyces cerevisiae* strain, followed by fermentation kinetics. The alcoholic distillate showed high concentration of copper and methanol, the volatile acidity and higher alcohols were above normal, while the other components are in compliance with the law. For the analyses, methodology (MAP) Ministry of Agriculture, Livestock and Supply was used.

Key words: Fruits of the caatinga, *saccharomyces cerevisiae* fermentation, distillate.

INTRODUCTION

The history of alcohol goes side by side with the history of chemistry, because it has reports of the same fermentation process with that of ancient Egypt, with the same inhaled flavoring vapors when fermented. The artisans have worked in fermentation and distillation processes, but they did everything empirically.

Sugar cane is the main raw material for the production of cachaça in Brazil, but the "cachaça" can be produced from any plant or fruit rich in sucrose (sugar), fructose, glucose, cellulose, etc. In Italy, Grappa is produce, a grape distillate; in Germany, Kirsch, a cherry distillate; Scotland, Whisky, sacrificed barley distilled; in Portugal, Brandy, distilled from grape pomace (Fernandes; Oliveira, 2010). As the Cajarana (Spondias sp), a fruit rich in sugar (fructose), can also produce a distilled alcohol by fermentation process. The Cajarana (Spondias sp) belongs to Anacardiácea family, originated in Central America, adapts to various types of soil and its fruits have a variety of major use in the production of pulp (ice cream, candy, juices, among others); It can be consumed raw or in the production of animal feed.

According to Silva et al. (1984), the Northeast region

*Corresponding author. E-mail: equeiroga.lima@gmail.com, Tel: +55 83 3511-3000.

presents a wide diversity of tropical fruits with good prospects for economic exploitation, although mostly present extractive character and commercialization restricted to fruit "in natura" or as juice or ice cream. The Spondias genus belongs to Anacardiaceae family, and has 18 species, some of which that occur in the Northeast (Spondias sp, *Spondias mombin* L, *Spondias purpurea, Spondias tuberosa*, L.) are tropical fruit trees in adaptation and of high commercial value (Mitchell, 1995). The mature fruit of Spondias has a high starch content and in some cases, one can even see the starchy taste in the fresh red mombin fruit. The total content of pectin is also high in comparison to most of the fruit, which together to the high starch content may impair the stability of juice (Melo, 2010).

The fruit fermentation process is followed by distillation were spirits is obtain, being necessary to adapt the production method according to the raw material. Decree No. 2314, of the MAP defines fruit spirit or brandy fruits as alcohol drink with 36 to 54°GL at 20°C, obtained from simple alcoholic distilled from fruit juice, or by the distillation of fermented mash fruit (Brazil, 1997). Yeasts of different strains of *Saccharomyces cerevisiae* were found in greater abundance in fermentation for the production of brandy (Morais et al., 1997) being the most distinctive by high alcohol yield and tolerance to high concentrations of ethanol.

The fermentation under controlled conditions involve chemical conversions. Some of the most important steps are: oxidation of ethanol to acetaldehyde (partial oxidation), and then acetic acid (total oxidation); from sucrose to citric acid and from dextrose to gluconic acid; reduction of aldehyde to alcohol (acetaldehyde to ethanol) and sulfur to hydrogen sulfide; hydrolysis of starch to glucose, and sucrose to glucose, fructose and alcohol; and esterification, hexose phosphate from hexose and phosphoric acid (Shreve and Brink Jr., 1977). The fermentation time ranges from 24 to 30 h, when the wine reaches 0° Brix (Lima, 1999; Faria, 1995). After that time, the yeast will settle to the bottom of the fermentation vat, and then the wine will be forwarded for distillation and a new wort vat would be added (Canton, 2006).

The pH is an important factor in the alcoholic fermentation process; it is recommended an initial pH values would be between 3.8 and 4.0; this pH range may be sufficient to allow rapid alcoholic fermentation and inhibit undesirable bacteria (Aquarone et al., 1983). The distillation of wine results in two fractions called phlegm (brandy) and vinasse. The first, which is the main product of distillation, consists of an impure water-alcohol mixture and vinasse, whose alcohol content should be zero, but it accumulate all fixed substances and part of volatile compounds (Nogueira and Venturini, 2005).

The type of distillery influences the content of volatile compounds. According to studies by Faria and Pourchet (1989) and Nascimento et al. (1998), cachaça distilled in copper destillery showed a higher aldehydes and methanol levels that the spirits distilled in stainless steel destillery, which in turn contained higher concentrations of higher alcohols and esters. After distillation, the cachaça must present an alcohol content between 38 to 48 GL (Miranda et al, 2007), and a quantity of a product "secondary" responsible for the characteristic flavor and odor (Almeida and Barreto, 1971; Lima, 1964; Yokoya, 1995).

The physical and chemical quality of the sugar cane brandy in Brazil is regulated by the Ministry of Agriculture (Brazil, 1997), which sets limits for various parameters (alcohol content, volatile acidity, esters, higher alcohols, aldehydes, furfural, methanol and copper). The fruit brandy follows the same law of cachaça, except for alcohol content limit which is 36 to 54°GL (Brazil, 2008).

The obtaining of distillate has a reasonable degree of complexity, and wide acceptance in domestic and international markets (because it is similar to cachaça, the distilled more consumed in Brazil), so this work aims to add value to the culture of Spondias, the man of the field in the Paraiba semi-arid region, study use of Cajarana as a potential for organic alcohol distillate production, with industrial purpose of analyzing their physical and chemical properties as well as its chemical composition, and describing their compliance with the standard identity and quality provided by law in Brazil in the production of beverages.

MATERIALS AND METHODS

For the experimental production of distilled alcohol, Cajarana (Spondia sp) was used with soluble solids content of 11.04°brix, produced in the Wood Chemical Laboratory of UFCG - Federal University of Campina Grande - Campus of Patos-PB. After each sample was taken, scavenging of the samples to remove unwanted material they were washed in solution 2% v / v for 30 min, rinsed with clean water and placed in a freezer at -15°C to maintain their chemical and bromatologic properties. The fruits were pulped and then centrifuged to remove excess of pectin, for this surplus implies a high concentration of methanol in distilled alcohol (Babylon, 2010).

Distillate of Cajarana (*Spondias* sp)

The alcohol distillate of Cajarana was fermented in stainless steel vats with a capacity of 30 liters of wort and copper stills with a capacity of 10 liters per cachaça making. The production of alcoholic distillate from Cajarana passes through five basic steps:

(1). Pulping, in which step removes the pulp of the fruit to initiate the whole process.
(2). Centrifuging the pulp to remove excess of pectin, since the pectin is responsible for the formation of methanol.
(3). Preparation of the wort, which is prepared from a mixture of Cajarana juice, which will be fermented and it will originate the cachaça, the fermentation and addition of yeast (Saccharomyces cerevisiae) to transform sugars into alcohol, carbon dioxide and other components.
(4). Distilling the beverage purification step, separating the

Figure 1. Preparation of fermentable wort in steel vat, up to 30 liters of wort.

unwanted components.
(5). Analysis of the distilled alcohol.

Fermentation

The preparation tank was made up of 150 g of Fleischmann's Yeast (lyophilized yeast) containing the yeast strain *S. cerevisiae* and sorbitan monostearate (a substance which facilitates dissolution and viscosity increasing ingredients) with 200 ml of water heated to 45°C and 200 ml of the "juice" of Cajarana, then adding 12.10 kg of the "juice." Fermentation took place in stainless steel fermentation vat, with capacity for thirty liters of fermentable wort (Figure 1).

Kinetics of fermentation

The fermentation started after the preparation of the tank's foot at ambient temperature, yeast, freeze-dried, of the Flechman brand, and the Cajarana wort were used, and they were prepared for fermenting for 24 h. During fermentation, monitoring was done and fermentation kinetics was used to analyzed alcohol content, ° Brix, pH and total acidity in all time intervals range from every hour, and after in two hours and finally at three hours.

The fermented alcoholic content was observed in ebulliometer 3300, with decimal determining the alcoholic strength, accompanied by a boiler with tap, protective tube, condenser and base in chromed steel, an alcohol lamp in aluminum, appropriate thermometer and cork latex, ruler in polypropylene with an alcohol content of scale 0 to 25°GL, sliding scale of 86 to 101°C, lock pin, cursor and graduated glass bucket. The Brix was found in automatic digital refractometer Acetec GDR 8600, at 20°C. The pH was checked at pH meter counters, digital ANALION PM 608. The total acidity was measured by volumetric titration method, a solution of 0.1 N sodium hydroxide was used, and as indicator, phenolphthalein alcohol solution of 3% was also used (Brazil, 1986).

Distillation

Distillation was carried out in copper still, adding approximately 12 L of wine (fermented), 2.5° Brix and alcohol content of 4.25°GL.

Physico-chemical analysis of distilled alcohol

The analysis of Cajarana distillate were made in the ITEP (PERNAMBUCO TECHNOLOGY INSTITUTE - Waste Analysis Laboratory of Pesticides and Alcoholic Beverages - LABTOX) using the POP TC 020 and IT 006 method (Quality System Document Lab Tox), with the Bibliographical references: MAP / DAS / CGAL - Beverage and Vinegars Analysis Manual, accreditation of INMETRO (CRL 0153), signatory of mutual recognition agreement for certification accreditation body activity of products and management systems quality and environmental. D.O.U. - Section 1 - Edition # 124 of 30/06/2005: MAPA Normative Instruction 13 of 29/06/2005. D.O.U. - Section 1 - Issue Number 184, 25/09/2009: INMETRO Ordinance 276 of 24/09/2009.

The alcohol content was analyzed by Anton Paar densimeter (Figure 2A) 4500 DMA (v / v), and density calculated in g / cm3, acidity was analyzed in the electronic tag titrator METTLER TOLEDO / DL22 (Figure 2B) and copper and arsenic by Atomic Absorption Spectrometry in EAA-001 spectrometer; (Figure 2C) GFS97 AASpectrometer model.

Chromatography

Analyzes were made of furfural, aldehydes, esters, higher alcohols (n-propyl alcohol, isobutyl alcohol and alcohols isoamílicos) by

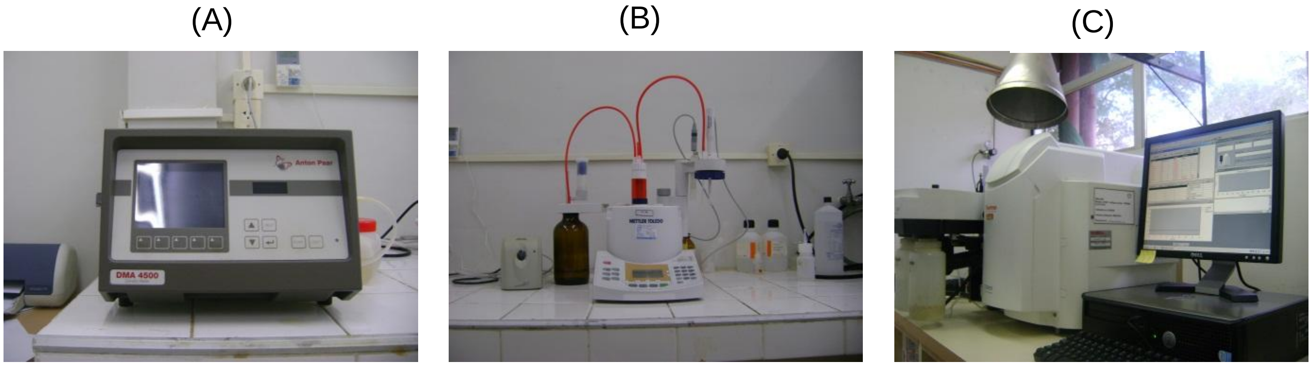


Figure 2. Equipment used for the analyzes of the alcoholic strength densimeter ANTON PAAR (a), acidity, titrator METTLER TOLEDO (b) and content of copper and arsenic Spectrometer AAS-001 (c).

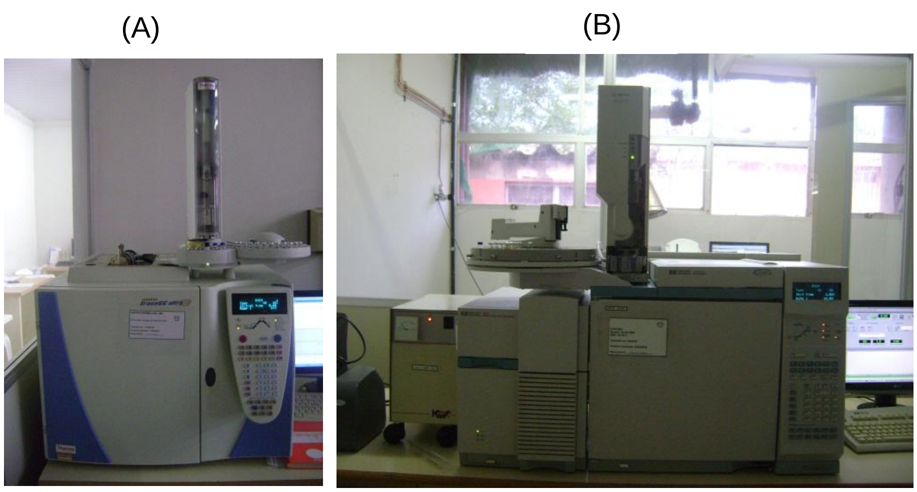


Figure 3. Chromatograph used for analysis of aldehydes, esters, higher alcohols (a) and ethyl carbamate (b).

means of gas chromatography (GC) using a gas chromatograph Varian CGC-006 with ionization detector FID flame, CARBOWAX 20M-type column (60 m x 0.25 mm x 1.0 microns), injector temperature of 230 and 250°C temperature detector, the volume of the injected sample of 1 µL, using as carrier gas Helium Ultra Pure with a flow of 1.5 ml / min patterns used in the ratio "SPLIT" 1:30 (Figure 3A). Also, chromatography was performed as the analysis of the concentration of ethyl carbamate using a Varian chromatograph GCC-003, model 6890 CGHP, MSD: HP 5973, column type CARBOWAX (60 m x 0.32 mm x 1 µm), injector temperature 24°C (SPLIR less) and sample volumes of 1 µL injection (Figure 3B).

RESULTS AND DISCUSSION

Physical and physico-chemical analysis of the fruit

Table 1 shows the results of physico-chemical analyzes. The analyzed fruits had an average length of 20.11 mm and weighing 9.78 g, and the length / weight 2.06 mm / g.

Kinetics of fermentation

During the first 12 h the fermentation was maintained in progress with ºbrix always decreasing, until the Brix remained constant during the remaining 12 h of fermentation. The initial Brix juice of the Cajarana, which is 11.04, is ideal for the fermentation process described by the literature, of Guangzhou (2006) ideally a ºBrix near 15. The ideal fermentation occurs in a range of 14 to 16°Brix, above this, fermentation becomes slow and incomplete (PATARO et al., 2002), whereas, less than 10°Brix (low) decreases the yield of distillate and facilitates infection of wort (Lima, 2001). The data obtained during the fermentation process are described in Table 2.

Table 1. Physico-chemical analysis of the pulp of Cajarana.

Analysis	Results
Carbohydrates (%)	9.59
Total protein (%)	0.75
Total lipids (%)	0.60
Acidity in citric acid (%)	1.39
Reducing sugars in glucose (%)	7.22
Nonreducing sugar in sucrose (%)	6.72
Total sugars (%)	13.94
Soluble solids in Brix degree (° Bx)	11.04
pH	2.74

Table 2. Analysis of Brix, alcohol content, pH and acidity during the fermentation process.

Hour	°Brix	Alcoholic content	pH	Total acidity (g/100 ml)
10h40	11.04	0	4.50	0.19
11h40	10.5	0.3	4.34	0.20
12h40	9.5	0.7	4.20	0.21
13h40	9	1.0	4.11	0.22
14h40	9	1.0	4.08	0.23
15h40	8	1.55	4.08	0.23
16h40	6.5	2.25	4.08	0.22
18h40	4	3.5	4.08	0.20
20h40	3	4.0	4.16	0.19
22h40	2.5	4.25	4.54	0.19
00h40	2.5	4.25	4.20	0.20
02h40	2.5	4.25	3.92	0.23
04h40	2.5	4.25	3.98	0.23
07h40	2.5	4.25	3.88	0.24
10h40	2.5	4.25	4.00	0.22
Mean	-	-	4.14	0.21

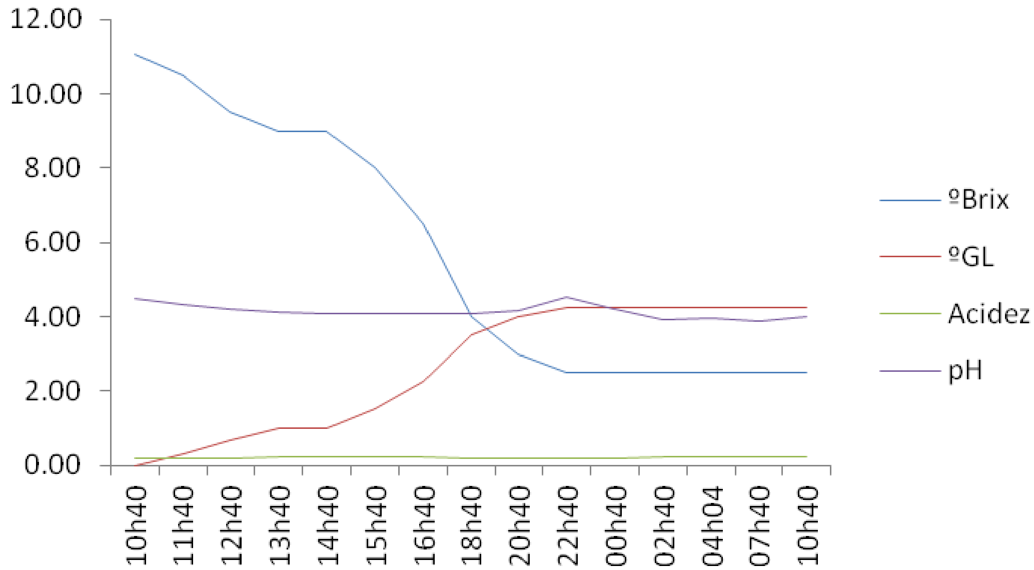
At the end of the fermentation process of this experiment, it is found that the sugar content (Brix) was not reset, which occurs within 24 to 36 h (Lima, 1999), this fact indicated that fermentation is not complete, one of the causes of this problem may be, the lower initial ºBrix of the wort (11.04). Graphic 1, express the results obtained in the fermentation, it appears that there was a decay in sucrose content (by lowering the Brix) during the first 12 h, and gradually increasing the alcohol content within 12 h if the final alcohol content remains constant because there is no more substrate consumption.

The lower pH was greater than 3.88 and 4.54, causing a pH change from 0.66 (ΔpH = 0.66) while the lowest total acidity was 0.19 g /100 ml and the greater was 0.24 g / 100 ml, there was a variation in the total acidity of 0.05 g/100 ml. The constant acidity indicates a good fermentation (Aquarone et al., 1975). The initial pH of the fermentation is 4.5. Studies of Aquarone et al. (1983) shows that the initial pH should be between 3.8 to 4.0, which allows a rapid fermentation, to Eiroa (1989) pH values below 4.5 development of bacteria.

Physico-chemical analysis of the fermentation

Comparing the fermentation data (pH and acidity) obtained in this study, the pseudo fermented cashew (Torres et al., 2006) and grapes for the production of red wine (Embrapa, 2000) (Table 3). The values of pH and acidity for the fermented Cajarana, corresponds to the arithmetic mean of all values observed throughout the fermentation process.

The fermentation of Cajarana occurs with low acidity and higher pH. The total acidity of wine should be in the range from 3.3 to 7.8 g / L (Rizzon et al., 1994). Observing Table 3, it is apparent that the fermented Cajarana presents a concentration of 2.1 g / L and less than the fermented concentration of cashew (7.2 g / L)



Graphic 1. Results of °Brix; °GL, pH and acidity as a function of time (h) obtained by the fermentation kinetics.

Table 3. PH and acidity in fermentation processes, of cajarana, cashew and grape.

Fermented	pH	Acidity (g/L)
Cajarana	4.14	2.1
Cashew	3.5	7.2
Grape	3.6	4.4

and grape (4.4 g / L). The initial pH of 4.14 of the fermented of Cajarana confers an increased resistance to infections or contaminations (Aquarone et al., 1983). The fermented of Cajarana has a pH equal to 4.14, this is due to lower total acidity in the fermented cashew (3.5) and grapes (3.6) (Torres et al., 2006; Brapa, 2000).

Statistical analysis

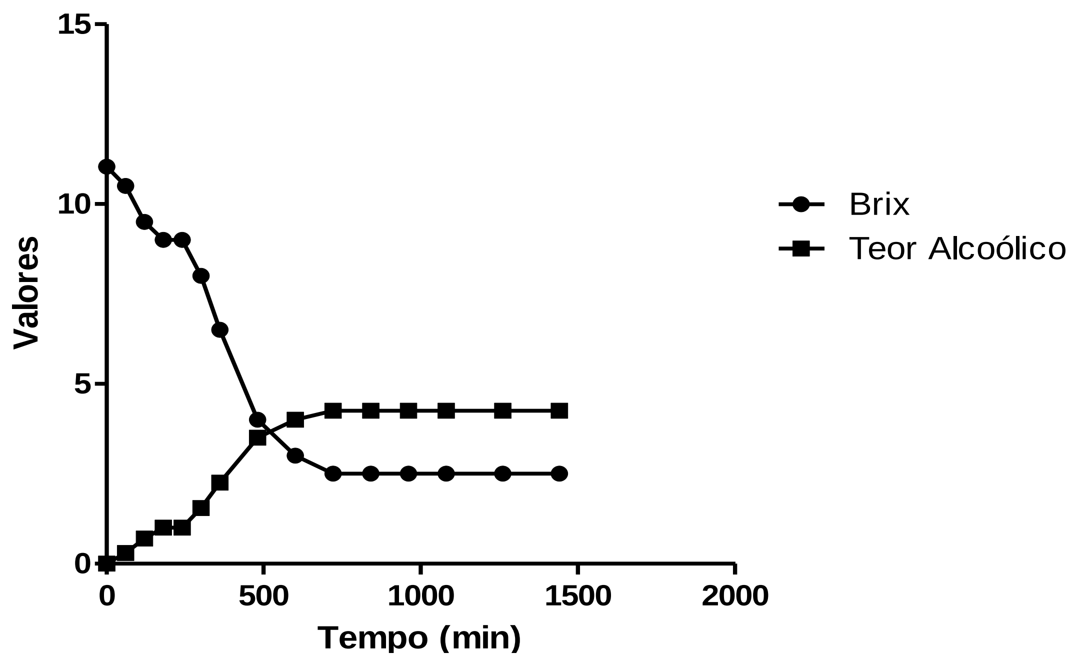
The evaluation of the fermentation kinetics was calculated using the correlation test of Pearson to the level of significance of 5% for the °brix and the alcohol content (Graphic 2). It is observed in Table 4 a negative correlation (Pearson r = -0.8888), its being observed in Figure 2 that fermentation becomes constant from the time of ¬720 min, with a membership around 79% (r = 0.7900). P value <0.0001 shows that there is a significant variation as it relates x fermentation time. For the alcohol content, a positive correlation (Pearson r = 0.8891) was observed. The 720 min did not observe further change, although there is a correlation around 79% (r = 0.7905). P value <0.0001 shows that there is a significant variation in time when relating x-alcohol.

Distillation

880 ml (cm^3) of the heart fraction of distillate were obtained, with a density of 0.96529 g / cm^3 (Brazil 2005), that means that 849.45 g of liquor, with the amount of collected fruit 36.85 kg (36,850 g) in the final process had a yield of 2.31%, in correlation with the wine (12,060 g or 12493.65 ml), the yield was 7.04%, Cardoso (2001) found brandy sugar cane varies from 15 to 17% of the "wine" for brandy with 38 to 54% ethanol.

Physico-chemical analysis of the distillate

The data of the physico-chemical analysis for alcohol distillate of Cajarana are shown in Table 5, along with data to be compared with the spirit of jabuticaba in a study conducted by Asquieri et al. (2009), and the



Graphic 2. Pearson correlation to the ºbrix and alcohol content.

Table 4. Data generated by the software Graphpad Prism, for the PEARSON correlation test.

Variables	ºbrix	Alcohol content
Number of XY Pairs	15	15
Pearson r	-0,8888	0,8891
95% confidence interval	-0,9628 to -0,6913	0,6920 to 0,9628
P value (two-tailed)	< 0,0001	< 0,0001
P value summary	****	****
Is the correlation significant? (alpha=0.05)	Yes	Yes
R square	0,7900	0,7905

analysis of Brazilian spirits and cachaça sugar cane made by Miranda et al. (2007) in parameter of quality of the Ministry of Agriculture, Livestock and Supply, according to Ordinance No. 65 of 23/04/2008, for fruit spirits.

Alcohol content

The alcohol content of distillate of Cajarana (28.94°GL) is below the minimum established by the Brazilian legislation for fruit brandy of 36 to 54°GL, (Brazil, 2008). The low alcohol content (28.94°GL) of this beverage is due to two factors:

(1). First, low °Brix of the fruit (11.04), which indicates that the result has a low amount of substrate (sugars) to be converted into alcohol. During the fermentation process, the sugars by the action of yeast are transformed into ethyl alcohol (Shreve and Brink, 1977), indicating that the amount of alcohol formed is directly proportional to the amount of sugars.

(2). Second, the Brix was not reset, leaving 2.5, that is beside the Cajarana present a small amount of sugars to be converted into alcohol, this small amount is not completely converted to alcohol. The fermentation ends between 24 and 30 h, when the wine reaches zero °brix (Lima, 1999; Do, 1995).

Concentration of furfural; ethyl carbamate; acrolein and arsenic

The concentration of each component was lower than that prescribed by law, as shown in Table 5, and the furfural values were higher than those found by works

Table 5. Comparative analytical data for distillate of Cajarana, jabuticaba and sugar cane.

Item to be analyzed	Tolerance	Mean values of distilled beverage of:		
		Cajarana	Jabuticaba	Cana-de-açúcar
Alcohol content	36º GL a 54º GL a 20 ºC	28.94	39	40.23
Copper	Máx. 5mg/L	52	0.70	2.57
Arsenic	Máx. 0,1 mg/L	<0.008	-	-
Sugar (sucrose)	Máx. 30 g/L	<1.0	0	-
Volatile acidity	Máx. 100 mg/100 ml	214	30	55.82
Total esters	Máx. 250 mg/100 ml	64.3	357	46.23
Aldehydes	Máx. 30 mg/100 ml	25	13.60	19.78
Furfural + hidroximetilfurf.	Máx. 5 mg/100 ml	<1.52	ND	0.11
Higher alcohols	Máx. 360 mg/100 ml	466.3	259.07	278.49
Congeners coefficient	200 a 650 mg/100 ml	769.4	659.67	400.46
Methanol	Máx. 20 mg/100 ml	62.1	4.3	8.53
Ethyl carbamate	Máx. 0,15 g/L	$<5 \times 10^{-5}$	-	-
Acrolein	Máx. 5 mg/100 ml	<1.31	-	-

done by Asquieri et al. (2009) and Miranda et al. (2007), which makes the beverage without carcinogenic compounds.

Methanol

The alcohol distillate of Cajarana has a methanol content of 62.1 mg / 100 ml, being above the maximum allowed by Brazilian law of 20 mg / 100 ml (Brazil, 2005), higher than the brandy of jabuticaba 4.3 mg / 100 ml (Asquieri et al., 2009) and higher than the analysis of Brazilian spirits in studies performed by Miranda et al. (2007), which is 8.53 mg / 100 ml. The high concentration of methanol in the distillate of Cajarana regarding the jabuticaba and sugar cane is due to the high concentration of pectin in Cajarana. Figure 4, shows that even after centrifugation, the limpid juicy is still cloudy which is also due to the high concentration of pectin since centrifugation is not sufficient for complete removal of pectin.

Total esters

The value found for the distillate of Cajarana, is 164.3 mg / 100 ml, this is below the maximum allowed by law, higher values were found for brandy of jabuticaba (Asquieri et el., 2009), which was 357 mg / 100 ml, and the analyzes for spirits and sugar cane cachaça, in a study conducted by Miranda et al. (2007), which was 46.23 mg / 100 ml. Reasonable concentration of esters in Cajarana distillate is responsible for its discrete characteristic aroma (Winhol, 1976), this may have occurred due to the low content of alcohol formed during fermentation, or according to Aquarone (2001) at a distillation rate slightly larger than the ideal.

Aldehydes

The value found for the distillate of Cajarana was 25 mg / 100 ml, lying close to the maximum allowed by Brazilian law, which is 30 mg / 100 ml (Brazil, 2005), which is a plus point. Values found by Asquieri et al. (2009) for jabuticaba spirits and Miranda et al. (2007), studies over Brazilian spirits, were respectively equal to 13.60 mg / 100 ml and 19.78 mg / 100 ml. The acetaldehyde is a compound that interferes negatively on brandy quality, because it can cause headaches, intoxication and problems related to the central nervous system (Cardoso, 1998).

Higher alcohols

The distillate of Cajarana has a concentration of higher alcohols of 466.3 mg / 100 ml, which is above the maximum limit established by Brazilian legislation of 360 mg / 100 ml and above jabuticaba Brandy values studied by Asquieri et al. (2009) which was 259.07 mg / 100 ml, and also above the values of spirits studied by Miranda et al. (2007) to 278.49 mg / 100 ml. This high strength must be connected directly to the fermentation process and the fermentation conditions (Giudici et al., 1990), since the concentration of ethyl alcohol was added to this low concentration of higher alcohols.

Volatile acidity

To volatile, acidity is allowed a maximum of 100 mg / 100 ml, for distillate of Cajarana was found a value of 214 mg / 100 ml, this value was still higher than those found by Asquieri et al. (2009), for brandy of jabuticaba 30 mg /

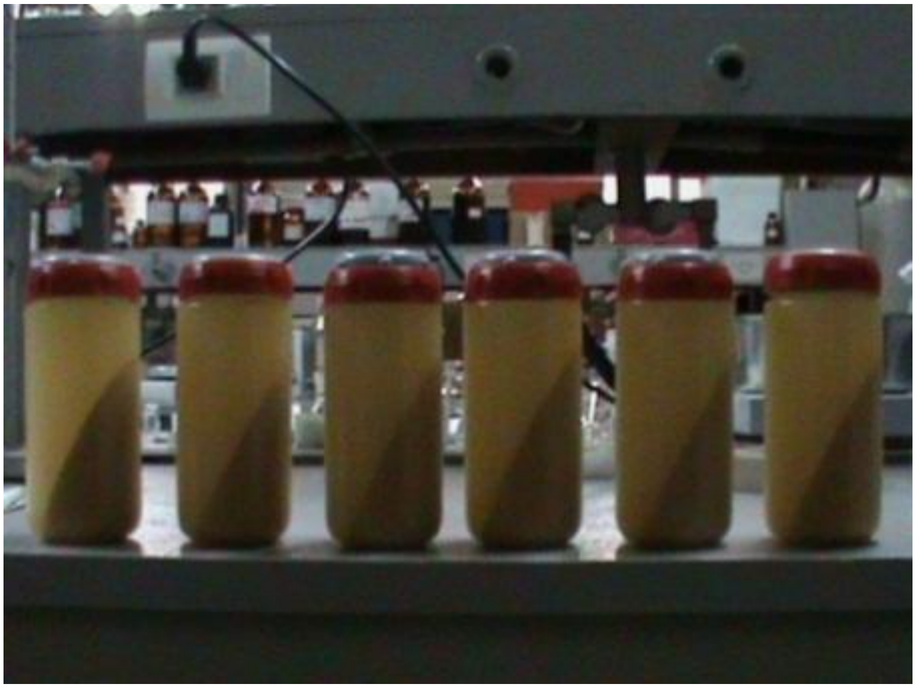


Figure 4. Cajarana centrifuged.

100 ml, and found by Miranda et al. (2009) for analysis of cachaça and spirits of sugar cane 55.82 mg / 100 ml. Acetic acid is the secondary component of greater responsibility for volatile acidity of Brandy (Lima, 1964; Nykamen and Nykamen, 1983).

Copper concentration

The concentration of copper in Cajarana spirit is ten times higher than the maximum set by the Brazilian legislation (Brazil, 2005), becoming irrelevant to compare this data with any other drink. This high copper concentration in the distillate may be due to the use of virgin copper which was first used for this study. Initial cleaning was carried out in three stages, first distiller was cleaned with soap and water washing, then washed again with lemon juice and finally was washed with pure water.

Conclusion

The production of Cajarana (Spondias sp), aiming to get alcoholic beverage, with a structured for the use of 100% of the fruit is certainly a viable process and very important for the semiarid of Paraiba. In pulping, the shell and core may be used for animal feed production, since they are rich in fiber. In centrifugation, pectin (the solid portion) can be used as a concentrated pulp for the production of juice, ice cream and others, as this keeps the mass and good organoleptic properties of minerals and vitamins of the fruit.

The yeast-alcoholic beverage distilled from Cajarana presents moderate alcohol content (28.94°GL), which is less than the alcohol content of cachaça, brandy and whisky, and greater than that of wine and beer, and may even be considered a low spirits alcoholic. The high content of methanol in the alcohol distillate of Cajarana is due to high concentration of pectin. To decrease the amount of methanol, a bi-distillation of the drink can be realized, which has not been possible due to the small amount of distillate obtained in the first distillation, or an enzymatic process for the extraction of the pectin after centrifugation. The industries of alcoholic beverage production derived from fruit are growing and perfecting techniques to improve final product quality and increase productivity, the same should apply to the material in this study, which may receive additional studies to improve the final product.

Conflict of Interest

The authors have not declared any conflict of interest.

ACKNOWLEDGMENT

The author’s sincere thanks go to the Center for Health Sciences and Rural Technology of the Federal University of Campina Grande for the assistance given to carry out

this study.

REFERENCES

Almeida MEW, Barreto HHC (1971). Álcoois superiores em aguardente de cana por cromatografia em fase gasosa. Rev. Inst. Adolfo Lutz. 31:117-124.

Aquarone E, LIMA UA, Borzani W (1975). Tecnologia das fermentações. São Paulo: E. Blücher. 1:49.

Asquieri ER, Silva AGM, Cândida MA (2009). Aguardente de jabuticaba obtido da casca e borra da fabricação de fermentado de jabuticaba. Ciênc. Tecnol. Alimentos Campinas. 29(4):896-904.

Babylon (2010). What are pectinesterases. Disponível em: <www.babylon6.demon.co.uk/pe.htmL>. Acesso em: dez.

BRASIL (1986). Ministério da Agricultura. Portaria nº 76 de 26 de novembro de 1986. Dispõe sobre os métodos analíticos de bebidas e vinagre. Diário Oficial da República Federativa do Brasil, Brasília, 28 nov. 1:2.

BRASIL (1997). Ministério da Agricultura. Decreto nº 2.314 de 4 de setembro de 1997. Regulamenta a Lei nº 8.918 de 14 de julho de 1994, que dispõe sobre a padronização, a classificação, o registro, a inspeção, a produção e a fiscalização de bebidas. Diário Oficial da República Federativa do Brasil, Brasília, 5 set.

Brazil (2005). Ministério da Agricultura. Instrução Normativa nº 13 de 29 de junho de 2005. Aprova o Regulamento Técnico para Fixação dos Padrões de Identidade e Qualidade para Aguardente de Cana e para Cachaça. Diário Oficial da República Federativa do Brasil, Brasília, DF, 30 jun. de 2005, Seção 1, P. 3.

Brasil (2008). Ministério da Agricultura. Pecuária e Abastecimento. Portaria n° 65, de 23 de abril de 2008: regulamento técnico para a fixação dos padrões de identidade e qualidade para aguardente de fruta. Brasília, DF, 2008. Disponível em: <www.agricultura.gov.br>. Acesso em: 10 dez. 2008.

Cantão FO (2006). Análises físico-químicas e avaliação da presença do cobre em aguardentes de cana por alumino silicatos. Dissertação (Mestrado). UFLA, Lavras-MG.

Cardoso MG (1998). Análises físico-químicas de aguardentes. In: Produção Artesanal de Aguardente. UFLA/FAEPE. pp. 107-121.

Cardoso MG (2001). Produção de aguardente de cana-de-açúcar. Lavras, Ed. UFLA. P. 264.

Eiroa MNV (1989). Microorganismos deteriorantes de suco de frutas e medidas de controle. Boletim SBCTA, Campinas 23(314):141-160.

Faria JB (1995). Sobre a produção de aguardente de cana. Engarrafador moderno. 6(40):9-16.

Faria JB, Pourchet CMA (1989). Eliminação do cobre contaminante das aguardentes de cana (*Saccharum officinarum* L.) brasileiras. Alimentos e Nutrição 1:117-126.

Fernandes SM, Oliveira FN (2010). Química. 3ª ed. 2010. P. 13.

Giudici P, Romano P, Zambonelle CA (1990). biometric study of higher Alcohol production in *Saccharomyces Serevisae*. Canadian Journal of Microbiology, Ottawa, 33(2):61-64.

Lima UA (1964). Estudo dos principais fatores que afetam os componentes do coeficiente não álcool das aguardentes de cana. Piracicaba: Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo. P. 141. Tese (Doutorado).

Lima UA (1999). Aguardente. Fabricação em pequenas destilarias. Piracicaba: Fundação Estudos Agrários "Luiz de Queiroz",. P. 187.

Lima UA (2001). Aguardentes. In: Aquarone, E.; Borzani, W.; Lima, V. A. Biotecnologia Industrial: biotecnologia na produção de alimentos. São Paulo: Edgard Blucher, 4:544.

Melo B, Martins ST (2010). *Spondias* (cajá e outras). Net, Uberlândia, MG, abr. 2010. Instituto de Ciências Agrárias, Universidade Federal de Uberlândia, MG. Disponível em: <http//www.fruticultura.iciag.ufu.br/cajá.htmL>. Acessado em: 01/04/2010.

Miranda MB, Martins NGS, Belluco AES, Horii J, Alcarde AR (2007). Qualidade química de cachaças e aguardentes brasileiras. Ciência e Tecnologia de Alimentos, Campinas 27(4):897-901.

Mitchell JD, Daly D (1995). Revisão das espécies neotropicais de *Spondias* (*Anacardiaceae*) In: CONGRESSO NACIONAL DE BOTÂNICA, São Paulo, 1995. Anais. São Paulo: USP, 1995, P. 207.

Morais PB, Linard VR, Pataro C, Maia ABRA (1997). Characterization and succession of yeast populations associated with spontaneous fermentations during the production of Brazilian sugar cane. World J. Microbiol. Biotechnol. 13:241-243.

Nascimento RF, Cardoso DR, Lima neto BS, Franco DW (1998). Influência do material de alambique na composição química das aguardentes de cana-de-açúcar. Química Nova, 21:735-739.

NOGUEIRA AMP, VENTURINI. Filho WG (2005). Aguardente de cana. Botucatu: Faculdade de Ciências Agronômicas. P. 71.

NYKAMEN L, NYKAMEN I (1983). Rum flavour of destilled beverages: Origin and development. Piggott, J. R. ED. Society of chemical industry / Ellis Harwood Limited. Chichester, UK pp. 49-63.

Pataro C, Gomes FCO, Araújo RAC, Rosa CA, SchwanRF, Campos CR, Claret AS, Castro HA (2002). Utilização de leveduras selecionadas na fabricação da cachaça de alambique. Informe Agropecuário, Belo Horizonte, 23(217):37-43.

Rizzon LA, Zanus MC, Manfredini S (1994). Como elaborar vinho de qualidade na pequena propriedade, 3ªed., Bento Gonçalves: EMBRAPA-CNPUV, P. 36.

Shreve RN, Brink Jr, Joseph A (1977). Indústrias de Processos Químicos, 4 ed. Rio de Janeiro: Guanabara Koogan, pp. 469-474.

Silva AQ da, Silva H, Nobrega JP da, Malavolta E (1984). Conteúdo de nutrientes por ocasião da colheita em diversas frutas da região Nordeste. In: CONGRESSO BRASILEIRO DE FRUTICULTURA, 7., 1983, Florianopólis. Anais... Florianopólis: SBF/EMPASC, 1.

Torres Neto AB, Silva ME, Silva WB, Swarnakar R, Silva FLH (2006). Cinética e caracterização físico-química do fermentado do pseudofruto do caju (*Anacardium occidentale* L.). Quim. Nova, 29(3):489-492.

Windholz M (1976). The Merck index. Rahway: Merck, P. 1606.

Yokoya F (1995). Fabricação de aguardente de cana (série fermentações industriais, n° 2). Campinas, SP: Fundação Tropical de Pesquisas e Tecnologia "André Tosello", P. 93.