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# Development and Physicochemical Evaluation of Wine Produced from Cashew Apple Powder

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**Abstract:** Fully ripe cashew apples (yellow variety) were sliced, dried (at 65°C) and ground to produce Cashew Apple Powder (CAP). The must prepared by mixing 75 g of CAP with 1litre of distilled water and then ameliorated to 20° Brix was inoculated with 1 g $L^{-1}$ Baker's yeast (Saccharomyces cerevisiae) and held at 28°C for 14 days. Total Soluble Solids (TSS), pH and Specific Gravity (SG) decreased, while Total Titratable Acidity (TTA) and alcohol concentration increased with increasing length of fermentation of the must. After 6 months of storage (ageing) the Wine produced from Cashew Apple Powder (WCAP) was light brown, slightly acidic in taste (total titratable acidity (0.74% w $v^{-1}$ tartaric acid)), low in tannin (0.60 mg/100 mL), low in vitamin C (14.2 mg/100 mL) and low in alcohol (7.2%) concentration. Sensory evaluation results showed that there were no significant differences ($p<0.05$) in aroma and overall acceptability between WCAP and the reference sample (Wine produced from Cashew apple Juice (WCJ)) but there were significant differences in taste and colour. Although, the Wine Produced (WCAP) rated as quite acceptable as an alcoholic beverage, significant differences ($p<0.05$) exist between the wine produced from cashew apple powder and commercial fruit wines particularly in taste, colour, aroma and overall acceptability.

**Key words:** Product development, cashew apple powder, fermentation, wine, physicochemical parameters, sensory evaluation

## INTRODUCTION

The cashew tree *Anacardium occidentale* L., generally considered to be native to the Northern part of South America, is now found in many tropical areas. Brazil, India, Vietnam and Nigeria are the main producers (Honorato *et al*., 2007). The fruit consists of mainly the nuts containing an embryo (kernel) and a false fruit commonly called cashew apple (Akinwale, 1999) and it is rated foremost of the native fruits in Nigeria (Akinwale, 2000).

Cashew is an important cash crop grown in Nigeria on an area of 331,000 ha which produced 660,000 tones of raw nuts in 2007. Given the weight ratio of apple to nut at 8:1 (Cormier, 2008), the annual production of cashew apple in Nigeria is about 5.2 million tones, most which is left to rot in the field under the trees for lack adequate storage facilities. The studies carried out at Cocoa Research Institute of Nigeria (CRIN) revealed that the present consumption of cashew apple either in raw or processed form is about 10% of production (Oduwole *et al*., 2001).

Cashew apple is a valuable source of minerals and vitamins. Indeed, cashew apple juice is reported to contain 5 times as much vitamin C as citrus juice (Akinwale, 2000; Azam-Ali and Judge, 2001) and10 times as pineapple juice (Ohler, 1988). The cashew apple juice also has medicinal uses. For instance, its high tannin content makes it suitable remedy for sore throat and chronic dysentery in Cuba and Brazil (Morton, 1987). It is also reported to have anti-bacterial, anti-oxidant (Melo-Cavalcante *et al*., 2003) and anti-mutagenic (Cavalcante *et al*., 2005).

The cashew apple is quite perishable and used locally unless preserved. It will rot within 24 h of falling or detached from a tree (Kristin, 1999). As a result of the need to find a wider use for cashew apples, the cashew producing countries of the world have explored and developed many different products. The reported works on the products from cashew apple included fermentation of juice into wine (Aderiye *et al*., 1991; Akinwale, 1999; Shuklajasha *et al*., 2005); preparation of jam and preserves (Ogunmoyela, 1983); conversion of apple juice into alcohol and non-alcoholic beverages, candied fruit, fresh juice, jelly, syrup and pectin (Winterhalter, 1991) and sun-dried cashew apple (Morton, 1987).

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Cashew wine is a light yellow alcoholic drink prepared from the cashew apples and it contains an alcohol content of between 6 and 12% alcohol (Wimalsiri *et al*., 1971; Azam-Ali and Judge, 2001). Many studies have been reported on wine production from grapes and other fruit musts and several physicochemical evaluations have been undertaken (Cristovan *et al*., 2000; Gonzalez *et al*., 2002; Maccarone *et al*., 1993; Aderiye *et al*., 1991; Akinwale, 1999; Shuklajasha *et al*., 2005; Winterhalter, 1991; Obisanya *et al*., 1987).

Screening of study revealed that Akinwale (1999) produced Cashew wine with alcohol content of 10.6% (v $v^{-1}$) from cashew apple juice in Nigeria. However, because cashew apple is a seasonal fruit, cashew wine production in Nigeria is limited to the fruit season period only. In view of the increasing losses of larger percentage of cashew apples (about 90% of total production) and unavailability of fresh cashew apple throughout the year for wine production, there is need to explore an alternative means of ensuring regular source of raw material.

The drying of cashew apple can be an excellent alternative to increase its shelf-life. It allows conversion of perishable materials into stabilized product by lowering the water activity to appropriate levels. It also prevents, microbial spoilage and quality deterioration due to undesirable biochemical reactions. In addition, drying reduces waste and post-harvest losses. The development of dried cashew apple (cashew apple powder), which maintain the relevant sensory properties as unaltered as possible, can contribute to the development of some value added products, which would be acceptable to the consumers.

Therefore, this study intends to develop a new wine product using cashew apple powder as a raw material and then determine its physicochemical parameters compared to the sensory qualities of similar fruit wines.

## MATERIALS AND METHODS

**Preparation of Cashew Apple Powder (CAP):** Ripe, matured fruits (yellow variety) were harvested at the cashew plantation of Cocoa Research Institute of Nigeria (CRIN) headquarters, Ibadan. The nuts were detached from the apple manually and the apples were sorted, weighed and washed with sodium metabisulphite solution (350 ppm) to remove any contaminants from the farm. Cashew apples were cut into small pieces of approximately, 1.0×1.0 cm with stainless steel knife and placed in stainless trays for drying process. The samples were oven dried at 65°C for 12 h until the final moisture attained 7.0%. After drying, the dried apple pieces were left to cool in desiccators and then ground in a domestic blender (Phillips brand) at low velocity for 5 min. Afterwards, the material was sieved to obtain a powder with an average particle size of 6 μm. The weight of the obtained cashew apple powder was recorded and immediately sealed in polyethylene bags and stored at room temperature (28°C).

**Extraction of the cashew juice:** Fresh, ripe and matured apples were sorted, weighed and then extracted with the aid of locally fabricated cashew extraction machine as described by Oduwole *et al*. (2001).

**Preparation of the must:** Based on the preliminary studies carried out at CRIN on the possible utilization of Cashew Apple Powder (CAP) for wine making, 75 g of CAP was mixed with 1 L of distilled water (75 g $L^{-1}$ of CAP) and the sample was labeled WCAP. The control sample was also produced from fresh cashew apple juice and was labeled WCJ. The wine samples were produced according to the methods described by Akinwale (1999). Briefly, sucrose was added to the samples to bring the specific gravity up to 1.083. About 450 ppm of sodium matabisulphite, 0.67% ammonium sulfate and 1 g $L^{-1}$ of citric acid were added to the must. The must was then pasteurized at 80°C for 10 min and allowed to cool down. All the samples were prepared in triplicates.

**Preparation of yeast starter:** *Saccharomyces cerevisae* (commercial baker's yeast) was used for fermentation. The starter culture was prepared using 1 g $L^{-1}$ of baker's yeast, which was made into slurry with some of the pasteurized must to be fermented.

**Fermentation of the must:** The must was dispensed into fermenting bottles (4.5 L each) in triplicates and fermented at room temperature (28°C). Fermentation process continued for 14 days, until all the sugar was exhausted. The wine was allowed to rest for about 2 weeks before racking.

**Maturation of the wine:** The fermented liquor was racked into a clean bottles filled up to the neck and slightly covered with cotton wool and allowed to age for about 52 weeks during which, racking was done at intervals of 3 months at a temperature of 28°C. After 6 months of storage, physicochemical parameters were carried out in triplicates and mean values were recorded.

**Physicochemical analysis:** The pH of the must and wine samples was determined using a digital pH meter (HI 1281 CE-Hanna Instrument, Portugal). Specific gravity and soluble solids were determined at 20°C using hydrometer and Lombe Abbe refractometer respectively. The titratable acidity (total, fixed and volatile acidity) and tannin content were determined by the methods of AOAC (2000). The total and fixed acidity were expressed as percent tartaric acid and volatile acidity were expressed as percent acetic acid.

The alcohol concentration was determined using the alcohol distillation and specific gravity method (Egan *et al*., 1981) and conversion table (Amerine *et al*., 1980). The ester was determined using Kirk and Sawyer (1991) method and calculated as percent ethyl acetate. Vitamin C was determined by titration (AOAC, 2000).

**Sensory analysis:** Five different coded samples of wine were presented to a panel of 20 randomly selected men and women of between 18-40 years of age, who are members of staff of CRIN and are regular wine drinkers. The samples were coded WCAP, WCJ and reference samples (cocoa wine, kola wine and tea wine). The tasting was done in an air conditioned and well illuminated room. Each assessor was presented with chilled (15°C) coded samples of wine in clear glass tumblers. Panelists were asked to assess wine for colour, taste, aroma and overall acceptability using nine-point hedonic scale with 9 representing like extremely and 1 representing dislike extremely.

**Statistical analysis:** Data were subjected to analyses of variance and means were separated using Duncan's multiple range test at $p<0.05$ (Steel and Torrie, 1980; Gomez and Gomez, 1985).

## RESULTS AND DISCUSSION

There were variation in pH, titratable acidity, vitamin C and tannin content of the must samples prepared from cashew apple powder and cashew apple juice (Table 1). This observation was similar to that of Akinwale *et al.* (2001) where, it was reported that the total acidity and vitamin C content of cashew apple were affected by heat treatment with value decreasing with increase duration of heat for vitamin C. The lower values for TTA (0.38%), vitamin C (42.2 mg/100 mL) and tannin (0.87 mg/100 mL) observed in the must of sample WCAP may be due to the heat treatment during the preparation of cashew apple powder.

Figure 1-5 showed physicochemical parameters of wine samples during fermentation. These results were within the range expected for fruit wine. The fermentation characteristics indicated that the pH, specific gravity and total soluble solids significantly decreased while the titratable acidity and alcohol concentration increased as the fermentation progressed.

Table 1: Physicochemical characteristics of the Must samples before fermentation

| Parameters | WCAP | WCJ |
|---|---|---|
| Percentage of total solids | 20.0[a] | 20.0[a] |
| Specific gravity | 1.083[a] | 1.083[a] |
| pH | 4.94[a] | 4.22[b] |
| Titratable acidity (% citric acid) | 0.38[b] | 0.64[a] |
| Tannin (mg/100 mL) | 0.87[b] | 1.86[a] |
| Vitamin C (mg/100 mL) | 42.2[b] | 203.5[a] |

Sample means with the same alphabets along the rows are not significantly different at $p<0.05$; WCAP: Wine sample produced from Cashew Apple Powder; WCJ: Wine sample produced from Cashew apple Juice

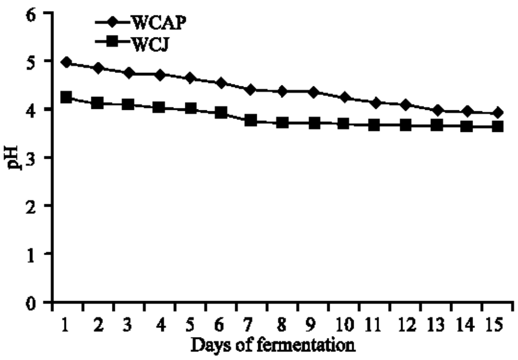


Fig. 1: Changes in pH of the wine samples during fermentation

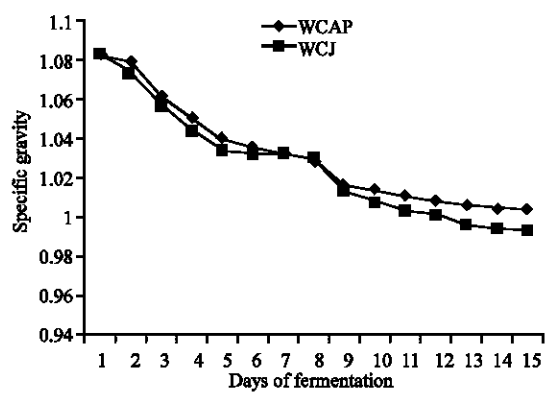


Fig. 2: Changes in Specific gravity of the wine sampleduring fermentation

This observation was in agreement with reports of other researchers (Aroyeun *et al*., 2005; Akinwale, 1999; Aderiye *et al*., 1991; Obisanya *et al*., 1987; Goreinsterin *et al*., 1984; Ojeh, 1981). This is due to the gradual decrease in the sugar present in the must as a result of the activities of the yeasts. As expected during fermentation of the Must, the specific gravity dropped due to the formation of alcohol.

At the end of fermentation period of 14 days (Table 2), the specific gravity of WCAP had dropped from 1.083-1.004 with an alcohol content of 7.0% (v $v^{-1}$), while that of WCJ dropped from 1.083-0.993 with an alcohol content of 9.2% (v $v^{-1}$). The pH decreased from 4.94-3.92 for WCAP, while that of WCJ decreased from 4.22-3.63. The Vitamin C content decreased significantly while there was a slight drop in tannin content in both samples as a result of chemical reactions during fermentation. Though there were significant differences among the sample but the values were within the limit for fruit table wine (Nduka, 1987).

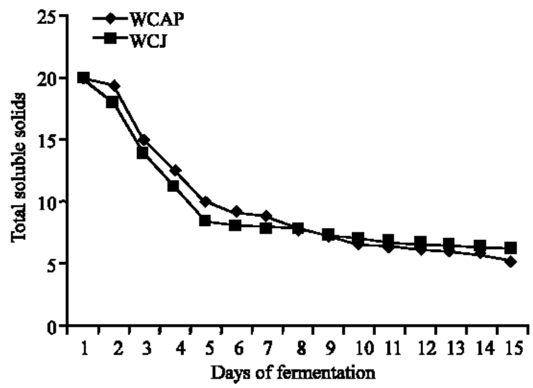


Fig. 3: Changes in Total soluble solids of the wine samples during fermentation

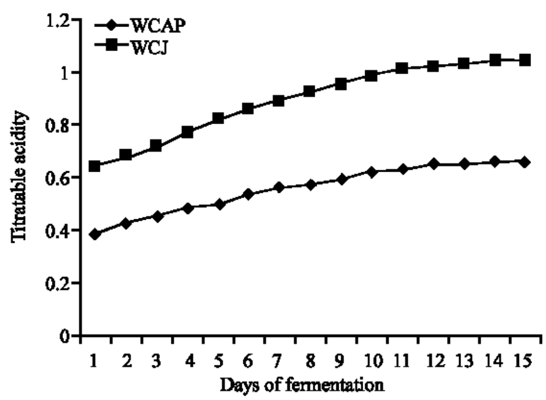


Fig. 4: Changes in Titratable acidity of the wine samples during fermentation

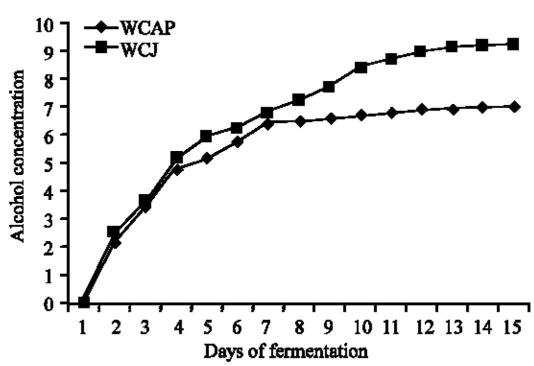


Fig. 5: Changes in alcohol concentration of the wine samples during fermentation

From Table 3, the physical examination of wine produced from cashew apple powder compared favourably with the wine produced from cashew juice. There was a slight difference in the colour. The variation in colour could be due to the raw material used for the

Table 2: Physicochemical composition of wines produced from cashew apple powder and cashew apple juice after 14 days of fermentation

| Parameters | WCAP | WCJ |
|---|---|---|
| pH | 3.92[a] | 3.63[b] |
| Specific gravity | 1.004[a] | 0.993[b] |
| Percentage of total solids | 5.2[b] | 6.0[a] |
| Percentage of alcohol (v $v^{-1}$) | 7.0[b] | 9.2[a] |
| Total acids (percentage of w $v^{-1}$ tartaric acid) | 0.68[b] | 1.04[a] |
| Fixed acids (percentage of w $v^{-1}$ tartaric acid) | 0.63[b] | 0.95[a] |
| Volatile acids (percentage of w $v^{-1}$ acetic acid) | 0.05[b] | 0.09[a] |
| Ester (percentage of Ethyl acetate) | 0.43[b] | 0.76[a] |
| Percentage of extract | 3.2[b] | 5.3[a] |
| Percentage of glycerol | 0.240[b] | 0.320[a] |
| Tannin (mg/100 mL) | 0.62[b] | 1.40[a] |
| Vitamin C (mg/100 mL) | 22.0[b] | 84.0[a] |

Values are means of three replicates; sample means with the same alphabets along the rows are not significantly different at p<0.05; WCAP: Wine produced from Cashew Apple Powder; WCJ: Wine produced from Cashew apple Juice

Table 3: Physical Examination of wine samples produced from cashew apple powder and cashew apple juice after 6 months ageing at 10°C

| | Condition of wine | |
|---|---|---|
| Attributes | WCAP | WCJ |
| Appearance | Bright and clear (no sediment) | Bright and clear (no sediment) |
| Condition when opened | Still | Still |
| Colour | Light brown | Light yellow |
| Odour | Clean and peculiar of cashew flavour | Distinct and peculiar of cashew apple |
| Taste | Slight acidic | Dry and acidic |

WCAP: Wine sample produced from Cashew Apple Powder; WCJ: Wine sample produced from Cashew apple Juice

Table 4: Effect of ageing on physicochemical attributes of wine produced from cashew apple powder and cashew apple juice after 6 months of storage at 10°C

| Parameters | WCAP | WCJ |
|---|---|---|
| pH | 3.71[a] | 3.42[b] |
| Specific gravity | 1.002[a] | 0.993[b] |
| Percentage of total solids | 5.0[a] | 6.0[a] |
| Percentage of alcohol (v $v^{-1}$) | 7.2[b] | 9.5[a] |
| Total acids (percentage of w $v^{-1}$ tartaric acid) | 0.74[b] | 1.06[a] |
| Fixed acids (percentage of w $v^{-1}$ tartaric acid) | 0.67[b] | 0.97[a] |
| Volatile acids (percentage of w $v^{-1}$ acetic acid) | 0.07[a] | 0.09[a] |
| Ester (percentage of Ethyl acetate) | 0.64[b] | 0.88[a] |
| Percentage of extract | 3.40[b] | 5.450[a] |
| Percentage of glycerol | 0.232[b] | 0.320[a] |
| Tannin (mg/100 mL) | 0.60[b] | 1.22[a] |
| Vitamin C (mg/100 mL) | 14.8[b] | 52.3[a] |

Values are means of three replicates; sample means with the same alphabets along the rows are not significantly different at p<0.05; WCAP: Wine sample produced from Cashew Apple Powder; WCJ: Wine sample produced from Cashew apple Juice

Table 5: Physicochemical attributes of cashew wine compared with some commercial fruit wines

| Parameters | WCAP | WCJ | Cocoa wine | Tea wine | Apricot | Capel | Peach |
|---|---|---|---|---|---|---|---|
| pH | 3.71$^{a}$ | 3.42$^{b}$ | 3.70$^{a}$ | 3.33$^{c}$ | 3.10$^{c}$ | 3.60$^{a}$ | 3.45$^{b}$ |
| Specific gravity | 1.002$^{b}$ | 0.993$^{c}$ | 0.992$^{c}$ | 1.030$^{a}$ | 1.040$^{a}$ | 1.000$^{b}$ | 1.034$^{a}$ |
| Percentage of total solids | 5.00 | 6.00$^{b}$ | 5.00$^{c}$ | 5.70$^{c}$ | 9.00$^{a}$ | 6.00$^{b}$ | 7.10$^{b}$ |
| Percentage of alcohol (v $v^{-1}$) | 7.2$^{b}$ | 9.50$^{a}$ | 10.01$^{a}$ | 6.00$^{c}$ | 7.00$^{b}$ | 10.00$^{a}$ | 7.10$^{b}$ |
| Total acids (percentage of w $v^{-1}$ tartaric acid | 0.74$^{c}$ | 1.06$^{b}$ | 0.46$^{e}$ | 4.25$^{a}$ | 1.10$^{b}$ | 0.68$^{d}$ | 0.80$^{c}$ |
| Fixed acids (percentage of w $v^{-1}$ tartaric acid) | 0.67$^{d}$ | 0.97$^{c}$ | 0.38$^{e}$ | 4.23$^{a}$ | 1.07$^{b}$ | 0.63$^{d}$ | 0.77$^{d}$ |
| Volatile acids (percentage of w $v^{-1}$ acetic acid) | 0.07$^{b}$ | 0.09$^{a}$ | 0.09$^{a}$ | 0.02$^{d}$ | 0.03$^{d}$ | 0.05$^{c}$ | 0.03$^{d}$ |

$^{a-e}$Means along same horizontal rows with same superscipts are not significantly different at $p<0.05$; WCAP: Wine sample produced from Cashew Apple Powder; WCJ: Wine sample produced from Cashew apple Juice

wine samples. Deep yellow colour was observed in the juice while the apple powder had light brown colour due to the process it underwent. However, both samples had acceptable characteristics as expected for similar wines (Nduka, 1987; Wimalsiri *et al*., 1971; Akinwale, 1999).

According to Table 4, there was a slight increase in acidity and a slight drop in pH for both samples after 6 months of storage. During maturation (ageing) at 10°C, more deposits settled from the wine samples and they became clearer, the taste was less harsh. During ageing and subsequent maturing in bottle many reactions, including oxidation, occur with the formation of traces of esters and aldehydes, which together with tannin and acids already present enhance the taste, aroma and preservative properties of wine (Wimalsiri *et al*., 1971). The wine samples were significantly difference in most of the parameters considered after 6 months of storage. However, the characteristics of the wines were also most acceptable and similar to those of other fruit wines (Ojeh, 1981; Akinwale, 1999; Kirk and Sawyer, 1991).

The physicochemical properties of samples WCAP and WCJ were compared with similar wines produced at CRIN (cocoa wine and tea wine) and other commercial samples like capel, peach and apricot (Table 5). Sample WCAP was significantly different from sample WCJ, cocoa wine, tea wine, capel, peach and apricot in most of the physicochemical parameters evaluated. This could be as a result of raw material components or due to different processing methods (Aroyeun *et al*., 2005). Sample WCAP was not significantly different from capel in pH, specific gravity and fixed acids. Also sample WCAP percentage alcohol was not significantly different from apricot and peach. Sample WCAP was low in alcohol (7.2% v $v^{-1}$) with significant value lower than sample WCJ, cocoa and capel wines. In general, the values obtained in our research fell within the acceptable limits for similar fruit wines imported into Nigeria (Kirk and Sawyer, 1991).

According to Table 6, the mean sensory scores for both samples WCAP and WCJ compared favourably well with commercial samples in taste, colour, aroma and overall acceptability and there were significant differences in most of the evaluated attributes ($p<0.05$). Samples WCAP and WCJ were significantly different in taste and colour at ($p<0.05$) with sample WCAP rated better. This could be due to lower titratable acidity, tannin and alcohol in sample WCAP. There were no significant differences in aroma and overall acceptability for both samples of cashew wine.

Table 6: Mean Sensory scores for the wine samples

| | Attributes | | | |
|---|---|---|---|---|
| Samples | Taste | Aroma | Colour | Overall acceptability |
| WCAP | 7.8$^{a}$ | 6.8$^{a}$ | 7.2$^{a}$ | 7.1$^{a}$ |
| WCJ | 6.2$^{b}$ | 6.4$^{a}$ | 6.6$^{b}$ | 6.9$^{a}$ |
| Kola wine | 6.1$^{b}$ | 5.2$^{b}$ | 6.5$^{b}$ | 5.1$^{c}$ |
| Cocoa wine | 5.8$^{c}$ | 5.0$^{b}$ | 6.7$^{b}$ | 5.3$^{c}$ |
| Tea wine | 4.3$^{d}$ | 4.5$^{c}$ | 5.3$^{c}$ | 4.5$^{d}$ |

$^{a-d}$Means along same vertical column with same superscripts are not significantly different at $p<0.05$; WCAP: Wine sample produced from Cashew Apple Powder; WCJ: Wine sample produced from Cashew apple Juice

## CONCLUSION

Wine was successfully brewed from the must prepared from cashew apple powder and was found to compare favourably with the wine produced from cashew apple juice in most of the physicochemical properties evaluated. It also compared well with other similar internationally brewed wines and it was organoleptically acceptable to the potential consumers. Since, cashew apples are still underutilized mainly due to its perishability nature, conversion of cashew apple to powder for subsequent utilization for wine production during the off-season period may have opened up a profitable outlet for utilizing excess cashew apples that normally rot under the trees during its season. The commercial brewing of cashew wine in Nigeria throughout the year may not be feasible due to lack of storage facilities for the fresh cashew apples. Hence, if wine making from cashew apple powder can be explored commercially, it might ultimately help to reduce the annual wastage of cashew apples and also increase the income of the cashew farmers. Finally, it might ultimately help to conserve foreign exchange on importation of wines to the country.

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