Rum.

By W. M. Miller.

AS one of the commercial products of the colony, the subject of this paper is one concerning which but little has been written. It does not even form a topic of conversation amongst the planters. In reports on estate's work it may have a few lines devoted to it; but it is seldom that any genuine interest is taken in it, either in its manufacture or in its quality. The usual feeling is that the rum makes itself, and does not require any looking after. The molasses is diluted and the wash distilled; and if the results are low, the molasses is blamed; and if the rum is bad, the distiller gets a reminder.

But in these latter days there has been a brightening up of interest about rum. The Government meditate new legislation; and home buyers are becoming more fastidious owing to the quantities of continental root spirit, called "Rum," that are thrown on the English market. This latter reason soon affects the manager of the estate, and for some time there is continuous rubbing of hands and sniffing, with more or less satisfaction—generally less. The smelling business is not satisfactory, and to those more initiated the dilution with water seems uncertain. Altogether there is a general feeling that something is wanted, like a polariscope for sugar, that will give in a figure at once, whether the sample is good, bad, or indifferent. But the polariscope only serves to pass or condemn non-chemical sugar, it, unfortunately, cannot gauge the price of a yellow sugar.

We have the misfortune to cater to a fancy of the most changeable type. So it is with rum. We have to suit an unknown personal taste, and, let us do our best, if we halve a sample, A. will laud it, while B. will probably call it "beastly stuff." But the chances are that B. does not know what a good rum is, as the sniffing test is still fashionable; and we come back again to the desirability of a "polariscope," wherein B's taste is the optical part that indicates "beastly stuff." In others words, if we had such ready chemical tests as could permanently record B's taste in some fixed way, we should be able to avoid shocking B., and at the same time to please A.

It is with the hope, therefore, that some universal method may be introduced, not only here but by the buyers also, so that every one's particular liking may be recorded in figures, that I have come forward with the following contribution to the subject. The "everybody" in this case is probably a few individuals in two or three markets.

Another reason that should demand the more systematic analysis of rum is the desire to guard our product from being imitated by the Continental spirit. Unless analyses of the genuine spirit be well known and widely circulated, analysts would find some difficulty in distinguishing the genuine from the imitation.

In no book or paper have I met with any analysis of rum. Writers content themselves with the mere mention that Rum is the spirit obtained from the fermentation of cane sugar molasses. BLYTH further gives the usual strength, and that it is always slightly acid, about ·5 per cent. (whatever that may be is doubtful), and that the solid residue varies from ·7 to 1·5 per cent. and the ash seldom more than 0·1. ALLEN goes a little further and says: "The characteristic "flavour of rum is due to the presence of ethyl butyrate "and formate." He further gives the means by which some factitious rums are concocted, and then mentions that "the presence of formates *might perhaps* serve to "distinguish genuine rum from a factitious product." Beyond the above, on rum proper, very little has been printed; but on the examination of spirits, mostly for impurities, there is scarcely any limit.

The examination of the rum should take place on the estate. Very little or nothing can be done after it has left the estate. But first I may be excused if I very briefly indicate some points that influence the rum while it is still in the fermentation vats.

The usual custom here is to allow the fermentation to proceed spontaneously, and if a return of 5 per cent. to 6 per cent. of 40 O.P. spirit be obtained from wash set up at 1060 the result is considered satisfactory. It may be interesting to calculate the highest possible that may be obtained, as the point is connected with the proposed legislation, which requires that for every 5 deg. of attenuation of the wash (water=1,000), three-fourths of one gallon of proof spirit shall be obtained. There is some uncertainty in the above requirements. Is it three-fourths of a gallon measured at 80 deg. F. of proof spirit that is required, or is it three-fourths of the standard gallon that only exists at 51 deg. F. and weighs 9.2366 lbs.? This is a matter, to the revenue at least, that is of considerable importance, for the weight of the gallon of proof spirit that exists at 80 deg. F., weighs only 9.109 lbs. The difference in the definition between the gallon of water and the gallon of proof spirit is, that, in the case of water, it is that *volume* of water that weighs 10 lbs. at 62 deg. F., while in the case of spirit it is *the gallon* of spirit that at 51 deg. F. weighs 9·2366 lbs.

By direct experiment it has been found that on fermentation the following results are obtained :—

	100 parts Sucrose produce.	100 parts Glucose produce.
Alcohol	51·11	48·40
Carbonic Acid	49·42	46·60
Glycerine	3·16	3·30
Succinic Acid	0·67	0·61
Cellulose, fat, etc. ...	1·00	1·20

It will be noticed that 100 parts sucrose produce 105·36 in different bodies; as in the invertion of the cane sugar, water (or the elements of water) is assimilated, and the solution becomes denser.

If, therefore, a wash be set up with sugar at a density of 1060, the density will increase to 1063 before attenuation sets in. Which of these is the true "originate" density? If the first, then the 3 deg. extra cannot be claimed, nor its production of 0·47 gallon proof spirit per 100 gallons wash. And if the second, the question may arise, when is the density of the wash to be taken?

The same weight of sucrose or glucose will set wash at the same density, but the return in the first case will be much higher than in the second. To put it in popular terms, suppose two vats set up at 1060, A. with sucrose, and B. with glucose, and they both completely ferment. The ultimate density of A. would be 986·8 while that of B. would be 987·4, and the return of A, per 5 deg. of attenuation would be 1.19 gallons of proof spirit (standard), and for B. 1.13, or a return of 17.45 per cent. proof spirit for A, and 16.74 per cent. for B.

This difference in the theoretical maximum is of importance. To legislate with such divergence in the standards, not to speak of the uncertainties, would at least be conflicting. One way by which to avoid this, would be to calculate all sucrose into glucose and take the increased density as the true original density. The theoretical maximum would then be 1.13, and the government requirements 66.37 per cent. of the theoretical maximum. This figure seems a very fair one, and one that should be very easily attained: and yet, in practice, during careful working, it has barely been reached.

In practice, as before stated, it is usual to allow the fermentation to proceed spontaneously. The addition of sulphuric acid or ammonia sulphate does not in the least start the fermentation. They may, or may not, improve the wash and make it a more suitable medium for the development of the yeast, but unless yeast in some way gets added, the addition of any quantity of these bodies can be of no use in starting fermentation. During grinding operations little trouble is found in starting fermentation through the addition, one way or the other, of the highly fermentable washings and scums; but if distillation has to be conducted by itself, after a period of rest, the trouble in starting a good fermentation and the low results, will no doubt be remembered by any one who has had to deal with it. To find the reason of this we must consider what fermentation is.

Alcoholic fermentation is the change a saccharine solution undergoes when the yeast plant developes in it. Being a plant, yeast wants food very much the same as other plants, and unless the foods are there it will not develope. But every variety of plant has one special soil best suited to it; and if it is our object to cultivate any particular plant, it is to our advantage to give it the food on which it flourishes best. Yeast requires carbohydrates such as glucose, mineral matter in the form of potassium phosphate with a little of the phosphates of lime and magnesia, and albumenoid bodies which must be in the soluble state. The reason why these foods must be in the soluble state, is that the yeast only feeds, as it were, through its skin.

In molasses, we have the carbohydrates and probably sufficient alkaline phosphates, but the soluble albumenoids are altogether wanting. It is owing to their absence that fermentation is not readily started in molasses. In cane juice, on the other hand, these albumenoids are in the best assimilable state, and hence the rapid fermentation that is so easily set up. We have here a very easy means then of establishing fermentation in molasses.

A little "cush-cush" can be made at a moment's notice, which, when once fermented, will serve to start the vat. The yeast when once started has the power to render soluble the insoluble albumenoids that exist in the molasses, so that the fermentation will then proceed of itself.

The advantage of establishing a vigorous and healthy fermentation cannot be too strongly recommended. It alone produces a pure alcohol. The languid insipid vat is productive of fusel oil, besides becoming an easy prey to the action of deleterious ferments.

Yeast develops best in a slightly acid medium—this acidity should not exceed 1 per cent.—and at a temperature of 92 deg. F. If the temperature rises higher, its power is weakened, while that of its enemy, the lactic acid ferment, is increased. The lactic acid ferment developes best in a neutral medium at a temperature of 112 deg. F., but if the acid amounts to 2 per cent. its action is stopped. But, on the other hand, if the acid is allowed to accumulate, mouldiness is set up.

The only means of escape then is to start such a vigorous fermentation that the predominance of the yeast will entirely obscure the harm done by the other ferments or kill them to a great extent; for in fermentation, as well as in everything else, it is only that which is adapted to the environment that flourishes.

As it is in the beginning of the fermentation that the lactic acid ferment is likely to get a hold, the necessity for quick starting of the alcoholic fermentation is obvious. Towards the end both the alcohol and the acid developed keeps it in check, but neither of these (the alcohol and acid) restrain much the action of the acetic acid ferment which begins to be very evident towards the end of the alcoholic fermentation. The appearance of a peculiar film on the surface of the wash indicates the presence of a species of Saccharomyces that is busy changing the spirit into acetic acid. It should be beaten down under the surface where it cannot obtain the oxygen necessary to destroy the spirit.

This is not the Acetic Acid ferment proper. It developes throughout the whole wash and is quite a different organism. It flourishes best at the same temperature as yeast and is thus difficult to restrain, but as it only appears after the alcohol is formed, much damage by it may be avoided by distillation at once.

The butyric acid ferment feeds on the fatty matters present. It is to the acid that this ferment produces, in combination with the alcohol, that the flavour of rum is partly due. The distillation of the wash should be conducted as regularly as possible. Any rapid increase in the temperature forces over impurities that otherwise should be retained by the rectifier. The temperature at the exit of the rectifier should not exceed 180 deg. F.

The following bodies come over with the spirit.

1. *Acetaldehyde.*—This body boils at a temperature 69·8 deg. F. and constitutes most of the vapours that come over at the starting of a distillation. Owing to its solubility in alcohol and especially the peculiar property "fusel oil" has of raising its boiling point, it, although considerably concentrated in the "heads," comes over during the whole distillation. As regards its formation, it may be produced at the expense of the alcohol, but I am of the opinion that, in this particular case, it is formed towards the end of a distillation, from the decomposition of the lactic acid, and passes into the low wines to appear in the "heads" of the next distillation. It is obvious then that if the "heads" are run into the "high-wines" side, the rectification is in great part undone. It possesses a pungent smell which is not altogether unpleasant. Its vapour is inflammable. Its presence in rum can be indicated by many tests, but probably in old rum it will all have become changed into acetic acid.

2. *Ethylic formate and acetate.*—The ethers—The first of these bodies boils as 130 deg. F. It possesses the delicate odour of peach-kernels. It is partly to this

ether that rum owes its characteristic odour. Unfortunately, coming over with the "heads," it has to be in a great measure sacrificed for the production of a pure spirit.

Ethylic acetate is always present in rum. It boils at a somewhat higher temperature than the formate, but under that of alcohol; it also comes over in the first runnings. In a dilute state it has the pleasant smell of fruit. It is not lost in keeping, and in a rum with free acetic acid, the amount is increased.

Alcohol boils at 173 deg. F., and is a perfectly colourless liquid at ordinary temperatures. Its other properties are well known. Its action in strong doses is that of a narcotic poison. Absolute alcohol is 75·25 deg. over proof.

3. *Ethylic butyrate*, the remaining ethereal salt that is found in rum, has a boiling point of 248 deg. F. It possesses a pine-apple odour. It is made commercially as a fruit essence, and constitutes the greater part of "Rum Essence" used in manufacturing factitious rums.

4. The mixture of higher alcohols generally termed "*Fusel oil*" has a boiling point of about 266 deg. F., but not being a definite compound no exact boiling point can be fixed. It is a mixture in varying proportions of propyl, butyl, and amyl alcohols, besides some oils of high boiling point. The propyl alcohol boils at about 200 deg. and has a pleasant fruity smell; butyl alcohol has a most unpleasant odour and boils at about 227 deg. F.; while amyl alcohol boils at a much higher temperature and has a strong smell and burning taste. They are all poisonous, amyl being the worst. Their intoxicating effect is in the order I have taken them, amyl being

fifteen times, and butyl five times, the strength of ordinary ethyl alcohol.

5. *Acetal* is present in most rums to a very small extent. In some no re-action was found. It, as well as acetaldehyde, acts, it is said, first as irritants on the mucous membrane, and then on the nerves.

Exact boiling points have been given for most of the bodies enumerated above that are present in rum, but that does not enable us by keeping one temperature to separate one from all the rest. In a mixture of bodies which are all in solution, the boiling points are, as it were, blended into one another, and how much one may be separated from another is fixed by a definite law. Thus although acetaldehyde and ethylic formate and acetate come over first in greatest quantity, their presence is found in rum in which the "heads" were returned to the "low wines;" and, on the other hand, although the temperature of the rectifier never approached the boiling point of "fusel oil," we have the misfortune to find it in the rectified spirit. Most of the bodies enumerated give distinctive colours when treated with strong clear sulphuric acid, and a very good insight into the running of a still may be obtained by this simple means.

Measure out 25 c.c. of the alcohol into a small glass flask, and drop in 15 c.c. strong sulphuric acid. Pure alcohol when treated in this way gives no colouration, but the presence of aldehyde gives the solution a brown colour, and the fusel oil a dark purple.

Tested in this way, the "heads" of a still give very deep dark browns, which fall very quickly and give place to a pink with a trace of blue; which continues till about the time when the "low wines is cut," when there is a sudden rise of colour, the dull purple predominating. The white rum itself can be tested in this way, and fair comparative results obtained.

Standard colours made from strong solutions of chlorides of iron, copper and cobalt, will serve for yellow, blue and red. The quantity of each taken to colour a quantity of water, the same volume as the mixture of alcohol and sulphuric acid, is recorded. The only difficulty is in the use of the standard colours, and that I hope will be overcome by the use of LOVIBOND'S tintometer. This instrument is divided into two parts, in one of which coloured glasses are put one after the other, till the same colour is obtained as the sample being tested, which is in the other. Both are viewed through one eye-piece so that no defects in the optical powers of the observer can influence the reading. The glasses have certain values which can be transmitted to paper directly, and thus the exact colour produced in the rum can be recorded at once.

The uses of this instrument to persons employed on a sugar estate are many. In the manufacture of yellow sugar it could be used for examining syrups and sugars, and in colouring rum, it would be invaluable.

The testing of rums which are already coloured, with sulphuric, of course cannot be done. It becomes first necessary to distil it from the colours. This should be done rapidly without the addition of any alkali, till all has passed over that can, without burning, the first-third and second-third being caught separate from the last. Halve each of the thirds, and mix them, this will represent the rum; and test the other portions separately. These separate portions will give further insight into the nature of the rum. The colours produced are estimated as before.

"Colour" used for rum often introduces bitter bodies that spoil the flavour, besides a considerable quantity of free acid. White rum very seldom reaches 0.05 per cent. by vol. of (acetic) acid, while 0.25 per cent. is not uncommon in a coloured rum. "Colour" before being added to the white rum is composed as under.

	I.	II.	III.
Specific Gravity	1·3153	1·2775	1·2377
Alcohol	9·904	10·400	10·720
Organic Matters	62·462	60·128	47·432
* Mineral Matters	3·634	6·372	4·148
Water	24·000	23·100	37·700
* Soluble in water	2·331	4·398	3·367

The results given in the table on the following page are the analyses of Demerara coloured rums. The methods used would not form very readable matter, but for those interested I may mention that the ethereal salts have been assayed by estimating the Barium salts of their acids; while the "fusel oils" were done by RŒSE'S method as modified by STUTZER and REITMAIR. The volume of Chloroform at a temperature of 80 deg. F. for pure, 30 per cent. alcohol, was found to be 22.1 c.c.

ANALYSES OF DEMERARA COLOURED RUMS.

PERCENTAGE BY VOLUME.

	1	2	3	4	5	6	7	8	9
Alcohol	80·84	80·40	79·19	77·39	76·68	80·56	77·32	80·98	80·19
Higher alcohols "fusel oil" ...	·8956	·7975	·4557	·5903	·6942	·6463	·3218	·9243	·1581
Ethylic formate	·0088	·0153	·0405	·0373	·0233	·0396	·0180	·0373	·0350
Ethylic acetate	·0243	·0231	.1258	·1563	·0645	·1018	·0542	·0636	·1229
Ethylic butyrate	·0101	·0334	·0499	·0510	·0115	·0302	·0165	.0186	·0661
Total acid (as acetic)	·148	·190	·196	·160	·196	·160	·166	.131	.136
Volatile acid (as acetic)	(·018)	(·018)	(·060)	(·024)	(·030)	(·016)	(·024)	(·021)	(·015)
Total solids (colour)	1·040	1·210	1·750	1.510	1·420	·990	1·750	·680	1·050
Potash (K2O) absorbed by colour ...	(·1974)	(·2128)	(·2820)	(.2162	(·2068)	(·1795)	(·2256)	(·1955)	(·1974)