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ASSESSING THE IMPACTS OF PUNJAB DISTILLERY COMPANY ON THE HEALTH STATUSES OF INHABITANTS OF SIERRA LEONE.CASE STUDY: NYANYAWAMA COMMUNITY KENEMA CITY.

ABSTRACT

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EASTERN POLYTECHNIC

PRIVATE MAIL BAG KENEMA

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Introduction:

A distillery is a geographic area or a place where the process of distillation of alcoholic spirits are manufactured through a series of complex chemical reactions that lead to the formation of desired products that are consumable by people. On the other hand, environmental impacts of a distillery are the overall-conspicuous results, effects and physical challenges which the desired products o by – products of the distillery posses on the inhabitants in that area, endangering their health and lives (**Alam M Z, 2010).** Distillery wastewater, for instance and its toxicity is concerns worldwide, as well as in Nyanyawama community in Kenema. Unfortunately, if discharged into the environment without proper treatment causes serious health and environmental problems both in humans and their domesticated animals. The operations and functioning of a distillery cannot be done without risking the normal health and the environment in which people live because it always involves dealing with large, potentially dangerous equipments and chemical reagents. What is more obvious is that those that manufacture alcoholic drinks/spirits often have to handle dangerous fumes, chemicals and other harmful substances which, when discharged into the surroundings will lead to environmental pollutions **(Chowdhurg P. Raj A- 2018).** Due to very high chemical oxygen demand (COD), biological oxygen demand (BOD), distillery wastewater causes inhibitory effects on seed germination and depletion of vegetables by reducing the soil alkalinity and manganese availability in agricultural lands; where as in aquatic environments, it reduces sunlight penetration and decreases photosynthetic activities and dissolved oxygen content- damaging the aquatic fauna and flora both.

In the 1997, the United Nation Water Conference (UNWC) held in place recommended in 1981 to 1990 to be designated to the International Drinking Water Supply and Sanitation (IDINSSD). Global consultation in safe water tracing the root courses of water contamination. The research result showed that about 21.08% - 25.70% of the pollutants came from distillery waste water. Other research work conducted to access the quality of drinking water in Freetown municipalities revealed that areas closed to distilleries gave high proportion of contaminants than those located far off. The results were also not consistent with the World Health Organization guideline values. Only one exceptional case sampling point was identified. According to **Dr. Rob Lipton and Dr. Paul J. Grunewald**, a growing number of studies and researches have recently been conducted, addressing the problems of community geography and the alcohol – related problems. According to them, distilleries operating in developing countries and even in most developed nations have failed to address properly the problems of:

- ❖ Controlling and detoxifying the release of about 91-93% of the waste water being discharged from distilleries which causes severe environmental stress;
- ❖ Establishment of advanced and sophisticated processing and degrading equipments and techniques, and the waste treatment technologies, especially in the developing countries, and;
- ❖ The Total Dissolved Solids (TDS) values of distilleries waste water which have been proved to be more problematic;

The consequent effects of these failures such as alteration of structure of the ecosystem like contamination of drinking water sources, reactions or combinations of the discharged ions, molecules and compounds with plants materials such as potato leaves, cassava leaves, grasses eaten by domesticated animals (sheep, goats, cattle's etc.) may directly affect human health and physical well – being. Domesticated animals are retarded in reproductive behavior. The point is that, the situation is actually unfit and unfavorable. Thus, the point source of the pollution that is population coming from a defined, specific source (thePunjab Distillery Company) is actually a major category of pollution affecting the people residing within the Nyanyawama community in Kenema City, to be specific. The various types of this point source pollution are chiefly from pollutants from the distillery which may be both organic and inorganic, collecting called **melanoidins,** and others like waxes, polysaccharides, proteins, reduced sugars, nitrogen, potassium, calcium and the sulphates and phosphate ions (**SO^{2-} and PO^{3-}** respectively). The consumption of alcoholic spirits may have some health benefits, but drinking alcoholic spirits which contains the exceeding amount/concentration of spirits of the international standard, will chemically increases the risk of addiction, depression, vomiting, mental retardation or impairment, stroke, cardiomyopathy, arrhythmias, hypertension, fatty liver and more drunk driving and drunk riding of motor bikes which are rampant in Kenema City. The by-products of the synthesis of these spirits (gin, wine, whisky, beer, cider, alcopos or malt liquor etc) increase the acidity of the polluted drinking waters in Nyanyawama community, Kenema City. The acidity is expectedly higher than normalcompared with the acidity of polluted drinking water in Mondema Village, (located in Gorama Mende Chiefdom) which is hundreds of miles away from the distillery, hence the acidity of polluted wellwater or hand-dug water in the Nyanyawama Community is environmentally and medically questionable. Though acid rain or acid precipitation contributes greatly to acidity of polluted drinking waters, the difference between the two places (in acidity value) is an indication of the environmental hazard being posed by the **Punjab Distillery company** on the inhabitants of the Nyanyawama community.

The Nyanyawama people greatly are dependent upon drinking water from hand-dug wells especially for drinking during the dry season, though impurities of the wells get dried within the months of February and March every year. Only very few pipe bond water supply is available within the entire community and most of the people are being driven off such facilities. As a result, they prefer to fetch drinking water from neighbouring wells and streams, thereby drinking the discharged from the distillery waste water, and a major health concern which the Ministry of health and Sanitation have to deal with seriously and promptly.

Aim and Objectives of the study:

The aim of this research is to investigate the environmental impacts of the Punjab distillery company on the health of inhabitants in the Nyanyawama community, Kenema city. The specific objectives include:

- To identify barriers to the development of least-cost option for pollution reduction and desirable steps that can be taken by Government of SierraLeone in collaboration with the international development organizations working on the ground.
- To quantitatively analyse the alcohol (or spirit) content of alcoholic beverages and compare the results to international standard values.

- To analyze the drinking water sources, deduce the total ions dissolved in each, and compare the result to international standard values of drinking waters.
- To suggest possible recommendations to the Ministry of Health and Sanitation about the impact of the Punjab Distillery on the health of the Nyanyawama community.

The impacts of alcoholic drinks on health and the environmental hazards of distillery waste water are really determined by the active ingredients of the alcoholic beverages, and the mode/manner of properly discharging or controlling the waste water, respectively. The alcohol in wine is brown in color to the body by the liver. Drinking wine and taking **met forming (Glucophage)** can cause serious side effects. The alcohol in wine can react with metronidazole (flagyl) and this lead to upset stomach, vomiting, sweating excessively, headache, and increased heartbeat. The research can help also researchers to know the adverse effect of taking high percentage of alcoholic beverages on the Liver which can results into Liver serosis**:** wine causes liver damage and other health problems. A new study cast's doubt over an earlier study that a research also suggested that wine was less harmful to the liver than whisky: The research could also be useful as it may help other researchers to know the level of sulphites to be consumed in alcoholic beverages : Addition of sulphites causes a negative side effect like nasal congestion, itchy throat, running nose, skin rashes (which are now very common in Kenema) .

It has been reported in medical literature that less than 1.0% of people have sulphites. The term "sulphite" is an inclusive term for SO_2, a preservative that is used in wine making for its antioxidant and antibacterial properties. However, sulphites are badly damaging. The table below shows the internationally agreed levels of spirits in some alcoholic drinks.

Table 1:

Drinks	**Typical Alcohol by Volume (ABV)**	
	Actual	**Deviation**
Wine	4.0 - 12%	Most often 14.0 – 16%
Beer	2.0 – 12%	Usually 4.0 – 6%
Cider	4.0 – 12%	Usually 4.0 – 8%
Alcopos	4.0 – 17.6%	Not available
Malt liquor	5.0% plus	Not available

8.

This research is important because, it gives useful information about the percentage composition of spirits in alcoholic drinks, and the percentage composition of toxic chemicals (discharges from distillery) and other contaminants present in various drinking water sources within the Nyanyawama community. This research is also helpful to the healthiest hazardous alcoholic drinkers, and the most dangerous ions or metallic element or organic compound that may have harmful properties to human health and to establish remedy to this problem. In 1989, a report from Primary Health Care (PHC) on drinking water, gave 77% of household in the capital, Freetown communities obtained their drinking water from pipe bond source. The report also explained that 86.3% of household and 19.7% of households both of the western urban and western rural area respectively get their drinking water from taps. Of these, 37.6% of Western rural household get their water source from water wells or hand-dug well. 4.7% and 11% both in the urban and rural centers obtained their water from springs, stream, and rivers. 5.3% and 3% of rural and urban households obtained drinking water from springs only. This information was further summarized in tables as illustrated below **(K.M. Bockarie, 2013).**

Table 3:

Source	**W.U #**	**%**	**W.R #**	**%**	**Wesrtern Area**
Tap waters	517	86%	119	19.7%	77.5
Project wells	None	none	189	38	4.2
Iron type	600	98.5	600	98.5	98.5
Hand-dug wells	39	7.0	165	28.5	9.5
Rivers and stream	28	5.0	98	16	6.5
Spring water	16	3.0	37	5.5	3.0

NB: W.U# = Western Urban Number

W.R# = Western Rural Number

This report showed that people living in the western rural greatly depend on project wells and hand-dug well for domestic purposes, and this intrigued the Ministry of Health and Sanitation. Likewise, the inhabitants of Nyanyawama community depend wholly and solely on hand-dug well for drinking and streams for cooking, laundering and drinking (minerals dissolved in the water are hardly removed by boiling!) which will be another health concern for the ministry. The Nyanyawama community people are the most vulnerable, and therefore the research was limited there. Other impediments of the expansion of the research were time factors, inadequate financial problems, and lack of appropriate research materials for collection of sample and identification. The samples were collected in improvised containers and transported to routine mining company (for spectroscopic analysis) and to Freetown (for qualitative analysis) since the experimental apparatus and reagents were not available in Kenema City. Because of these drawbacks, there were high possibilities of contaminating the sample- which may bring about a deviation from the actual results accuracy. Large numbers of researchers havedone on environmental hazards, especially on alcohol production and its impacts on the environment, distillery wastewater and its toxicity on drinking water, and the spirit (alcohol) contents in alcoholic beverages, by many authors and writers of text books. Their experimental results have shown some positive correlation on the destruction of the environments and the loss of many lives on earth. Distillery wastewater contains various types of recalcitrant- organic and inorganic pollutants due to the presence of water – soluble recalcitrant, coloring of compounds containing organic and inorganic species.

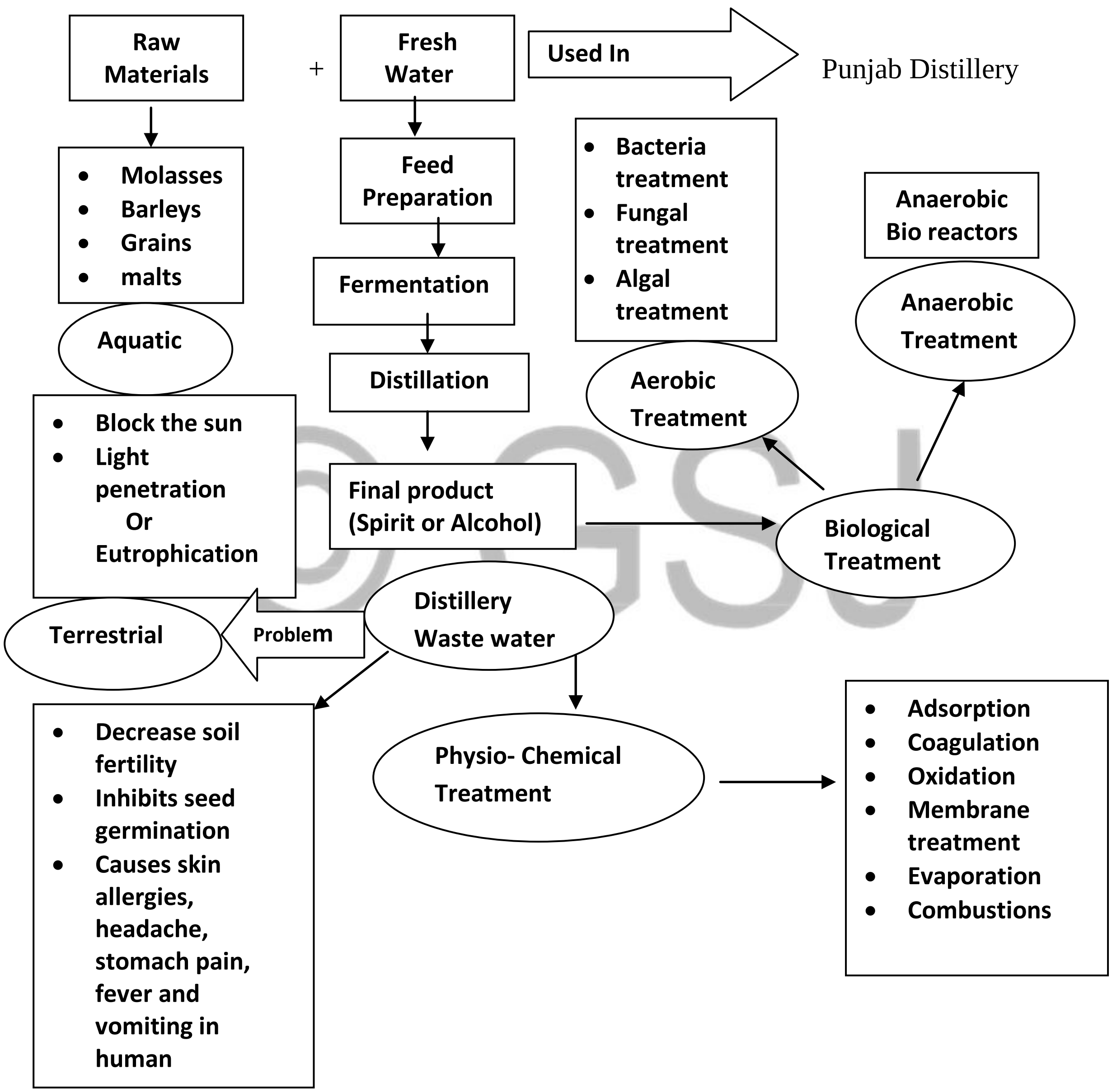

Figure 2.0: Schematic Representation of Alcohol Production and Its Impacts on the Environment:

Melanoidin is formed by the reaction of "Millard reaction", between a carbohydrate and an amino acid. This pollution contains chemicals that causes hormonal imbalance and disturb reproductive fitness in human. In aquatic regions, distillery wastewater can block out sunlight from streams, thus reducing oxygenation of the water by photosynthesis, and hence becomes detrimental to aquatic life's. More importantly, it has a high pollution load, which would result in eutrophication of contaminated water sources Run-off water can carry the waste water from distillery into streams, and even in the hand- dug wells since these wells are not properly protected. The schematic representation of alcohol (spirit) production and its environmental impacts is shown below **(Bharagava RN Chandra RI, 2010)**

It has been confirmed that distillery waste water also causes soil pollution and acidification in the case of inappropriate land discharge. It is reported to inhabit seed germination, reduce soil alkalinity, and causes soil manganese deficiency, damages agricultural crops production. It also affects the domestic and farm animals like fowls, ducks, sheeps, goats and cattle etc. They drink it and resulted in increased livestock mortality, poor health and reduced milk yield. Even the human beings are the most vulnerable as they live in distillery waste water polluted areas (Nyanyawama) and are affected by skin allergies, headache, vomiting sensitization, irritation of eyes, fever and stomach pain. It is analyzed that distillery waste water, highly polluted and having very high Chemical Oxygen Demand (COD) or Biological Oxygen Demand (BOD), and it is dark brown and reddish in color. Some of the contaminants such as certain levels of minerals or compounds are not only harmful to health but also create a long term effect such as cytotoxic and genotoxic effects. The review of the related literatures generally explained the methodologies of operations. Here, the results from each experiment are the target for the chemical analysis (both quantitative and qualitative analysis). The final results determined the percentages of spirits in each alcoholic drinks, the nature and composition of the ions, organic and/or inorganic compounds under studies. The various methods or techniques employed are the following:

- Hydrometer
- Spectrophotometer
- Electrical conductivity
- Temperature
- Total dissolved solids
- Potential (or power) of hydrogen, PH

Hydrometer (English Author): C.J.J Berry – A hydrometer is an analytical instrument used to measure the change in specific gravity (or relative density) of the solution before and after the fermentation process. This instrument enabled us to determine the “alcohol by volume” or ABV of each alcoholic drink, and thus the specific gravity of alcohols such as ethanol, 2 – methyl/butanol etc.

Spectrophotometer: The single – beam potable photometer – 9,500 (ECOSENSE) was used to measure the concentration of metallic ions (heavy metal ions) in water sample in milligrams per liter (mgL^{-1}). It is operation is based on Beer- lamberts Law-that is, the concentration of the analytic is directly proportional to amount of light absorbed.

That is, $A = \varepsilon CL$, where

A = absorbance

Ɛ = molar extinction coefficient or molar absorptivity co-efficient

C = concentration of analyte

L = path length of tube (cuvette)

The instrument measures the relative light intensity before and after the test sample was inserted. It can have a larger dynamic range, and is optically simpler to operate and more compact. It compares quantitatively the fraction of light passing through the reference solution to that passing through the test solution.

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Electrical Conductivity:

The electrical conductivities of the various samples collected were measured by a conduct metric meter.

It consists of two electrodes which were initially immersed into a reference solution and the readings on the meter noted and recorded. The test solutions were then tested and the change in conductivities were similarly measured, and recorded.

Temperature (Holton – 1983 and Carin Cross – et al 1998): Both Holton and cross explained the actions of bacterial species as, the system temperature fluctuates. The Holton's view is that temperature has a remarkable effect on the actions of bacteria, and the reaction rate of bacteria in water or in moisture can even control the initiation of dissolved oxygen saturation, algal blooms and carbon (iv) oxide concentration, (CO_2).

Carin cross on the other hand noted that bacteria of certain species show feature of adaptation such that they can even survive at lower temperatures, and their rate of survival can be even lowered as temperature is raised.

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Total Dissolved Solid (TDS) : This quantity describes the concentration of salts, and tiny quantities of organic and inorganic matter in a given volume of a sample. The total dissolved solid of water samples were determined by the Horiba U – 10 Multiprobe meter. The method was employed to determine the concentrations of ions from the distillery waste water (into drinking waters) such as potassium, calcium, nitrates, chloride etc.**(K.M. Bockarie, 2013)** For international standards, it is recommended that water containing total dissolved solid (TDS) concentration above 100mg/L is totally forbidden and unacceptable to consume/drink.

The table below gives the international standard values for TDS. It values were provided by World Health Organization (WHO).

Concentration of TDS (g/L)	**Remarks**
0.000 to 0.300	Excellently safe
0.300 to 0.600	Very good and friendly to consume
0.600 to 0.900	Poor, unfit, causes harm
0.900 to 1.200	Very poor, can lead to illness and can result to death
1.200 and above	Forbidden, completely unacceptable

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P^H: P^H is an acronym representing "power of hydrogen" or: potential of hydrogen". In chemical terms, it is the negative logarithm to the base 10 of hydrogen ion concentration, $[H^+]$. Mathematically

$$\mathbf{PH = -log_{10}^{[H+]}}$$

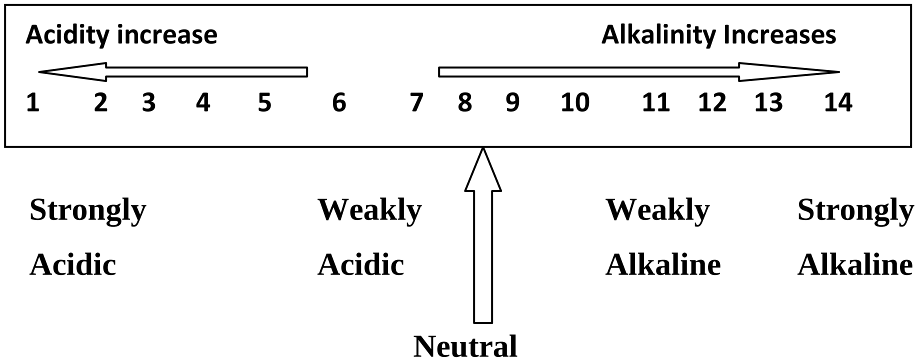
The concentration of hydrogen ion, denoted by $[H^+]$ is measure of the degree of acidity of solution. The greater the number of hydrogen ions, the smaller the value of PH and hence the stronger the acid. The PH scale can also measure the degree of alkalinity of solution. Mathematically

POH = -log $^{[OH-]}$, where $[OH^-]$ denotes the concentration of hydroxide ion, OH^- and P^{OH} is the potential or power of hydroxide ion concentration.

Thus a relationship exists between P^{OH} and P^H!

$$\mathbf{P^H + P^{OH} = 14}$$

This relationship implies that the P^H scale is labeled from zero to 14 as illustrated below



Thus:

P^H = 7 is neutral

P^H > 7 is basic

P^H < 7 is acidic

P^H from 1 to 3 is strong acid

P^H from 4 to 6 is weak acid

$P^H$from 8 to 11 is weak alkaline

P^H from 12 to 14 is strong alkaline

General Properties of Contaminants:

Distillery Waste water and Alcoholic Spirits:

- **Melanoidins**

Melanoidins are major pollutants. They cause many types of recalcitrant.Organic pollutants such as endocrine disruptions, chemicals like plithalates, hormonal imbalance, reproductive unfitness and carcinogenesis. These melanoidins with dark brown to black coloured recalcitrant in character are a product of “Millard Reaction” between sugars and amino acids, which are produced during the passing of sugar cane juice in distillery molasses in the manufacturing centers. They can impact both environmentally and medical stress if not properly discharged or control. **(Dixit S. Yadau, 2015).** Because the “active ingredient” of alcohol determines the side effects of given alcoholic drinks, a slight increments in concentration above recommended values can lead to fatty liver, hypertension, cardiomyopathy, mental health problem, drunk driving and drunk riding, depression, addiction and violence among users. **Added Sulphites:** Added sulphites to alcoholic drinks induceabnormalities such as stomach congestion, itchy throat, running nose and skin rashes. Sulphite, SO_3, also called sulphur (iv) oxide, is very reactive. It reacts with water to form sulphurous acid, H_2SO_3, a weak acid (RN Ramsden)

$$SO_2(g) + H_2O\ (c) \longrightarrow H_2\ SO_3\ (ag)$$

This acid, can intrigue many other reactions and its concentration at a particular level can kill. With strong base, sulphite reacts to form sulphate ion and proton (hydrogen ion).

$$SO_{2(g)} + 2OH_{(ag)} \longrightarrow SO_{3(ag)} + H_2O_{(1)}$$

$$SO_{3(ag)} + H_2O(1) \quad SO_{4(ag)} + 2H^+_{(og)} + 2é;\ E^o = -0.17V$$

Sulphate ion

It also reacts with O_2 to form O_3 and with Cl_2 to form $SO_2\ Cl_2$. It is colourless gas with a characteristics pungent smell. It fumes and is very soluble in water. The sulphite ions, SO_3 are oxidized by air, chlorine, Iron (iii) ions, dichromate (vi) ions and manganese (vii) ions. The reaction with dichromate (vi), resulting in a change from orange to blue, and the decolonization of manganate(vii) are used as test for sulphites, SO_2.

Biogenic Amines (Loret S, Deloyer P, 2005):

Biogenic amines (Bas) and polyamines present another serious consequence of microbial contamination of beer. These compounds are found in a wide range of foods and beverages, including fish, meat cheese and wine (in higher concentrations) and are formed by microbial decarboxylation of amine acids. Bas pose a health hazard to sensitive individuals, resulting in allergy – like reactions. Migraine and/or toxic reactions with monoamines oxidase inhibitor drugs (Shulman KI, Tailor SAN). Bas in beer are formed primarily during fermentation but can also be produced by microbes in barley, malt, work and hops **(Gasarasi G, Kelgtermans M-1994).**

Metallic Elements- Properties (General):

Groups 1 and 2:

According to **Dr. Martin S**. **Silberberg** in his book titled "The Molecular basis of matter and change", the members of group 1 (alkaline metals) and group 2 (alkaline earth metals) are all reactive metals. In these metals, the metallic bond is relatively weak, with the group 1 forming the most reactive metals – their reactivities increase as we move from top to bottom of the periodic table. They are all silvery white metals when freshly cut and tarnish rapidly in air.

$4M_{(s)} + O_{2(g)} \longrightarrow 2M_2O_{(s)}$, where M is an alkaline metal (Na, K, etc). Also the alkaline earth metal tarnish similarly in air

$$2M_{(s)} + O_{2(g)} \longrightarrow 2MO_{(s)}$$, where M = Ca, Mg, Ba etc.

The members of group 1 react violently with water, form strong, powerful alkaline solution with the evolution of hydrogen gas $H_{2(s)}$: Example

$$2Na_{a(s)} + 2H_2O_{(1)} \longrightarrow \underset{\text{Strong alkaline}}{2NaOH_{(ag)}} + H_{2(g)}$$

Magnesium reacts only slightly with cool water but with steam rapidly to form the oxide and $H_{2(g)}$.

$$Mg_{(s)} + H_2O_{(g)} \longrightarrow MgO_{(s)} + H_{2(g)}$$

The vigor of the reaction with water is a good illustration in moving down the group. In short

- Lithium react slowly with water, violently with acids
- Sodium reacts vigorously with water, violently with acids
- Potassium reacts vigorously with water, bursting into flame-the hydrogen gas catches fires.

In chemical character, aluminumreacts with non-metallic elements:

With metal oxides and both acids and bases – amphoteric property.

With acids $2Al_{(s)} + 6HCl_{(ag)} \longrightarrow 2AlCl_{3(ag)} + 3H_{2(g)}$

$$2Al_{(S)} + 6H_2SO_{4(ag)} \longrightarrow Al_2(SO_4)_{3(ag)} + 3SO_2 + 6H_2O_{(3)}$$

With bases/alkaline: $2Al_{(s)} + 2OH_{(ag)} + 6H_2O_{(1)} \longrightarrow 2Al(OH)_{4(ag)}$

$3H_{2\,(g)}$

Aluminum can coordinate well, that is, it forms coordinate covalent bond with donor ligands eg: $[Al(H_2O)_6]^{3+}$

CUPPER, Cu : Copper is a d- block metal with a number of biological importance, including:

- Acting with learn as the terminal oxidase step. That is as cytochrome oxidase.
- In animals such as humans, it oxidizes amines and thus acts as animals oxidase.
- It oxidizes alcohol to form aldehyde in the monosaccharide, galactose – that is OH groups are converted to CHO groups.

- Anaerobic walls of cell can be greatly affected by copper – lysine oxidase.
- In the metabolism of iron, copper plays an important function of cerulapsmin, and affects skin pigmentation in a process of enzyme called pyrosinase, and also brain function which affected by dopamine hydrozylase. (K.M. Bockarie, 2013).
- Rubidium and caesium react even more violently.
- Beryllium does not reacts with water, but reacts with acid rapidly.
- Magnesium react slowly with water, fast with steam and vigorously with concentrated acids.
- Calcium under goes a steady reaction with water and a vigorous reaction with acids.
- Strontium and barium are more reactive than calcium and about equal in reactivity to lithium.

The hydrate of magnesium sulphate, MgSO4, 7H2O, is present in tap water and is the chief culprit of permanent hardness. Of course, calcium and magnesium are responsible for the formation of "scum" with soap, the calcium and magnesium actadecanoate:

$$Ca^{2+}_{(ag)} + 2C_{17}H_{35}CO^{-}(ag) \longrightarrow (C_{17}H_{35}CO)_2\,Ca(s)$$

"Scum"

Temporary hardness is brought about by hydrogen carbonates of magnesium and calcium, only remove by boiling:

$$CaCO3(s) + H2O(_1) \longrightarrow Ca(HCO_3)_2(ag)$$

Permanent hardness is caused by sulphates of Ca and Mg and is removed by chemical method – washing soda addition or permuted methods.

Aluminium and the Heavy Metals:

Aluminium: According to **Doctro EN Ramsden**, formally of Wolfreton school, Hall aluminium is amazing in being a good thermal conductor which can be used as a good thermal insulator. As a thermal conductor, it is used for the manufacture of saucepans and cooking foils. The insulating property of Al arises from its ability to reflect radiant heat (infrared rags)

Zinc (Zn):

Forms the second most abundant of the d-block element. It has slightly different properties than the "actual" d-block elements in that:

- Zinc does not form coloured ions in solution.
- It does not form variable oxidation state.
- It does not exhibit Para magnetism**.**

Zinc occurs in many biological enzymes. Thus, the biological functions are enzymatically active:

- It acids in the release or generation of energy in combination with alkaline phosphates.
- In the metabolism of alcohol; act as promoter of dehydrogenises and aldolases.
- It increases the rate of absorption of CO_2 by erythrocytes in muscles and other cells, and the evolution of CO_2 in the lungs in the opposite direction. It also regulate PH and takes part in respiration processes.

The World Health Organization (WHO) has provided a limit or guideline for the concentration of metallic ions in drinking water

Metallic specie or Non Metallic ions	Symbol	Electron Configuration	Guideline Value (Mg/L)
Aluminum	Al	[Ne] $3S^2$ $3d^1$	
Copper	Cu	[Ar] $4S^1$ $3d^{10}$	0.30mg/L
Zinc	Zn	[Ar] $4S^2$ $3d^{10}$	5.00mg/L
Magnesium	Mg	[Ne] $3S^2$	0.65mg/L
Hydrogen ion	H^+	$1S^o$	0.81-0.93mg/L
Chloride ion	Cl^-	[Ar]	1.00mg/L
Sulphate ion	$SO^{2-}{}_4$	-	0.05mg/L
Faecal coli form	-	-	0.00 per 100
Total dissolved soild	TDS	-	1000.00mg/L
Turbidity	-	-	5 units

THE RESEARCH PROCEDURE, INSTRUMENTATION AND EXPERIEMENTATION:

Geographical Feature of Study Area:

This research was conducted within the Nyanyawama community in Kenema city. The Nyanyawama section boundaries with three other sections, viz: the **Lehgbeteh section**, the **Lumbebu section** and the **IDA** (International Development Association) **section**. It is bordered by the Lumbebu section in the North-east, the IDA section in the North and by the Lehgbeteh section in the West. The total area occupied by the Nyanyawama Community is about $234.70m^2$. At the heart of the community is found the **Kapuwa Avenue**. This avenue is mostly swampy with small amount of sandy soil mixed with some clay soil. The inhabitants there perform agricultural (garden) activities such as growing of okra, potato leaves, cassava leaves, corn, onion and green or Crain-Crain. Domestic animals are mostly fowls, ducks, sheep and goats. **“Aues”** such as pigeon are also domesticated there. The entire Nyanyawama community is completely surrounded by swamps. The map of the geographical feature of the Nyanyawama community is illustrated in the next page, and was as a result of a survey on the community. There are many hand-dug water wells in their community. Only few people have tap water system in their houses. The distillery itself is north-west of the Nyanyawama community, and the survey revealed that the distillery water wastes (discharge) are emptied directly in a swampy land located at the back of the distillery. The soil there is different in color from areas located far off the distillery. The soil is **black in color** and mixed with organic matter by mere observation

Methods of Sampling and procedure:

A simple random sampling was conducted within the study area.

- Five different kinds of alcoholic beverages (drinks) were bought and analysed. The analysis was based on the determination of the spirit content of each drink or beverage and then compares the results with international standards.
- Water samples were also collected at five different sources where people used it for drinking every day. The water was analyzed to determine the concentration of minerals or ions and also compare to international standards.

Procedures:

The following precautions and direction were strictly adhered to during the sampling**:**

- Samples were collected from the appropriate sample points, and then protected immediately from damp air, dust or sort.
- The sampling instruments were clean and dried.
- Representative samples were drawn, after ensuring that the contents of each container selected for sampling was thoroughly mixed by suitable means.
- The containers selected for sampling, the sampling instrument and the container for storing water samples were protected from extraneous contamination.
- Samples were placed in suitable, clean and dried containers. Appropriate sample cans and tubes were selected in terms of size, shape, easy handling and capacity.
- Each sample container was sealed air **–** light with suitable stopper after fitting each.
- Each sample sealed was mark immediately with full detailed of sampling including date, point of selection, name, size, number etc. for traceability of results.
- No storing was made for the water samples in order to avoid any chemical reaction that may interfere with the system under the normal conditions of temperature and pressure.

INSTRUMENTATION AND EXPERIMENTATION

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INSTRUMENTATION:

The Hydrometer:

During the production of wine, beer and whisky yeast is added to the sugar solution. Fermentation takes places during which the yeast consumes the sugar and subsequently produces alcohol. The chemical equation for the fermentation process is:

$$C_6H_{12}O_6(ag) \longrightarrow 2C_2H_5OH(ag) + 2CO_2(g)$$

The density of sugar in water is greater than the density of alcohol in water. A hydrometer was used to measure the change in specific gravity (SG) or the relative density of the solution before and after the fermentation process.

Spectrometer:

The single beam spectrometer which was digitally operated was used to determine the:

i. Absorbance (A) of metallic ions in water samples (drinking water sources which were predicted to have been contaminated by distillery waste water).

ii. Alcohol (or spirit) content of an unknown beverage. This enables us to decide rationally on the experimental results because, the hydrometer measures alcohol contents of known beverages.

The instrument consists of cuvette, monochromatic, knob (regular), prism and grating photomultiplier tube, read –out device, and a computer with screen.Since the concentration of ions is related to conductivity , this instrument was used to deduce the presence of metal ions in water samples. The values obtained were again compared to that obtained by the photometer before a tangible conclusion was made.

PH Meter:

This was used to determine hydrogen ion concentration in water sample. It is electronically operated. Measurements were made in the laboratory in order to establish the concentration of hydrogen ion and bicarbonates, and carbonate ions. This measurement was possible because, an equilibrium is established when carbonate is get into contact with water;

$$HCO^-_3 + H_2O \longrightarrow CO^{2-}_3 + H_3O^+$$

OR

$$H_2CO_3 + H_2O \longrightarrow HCO^-_3 + H_3O$$

Thus knowing the concentration of any one of the species, say [H_3O^+], and the dissociation constant of carbonate and the bicarbonate from standard teaks, it was possible to determine the concentrations of all the species (both ionic and molecular) in the water sample.

Experimentation:

The rest of the experiments were performed to determine the concentration of ions (cations and anions) in water samples.

Experiment 1

Aim: Titrimetric method of determining magnesium ions, Mg^{2+} in water sample

Procedure:

- ✓ Pipette 25ml of water sample into 75ml distilled water to make 100ml sample solution. A 2ml buffer solution of $P^H = 10$ was added immediately.
- ✓ The indicator used was erochrome black T. This was added to the solution in step 1, followed by a 0.04ml EDTA (ethylenediaminetetracetic acid) until the color changed from red to purple blue at the end point. The EDTA was the solution in the burette. The last trace of the reddish color was made to disappear completely at the end point.
- ✓ The titration process was performed steadily since complex does not form instantaneously.
- ✓ The solution was warmth to about 40°C during the preparation of the buffer solution with $P^H = 10$.
- ✓ The solution in 4 was dissolved by making 70g of NH_4Cl in 200ml of distilled water and was mixed with 570ml concentrated NH_3 to give 1.0dm^3 solution.

This buffer was used in the titration process

CALCULATION:

$$\text{Mass (g) of } Mg^{2+} \text{ in lL} = \frac{(V_t - V_b) \times M_{ed} \times 24.30}{\text{Volume of sample used}} \times 100$$

Where	Vt	=	volume of titrant or sample
	Vb	=	volume of blank
	Med	=	malarity of EDTA solution
	24.30	=	relative cetamic mass of magnesium

Conversion factor $1dm^3$ = $1000cm^3$ = lL

Experiment I1:

Aim: To determine chloride ion in water sample with a 0.02M Ag NO_3 salt

Procedure:

- ✓ To a 100ml conical flask was added 10ml of the sample solution from the pipette.
- ✓ Three (3) drops of Potassium dichromate indicator, K_2 Cr_2 O_7 was added and swirled for even distribution of color.
- ✓ This was titrated against 0.02M silver nitrate solution.
- ✓ The end –point was determined by noting the appearance of the first permanent white gelatinous precipitate of silver chloride Ag $Cl_{(s).}$
- ✓ The titration procedure was repeated until consistent liter values were obtained.
- ✓ The molar concentration of Cl^- ions was calculated and the result converted to mg/L of Cl^- ion.

CALCULATION:

Mass of Cl^- ions (grams) $= \frac{(Vt - Vb) \times Mr}{Vp} \times 100$

$= \frac{0.02 \times 35.5080 \times 2 \times 1000}{\text{Volume pipette}}$

$= \frac{0.02 \times 35.5080 \times 2 \times 1000 \times \text{Vol Ag } NO_3}{10ml}$

Where V_t and V_b are the volumes of tyrant and blank respectively.

Mr = relative atomic mass of Cl = 35.5080

All aliquot of sample used = 10ml

Conversion factor: lL – ldm^3 = $1000cm^3$

Experiment 111:

Aim: To determine Al^{3+} ions and H^+ ions in water sample.

Procedure:

- ✓ 20ml sample and blank (distilled water) were separately pipetted into a 50ml Erlenmeyer flask.
- ✓ Four (4) drops of indicator (phenolphthalein) was added and the initial color noted.
- ✓ It was titrated against 0.02M Na OH until the color at end point was pink.
- ✓ 0.02M HCl solution of this acid was added to the end – point to bring the pink color to colorless solution in the Erlenmeyer flask.
- ✓ A 4.0% NaF of 2ml was added and stirred thoroughly.

The idea was necessary because, any Al^{3+} ion would make the pink colorreappear and when titrated with a 0.02M HCl solution, the color disappeared and subsequently failed to reappear in the sample solution. The same procedure was repeated three times for the other samples. The mili-equivalent of the acid used in the second titration should be computed as a measure of the exchangeable Al^{3+}ions, the mili-equivalent of H^+ ions exchangeable was determined by subtracting the mili-equivalent of Al^{3+} and H^+ and the concentration recorded in mg/L.

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SAMPLE CALCULATION:

Exchangable Acidity of Al^{3+} and H^+ in water $= \frac{(V_t - V_b) \times M_B}{Vs} \times 100$

Where
- Vs = volume of sample pipette;
- M_B = molarity of base, NaOH
- V_t = volume of litre in water sample
- V_b = volume of blank (distilled water)

M. E of acidity $= \frac{(V_t - V_b) \times M_B}{Vs} \times 100$

M. E of exchangeable Al^{3+} $= \frac{(V_t - V_b) \times M_A}{Vs} \times 100$

M. E of H^+ per 1000 = (M. E. of acidity) - (M. E of Al^{3+})

Where M. E denotes mili – equivalent
M_A = molarity of acid, HCl

Since M_B (NaCH) = 0.02M
and Volume of Al^{3+} = 30ml
Vb = volume of blank = 0

$$\text{Therefore, M.E of exchangeable } Al^{3+} = \frac{(V_t - V_b) \times 0.02 \times 100}{20}$$

Experiment 1V:
Aim: To determine the total zinc content in water (U.S.A Approved Pro. Water Analysis)

Procedure:

- ✓ The stored number for zinc was entered and the wavelength dial was rotated until small display showed. When the current wavelength was dished in, the display was quickly showed to be zero sample, and then mg/L zinc.
- ✓ A 10-ml call riser was inverted into the cell compartment and a 25-ml graduated mixing cylinder with 20-ml of sample was filled. Only glass stoppered cylinders were used, and were rinse with 1:1 HCl in deionised water before used.
- ✓ The contents of one zinc was added over 5 reagents powder pillow stopper and inverted several times to completely dissolve the powder.
- ✓ The powder must be completely dissolved. The sample should be orange and if it is brown or blue, you must dilute it and repeat the test.
- ✓ A 10-ml of the sample was then measured into a sample cell- the blank. Then, a 0.5ml cyclohexane was added to the remaining solution in the mixing cylinder. Here again, a plastic dropper should not be used as a rubber bulb to avoid contamination of the cyclohexane.
- ✓ The cylinder was stopped, shake vigorously for 20 seconds. Again, the sample at this stage should be red-orange, depending on the zinc concentration.
- ✓ Press: shift time and in 3 minutes, the reaction was begun and during this stage, step 9 below will be completed.
- ✓ When the reaction was in progress, the solution waspoured from the cylinder into the sample cell. As the time beats, the blank was placed into the cell holder, and closed.
- ✓ The "zero" button was pressed and the display showed the zeroing and then 0.00mg/L zinc.
- ✓ The reference sample was placed into the cell holder and the height shield closed.
- ✓ Finally the "Read" button was pressed and the display showed: Reading………….. Then, the result in mg/L of zinc was displayed.

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Experiment V: Aim: To determine the total copper from (0 to 500ml) in a water sample. (The BIO-INORGANIC METHOD – Powder –pillows or Accu Vac – USEPA approved for reporting water analysis).

Procedure:

- ✓ The stored number for copper, Cu, was entered into the bicinchininate powder pillow and then the button labeled "135 Enter" was pressed. The display here showed: dial nm to 560.
- ✓ The wavelength dial was rotated until the small display showed 560 nm (the wavelength, 2). With the correct wavelength dialed, the display showed zero sample, and then mg/L copper Biome.
- ✓ A 10-ml sample cell was entered into the cell compartment, and filled with a 10-ml a sample solution.
- ✓ In order to determine a reagent blank for each new lot of reagent, deionized water was used in place of the sample. The value was then subtracted from each result obtained. The P^H was adjusted before analysis started.
- ✓ The content of one curve/copper reagent powder pillow was added to the sample cell (the preferred sample) and then swirled in order to mix it. A purple color appeared when copper was present or detected.
- ✓ The "shift timer" button was pressed and a two minutes reaction period begun.
- ✓ As the timer beeped, the display showed mg/L Cu^{2+} ion, and a second 10-mL sample cell was filled (the blank) with a 10-mL of sample.
- ✓ The blank was placed into the cell holder and the light shield closed. Then the zero button was pressed and the display showed: zeroing ………………., then 0.00mg/L of Cu^{2+} ion.
- ✓ Within the interval of 30 min when the timer beeped, the prepared sample was placed into the cell holder and the light shield closed.
- ✓ Finally, the "Read' button was pressed and the display showed: Reading…………

The result in mg/L copper was displayed.

The research work was done in laboratory **(Eastern Polytechnic, Kenema**) to determine the total alcohol/ethanol content of five (5) different alcoholic beverages (brands) at the **Punjab Distillery unit** located at the Nyanyawama Community – Kenema City.

APPARATUS/MATERIALS:

- Distillation apparatus (full set)
- Electronic balance
- Thermometer
- Heating/heat source (gas store)
- Measuring cylinder
- Beakers
- Dropper
- Laboratory kits**:** lab coat, hand glove, eye protection goggle etc

REAGENTS:

Five different brands samples of alcoholic beverages manufactured by the Punjab distillery company in Kenema. The table below gives the names of each brand used in the experiment and their respective labels on the containers.

No	**Name of brand**	**Composition**	
		Percent by Volume (%)	**Volume of Container**
A	Best choice	18% vol.	50ml
B	Old n cold	40% vol.	50ml
C	Lemon Twist	43% vol.	50ml
D	Night Train	18% vol.	No Specification
E	Fruit wine	18% vol.	No specification

BASIC ASSUMPTIONS:

Before the experiment was conducted, seven (7) basic assumptions were made in order to keep track of the observations, inference/deductions and any other constraint to be encountered during or after the experiment. These assumptions are as follows:

- That the "main or key intoxicant" of the beverages analyzed is an alcohol, namely ethanol, C_2H_5OH.
- That the boiling temperature of the alcohol is 78.3^oC.

- That the original labels indicated on the containers of each alcoholic beverage by the manufacture are all correct. For example, the brands, best choice, was/is labeled as 50ml (18% vol), assuming that the labeling and, of course, all the others are truly correct.
- That the alcohol itself in the beverages does not undergo any chemical reaction that will destroy it`s intended purposes (its intoxicating power) during distribution to final consumers and it`s long storage in the containers.
- That each of the beverages is heated between 78^{o}C to 80^{o}C, all of the alcohol must be evaporated, leaving behind the non-alcoholic components.
- That change in volume and the change in mass before and after heating process (in assumption 5) correspond to the volume and mass of the alcohol in the beverages.
- That at the end of the exercise/experiment, any deviation suspected from these assumptions will imply that alcohol is NOT the only intoxicant used in the beverages/brands by the manufacturer(s) – when we consider the percentage of alcohol.

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PROCEDURES/METHODS:

(See photos on the next page for experimental set up). The five different brands to be analyzed were all collected/purchased and taken to the laboratory for analysis. Two physical quantities were considered when determining the total alcohol content of each of the brands/beverages**:**

- The volume of the alcohol in each brand;
- The mass of the alcohol in each brand;

For each of the brands, the initial volume **V_1/ml** and the corresponding initial mss**M_1/g** before heating process was measured and recorded. After heating **(between 78^{o}C to 80^{o}C),** the final volume **V_2/ml** and corresponding final mass **m_2/g** were again measured and recorded after allowing enough time for cooling to take place.

THEORY/CALCULATION: Within the limits of experimental error and assuming that the boiling point of alcohol used is **78.3^{o}C,** the two parameters stated above were determined before and after the heating process as follow.

Before heating, i.e. between 78^{o}C and 80^{o}C

Mass of clean and dry empty beaker = **m_1g**

Mass of empty beaker + mass of brand = **m_2g**

:. Mass of brand alone ⟹ **m_3g** = **$m_2g - m_1g$**

Initial volume of brand alone (m1g) = **V_1ml**

After heating, i.e., between 78°C to 80°C

Mass of brand remaining = **m_4g**

:. Change in mass = mss of ethanol = **$\Delta m = (m_3 - m_4)g$**

Volume of brand remaining = **V_2ml**

:. Change in volume = volume of ethanol= **$\Delta V = (V_1 - V_2)$ ml**

CALCULATION:

1. Percent by mass of alcohol = $\frac{\text{change in mass}}{\text{Original mss}} \times \frac{100\%}{1}$

2. Percent by volume of alcohol = $\frac{\text{change in mass}}{\text{Original mss}} \times \frac{100\%}{1}$

Or symbolically

1. % by mass of alcohol $= \frac{\Delta m}{m_3} \times 100\%$

$$= \frac{m_3 - m_4}{m_3} \times 100\%$$

2. % by volume of alcohol $= \frac{\Delta V}{V_1} \times 100\%$

$$= \frac{V_1 - V_2}{V_1} \times 100\%$$

We must have to note here that:

$m_3 > m_4$ and $V_1 > V_2$

The results are tabulated below for each brand/ alcoholic beverage been analyzed.

No	Brand Name	Volume of brand /ml		Mass of brand/ml		Calculated Percentage	
		Initial (V1)	final (V2)	Initial (m3)	final (m4)	By volume(%)	By mass (%)
A	Best choice	40.50	37.50	42.18	39.01	7.41	7.52
B	Old n cold	41.20	37.99	38.90	35.75	7.79	8.10
C	Lemon twist	39.99	36.50	38.75	35.78	8.73	7.66
D	Night Train	50.00	48.50	49.82	48.61	3.00	2.43
E	Fruit wine	50.00	45.00	48.09	43.52	9.00	9.50

PRECAUTIONS:

All the measuring and weighing apparatus were clean and dry before and after measuring of each brand. It was ensured that the heating processes were maintained at temperatures between 78^{o}C and 80^{o}C since the boiling temperature of alcohol (ethanol) is 78.3^{o}C, which is the presumed intoxicant. After each heating process, the contents of the distillation flask (brands) were each allowed to cool before measurement of the final volumes and masses were made. This was to ensure complete evaporation of the alcohol. All the observations, inferences and Measurements were recorded immediately as they were made, to avoid wrong entering of data.

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EXPERIMENTATION:

AIM: Determine of the total alcohol/ethanol content of five (5) different alcoholic beverages (brands) from the Punjab Distillery unit located in Nyanyawama Community – Kenema City.

APPARATUS/MATERIALS:

- Distillation apparatus (full set)
- Electronic balance
- Thermometer
- Heating/heat source (gas store)
- Measuring cylinder
- Beakers
- Dropper
- Laboratory kits: lab coat, hand glove, eye protection goggle etc

REAGENTS:

The reagents used were five different brands (alcoholic beverages) manufactured by the punjob distillery company in Kenema. The table below gives the names of each brand used in the experiment and their respective labels on the containers.

No	Name of brand (on Labelled Container)	Labeling indicated on the container/ composition	
		Percent by Volume (%)	Volume of Container (total)
A	Best choice	18% vol.	50ml
B	Old n cold	40% vol.	50ml
C	Lemon Twist	43% vol.	50ml
D	Night Train	18% vol.	No label indicated
E	Fruit wine	18% vol.	No label indicated

BASIC ASSUMPTIONS:

Before the experiment was conducted, I had to make seven (7) basic assumptions in order to keep track of the observations, inference/deductions and any other constraint to be encountered during or after the experiment. These assumptions are as follow:

1. That the "main or key intoxicant" of the beverages analysed is an alcohol, namely ethanol, C_2H_5OH.
2. That the boiling temperature of the alcohol is 78.3^oC.
3. That the original labels indicated on the containers of each alcoholic beverage by the manufacture are all correct. For example, the brands, best choice, was/is labeled as 50ml ……..18% vol. I assumed that this labeling and, of course, all the others are truly correct.
4. The alcohol itself in the beverages does not undergo any chemical reaction that will destroy it s intended purposes (its intoxicating power) during distribution to final consumers and its long storage in the containers.
5. When each of the beverages is heated between 78^oC to 80^oC, all of the alcohol must be evaporated. Leaving behind the non-alcoholic components.
6. The change in volume and the change in mass before and after heating process (in assumption 5) correspond to the volume and mass of the alcohol in the beverages.
7. At the end of the exercise/experiment, any deviation suspected from these assumptions will imply that alcohol is NOT the only intoxicant used in the beverages/brands by the manufacturer(s) – when we consider the percentage of alcohol.

PROCEDURES/METHODS:

(See photo on the net page for experimental set up). The five different brands to be analysed were all collected/purchased and taken to the laboratory for analysis. I considered two physical quantities when determining the total alcohol content of each of the brands/beverages:

1. The volume of the alcohol in each brand;
2. The mass of the alcohol in each brand;

For each of the brands, the initial volume V_1/ml and the corresponding initial mss M_1/g before heating process was measured and recorded. After heating (between 78^{o}C to 80^{o}C), the final volume V_2/ml and corresponding final mass m_2/g were again measured and recorded after allowing enough time for cooling to take place.

THEORY/CALCULATION:

Within the limits of experimental error and assuming that the boiling point of alcohol used is 78.3^{o}C, the two parameters stated above were determined before and after the heating process as follow.

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Before heating to 78oC and 80oC

Mass of clean and dry empty beaker = m_1g

Mass of empty beaker + mass of brand = m_2g

:. Mass of brand alone ⟹ m_3g = m_2g – m_1g

Initial volume of brand alone (m1g) = V_1ml

After heating between 78^{o}C to 80^{o}C

Mass of brand remaining = m_4g

:. Change in mass = mss of enthanol = $\Delta m = (m_3 - m_4)$g

Volume of brand remaining = V_2ml

:. Change in volume = volume of enthanol = $\Delta V = (V_1 - V_2)$ ml

CALCULATION:

3. Percent by mass of alcohol $= \frac{\text{change in mass}}{\text{Original mss}} \times \frac{100\%}{1}$

4. Percent by volume of alcohol $= \frac{\text{change in mass}}{\text{Original mss}} \times \frac{100\%}{1}$

Or symbolically

3. % by mass of alcohol $= \frac{m}{m_3} \times 100\%$

$$= \frac{m_3 - m_4}{m_3} \times 100\%$$

4. % by volume of alcohol $= \frac{V}{V_1} \times 100\%$

$$= \frac{V_1 - V_2}{V_3} \times 100\%$$

We must have to note here that:

$m_3 > m_4$ and $V_1 > V_2$

The results are tabulated below for each brand or alcoholic beverage been analyzed.

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No	**Brand Name**	**Volume ob brand /ml**		**Mass of brand/ml**		**Calculated Percentage**	
		Initial (V1)	**Initial (V2)**	**Initial (m3)**	**Initial (m4)**	**By volume(%)**	**By mass (%)**
A	Best choice	40.50	37.50	42.18	39.01	7.41	7.52
B	Old n cold	41.20	37.99	38.90	35.75	7.79	8.10
C	Lemon twist	39.99	36.50	38.75	35.78	8.73	7.66
D	Night Train	50.00	48.50	49.82	48.61	3.00	2.43
E	Fruit wine	50.00	45.00	48.09	43.52	9.00	9.50

PRECAUTIONS:

All the measuring and weighing apparatus were clean and dry before and after measuring of each brand. I also ensured that the heating processes were mentained at temperatures between 78^{o}C and 80^{o}C since the boiling temperature of alcohol (ethanol) is 78.3oC, which is the presumed intoxicant. After each heating process, the contents of the distillation flask (brands) were each allowed to cole before measurement of the final volumes and masses were made.

This was to ensure complete evaporation of the alcohol. All the observations, inferences and measurements were recorded immediately as they were made, to avoid wrong entering of data.

ANALYSIS (DISCUSSION) OF EXPERIMENTAL RESULTS: For each of the alcoholic beverages in the plastic containers (i.e. Best choice, Old n cold, and Lemon Twist), the actual labels were all 50ml capacities, as shown in table 1, column 3. The other two brands, that is Night Train and Fruit wine, were in bottle and no labeling of volumes are indicated on them (table 1, column 3). Thus, from my measurements, the contained volumes were 40.50ml, 41.20ml, and 39.99ml for "Best choice", "Old n cold" and "Lemon Twist", respectively. These results gave total deviations of 9.50ml, 8.80ml and 10.01ml respectively for the three alcoholic beverages analyzed. For the other two alcoholic beverages, I only measured 50.00ml from each bottle and analyze it, since they contained more than 50ml capacities. The percentage of alcohol on each of the brands, as labeled by the manufacture, are also shown in table 1, column 2. From my experimental findings, the alcohol content of fruit wine (% by volume alcohol) calculated was 9.00% and % by mass gave 9.50% by mass. This value is half of the value on the labeled bottle which is "18% vol." The other brand, Night train, gave results for the alcohol percentages as 3.00% by volume and 2.43% by mass; which is approximately $^{1}/_{6}{}^{th}$ of that on labeled bottle. The other three brands in plastic containers all gave experimental results that were somewhat closely related or co-correlated, and the ranges were also calculated as shown below, from the formula:

(Percent by volume) - (Percent by mass)= + (Range)

Table 3: Range of values from experimental data

No	Name of Brand	Percent by volume (%)	Percent by mass (%)	+ (Range)
A	Best choice	7.52	7.41	0.11
B	Old n cold	8.10	7.79	0.31
C	Lemon twist	8.73	7.66	1.07
D	Night train	2.43	3.00	0.57
E	Fruit wine	9.50	9.00	0.50

Night train, D for example, is a very heavy alcoholic beverage – it has high intoxicating power. But my experimental results showed that it has very small percent by volume alcohol = 2.43% and percent by mass alcohol = 3.00%. The labeling on the bottle of Night Train = "18% vol." But why is it that the beverage has high intoxicating effect? There are two alcoholic beverages with 40% vol. and 43% vol. of alcohol, namely Old n cold and Lemon twist respectively. The table 3 above gives almost approximately the same average value for the two beverages of = 8%. This value is not much different from Best choice with label "18% vol." Thus the labeling on the two beverages B and C are questionable. Overall, there are very wide gaps amongst experimentally determined percentages and

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those on the labeled containers. However, the very closed – correlations amongst the experimental values will probably and most possibly mean that the labeling on the containers are not correct, and therefore, something else might be the chief cause.

ANALYSIS OF EXPERIMENTAL RESULTS:

Table 1:

No	Name of brand	Composition	
		Percent by Volume (%)	**Volume of Container**
A	Best choice	18% vol.	50ml
B	Old n cold	40% vol.	50ml
C	Lemon Twist	43% vol.	50ml
D	Night Train	18% vol.	No Specification
E	Fruit wine	18% vol.	No specification

From the above table, it was observed that for each of the alcoholic beverages in the plastic containers **(i.e. Best choice, Old n cold, and Lemon Twist)**, the actual labels were all 50ml capacities. The other two brands, that is, **Night Train and Fruit wine**, were in bottle and no labeling of volumes indicated (no specification).Thus, from measurements, the content volumes were **40.50ml, 41.20ml, and 39.99ml** for "Best choice", "Old n cold" and "Lemon Twist", respectively. These results gave total deviations of **9.50ml, 8.80ml** and **10.01ml** respectively for the three alcoholic beverages analyzed. For the other two alcoholic beverages, a measurement of 50.00ml for each bottle was analyzed, since they contained more than 50ml capacities. The percentages of alcohol on each of the brands, as labeled by the manufacturer, were also shown in table 1. From the experimental findings, the alcohol content of fruit wine **(% by volume alcohol)** calculated was **9.00%** and % by mass gave **9.50%** by mass. This value is half of the value on the labeled bottle which is**"18% vol**." The other brand, Night train, gave results for the alcohol percentages as **3.00%** by volume and **2.43%** by mass; which is approximately $^{1}/_{6}{}^{th}$ of that on labeled bottle. The other **three brands** in plastic containers all gave experimental results that were somewhat closely related or correlated, and the ranges were also calculated as shown below, from the formula:

(Percent by volume) - (Percent by mass) = + or - (Range)

Table 2: Range of values from experimental data

No	Name of Brand	Percent by volume (%)	Percent by mass (%)	+ 0r -(Range)

A	Best choice	7.52	7.41	0.11
B	Old n cold	8.10	7.79	0.31
C	Lemon twist	8.73	7.66	1.07
D	Night train	2.43	3.00	0.57
E	Fruit wine	9.50	9.00	0.50

Night train, D for example, is a very heavy alcoholic beverage – it has high intoxicating power. But experimental results showed that it has very small percent by volume alcohol = **2.43%** and percent by mass alcohol = **3.00%.** The labeling on the bottle of Night Train = **"18% vol."** But why is it that the beverage has high intoxicating effect? There are two alcoholic beverages with **40% vol. and 43% vol.** of alcohol, namely Old n cold and Lemon twist respectively. The table 2 above gives almost approximately the same average value for the two beverages of = **8%.** This value is not much different from Best choice with label **"18% vol."** Thus the labeling on the two beverages **B and C** are questionable. Overall, there are very wide gaps amongst experimentally determined percentages and those on the labeled containers. However, the very closed – correlations amongst the experimental values will probably and most possibly mean that the labeling on the containers are not correct, and therefore, something else might be the chief cause and requires further findings.

WATER SAMPLES COLLECTED AT DIFFERENT POINTS WITHIN THE COMMUNITY.

SAMPLE P^H

The samples collected at the various sites were acidic with $P^{\mathbf{H}}$ values below six. These P^H value has the ability of increasing any metal ions present in the drinking water system and as such do not possess most of the qualities of drinking water. According to **Brandy (2000),** certain metals such as Cu, Mn, Zn, and Ni are definitely affected by P^H. The World Health Organization range of P^H for drinking water is between 6.5 to 8.5.from the results; all samples were acidic as a result of pollutants from the factory.

Table 2: shows the results of P^H readings at the various sites in water samples collected.

SAMPLE POINTS	P^H VALUES
a	**5.50**
b	**5.70**

C	**5.80**
D	**5.50**
E	**5.45**

CALCIUM IONS (Ca^{2+}) DETERMINATION IN WATER SAMPLE.

The values obtained for samples **b, c, d** and **e** were very high and that obtained for **sample a** very low. The presence of high quality of calcium in the drinking water sources at B, C, D and E indicates that the water sources are hard for drinking purposes. According to **Dominic,(1972),** the high levels does not indicates that calcium is coming from anthropogenic sources. There is a strong correlation existing between calcium and magnesium results at the various sites under investigation. Calcium is also base status mineral like that of magnesium and expected to be low in acidic water. Calcium contributes to the water hardness with bicarbonate forming temporal and permanent hardness.

Table 3 :

SAMPLE POINTS	$[Ca^{2+}]$ (mg/l)
a	2
B	20
C	35
D	48
E	38

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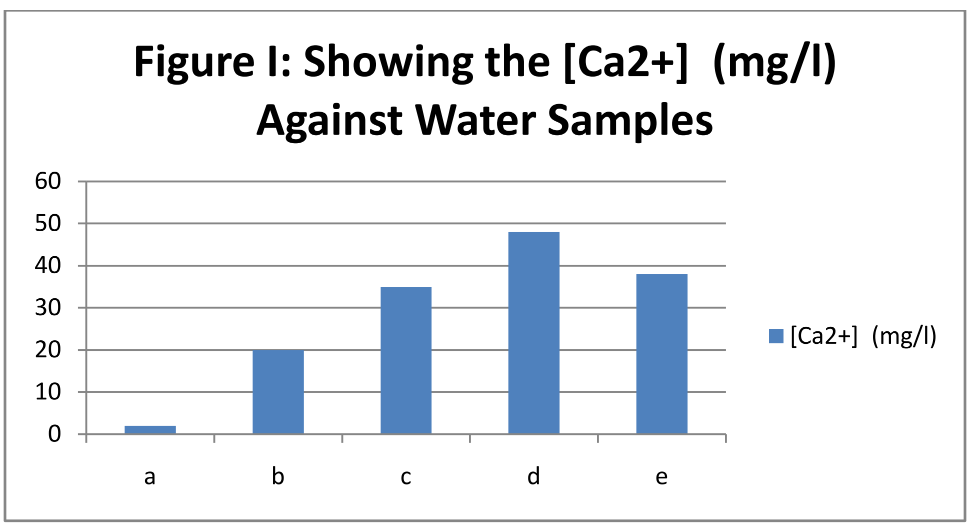

WHO GUIDELINES STANDARD FOR CLASSIFICATION OF EXCHANGEABLE CALCIUM

CLASS	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
Exchangeable Calcium (mol/kg)	< 0.5	0.5 – 2.0	2.0 – 4.0	4.0 – 6.0	> 6.0

DETERMINATION OF EXCHAGEABLE ACIDITY OF HYDROGEN AND ALUMINIUM The data obtained for **samples that** were extremely high as compared to the world health organization standards which are 0.2mg/l. The results obtained using 0.02MNaOH shows that high quantity of aluminum was present and when 0.02MHCl was used, there were no traces of aluminum and hydrogen present in the samples. The lack of exchangeable aluminum in the samples was as a result of lack of alum (aluminum sulphate in the drinking water sources).

Table 4.

SAMPLE POINTS	$[Al^{3+}]$ and $[H^{+}]$ (mg/l)
A	0.82
B	0.78
C	0.94
D	0.92
E	0.80

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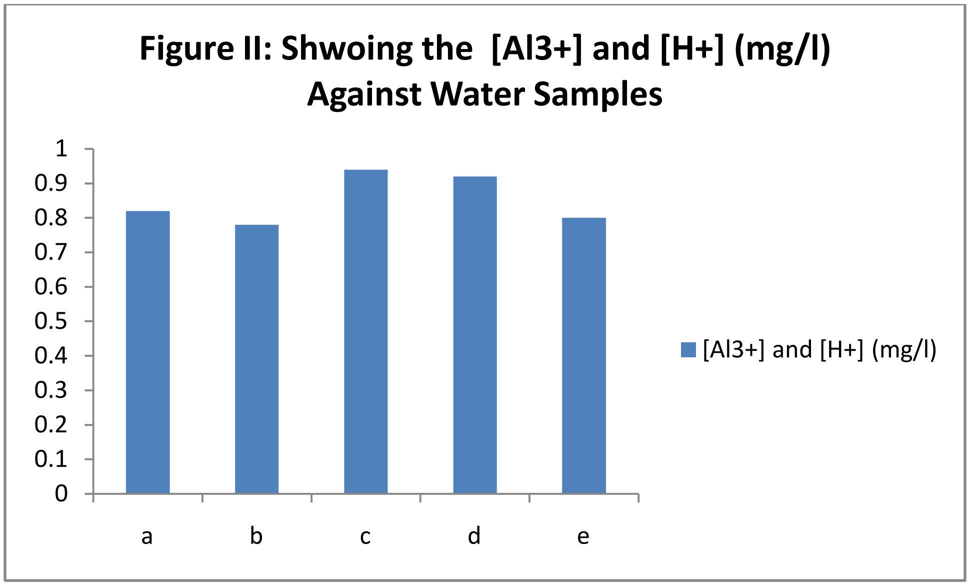
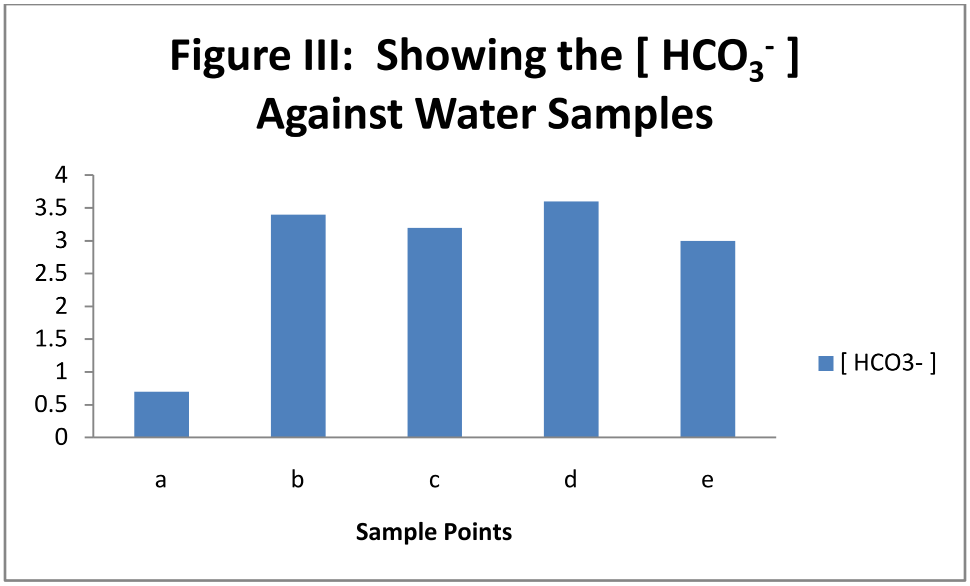


DETERMINATION OF CARBONATE AND BICARBONATE IN THE WATER SOURCES

The results obtained for bicarbonate in four of the water sources, that is**, b, c, d** and **e** were extremely high and in fact not within the world health organization guideline values. The high values of HCO_3^- in the water samples tend to maintain the P^H value 6.5 to 8.5 and this shows buffer effects.

The sample point **a** has low bicarbonate concentration. Because of low HCO_3^- concentration, there is no buffering effects and contributes to the low P^H value. At low P^H, the bicarbonate is converted to carbon dioxide which dissolves in portable water to form carbonic acid **(Amodixyl et al, 1991).**

SAMPLE POINTS	[HCO_3^-]
a	**0.7**
b	**3.4**
c	**3.2**
d	**3.6**
e	**3.0**



DETERMINATION OF CHLORIDE IONS CONCENTRATION IN WATER SAMPLE

The results obtained for **a**, **b, c, d** and **e** are extremely high in the water samples as compared to the World Health Organization guideline values (1984 and 1993), that is, 250mg/l. the high level of chloride ions in the water sources was as a result of the industrial waste from Punjab and the few agricultural practices carried within the community under investigation. The seepage of industrial waste from the factory can result in to contamination of the portable water sources within the water sources closer to the factory.

SAMPLE POINTS	[Cl-] (mg/l)
a	75
b	82
c	90
d	78
e	85

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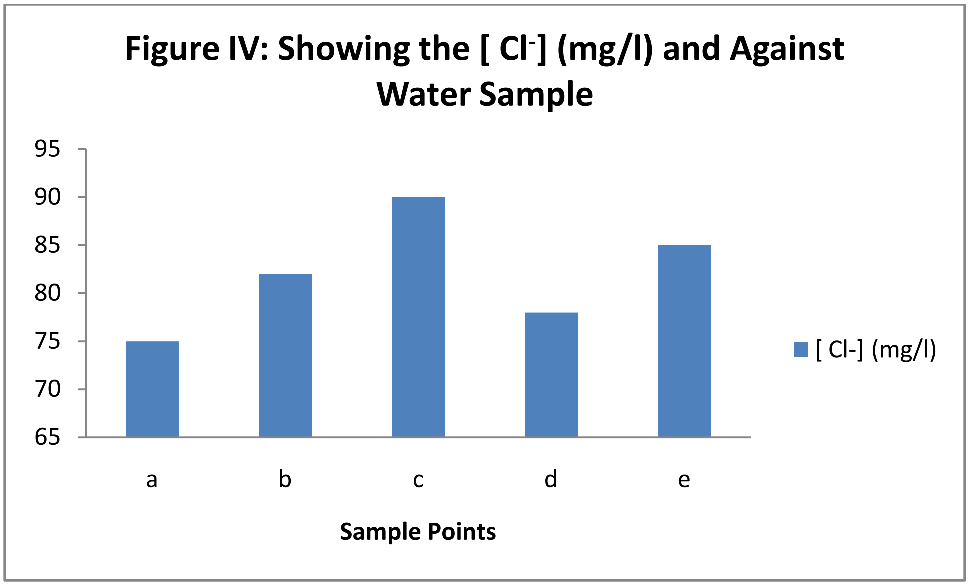

CONCLUSION AND RECOMMENDATION

CONCLUSION:

Before conclusion(s), the basic assumptions/hypotheses stated earlier were considered for any agreement or disagreement between the experimental results and the manufacturing results.

- ✓ **Assumption 1** says that the main or key intoxicating species in the alcoholic beverages analyzed must be an alcohol, ethanol, C_2H_5OH. Thus if this is true, then there should have been agreement amongst experimental results and manufacturing results. This point can even be turned round to be wrong because even the 50ml labels on the plastic containers were all wrong or not correct. So assumption 1 does not hold. This same argument can be technically applied to **assumptions numbers 2 and 3**.

- ✓ **For assumption 4,** the alcohol performs its best functions or intended purposes if, and only if, it does not react to produce product(s) that will destroy its normal functions. If any chemical reaction occurs, then the volume and hence the concentration of the alcohol will decrease. Because the rate of a chemical reaction is a time – dependent quantity, then concentration or volume of the alcohol must have been decrease with the long time of storage and distribution. Thus ,if this assumption makes sense, then the beverages are chemically not fit for consumption by humans because the nature of the product(s) formed is yet unknown.
- ✓ **The final assumption 7** is the most justifiable because there are complete or total deviations amongst the experimental readings and those provided by the manufacturer(s).

But turning the table round, the data from the experiment are indications of some amount of precision (of experimental data). It can finally be concluded that**:**

- The manufacturer **(the Punjab distillery company),** located in Kenema, have provided wrong labeling of their products, especially those in plastic containers.
- The key or main intoxicating substances in the alcoholic beverages produced by the Punjab Distillery Company (in Kenema) is or are not **only alcohol or ethanol** but there must be other chemical substance(s) which provides intoxicating effects other than alcohol.
- The chemical with this intoxicating effect must have boiling temperature greater than that of ethanol and also its density must be greater than alcohol which gives the greater intoxicating effect, and may be chemically questionable for consumption purposes.

RECOMMENDATIONS:

The following recommendations as an **URGE** from the experimental findings to the ministry of health and sanitation and to any of the authorities or stakeholders who receive and goes through this work:

- That the Punjab distillery company should stop its operations or stop the production activities until more sophisticated experimental results are achieved.
- That there should be trained and qualified chemists or analytical chemists to investigate composition of the beverages and subsequently identify the **"key intoxicating" species predicted in the conclusions'.**
- That the company has to be fined, or charges should be levied on it for cheating people because of wrong labeling of their containers being sold to retailers and consumers.
- That the ministry of health and sanitation should make or construct **by-laws** that will enforce the regular visiting of those distillery units within the country, by specialized analytical chemists. This will help rescue the fate of the future generation.
- That any other analytical method to access the safeness of the alcoholic beverages manufactured by the Punjab distillery company should be put in place with immediately effect so as to avert any further problem in the future.

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