"TWO SIEVE" TABLE SUITABLE FOR A SUGAR APPROXIMATING TO M.A. 0·02, C.V. 25, USING TYLER SIEVES.

28 / 42 Per cent	5% M.A.	5% C.V.	10% M.A.	10% C.V.	15% M.A.	15% C.V.	20% M.A.	20% C.V.	25% M.A.	25% C.V.	30% M.A.	30% C.V.	35% M.A.	35% C.V.	40% M.A.	40% C.V.	45% M.A.	45% C.V.	50% M.A.	50% C.V.
66 ..	·0151	28	·0161	33	·0163	39	·017	42	—	—	—	—	—	—	—	—	—	—	—	—
68 ..	·016	26	·0163	32	·0167	37	·0172	40	—	—	—	—	—	—	—	—	—	—	—	—
70 ..	·016	26	·0165	30	·017	34	·0174	37	—	—	—	—	—	—	—	—	—	—	—	—
72 ..	·0163	26	·0169	28	·0173	32	·0178	35	·0182	39	·0188	43	—	—	—	—	—	—	—	—
74 ..	·0164	25	·017	27	·0174	29	·0179	33	·0182	38	·0189	40	—	—	—	—	—	—	—	—
76 ..	·0166	25	·0173	26	·0178	28	·0182	31	·0187	34	·0192	38	·0199	41	—	—	—	—	—	—
78 ..	·0169	23	·0173	26	·0179	28	·0183	30	·0188	33	·0193	36	·0199	39	—	—	—	—	—	—
80 ..	·0171	21	·0175	24	·018	27	·0183	29	·0189	32	·0193	35	·0199	37	—	—	—	—	—	—
82 ..	·0173	20	·0177	23	·0181	26	·0186	28	·0191	30	·0194	34	·0201	35	—	—	—	—	—	—
84 ..	·0175	19	·018	22	·0183	24	·0189	25	·0192	28	·0198	30	·0203	32	·0212	34	·022	37	—	—
86 ..	—	—	·0182	21	·0186	23	·0190	24	·0194	26	·0198	28	·0205	31	·0213	32	·0221	34	·0224	37
88 ..	—	—	·0184	20	·0188	22	·0192	24	·0197	26	·0203	27	·0207	30	·0215	31	·0222	32	·023	36
90 ..	—	—	·0186	19	·019	21	·0193	22	·02	23	·0204	24	·021	25	·0216	27	·0222	29	·023	31
92 ..	—	—	—	—	·0192	19	·0195	22	·0201	23	·0206	24	·0211	25	·0217	26	·0222	28	·023	29
94 ..	—	—	—	—	—	—	·0197	20	·0202	20	·0207	21	·0212	22	·0218	23	·0222	25	·023	26
96 ..	—	—	—	—	—	—	·02	18	·0204	19	·021	20	·0213	20	·0218	21	·0223	22	·023	23

Horizontal percentages refer to % on 28 sieve. Vertical percentages refer to % on 28+% on 42 sieve.

methods; (*b*) to the adequate accuracy of the sieves used, the highest accuracy obtainable by a reputable maker being demanded; (*c*) to the operation of the mechanical shakers for a period of time proven to be sufficient to pass all the sieve is actually capable of doing.

The writer wishes to record his indebtedness to Mr. PHILIP LYLE for his development of the "M.A.–C.V." method, to W. BROOME for a great part of the experimental work entailed, and to the Directors of Messrs. Tate & Lyle Ltd. for their encouragement and permission to publish this paper.

The Production of Straight Light Rums from Blackstrap.

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[*The author is well-known as a consulting chemist and fermentologist. He is the author of a number of valuable articles,*[1] *and of a book entitled "Studies on Rum," which has attracted much attention in different countries.*[2] *In the present article he points out that, at the present time, light rums are nearly always obtained by blending aged rums with neutral or semi-neutral spirits. Heretofore, the production of straight or unblended light rums from blackstrap molasses has baffled rum distillers. Yet this should be possible by adopting certain techniques, which are outlined by him here. This article forms a valuable contribution to the technology of rum production*].

The reader is probably better acquainted with light rums that with any other type. When he is buying his preferred brand of light rum he nearly always is obtaining a blend of rum and neutral or semi-neutral spirits. Present techniques for the manufacture of these so-called "light rums" may vary in small and unimportant details; but fundamentally the various products in the market represent blends of aged rums, obtained from either cane juice or molasses, and neutral or semi-neutral spirits distilled from blackstrap. The proportions more commonly used are 20–35 per cent. of the aged rum, and 65–80 per cent. of the neutral or semi-neutral spirits.

These blended rums are not labelled as such, this not being required by law. Before their final presentation to the consuming public they necessarily receive some artificial conditioning which involves colour and extract adjustments and, in some cases, the extra addition of flavouring and aromatic ingredients. Before receiving this conditioning these blends are characterized by low "body" value, weak aroma, very low non-alcohol number, and extremely low extract content. Since rums of very low extract are considered as relatively young and immature, it is the custom to add considerable amounts of sugars of various kinds in order to bring up the content of total extract. Sugars-free extract is by necessity low in this class of blended light rums.

[1] See *I.S.J.* indexes since 1940 under Arroyo; and *I.S.J.*, 1947, pp. 292, 325. [2] *I.S.J.*, 1946, p. 163.

Problem of Straight Light Rum Production.

Two questions arise : (1) why do difficulties occur in the production of straight rums in the so-called light types ? and (2) would it be possible to produce the genuine light type without recourse to blending with neutral spirits, and without the need of artificial adjustments of body, bouquet, taste, colour and extract ? Our answer to the first question is that present fermentation and distillation methods in most rum distilleries preclude the obtaining of straight light rums ; to the second question our answer is in the affirmative. It is the purpose of this article to offer a few suggestions as to how straight light rums may be obtained.

At the present time, most distillers think it cheaper and easier to produce rum and neutral spirits, and then mix them together in the desired proportions for the production of light rums for the market. We grant that this may be the easier way out, but disagree as to its being the cheaper. Even if present techniques were both cheaper and easier, they certainly do not produce the best quality drink. Besides, the obligatory introduction of extraneous ingredients for the final conditioning and adjustment of the commercial product bring the element of uncertainty, and the danger of using ingredients perilous to the public health. Also, these methods may enter into conflict with future governmental regulations that may restrain, or entirely forbid, some of the practices involved in the existing manufacturing methods. Let us then offer some suggestions for the effective production of these rums that would obviate the present and future difficulties.

It is well-known that blackstrap molasses, in its natural state, contains chemical impurities and microbiological contaminations that in rum distillery practice militate against the obtaining of light straight rums. Among the former we may mention pectic substances (gums), certain proteins, and excessive ash content ; and, among the latter, the various infecting micro-organisms in the form of yeasts, bacteria and moulds. The amount and kind of proteins contained in the molasses are of particular importance in the quantity and quality of congeneric products of alcoholic fermentation produced, since it is from this source that the yeast manufactures such substances as fatty acids and higher alcohols, which, in turn, interact for the formation of organic esters. All of these bodies enter into the formation of the so-called non-alcohol number, or the non-alcohol coefficient of rums.

The mechanism of the formation of these congeneric products from the available proteins in the molasses is the following : Proteolytic enzymes, always present during alcoholic fermentation, act upon the proteins, degradating them, or some of them, into amino-acids. Then the yeast obtains nitrogen by splitting off ammonia from these amino-acids. When this splitting occurs, in every case either an alcohol or an acid is formed with one less carbon atom ; for example $R . CH . (NH_2) . COOH + O$ yields $R . CO . COOH + NH_3$. The ketonic acid loses CO_2, forming an aldehyde with still one less carbon atom ; thus, $R . CO . COOH$ yields $R . CHO + CO_2$. The resulting aldehyde $R . CHO$ forms then an alcohol or an acid, by reduction or oxidation respectively. Thus $R . CHO + O$ yields $R . COOH$; and $R . CHO + 2H$ yields $R . CH_2 . OH$, R representing an organic group which differs for each amino-acid. The higher alcohols and the acids produced play an important part in the formation of flavour and aroma, both by themselves and through combination into esters during the fermentation and distillation of the rum.

Conditioning the Mash.

When adequate amounts of nitrogen are available to the pitched yeast in the forms of ammonia water or ammonium salts of inorganic acids, such as ammonium sulphate or phosphate, the degradation of proteins in the mash by the proteolytic enzymes is greatly reduced or entirely eliminated, the yeast using preferably the added nitrogen in the forms of ammonia water or inorganic ammonium salts. This brings about the subsequent lesser formation of congeneric products, and the resulting rum will have natural characteristics of a light type. Hence, the first step to take for the production of straight light rums will be the purification and conditioning of the raw material previous to its being acted upon by the yeast during fermentation. This stage of light rum manufacture can best be accomplished by converting the molasses into a "thick mash" of between 50 and 65° Brix. Then to this thick mash is given a suitable heat treatment, adding at the same time the calculated amounts of such chemicals as shall condition it for the production of light rums during fermentation. Addition of suitable amounts of sulphuric and phosphoric acids will precipitate both inorganic and organic impurities in a great measure, especially the objectionable excess of ash ; and the heat treatment will clean the material of the infecting micro-organisms in their vegetative stage. The precipitated impurities of organic and inorganic nature are then separated in a special type of solid bowl centrifuge. The purified and conditioned run-off is cooled and used as the new raw material for fermentation.[1]

Selecting the Right Yeast Strain.

The second step consists in having the right sort of yeast strain specially selected for the production of light rums. A study of the various strains of rum yeasts shows that they differ quite appreciably in the production of congenerics during rum fermentation.

[1] A more detailed account of these operations may be found in the writer's specification, U.S. Patent 2,295,150, entitled "Ethanol Fermentation of Blackstrap Molasses"; *I.S.J.*, 1943, p. 250.

Some are naturally good producers of large amounts of congeneric products, while others produce these metabolic products in much lesser amounts. No doubt the enzyme systems possessed by different strains are responsible for these variations to a great extent. Again, yeast strains will differ not only in the total amounts of congenerics produced, but also in the kind of these congenerics, a fact of great importance to rum producers. The above characteristics, important as they are, should not be the only qualities to look for in the selection of yeast for rum production. We must also be certain that the yeast strain selected for purposes of light rum fermentation is a fast converter of hexose sugars into alcohol, and that it is able to stand high alcoholic concentrations in the fermenting substrate. In the fermentation of blackstrap molasses for the production of light rums, these latter characteristics are essential in the yeast, since a high percentage of alcohol must be developed in the shortest possible period of fermentation. When we refer to high alcoholic concentrations, we have in mind percentages of from 10 to 13 by volume. We have thus established that the yeast selected for straight light rum production from blackstrap molasses should have the fol'owing characteristics : (*a*) it must produce a small amount of the suitable kind of metabolic products other than ethyl alcohol itself ; (*b*) it must be a rapid converter of total sugars into alcohol, so that a short period of fermentation will result ; and (*c*) it must be able to build up. and stand without loss of vigour, high alcoholic concentrations in the fermenting liquid.

Precautions in Fermentation.

The third step to consider is the method of fermentation to be followed at the distillery. In the first place we must make sure that the footing of yeast that will serve as seed for the fermenters is composed of young, active, healthy cells, in the right amount and in pure culture. That is, no contamination should be present in this seed, however small and seemingly insignificant ; an adequate cellular concentration should be present per unit volume of mash. Nothing below 50 million cells per c.c. of mash should be available in the fermenter at the initiation of fermentation. This will necessitate about 500 million cells per ml. in the footing that will seed the fermenter when a 10 per cent. yeast footing is used as starter. The fermenters should preferably be of the closed, aseptic type, with provision for very effective cooling of the fermenting liquid all the time during the fermentative lapse. The danger of infection during fermentation must be entirely avoided or, at least, reduced to a minimum. A stirring device placed at the bottom of the fermenter should be put into action towards the finishing stages of fermentation so as to refloat the yeast cells that tend to settle and accumulate on the bottom of the fermenter. This will bring about a quicker and sharper finishing of the fermentation process. Strict temperature control should be maintained during fermentation. This will avoid premature exhaustion of the yeast, as well as the production of the phenomenon of "stickiness," by which is meant the paralysis of the yeast's activities when considerable amounts of fermentable hexoses are still present in the fermenting substrate. High fermentation temperatures also operate very effectively in producing endoproteolysis and autolysis of the yeast cells ; when this happens a great many products of decomposition are formed, many of which are later responsible for foul odour and bad taste in the distilled spirit. Rather low *pH* values should be used (within the range 4·5 to 4·7), and the total sugars concentration at setting should never exceed the optimum found for the yeast strain in use. Sufficient and well-balanced yeast nutriments should be present in the fermenting medium so that no retardation of fermentation may be occasioned through poor conditions of nourishment. The temperature of fermentation must be controlled within narrow limits (27 to 31°C.), and the total period of fermentation should not exceed 30 hours.

Procedure in Distillation.

The fourth step is the proper distillation of the treated "beer." In order to liberate suspended solid impurities from it, including yeast cells, bulk centrifuging of the fermented mash should be done. This separation of all solid impurities before submitting it to distillation will, in a great measure, eliminate rank odour from the distillate, since the greatest source of rankness in recently distilled spirits comes from the over-heating of these nitrogenous solid particles on the plates and sides of the distilling column.

Distillation should take place in a modern rum still of the continuous type. A one-column still is not suitable, as in this type of apparatus the only possible control is that of proof. The distillation outfit should include a purifying column by which selective extraction may be practised during distillation. It is the purpose of this column to eliminate those rum constituents which are not desirable, and to keep in the final product the desirable ones. The product should be drawn continuously from the base of this purifying column ; while objectionable products are vaporized and condensed in a separate condenser at the head of this purifying column. The distillation may be kept within the range 170 to 180 American proof (85–90 per cent. alcohol by volume), and for best results a vacuum still should be used.

When all these precautions are followed it becomes quite feasible to obtain straight light rums. Most rum distilleries are, however, not equipped for this technique, so that they are compelled to resort to blending, but the straight unadulterated product would unquestionably be greatly preferable. We believe that all blended rums should be required by law to be so labelled, as in the case of whiskeys.