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SELECTION OF A YEAST STRAIN FOR SWEET SORGHUM FERMENTATION

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DISCLAIMER

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Abstract

Selection of a Yeast Strain for Sweet Sorghum Fermentation

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Seven natural and eight commercial yeast strains were tested for fermenting the high sugar content of sweet sorghum juice with a high yield of alcohol and a high percentage utilization of the sugar within a ten day period. The sorghum juice pH was adjusted to range between 4 and 5. A comparison was made with and without an added nitrogen source. Fermentation temperatures were maintained at 27°C.

The American Type Culture Collection #918, a Saccharomyces species fermented the sorghum juice at the 26 and 18-20 balling (brix). No yeast strain was found to ferment the 30 balling juice within a ten day period at 90% utilization.

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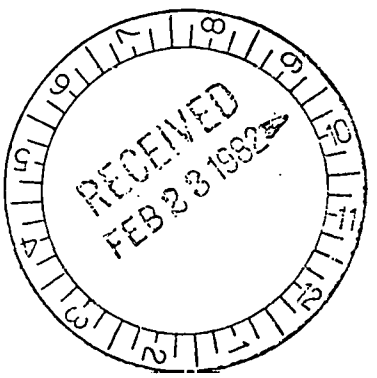


PURPOSE

To select a yeast strain which will ferment the high sugar content of sorghum juice at 27°C and yield a high alcohol content.

PROCEDURE

Yeast Procurement

The following cultures of yeast were purchased from the American Type Culture Collection, 12301 Parklawn Drive, Rockville, Maryland 20852.

ATCC # 26603	Saccharomyces cerevisiae
918	S. species
26602	S. uvarum

The above yeast strains are available free from the Culture Collection Research, Fermentation Laboratory, USDA, 1815 North University Street, Peoria, Illinois, 61604. NRRL Y-2034 Saccharomyces cerevisiae was received as an additional strain from this source.

The commercially used strains below were donated by Viking Distillery, Albany, Georgia.

Red Star (bakery yeast, dehydrated, Universal Foods)
Budweiser (compressed brewer's yeast)

Two additional commerical yeast tested were

Fleischmann's Active Dry Yeast (Standard Brands, Inc.)
Fisher's yeast (Brewers, Fisher Scientific Co.)

The natural yeasts were collected from plants or natural solution of high sugar content. The yeast were isolated by temperature gradients, thioglycollate medium, streak and pour plates of yeast maintenance agar, 20 and 25% glucose solutions at pH's of 3,4,5, and 6, and/or 5% sorghum sort. The more successful technic of isolating the natural yeast from other protista and procaryots was with the acid-glucose to pour plates, to microscopic examination, to YMA slants. The isolates were maintained on refrigerated YMA slants. The following natural yeast strains were tested.

AJC 01	from brochlli head, Lee Co., GA 4/22/81
AJC 02	from corn silk, Lee Co., GA 7/1/81
AJC 04	Sweet sorghum, Griffin Agriculture Expt. Sta., GA 6/17/81
AJC 05	Dyer's Sorghum juice, Blairsville, GA 10/18/80
AJC 06	Grain sorghum head, Richmond, GA 11/1/80
AJC 07	Grain sorghum head, Westover Road, Do. Co., GA 1/21/81
AJC 08	Grain sorghum head, Silk Hope Road, Chatam Co., NC 9/1/81

Media for Fermentation

Sorghum syrup was purchased from Roy Farrell of Cordele, GA, and from New Communities, Inc., Leesburg, GA. Sorghum juice (one squeezing) was purchased from the Dyers, Blairsville, GA. Dilutions and readings of sugar content was made by use of Balling (Brix) hydrometers. The sorghum juice had an initial balling of 18.5 - 21.5. Undiluted syrup has more than a 30 balling.

The pH of the fermentative medium was adjusted where necessary to range from 4 to 5 with H_2SO_4. A nitrogen source in the form of 0.8% Ammonium Monophosphate $[(NH_4)_2HPO_4]$ was added to some media. 400 ml. of medium was used per fermentation. The medium was sterilized in the fermentation flasks prior to inoculation.

Yeast Wort

Yeast strains were transferred to a 5 balling sorghum dilution. 40 ml of wort was used as the inoculum for the flasks. During fermentation, the aeration or lack of areation did not alter the results.

Fermentation Flasks

A 500 ml Erlenmyer flask outfitted as in Diagram A served as the fermentation flask.

Alcohol Produced and Percent Utilization

The amount of alcohol produced was computed by determining the difference between the original balling measurement from the subsequent readings and multiplying by the maximum alcohol production factor, 0.511. The amount of sugar used by the yeast strains for fermentation divided by the original balling reading equals the percent utilization.

When the balling reading did not change after successive readings, fermentation was assumed to have ceased. Dilution plate technic was used to count the yeast after each reading.

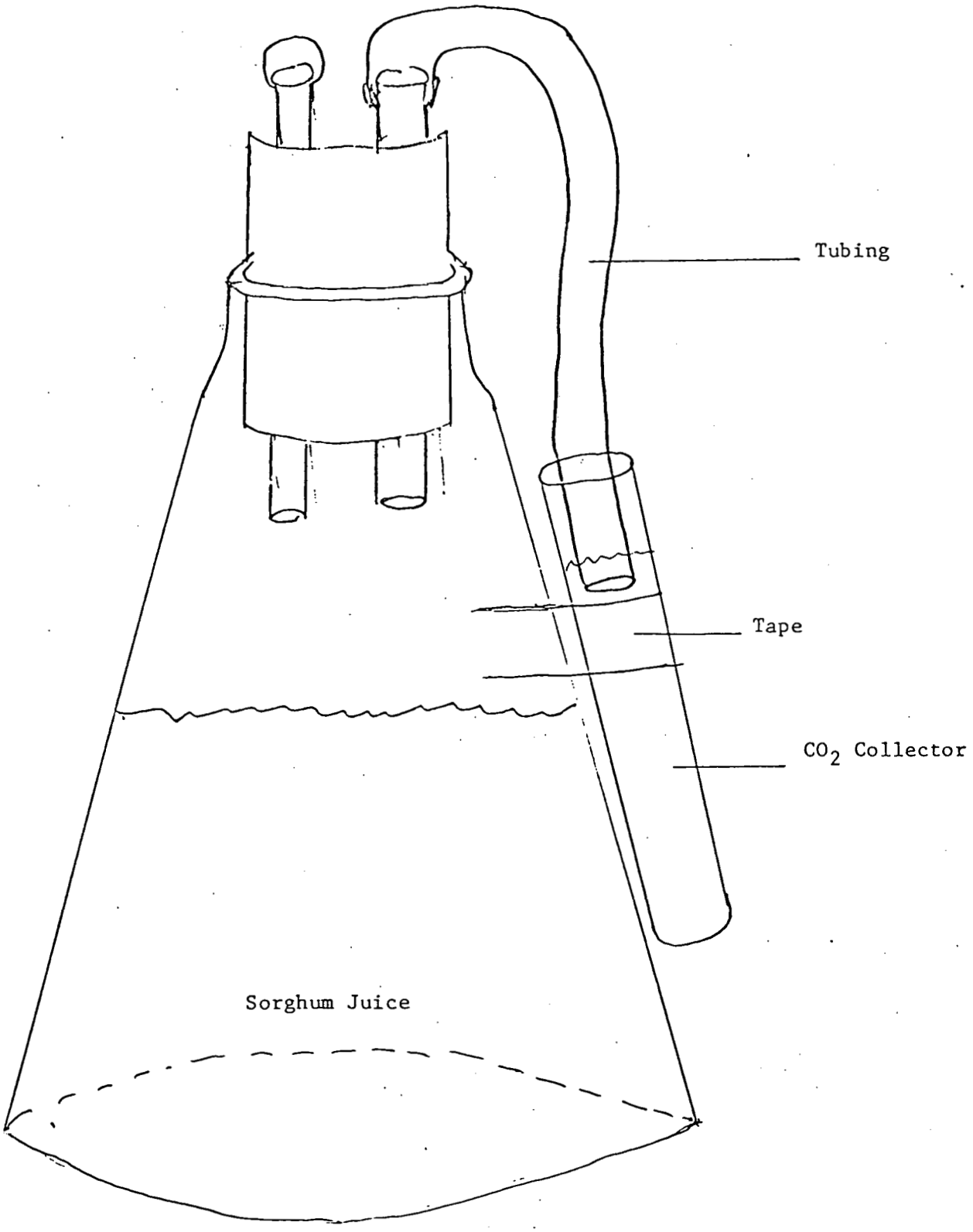
Fermentation Temperature

The temperature during fermentation was maintained at 27°C.

RESULTS

In table I at 30 balling, the natural yeast took considerably longer to ferment the sugars. The addition of a nitrogen source did appreciably alter the rate of fermentations. Of the commercial yeasts, only Fisher's produced less with a nitrogen source. The highest yield, highest % utilization of sugar, and least time was Fleischmann's yeast. All inoculums decreased in number of individuals at termination.

DIAGRAM A



500 ml Erlenmyer Flask

TABLE I. 30 BALLING

Yeast Strain	Balling	Balling[1]	Alcohol Percent	Orig-Final / Original	Percent Utilization	Days Ferment
ATCC 26603	30		13.29	26/30	86.7	14
		30	11.24	22/30	73.3	20
ATCC 918	30		13.29	26/30	86.7	14
		30	10.73	21/30	70.0	13
ATCC 26602	30		13.29	26/30	86.7	14
		30	9.45	18.5/30	61.7	18
NRRLY-2034	30		13.54	26.5/30	88.3	27
		30	10.73	21/30	70.0	18
Red Star	30		10.22	20/30	66.7	4
		30	9.2	18/30	60.0	6
Budweiser	30		11.88	23.25/30	77.5	9
		30	2.17	4.25/30	14.2	9
Fleischmann's	30		13.29	26/30	86.7	5
		30	9.96	19.5/30	65.0	18
Fisher's	30		7.79	15.25/30	50.8	13
		30	8.94	17.5/30	58.3	6

[1]No addition of $(NH_4)_2HPO_4$

TABLE I.

Yeast Strain	Ba-ling	Balling[1]	Alcohol Percent	Orig-Final / Original	Percent Utilization	Days Ferment
AJC 01	30		12.26	24/30	80.0	22
		30	11.37	22.25/30	74.2	27
AJC 02	30		12.14	23.75/30	79.2	54
		30	10.73	21/30	70.0	50
AJC 04	30		12.01	23.5/30	78.3	23
		30	12.26	24/30	80.0	30
AJC 05		30	12.01	23.5/30	78.3	14
AJC 06	30		9.45	18.5/30	61.7	37
		30	12.90	25.25/30	84.2	21
AJC 07	30		12.14	23.75/30	79.2	30
		30	11.75	23/30	76.7	19
AJC 08		30	13.29	26/30	86.7	25

[1]No addition of $(NH_4)_2HPO_4$

Table II contains the results of the intermediate ballings, 25-26.5. Of the commercial yeast, Fleischmann's produced more alcohol at a higher percent of utilization within the least time. The natural yeast have a higher percent of utilization but all require sixteen days or longer. The inoculums varied in number of individuals at termination.

Tables III list the results at low ballings. The natural yeast, AJC 07, had one fermentation at a 95% utilization and 9.71% alcohol. The yeast strain ATCC 26603 surpassed AJC 07 with a nitrogen additive. ATCC 918 performed best without the nitrogen additive in terms of days fermentation.

TABLE II. INTERMEDIATE BALLINGS

Yeast Strain	Balling	Balling[1]	Alcohol Percent	Orig-Final / Original	Percent Utilization	Days Ferment
ATCC 26603	26.5		12.78	25/26.5	94.3	18
	25.5		11.24	22/25.5	86.3	5
ATCC 918	26		12.01	23.5/26	90.4	9
	26		11.75	23/26	88.5	19
ATCC 26602	26		12.26	24/26	92.3	16
	25		10.99	21.5/25	86.0	19
NRRLY-2034	26		11.75	23/26	88.5	10
Red Star	25		9.71	19/25	76.0	6
		25	7.41	14.5/25	58.0	6
Budweiser	25		10.73	21/25	84.0	9
		25	5.24	10.25/25	41.0	21
Fleischmann's	26.5		12.26	24/26.5	90.57	10
Fisher	25		7.92	15.5/25	62.0	6
		25	8.43	16.5/25	66.0	13
AJC 01	26		10.86	21.25/26	81.7	20
		26	12.78	25/26	96.2	18
AJC 02	25		12.14	23.75/25	95.0	34
		25	12.78	25/25	100.0	32

Table II. Intermediate Balling (Continued)

Yeast Strain	Balling	Balling[1]	Alcohol Percent	Orig-Final / Original	Percent Utilization	Days Ferment
AJC 04	25		10.73	21/25	84.0	27
		25	12.01	23.5/25	94.0	27
AJC 05	26		12.52	24.5/26	94.2	20
(2)	26		11.24	22/26	84.6	19
	26.5		12.01	23.5/26.5	88.7	18
AJC 06	26		12.26	24/26	92.3	16
	26		11.50	22.5/26	86.5	19
AJC 07	26		12.39	24.25/26	93.3	16
	26		11.26	24/26	92.3	16
	26		11.50	22.5/26	86.5	19
AJC 08	25		10.48	20.5/25	82.0	25
		25	11.50	22.5/25	90.0	19

[1]No addition of $(NH_4)_2HPO_4$

TABLE III. LOW BALLINGS

Yeast Strain	Balling	Balling[1]	Alcohol Percent	Orig-Final / Original	Percent Utilization	Days Ferment
ATCC 26603	20		10.17	19.9/20	99.5	7
		20	9.71	19/20	95.0	17
		20	9.20	18/20	90.0	10
ATCC 918	18.5		9.45	18.5/18.5	100	12
	21		9.45	18.5/21	88.1	11
	20		10.22	20/20	100.0	18
	21		9.71	19/21	90.5	14
	18		7.79	15.25/18	84.7	16
		20	9.71	19/20	95.0	7
		20	9.20	18/20	90.0	5
ATCC 26602	19.5		9.71	19/19.5	97.4	21
		20	9.71	19/20	95.0	14
		20	9.20	18/20	90.0	7
NRRLY-2034	21.5		9.71	19/21.5	88.4	12
		20	9.71	19/20	95.0	12
		20	9.20	18/20	90.0	10

Table III. Low Ballings (Continued)

Yeast Strain	Balling	Balling[1]	Alcohol Percent	Orig-Final / Original	Percent Utilization	Days Ferment
Red Star	20		8.94	17.5/20	87.5	8
		20	9.07	17.75/20	88.8	11
		20	8.94	17.5/20	87.5	5
Budweiser	20		9.45	18.5/20	92.5	9
		20	4.09	8/20	40.0	16
		20	6.90	13.5/20	67.5	7
Fleischmann's	18.5		9.34	18.25/18.5	98.6	13
		20	9.71	19/20	95.0	10
		20	9.20	18/20	90.0	7
Fisher	20		7.41	14.5/20	72.5	20
		20	8.18	16/20	80.0	6
		20	9.20	18/20	90.0	7

[1]No addition of $(NH_4)_2HPO_4$

TABLE III.

Yeast Strain	Balling	Balling[1]	Alcohol Percent	Orig-Final / Original	Percent Utilization	Days Ferment
AJC 01	20		9.96	19.5/20	97.5	14
		20	9.20	18/20	90.0	10
		20	10.22	20/20	100.0	14
AJC 02	20		9.58	18.75/20	93.8	25
		20	10.22	20/20	100.0	27
AJC 04	20		8.43	16.5/20	82.5	23
		20	9.45	18.5/20	92.5	21
AJC 05	18.5		9.33	18.25/18.5	98.6	20
	19.5		9.45	18.5/19.5	94.9	19
		20	9.71	19/20	95.0	10
		20	9.07	17.75/20	88.8	14
AJC 06	18.5		9.33	18.25/18.5	98.6	16
		20	9.71	19/20	95.0	10
		20	9.07	17.75/20	88.8	12
AJC 07	18.5		9.20	18/18.5	97.3	18
		20	9.71	19/20	95.0	7
		20	8.69	17/20	85.0	10
AJC 08	20		9.45	18.5/20	92.5	22
		20	10.22	20/20	100	25

[1]No addition of $(NH_4)_2HPO_4$

CONCLUSIONS

A yeast strain was not found which would ferment sweet sorghum juice above the 90% utilization in less than ten days for ballings above 25. ATCC 918 was the only yeast to ferment an intermediate balling, 26, above the 90% utilization within ten days. At the low ballings, ATCC 26603, ATCC 918, Budweiser, and AJC 07 fermented above 90% utilization within ten days.

ATCC 918 and AJC 07 were the only yeast strains to perform the above fermentations at the low ballings without a nitrogen additive.

ATCC 918 with a nitrogen additive performed the best at the intermediate balling. At the lower balling ATCC performed better without a nitrogen additive. From these limited tests, ATCC 918 Saccharomyces species produced the highest yield of alcohol with the highest utilization percentage.

A note of thanks to Don Bragg, student research assistant.