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Physico-Chemical Analysis of Locally Brewed Gin - Ogogoro

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Abstract: ***The consumption of Nigeria's locally brewed gin has long been part of the cultural fabric of its society. Howbeit, there has been no contemporary investigation on its content, production process and associated safety. The objective of this study is to investigate the production of locally brewed gin, identify and quantify its constituents. To accomplish this, a quantitative laboratory analysis of samples from 3 sources was undertaken. Analytical methods include use of spectrophotometry for nitrates, trimetric method for chloride, pyonometer for impurities water and alcohol. It was found that that local dry gin (Ogogoro) has a high alcoholic content as evidenced by values of up to 91%, varying amounts of additives nitrates copper, chloride and lead. It also found that the production process involves extraction of resource material call palm sap, fermentation and repeated distillation using an improvised distillery. It is recommended that Nigeria government and other regulatory agencies such as the National Agency for Food and Drug Administration and Control (NAFDAC) should collaborate and build the capacity of local distillers to improve the production process, quality and safety of Ogogoro.***

Keywords: local dry gin, Ogogoro, palm wine, alcohol

1. Introduction

The term local dry gin has other nomenclatures with which they are known across several locations in Nigeria and other places where they are being consumed as an alcoholic beverage derived from the distillation of the fermented sap of Raphia palms (Raphia hookeri), oil palm (Elaeis guinesis), and coconut palm (cocus-nucifera) [1, 2]. For instance, it is commonly known as "kaikai" or "ogogoro" in most locations in Nigeria; in some other locations, it has been given nicknames like "akpeteshie, push me I push you, Sapele water, wuru, kparaga, ufofob, baba-erin, eyinbogo, robirobi among others" [1, 2]. In Nigeria, local dry gin is gotten by distillation of juice from raphia palm tree. It is observed that the local fermentation "involves the incision of the trunk of the tree with the juice collected in a gourd placed by the trunk of the tree after 1-2 days followed by its extraction and boiling of the sap thus forming steam which is condensed and subsequently collected for consumption" [1]. Also, it is observed in some studies that local dry gin contains ethanol as one of the major ingredients which scales between at above 30% but below 60% as produced by local brewers; thus, increasing the adverse toxic effect of its consumption to human health; thus, it can be said that its consumption leads to intoxication and neurotoxicity, especially when its consumption is at a high volume [3]. According to Obot [1, 2, 4], local dry gin which is popularly known in Nigeria as Kaikai or Ogogoro is usually brewed by way of fermentation and distillation. The product is a household name in Nigeria, as it is referred in diverse names not limited to Kaikai, Akpeteshi, Sapele water or push-me-I push-you, among others. In the process of production, it is distilled from palm wine and locally brewed through a process of fermentation and distillation. Amongst the local brewers, the addition of diverse forms of toxic additives has become common over the years. It is observed that usually, the additives added to the contents by the brewers are the causes of the toxicity present in local dry gin [5]. It need not be argued extensively, that brewing of local dry gin, especially small-scale production, has become one of the major sources of income for various households in Nigeria. Thus, owing to the facts that most of the brewers are concerned about the profits to be made and not necessarily the health implications, and owing to the rate of illiteracy of producers; the toxicological constituents of the local dry gin are not well monitored and brewed in a state of health consciousness [2].It's been reported that ethanol, Iso-propanol, n-butanol and n-propanol are present in local dry gin as discovered using gas chromatography [2]. The presence of methanol in different samples of local dry gin could be attributed to the pathways of the microorganisms in the substrate (palm wine). Its presence as a metabolic product of fermentation explains the speculation that it would be the possible cause of blindness among drinkers of local dry gin since it affects the optic nerves. Other compounds (congeners) such as acetone, acetaldehyde, ester and ethyl acetate were also found to be in very high percentage in the local dry gin architecture of the pancreas [6, 7, 8, 9, 10, 11]. The constituents of Ogogoro has been largely unmentioned in many local and international scientific studies, hence this study has set out to unveil the respective constituents. The aim of this study is to identify and quantify the constituents and put in perspective the fermentation process of Nigeria brewed local gin call Ogogoro.

2. Materials and Method

A combined qualitative and quantitative analytical research methods which involved participatory field observation, sampling and laboratory analysis of local gin samples from three states (Delta, Rivers and Bayelsa) in Nigeria.

Study area

The study was carried out in three core states of the Niger Delta area of Nigeria. These states were chosen since brewing of local gin is common in these areas as evidenced by plethora of brewing settlements, camps and villages all over the coastal line of the states. Besides, the raw materials needed is commoner in these areas as there is a rich reserve of palm trees plantation including raphia palm (Raphia hookeri *or* R. vinifera) and the oil palm (Elaeis guineense).

Field visits

Field visits were undertaken to 3brewing centres and 8 retail outlets in Bayelsa, Rivers and Delta state to sift the methods employed in the production and to investigate whether additives of toxicological relevance were used in the course of production and retailing. This was achieved through participatory observation. Samples of kaikai were collected from popular retail outlets in Delta, Bayelsa and Rivers states using non-reactive laboratory bottle containers. These were sent to FUGRO industrial laboratory Port Harcourt in Nigeria for analysis.

Laboratory analysis of local gin samples

500 millilitresof kaikaiwas collected in each state of Rivers (Port Harcourt), Bayelsa, (Opukushi) and Delta (Warri) using non-reactive laboratory bottles and sent for laboratory analysis, where methods in tandem with international analytical procedures were used to analyse the contents.

- **Alcohol and Water:** Alcohol and water content was determined using the 'Pyonometer method'. This is in accordance with the Association of Official Analytical Chemists official method 942.06 which involves the use of dry and wet Pyonometer, Liebig condenser, distillation flask, glass bead, and a heating chamber. This method was accomplished by distillation process.
- **Impurities**: This was carried out using the 'Pyonometer method' in accordance with the Association of Official Analytical Chemists official method 942.06. This method was accomplished using the evaporation and estimation process.
- **Nitrates**: Nitrate was determined by carrying out 'Spectrophotometry' on all samples. This was in accordance with the Environmental Protection Agency method 352.1.
- **Chloride:** Chloride was determined using the 'Trimetric method' in accordance with the Association of Official Analytical Chemists official method 966.09. This method was accomplished using distillation process.
- **Copper:** Copper was determined by using 'Atomic Absorption Spectrophotometric method' in accordance with the Association of Official Analytical Chemists official method 967.08.

3. Findings

Sample Analysis

Analysis of samples yielded:89.2%, 78.9%, 91% of alcohol in each sample from Bayelsa, Delta, and Rivers state respectively while on extrapolation yielded 892, 000; 789, 000; and 910, 000 in mg/l; 9.48%, 17.9%, 7.35% of water in each sample from Bayelsa, Delta, and Rivers state respectively; 40.0 mg/l, 2.00mg/l, 4.00mg/l of impurities in each sample from Bayelsa, Delta, and Rivers state respectively; 0.13 mg/l, 0.17 mg/l, 0.14 mg/l of nitrates in each sample from Bayelsa, Delta, Rivers state respectively; 7.5 mg/l, 18.1mg/l, and 3.74mg/l of chloridein each sample from Bayelsa, Delta, Rivers state respectively; and 10.7 mg/l, 1.27mg/l, less than 0.05 mg/l of copper in each sample from Bayelsa, Delta, and Rivers state respectively (see Table 1 for details).

Table 1: Constituents of Analysed local gin

Parameter	Method	Result		
		Bayelsa (Opukushi)	Delta (Warri)	Rivers (Rumuji)
Alcohol content (%)	AOAC 942.06	89.2	78.9	91.0
Alcohol content (mg/dl)	AOAC 942.06	892, 000	789, 000	910, 000
Water content (%)	AOAC 942.06	9.48	17.9	7.35
Impurities as suspended particles (mg/l)	AOAC 940.99	40.0	2.00	4.00
Nitrates (mg/l)	EPA 352.1	0.13	0.17	0.15
Chloride (mg/l/)	AOAC 966.09	17.5	18.1	3.74
Copper (mg/l)	AOAC 967.08	10.7	1.27	⟨ 0.05

Table 4: Analysis of samples

The participatory observation revealed that after local fermentation and distillation, the product is usually a clear liquid that possesses an alcoholic content rate of more than 30% and in most products, reaches 60%. Local dry gin is contained in large rubber storage containers; from whence, they are dispensed to retailers across the country outlet.

Field Visit: Participatory observations and interviews at brewing centres and drinking outlets revealed that the sequence of production of Ogogoro entails collection of Sap from the palm tree, followed by fermentation of the palm sap which gives yield to palm wine. Ogogoro is then produced by the distillation of the fermented palm wine through a process of heating and condensation of vapour into a liquid which is initially bluish in colour. Beside the usual production processes of fermentation and distillation, certain additives were added to enhance the taste, colour, flavour and appeal. The additives include soap which were locally produced from plantain ash and palm oil; detergent that gives the foam or lather, since foaming gin is often associated with high quality, potash, native chalk. At the retail outlet the gin retailers also adulterate the product with other additives; some adds different types of herbs, dried roots, dried leaves, bark of different trees, unknown drugs with unknown expiry dates. These drugs are usually gotten from the medicine store. A major and recurring discovery in the brewing centres and retail outlet was the poor hygienic conditions under which the gin was fermented, distilled, packaged, sold and consumed.

Collection of palm sap: The palm sap is the initial raw material used in the production process derived from the Palm tree. Two main species of Palm tree, Elaeis guineensis and Raphia hookeri, are tapped in Nigeria. The specie of Palm tree commonly used to produce palm wine is the

Elaeisguineensis. The sap is collected from a growing palm by tapping the palm tree. This entails making a well-defined, groove cut in the bark of the palm, from the top of the trunk downwards. A locally improvised, open conduit is tied to the end of the engraved groove in the palm bark which allows the collection of the sap as it oozes out of the palm's bark, this runs through the open conduit and trickles down to a collector Can that is emptied every 1-2 days into Jerry Cans. This palm juice or sap is a clear, sweet and colorless juice containing sugar. The sap is collected each day and should be consumed within few hours of collection or processes further for Ogogoro through fermentation.

Fermentation: Sap fermentation process is an alcoholic fermentation of the sugars in the sap to produce alcohol and carbon dioxide gas. After collection it undergoes a rapid natural fermentation to produce palm-wine (alcohol). This often occurs by a natural process, which is occasioned by the presence of microorganisms which may have been attracted to the sap due to the significant sugar content of the juice and exposure leading to unconscious contamination by a cocktail of microorganism. It is these microorganisms that act on the sap to produce palm-wine. Fermentation starts soon after the sap is collected and within an hour or two becomes reasonably high in alcohol. If allowed to continue to ferment for more than a day, it starts turning into vinegar. Sap constitutes a good growth medium for numerous micro-organisms especially for yeast, lactic and acetic acid bacteria. The natural fermentation process of the sap produced in most Nigeria camps are privileged by gross unsanitary conditions surrounding the sap collection points which are often characterized by a beehive of flies. Palm wine contains nutritionally important components including amino acids, proteins, vitamins and sugars. These make this wine a veritable medium for the growth of a consortium of microorganisms, whose growth in turn, change the physicochemical conditions of the wine, giving rise to competition and successions of organisms.

Distillation: This was achieved through the use of locally fabricated distillation unit commonly found in the distillerie camps. This unit consist of a horizontal or vertical drum placed over a heat source with a lead pipe passing from the upper part of one side through a cooling chamber that is filled with water to a dripping or collection point. The process involves pouring an estimated amount of the palm wine (see figure 1) into the heating chamber (large drum) and heated to a high temperature (see figure 2).

Figure 1: Palm wine poured into the heating chamber for evaporation by heating

Figure 2: Heating chamber made of horizontally positioned drum place over a heating source

This will lead to evaporation of the palm wine which will move out of the heating chamber by conventional current through the lead pipe. While inside the lead pipe the gaseous substance will condense to form a liquid by virtue of the cooling effect of the surrounding deluge of water within a sealed wooden containment (see Figure 3).

Figure 3: Cooling chamber made of locally fabricated large bowl of water through which the lead pipe passes to a dripping point.

The initial condensed liquid substance is usually bluish in colour which would drip from the tip of the lead pipe into a collection container (see figure 4).

Figure 4: Dripping or collection point showing the condensed alcohol vapour

This liquid contains a high and dangerous content of ethanol and impurities from the lead pipe. It is hazardous and not usually consumed often referred to as 'ATAKARA' in Ijaw extraction. This condensed liquid re-heated severally by pouring into the heating chamber and heated to a high temperature; it will undergo evaporation and condensation process to yield a clear liquid, although with a tint of blue colour. This is re-poured into the heating chamber and heated for 30 minutes to yield a crystal-clear colourless liquid referred to as 'kaikai'. This is fit for consumption hence it is retailed as a local brew. The beverage is then poured in large rubber storage containers (see Figure 5); from whence, they are dispensed to retailers across the country outlet.

Figure 5: A typical brewing unit along the coastal areas of Bayelsa State with rubber containments

The sample of Ogogoro collected from Opukushi in Bayelsa was brown in colour with widely distributed dark precipitations and strong odour; the sample from Rumuji in Rivers state was colourless, had white suspended particles with no alcohol smell, the sample from Warri, Delta possessed alcohol odour but with clear and mild brownish colour.

4. Discussion

This study revealed alcohol content of 89.2%, 78.95 and 91.0% from Bayelsa, Delta and Rivers states of Nigeria respectively. Never in any literature was an alcohol content of 89.2%, 78.95 and 91.0% reported [2, 7]. Uguru-Okorie *et al* reported Ogogoro as ethanol and a suitable fuel for internal combustion engines with 30% - 60% alcohol as content [11].This was a landmark discovery; and this level of alcohol is capable of inflicting severe health consequences including death. In addition, a major and recurring discovery in the brewing centres and retail outlet was the poor hygienic conditions under which the gin was fermented, distilled, packaged, sold and consumed. The poor hygienic status has the potential to harbour microorganisms that could inflict food poison. Relatedly, in 2008, the National Agency for Food and Drug Administration and Control (NAFDAC) of Nigeria, reported that their laboratory analysis indicated Ogogoro contained high concentrations of methanol in excess of 20g/100l and contaminants which include toluene and benzene and these chemicals can cause severe organ damage [2, 7, 9].Idonije & Festus, et al., observed that methanol, Iso-propanol, n-butanol and n-propanol are present in local dry gin; that was observed by way of gas chromatography [2, 8, 10, 12, 13, 14, 15]. He further observed that the presence of methanol in different samples of local dry gin could be attributed to the pathways of the microorganisms in the substrate (palm wine).

Alcohol containing steam generated from the 'heating chamber' usually follows a conventional pattern by flowing through a lead pipe that would pass through a chamber filled with water to achieve condensation of alcohol steam. It is presumed that local reaction often occurs between the hot alcohol steam and the lead pipe with resultant lead oxide being generated in addition to the local gin. When consume this has an insidious capability of causing toxicological effects to humans. In addition to the additives at the distillery, gin retailers at the sale outlets also adulterate the gin with other additives; some adds different types of herbs, dried roots, dried leaves, bark of different trees, unknown drugs with unknown expiry dates. In 2007, Obiora et al in a study reported that one of the samples of the home brew he analysed contained an unknown additive and was being sold as an 'antimalarial'. One of the authors (O.E.) who lives in Nigeria claims that this is a common practice. Malaria is endemic in Nigeria and use of these home brews as 'antimalarials' can have public health consequences because it can deter individuals from getting proper treatment for this debilitating condition. Further investigation of these additives is needed [15]. Metallic constituents of varying amount had been reported in samples of Ogogoro from Southern Nigeria. These metals include cadmium, lead, nickel, copper, iron, magnesium, potassium and sodium. However, the mean value of the metallic constituents was found to be below the statutory limits for metals in alcoholic beverages [16, 17].

5. Conclusion

From this study it is ascertained that local dry gin contains substances and constituents of toxicological relevance that has the potential to inflict health impacts. It is therefore important that local gin consumption should be viewed as flash point for negative public health issues; hence implementation of recommendations stated below would protect the public. Although, some of the discoveries in this study include high content of alcohol, presence of impurities and use of toxic additives in the brewing process; these can be scientifically modified to a safe level when armed with the necessary brewing skills and knowledge. For long, the regulating agencies have towed a lopsided path of invoking consequence management on brewers of the local gin also dubbed as "illicit drink" by them; it is noteworthy that the substandard context of local gin production is mainly driven by economic quest for survival. On this note, the production and adulteration with its implications as unveiled in this study would be unabated. In this regards, it will be preferred if the regulating agencies would adopt a capacity building campaign for locals interested in the production of local gin on safe brewing methods, application of quality assurance and quality control, business ethics, simple methods of sampling and analysis of products, safe content modification technique, hygiene, acceptable local gin constituent formulary and provide laboratory services for brewers to analyse their products before wholesale. Additionally, further studies will be required to explore and present the impact of this local gin on animal models to gain idea of what it will look like in human health.

6. Conflicts of Interest

The author declares no conflicts of interest.

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