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Establishment of the Status of Nigerian Produced Wines Compared with Internationally Recognized Foreign Wines

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Abstract: Analysis of the metal concentration in Nigerian produced wines and foreign produced Wines were carried out to establish the status in each case. The results obtained from the comparative study of the wine samples analyzed have shown that the level of pH of both foreign made (pH range of 3.0-3.8) and locally made wines (pH range of 3.3-3.8) obtained from Ibadan and Lagos but made from different locations of the world showed an agreement and were found to fall within the same acidic range. The results of most of the parameters fall within the acceptable limit as required in wine. It had been discovered that copper (0.001-0.171 mg/L), zinc (0.423-0.882 mg/L) and sodium (35.52-271.52 mg/L) gave higher concentrations in the local wines than the copper (0.009-0.143 mg/L), zinc (0.112-0.857 mg/L) and sodium (32.52-229.52mg/L) in foreign wines. However, local wines were found to have lower concentrations of iron (0.037-2.143 mg/L), lead (0.038-0.125 mg/L), potassium (104.730-762.730 mg/L), aluminium (0.316 - 0492 mg/L) and calcium (0.271-48.021 mg/L) than in iron (1.206-6.188 mg/L), lead(0.050-0.135 mg/L) calcium (3.766-42.209 mg/L) and aluminium (0.159-3.003mg/L) in foreign wines.

Key words: Metals · Wines · Atomic absorption spectrophotometer · Flame emission spectrophotometer

INTRODUCTION

Table wine consumption in Nigeria has increased dramatically during the past decades. A need for extended compositional data for domestic wines exists for several reasons. These include the increasing popularity of wine and increasing consumer awareness concerning the nutritional value of all food. Wine is a widely consumed beverage with thousands of years of tradition, which, besides water and alcohol, contains a great variety of inorganic and organic components [1]. The composition of wine is due to many factors, related to the specific production area, such as grape variety, soil and climate, culture, yeast, wine-making practices, transport and storage. All of them have important influences on the quality of wine and they are very important in the characterization and differentiation of wines, with applications to the detection of frauds [2].

Wine is one of the most widely consumed beverages and strict analytical control of trace elements content is required during the whole process of wine production. Levels of trace elements in wine are important from both points of view: organoleptic-Fe, Cu and Zn concentrations are directly related to the destabilization and oxidative evolution of wines and toxicological-toxic elements content should be under the permissible limit, wine identification. The identification of metals in wine is a subject of increasing interest since complexation may reduce their toxicity and bioavailability [3]. Metals in wine can originate from both natural and anthropogenic sources and its concentration can be a significant parameter affecting consumption and conservation of wine. Since metallic ions have important role in oxide-reductive reactions resulting in wine browning, turbidity, cloudiness and astringency, wine quality depends greatly on its metal composition. Consumption of wine may contribute to the daily dietary intake of essential metals (i.e., copper, iron and zinc) but can also have potentially toxic effects if metal concentrations are not kept under permissible limits [4].

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MATERIALS AND METHODS

Materials: Six samples of locally made wines from Nigeria and South Africa (code LW) and eight samples of foreign wines made in different countries apart from Nigeria and South Africa (code FW) were purchased.

Samples Corresponded to Different Types of Wines:

- Nigerian made wines (1 sample with alcoholic content greater than 10% and 2 samples with alcoholic content less than 10%);
- South African made wines (2 samples with alcoholic content greater than 10% and 1 sample with alcoholic content less than 10%) and
- Foreign made wines (5 samples with alcoholic content greater than 10% and 3 samples with alcoholic content less than 10%).

FW1: Wild Vines,
FW2: Conde Noble Tinto,
FW3: Baron Romero,
FW4: Gandia (Vin Rouge),
FW8: Don Simon (Vino Tinto),
FW9: Royalty,
FW10: Crystal Sparkling Cocktail,
FW14: J.P. Chenet,
LW5: Classic Red,
LW6: Zulu Royal,
LW7: Bacchus Tonic Wine,
LW11: St Lauren,
LW12: Don Romereon and
LW13: Finlays.

METHODS: The wines were analyzed for the eight metals by AAS and Flame photometry. All analyses were done in triplicate. During the analysis period, thewine samples were stored in a refrigerator at 4°C.

Analyses by Aas and Flame Photometer: The metals Ca, Pb, Fe, Cu, Zn and Al were determined using Atomic Absorption Spectrophotometer, Perkin Elmer model 200A using an air/acetylene flame while a Flame Photometer of Jenway model was used in determining Na and K metals in the wine samples using butane gas. Distilled water was used to prepare standard solutionsand to dilute wine samples where necessary. Allglassware was soaked in HNO_3 (20%) overnight priorto analysis to complex any metal contaminants. The instrument was interfaced to a computer for operationand data analysis.

RESULTS AND DISCUSSION

Results: Tables 1 and 2 show the analyses of the mean levels (± standard deviation) of Cu, Zn, Fe, Pb Al, K, Na and Ca in Locally made wines and Foreign wine respectively. The range of concentrations of Cu, Zn, Fe, Pb, Al, K, Na and Ca in foreign and local wines were also given in the aforementioned Tables.

Trace Metal Content in Wine Samples

Copper in the Wine Samples: These results showed that Cu concentration in the local wines were fairly higher than the foreign made wines. Moreover, it was discovered that copper was detected in very trace amount in six of the wine samples analyzed: 5 foreign wines made in Spain and England with 1 Nigerian wine. With the exception of a Spanish wine with Cu level of 0.143 ± 0.003 mg/L, Cu concentrations were found to be higher in South African made wines and Nigerian made wines than those wines made in other countries like Spain and England. The highest Cu level was found in an alcoholic Nigerian made wine with an average concentration of 0.171 mg/L.The comparative analysis suggests that, for the wine samples analyzed in this study, copper was not added during the course of production; even if it was added, it would have been in a minute quantity since the Cu level did not reach nor exceed the recommended limit value of 1mg/L [5]. Moreover, Cu range in both foreign

Table 1: Concentrations of metals measured in Nigerian wines.

Metals	Range (mg L^{-1})	Mean ± S.D. (mg L^{-1})
Copper	0.001-0.171	0.093 ± 0.061
Zinc	0.423-0.882	0.0470±0.241
Iron	0.037-2.143	1.132±0.768
Lead	0.038-0.125	0.084±0.031
Aluminium	0.316-0.492	0.194±0.173
Potassium	104.730-762.730	328.903±315.789
Sodium	35.520-271.520	129.187±83.404
Calcium	2.713-48.021	15.328 ±18.348

Table 2: Concentrations of metals measured in foreign wines

Metals	Range(mg L^{-1})	Mean ± S.D. (mg L^{-1})
Copper	0.009-0.143	0.042±0.044
Zinc	0.112-0.857	0.299±0.246
Iron	1.206-6.188	3.289±1.659
Lead	0.050-0.135	0.080±0.027
Aluminium	0.159-3.003	0.650±0.920
Potassium	242.000-1356.730	849.889±386.496
Sodium	32.520-229.520	78.145±62.710
Calcium	3.766-42.209	31.867±27.944

and locally made wines were found to be between 0.001mg/L and 0.171mg/L, which was in agreement with the concentrations obtained from other wine researches performed but fairly lower. Also, cloudiness that occur in wine when Cu level is between 0.2 - 0.4 mg/L [1] would not occur in the wines analyzed in this study because concentration of copper in the wines was found to be generally low compared to the literature, which may be due to the ability of dead yeast cells to take at copper [6]. Hence, considering the Cu level of both the foreign and local wines in this study, it showed that they would not cause toxic effects due to low level of Cu present when consumed.

Zinc in the Wine Samples: It was discovered that the Nigerian and South African wines had higher Zn concentrations than those made in Spain, United State of America and England. However, from the foreign wines analyzed, those made in France have higher values of Zn than other foreign made ones.

Considering the non-alcoholic wines from this study, the range of Zn concentration was found to be between 0.081 and 0.882 mg/L for both locally made wines and foreign wines. The foreign non-alcoholic wines were found to have a very low concentration of Zn of the range 0.081 mg/L-0.163 mg/L while the local non-alcoholic wines had a range of 0.268 mg/L-0.882 mg/L of Zn.

From the literature, the range of zinc concentration in the non-alcoholic wine was observed to be 0.23-1.96 mg/L [7]. Another research analysis of Zn in wine samples gave a range of 0.34 to 1.61 mg/L [2]. The maximum content of zinc at 5 mg/L was fixed for Argentina wines. Both foreign and local wines were found to fall within the acceptable range limit of Zn and correlates with those of the literature. These results suggest that zinc toxicity that occurs in humans would not occur when some of these wines are consumed. However, the occurrence of the symptoms in other analyzed wine drinkers would be minimal if it occurs at all, due to the fact that zinc level in all the wines analyzed is within the acceptable limit. Hence, symptoms associated with zinc toxicity like vomiting, dehydration, electrolyte imbalance, abdominal pain, nausea, lethargy, dizziness and lack of muscular coordination would not be observed when there is a moderate consumption of the wines analyzed in this study unless they are taken in excess.

Iron in the Wine Samples: Evaluation of iron content in wines is of major importance due to the changes in stability, it may cause and its effects on the oxidation and wine aging [6]. The range of concentrations of iron in all the wine samples analyzed was found to be within 0.037 mg/L and 6.188 mg/L. An alcoholic Nigerian wine gave the lowest value of 0.037 ± 0.009 mg/L while a non-alcoholic wine made in England gave the highest value of 6.188 ± 0.046 mg/L. At these low concentrations, iron plays important roles in metabolism and fermentation processes as an enzyme activator, solubiliser and functional component of proteins. Also, the alcoholic local wines have a range of 0.037 to 2.143 mg/L of Fe.

The iron concentrations found in this study were averagely low when compared to other wines analyzed by other researchers. The range of Spanish wines from previous research work was found to be within the range of 0.4 and 17.4 mg/L [8] which agrees with the Spanish wines of 1.008 mg/L-4.302 mg/L obtained in this study.

Cloudiness observed in wines when Fe level is between 7-10 mg/L [1] would not occur in the wines studied because their range of Fe level is below the given range. The concentration of iron in wine due mainly to contact with equipment and soil contamination, is usually low [8] the high iron content observed in the foreign wines could be due to iron metals released from machinery, piping and storage tanks [6]. This could be the reason why Nigerian wines are lower in iron content than the foreign ones.

Lead in the wine samples: From this study, lead content for non-alcoholic wines was found to be within the range of 0.072 -0.125 mg/L for local wines; which falls in the same range of 0.003-0.280 mg/L as seen in the literature for non-alcoholic wines. The average concentration of Nigerian wines from this study is below the Nigerian standard of 0.200 mg/L [7]. The Nigerian wines were found to have concentrations less than 0.100 mg/L (0.038-0.078 mg/L) which is drastically lower than the maximum allowable concentration of 0.250 mg/L found in the literature [9].

Argentina gave the maximum content of lead in wines to be 0.15 mg/L. Hence, the results obtained from this study showed a good agreement with those reported in the literature. Nigerian wines were observed to have minimal Pb content compared to foreign wines. These lower concentration of Pb found in the local wines showed that they are of better nutritional value and are of more economic importance if consumed than the foreign made wines since Pb could be very toxic to humans when ingested [6]. Wine is susceptible to lead contamination from the seals on wine bottles and the linings of wine casks.

Aluminium in the Wine Samples: The range of mean values obtained for all the wine samples analyzed for Al in mg/L was found to be between 0.130 mg/L and 3.003 mg/L as seen from the results obtained from Tables 1 and 2. Local wines analyzed in this study were found to have a lower concentration of Al compared to the foreign wines. It was also discovered that Al content was found to be very low in 4 alcoholic wines made in Nigeria and South Africa.

Table 2 showed that Al content was very low in a non-alcoholic Spanish wine and in an alcoholic Spanish wine which gave 0.130 mg/L and 0.159 mg/L respectively, while other foreign wines analyzed gave a concentration range of 0.266 -3.003 mg/L of Al. The aluminium concentrations obtained when Argentine wines were analyzed from literature for about 20 samples gave a range of 0.017 to 0.018 mg/L [6]. The maximum permissible concentration of Al in wine is given as 8.00 mg/L [9]. Though, from this study, it was discovered that the foreign wines were of higher Al content than the local wines, yet, both concentration ranges are not up to the maximum permissible content of 8.00 mg/L of Al. This signifies that the wine samples analyzed are fit for human consumption, such that the adverse effect caused by Al would not be observed by the intake of these wines unless if taken in excess. This also showed that there was a proper handling of the product during processing with a good manufacturing practice. The concentration of aluminum in wines may be elevated due to the use of bentonite for filtration and, to a lesser extent, from contact with aluminum surfaces during production [6].

Major Cation Contents in Wine Samples

Potassium: The average concentrations of potassium in all the wine samples analyzed in this study was found to be within the range of 104.73 and 1356.73 mg/L. An alcoholic Nigerian wine gave the lowest value while an alcoholic wine made in France had the highest value. The foreign made wines have reasonably higher values of potassium than the local wines with a range of 242.00 to 1356.73 mg/L (Table 1) and 104.73 to 762.73 mg/L (Table 2) respectively. Nevertheless, the non-alcoholic Spanish wine should be enriched with more potassium such that the sodium content would not be more than potassium content because sodium can increase blood pressure in some people. Most of the Nigerian made wines were found to have low potassium value (134-136.73 mg/L) compared to the wines made in other countries. South African wines analyzed had a range of 104.73 -762.73 mg/L. Hence, the locally made wines should be enriched with potassium supplements.

From this study, it was noticed that the concentration range of K in most of the foreign wines analyzed agree with those given from previous research work in literatures such as 1159.50 ± 193.74 mg/L for about 40 samples of Southern Italian wines [10]. Also considering the K content of the conventionally and organically produced wines, it was discovered that K gave a concentration range of 898 to 1352 mg/L for Croatian wines [5]. It had been discovered that the ratio of potassium to sodium should be in ratio 1:1 in the body in order to prevent some health risks like hypertension [11]. In this research work, the foreign wines were observed to have higher potassium concentration than their respective sodium content which compensates for the health risks attached if both metals were to be of the same concentration in the wine.

The results obtained from other analyses agreed with those of foreign made wines analyzed in this study. However, the Nigerian made wines gave lower values of potassium compared to the foreign made wines, which suggested no potassium additive during production. South African made wines gave higher concentrations of potassium than those made in Nigeria, but they are still within the acceptable limit.

Sodium in the Wine Samples: The range of concentration of Na obtained in all the wine samples analyzed was found to be between 32.52 and 271.52 mg/L. However, Tables 1 and 2 showed Na concentration range for local and foreign wines to be 35.52-271.52 mg/L and 32.52-229.52 mg/L respectively. It was observed from these Tables that both foreign and local wines were of high concentrations but local wines are slightly higher than the foreign wines.

An alcoholic Spanish wine gave the lowest value while a non-alcoholic Nigerian wine gave the highest value of sodium. This showed that the non-alcoholic local wines are of less quality than the alcoholic since the body requires less of Na for a healthy living. It was discovered that non-alcoholic foreign wines (45.52 -66.52 mg/L) gave a Na concentration range which is lower than the alcoholic foreign wines (54.52 -229.52 mg/L).

Croatian wines were studied and gave a Na concentration range of 5.31 to 20.8 mg/L [5]. It was noted that the higher range value obtained for sodium in Croatian wines was not up to the lower range value of 32.52 mg/L obtained in this study. The foreign made wines were observed to have lower concentrations of Na than the Nigerian made wines (103.52 and 271.52 mg/L).

Calcium in the Wine Samples: The range of concentrations of calcium in all the wine samples was found to be in between 0.271 mg/L and 88.972 mg/L. An alcoholic Nigerian made wine gave the lowest Ca concentration while a non-alcoholic Spanish wine gave the highest.

Considering Tables 1 and 2, the concentrations of the foreign wines are observed to be generally higher than the local wines. Other wine researchers found out that in some Croatian wines, calcium gave a range of 72.4 to 87.1 mg/L [5]. The concentration obtained for calcium in Argentine wines ranged from 10.00 to 15.00 mg/L [6] unlike the high values of calcium obtained in the studied foreign wines. From these results, it was discovered that the range of foreign wines obtained did not exceed that of the literature apart from a Spanish non-alcoholic wine which gave a high value of 88.972 mg/L. However, the local wines gave lower concentrations of Ca which did not exceed those of literature.

CONCLUSIONS

The results from this study have shown that the level of pH of both analyzed foreign made and locally made wines obtained from Ibadan and Lagos were found to be acidic as expected. Moreover, when these wines made in Nigeria, South Africa, Spain, France, England and United States of America were analyzed for Cu, Zn, Fe, Pb, Al, K, Na and Ca, it was discovered that the concentrations of iron, lead, aluminum, potassium and calcium in foreign wines were higher than the locally made wines. For copper, zinc and sodium the local wines gave higher concentrations than the foreign ones. However, foreign wines have been discovered to have higher Fe concentrations than the local wines. The non-alcoholic foreign wines have greater Fe contents than the alcoholic foreign wines while the alcoholic local wines are of greater Fe concentrations than the non-alcoholic local wines.

Generally, the local wines have lower Pb contents than the foreign. Since Pb could be highly toxic when consumed and it does no good to the body, then the lower it is consumed, the better for the consumer's health. Hence, Nigerian wines should be exported. Al content in foreign wines was higher than in local wines but average concentration of both do not exceed the maximum tolerable limit of 8.00 mg/L. So, it is better one goes for Nigerian wines because Al poses danger to one's health. Generally the local (Nigerian) wines gave very high concentrations of Na than foreign. Alcoholic foreign wines have higher Na content than the non-alcoholic while non-alcoholic local wines possess greater Na concentration than the alcoholic.

It was also concluded that potassium content in these wine samples were found to be greater than the sodium content. This implies that hypertension would not be found for people consuming these wines analyzed in this study. However, the Nigerian wines and a Spanish non-alcoholic wine gave their potassium content to be lower than the sodium content. It had been discovered that Nigerian wines were fairly lower in K than foreign wines. However, foreign wines are higher in Ca than in local wines. Since Ca is essential for a good nutrition, this should be inculcated more into wine during production.

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