to hold it from turning. In sampling hay, the tube, after entering a short way, will drive itself without aid of the yoke and nut. Releasing the yoke at this time reduces the power required.

The diameter of the circular knife was chosen to give a cross-sectional area of 10 sq. cm.; and the length of the tube, to permit cutting to a depth of 100 cm. Cut to this depth the weight of the core in kilograms should give directly the specific gravity. Cutting to a lesser measured depth, the specific gravity may be readily calculated from the weight of the core in grams.

The cost of making a single machine, especially the reduction gearing, is quite high. The tube may be operated by hand, but the motor saves much labor. The makers state that the cost could be materially reduced by even small-quantity production.

The machine as described was constructed for the Department of Dairy Husbandry, University of Illinois, for use in connection with feeding investigations. It has been in use for two years with satisfactory results. The present form of tube requires considerable power, however, and in sampling very compact stuff to full depth the motor is slowed down to such an extent as to make it desirable to have more speed. A motor of greater power is therefore to be recommended, and the manufacturers state that one of their larger drill motors could be readily substituted. It may be possible, also, to modify the sampling tube in certain details so that it would require less power to operate.

Alcohol from Cane Blackstraps[1]

Effect of Varying Additions of Acid

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The acidification of cane molasses is one of the most important steps preparatory to its conversion into alcohol. The amounts of acid required have been found to vary, not only with the type of molasses used, but also with the race of yeast employed for its fermentation. The acid requirements of the various yeast cultures are more constant in Cuban than in Louisiana molasses. The addition of acid to both Louisiana and Cuban molasses results in an initial depression with the addition of the minimum quantity of acid, followed by a stimulation, and this in turn by a final depression after the optimum addition had been exceeded. The more efficient races of yeast seem more tolerant of wide variations in the acidity of molasses than the less efficient races.

THE acidification of the wort is one of the most important stages of manufacture through which molasses passes in its conversion into alcohol. It may be conservatively stated that it ranks second only to the process of yeasting in its effect upon the efficiency of alcohol manufacture from molasses. If unintelligently employed, it may render entirely ineffectual the utilization of the most efficient strains of yeast. On the other hand, the intelligent and discriminating use of acid may greatly increase the efficiency of the poorest strains of yeast, and may even direct the spontaneous fermentation of molasses wort into fairly productive channels.

In spite of its great importance, however, the control of acidification in molasses distilleries has not yet become a standardized procedure. There remains to be developed some method for measuring the acid requirement of molasses for distillery purposes, which can be used as a control measure. At the present time the general practice is to add a constant amount of acid to all types of molasses, irrespective of source or composition. It is not surprising, therefore, that unsatisfactory and unprofitable yields of alcohol frequently result from the improper acidification of the wort. Molasses with unusually large acid requirements is very susceptible to trouble from bacterial infection, when diluted and set up in the customary way. Apparently, the accurate and rational method of determining the acid requirement of molasses for distillery purposes would be by measuring the H-ion concentration. The purpose of this investigation, however, is to determine the effect of acid additions, rather than to seek ideal means by which the requirements for such additions can be correctly measured. Unfortunately, the methods of measuring H-ion concentration have not been developed to a point where they can be carried out as routine procedures in molasses distilleries.

[1] Received October 8, 1923.

Former Practice

Perhaps as a result of the variation in the buffer action of the salts contained in various types of blackstrap, which suppress the ionization of the added acid to varying degrees, recommendations of a very varied nature as to the amounts of acid required in the acidification of molasses wort are found in the literature.

Peck and Noel Deerr[2] state that an acid addition of 10 gallons of sulfuric per 1000 gallons of wort is the common practice in molasses distilleries. In their experiments, however, they use it in the proportion of 1 to 1000. Noel Deerr[3] states that in Demerara it is customary to add sulfuric acid at the rate of 1 gallon to 1000 gallons of wort. Humboldt[4] recommends an addition of only 1 gallon to 10,000 gallons of cane molasses wort, and Arnstein[5] prescribes such an addition of sulfuric acid as will give an acidity corresponding to 1.5 to 2.0 cc. of 1 N sodium hydroxide per 100 cc. Williams[6] claims that the molasses wort must contain 0.1 per cent free sulfuric acid, and Henneberg[7] states that the addition of 0.75 per cent of sulfuric acid to cane molasses wort resulted in twice as much alcohol as where only 0.1 per cent was added, and 1 per cent was better than 0.75. (Per cent here refers to cubic centimeters 1 N required for 20 cc.) Effront and Prescott[8] state that the best practice of acidification in cane molasses distilleries is to maintain an acidity equivalent to 1 to 2.5 grams of sulfuric acid per liter. Molhant[9] patented a process of fermentation in which the acidification was carried out with hydrochloric acid in the proportion of 3.5 cc. per liter.

The general practice in this country is to acidify with sulfuric acid in the proportions of 1 gallon to 1000 gallons of wort. In the Magne process, which is very extensively used in the fermentation of blackstrap molasses, sulfuric

[2] *Hawaiian Sugar Planters' Assoc., Bull.* **28**.
[3] "Cane Sugar," p. 568.
[4] *Louisiana Planter*, **68**, 206 (1922).
[5] *Ibid.*, **68**, 126 (1922).
[6] "Power Alcohol, Its Production and Utilization," p. 64.
[7] "Gärungsbakteriologische Praktikum," p. 188.
[8] "Enzymes and Their Application," p. 89.
[9] *Bull. assoc. chim. sucr. dist.*, **31**, 936 (1916).

TABLE I

Yeast	Molasses	Check Number	° Brix	Decrease ° Brix	Acid	Increase Acid	Sucrose %	Reducing Sugar %	Total Sugar %	25° C./4° C. Sp. Gr.	Alcohol Distilled %	Alcohol in Distillate from 200 Cc. Wort G.	Alcohol Theor. G.	Sugars Consumed %	Total Sugar %
No. 83	La.	1	5.24	11.50	8.0	3.9	...	0.67	....	0.97925	10.78	10.56	11.36	93.00	87.85
		2	4.89	11.85	7.9	3.6	...	0.58	....	0.97910	10.88	10.65	11.45	93.03	88.61
	Cuban	1	6.87	10.19	9.1	2.0	...	1.09	....	0.98204	8.88	8.72	9.24	94.38	84.50
		2	6.57	10.49	9.0	1.9	...	1.12	....	0.98197	8.92	8.76	9.21	95.11	84.88
Magne	La.	1	4.74	12.00	7.2	2.9	...	0.63	....	0.97870	11.16	10.93	11.40	95.80	90.85
		2	4.90	11.84	7.4	3.1	...	0.61	....	0.97893	11.00	10.77	11.42	94.32	89.60
	Cuban	1	6.72	10.34	7.8	0.7	...	0.91	....	0.98179	9.04	8.88	9.41	94.37	86.05
		2	6.57	10.49	7.9	0.8	...	0.83	....	0.98181	9.03	8.87	9.50	93.35	85.95
No. 74	La.	1	4.45	12.29	6.5	2.2	...	0.58	....	0.97899	10.96	10.73	11.45	95.74	91.18
		2	4.36	12.38	6.6	2.3	...	0.55	....	0.97844	11.35	11.11	11.48	98.90	94.43
	Cuban	1	6.57	10.49	8.1	1.0	...	1.11	....	0.98173	9.08	8.92	9.22	98.48	87.99
		2	6.67	10.39	8.1	1.0	...	0.90	....	0.98182	9.02	8.86	9.48	95.15	87.40
Controls	La.	.	16.74	....	4.3	...	6.80	4.48	11.64	......	....	....	12.02	....	....
	Cuban	.	17.06	....	7.1	...	3.76	6.03	9.98	......	....	....	10.32	....	....

TABLE II

Yeast	Molasses	Check Number	° Brix	Decrease ° Brix	Acid	Increase Acid	Sucrose %	Reducing Sugar %	Total Sugar %	25° C./4° C. Sp. Gr.	Alcohol Distilled %	Alcohol in Distillate from 200 Cc. Wort G.	Alcohol Theor. G.	Sugars Consumed %	Total Sugar %
No. 83	La.	1	5.02	12.10	9.5	3.7	...	0.84	....	0.97888	11.03	10.80	11.41	94.63	88.24
		2	4.82	12.30	8.1	2.3	...	0.76	....	0.97921	10.81	10.59	11.49	92.16	86.52
	Cuban	1	6.72	10.28	9.9	1.2	...	1.13	....	0.98150	9.24	9.07	9.57	94.79	84.85
		2	6.54	10.46	9.7	1.0	...	1.07	....	0.98148	9.27	9.10	9.63	94.53	85.13
Magne	La.	1	4.82	12.30	8.2	2.4	...	0.58	....	0.97885	11.06	10.84	11.67	92.89	88.56
		2	4.52	12.60	7.8	2.0	...	0.63	....	0.97899	11.02	10.79	11.62	92.85	88.15
	Cuban	1	6.62	10.38	9.4	0.7	...	0.98	....	0.98150	9.24	9.07	9.79	92.69	84.83
		2	6.62	10.38	9.5	0.8	...	1.11	....	0.98184	9.00	8.94	9.59	93.25	83.63
No. 74	La.	1	4.57	12.55	8.0	2.2	...	0.46	....	0.97886	11.05	10.82	11.78	91.85	88.40
		2	4.47	12.65	8.1	2.3	...	0.51	....	0.97850	11.30	11.06	11.74	94.21	90.36
	Cuban	1	6.81	10.19	9.4	0.7	...	1.10	....	0.98168	9.12	8.95	9.60	93.23	83.72
		2	6.62	10.38	9.5	0.8	...	1.03	....	0.98152	9.22	9.05	9.67	93.59	84.66
Controls	La.	.	17.12	....	5.8	...	6.69	4.80	11.84	......	....	....	12.24	....	....
	Cuban	.	17.00	....	8.7	...	3.98	6.15	10.34	......	....	....	10.69	....	....

acid is added in the proportions of from 0.8 to 1 gallon of acid per thousand of wort, the intermediate yeast tubs receiving an addition of 1.2 gallons of acid per thousand and the yeast apparatus in which the yeast culture is propagated receiving a still greater addition of acid. Owen[10] obtained a decreasing yield of alcohol upon the addition of acid in the proportion of 0.5 and 1.0 cc. per liter of Louisiana blackstrap wort and an increasing yield from this same treatment of Cuban blackstrap. The addition of both quantities of acid, however, did result in a closer agreement between the duplicate samples used in the experiments, which indicated the value of the acid addition in prevention of bacterial infection. The present investigation was carried out for the purpose of determining whether the results previously obtained would apply to blackstraps of the present time.

Experimental

The samples used were lower in total sugars, and one of them, the Cuban, much lower in purity. The analyses of the original samples were as follows:

Molasses	° Brix	Sucrose %	Invert Sugar %	Total Sugars as Invert %	Ash %	Gallons of U. S. Proof Spirits Potential Yield per Gallon of Molasses
Louisiana	78.6	32.85	21.84	56.42	6.13	0.965
Cuban	79.5	18.95	27.64	47.59	5.67	0.820

The following yeasts were used in the experiments: Cultures 83 and 74, obtained from the Scientific Station for Pure Products, New York City; *Saccharomyces ellipsoideus* and *cerevisiae*, obtained from the New York Museum of Natural History; two cultures, *X* and *Z*, obtained from miscellaneous sources, and a culture of the Magne yeast used in his process. All these cultures, with the exception of the ones obtained from the Museum of Natural History, are used in cane molasses distilleries and hence are thoroughly adapted to the conditions of these experiments.

PROCEDURE—The molasses was diluted to 16°–17° Brix, and 250 cc. were poured into 500-cc. Florence flasks. In every case the diluted molasses received an addition of ammonium sulfate at the rate of 1 gram per liter of wort, and sulfuric acid varying from 0 to 2.0 cc. per liter. The flasks were plugged with cotton and sterilized for 1 hour in an Arnold sterilizer. Duplicate flasks were used for each culture of yeast in every experiment. Upon cooling, the flasks were seeded with yeast obtained from a 24-hour culture in sterile wort of composition identical with that of the wort used in the experiment. Each flask received such an addition of seed yeast as to give it an initial yeast content of 1,000,000 cells per cubic centimeter. The inoculated flasks were kept in an incubator at a constant temperature of 32° C., where they were allowed to remain for 72 hours. Under the conditions of the experiment, the temperature and the activity of the seed yeast were maintained as nearly constant as possible.

ANALYTICAL DETERMINATIONS—Sucrose was determined by the Clerget method of double polarization, density by the Brix spindle, and reducing sugars by Low's method, using Soxhlet's solution and titrating the unreduced copper against sodium thiosulfate. The alcohol determinations were made by distilling and determining the specific gravity of the distillate with a pycnometer. The yields of alcohol were calculated on the maximum obtainable, and not upon the theoretical.

Results of Fermentation of Final Molasses

Series I (Table I)—No Sulfuric Acid Added

The agreement between the samples from the duplicate flasks was closer than in a previous investigation when no acid was added. The yields were good in every case—those from No. 74 being higher than the others, on both the Louisiana and Cuban blackstraps. The efficiency of the fermentation was higher on the former than on the latter product, and the ratio of efficiency of the yeast cultures on both types of molasses was approximately the same.

Series II (Table II)—0.5 Cc. Sulfuric Acid per Liter of Wort

It will be observed, in comparing the results in this table with those in the previous one, that the yields of alcohol calculated on the maximum were considerably lower than in the previous experiment in every case, with the exception

[10] "Facts about Sugar," 1922.

TABLE III

Yeast	Molasses	Check Number	° Brix	Decrease ° Brix	Acid	Increase Acid	Sucrose %	Reducing Sugar %	Total Sugar %	25° C./4° C. Sp. Gr.	Alcohol Distilled %	Alcohol in Distillate from 200 Cc. Wort G.	Alcohol Theor. G.	Sugars Consumed %	Total Sugar %
No. 83	La.	1	4.92	12.07	10.1	3.9	...	0.87	....	0.97928	10.78	10.56	10.91	96.79	89.79
		2	4.88	12.11	10.8	4.6	...	0.62	....	0.97872	11.17	10.93	11.15	98.03	92.94
	Cuban	1	6.58	10.46	12.2	2.3	...	1.16	....	0.98188	9.03	8.87	9.63	92.11	82.28
		2	6.58	10.46	12.7	2.8	...	1.06	....	0.98145	9.32	9.15	9.73	94.04	84.88
	Controls	La.	16.99	....	6.2	...	6.14	4.92	11.38	......	....	....	11.76	....	....
		Cuban	17.04	....	9.9	...	3.92	6.30	10.43	......	....	....	10.78	....	....
Z	La.	1	4.88	12.19	10.7	4.4	...	0.65	....	0.97865	11.20	10.96	11.66	94.00	89.76
		2	4.93	12.14	10.6	4.3	..	0.63	....	0.97876	11.12	10.88	11.69	93.07	89.11
	Cuban	1	6.69	10.53	10.7	0.9	...	1.52	....	0.98165	9.14	8.97	9.14	98.14	84.22
		2	6.64	10.58	10.9	1.1	...	1.46	....	0.98213	8.81	8.65	9.20	94.02	81.22
	Controls	La.	17.07	....	6.3	...	6.48	5.06	11.90	......	....	....	12.21	....	....
		Cuban	17.22	....	9.8	...	3.48	6.63	10.29	......	....	....	10.65	....	....
Magne	La.	1	4.70	12.44	11.2	4.8	...	0.62	....	0.97856	11.28	11.04	11.49	96.08	91.24
		2	4.75	12.39	10.6	4.2	...	0.51	....	0.97844	11.37	11.12	11.60	95.86	91.90
	Cuban	1	6.52	10.68	11.9	1.6	...	1.06	....	0.98081	9.71	9.52	9.77	97.44	87.99
		2	6.37	10.83	11.9	1.6	...	0.93	....	0.98142	9.29	9.12	9.90	92.12	84.29
	Controls	La.	17.14	....	6.4	...	6.21	5.11	11.65	......	....	....	12.10	....	....
		Cuban	17.20	....	10.3	...	3.73	6.53	10.46	......	....	....	10.82	....	....
X	La.	1	4.60	12.19	10.2	3.6	...	0.61	....	0.97949	10.62	10.40	11.33	91.79	87.17
		2	4.50	12.29	10.4	3.8	...	0.65	....	0.97922	10.80	10.56	11.29	93.53	88.52
	Cuban	1	6.67	10.53	12.0	1.7	...	1.00	....	0.98144	9.28	9.11	9.83	92.68	84.19
		2	6.57	10.63	11.7	1.4	...	1.14	....	0.98150	9.24	9.07	9.69	93.60	83.83
	Controls	La.	16.79	....	6.6	...	6.22	5.00	11.55	......	....	....	11.93	....	....
		Cuban	17.20	....	10.3	...	3.73	6.53	10.46	......	....	....	10.82	....	....
S. Ellipsoideus	La.	1	4.89	12.51	10.8	3.9	....	0.65	....	0.97864	11.20	10.96	11.34	96.65	91.48
		2	4.98	12.42	10.8	3.9	...	0.57	....	0.97878	11.10	10.86	11.42	95.10	90.65
	Cuban	1	7.17	10.03	11.9	1.6	...	0.95	....	0.98168	9.12	8.95	9.88	90.59	82.72
		2	6.67	10.53	11.2	0.9	...	1.11	....	0.98186	9.00	8.84	9.72	90.95	81.70
	Controls	La.	17.40	....	6.9	...	6.14	5.11	11.57	......	....	....	11.98	....	....
		Cuban	17.20	....	10.3	...	3.73	6.53	10.46	......	....	....	10.82	....	....
S. Cerevisiae	La.	1	4.61	12.57	11.0	2.1	...	0.63	....	0.97854	11.28	11.04	11.73	94.12	89.39
		2	4.65	12.53	11.2	2.2	...	0.63	....	0.97828	11.46	11.21	11.73	95.57	90.77
	Cuban	1	6.55	10.48	11.7	1.6	...	1.15	....	0.98165	9.14	8.97	9.49	94.52	84.38
		2	6.63	10.40	12.2	2.1	...	1.05	....	0.98165	9.14	8.97	9.59	93.53	84.38
	Controls	La.	17.18	....	8.9	...	6.47	5.13	11.94	......	....	....	12.35	....	....
		Cuban	17.03	....	10.1	...	3.82	6.26	10.28	......	....	....	10.63	....	....
No. 74	La.	1	4.54	12.71	10.6	3.8	...	0.60	....	0.97853	11.28	11.04	11.23	98.31	93.40
		2	4.67	12.58	10.6	3.8	...	0.60	....	0.97810	11.59	11.34	11.23	101.00	95.92
	Cuban	1	6.77	10.53	12.7	2.2	...	1.05	....	0.98169	9.11	8.94	9.76	91.60	82.78
		2	6.67	10.63	12.8	2.3	...	0.95	....	0.98180	9.03	8.87	9.86	89.96	82.13
	Controls	La.	17.25	....	6.8	...	6.00	5.10	11.42	......	....	....	11.82	....	....
		Cuban	17.30	....	10.5	...	3.44	6.82	10.44	......	....	....	10.80	....	....
Fleischman	La.	1	5.40	11.51	10.6	3.7	...	0.52	....	0.97949	10.38	10.17	11.00	92.46	86.35
		2	4.70	12.21	10.3	3.4	...	0.65	....	(110 cc.) 0.98139	9.31	10.05	10.88	92.37	87.32
	Cuban	1	6.65	10.41	12.3	2.5	...	1.02	....	0.98203	8.88	8.72	9.16	95.42	85.82
		2	6.70	10.36	12.3	2.5	...	0.99	....	0.98194	8.94	8.78	9.21	95.40	86.39
	Controls	La.	16.91	....	6.9	...	5.82	5.05	11.18	......	....	....	11.51	....	....
		Cuban	17.06	....	9.8	...	3.16	6.50	9.83	......	....	....	10.17	....	....

TABLE IV

Yeast	Molasses	Check Number	° Brix	Decrease ° Brix	Acid	Increase Acid	Sucrose %	Reducing Sugar %	Total Sugar %	25° C./4° C. Sp. Gr.	Alcohol Distilled %	Alcohol in Distillate from 200 Cc. Wort G.	Alcohol Theor. G.	Sugars Consumed %	Total Sugar %
No. 83	La.	1	5.30	12.14	11.5	3.7	...	0.52	....	0.97859	11.24	11.00	11.48	93.64	91.74
		2	4.80	12.64	11.9	4.1	...	0.53	....	0.97864	11.20	10.96	11.47	95.55	91.41
	Cuban	1	6.76	10.52	12.6	1.8	...	0.98	....	0.98188	8.98	8.82	8.92	98.88	89.68
		2	6.46	10.82	12.1	1.3	...	1.01	....	0.98206	8.86	8.70	8.86	90.19	87.97
Magne	La.	1	4.80	12.64	11.7	3.9	...	0.54	....	0.97821	11.51	11.26	11.46	98.26	93.91
		2	4.65	12.79	11.6	3.8	...	0.53	....	0.97812	11.57	11.32	11.47	98.72	94.41
Magne	Cuban	1	6.66	10.62	12.2	1.4	...	0.87	....	0.98165	9.13	8.96	9.03	99.23	90.60
		2	6.51	10.77	12.3	1.5	...	1.02	....	0.98190	8.97	8.81	8.88	99.21	89.08
No. 74	La.	1	4.65	12.79	11.3	3.5	...	0.58	....	0.97847	11.32	11.08	11.41	97.11	92.41
		2	4.70	12.74	11.5	3.7	...	0.53	....	0.97833	11.43	11.18	11.47	97.47	93.24
	Cuban	1	6.56	10.72	12.1	1.3	...	1.07	....	0.98166	9.13	8.96	8.83	101.47	90.60
		2	6.51	10.77	12.2	1.4	...	0.95	....	0.98169	9.11	8.94	8.95	99.89	90.38
Controls	La.	.	17.44	....	7.8	...	5.76	5.52	11.58	......	....	....	11.99	....	....
	Cuban	.	17.28	....	10.8	...	2.60	6.82	9.56	......	....	....	9.89	....	....

of No. 83 on Cuban molasses, when it was very slightly higher. The No. 83 yeast seemed to be least adversely affected by the small addition of acid. From the analyses of the controls given at the bottom of the table, it is found that the acidities of the worts after adding 0.5 cc. of acid were 5.8 cc. and 7.1 cc. 1 *N* sodium hydroxide per 100 cc. of the Louisiana and the Cuban wort, respectively. Even the unacidified molasses used in the previous experiment had a higher acid content (1.5 to 2.0 cc.) than that recommended by Arnstein.

Series III (Table III)—1.0 Cc. Sulfuric Acid per Liter of Wort

In this experiment four additional cultures were used to determine their relative fermentation efficiency. The results show that, without a single exception by all three cultures of yeast, the percentage yield of alcohol from the Louisiana molasses was greater than in either of the preceding experiments. On the Cuban molasses only the Magne yeast had shown an increase over the yields of alcohol previously obtained therefrom. Yeast 74 gave the best yield on the Louisiana but the poorest on the Cuban molasses. Of the new cultures used, *S. ellipsoideus* gave the highest yields on the Louisiana and *S. cerevisiae* the highest on the Cuban.

Series IV (Table IV)—1.25 Cc. Sulfuric Acid per Liter of Wort

The results of this experiment show that the further addition of acid increased the yield of alcohol from the Louisiana molasses only where the Magne yeast was used. Yeast 83 showed about the same percentage yield as in the previous experiment. With the Cuban molasses the increase in acid resulted in an increase in alcohol yield in every case. In this experiment the Magne yeast gave the best results on the Louisiana and the No. 74 slightly higher yields on the Cuban molasses.

Series V (Table V)—1.5 Cc. Sulfuric Acid per Liter of Wort

These results show that the addition of 1.5 cc. of acid per liter exercised a very depressing action upon all the cultures with the exception of No. 83, which still responded to the increasing acidification, with a higher yield. On the Cuban molasses the yeasts were even more retarded than on the

TABLE V

Yeast	Molasses	Check Number	° Brix	Decrease ° Brix	Acid	Increase Acid	Sucrose %	Reducing Sugar %	Total Sugar %	25° C./4° C. Sp. Gr.	Alcohol Distilled %	Alcohol in Distillate from 200 Cc. Wort G.	Alcohol Theor. G.	Sugars Consumed %	Total Sugar %
No. 83	La.	1	4.93	12.10	13.7	4.4	...	0.73	....	0.97961	10.53	10.32	10.69	96.44	90.45
		2	4.53	12.50	12.3	3.0	...	0.46	....	0.97887	11.05	10.82	10.96	98.72	94.83
	Cuban	1	6.43	10.62	13.9	1.4	...	0.96	....	0.98144	9.28	9.11	9.70	93.92	85.54
		2	6.53	10.52	14.0	1.5	...	0.99	....	0.98180	9.03	8.87	9.67	91.73	83.29
	Controls	La.	17.03	....	9.3	...	4.89	6.09	11.24	......	....	....	11.41	....	....
		Cuban	17.05	....	12.5	...	3.56	6.56	10.31	......	....	....	10.65	....	....
Magne	La.	1	4.88	12.19	11.5	2.7	...	0.59	....	0.97887	11.04	10.81	11.21	96.43	91.69
		2	4.63	12.44	11.8	3.0	...	0.60	....	0.97926	10.77	10.55	11.20	94.20	89.48
	Cuban	1	6.07	10.50	12.5	1.2	...	0.81	....	0.98163	9.16	8.99	9.64	93.26	86.12
		2	5.97	10.60	12.3	1.0	...	0.90	....	0.98189	98.97	8.80	9.56	92.05	84.29
	Controls	La.	17.07	....	8.8	..	5.05	6.08	11.40	......	....	....	11.79	....	....
		Cuban	16.57	....	11.3	...	3.19	6.76	10.12	......	....	....	10.44	....	....
X	La.	1	4.67	12.39	10.9	2.2	...	0.61	....	0.97982	10.39	10.18	12.04	84.55	80.54
		2	4.73	12.33	11.0	2.3	...	0.44	....	0.98024	10.10	9.90	12.20	81.16	78.32
	Cuban	1	6.42	10.74	12.3	0.9	...	0.83	....	0.98143	9.28	9.11	9.46	96.30	88.62
		2	6.27	10.89	12.4	1.0	...	1.01	....	0.98184	9.00	8.84	9.28	95.26	85.99
	Controls	La.	17.06	....	8.7	...	6.54	5.34	12.22	......	....	....	12.64	....	....
		Cuban	17.16	....	11.4	...	3.25	6.52	9.94	......	....	....	10.28	....	....
S. Ellip-	La.	1	5.33	12.14	11.5	3.1	...	0.56	....	0.97994	10.30	10.09	11.86	85.08	81.31
		2	5.23	12.24	11.2	2.8	...	0.64	....	0.98005	10.23	10.03	11.77	85.22	80.82
soideus	Cuban	1	6.60	9.88	12.5	1.0	...	0.96	....	0.98243	8.60	8.45	10.11	83.58	76.33
		2	6.30	10.18	12.3	0.8	...	0.94	....	0.98251	8.56	8.41	10.13	83.02	75.97
Cere-visiae	La.	1	5.13	12.34	11.1	2.7	...	0.63	....	0.97910	10.88	10.65	11.79	90.33	85.82
		2	5.28	12.19	10.9	2.5	...	0.58	....	0.97985	10.37	10.16	11.84	85.81	81.87
	Cuban	1	8.71	7.77	14.0	2.5	...	1.48	....	0.98452	7.25	7.14	9.59	74.45	64.50
		2	8.91	7.57	14.2	2.7	...	1.55	....	0.98588	6.89	6.78	9.52	71.22	61.25
No. 74	La.	1	4.88	12.59	10.6	2.2	...	0.61	....	0.97867	11.18	10.95	11.81	92.72	88.23
		2	4.88	12.59	10.3	1.9	...	0.63	....	0.97938	10.70	10.48	11.79	88.89	84.45
	Cuban	1	6.08	10.40	12.2	0.7	...	1.06	....	0.98195	8.93	8.77	10.02	89.12	80.67
		2	6.00	10.48	12.3	0.8	...	1.15	....	0.98255	8.54	8.39	9.93	86.00	77.15
Controls	La.	.	17.47	....	8.4	...	4.92	6.80	11.98	......	....	....	12.41	....	....
	Cuban	.	16.48	....	11.5	...	3.71	6.82	10.73	......	....	....	11.07	....	....

TABLE VI

Yeast	Molasses	Check Number	° Brix	Decrease ° Brix	Acid	Increase Acid	Sucrose %	Reducing Sugar %	Total Sugar %	25° C./4° C. Sp. Gr.	Alcohol Distilled %	Alcohol in Distillate from 200 Cc. Wort G.	Alcohol Theor. G.	Sugars Consumed %	Total Sugar %
No. 83	La.	1	5.79	11.31	12.0	2.0	...	0.69	....	0.98033	10.04	9.84	11.34	86.77	81.87
		2	5.74	11.36	12.4	2.4	...	0.75	....	0.97968	10.48	10.27	11.28	91.05	85.44
	Cuban	1	6.33	10.50	13.4	0.7	...	1.30	....	0.98171	9.09	8.92	9.36	95.30	83.76
		2	6.07	10.76	13.3	0.6	...	1.22	....	0.98193	8.95	8.79	9.44	93.12	82.54
Magne	La.	1	5.04	12.06	11.9	1.9	...	0.44	....	0.97889	11.03	10.80	11.58	93.26	89.85
		2	4.94	12.16	12.1	2.1	...	0.52	....	0.97887	11.04	10.81	11.50	94.00	89.94
	Cuban	1	6.13	10.70	12.7	0.0	...	1.39	....	0.98173	9.08	8.91	9.27	96.12	83.66
		2	5.68	11.15	12.7	0.0	...	1.30	....	0.98172	9.09	8.92	9.37	95.20	83.76
No. 74	La.	1	5.35	11.75	12.2	2.2	...	0.69	....	0.97994	10.30	10.09	11.33	88.65	83.94
		2	6.00	11.10	12.3	2.3	...	0.83	....	0.98057	9.87	9.68	11.20	86.43	80.53
	Cuban	1	6.79	10.04	13.1	0.4	...	1.46	....	0.98192	8.94	8.78	9.20	95.43	82.44
		2	6.09	10.74	13.1	0.4	...	1.34	....	0.98147	9.26	9.09	9.30	97.74	85.35
Controls	La.	.	17.10	....	10.0	...	4.45	6.94	11.62	......	....	....	12.02	....	....
	Cuban	.	16.83	....	12.7	...	2.71	7.46	10.31	......	....	....	10.65	....	....

TABLE VII—ALCOHOLIC FERMENTATION. SUMMARY—EFFECT OF ACIDITY OF WORT

	Louisiana Molasses									Cuban Molasses								
Yeast	Concd. H_2SO_4 Added, Cc./L.	Acidity H_2SO_4, G./L.	Brix Wort	Attenuation	Increased Acid, G./L.	Residual Sugars, %	Alcohol Distilled, %	Alcohol % Sugar Consumed	Alcohol % Total Sugar	Acidity, G./L.	Brix Wort	Attenuation	Increased Acid, G./L.	Residual Sugars, %	Alcohol Distilled, %	Alcohol % Sugar Consumed	Alcohol % Total Sugar	Growth Yeast Cells per Cc.
No. 83	0.0	2.11	17.06	50.3	1.86	0.63	10.83	93.03	88.23	3.48	16.74	42.3	0.96	1.10	8.90	94.75	84.69	
	0.5	2.84	17.12	51.2	1.47	0.80	10.92	93.40	87.38	4.26	17.00	43.7	0.54	1.10	9.25	94.66	84.99	
	1.0	3.04	16.99	50.7	2.08	0.74	10.98	97.41	91.37	4.85	17.04	44.1	1.25	1.11	9.17	93.08	83.58	
	1.25	3.83	17.44	52.1	1.91	0.52	11.22	94.60	91.58	5.29	17.28	45.1	0.76	1.00	8.92	98.54	88.58	47,000,000
	1.5	4.56	17.03	51.5	1.82	0.60	10.79	97.58	92.64	6.13	17.05	44.6	0.71	0.97	9.15	92.83	84.42	
	2.0	4.90	17.10	47.7	1.08	0.72	10.26	88.91	83.66	6.22	16.83	44.7	0.32	1.26	9.02	94.21	83.15	
Magne	0.0	2.11	17.06	51.3	1.47	0.62	11.08	95.06	90.23	3.48	16.74	42.6	0.37	0.87	9.03	93.86	86.00	
	0.5	2.84	17.12	52.2	1.08	0.60	11.04	92.87	88.36	4.26	17.00	43.8	0.37	1.04	9.12	92.97	84.23	
	1.0	3.14	17.14	52.1	2.20	0.56	11.33	95.97	91.57	5.05	17.20	45.4	0.78	1.00	9.50	94.78	86.14	
	1.25	3.83	17.44	53.4	1.89	0.54	11.54	98.54	94.16	5.29	17.28	45.1	0.71	0.94	9.00	99.22	89.84	45,000,000
	1.5	4.31	17.07	51.6	1.40	0.60	10.90	95.32	90.59	5.54	16.57	44.1	0.54	0.85	9.06	92.66	85.21	
	2.0	4.90	17.10	50.8	0.98	0.48	11.03	93.63	89.90	6.22	16.83	45.9	0.00	1.35	9.08	95.66	83.71	
No. 74	0.0	2.11	17.06	53.0	1.10	0.56	11.16	97.32	92.81	3.48	16.74	42.7	0.49	1.00	9.05	96.82	87.70	
	0.5	2.84	17.12	52.8	1.10	0.48	11.17	93.03	89.38	4.26	17.00	43.4	0.37	1.07	9.17	93.41	84.19	
	1.0	3.33	17.25	53.4	1.86	0.60	11.44	99.66	94.66	5.15	17.30	44.7	1.10	1.00	9.07	90.28	82.46	
	1.25	3.83	17.44	53.7	1.76	0.55	11.37	97.29	92.83	5.29	17.28	45.4	0.66	1.01	9.12	100.68	90.49	71,000,000
	1.5	4.12	17.47	48.8	1.00	0.62	10.94	90.81	86.34	5.64	16.48	43.9	0.37	1.10	8.74	87.56	78.91	
	2.0	4.90	17.10	48.1	1.10	0.76	10.09	87.54	82.24	6.22	16.83	43.8	0.20	1.40	9.10	96.59	83.90	

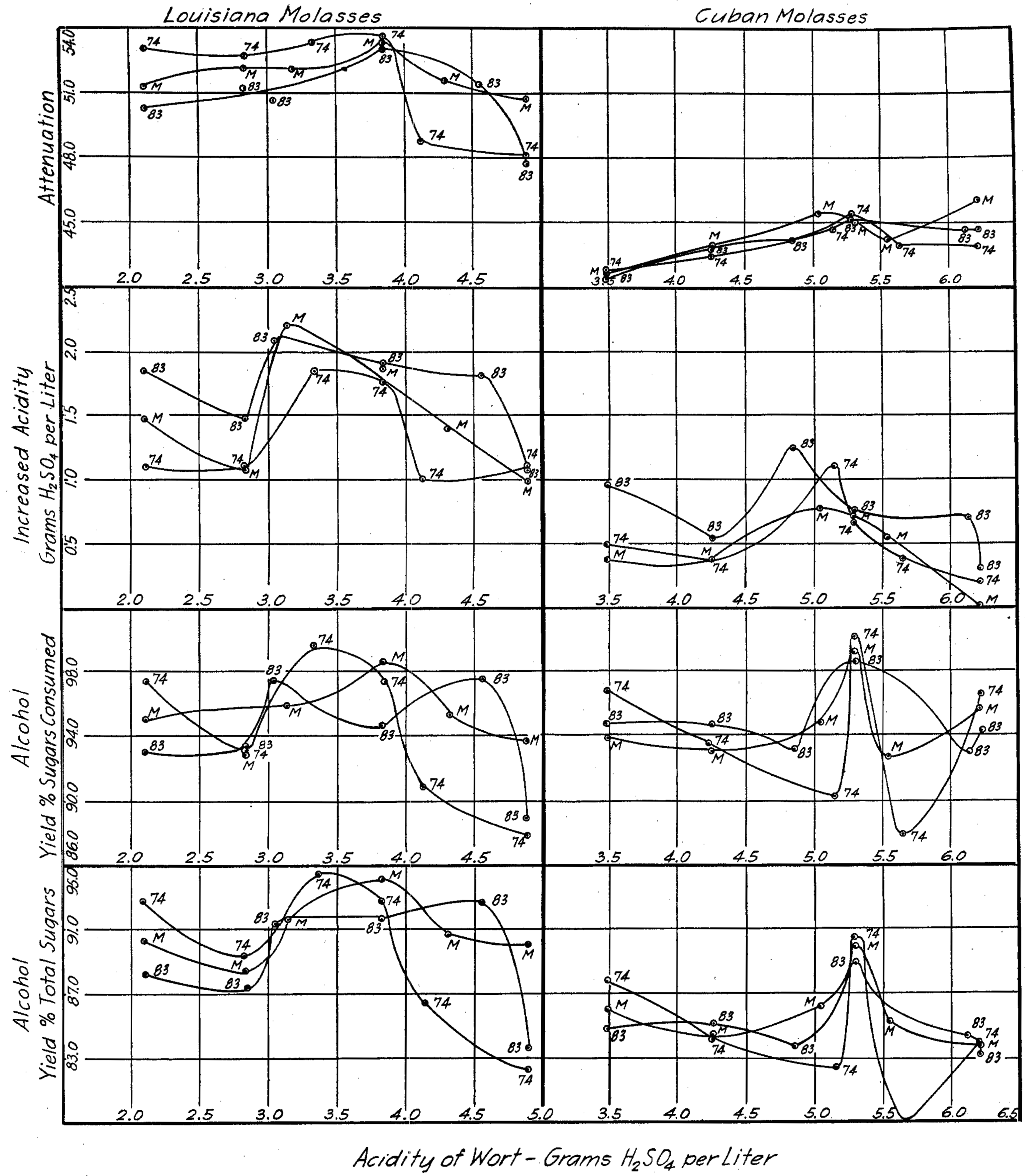
Louisiana, the Magne yeast alone showing the same relative decline on both types of molasses.

Series VI (Table VI)—2.0 Cc. Sulfuric Acid per Liter

These results indicate that the proportion in which the acid was added to both kinds of molasses exceeded the amount required for the maximum efficiency of all cultures of yeast. On the Louisiana molasses the Magne yeast was depressed least, and No. 83 most, of any of the cultures. On the Cuban molasses the latter culture was depressed least, and No. 74 most. The Magne yeast gave the highest yields.

SUMMARY AND DISCUSSION OF RESULTS

The results of the six tables are summarized in Table VII. In studying these data some very striking relations are observed between the efficiency of the various cultures of yeast as affected by the rate of acidification. For example, each culture of yeast has a different acid requirement, which differs in the case of most of the cultures for the two types of blackstrap. Thus, No. 83 gives the best yields of alcohol from Louisiana molasses acidified at the rate of 1.5 cc. per liter, while on Cuban molasses its maximum yield coincides



ALCOHOLIC FERMENTATION OF FINAL MOLASSES: ACIDITY OF WORT

with an acid addition of only 1.25 cc. The Magne yeast attains its maximum yield on both types of molasses, with an addition of 1.25 cc. per liter, and No. 74 attains its maximum at 1.0 cc. and 1.25 cc. for Louisiana and Cuban, respectively.

The variation in the maximum yields of alcohol produced by each culture under the varying degrees of acidification indicates the relative tolerance of the cultures toward wide ranges of pH. In this respect the Magne yeast seems to be the most tolerant and the No. 74 the least tolerant of the three cultures. In Table VIII the most important data in Table VII are still further summarized.

It is of significance to note that, while the optimum acidification of the Louisiana molasses varied from 1.0 to 1.5 cc.

for the different cultures of yeast, it was constant for all cultures with the Cuban molasses. The variation between the maximum and minimum yields was lowest with the Magne yeast on the Louisiana molasses, and with No. 83 on the Cuban. On both types of molasses it was highest with No. 74. The total average variation for the two types of molasses was lowest with the Magne yeast and highest with No. 74. The average yield on both types of molasses was highest with the Magne yeast. Since the variation between the maximum and minimum yields under varying acidification measures the tolerance of a culture to widely varying conditions of H-ion concentration, it follows that the culture showing the least variation is the most tolerant of these conditions; and since molasses of various types and compositions is presumed to vary greatly in respect to the buffer action of their salts, this tolerance on the part of a yeast contributes greatly to its efficiency in molasses distilleries.

TABLE VIII

Yeast Culture	Average Yield on Louisiana %	Variation %	Average Yield Cuban Molasses %	Variation %	Acidification Maximum La. %	Giving Yields Cuban %
Magne	90.8	5.80	85.86	6.13	1.25	1.25
No. 83	89.14	8.98	84.90	5.43	1.5	1.25
No. 74	89.70	12.42	84.61	8.03	1.0	1.25

The results of the preceding experiments are more strikingly brought out in the form of curves, as shown in the chart. A study of the curves on the bottom of the chart, giving yields of alcohol on total sugars, shows that on both types of molasses the curves have one property in common—namely, that they all show an initial decline upon the addition of the first amount of acid. The only apparent exception is in the case of No. 83 on Cuban molasses. The form of the curves for the different yeast cultures varies greatly. No. 83 rises abruptly to its maximum on Louisiana molasses, and assumes the form of a straight line, which it maintains for some length, then falls almost perpendicularly. The Magne yeast rises to a higher level, where it forms a rounded dome, while No. 74 rises more abruptly, forms a more pointed summit, and falls more sharply and to much lower levels than either of the other cultures.

On the Cuban molasses the initial decrease is more gradual, the rise to the maximum being almost perpendicular and the summits more pointed in every case. The peaks of all the different curves lie in the same perpendicular plane, thus illustrating the fact that the maximum yields by all the cultures were produced by the same acidification.

The initial decrease in the efficiency of the fermentation of both types of molasses approximately confirms the results obtained in the previous investigation. This initial depression, resulting from the addition of inadequate quantities of acid, has been known to result frequently from the use of insufficient quantities of acid in distilleries. Its cause is difficult to explain, but it is probably the result of the action of the organic acids liberated by the sulfuric acid. Where larger amounts of sulfuric acid are used, there is enough of that acid present to counteract the inimical effects of the free organic acids.

CONCLUSIONS

1—The acid requirements of blackstrap molasses for distillery purposes vary greatly with the strain of yeast used for its fermentation, as well as with the source of the molasses.

2—The variation in the acid requirement of the Louisiana molasses for the various yeasts used was greater than that for the Cuban.

3—The addition of insufficient amounts of acid depressed the yield of alcohol, by all of the yeast cultures, from both the Cuban and the Louisiana molasses.

4—The Magne yeast showed the highest efficiency on both types of molasses and the greatest tolerance of the various acidifications of any of the cultures used.

5—The acid requirement of any molasses for alcohol manufacture should be determined for each type of yeast used in its fermentation.

Tenth Chemical Industries Exposition Broadly Planned for 1925

IT IS predicted that the Tenth Chemical Industries Exposition, which is to be held during the week of September 28 to October 3, 1925, at the Grand Central Palace, New York, will be the greatest of any chemical exposition yet staged. There will be no chemical exposition this year, to the regret of many in the industry.

The decision to forego a chemical exposition in 1924 was made by a vote of the exhibitors at the last (1923) exposition. A decisive vote concluded that the exposition should be held in New York with an interval of two years, in order to give the chemical apparatus and machinery manufacturers opportunity to prepare exhibits and displays of the most interesting nature they could conceive and produce in the interval. Already the main floor is fully taken, most of the second floor, and some of the third.

From this it is seen a great and unusually interesting exposition is in view. New features are to be introduced. The coöperation of many prominent professional organizations is assured to make these feature sections successful and of direct benefit to technical men, as well as of broad general interest.

It is intended to develop a program of meetings of technical associations, institutions, and societies coincident with the exposition. Already three big national organizations have indicated their intention of coöperating with the exposition in this manner, but no executive authority permits announcing these intentions at this early date. This coöperation between the exposition and the technical organizations is an arrangement which benefits technical men from the industry and exhibitors alike; technical men may attend the meetings of their organizations and at the same time have the opportunity to study the exhibits. By the large gatherings such as the chemical exposition can bring together, exhibitors have increased opportunities over what a single unit could bring, and it is the purpose of those in charge to make the exposition of supreme benefit to technical men in every phase of chemical industry, to the profession, and to the nation.

An interesting development of the exposition is the series of meetings that are arranged for various technical associations. At these meetings exhibitors are invited to present discussions of their products, and thus give the technical men an opportunity to hear about the newest and latest products either completed or soon to be placed upon the market. Through such programs exhibitors have been able to place their products in plants in much shorter time than is usually required for their introduction, and industry, too, has been benefited. Associations for which these programs are arranged do not permit the presentation of papers of a commercial nature at their regular meetings, and this coöperation with the exposition frees the association of criticism through commercial relations and at the same time gives its members the advantages of such information.

The expression "bigger and better" is no empty phrase so far as the 1925 Chemical Exposition is concerned. It will meet the expectation of every interested person.