Production Techniques and Quality Evaluation of Distilled Alcoholic Beverages (Rum Spirits) in Onitsha Metropolis of Anambra State, Nigeria

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Received:- 06 August 2021/ Revised:- 13 August 2021/ Accepted:- 21 August 2021/ Published: 31-08-2021

Abstract— *Evaluation of production techniques and quality of rum distilled alcoholic beverages (Rum spirits) sold in Onitsha metropolis, Anambra State, Nigeria was carried out using survey and laboratory studies. Rum distilled alcoholic beverage brands investigated included Nigerian and foreign makes. Nigerian made rums evaluated included DCL, SBD, S5BD, PBC, BWR, CBD and foreign made rums included KSCR, ELR, IVGR and GMCR. Field studies involved administration of questionnaires to the sellers of spirit alcoholic beverages in only three markets in Onitsha metropolis namely Ose-Okwodu, Relief and bridge Head markets that were purposely sampled for this study. Questions asked the sellers of distilled alcoholic beverages included names, background, and status of respondents and physicochemical characteristics of the products. There were also laboratory production of rum spirit beverage (LBC) based on survey studies and findings from producers. The laboratory produced and market samples were analyzed for physicochemical and organoleptic attributes. The mean and standard deviation of the data obtained were presented in tables whereas the statistical differences of the obtained data were determined by ANOVA ($P < 0.05$) using SPSS 22. The significant means were compared using Fisher's Least Significant Difference (LSD). The alcohol content, pH, titratable acidity, specific gravity, total solids, suspended solids and dissolved solids contents of the eleven rum spirit brands ranged from 42% to 50% and average of 47%, pH3.3- 5.1 (average pH value of 3.7), 011 to 4.5 (average value of 0.74), 0.87-0.99 and average value of 0.94, 3.03 to 32.18 (average of 8.45), 1.19 and 12.31(average of 6.08) and 1.53to 18.05 (average of 6.38) respectively. The consumer acceptance and preference evaluation of the rum spirit brands using 10 panelists and 9-point Hedonic scale revealed sensory scores of 3.70-6.40, 2.50-6.80, 3.20- 6.70, 2.60-6.70 and 3.30-6.60on colour, taste, aroma, mouth feel and general acceptance respectively.*

Keywords— Distilled Alcoholic Beverages, Rum Spirits, Anambra State.

I. INTRODUCTION

Alcoholic beverages have been prepared and consumed by mankind since ancient times in most of the world's culture (1; 2; 3; 4; 5).The forms of alcoholic beverages consumed in various regions of the world vary considerably in accordance to location and ingredients. But in many developing countries, various types of homemade or locally produced alcoholic beverages such as sorghum beer, palm wine or sugarcane sprits continue to be the main available beverage types (6).The global alcoholic drink industry exceeded USA $1 trillion in 2014 (7). Alcoholic drinks are most widely used recreational drugs in the world with about 33% of people being current drinkers (8). Furthermore, it was reported that alcoholic beverage production serves some nutritional, psychological, religious and social functions (9).

Alcoholic beverages are drinks that include wine of different sources; spirits such as brandy, whisky, gin, rum; and beer that contain ethanol, a type of alcohol produced by fermentation of grains, fruits or other sources of sugar (10). Depending on their alcoholic contents, Alexis, (11) reported that unsweetened, distilled alcoholic drinks that have alcoholic content of at least 20%Alcohol By Volume (ABV) are called spirits and that they include large variety of liquor produced with distillation process such as whiskey, Brandy, Gin, Vodka, Tequila, Rum, etc.

In general, spirits are liquids of high alcoholic contents which are obtained by distillation from such fermentable materials distilled to a point where they are purified yet still retain sufficient by-products to impart the particular characteristics of the original base material (12; 13;14). (15) Portrays distilled alcoholic beverages as being produced by distilling ethanol through fermentation of grains, fruits, vegetables, sugarcane juice, molasses, fermented mash of cereals and potatoes as well as fermented malt of barley and rye with alcohol content ranging between 40 and 60%. They further reported that the main ingredients for these beverages are water and ethanol and they account for all of 99% of the total content of the spirit beverages which range between 40 and 60% (9).

Rum is a distilled alcoholic beverage made from fermented sugar cane juice, sugar cane syrup or molasses (16). Most rums are produced from sugar cane molasses although as allied product cachaca is produced in Brazil from sugar cane juices (17;18). In Australia, rum is defined as a portable alcohol distillate from fermentation which unless otherwise required by this standard, contains at least 37% alcohol by volume, produced by distillation of fermented liqueur derived from food source so as to have the taste, aroma, and other characteristics generally attributable to rum (19).

In the U.S.A., rum is an alcoholic distillate from the fermented juice of sugar cane, sugar can syrup, sugar cane molasses, or other sugar cane by-products, produced at less than 190^{o} Proof in such manner that the distillate possesses the taste, aroma and characteristics generally attributed to rum and bottled at not less than 80^{0} Proof and also includes mixtures solely of such distillates (20). Elsewhere, European definition of rum portrays rum as a spirit drink produced exclusively by alcohol fermentation and distillation, either from molasses or syrup produced in the manufacture of sugar cane juice itself and distilled at less than 96% v/v, so that the distillate has discernible specific organoleptic attributes of rum; has the aromatic characteristic specific to rum and a content of volatile substances equal to or exceeding 225ghl-1 of alcohol of 100% v/v (2250 parts per million). It is bottled at minimum alcohol strength of 37.5% v/v (21).

The distinguishing features of rum from other spirits included its composition of higher quantity of caramel (0.6mls/litre), sweetener up to 9.6mls/litre sugar syrup and rum / coffee flavor that give the product discernible specific organoleptic characteristic of rum. The minimum alcoholic content of rum is 37.5% (22). Rum has different grades and colours such as gold rum, white rum, dark/ black rum and premium rum. Gin distilled spirit drink is colourless and flavoured with juniper berries. London dry gin may not contain added sweetening not exceeding 0.1g of sugar per litre of the final product nor colourants, nor any added ingredients other than water. The term 'London gin' is used interchangeably with dry gin. Gin has alcoholic strength of 37.0%ABV (22). Gin is termed "London dry gin" if it does not contain any sweetening agents (23).Whisky is bottled at not less than 40% ABV (80Proof). It contains caramel for colour enhancement and whisky flavor. Brandy contains caramel colouring, brandy flavor and bottled at not less than 36.0.% ABV(22).Brandy is a liquour produced by distilling wine which generally contains minimum of 36.0% alcohol by volume (22) and typically consumed as an after dinner digestive. Some brandies are coloured with caramel colouring to imitate the effect of aging while some are produced using combination of both aging and colouring. Vodka is a distilled beverage composed primarily of water and ethanol but sometimes with traces of impurities and flavourings. Flavoured Vodka is vodka with minimum alcoholic strength of 37.5%which has been sweetened, blended, flavoured with a predominant flavor other than that of the raw materials and matured or coloured (22).

NAFDAC Standard for rum include; 37.5%v/v minimum alcohol content, methyl alcohol(2ppm maximum), aldehydes (as acetaldehyde) 40ppm maximum, furfural (20ppm maximum), higher alcohol (50ppm maximum), total acidity (100ppm maximum), ethyl carbamate (0.015ppm maximum), ester (50ppm maximum), total ash (0.2ppm maximum), additives; food colours, flavourings, sweetening agents(As permitted by the agency), sulphur (10mg/kg maximum), appearance (free and clear), colour and flavor; characteristics of rumlead (0.2ppm minimum), arsenic (0.2ppm minimum), copper (2.0ppm minimum), iron (1.0ppm minimum). The product shall be free of pathogenic micro- organisms or their metabolic products or other toxic substances when analyzed according to the method prescribed in the standard (22)

The quality and identity of distilled alcoholic spirits is of paramount necessity especially as it pertains to their social, health and psychological implications. Therefore, this study was aimed at evaluating the production techniques and quality of rum spirit drinks, both produced and not produced in Onitsha metropolis, Anambra State.

II. MATERIALS AND METHODS

2.1 Sources of materials

This study covered Onitsha metropolis which included Onitsha and parts of adjoining towns in Ogbaru, Obosi, Ogidi, Ogbunike and Nkwelle Ezunaka. Onitsha is a seaport and market town in Anambra state, Nigeria with an estimated urban

population of over 7,425,000 (Demographia, 2016). The raw materials for laboratory produced rum spirit and market samples of rums were procured from this study location.

2.2 Research design

The design is such that the research consists of three phases namely field studies, production of rum based on findings of survey studies, laboratory and statistical analyses. Administration of questionnaires and oral interviews to the sellers and producers of rums in only three markets in namely Ose-Okwodu, Relief and Bridge Head markets that were purposely sampled for this study.

Questions asked included names background status of respondents and physicochemical characteristics of the products.The administration of questionnaires was supplemented with observation of production techniques for rum spirits among producers of rum in Onitsha metropolis.

Ten rums (distilled alcoholic beverages) four of which were foreign (produced outside Nigeria) and six Nigerian-made for this study were purposively and randomly obtained from three different markets in Onitsha metropolis (Onitsha and Ogbaru Local Government Areas) namely Ose-Okwodu, Relief and Bridge Head markets. These markets were purposively selected as they are generally known to be popular with sales of distilled alcoholic beverages. Details of the six Made-in-Nigeria and four Not-Made-in-Nigeria rum spirits that were selected for this study given in table 1:

One (1no.) rum spirit was self-produced in the laboratory following standard specifications for comparison with market samples. For ethical and legal considerations, the actual names of the sampled rums were not made public (Table 1).

TABLE 1
NAMES AND MARKET SOURCES OF SELECTED RUM SPIRITS FOR STUDY

No	Brand Name of Rum Spirits	Market-Sources	Country of production
1	DCL	Bridge Head market	Nigerian-Made
2	SBR	Ose- Okwodu	Nigerian-Made
3	S5BD	Bridge head market	Nigerian-Made
4	PBC	Ose- Okwodu	Nigerian-Made
5	BWR	Relief market	Nigerian-Made
6	CBD	Relief market	Nigerian-Made
7	KSCR	Bridge Head market	Not-Made-in-Nigeria
8	ELR	Ose-Okwodu	Not-Made-in-Nigeria
9	IVGR	Relief market	Not-Made-in-Nigeria
10	GMCR	Relief market	Not-Made-in-Nigeria
11	SBCR	Self-processed in laboratory	Nigerian-Made

2.3 Production of rum in the laboratory

The self-processed rum in the laboratory was labeled SBCR. The raw materials for the production of SBCR (Laboratory sample); (treated and de- mineralized water, food grade ethanol, sugar syrup, vanilla flavor, caramel, rum flavour and coffee flavour) were measured accurately with the help of weighing balance and calibrated stainless steel vessels. The batch formulation for production of SBCR was strictly maintained. The volume of water and ethanol used for the production of 48% SBCR measured into the mixing vessel. Ten litres of food grade ethanol and 9.7litres of de-mineralized water were measured into a mixing vessel (200L capacity) and the mixture stirred continuously for 3 to 5minutes. Fifty six milliliters of caramel was added, followed by the addition of 4 litres of sugar syrup, 64 ml rum flavour, 4ml vanilla flavor and 192ml coffee flavor making a total volume of 34.016 litres. The mixture was briskly blended for 10 to 20 minutes. The in-process sample was collected for sensorial (aroma, colour, taste and mouth feel and general acceptance) and physico- chemical analysis (p^H, specific gravity, titratable acidity, alcohol content, dissolved solids, suspended solids and total solids). Satisfactory result of the physico-chemical and sensorial analysis on the collected samples gave approval for filtration, aging for 24 hours and bottling (filling and capping) of the product. The products (SBCR) were sighted, labeled with appropriately date marked labels. Quality control checks were carried out on the finished product (SBCR) to ensure that the fill volume, date mark, batch code were properly done and sub-standard labels were not used. The products were also

checked for sensorial and physico-chemical parameters. The satisfactory products were stored on pallets in the laboratory shelf.

2.4 Methods of Laboratory Analyses

Physicochemical and sensory analyses on samples were conducted on market and self-produced samples. Analyses conducted on the samples included pH, titratable acidity, specific gravity and alcoholic content. Others were dissolved solids, suspended solids and total solids.

Standard methods were used in the various laboratory analyses. The P^H of the rums was determined using a P^H meter type pHs-2F, Harris, England (24).

Methods for other determinations included titratable acidity, for coloured spirits (25) and for non coloured spirits (25). Specific gravity (26); alcohol content determination (27); suspended solids (28) dissolved solids (28) and total solids (28). The sensory evaluation of the rum distilled beverage samples was carried out using a 9-point Hedonic scale by ten panelists (29).

2.5 Statistical Analysis

The mean and standard deviation of the data obtained were presented in tables whereas the statistical differences of the obtained data were determined by ANOVA ($P < 0.05$) using SPSS 22 (SPSS Inc., Chicago, and U.S.A). The significant means were compared using Fisher's Least Significant Difference (LSD)

III. RESULTS AND DISCUSSIONS

3.1 Production Techniques of Rum in Onitsha Metropolis

Field studies on the producers of rum spirit beverages in Onitsha metropolis showed that blending technique is used to produce their various rum categories such as blended white rum, blended dark rum, blended light rum/ blended rum and blended café rum. The choice of rum product adopted by each producer is dependent on the specific organoleptic and physico-chemical attributes desired which in turn affected the raw materials (Rum flavor, coffee flavor, sweetener (such as sugar, sugar syrup, sorbitol, fructose and aspartame), vanilla flavor, caramel, ethanol and water) utilized.

Ethanol and de-mineralized water (treated and de-ionized water) are the basic raw materials for any of the categories. It was discovered that two categories of distilled imported ethanol (Food grade sealed drums and refill drums) were available for production of distilled alcoholic beverages. It was also observed that we do not distil alcohol on commercial bases in Nigeria.

The producers of distilled alcoholic beverages all had treated and de-mineralized water sources, stainless steel mixing tank with in- built stirrer for blending the raw materials, ageing tank which gives room for proper reaction of the constituents and/ or continuous filling tank, from where the product flows into the filling machines for filling into desired packaging container. There was also filtration columns with different micron sizes of filters positioned between the mixing tank and prior filling. The producers have laboratory section where the physicochemical and sensorial parameters were determined on the raw materials (Weight, alcohol percentage, colour, taste, aroma, expiration date of the raw materials), in-process (alcohol percentage, colour, taste, aroma, pH, titratable acidity, total solids, dissolved solids, suspended solids, and specific gravity) before commencement of filling, and the finished product (batch coding, date marking, fill volume, colour, taste, aroma, specific gravity, alcohol percentage, pH, titratable acidity, total solids, dissolved solids and suspended solids), once the product was found to be in-line with the specifications for rum in accordance with regulatory standards of NAFDAC and SON.

Table 2 summarized the production techniques of rums produced and sold in Onitsha while table 3 gives a summary of rum spirits produced outside Nigeria and sold within Onitsha metropolis. Among the foreign rums, only ELR is registered with NAFDAC. All the locally produced rums are registered with NAFDAC. Both the foreign and locally produced rums are packaged in bottles. None of the rum spirit brands had nutritional labeling. There was no raw material listing on ELR, IVGR and GMCR. Their alcohol contents as specified on their labels range from 42% to 47%.

TABLE 2

NAMES AND PRODUCT CHARACTERISTICS OF RUMS PRODUCED IN ONITSHA METROPOLIS ANAMBRA STATE, NIGERIA

No	Product characteristics	Types of rum sold in Onitsha					
1	Product Name	DCL	SBD	S5BD	PBC	BWR	CBD
2	Place of manufacture	Ota, Ogun state, Nigeria	Ota, Ogun state, Nigeria	Nkpor, Anambra state Nigeria	Obosi, Anambra state, Nigeria	Ogidi, Anambra state Nigeria	Nkwelle-Ezunaka Nigeria
3	% Alcohol	45	42	45	43	40%	43%
4	Volume	100mls	700mls	120mls	100mls	120mls	120mls
5	Colour	Golden brown	Dark brown	Dark brown	Dark brown	Colourless	Golden brown
6	Nutritional labeling	NIL	NIL	NIL	NIL	NIL	Nil
7	Packaging	Glass bottle	Glass bottle	Pet bottle	Pet bottle	Pet bottle	Pet bottle
8	NAFDAC No.	Yes	Yes	Yes	Yes	Yes	Yes
9	Raw materials used	Ethyl alcohol, de-ionized water, sugar, coffee flavour, cream flavour, whisky flavour,	Demineralized water, ethyl alcohol, rum spirit, sugar, colour(E150(a)	Ethanol, treated water, sugar syrup, caramel, rum flavor	Ethanol, caramel, de-ionized water, rum flavor, coffee flavor, sugar syrup,	Food grade ethanol, treated water, sugar syrup	Ethanol, rum flavor, water, caramel

TABLE 3

NAMES AND PRODUCT CHARACTERISTICS OF FOREIGN-MADE RUMS SOLD IN ONITSHA METROPOLIS ANAMBRA STATE, NIGERIA

No	Product characteristics	Types of rum sold in Onitsha			
1	Product Name	KSCR	ELR	IVGR	GMCR
2	Place of manufacture	India	Spain	India	India
3	% Alcohol	47	47	42.8	42.8
4	Volume	70cl	70cl	750mls	750mls
5	Colour	Amber	Amber	Dark brown	Dark brown
6	Nutritional labeling	NIL	NIL	NIL	NIL
7	Packaging	Glass bottle	Glass bottle	Glass bottle	Glass bottle
8	NAFDAC No.	NIL	Yes	NIL	NIL
9	Raw materials used	Extra neutral alcohol, demineralized water, coffee extract, natural identical flavouring substance, sugar, colour (E150(a)	NIL	NIL	NIL

TABLE 4
PHYSICOCHEMICAL CHARACTERISTICS OF RUM SPIRITS MARKETED IN ONITSHA METROPOLIS

No	Name	% Alcohol	pH	T. - Acidity	Specific gravity	Total solids	Susp-solids	Dissolved solids
1	ELR	50.0±0.20^{d}	3.7±0.17^{ab}	0.16±0.06^{c}	0.92±0.01^{d}	4.40±0.40^{bc}	2.20±0.04^{c}	7.00±0.50^{f}
2	KSCR	48±0.10^{d}	3.7±0.35^{abc}	0.4±0.01^{f}	0.93±0.06^{d}	32.18±0.16^{g}	12.31±0.27^{h}	18.05±0.50^{h}
3	IVGR	47±0.10b^{c}	3.4±0.36^{ab}	0.64±0.00^{i}	0.94±0.00^{e}	10.64±0.99^{f}	5.90±0.05^{e}	6.44±0.41^{ef}
4	PBC-Rum	45±0.10^{b}	4.2±0.36^{cd}	0.47±0.00^{f}	0.99±0.00 ^{h}	7.09±0.30^{a}	5.57±0.21^{d}	1.53±0.21^{a}
5	S5BD-Rum	45±0.17^{b}	4.2±0.26^{cd}	0.56±0.00^{h}	0.97±0.00^{g}	3.03±0.30^{ab}	10.28±0.23^{g}	5.30±0.10^{cd}
6	SBD-Rum	42±0.17^{a}	4.7±0.10^{ef}	0.11±0.00^{a}	0.97±0.00^{g}	4.36±0.31^{bc}	6.43±0.01^{f}	5.59±0.18^{cde}
7	DCL-Rum	42±0. 00^{a}	4.5±0.26^{de}	4.5± 0.26^{de}	0.90±0.60^{c}	5.60±2.50^{de}	5.85±0.04^{e}	3.23±0.22^{b}
8	GMC-Rum	47±0.12^{bc}	3.7±0.38^{abc}	0.45±0.00^{e}	0.88±0.00^{b}	6.83±0.02^{d}	5.71±0.03^{a}	8.95±1.46^{g}
9	CBD-Rum	48±0.10^{cd}	5.1±0.10^{f}	0.31±0.06^{d}	0.99±0.00^{h}	6.35±0.14^{d}	5.90±0.04^{a}	4.57±0.66^{c}
10	CW-Rum	50±0.20^{d}	3.3±0.26^{a}	0.66±0.00^{j}	0.87±0.00a	3.42±0.05^{ab}	1.19±0.02^{b}	5.89±0.03^{de}
11	SBC-Rum	48±0.10^{cd}	3.9±0.10^{bc}	0.54±0.00^{g}	0.95±0.06^{f}	9.04±0.70^{e}	5.59±0.07^{f}	3.44±0.50^{b}

NB:
Values are mean± standard deviation of the three replicates
Values in the same column bearing different superscripts differ significantly ($p \leq 0{,}05$)

3.2 Physicochemical characteristics of rum produced in Onitsha metropolis

Physicochemical characteristics of eleven rum distilled alcoholic beverages (Rum spirits) both Nigerian and foreign makes including the laboratory produced (LBC) were evaluated and results are shown in Table 4.The alcohol content of the eleven rum spirit brands differed among themselves ($P \leq 0.05$). However, ELR and KSCR, CBD, BWL and LBC do not differ significantly, ($P \geq 0.05$) Also, SBD and DCL do not differ significantly ($P \geq 0.05$). PBC and S 5BD do not differ significantly ($P \geq 0.05$).

The alcohol content of the rum spirit brands range from 42% to 50% and average of 46.5%. ELR and BWR have the highest percentage alcohol content of 50% while DCL and SBD have the lowest alcohol percentage of 42%. This work differs with the works of (30) who reported the alcohol contents of native spirituous beverages from Africa including Burukutu (Sorghum beer), Ogogoro (Distilled palm wine) Kunnuzaki, whistle palmwine, Adoyo, Nunu, Fura da nunu, Zobo, and Omi wara to be 37.6%v/v for Ogogoro, 4.6%v/v for Burukutu, 3.1%v/ for Palm wine and others (0.3%).

Similarly, Cachaca, a typical and exclusive cane sugar liqueur of Brazil, is distilled from fermented must of the sugar cane broth with alcohol content from 38 to 48% v/v at 20^{o}c (31). However, this work is in line with the works of IARC *(32*) who reported the alcohol in alcoholic beverages to range from 3.2- 4.0% for beer, 3.2- 7.0% for malt liquor, 7.1-14.0% for table wines, 8.0-14% for sparkling wines, 14- 24% for fortified wines,40- 95% for hard liquor. 4.8% for beer, 10-22% for wines, 40- 50% for brandy and 40 – 55% for whisky and rum. (Shrikant *et al* (33) also revealed that distilled alcoholic beverages contain 40-60% alcohol. This work differs with the works of Yohannes and Siraj (34) who reported traditional spirituous beverages produced in Ethiopia Tella, Tej and Areki to have an average alcohol content of 5.17%.

The pH in conjunction with other storage or aged conditions (such as the oxidation reactions of some of the constituents and reactions with the contact surfaces of the storage container) play a key role in determining the organoleptic properties of spirituous beverages (35 ; 36). The pH of the rum spirit brands differ significantly ($P \leq 0.05$) but ELR, GMCR, BWR and IVGR do not differ significantly ($P \geq 0.05$). The range of the rum spirit varies from pH 3.3 to pH 5.1 with an average of pH 4.03. CBD had the highest pH value of 5.1 while BWR had the lowest pH value of 3.3 respectively IVGR and BWR.

An acidic pH is related to the presence of organic acids in the rum brands (37). Low pH could also be dependent on the oxidation reactions of some constituents in contact with metals (38) Low pH of BWR and IVGR could presumably, be because some of the volatile components that predominate in them are carboxylic acids that evidently contribute to the acidity of the beverage. Other components added along the production process might be responsible for the acidity (39).

The physico-chemical properties of some spirits beverages from Nigeria (Palm wine), Mexico (Tequilas), Ethiopa (Tella), and Cynthiana (Cynthiana) reveals that they have pH values 4.3, 3.5-4.9, 4.0,4.11 respectively (34). Similarly, Muoro, a Greek spirit distilled from fermented fruit of Mulberry tree has a pH equal to4.46 similar to tequila pH (4.7). Similar pH values observed in these spirit beverages may possibly be due to the fact that these spirits share similar raw materials and production procedures (40).

The titratable acidity of the rum spirit brands (Table 4) shows that the rum spirits differ significantly ($P \leq 0.05$). KSCR and PBC do not ($P \geq 0.05$). Similarly, GMCR and DCL do not differ significantly ($P \geq 0.05$).The titratable acidity of the rum spirit brands varies from 0.11 to 0.66 an average value of 0.80. SBD has the lowest titratable acidity value (0.11) while BWR has the highest titratable acidity value of 0.80.

The specific gravity of the rum spirit brands (Table 4), shows that the rum spirit brands differ significantly ($P \leq 0.05$). However, ELR and KSCR do not differ significantly ($P \geq 0.05$). Similarly, S5BD and SBD do not differ significantly ($P \geq 0.05$). PCR and CBD do not differ significantly ($P \geq 0.05$).The specific gravity of the rum spirit brands vary from 0.87- 0.99. PBC and CBD showed the highest specific gravity (0.99.) while BWR has the lowest specific gravity (0.87).

Total solids of the rum spirit brands (Table 4) shows that the brands KSCR differ significantly from the other brands ($P \leq 0.05$). Similarly, IVGR differed significantly ($P \leq 0.05$) from the other brands. The total solids of the rum spirit brands vary from 3.03 to 32.18 and an average of 8.45. S5BD blended dark rum has the lowest total solids (3.03) while KSCR has the highest total solids (32.18). The total solids revealed from this works compares favorably with the works of Oleiveras *et al* (41) on Palm wine (3.4%), Ogogoro (12%), Fura da nono (21.8%), Burukutu (7.9%).

The suspended solids of the rum spirit drinks (Table 4), shows that KSCR differed significantly ($P \leq 0.05$) from the other rum spirit brands. Similarly, IVGR differed significantly ($p \leq 0.05$) from the other brands ($P \leq 0.05$). The suspended solids of the rum spirit brands range from 1.12% and 12.31% with an average of 6.08%. BWR contains the lowest suspended solids

(1.12%) while KSCR has the highest value of suspended solids (12.31%). Adeleke and Abiodun (42) observed total suspended solids in ogogoro (3-10.7%) and Burukutu (0.8%).

The dissolved solids of the rum spirits show that they differ significantly ($P \leq 0.05$). However, ELR and IVGR do not differ significantly ($P \geq 0.05$) but the KSCR differed significantly from the other brands ($P \leq 0.05$). The dissolved solid content of the rum spirit brands vary from 1.53%- 18.05% with an average of 6.36%. PCR showed the lowest dissolved solids content (1.53%) while KSCR contained the highest dissolved solids (18.05%).

3.3 Sensory properties of rum alcoholic spirits

The sensory properties evaluated on the rum spirit brands for consumer acceptance and preference using 10 panelists on a 9-point Hedonic scale on colour, aroma, taste, mouth feel and general acceptance, gave results as presented in Table 5.

TABLE 5
ORGANOLEPTIC ACCEPTABILITY OF RUM SPIRITS MARKETED IN ONITSHA METROPOLIS

No	Name	Aroma	Taste	Colour	Mouth feel	General Acceptance
1	ELR	6.70 ± 1.70^{c}	5.50 ± 2.37^{bc}	6.40 ± 2.41^{b}	6.20 ± 2.25^{bc}	6.60 ± 1.43^{c}
2	KSCR	3.40 ± 2.27^{ab}	2.50 ± 1.96^{a}	4.40 ± 3.24^{ab}	2.60 ± 2.72^{a}	3.30 ± 2.41^{a}
3	IVGR	5.40 ± 1.71^{bc}	4.70 ± 2.67^{abc}	5.60 ± 1.51^{ab}	4.30 ± 2.21^{ab}	5.00 ± 2.54^{abc}
4	PCR	5.70 ± 1.57^{c}	4.50 ± 2.84^{abc}	4.70 ± 1.77^{ab}	4.30 ± 2.41^{ab}	5.90 ± 1.73^{bc}
5	S5BD	3.20 ± 12.82^{a}	3.00 ± 2.36^{a}	4.30 ± 2.95^{a}	3.60 ± 2.17^{a}	3.40 ± 2.01^{a}
6	SBD	4.90 ± 2.38^{abc}	4.50 ± 2.32^{abc}	4.00 ± 2.79^{ab}	3.70 ± 1.95^{a}	4.10 ± 1.80^{ab}
7	DCL	6.70 ± 2.26^{c}	6.80 ± 1.40^{c}	6.40 ± 0.97^{a}	6.70 ± 1.06^{c}	6.30 ± 1.50^{c}
8	GMCR	6.60 ± 2.37^{c}	6.10 ± 2.02^{bc}	5.80 ± 2.15^{ab}	4.60 ± 1.26^{ab}	6.20 ± 1.48^{c}
9	CBD	5.30 ± 1.70^{abc}	4.80 ± 1.55^{abc}	5.10 ± 1.91^{ab}	4.30 ± 1.95^{ab}	4.70 ± 2.06^{abc}
10	BWR	4.80 ± 2.90^{abc}	2.90 ± 2.51^{a}	3.70 ± 3.16^{a}	4.00 ± 2.49^{a}	4.60 ± 2.41^{abc}
11	LBC	5.50 ± 1.72^{bc}	4.10 ± 2.81^{ab}	5.60 ± 2.17^{ab}	3.80 ± 2.53^{a}	5.00 ± 2.10^{abc}

NB:

i. Values are mean± standard deviation of the ten replicates

ii. Values in the same column bearing different superscripts differ significantly ($p \leq 0,05$)

The aroma of the rum spirit brands as presented in Table 5, shows that the aroma of the rum brands do not differ significantly($P \geq 0.05$).S5BDdiffers significantly($P \leq 0.05$) from ELR. However, ELR do not differ significantly ($p \geq 0,05$) from PCR, DCL and GMCR Similarly, S5BD do not differ significantly ($p \geq 0,05$) from KSCR, SBD, CBD and BWR. The panelists' scores of aroma of the rum spirit brands vary from 3.20- 6.70. S5BD has the lowest score (3.20) and was disliked moderately.ELR and DCL on the other hand, scored the highest ((6.70).) and were liked moderately.

The taste scores of the rum spirit brands (Table 5), shows that they differ significantly ($P \leq 0.05$). DCL differed significantly from BWR, S5BD and KSCR. However, ELR, IVGR, SBD, PCR, GMCR, CBD and LBC do not differ significantly ($P \geq 0.05$). Similarly, KSCR did not differ significantly ($P \geq 0.05$) from IVGR, CBD, LBC, and SBD The range of panelist scores for taste of the rum spirit drinks vary from 2.50- 6.80. KSCR has the lowest score (2.50) and was disliked very moderately while DCL has the highest score (6.67).and was liked moderately

The colour of the rum spirit brands (Table 5) shows that the brands differed significantly ($P \geq 0.05$). ELR differed significantly ($P \leq 0.05$) from S5BD, DCL and BWR. However, ELR, did not differ significantly ($P \leq 0.05$) from KSCR, IVGR, PCR, SBD, GMCR, CBD and LBC. Panelists' scores of colour on the rum spirit brands varied from 3.70- 6.40. BWR has the lowest score (3.70) and was disliked slightly. On the other hand, ELR and DCL had the highest scores (6.40) and were liked slightly

The mouth feel of the rum spirit brands (Table 5) shows that the rum spirits differed significantly ($P \leq 0.05$). ELR rum and DCL do not differ significantly ($P \geq 0.05$). However, DCL, S5BD, SBDBWR, LBC, CBD, GMCR, KSCR, IVGR and PCR did not differ significantly ($P \geq 0.05$). Panelists's scores for the mouth feel of the rum spirit brands vary from 2.60 – 6.70. KSCR had the least score (2.60) and was disliked moderately while DCL had the highest score (6.67).and was liked moderately

The sensory scores of the general acceptance of the rum spirit brands (Table5), shows that the brands differed significantly ($p \leq 0,05$). KSCR differed significantly ($P \leq 0.05$) from ELR, IVGR, PCR, SBD, CBD, BWR and LBC, and GMCR. Similarly, SBD differed significantly ($P \leq 0.05$) from IVGR, PCR, CBD and LBC. However, KSCR, S5BD, IVGR, SBD, CBD, BWR, and LBC did not differ significantly ($P \geq 0.05$). Panelists' scores of general acceptance of the rum spirit brands varied from 3.30- 6.60. KSCR scored the lowest (3.30.)and was disliked moderately while ELR scored the highest (6.67) and was liked moderately.

IV. CONCLUSION

This study on the production techniques and quality evaluation of rum distilled alcoholic beverages (Rum spirits): a case study of Onitsha metropolis revealed that there are observable deviations in the physico-chemical and sensorial characteristics of some of the rum spirit brands evaluated, from the standards set by regulatory bodies like NAFDAC and SON. It is therefore evident, that better products can be achieved using optimization of some of the response variables like alcohol content, titratable acidity, total solids, dissolved solids, specific gravity colour and taste, in order to produce rum spirit beverage with better quality attributes.

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