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The Metabolism of Pathogenic Yeasts.*

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Frequent reference is made in the literature[1] to the fermentation of sugars by pathogenic yeast-like organisms. Cultures of such organisms in sugar-rich media may evolve much CO_2 and have a "beery" odor. Quantitative data as to the extent of the alcoholic fermentation are not, as far as we are aware, available.

The organisms were obtained from various sources, as indicated in Table I. We are particularly indebted to Dr. H. C. Hesseltine for identification of organisms 4 to 14 inclusive. Six of these were identified as *Monilia albicans* and 5 as *Monilia candida.*

The medium contained one percent of peptone (Difco), 0.3% of meat extract, 0.2% of KH_2PO_4, traces of $CaCl_2$ and $MgSO_4$, enough NaOH to bring the reaction to pH 7.6, and 5% of glucose. The glucose, in 20% solution, was autoclaved separately. Four liters of this medium were prepared at one time and mixed thoroughly with the sugar immediately after autoclaving. Exactly 200 cc. were then pipetted into tall 8 oz. dispensing bottles. With the exception of the brewers' yeast, organism 1, which was incubated at room-temperature, the cultures were kept 48 hours at 37.5°C. Exactly 20 cc. of *N* H_2SO_4 were then added to stop metabolic activities. The bottles were kept in the refrigerator until analyzed. The following analytical methods were used: Glucose, Shaffer-Somogyi;[2] ethyl alcohol, Friedemann and Ritchie;[3] lactic acid, Friedemann and Graeser.[4] The total acids were determined by titration of 25 cc. samples with 0.1 *N* NaOH after 15 minutes of rapid aëration with CO_2-free air. The gases were qualitatively examined for CO_2 and hydrogen.

The results shown in the table represent the decrease in sugar and

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1 Castellani, A., *Arch. Derm. Syphilis*, 1928, **17**, 61; Zinsser, H., and Bayne-Jones, S., *Textbook of Bacteriology*, D. Appleton-Century Co., 7th edition (1934).

2 Shaffer, P. A., and Hartmann, A. F., *Biol. Chem.*, 1920-21, **45**, 365; Peters, J. P., and Van Slyke, D. D., *Quantitative Clinical Chemistry*, Baltimore, 1932, **2**, 465.

3 Friedemann, T. E., and Ritchie, E. B., PROC. SOC. EXP. BIOL. AND MED., 1933, **30**, 451.

4 Friedemann, T. E., and Graeser, J. B., *J. Biol. Chem.*, 1933, **100**, 292.

TABLE I.

No.	Organism	Glucose used mM. per l.	Ethyl alcohol mM. per l.	Yield of alcohol % of theory	Total acids cc. N per l.	Source
1.	Saccharomyces, brewers' yeast	90	158	88	4.5	Anhäuser-Busch Brewing Co.
2.	" bread yeast	270	524	97	9.4	Fleischmann Co. culture No. 40
3.	" " "	256	491	96	7.0	" " " " 135
4.	Monilia	124	229	92	5.4	Vaginal mycosis*
5.	"	115	226	98	4.7	" " *
6.	"	148	275	93	3.6	" " *
7.	"	121	206	85	5.6	" " *
8.	"	244	423	87	14.6	" " *
9.	"	127	225	89	3.4	" " *
10.	"	109	200	92	4.0	" " *
11.	"	132	118	45	3.6	" " *
12.	"	102	159	78	3.4	" " *
13.	"	253	493	97	7.4	Bronchiectasis†
14.	"	128	230	90	5.4	" †
15.	" *albicans* No. 1886	129	236	92	6.1	Oral thrush‡
16.	*Cryptococcus hominis* No. 2396	191	350	92	9.5	White hairy tongue‡

*Cultures supplied by Dr. H. C. Hesseltine.
†From two cases of Dr. Harry L. Huber.
‡From Dr. Fred D. Weidman, Philadelphia.

increase in alcohol and total acidity as compared with the uninoculated acidified medium.

No increase whatsoever of lactic acid was noted in any of the cultures. All of the organisms produced acids, but the quantity was small and variable. From 4.5 to 9.4 cc. *N* acid with an average of 7.0 cc. was produced by the non-pathogenic yeasts. The 12 cultures of monilia produced from 3.4 to 14.6 cc. *N* acid, with an average of 5.6 cc. The chief products of metabolism were CO_2 and ethyl alcohol. The average yield of alcohol from the 3 non-pathogenic yeasts was 94%. Excluding the results from organism 11, the monilia yielded 90% of alcohol. *Cryptococcus hominis* yielded 92% of alcohol.

Conclusions. The principal products of 13 pathogenic yeasts (12 monilia and *Cryptococcus hominis*) in a buffered peptone-meat-extract medium, with 5% glucose, were ethyl alcohol and CO_2. The yield of metabolic products was identical with that from 3 non-pathogenic yeasts.

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I. Quantitative Measurement of Coproporphyrin and Total Coproporphyrin I Excretion in Normals.

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Coproporphyrin I is excreted in the urine and feces under normal and most pathological circumstances.[1, 2, 3] In order to determine the relations between normal and abnormal pigment construction and destruction it has been necessary to develop an adequate method for the exact quantitative separation and measurement of porphyrins. Urine and feces were collected for one- to 3-day periods and kept in the dark. After careful mixing aliquot portions were analyzed. Not less than 50 gamma of coproporphyrin should be available for measurement; normally this amount is present in about half the daily amount of urine and about one-quarter of the daily feces. The

[1] Dobriner, K., *J. Biol. Chem.*, 1936, **113**, 1.

[2] Dobriner, K., *J. Biol. Chem.*, in press.

[3] Watson, C. T., *J. Clin. Invest.*, 1935, **14**, 110; 1936, **15**, 327.