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# FACTORS AFFECTING THE ORGANOLEPTIC CHARACTERISTICS OF PALM WINE FROM NSUKKA AREA, EASTERN NIGERIA

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## ABSTRACT

The organoleptic characteristics of oil palm wine tapped in Nsukka area of eastern Nigeria were studied in order to ascertain how they vary over the year and the factors that may be responsible for the variations. The organoleptic qualities considered were taste, colour, flavour/scent, ability to intoxicate as well as that of retaining quality over time. The locations used were designated A, B and C. Location B is about 5 km east of Nsukka while location A and C are approximately 10 km south and 25 km north of location B respectively.

The study revealed that palm wine from both locations B and C were equally rated for their ability to intoxicate and retain quality over time. Wines from both locations were rated significantly ($P < 0.05$) higher in their ability to intoxicate than palm wine from location A while wine from same location A was rated better than those from both locations B and C in terms of ability to retain quality over time. Other quality characteristics seemed to be the same for wines from all the three locations. The most important factor considered to influence the quality characteristics was soil type. The soil properties, which appeared to make positive contributions included pH, exchangeable K, Ca, Mg and base saturation while exchangeable Na and available phosphorus seemed to have negative influence. Another factor that influenced the quality characteristics positively was rainfall distribution. Well-distributed rainfall (about 1500mm per annum over 10 months as obtained in location C) seemed to promote the quality of palm wine.


**Key words**: Palm wine, Nsukka, organoleptic properties, causes of variation

## Introduction

Palm wine is an alcoholic juice usually tapped from different palm trees including oil palm, raffia palm, date palm and coconut palm (Okafor 1978). In Nsukka area palm wine is usually tapped from oil palm trees (*Elaeis guineensis*) in commercial quantities and the wine preferred is from the male inflorescence. The wine contains natural yeast/sugar and alcohol which when taken in reasonable amounts intoxicates the drinker.
Palm sap is generally known to contain 10-13 % neutral sucrose solution (Bassir 1968, Okafor 1978) and other nutrients such as amino acids (Van Pee and Swings 1971) and vitamins (Okafor 1978, Okigbo 1989). According to Okigbo it is rich in vitamin B complex. It also contains trace amounts of glucose and fructose. The microorganisms in the sap aided by the live yeast are responsible for converting the sugars to alcohol by fermentation process. This process changes the sweet taste to sour taste, which influences consumers' preferences.
Palm wine with sweet-bitter taste has been reported to be the most preferred by regular drinkers (Onyemachi 1991). Palm wine also contains some proteins, the level of which is related not only to the variety of oil palm but also to the season (Bassir 1968), length of fermentation (Faparusi and Bassir 1972) and the content of alcohol (Ayenor and Matthew 1972). Palm wine is different from grape wine and barley beer because the organisms causing fermentation are removed in the latter before they are consumed (Rose 1977). Generally it is the preferred beverage to brewed beer in Nsukka presently. Again a peculiar characteristic about the wine is that once it is tapped, it is taken without further processing.

Culturally palm wine is used strictly in traditional marriage, burial and funeral ceremonies as well as other important occasions in Igboland (Eastern Nigeria). In marriage ceremony when the prospective spouses drink and exchange palm wine it is a sign that both have accepted hands in the marriage.

Nsukka (Lat. 06° 52'N and Long. 07° 24'E) is centrally located in eastern Nigeria where palm wine is drunk on regular basis. Palm wine tapped from at least five different communities including Eha-Alumona, Enugu-Ezike, Ohodo, Obukpa and Ihunaowerre are usually available at Nsukka every day. There have always been contentions among individual drinkers as to where the best quality palm wine was tapped from among those communities. Opinions differ widely among drinkers and have not been based on any empirical data.

The bottling of wines from both oil palm and raffia palms have been tried around the area but drinkers often preferred the fresh wines from both. The reasons adduced were related to the changed qualities of the wines when bottled. The

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organoleptic assessment of palm wine quality variations over the year as well as the factors responsible for such variations has not been reported in Nsukka before. The objectives of the study were therefore to assess the quality characteristics of different oil palm wines tapped at different times of the year, determine factors responsible for the changes in qualities and relate the observed changes to those factors.

## 2. Materials and methods

*Site Selection*

Three locations designated A, B and C known for producing palm wine in commercial quantities in Nsukka area were purposively selected. Location B is about 5 km east of Nsukka while locations A and C are about 10 km south and 25 km north of location B. Palm wine from each of these locations is available to Nsukka urban dwellers who were used as the respondents in the organoleptic studies.

*Sampling*

Three tapers were randomly selected from a list of resident tapers in each of the locations. From each taper one-palm tree that satisfied some set conditions especially age and height, was selected and palm wine from each tree was used for the different tests. The method of tapping was standardized in all the locations by requesting the tapers to adopt similar methods. Sampling of the wine was done the same day from all the locations and in the months of January, March, July, September and November.

*Quality assessment*

The organoleptic characteristics considered were taste, flavour/scent, colour, ability to intoxicate, and ability to retain quality over time. Each of these characteristics was scored on a scale of 6-1 where 6 is equivalent to excellent, 5 very good, 4 good, 3 fair, 2 poor and 1 very poor. For each period at least 18 testers responded to invitation to participate.

*Environmental studies*

Rain gauge and thermometers were installed in each of the locations to record the rainfall and temperature respectively throughout the period of the study. Temperature was taken three times a day at 8.00am, 12.00noon, and 6.00pm.

Soils around each of the tagged palm trees in each of the locations were sampled to a depth of at least 120 cm. The physico-chemical properties determined were particle size distributions (%clay, silt and sand), pH, exchangeable Ca, K, Mg, Na, total exchangeable acidity (TEA), and bases (TEB), cation exchange capacity, total N, organic matter (OM) and available P. These were determined using standard methods as follows:

Particle-size distribution analysis was done by the Bouyoucos (1951) method using sodium hexametaphosphate ... pH was determined ... meter, in a soil: liquid suspension of 1:2.5. Exchangeable bases were extracted with neutral, 1N ammonium acetate ($NH_4OAc$), Ca and Mg were determined by atomic absorption spectroscopy while K and Na were determined using flame photometry. Exchangeable acidity was determined by the method outlined by Mclean (1965). Ammonium acetate cation exchange capacity (ACEC) was determined by washing the $NH_4$-saturated soil sample free from excess $NH_4OAc$ with methanol and distilling the exchangeable $NH_4$ with water and MgO, into 4% boric acid solution. The $NH_3$ in the boric acid was got by titrating with standard HCl. Effective cation exchange capacity (ECEC) was obtained by summing up the total exchangeable bases (TEB) and total exchangeable acidity (TEA). Base saturation was calculated from 100TEB/ECEC. Total nitrogen was determined by the macro-Kjedahl wet oxidation method (Bremner 1965). Organic carbon was determined by the method of Walkley and Black (1934), and this was converted to organic matter (OM) by multiplying the percentage carbon by 1.724. Available P was determined by Bray11 method (Bray and Kurtz 1945).

*Statistical analysis*

Both the analysis of variance (ANOVA) and stepwise regression analysis were by the SAS (1985) procedure. The ANOVA was done to detect the effects of location, taper and their interaction on the quality scores while the regression analysis was done to relate the soil physico-chemical properties to the quality variations.

## 3. Results and discussion

*Preliminary information*

The rainfall distribution shown in table 1 indicates that even though location A had the highest total rainfall amount, the rain fell between the months of April and November with a wide variation of more than 135%. The total amount obtained from location C was the second but it was more widely distributed from January to November. The least amount was from location B; it fell only between the months of March and October. Variation in the amount of rainfall was, however, the same at both locations C and B (CV ≅ 105%).

The distribution of rainfall was bimodal in each location. This is the general characteristic of the rainfall pattern in Nsukka area of eastern Nigeria (Asadu 1996). However, while the first peak was in July in location A, the first peak was in June in both locations B and C. Generally the second peak was in the month of September in all the locations. The trough (*August Break*) occurred in the month of August in all the locations thus reflecting the normal period the short dry season is experienced in the area as earlier reported by Mbagwu and Satoye (1992), and Asadu (1996). The number of rain days was highest in location C followed by that in locations B and C in a decreasing order. Thus, this indicates that rainfall is best distributed in location C over the year than at both locations A and B.

**Table 1. Summary of rainfall data obtained in 1998.**

| | Location A | | Location B | | Location C | |
|---|---|---|---|---|---|---|
| Month | Rainfall(mm) | Rain days | Rainfall(mm) | Rain days | Rainfall(mm) | Rain days |
| Jan | 0 | 0 | 0 | 0 | 0 | 0 |
| Feb | 0 | 0 | 0 | 0 | 1.85 | 1 |
| Mar | 0 | 0 | 28.12 | 1 | 0.91 | 1 |
| Apr | 38.5 | 2 | 166.3 | 6 | 271.21 | 7 |
| May | 66.2 | 2 | 127.30 | 6 | 10856 | 7 |
| Jun | 244.09 | 9 | 283.40 | 8 | 244.0 | 10 |
| Jul | 433.51 | 14 | 109.71 | 10 | 151.85 | 10 |
| Aug | 73.1 | 8 | 63.6 | 10 | 93.98 | 8 |
| Sep | 625.24 | 12 | 313.54 | 12 | 352.17 | 15 |
| Oct | 251.02 | 8 | 229.70 | 10 | 271.21 | 10 |
| Nov | 60.06 | 3 | 0 | 0 | 1.18 | 1 |
| Dec | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 1792.26 | 58 | 1321.9 | 63 | 1496.92 | 70 |
| Mean | 149.36 | - | 110.2 | - | 124.74 | - |
| CV (%) | 135.2 | | 104.8 | | 104.7 | - |

The average morning (8.00 am) hour temperature was similar in all the locations (Table 2). Similarly both average noon (12.00 noon) and evening (6.00 p.m.) temperatures were the same in both locations A and B. The corresponding values obtained in location C were substantially higher. Thus the mean daily temperatures seemed to be generally higher in location C compared with other locations.

The implications of temperature variations are that differences in mean temperature which may affect palm wine quality may be related to both noon and evening temperatures. However, the differences in the mean temperatures reflect that of microenvironment because the overall averages were similar to those reported for the entire Nsukka area (Asadu 1996). Again this suggests that specific studies on the effect of climate on palm wine quality should not rely on general climate but on data at microclimate level.

*Soil and land use*

The mean values of 18 physico-chemical properties of the soils of the three locations are shown in table 3. The particle size distribution varied widely both within and across the locations. However, the differences between the fine and coarse sand fractions seemed to be outstanding. Fine sand was highest in location A and least in location B while coarse sand was highest in location B and least in location A. The mean values obtained in location C were intermediate in each case.

The pH (KCl) appeared to show conspicuous variations across the locations. The highest value (5.1) was obtained in location B while the least (4.4) was obtained in location A. Both OM and total N were generally low in all the soils; the lowest values were from the soils of location B followed by those from location C.

Exchangeable cations and total exchangeable bases (TEB) were highest in the soils of location B followed by those from the soils of location C. On the other hand total exchangeable acidity (TEA) was highest in the soils of location A followed by the values obtained from the soils of location C. Though the ammonium acetate CEC (ACEC) was highest also in soils of location A,

**Table 2: Mean temperatures obtained from the three locations**

| Location | Time temperature was taken | | |
|---|---|---|---|
| | 8.00 am | 12.00 noon | 6.00 p.m. |
| A: mean | 24.4 | 28.9 | 25.6 |
| CV (%) | 6.4 | 5.5 | 5.8 |
| B: mean | 24.9 | 28.5 | 26.4 |
| CV (%) | 5.5 | 7.4 | 7.1 |
| C: mean | 24.9 | 32.6 | 29.4 |
| CV (%) | 8.5 | 8.9 | 8.1 |

**Table 3: Physico-chemical properties of the soils of the three locations**

| Soil property | Location A | | | Location B | | | Location C | | |
|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | CV (%) | Range | Mean | CV (%) | Range | Mean | CV (%) |
| Clay(%) | 8-30 | 15.1 | 43 | 8-38 | 17.8 | 66 | 8-36 | 18.2 | 64 |
| Silt(%) | 2-6 | 3.6 | 25 | 2-6 | 3.1 | 47 | 2-8 | 3.6 | 62 |
| Fine sand(%) | 18-34 | 25.1 | 18 | 10-22 | 16.2 | 24 | 14-30 | 20.4 | 27 |
| Coarse sand(%) | 26-68 | 52.9 | 25 | 48-74 | 62.9 | 13 | 44-68 | 57.8 | 15 |
| Total sand(%) | 60-88 | 78.0 | 12 | 58-90 | 79.1 | 15 | 58-90 | 79.1 | 15 |
| PH ($H_2O$) | 4.7-5.9 | 5.0 | 8 | 4.9-6.3 | 5.6 | 9 | 4.6-5.8 | 5.2 | 10 |
| PH (KCl) | 4.1-5.0 | 4.4 | 9 | 4.3-5.9 | 5.1 | 10 | 4.0-5.4 | 4.6 | 12 |
| OM (%) | 0.55-1.38 | 0.81 | 38 | 0.28-0.90 | 0.54 | 46 | 0.41-1.03 | 0.73 | 34 |
| Total N(%) | 0.029-0.079 | 0.046 | 41 | 0.014-0.049 | 0.028 | 47 | 0.21 0.056 | 0.036 | 35 |
| Exc. Na (cmolkg$^{-1}$) | 0.17-0.22 | 0.19 | 11 | 0.20-0.66 | 0.38 | 51 | 0.17-0.25 | 0.20 | 12 |
| Exc. K (cmolkg$^{-1}$) | 0.04-0.20 | 0.08 | 65 | 0.09-0.21 | 0.12 | 36 | 0.07-0.12 | 0.09 | 21 |
| Exc. Ca (cmolkg$^{-1}$) | 0.6-2.0 | 1.13 | 46 | 1.4-3.0 | 2.0 | 26 | 0.7-2.8 | 1.6 | 42 |
| Exc. Mg (cmolkg$^{-1}$) | 0.4-1.2 | 0.68 | 37 | 0.3-1.4 | 0.86 | 35 | 0.3-1.1 | 0.70 | 33 |
| TEB (cmolkg$^{-1}$) | 1.39-3.29 | 2.07 | 37 | 2.49-4.49 | 3.36 | 20 | 1.66-3.93 | 2.59 | 29 |
| TEA (cmolkg$^{-1}$) | 0.6-2.4 | 1.56 | 41 | 0.4-1.6 | 0.73 | 49 | 0.4-2.4 | 0.91 | 66 |
| ACEC (cmolkg$^{-1}$) | 5.5-9.5 | 7.4 | 19 | 4.0-9.0 | 6.0 | 29 | 4.5-9.5 | 6.5 | 30 |
| BS(%) | 18-58 | 32.9 | 43 | 33-89 | 60.3 | 33 | 26-87 | 46.4 | 46 |
| Avail. P (mgkg$^{-1}$) | 8-53 | 27.2 | 71 | 2-32 | 8.4 | 125 | 4-17 | 9.9 | 55 |

base saturation was lowest there. Thus soils of location B with the highest base saturation seemed to have relatively more nutrients available to plants followed by soils of location C. Available P was highest in the soils of location A and higher in the soils of location C than those of location B.

Land utilization types in all the locations where the palm trees were sited seemed to be similar. Apart from palm trees, other tree crops often found on the plots were *Kola acuminata* (kola) and *Iverngia gaboneensis* (Ogbono trees). The Ogbono trees were more predominant in location C. Food crops commonly found in the same location were mainly cocoyam and cassava.

*Characteristics of the respondents (testers)*

At the beginning of each of the six tests, each of the respondents was requested to supply information about his age, length of time he has been drinking palm wine (experience in drinking), and whether or not he has taken wine tapped from the selected locations. They were also asked to rank five selected factors in order of importance they would affect palm wine quality. It must be noted that some respondents attended the tests more than once, herefore it was possible that the responses were epeated for such persons.

Out of the 84 respondents who indicated heir age, 68% of them were in the age range of 25-5 years while the rest were more than 45 years old. )nly 5% of the respondents have had less than 10 ears experience of drinking palm wine, 35% have ad 10-25 years experience while the rest (60%) ave had more than 25 years of experience. bout 93% of the total aggregate respondents of 33 indicated that they have taken palm wine from l the three locations, 29 % from location A only, % from location B only and 33% from location C ly. Thus about 60% have taken wine from both ations A and B, 62% from both locations A and 64% from both locations B and C. This information suggests that the respondents have had enough background experience about the palm wine from the three locations.

The five factors that were ranked by the testers were soil type, rainfall, temperature/heat, age of palm trees and method of tapping. About 85% of the respondents ranked soil type as the most important factor that influences palm wine quality characteristics, followed by age of palm trees (50%), and rainfall (37%). Temperature and method of tapping were ranked the 4$^{th}$ and 5$^{th}$ factors respectively.

*Location and taper effects on quality characteristics*

Table 4 shows that location effect was significant on the ability of palm wine to intoxicate and its ability to retain quality over time based on the testers scores. The LSD analysis on the scores also indicated that palm wine from locations B and C with respective mean scores of 3.9 and 3.8, were significantly better than palm wine from location A with a mean score of 3.6. However, similar analysis indicated that palm wine from location A (mean score of 3.7) had significantly ($p<0.001$) higher ability to retain its quality over time than wines from both locations B and C. The mean scores for these two locations were similar (3.2). It is possible that tapers in location A had earlier recognized the low ability of their palm wine to intoxicate because the routine method of tapping was to leave the palm wine for at least two days before collecting/harvesting. During this period, fermentation of sugar to alcohol normally takes place and the ability of palm wine to intoxicate depends on the quantity of alcohol in the wine. Again the quantity of alcohol is a function of the length of fermentation (Ayenor and Matthew 1972). In this study the palm was tapped on daily basis as a standard across all the three locations.

**Table 4: Effects of location and taper on the organoleptic characteristics of palm wine**

| Sources of variation | DF | Type 1 SS | Mean square | F-value/ Prob. Level |
|---|---|---|---|---|
| | | Colour | | |
| Location | 2 | 0.6004 | 0.3002 | 0.22ns |
| Taper | 2 | 22.9485 | 11.4924 | 8.51** |
| Location X taper | 4 | 10.6015 | 2.6504 | 1.96ns |
| | | Falvour/scent | | |
| Location | 2 | 6.7682 | 3.3841 | 2.32ns |
| Taper | 2 | 62.6036 | 31.3018 | 21.43*** |
| Location X taper | 4 | 18.7627 | 4.6907 | 3.21** |
| | | Taste | | |
| Location | 2 | 0.457 | 0.2288 | 0.17ns |
| Taper | 2 | 61.6214 | 30.8107 | 22.41*** |
| Location X taper | 4 | 24.3434 | 6.0859 | 4.43*** |
| | | Ability to intoxicate | | |
| Location | 2 | 10.7395 | 5.3697 | 3.63* |
| Taper | 2 | 40.3862 | 20.1931 | 13.66*** |
| Location X taper | 4 | 8.1303 | 2.0326 | 1.37ns |
| | | Retention of quality | | |
| Location | 2 | 9.3730 | 4.6865 | 3.35* |
| Taper | 2 | 35.8497 | 17.9246 | 12.80*** |
| Location X taper | 4 | 4.8013 | 1.2003 | 0.86ns |

**Notes: ns, *, **, *** = not significant, significant at 0.05, 0.01 and <0.001 probability levels respectively.**

The effects of location on palm wine colour, flavour and taste were not significantly different across the locations (Table 4).

The effect of individual taper was significant (p< 0.01) on all the quality characteristics (Table 4). This may be related to individual tapers' differences in handling the palm wine since the method of tapping was similar in all the locations and care was taken to select palm trees of approximately the same height/age in all the locations. This handling may be related to such factors as covering the inflorescence to avoid entry of water into the wine during rains or to the specific time of clearing the point of tapping (hole at the base of the inflorescence), since the regularity of carrying out this process (three times daily) was the same in all the locations. Another possible source of error could be due to the age of the inflorescence

*Relationship between wine quality and soil properties*

The testers rated soil type as the most important environmental factor influencing palm wine quality. To ascertain which soil properties were most responsible for imparting certain qualities to palm wine, a stepwise regression analysis was done to relate palm wine organoleptic characteristics to soil properties.

Table 5 indicates that soil pH had significant contributions to all the quality characteristics except the ability of palm wine to retain quality over time. This is because pH was not selected as an important factor by the regression procedure. Other soil characteristics that influenced palm wine colour, though negatively were coarse sand content, total nitrogen, exchangeable sodium and total exchangeable bases.

Palm wine flavour was positively influenced by pH and CEC, and negatively influenced by exchangeable sodium. This trend was similar to their effects on wine taste.

The retention of wine quality was significantly and positively influenced by pH (p<0.001) and also positively influenced by exchangeable potassium though the effect was not significant (p<0.05). Both exchangeable sodium and available phosphorus had significant effect on the retention of palm wine quality.

Both exchangeable potassium and base saturation had positive influence on the ability to intoxicate. However, only the effect of exchangeable potassium was significant (p=0.05). Available phosphorus had non-significant negative effect on the ability of palm wine to intoxicate.

The soils of locations B and C gave the highest pH values and the best palm wine in terms since it was impossible to get inflorescence of the same age from all the tapped palm trees in all the

**Table 5: Regression results between palm wine quality and selected soil properties by stepwise procedure**

| Variables | Parameter estimate | Standard error | Type 11SS | F-value/ Probability level |
|---|---|---|---|---|
| | | Colour | | |
| Intercept | 30.6497 | 0.3806 | 1.6100 | 91.95*** |
| Coarse sand (%) | -0.0089 | 0.0032 | 0.1364 | 7.79* |
| pH( KCl) | 1.3032 | 0.2347 | 0.5400 | 30.34*** |
| Total N (%) | -3.7376 | 1.7541 | 0.0795 | 4.54* |
| Exc. Na ($cmolkg^{-1}$) | -0.3910 | 0.2507 | 0.4426 | 2.43ns |
| TEB ($cmolkg^{-1}$) | -0.1510 | 0.0827 | 0.584 | 3.34ns |
| | | Flavour | | |
| Intercept | 0.2516 | 0.7429 | 0.0073 | 0.11ns |
| pH( KCl) | 0.6571 | 0.1277 | 1.6856 | 26.47*** |
| Exc. Na ($cmolkg^{-1}$) | -0.9964 | 0.3960 | 0.4030 | 6.33* |
| ACEC ($cmolkg^{-1}$) | 0.0683 | 0.0367 | 0.2209 | 3.47ns |
| | | Taste | | |
| Intercept | 0.8327 | 0.8684 | 0.598 | 0.92ns |
| pH( KCl) | 0.1357 | 0.3397 | 0.7300 | 11.18** |
| Exc. Na ($cmolkg^{-1}$) | -1.1120 | 0.4003 | 0.5019 | 7.72* |
| ACEC ($cmolkg^{-1}$) | 0.0734 | 0.0372 | 0.2534 | 390ns |
| | | Retention of quality | | |
| Intercept | 2.0231 | 0.3283 | 1.1782 | 37.97* |
| pH( KCl) | 0.3000 | 0.0789 | 0.4479 | 14.43*** |
| Exc. Na ($cmolkg^{-1}$) | -0.6679 | 0.2772 | 0.1802 | 5.81* |
| Exc. K ($cmolkg^{-1}$) | 1.7906 | 0.9359 | 0.1141 | 3.68ns |
| Avail. P ($mgkg^{-1}$) | -0.0055 | 0.0024 | 0.1674 | 5.39* |
| | | Ability to intoxicate | | |
| Intercept | 3.2732 | 0.2025 | 13.1135 | 261.19*** |
| Exc. K ($cmolkg^{-1}$) | 2.06052 | 1.1807 | 0.2444 | 4.87* |
| Base saturation (%) | 0.0043 | 0.0026 | 0.1311 | 2.61ns |
| Avail. P ($mgkg^{-1}$) | -0.0051 | 0.0032 | 0.1301 | 2.59ns |

**Notes: ns, *, **, *** = not significant, significant at 0.05, 0.01 and <0.001 probability levels respectively.**

locations at the same time throughout the year. Tapers' handling of various materials used in tapping such as knife, funnel and gourd have been noted to influence the quality of wine since they are also sources of some enzymes and bacteria that have been implicated in fermentation process (Okafor 1978). The implication of this is that even within each location wine from different tapers may vary considerably in quality unless extremely care including sterilization of the tapping materials is taken regularly.

Location X taper interaction (Table 4) effects was significant on palm wine flavour and taste only. Thus the two most important quality characteristics namely ability to intoxicate and ability to retain quality were not significantly affected by location x taper interaction. of ability to intoxicate. This might imply that soil pH is an important soil factor that influences this specific wine quality which is about the most desired quality by most regular drinkers. Other soil properties that were highest in soils of both locations and could have contributed to the best quality palm wine obtained from there were exchangeable potassium and base saturation. Again exchangeable calcium and magnesium, though were not selected by the regression procedure as major determinants of ability to intoxicate, their values were also highest in the soils of both locations B and C. Therefore they may also have contributed to influencing positively the palm wine's ability to intoxicate. The soil properties that were better in location A than in two other locations which could have contributed to the wine's better ability to retain quality over time were total nitrogen, total exchangeable acidity and available phosphorus.

## 4. Conclusion

A study of oil palm wine tapped from different areas around Nsukka in eastern Nigeria indicates that regular drinkers can detect and rate differences in the following organoleptic characteristics: taste, colour, flavour/scent, ability to intoxicate and retain quality over time. Similarly the drinkers also have ideas about the factors that influence the above qualities such as soil type, rainfall, temperature/heat, age of palm tree, and method of tapping.

The study revealed that location effect was significant on the ability of palm wine to intoxicate namely B and C were rated equal for their ability to intoxicate and significantly better than palm wine tapped from location A in this property. However, wine from location A was significantly better than those from both other two locations in terms of ability to retain quality over time. The effect of location was essentially similar on other quality characteristics across all the locations. The effect of taper was significant on the quality characteristics.

Soil type was rated the most important factor influencing wine quality characteristics. The as well as its ability to retain quality over a period of time. Palm wines tapped from two locations soil properties found to positively influence palm wine characteristics were soil pH (KCl), exchangeable K, Ca, Mg and base saturation. Those soil properties that seemed to have conspicuous negative effects on wine qualities were exchangeable Na, and available P. It was also found that rainfall distribution was best in both locations where best quality palm wine (in terms of ability to intoxicate) was obtained. A comprehensive chemical analysis of the wines over the season would be a good complement of this study and is suggested.

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**References**

Asadu, C.L.A., 1996. Fluctuations in the characteristics of a minor tropical season, August Break, in eastern Nigeria, Paper presented at a conference of the Nigeria Meteorological at IITA, Ibadan.

Ayenor, G.K. and Matthew, J.S., 1972. The sap of the palm (Elaeis guineensis) as a raw Material for alcohol fermentation in Ghana. Trop. Sci. XIII: 71-73

Bassir, O., 1968. Some Nigerian wines. West Afri. J. of Bio. Chem. 10:42-45.

Bouyoucos, G. H., 1951. A calibration of the hydrometer method for making mechanical analysis of soils. Agron. J. 43; 434-438.

Bray, R.H. and Kurtz, L.T., 1945. Determination of total organic and available forms of phosphorus in soil. Soil Sci. 59: 39-45.

Bremner, J.M., 1965. Total nitrogen. In Methods of Soil Analysis, Part II (ed. C.A. Black). American Society of Agronomy Monograph 9, 1149-1178.

Faparusi, S.I. and. Bassir, O., 1972. Factors affecting the quality of palm wine. West Afri. J. of Bio. and Appl. Chem. 15:42-45.

Mbagwu, J.S.C. and Satoye, A.O., 1992. Modeling pan evaporation in a dry-wet tropical environment with few meteorological data. Beitre. trop. Landwirt Sch. Vet, Med., 30: 251-262.

Aclean, E.O.,1965. Aluminum. In. Methods of Soil Analysis. C.A. Black (ed.). Agronomy Manual No. 9 Part1. American Society of Agronomy. Madison Wisconsin.

Okafor, N., 1978. Preliminary microbiological studies on the preservation of palm wine. J. Appl. Bact. 38:1-7.

Okigbo, B., 1989. Role of multipurpose trees in compound farming in Tropical Africa. Pp172-181 In: Alley farming in the humid and subhumid tropics. Proceedings of the International Workshop held at Ibadan, Nigeria, 10-14 March 1986.

Onyemachi, H.E., 1991. Kinetics of Raphia palm sap/wine fermentation (Raphia hookeri) B.Sc. thesis, University of Nigeria, Nsukka.

Rose, A.H., 1977. Alcoholic Beverages. Academic Press, New York. p33.

Statistical Analyses System (SAS). 1985. *SAS User's Guide: Statistics, Version 5 edition.* SAS Institute Inc., North Carolina, U.S.A.

Van Pee, W. and Swings, J.G. 1971. Chemical and microbial studies on Congolese palm wine (*Elaeis guineensis*). East Afri. Agric. For. J. 36: 311-314.

Walkley, A. and Black, I.A. 1934. Determination of organic carbon in soils. Soil Sci. 37:29-38