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Simultaneous Production of "Light" and "Heavy" Rums

From the same Beer using the same Distillation Equipment and Technique.

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Fundamental differences in chemical composition, physical characteristics and organoleptic qualities regarding aroma and taste, between the so-called light and heavy types of rum, have been well recognized by rum experts, manufacturers, rum tasters, and generally by the consuming public. These two main products of rum manufacture are differentiated by their corresponding Non-Alcohol-Number Coefficient, also called the Coefficient of Impurities, as well as by the differences established above. A heavy rum is regarded as possessing a much higher Non-Alcohol-Number Coefficient, and more body, greater viscosity, more intense colour and richer and more pronounced taste and aroma than a light rum. The heavy rum is also distinguished in possessing a very much higher Index of Persistence in both aroma and taste, by which is meant that it can endure high dilution with aqueous solutions of neutral spirits before its characteristic taste and aroma can no longer be perceived by an experienced rum taster. The Index of Persistence, in the case of light rums, is usually rather low, amounting to but one-fifth to one-tenth of that of heavy rums.

These fundamental differences have made it necessary hitherto to use different methods of manufacture for the industrial production of each type of rum. This involves different mashing methods, and different techniques of fermentation; and, for the distillation, there are differences not only in technique, but also in the equipment itself. This, of course, has created difficulties both of a technical and an economic nature when attempting to produce both types of rum in the same distillery without practical duplication of space and equipment. A clearer conception of the differences between the light and heavy classes of rum may be obtained from Table I, which offers representative analytical data for two four-year-old rums, one representative of each type.

But now experiments performed by the writer have made it possible to develop a new method of manufacture through which the former difficulties are readily obviated, and the two classes of rum may be simultaneously produced from **one and the same beer,** while using **exactly the same distillation equipment and distillation technique.**

TABLE I.

Characteristic respective analyses of four-year-old commercial rums of the "Heavy" and "Light" types. The ratios among individual components or group components are also given.

	Heavy Rum.	Light Rum.
Alcohol by volume (per cent.)	48·50	43·15
Total acidity (mgrm./100 ml. Abs. (Alcohol)	208·91	84·27
Fixed Acidity (do.)	163·71	60·00
Volatile Acidity (do.)	45·20	24·27
Esters (do.)	280·42	79·78
Aldehydes (do.)	57·21	42·80
Higher Alcohols (do.)	82·94	52·41
Extract (do.)	518·25	212·15
Ash (do.)	20·20	23·60
Ratios among Constituents :		
Esters : Higher Alcohols	3·38 : 1	1·52 : 1
,, : Volatile Acidity	6·20 : 1	3·25 : 1
,, : Aldehydes	4·90 : 1	1·86 : 1
Volatile Acidity : Total Acidity	0·21 : 1	0·29 : 1
High : Low Boiling Pt. Esters	0·80 : 1	0·37 : 1
High : Low Boiling Pt. Aldehydes	0·98 : 1	0·67 : 1
Higher Alcohols : Non.-Alc. No.	0·13 : 1	0·20 : 1
Non-Alcohol Number (mgrm.)	629·48	259·27
Index of Persistence	1 : 100,000	1 : 20,000

The new process starts by the fermentation of blackstrap molasses in accordance with the technique developed by the writer for the production of heavy rum-producing beers, as described in his patent specification[1] entitled "Production of Heavy Rums." As the fermentation process appears in this patent and also in other of the writer's publications,[2] we shall omit further particulars here and pass on to a description of the novel method of distillation by which the two different classes of rum may be simultaneously produced from one and the same beer.

THE NOVEL METHOD OF DISTILLATION.

The beer is first distilled to produce a high wine in a single-column still of the continuous type. This column has a beer exhaustion section, and a rectifying section directly on top of the exhausting one. The beer section consists of 17 plates so arranged that the feed of beer may be made at any of the four top plates. The rectifying section comprises five plates, with provision for fusel oil extraction from the first four of these plates, counting from the plate nearer to the exhausting section.

In this manner the fusel oil content of final distillate may be controlled within certain margins by the

[1] "The Production of Heavy Bodied Rums," U.S. Patent 2,386,924, issued on October 16th, 1945; *I.S.J.*, 1946, p. 250.
[2] *I.S.J.*, 1946, p. 101.

distiller. The final distillate obtained from this continuous column will have a proof within the range 120–140° U.S. proof at 60°F., equivalent to 60–70 per cent. of alcohol by volume. This distillate will be further diluted to an alcoholic concentration of exactly 40 per cent. by vol. with ordinary tap-water, which mixture is submitted to fractional distillation in a batch still.

The salient features of the batch-still are : (1) A kettle in which the high wine is heated with a very fine control of temperature, so that violent ebullition of the alcoholic liquid is effectively avoided during the entire fractionating period. Turkey Red oil (sulphonated castor oil) is added to the liquid in the kettle in the proportion of one of oil to 6,000 parts of the alcoholic liquid in order to better control the rhythmic boiling of the liquid. In order that the still attendant may have complete control over the boiling operation, the body of the kettle is provided with interior illumination and with a sight-glass, by means of which the attendant is able to effectively observe the boiling condition at the surface of the liquid. (2) The still head provides for effective fractionation and dephlegmation during the period of distillation. (3) Thermal regulation of the temperature of the vapours actually passing into the condenser of the still must be accomplished with precision. A very sensitive and accurate thermometer placed at the point where these vapours pass into the condenser records this part of the operation. (4) The rate of reflux of the higher boiling point components, and azeotropic mixtures of these with the ethyl alcohol, are also under complete control of the still operator.

The Secondary Distillation.

In such a batch-fractionating unit, the product obtained from the continuous column is carefully submitted to a secondary distillation under high fractionating and dephlegmatory action. The different fractions obtained (five in all) are collected into separate receivers, and the moment of changing the flow of distillate from one to another of these receivers will be indicated by the temperature readings of the thermometer before mentioned. The first fraction will pass within the range 69–72°C. This will show an alcoholic concentration of around 91 per cent. by vol. and will amount to about 5 per cent. of the total volume of distillate to be obtained in all the fractions taken together.

Chemically, it will consist of ethyl alcohol in admixture, with appreciable quantities of the lower boiling point aldehydes, organic acids of the saturated monobasic aliphatic series, esters, and a small amount of the lowest in the higher alcohols series. Methyl alcohol, acetal and acetone are also sometimes found in minute quantities. This first fraction will not enter the composition of either of the two different types of rum that will be produced through judicious combinations of aliquots from the different fractions distilled. It will be accumulated with other successive similar fractions, and when a large enough quantity has been secured, it will be submitted to refractionation for the recovery of the main part of the ethyl alcohol contained therein. The reason for not using this particular fraction as a rum component is that therein are obtained the most undesirable constituents of the beer, and these constituents would militate against the purity and quality of either class of rum.

The second fraction will pass over within the temperature range 72–78°C. This fraction will represent about 10 per cent. of the total volume of distillate, and will have an alcoholic concentration of 93–94 per cent. by vol. It will consist of a mixture of ethyl alcohol with appreciable amounts of esters and aldehydes. Also, organic acids, mostly acetic acid, will be found in small quantities, besides some higher alcohols.

The third fraction is the largest in volume, and the one taking the longest period of distillation. It will be obtained at the fixed temperature of 78°C. Its collection begins as soon as the temperature of distillation reaches the degree named, and will be finished as soon as the temperature begins to rise appreciably from 78°C. A rise not greater than 0·5° should be allowed to occur for the shifting of the flow of distillate into the receiver for fraction (4). This third fraction will have an alcoholic strength varying between 95 and 96 per cent. by vol. It consists almost entirely of ethyl alcohol, with very small amounts of congeneric products of rum fermentation, such as medium boiling point esters, aldehydes and higher alcohols. It contains the least amount of organic volatile acids. Its volume will represent from 55–60 per cent. of the total volume of distillate to be collected.

Collection of the fourth fraction takes place, as already indicated, just as soon as the temperature of distillation rises by a few tenths of a degree C. over the 78° mark. Its temperature range will then be 78–85°C. and its alcoholic concentration will be around 89–91 per cent. by vol. A characteristic of this fraction is that in it are collected the last of the low boiling rum constituents and the higher boiling point ones also begin to appear. It is also characterized by the presence of the major part of the higher alcohols found originally in the high wines. The content of esters, aldehydes and fatty acids is larger here than in the previous fraction.

The fifth and last fraction is collected within the temperature range 85–90°C. and will contain 25–30 per cent. of alcohol by vol. Its physical appearance will be opalescent or turbid, due to the presence of natural essential oils and some of the highest boiling point esters and aldehydes, all of which are more soluble in alcohol than in water. It is, however, one of the most important fractions from the standpoint of rum making, for here will be found those congenerics of rum fermentation such as those mentioned

above, to which good rums of quality in either class owe their more cherished characteristics. The content of higher alcohols will be almost negligible in this last fraction, but there will be a sharp rise in the content of organic acids of the saturated, aliphatic, monobasic series.

Distillation and fractionation are completed with the collection of the fifth fraction. There will remain within the liquid in the kettle about 2 per cent. of ethyl alcohol mixed with large quantities of organic acids, and very small amounts of essential oils, esters and aldehydes of very high molecular weights and boiling points. These remains from the kettle are mixed with the beer being distilled at the continuous column, thus saving the ethyl alcohol and some of the other products remaining in this liquid.

The typical products obtained by this fractionation, together with the respective temperatures of distillation and alcoholic concentrations, will be found in Table II.

TABLE II.

Typical results of the fractional distillation as described. Percentages of alcohol are reported by volume, and other data are expressed in mgrm. per 100 ml. of absolute alcohol in distillate.

		Chemical Analysis				
Fraction No.	Temp. Range °C.	% Alcohol Vol.	Mgrm. Total Acidity.	Mgrm. Esters.	Mgrm. Aldehydes.	Mgrm. Higher Alcohols
1	69—72	91·0	7·50	105·11	165·60	11·49
2	72—78	93·5	3·28	96·45	24·30	5·90
3	78—78	95·5	1·49	11·97	9·50	4·40
4	78—85	90·0	7·13	23·94	17·16	89·85
5	85—98	27·5	28·79	78·50	37·50	3·13

The next step in the process will be the formation of each of the two types of rum by the judicious and expert combination of proportionate aliquots from fractions 2 to 5 (inclusive). The best proportions to use in the formation of each class of rum are determined by experience and taste, as well as by the ultimate chemical composition one desires in each type of rum.

TABLE III.

Representative analyses of freshly distilled rums of each of the two classes obtained by the fractional distillation outlined. Alcohol contents indicated in percentages by volume, and *other determinations as mgrm. per 100 ml. of absolute alcohol.*

	Light Rum.	Heavy Rum.
Alcohol by volume	52·50	55·00
Total Acidity	8·74	31·95
Total Esters	53·94	156·92
Total Aldehydes	23·28	65·18
Higher Alcohols	40·06	63·22
Non-Alcohol-Number	125·02	317·27
Index of Persistence	1 : 7,500	1 : 35,000
Ratios among Constituents :		
Esters : Higher Alcohols	1·34 : 1·00	2·48 : 1·00
,, : Total Acidity	6·17 : 1·00	4·91 : 1·00
,, : Aldehydes	2·32 : 1·00	2·41 : 1·00
Higher Alcohols : Non-Alc. No.	0·24 : 1·00	0·20 : 1·00
High : Low Boiling Pt. Esters	0·28 : 1·00	0·74 : 1·00
High : ,, Aldehydes	0·32 : 1·00	0·96 : 1·00

We offer the following typical combination, which has been proved to produce good types in each class of rum. For the light rum there should be mixed 25 per cent. of fraction (2); 50 per cent. of fraction (3); 40 per cent. of fraction (4); and 15 per cent. of fraction (5). The balances left in each case are then mixed together for the formation of the heavy rum. Both rums are then diluted to the desired alcoholic concentration with distilled water. The light rum is usually diluted to about 105° U.S. proof and the heavy rum to about 100° before submitting them to the customary ageing in oak barrels. Table III shows representative analyses for each of the two classes of rum in their raw condition. Alcohol contents are indicated in volume percentages, and other determinations are expressed as mgrm. per 100 ml. of absolute alcohol.

ADVANTAGES OF PROCESS.

Advantages obtained by this process of rum manufacture are as follows: So far, no other process provides for the simultaneous production of these two widely different types of rum. The rums are produced with minimum use of technical personnel, labour, floor space and equipment. One and the same distillery can produce both classes of rum economically. Process losses are reduced to a minimum. Due to the highly selective chemical constitution and physical characteristics of the raw rums, they will acquire the desired maturity in a comparatively short period of ageing.

This process provides for the effective elimination of those substances that will militate against the high quality, good taste and excellency of aroma in the final product. This is done through elimination of excess higher alcohols during the continuous distillation of high wines, and by the rejection of the first fraction obtained during fractionation of the high wines. The selective extraction exercised throughout the fractional distillation precludes the admission into the final products of such deleterious ingredients as methyl alcohol, acetone, acetal, formic acid, obnoxious esters of low boiling point (as, for instance, methyl formate, acetate and propionate), ethyl formate and propyl formate, and the main part of low boiling point aldehydes of irritating qualities. These are excluded by rejection of the first fraction.

Commercial rums of definite and permanent chemical composition and of uniform organoleptic qualities are produced in each class by disintegrating the high wines into several fractions of different compositions, and selecting the desirable constituents in the desirable amounts and rejecting the undesirable ones. The consumer's health is protected by the highly selective technique employed in the manufacture of these rums and by the extraction of those substances that are apt to be injurious to his well-being. A truly scientific method of rum manufacture is thus created which is economical in equipment, floor space, buildings, trained personnel and labour, and which, besides making possible the simultaneous production of widely different rums from the same beer, carefully adjusts the chemical composition and organoleptic characteristics of each class of rum through highly discriminating methods of selective distillation and extraction.

(*U.S. Patent Rights applied for on April 13th*, 1948).

LIST OF MORE IMPORTANT BUILDINGS AND STRUCTURES.

1—Enclosure for meteorological instruments. 2—Chemical laboratories. 3—Lorry shed. 4—Mill room. 5—Chemical store room. 6—Garage.
7—Bachelor staff quarters. 8—Garage. 9—Main building—administrative offices, library, botanical and entomological laboratories.
10—Glasshouse for plant pathological work. 11—Workshop and storeroom for botanical department. 12—Insectary. 13—House of Mr. P. G. C. Brett, Plant Breeder.
14—Lawn tennis court. 15—Director's house (Dr. H. H. Dodds). 16—House of Senior Agricultural Officer (Mr. W. L. Fielding).
17—House of Dr. J. Dick, Entomologist. 18—House of Dr. A. McMartin, Botanist. 19—House of Mr. C. D. Sherrard, Agricultural Officer.
20—House of Mr. H. G. Munro, Carpenter & Builder. 21—Water tower. 22—House of Mr. C. Booth, Agricultural Officer.
23—House of Mr. F. L. Almond, Agricultural Officer. 24—House of Mr. J. L. du Toit, Chemist. 25—House of Mr. N. C. King, Plant Pathologist.

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