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Research Paper

Determination of the concentrations of ethanol, aldehydes and acetic acids in locally brewed alcohol (*Burkutu*) in some selected Local Government Areas of Adamawa State, Nigeria

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ABSTRACTS

The rate of consumption of locally brewed alcohol (Burkutu) amongst selected people of Adamawa State cannot be overemphasized. Hence, the need to study the chemical pollutants present in the beer is of paramount importance. Burkutu, a locally brewed alcohol obtained from five local government areas of Adamawa State, namely Hong, Song, Yola North, Numan and Ganye, was examined for the presence and concentrations of ethanol, aldehyde and acetic acid in the samples using UV-Vis Spectrophotometer. The results of the analysis showed that burkutu sample obtained in Ganye, Numan and Song Local Government Area had the highest content of Ethanol, Aldehydes and Acetic acids of 58.0246, 6.3945 and 6.8829 mg/L, respectively as compared with the burkutu sample obtained from the rest of the other local government studied. The presence of ethanol, aldehyde and acetic acid in all the burkutu samples analyzed, renders the alcoholic beverages unhealthy for consumers because of the toxicity of the substances determined. This study achieved its objectives by determining the concentration of persistent pollutants in locally brewed alcohol. Ethanol (C_2H_5OH), Aldehyde (CHO) and Acetic acid (CH_3COOH) tend to be persistent in all the drinks which is very toxic to the liver and human system and the accumulation of such persistent pollutants in the body can lead to severe health risks including liver cirrhosis, diabetes mellitus, cancer etc which degrades the quality of life and eventually leads to death.

Key words: Alcohols, aldehydes, acetic acid, Burkutu, Nigeria.

INTRODUCTION

Ethyl alcohol is the major physiologically active components of most alcoholic drinks, other fractions present are often called congeners (Jung et al., 2010). Congeners are biologically active chemicals that are often contained in alcohols and exert a lot of effects on the body and brain. They are majorly pollutants produced during the process of fermentation or ageing. Examples of congeners are acetaldehyde, esters, ethyl esters and fusel oil. Fusel oil (bad spirits) are by-products in the distillation of fermented alcohols (Hazelwood et al., 2008). They includes carbonyl compounds, esters and acids. The presences of congeners in alcoholic drinks is undesirable as they affect the quality of finished products and lead to various health challenges when consumed (Leon-Rodriguez et al., 2006). The congeners (pollutants) of interest in this research are aldehydes and acetic acids. They are produced during alcohol metabolism originating from fermented raw materials (Plutowska and Wardencki, 2008). Acetaldehyde produced during this process undergoes further chemical oxidation, leading to the formation of acetic acid. The levels of these pollutants (aldehydes and acetic acids) are influenced by several processing factors such as the variety of raw material, fermentation conditions and distillation techniques used. The consumption of these pollutants

exposes consumers to great potential health risks (Silva and Malcata, 1998). Burkutu is vinegar – like flavored alcoholic beverage prepared from cereal grains. It is a cloudy alcoholic beverage and its alcoholic contents ranges from 3 to 8%. It is widely consumed in West Africa most especially North Eastern part of Nigeria, Adamawa State by the Bwachama/Mbula, Chamba, Yungur, Lunguda, Kilba, Highi, Marghi and Fulani tribes within the state during occasions such as festivals, wedding, burial, farming and daily, most especially the one produced on commercial basis (Osaretin and Chioma, 2007). The relevance of burkutu to some inhabitants of Hong, Song, Yola-North, Numan and Ganye Local Government Areas cannot be over emphasized, as such, there is need for the awareness of the persistent pollutant present in the locally brewed alcohols (burkutu) and health effects caused by these pollutants when consumed (Nikander et al., 1991). Several studies have being carried out to show the general taste and effect of alcohol to the human system but scarcely on burkutu. On 8th and 20th June, 2015, 8 - 35 people were killed aftermath of taking alcohol in Cross –River State of Nigeria and India, respectively. Some reports related this to the chemical constituents present in the alcohol e.g. methanol which is the simplest form of alcohol. It is closely related to ethanol, the alcohol normally found in beer, wine and spirits – but much more toxic. The potential for its presence in drinks made from home – distilled spirits is a serious health risk. Also the people of Adamawa State are used to the consumption of locally brewed beer popularly called Burkutu, hence there is a need to study the chemical pollutants persistent present in the locally brewed beer. However, no conclusive research has been carried out to determine the concentrations of the persistent pollutants present in the *burkutu*, most especially when it is ready for consumption, this necessitates the present study. Also the raw materials frequently used in burkutu brewing activity such as cereal grains are vulnerable to fungal and bacterial infestation in the field, storage and during malting stages (Mbugua and Gathumbi, 2004). This leads to various diseases, such as cirrhosis, cancer, kidney effects etc. This study was conducted to determin the concentrations of ethanol, aldehydes and acetic acids in a locally brewed alcohol (burkutu) in some selected Local Government Areas of Adamawa State and determine whether these levels were within the maximum permissible levels of each contaminant in alcoholic drinks.

MATERIALS AND METHODS

Sampling

The main purpose of sampling was to collect the sample of interest to represent the whole (bulk) sample of Burkutu needed for analysis. The Burkutu of interest was collected such that their quality represents the overall quality of the samples in question. Extra precaution was taken during sampling to obtain samples representation of the whole Area studied. The containers that was used to collect the samples were 10 (ten) glass bottles of 1.7 L each for burkutu. The sampling bottles were washed and rinsed with distilled water and the burkutu to free it from impurities using sample handling techniques specially designed for collection of sample for the assessment of the persistent pollutants at trace levels. The samples were preserved by the addition of 5 ml of pretested 10% HNO_3 per 1.7 L of sample, depending on the time between sample collection and arrival at the laboratory.

Samples and sampling areas

Samples of guinea corn was selected and obtained from the various Local Government Areas taking into account the requirements for the preparation of the brews. This information was obtained from the people who process and sell the brews. A sample raw material was obtained from market places nearest to the beverage sampling stations.

The sampling Areas were five Local Government Areas within Adamawa State; that is, Hong, Song, Jimeta – Yola, Numan and Ganye respectively where they produce and sell locally brewed Alcohol (Figure 1).

Procedure

Brews

The brew sample bottles (acid washed with 1.7 L) were rinsed 3 times before sampling. It was filled approximately $^2/_3$ full, tight cap and freeze cruise. The sample bottles numbered were according to their Local Government Area and data sheet. All the brew sample bottles were rinsed first with the alcohol for alcohol samples before the brew samples were collected. 50 ml of the burkutu sample was poured into a kadjiel flask. Then HCL and Nitric acid in 1:3 ratios were added to the 50 ml of the burkutu sample. The mixture was wet digested at 100°C for 1 h. The mixture reduced and 5 ml of nitric acid was added, boiled for 15 min and then allowed to cool. Thereafter, 5 ml of peroxide was added to the mixture and a clear solution was obtained. The mixture was transferred to 1000 cm^3 volumetric flask and distilled water was added to the mark. 50ml of the clear solution was transferred into a cuvett and labeled according to the local government area it was obtained from after words were taken for analysis. The same procedure was repeated for all sample to be analyzed for metals.

Using the Win lab 32 software for Atomic Absorption Spectrometer (AAS), the method window was opened and a method was created, these include feeding the information in relation to the sample unit of measurement, replication

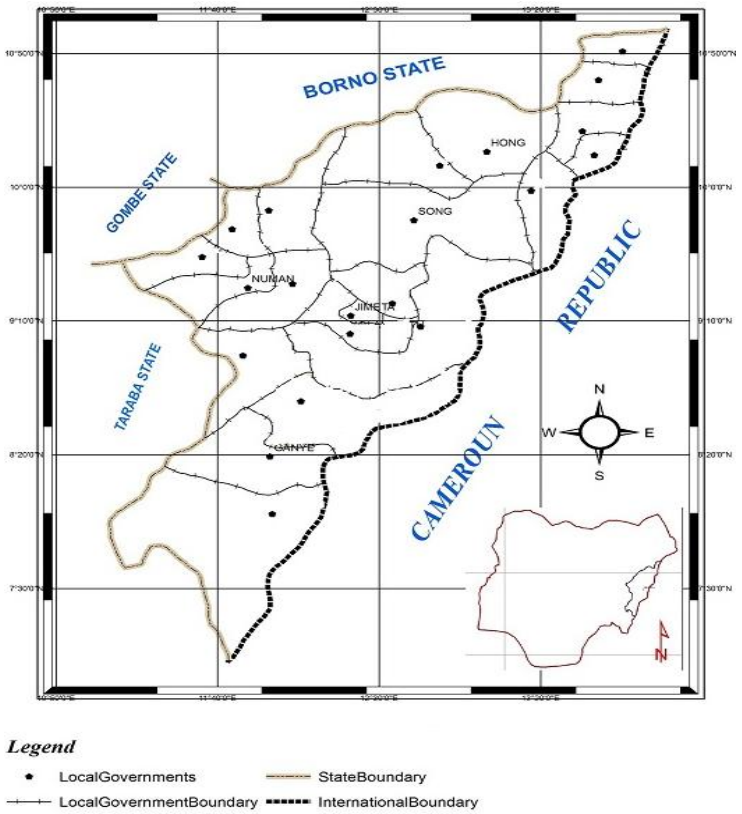


Figure 1: Map of Adamawa State and the study area.

of analysis, delay time etc. the information was saved. After measurement of the standard and the blank samples were individually introduced to the equipment through the nebulizer into the flame, the measure icon was clicked and after few seconds the result was displayed in mg/L through result window.

The extraction of pesticide residues

Water and Acetonitrile of HPLC grade, Dimethyl formamide of analytical grade, and anhydrous sodium sulphate were obtained from Fischer-Scientific. Acetic acid and sodium acetate from Merck were used for sample preparation. Analytical grade pesticide standards were obtained from Sigma-Aldrich. A standard mix solution was prepared from the individual stock solution to yield 10 mg/ml. The acetate buffered sample preparation method for pesticide was applied to all samples. 50 mg samples were homogenize with 100 ml acetonitrile. Then 10 g of sodium chloride was added to it. Thereafter, 6 g $NaSO_4$ were added to absorb moisture and then shaken very well. The extract was centrifuged at 5000 rpm for six minutes. Pesticide was eluted with 20 ml acetonitrile. Sample was concentrated using a rotary evaporator.

HPLC condition

Analytical Technologies 3000 series HPLC having UV/visible detector was used for the identification and quantification of pesticides. Separation was performed on C18 (4.6ID × 250 mm) column. Samples were injected manually through Rhyodyne injector. Detector was connected to the computer for data processing. The working condition of HPLC was binary gradient, mobile phase was acetonitrile: water (70:30), flow rate was 0.8 ml/min, injection volume 20 µl, pressure 6-7 MPa and the wavelength of the detector was fixed at 254 nm for the residual analysis of three pesticides: endosulfan, Carbendazim and Chloropyrifos.

Instruments

The samples of interest was determined for metals, pesticides residues, Ethanol, Aldehyde and Acetic acid concentration in locally brewed alcohol (burkutu) using Atomic Absorption Spectrophotometer (AAS), high performance liquid chromatography (HPLC) and Ultraviolet Spectrophotometer (UV), a product of Perking Elmer Company respectively. The method for the collection,

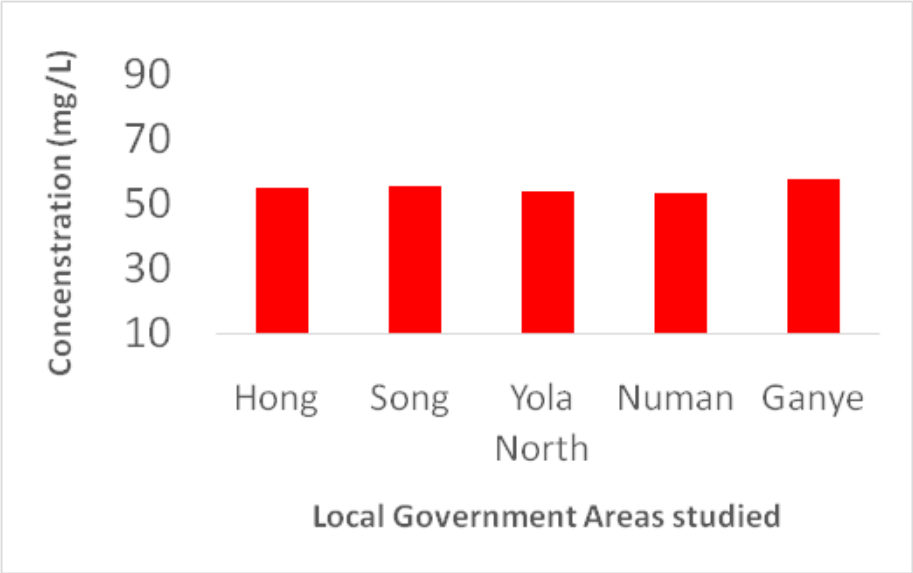


Figure 2: Concentration of ethanol in burkutu obtained from five local government area studied.

preservation, and analysis of the brews was adopted according to William (2000).

Data analysis

The data collected were subjected to statistical analysis using simple descriptive statistics, one way analysis of variance (ANOVA) and T-Test analysis.

RESULTS AND DISCUSSION

Results for ethanol analysis in five local government areas studied

Ethanol was analyzed in all the burkutu samples obtained from the local government areas studied, such as Hong, Song, Yola-North, Numan and Ganye respectively, using Ultraviolet Spectrophotometer (UV). The result of the analysis is shown in Figure 2 and the results are all in mg/L. The result for ethanol concentration for Hong burkutu sample was 55.6016 mg/L. The concentration of ethanol in burkutu samples obtained in Song was 55.7880 mg/L. The sample of burkutu obtained in Yola-North showed ethanol concentration of 54.091 mg/L. The concentration of ethanol in burkutu samples obtained in Numan local government area was 53.926 mg/L, while the concentration of ethanol in Ganye burkutu sample was 58.0146 mg/L.

The data indicated that the burkutu collected from Ganye Local Government Area showed the highest concentration of ethanol with a value of 58.0146%. All the ethanol contents analyzed were high in the local brews which can lead to intoxication, slurred speech, sickness and even death when consumed in large quantity.

Ethanol is a chemical substance obtained during fermentation process of Glucose or malting in the presence of an enzyme zymase to produce ethanol and carbondioxide which is very toxic to the human system; ethanol has the chemical formula C_2H_50H, this is obtained from the equation presented as follows:

$$C_6H_{12}O_6 \xrightarrow{\text{Zymase}} 2C_2H_5OH + 2CO_2$$

From the results obtained using Ultraviolet Spectrophotometer (UV), it was shown that ethanol was absorbed at wavelength of 237.0 nm. Therefore, the ethanol content analyzed showed the presence of this substance which makes the burkutu unfit for consumption.

Results of aldehyde analysis obtained in *burkutu* samples from the five (5) different local government areas studied

Aldehyde is obtained from mild oxidation of ethanol, it is very toxic to the human system most especially the liver; 90% of the ethanol or alcohol is being processed in the liver. On mild oxidation, it converts ethanol into aldehyde (CHO) and lead to various diseases, such as liver cyrolysis, diabetes mellitus etc. The result of the analysis showed that aldehyde was absorbed at the wavelength of 230.0, 240.0 and 340.0 nm, respectively. The concentration of aldehyde in burkutu samples analyzed is shown in Figure 3.

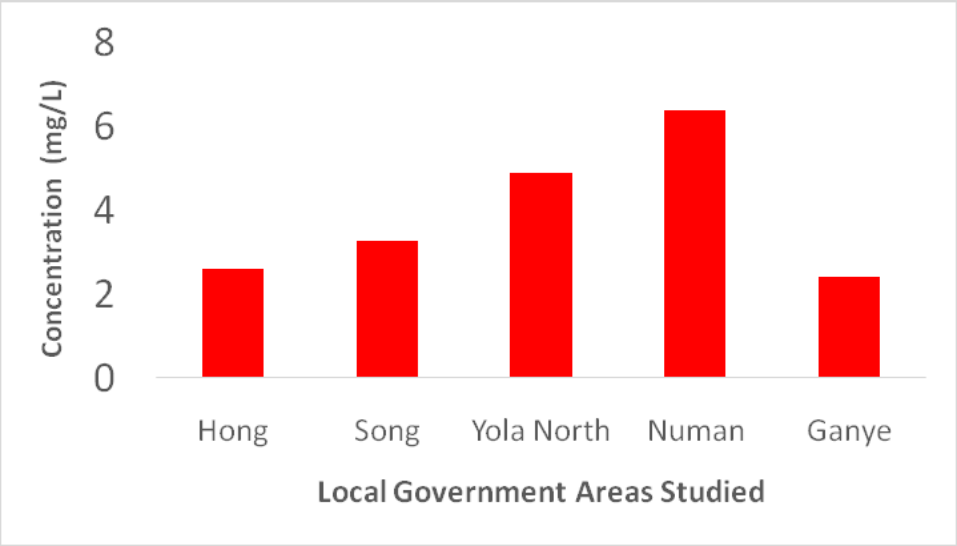


Figure 3: Concentration of aldehyde in *burkutu* obtained from the five local government area studied.

The presence of aldehyde was shown in all the burkutu samples analyzed. The result of aldehyde obtained in burkutu samples from Hong local government area was 2.6003 mg/L, and the concentration of aldehyde in burkutu sample obtained in Song local government was 3.2565 mg/L. The result of aldehyde in Yola-North burkutu sample was 4.9045 mg/L. In Numan town, the concentration of aldehyde was 6.3945 mg/L, while the aldehyde concentration in burkutu samples obtained in Ganye Local Government was 2.4128 mg/L. Therefore, from the result of the analysis, it can be deduced that the burkutu obtained from Numan Local Government Area had the highest concentration of aldehyde as compared with the rest of the other four (4) local government areas studied, with concentration of 6.3945%. Therefore, the burkutu obtained from this locations is not safe for consumption because of the presence of aldehyde (CHO), a very toxic substance found in the locally brewed alcohol.

Results of acetic acid found in *burkutu* samples from five local government areas studied

Acetic acid also known as ethanoic acid, is an organic compound best recognized for giving vinegar its sour taste and pungent smell. It is one of the simplest carboxylic acids (the second-simplest, after formic acid) and has the chemical formula CH_3COOH. It is corrosive, and its vapour irritates the eyes, produces a burning sensation in the nose, and can lead to a sore throat and lung congestion. Also, it is toxic to the human system on consumption, which can be obtained during dehydrogenation of aldehyde (CHO). The result of analysis of acetic acid in burkutu samples for all the five (5) local government areas is shown in Figure 4.

All samples were subjected to Ultra-Violet Spectrophotometer in mg/L. The concentration of acetic acid in burkutu samples obtained from Hong Local Government Area was 6.4139 mg/L, while that obtained from Song town was 6.8829 m/L. In Yola-North, the concentration of acetic acid in the burkutu sample was 4.0496 mg/L, while in burkutu sample obtained from Numan Local Government Area, the concentration of the acetic acid analyzed was 4.7305 mg/L, and that of Ganye local government area was 4.7482 mg/L. From the analysis obtained, it is obvious that the burkutu obtained from Song Local Government Area had the highest concentration of acetic acid in all the burkutu samples analyzed for acetic acid with a value of 6.8829 mg/l. This result implies that the presence of high content of acetic acid in this location can be due to method of production and preservation of the burkutu in Song Local Government Area as compared with the other local government areas studied.

The equation represented by the reaction of enzymes on ethanol to acetic acid is as follows:

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \xrightarrow{\text{Zymase}} \underset{\text{Ethanol}}{2CH_3CH_2OH} + \underset{\text{Carbondioxide}}{2CO_2}$$

On mild oxidation, it convert ethanol to aldehyde (CHO):

$$\underset{\text{Ethanol}}{2CH_3CH_2OH} \xrightarrow{\text{Mild oxidation}} \underset{\text{Ethanal}}{CH_3-\overset{\overset{O}{\|}}{C}-H} + 2H$$

Acetaldehyde is destroyed almost immediately by the dehydrogenase enzyme, which converts aldehyde (CHO) to acetate ions ($CH3COO^-$):

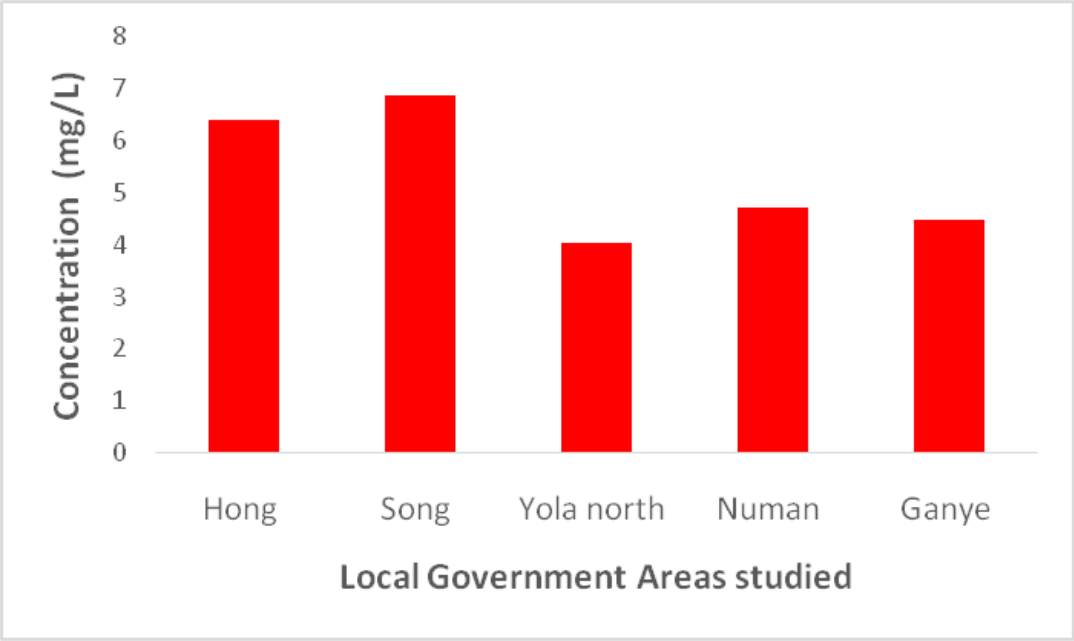
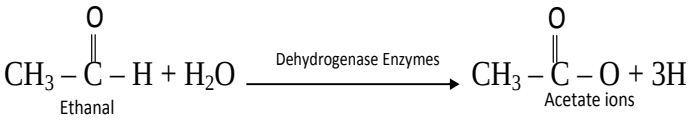


Figure 4: Concentration of acetic acid in *burkutu* obtained from five local government area studied.



Therefore, from the result of the analysis, the presence of acetic acid in the locally brewed alcohol for all the local governments analyzed renders the alcoholic drink unfit for consumers.

CONCLUSIONS

This research is only interested in the determination of the concentration of Alcohols, Acetic acids and Aldehydes in the final product obtained from brewing sorghum (burkutu) which is ready for consumption to the public. Therefore, based on the findings of the study, the following conclusions were drawn:

1). The presence of ethanol, aldehyde and acetic acid in all the burkutu samples analyzed, renders the alcoholic beverages unhealthy for consumers because of the toxicity of the substances determined.
2). This study has achieved its objectives by determining the concentration of Ethanol (C_2H_5OH), Aldehyde (CHO) and Acetic acid (CH_3COOH) tend to be persistent in all the drinks which are very toxic to the liver and human system and the accumulation of such persistent pollutants in the body can lead to diseases such as liver cirrhosis, diabetes mellitus, cancer and death.
3). The ethanol content was high in Ganye Local Government with 58.0146 mg/L at wavelength of 237.0 nm. Aldehyde content was the highest in Numan Local Government with 6.3945 mg/L at wavelength of 230.0, 240.0 and 340.0 nm, respectively as compared with the burkutu samples obtained from the other four local government areas. For Acetic acid, the concentration was high in Song Local Government Area with 6.8829 mg/L at wavelength of 253.0 nm.

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