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Vino de Agua de Coco: Evaluación Físico-Química y Sensorial

Coconut water wine: physicochemical and sensory evaluation

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Resumen

Se evaluaron las características físico-químicas y sensoriales de vino de agua de coco. La fermentación se realizó con *Saccharomyces cerevisiae* a 25 °C durante 30 días. Se hicieron las determinaciones de acidez titulable, acidez volátil y fija, pH, azúcares reductores, sacarosa, densidad, contenido de alcohol, rendimiento y análisis sensorial. Durante la fermentación, la acidez aumentó de 33,56 a 63,53 mEq/L y el pH disminuyó de 4,80 a 3,61. El vino de agua de coco tuvo 5,25 mEq/L de acidez volatil y 58,27 mEq/L de acidez fija. La concentración de azúcares reductores fue de 63,0 g/L y el contenido de sacarosa fue 129,83 g/L. El contenido de alcohol fue 11.30 °GL. La densidad se redujo de 1,6870 a 1,0197. El vino producido está conformidad con las normas establecidas por la legislación brasileña y su rendimiento fue del 77,75%. El producto tuvo buena aceptación sensorial, siendo un producto con potencial de comercialización.

Palabras clave:Bebida alcohólica; Fermentación; Aceptación sensorial; *Saccharomyces cerevisiae.*

Abstract

The physicochemical and sensory characteristics of a wine produced with coconut water were evaluated. The fermentation was conducted with *Saccharomyces cerevisiae* at 25 °C for 30 days. Titratable acidity, volatile and fixed acidity, pH, reducing sugars, sucrose content, density, alcohol content, yield and sensory analysis were determined. During the fermentation, titratable acidity increased from 33.56 to 63.53 meq/L and the pH decreased from 4.80 to 3.61. The coconut water wine had 5.25 meq/L of volatile acidity and 58.27 meq/L of fixed acidity. The reducing sugars were of 63.0 g/L and the sucrose content was 129.83 g/L. The alcohol content was 11.30°GL. The density reduced from 1.6870 (must) to 1.0197. The wine meets standards established by Brazilian law and yield was 77.75%. The product was well-accepted, being a potential product for commercialization.

Keywords: Alcoholic beverage; Fermentation; Sensory acceptance; *Saccharomyces cerevisiae.*

Introduction

The wine has been one of the most popular beverages among peoples and its consumption has been increasing due to its positive health benefits and also an indispensable part of etiquette culture at dinner table in some countries. Although wine is traditionally made from the fermented juice of grapes, many countries produce fruit wines. Fruit wines have considerable economic potential due to the trend of increasing acceptance in consumer surveys and the contribution they make to reducing postharvest losses of perishable fruits (1, 2).

Thus, many research groups, mainly in tropical countries, have employed the same processes used in winemaking to prepare fruit wines of pomegranate (3), cagaita (4), cocoa (5), gabiroba (6), cupuassu, jaboticaba and umbu (7).

Another tropical fruit that can be used for the production of fermented alcoholic beverage is the coconut. The coconut (Cocos nucifera L.) is a tropical plant cultivated in equatorial and sub-equatorial areas to produce copra, the dried kernel that is later processed into oil. Coconut water is a traditional sweet and refreshing tropical drink that comes directly from the inner part of immature fruits. This refreshing liquid extracted from the coconut fruit has been described as "rehydrating beverage" (8).

When consumed in coconut-producing countries, coconut water is extracted from fresh immature coconut fruits or drunk directly from inside the natural coconut vessels using a straw. Although coconut water is sterile in the inner cavity of the nut, it is a very fragile fluid. As soon as the nut is cracked, the biochemical composition and physical appearance of coconut water change. With an average pH of 5, micro-organisms such as yeasts can grow easily in this natural medium. A particular mineral composition and reasonable total sugar content can make coconut water a natural isotonic liquid (9).

Therefore, the production of a fruit wine from coconut water is an alternative that could prevent waste arising from the short life of this fruit. The aims of this study were to assess the adequacy of the coconut water for the production of fruit wines and to evaluate the physical–chemical, and sensory characteristics of the wine.

Materials and methods

Coconut water

Green coconuts with maturation age between 5 and 6 months were obtained in local market at Imperatriz, Brazil. Sixty coconuts were selected by similar size, shape and absence of spots. The coconuts were cleaned in chlorinated water (200 ppm of sodium hypochlorite) for 20 min. The excess was removed by immersion in chlorinated water (5 ppm of sodium hypochlorite) and after the water was drained.

The fermentative process was conducted by triplicate. In each replicate, the water of 20 coconuts was collected and mixed. Table 1 gives the physico-chemical characteristics of coconut water.

Table 1: Physico-chemical characteristics of coconut water used for the production of coconut water wine.

Characteristics	Mean[a]
pH	4.81 ± 0.19
Total soluble solids (ºBrix)	5.73 ± 0.21
Density	1.03 ± 0.00
Titratable acidity (meq/L)	33.56 ± 0.00
Reducing sugars (g/100 mL)	4.87 ± 0.00
Sucrose content (g/L)	59.49 ± 0.00
[a] Values expressed as the mean ± SD (standard deviation).	

Fermentation of coconut water

For each replicate of fermentation, the total soluble solids (TSS °Brix) of the coconut water was gauged. The chaptalization was performed to obtain a beverage with alcohol content between 10°GL and 13°GL. Commercial sucrose was used for the must correction adding an amount of sugar enough to reach a concentration of 24°Brix. To reduce the microbial load without affecting the activity of fermentative yeasts and preventing oxidation reactions, 200 ppm sodium metabisulphate was added to the must to obtain 100 ppm of sulphur dioxide residual. Each replicate of the coconut water was introduced into 5 L to low density polyethylene packaging. In the upperpart of the packaging, in a small opening was introduced a plastic hose. The other end of the hose was submerged in water, allowing the exit of CO2 and acting as a barrier to the entry of air.

Then, 200 ppm dry yeast S.cerevisiae was added. Fermentation was performed for 30 days at the 298 K in static mode. Samples were taken during fermentation for determination of TSS. At the end of fermentation, the fruit wine were transferred to a 10 °C incubator to promote sedimentation of solid material of the coconut water. After, the coconut water wine was filtered (whatman paper n° 1 filter) for removing yeast and sodium metabisulfite still suspended. The coconut water wine samples were dispensed into 500 mL sterile glass bottles closed with screw caps until analysis.

In the coconut water wines were recorded the TSS, pH, titratable acidity, volatile and fixed acidity, reducing sugars, sucrose content, density, alcohol, yield and sensory analysis.

Total soluble solids, pH and titratable acidity

The TSS was performed by refractometer (Nova 2WA). The pH was determined by direct measurement in potentiometer (Marconi PA 200) and the titratable acidity was measured by titrating with 0.10 M NaOH.

Volatile and fixed acidity

The volatile acidity was measured by titrating of distillated samples with 0.1 M NaOH. The fixed acidity was determined by difference between the total and volatile acidity (10).

Reducing sugars and sucrose content

The content of reducing sugars was determined spectrophotometrically using 3,5-dintrosalicylic acid (11). The sucrose content was determined according to Torres Neto *et al.* (12) by TSS. The results were calculated with Equation 1. For the total sugar content, the sucrose values were added to reducing sugars (Equation 2).

$$Sucrose = 10.130\,(TSS) + 1.445 \quad (1)$$

where Sucrose is sucrose content, g/L; and, TSS is total soluble solids, °Brix.

$$ST = SC + RS \quad (2)$$

where ST is total sugar, g/L; SC is sucrose content, g/L; and, R is reducing sugars, g/L.

Alcohol content

For the alcohol determination, ¾ of the distillate of wine sample was collected. It was determined the relative density of distillate at 20°C, using a picnometer. To calculate the alcohol content, was used a conversion table (13).

Density and yield

The density was measured using a picnometer at 20 °C according to Instituto Adolfo Lutz (13). The yield of coconut water wine was calculated by Equation 3.

$$Yield(\%) = \left(\frac{Q_{exp}}{Q_{teo}}\right) * 100 \quad (3)$$

where Yield is yield in percentage, dimensionless; Qexp is experimental ethanol concentration (0.7895 (g/L) (ºGL/100) 1000(mL/L)); and, Qteo is amount of consumed sugar, g/L.

Sensory evaluation

Sensory analysis was realized with 54 untrained tasters (56.36% female and 43.63% male), students and staff of the Universidad Federal of Maranhão, aged between 19 and 25 years. The session was conducted in individual booths under white light. Sample 30 mL at 20 °C, were provided individually in plastic cups coded along with the evaluation form. Acceptance tests were applied by using of nine-point hedonic scale in which: 1 (dislike extremely) and 9 (like extremely). The attributes evaluated were color, appearance, aroma, body, flavor and overall acceptance (14). For these attributes, the sum of hedonic values percentages from 1 (dislike extremely) to 4 (dislike slightly) was named "rejection region," the hedonic value percentage at score 5 (neither like nor dislike) was named "indifference region" and the sum of hedonic values percentages from 6 (like slightly) to 9 (like extremely) was named "acceptance region".

For evaluation of data were also collected using 5 point categorical Just-About-Right scale, sweetness, acidity, bitterness, alcohol taste and aftertaste of the coconut water wine, ranging from +2 (much stronger than the ideal) to -2 (much less stronger than ideal). For these attributes, the sum of values percentages of +1 and +2 was named "stronger than the ideal region", the percentages of 0 was named "ideal region" and the sum of values percentages of -1 and -2 named "Region less strong than ideal" (15). Purchase intention was also evaluated using a five-point scale ranging from 1 (definitely would not buy) to 5 (definitely would buy).

Results and discussion

Physico–chemical composition and yield

Titratable, volatile and fixed acidity, sugar content and alcohol content were within the limits acceptable by the Brazilian law (16).

The titratable acidity of coconut water wine increased from 33.56 meq/L to 63.53 meq/L (Table 2). Oliveira *et al.* (4) reported low titratable acidity values (44.93 meq/L and 47.78 meq/L) in the fruit wine produced from cagaita. The increase in this parameter obtained in the present study is important because the higher acidity reduce the microbial contamination, increasing the coconut water stability. The coconut water wine had 5.25 meq/L of volatile acidity (Table 2). Alves *et al.* (1) reported than lychee wine produced had a higher volatile acidity than prescribed by law. These authors concluded that this high level of volatile acid content might be related to the final processes winemaking, indicating the presence of undesirable microorganisms after preparation resulting in exposure to atmospheric oxygen, which can eventually convert wine into vinegar. According to Baiano *et al.* (17), high levels of volatile acidity in wine from grapes is considered as unmarketable factor due to the impact on the flavor and might come from microbiological changes caused by poor sanitation of the fruit, a lack of cleanliness and hygiene of the containers, and other inadequate procedures.

Table 2: Physico-chemical and yield values found in coconut water winea and limits established by brazilian legislation.

Characteristics	Mean	Limits established [b]		
		Minim	Maxim	Classification
Titratable acidity (meq/L)	63.53± 0.17	50.00	130.00	-
Volatile acidity (meq/L)	5.25±0.00	-	20.00	-
Fixed acidity (meq/L)	58.27±0.00	30.00	-	-
Sugar content(g/L)	136.13±0.00	-	≤ 20.00	Wine dry
		> 20.00	-	Wine sweet or suave
Reducing sugars(g/100 mL) 6.30±0.00		-	-	-
Sucrose content (g/L)	129.83±0.00	-	-	-
Alcohol (ºGL)	11.30±0.53	4	14	-
pH	3.63±0.01	-	-	-
Density at 20ºC	1.01±0.01	-	-	-
Yield (%)	77.75±0.00	-	-	-

[a] Values expressed as the mean ± SD (standard deviation). [b] Limits established by Brazilian legislation (16).

The fixed acidity of coconut water wine was 58.27 meq/L (Table 2). The TSS of the coconut water wine reduced from 24.00 to 12.25ºBrix during the fermentation (Figure 1). This decreasing during fermentation is due to the utilization of sugar for growth of the culture and production of alcohol.

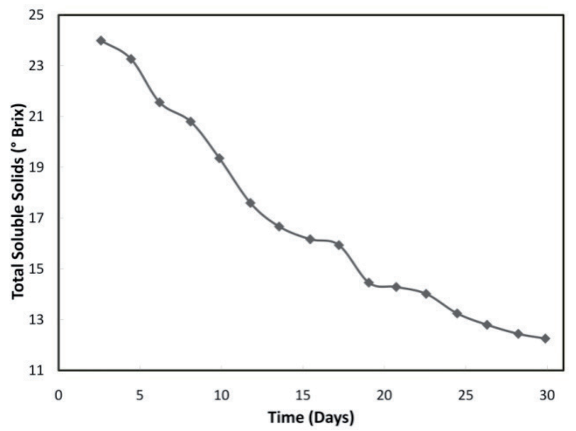


Figure 1: Consumption of total soluble solids (°Brix) during the fermentation of coconut water wine.

For sugar content, the coconut water wine showed values of 136.13 g/L (Table 2) and, according to Brazilian law, sugars content above 20.00 g/L are classified as sweet. The sucrose content of the wine was 129.83 g/L. The sucrose added in the begging fermentation was converted into glucose and fructose (18). The alcohol content of coconut water wine was 11.30°GL (value within the limits acceptable by Brazilian law). Although the alcohol content minimum is 4.00°GL, in the present study, was attempted alcohol content above 9.00°GL. This because according to Santos *et al.* (19), wines with less than 9.00°GL are not stable and have higher chances of vinegar. Moreover, the most tasters (53.07%) considered this alcoholic content ideal (Figure 3).

Coconut water wine had pH of 3.61 (Table 2), while the coconut water has 4.80 (Table 1). Lee *et al.* (20), evaluating of physicochemical properties of apple wines also observed a reduction in the pH, that was attributed to organic acids production.

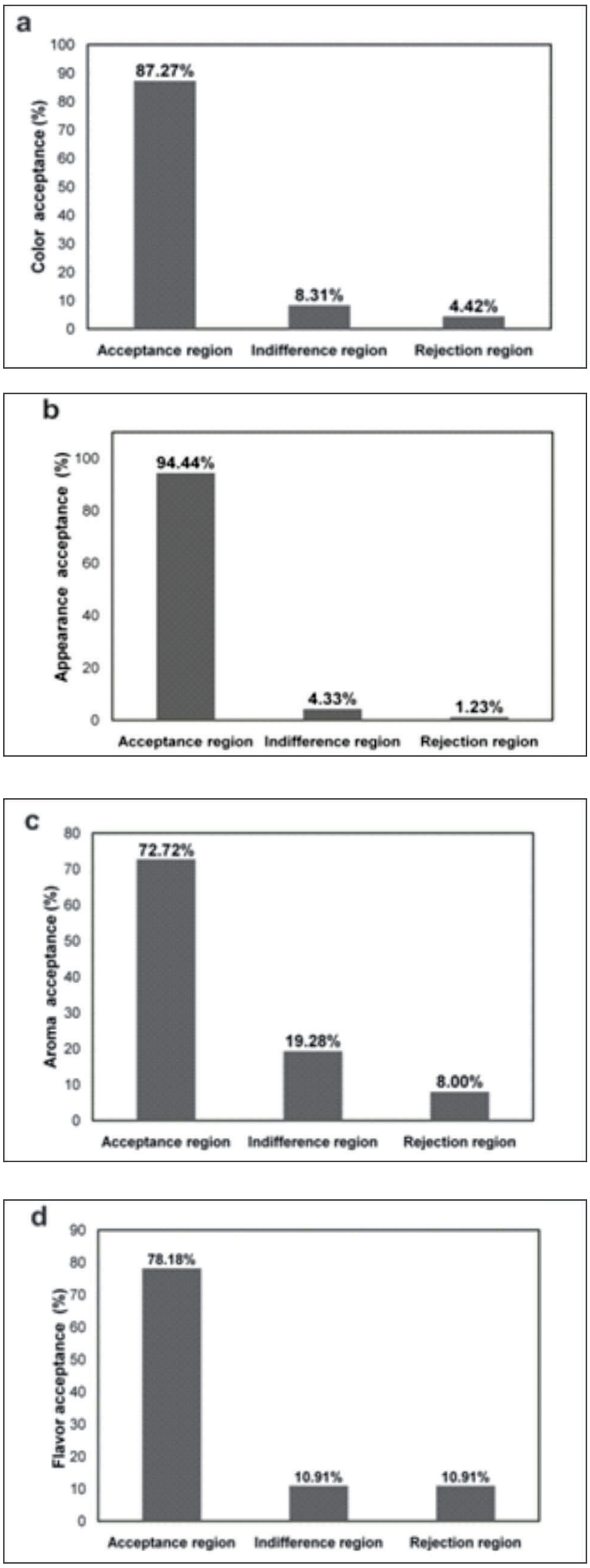
The yield of the coconut water wine was 77.75% (Table 1). However, Towantakavanit *et al.* (21) evaluating quality properties of wine from Korean kiwifruit reported yield of 66.19%. Thus, the yield of coconut water wine study is satisfactory.

Sensory evaluation

The color of the coconut water wine had high percentages (87.27%) in the acceptance region, indicating a good acceptability (Figure 2a). According to Jackson (22), the sweet white wines may vary from a pale straw to yellow-gold. Moreover, the color often influences the perception of wine quality and it is one of the most important quality parameters for buying.

The appearance of the coconut water wine was the attribute that had high percentages (94.44%) in the acceptance region (Figure 2b). Duarte *et al.* (7), evaluating the appearance acceptance of umbu and cupuassu wines obtained lower results, 63.00 and 61.00%, respectively. Thus, the results obtained in the present study are positive. The presence of haze in bottled white wines is a serious quality defect as turbidity makes a wine undesirable for consumers. The hazing potential of a white wine is affected by variations in the relative proportions of its macromolecular components occurring in the early stages of winemaking (23). Therefore, the results of appearance can be due to filtration that was effective in retaining larger particles giving higher brightness drink.

The aroma presented high percentage (72.72%) in the acceptance region (Figure 2c). The components present in wine, responsible for the typical smell, has its origin the metabolism of yeasts that is the main source of components formed during fermentation, and components of the fruits (24). Lee & Lee (25) evaluated the overall preferences for ten Korean rice wines. These authors concluded that intense fruitiness aroma was appealing to different clusters of consumers. Therefore, the coconut water aroma can have contributed to high acceptance of the beverage. In study conducted by Prades *et al.* (8) featuring the volatile profile of coconut water was reported that there was a prevalence of ketones, alcohols and aldehydes. According to authors, the ketones found in coconut water are responsible for fruity notes.



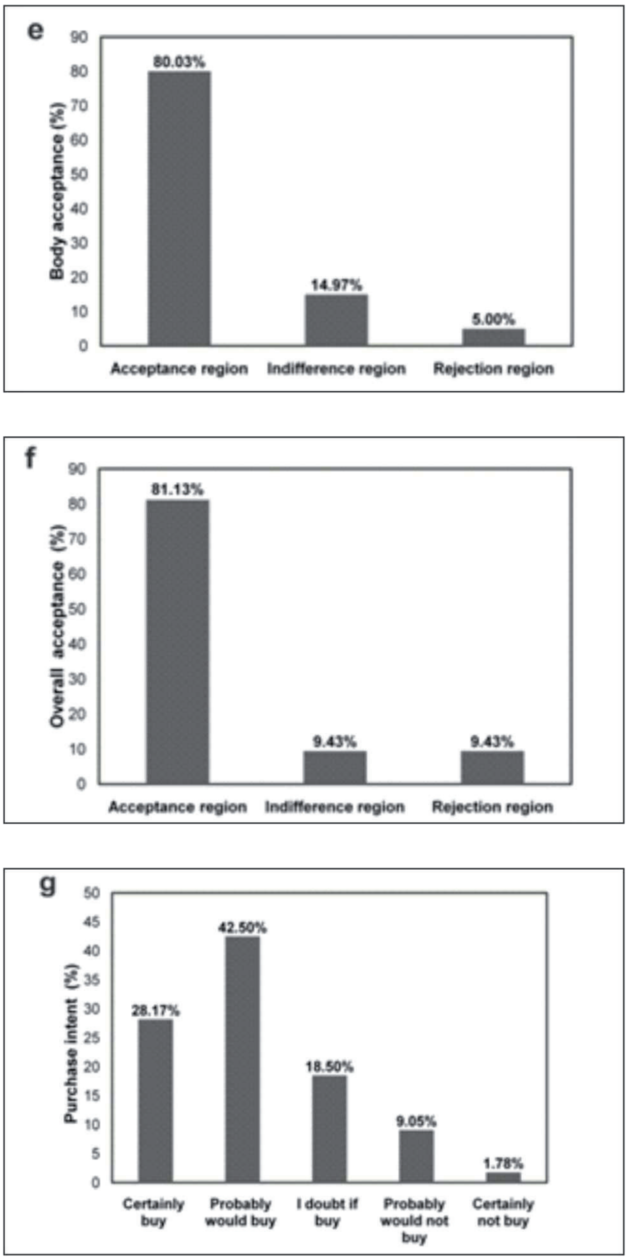


Figure 2: Color acceptance (a), appearance acceptance (b), aroma acceptance (c), flavor acceptance (d), body acceptance (e), overall acceptance (f), and, purchase intent (g) of the coconut water wine.

For flavor, a high percentage (78.18%) is in the acceptance region (Figure 2d). Consumers also were asked about their consumption of white wine and coconut water. The percentage of acceptance of white wine was 64.27% and coconut water was 98.20%. This result revealed good acceptance of the beverage, mainly when taking into account that the tasters were not familiar with this product. Moreover, only 45.28% of the tasters said have the habit of consuming alcoholic beverage as white wine. Comparing with others fruit wines, the flavor acceptance of coconut water wine had best results. Duarte *et al.* (6) reported percentage acceptance of 54.35% to flavor of gariroga wine, a fruit native to the western and southern Brazilian. Duarte *et al.* (7) reported lower values evaluating the flavor acceptance of cacao (58.00%), cupuassu (58.00%), jaboticaba (61.00%) and umbu (51.00%).

The best result of flavor obtained in the present study when compared to fruit wines obtained for these authors can be due to the coconut water produced be classified as sweet and the fruit wines of these authors be classified as dry. According to Towantakavanit *et al.* (21), the sweetness is one of the significant parameters for wine acceptation by panelists, who prefer sweeter wines.

The body acceptance of the coconut water wine showed values de 80.03% in the acceptance region (Figure 2e). This result is higher than the result obtained by Silva *et al.* (26) evaluating the body acceptance of bounty mango wines (66.66%). This higher acceptance can be related to coconut water wine be thicker, characteristic reported for some tasters. According to Romano *et al.* (27), the increase of the wine viscosity can be resultant of the high concentrations of 2,3-butanediol which is produced by yeast metabolism during fermentation.

For the overall acceptance of the coconut water wine, the percentage of 81.13% was obtained in the acceptance region (Figure 2f). Dias *et al.* (5) reported overall acceptance of 60.00% to cocoa wine and concluded that this had a good acceptance. Asquieri *et al.* (28), evaluating jackfruit wine reported overall acceptance of 78.00%, concluding that an index above 70.00% approval reveals a good acceptance. Thus, these results confirm those obtained for others attributes of coconut water wine, indicating that this beverage can be one of the alternatives for the use of the coconut water.

The coconut water wine presented purchase intention of 70.67% of the tasters (percentages of “certainly buy” and “probably would buy”) (Figure 2g). Oliveira *et al.* (29) reported purchase intention about 65.00% to “certainly buy” and “probably would buy” for fermented beverage using residual syrup of osmotic dehidration of pineaple. According to theses authors, the comments of some tasters, wine required more aroma and flavor of pineapple. Undesirable changes in the flavor were not reported and the coconut water wine.

For the sweetness, 50.00% of the tasters said it was ideal and about 30.00% said that it was “less strong than ideal” (Figure 3). This result reflects the preference by Brazilian consumers. According to Behrens *et al.* (30), the Brazilian consumers of the white wine preferred sweet table wines.

The acidity presented 52.63% in the ideal region (Figure 3). Bindon *et al.* (31) reported that the wine acidity attribute is strongly associated with titratable acidity and pH, as well as related to astringency. In wines with pH values up to 3.5, the perception of astringency is increased (32). Williamson *et al.* (33) reported that the consumers preferred wines low acidity. Thus, the low acidity obtained in the present study contributed to high percentages on the ideal region. Moreover, perception of astringency was not reported by consumers.

Bitterness attribute presented a percentage of 61.48% in the ideal region (Figure 3). This result is favorable because others authors related that bitterness reduce the acceptance. Alves *et al.* (1) evaluating the sensory characteristics of lychee wines, reported that bitter flavors was responsible in part for the low scores attributed to the fermented flavor. Lee & Lee (25) reported that all consumers that evaluated Korean rice wines considered bitterness as negative.

According to 59.25% of the panelists, the alcohol content was classified as ideal. Bindon *et al.* (31) evaluating the sensory characteristics of Vitis vinifera L. cv Cabernet Sauvignon wine by Australians consumers reported that consumer testing revealed that the lowest-alcohol wines (12.00%) were the least preferred. This preference was different in the present study with Brazilian consumers that considered 11.30% as ideal and about 35.00% said that it was "stronger than ideal".

The aftertaste had 53.07% in the ideal region (Figure 3). Mohanty *et al.* (34) compared the after taste of cashew apple wine with a selected commercial brand of white grape wine. These authors reported that the consumers gave low notes to cashew apple wine than commercial grape wine and attributed to high tannin content in the cashew apple wine.

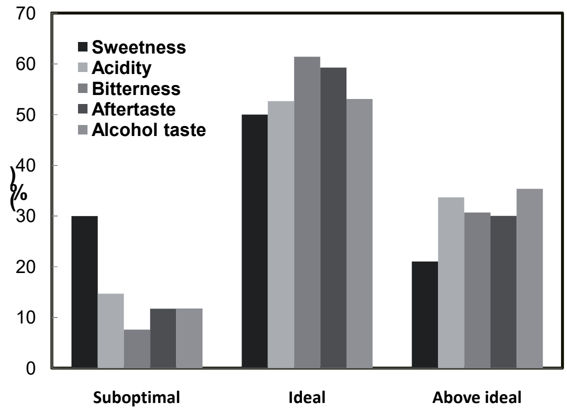


Figure 3: Percentages for "above ideal", "ideal" and "suboptimal" for the attributes evaluated.

Conclusions

It can be concluded that the methodology described here is simple and can be applied in a relatively small space without high cost. The use of the SO2, which in the applied concentration, inhibited the growth of bacteria and did not interfere with the quality of the final beverage. The wine showed identity and quality standards in accordance with limits established by Brazilian law, and a satisfactory yield. The sensory analysis revealed good acceptance. Therefore, coconut water showed good potential for use in the production of fermented beverage. It was observed that, from the acceptability of the beverage, this technology can be an alternative for the use of the tropical fruit, and may provide a new industrial outlet for this fruit.

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