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Carbohydrate Utilization by Bacteria Without Evident Acid Production.

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There has been developing recently an increasing realization that bacteria may utilize carbohydrates without an increase in hydrogen-ion concentration. We have undertaken to determine the extent of this type of carbohydrate utilization by examining a number of microorganisms representative of a wide range of bacterial groups, testing each organism in those sugars in which it showed no acid according to the usual indicator method. A series of sugars was added to (1) sugar free beef infusion broth and (2) 2% peptone 0.5% sodium chloride solution as basic mediums, to make 0.4% solutions of the monosaccharides and 0.8% of the disaccharides. The organisms were grown in these sugar mediums at 37° C. for 2-3 weeks (lactose for 3 months, also) and then the mediums were analyzed quantitatively for sugar by a copper reduction method.[1] In most cases, when the use of sugar was apparent only by quantitative analysis, the experiment was repeated and the hydrogen ion concentration determined daily. In doubtful instances, the experiment was repeated in these mediums buffered with phosphates.

Table I shows the sugars employed and those organisms with which the utilization of sugar was always accompanied by evident acid production. Table II shows those organisms which utilized one or more sugars according to quantitative analysis while concurrently the medium increased in alkalinity. In such instances, subcultures to the appropriate carbohydrate indicator agar plates failed to exhibit acid production, except regularly with *Sarcina lutea* in maltose, and irregularly with *B. pyocyaneus* in xylose. There were no manifest evidences of colonial dissociation. The sucrose, mannitol, indol, negative *B. dysenteriae* Shiga cultures were the only ones to show a decrease in pH (a rather sudden drop to about pH 6.0 after remaining at about 6.8 for 10-15 days). The entire typhoid-paratyphoid group have given irregular evidences of slight lactose utilization, but nothing conclusive, even after 3 months' growth.

The tables indicate that for most organisms, utilization of carbo-

[1] Stiles, H. R., Peterson, W. H., and Fred, E. B., *J. Bact.*, 1926, **12**, 427.

TABLE I.

Organism	Strains	Dextrose	Mannose	Fructose	Galactose	Xylose	Arabinose	Lactose	Maltose
Staphylococcus	5	+	+	+	+	—	—	+	+
Staph. citreus	1	—	—	—	—	—	—	—	—
Streptococcus	1	+	+	+	+	+d	—	+	+
M. tetragenus	1	+	+	+	+	—	—	+	+
M. catarrhalis	1	—	—	—	—	—	—	—	—
B. alcaligenes	1	—	—	—	—	—	—	—	—
B. dysenteriae Flexner	2	+	+	+	+	—	+	—	+
B. typhosus	4	+	+	+	+	+	—	—	+
B. paratyphosus alpha	4	+	+	+	+	—	+	—	+
B. paratyphosus beta	2	+	+	+	+	+	+	—	+
B. cholerae suis	1	+	+	+	+	+	+	—	+
B. enteritidis	1	+	+	+	+	+	+	—	+
B. icteroides	1	+	+	+	+	+	+	—	+
B. morgani	1	+	+	+	+	—	—	—	—
B. pullorum	1	+	+	+	+	+	+	—	—*
B. avisepticus	1	+	+	+	+	+	+	—	+
B. diphtheriae	2	+	+	+	+	—	—	—	+
B. diphtheriae (Park 8)	1	—	—	—	—	—	—	—	—
B. hofmanni	1	—	—	—	—	—	—	—	—
B. anthracis	3	+	I	+	—	—	—	—	+

+ = clearly evident acid; d = delayed utilization; — = no sugar utilization according to quantitative analysis or indicator; * = irregular; I = inconclusive at present.

TABLE II.

Organism	Strains	Dextrose	Mannose	Fructose	Galactose	Xylose	Arabinose	Lactose	Maltose
Sarcina lutea	1	A_p†	C_3	I	—	I	—	I_3	A_p*
B. pyocyaneus	2	C_p	C†	C_p	C†	C_3*	C	I_3	A_p†
B. leprae	2	B_p	B_p	B_p	I	C_p	A_p	$—_3$	—
B. smegmatis	1	B_p	C_p	C_p	C_p	C_p	C_p	$—_3$	—
B. phlei	2	+	+	+	+	C_p	C_p	+	+
B. mesentericus	1	+	C_p	+	B_p	B_p	C_p	B	—
B. subtilis (Cohn)	1	+	+	+	$+_d$	C_p	+	C	+
B. proteus	7	+	—	+	+	+	$—_3$	A	+
B. dysenteriae Shiga	2	+	+	+	+	—	—	C_3*	+

+ = clearly evident acid accompanying utilization.

A = 10-20% sugar utilized; B = 20-50%; C = 50-100%.

p = daily pH showed gradual rise; d = delayed utilization.

3 = 3 months culture (2 weeks inconclusive).

I = inconclusive; * = see text; † = inconstant.

— = no evidence of utilization by quantitative analysis or by indicator.

hydrate is accompanied by clearly evident acid formation, but that (as others have pointed out) certainty as to utilization of carbohydrate can not be attained by methods relying alone upon such formation. This work is being continued.

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Skin Tests for Sensitivity to Virus of Poliomyelitis.

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Early investigators[1,2] denied that the convalescent state in monkeys recovering from poliomyelitis was accompanied by cutaneous hypersensitiveness. Aycock[3] has stated that he has been unable to detect skin hypersensitiveness to monkey passage virus in human convalescents. Both Aycock and Kagan[4] and Stewart and Rhoads[5] while actively immunizing monkeys by the intracutaneous method, failed to note cutaneous allergic reactions. Recently, Jungeblut[6] has found that while cutaneous reactions of hypersensitiveness are lacking in convalescent monkeys, there is a high degree of generalized hypersensitiveness in these animals as judged by the occurrence of an immediate thermic response to the introduction of virus either intracerebrally or subcutaneously. Such a response was lacking in animals that had been uninfected. According to this author[7] the reverse situation obtains in man, as he observed a definite specific cutaneous reaction to an emulsion of virus-bearing monkey spinal cord in each of 27 human individuals with residual paralysis due to poliomyelitis. Sabin[8] has failed to find evidence of an allergic skin reaction in normal adults or in human convalescents either recent or of long stand-

[1] Römer, P. H., "Die Epidemische Kinderlähmung", Berlin, Springer, 1911.
[2] Leiner, C., and von Wiesner, R., *Wien. klin. Wchnschr.*, 1909, **46**, 2331.
[3] Aycock, W. L., personal communication.
[4] Aycock, W. L., and Kagan, J. R., *J. Immunol.*, 1927, **14**, 85.
[5] Stewart, F. W., and Rhoads, C. P., *J. Exp. Med.*, 1929, **49**, 959.
[6] Jungeblut, C. W., *J. Exp. Med.*, 1931, **53**, 159.
[7] Jungeblut, C. W., PROC. SOC. EXP. BIOL. AND MED., 1931, **28**, 1072.
[8] Sabin, A. B., quoted by Harrington, H., in "Poliomyelitis", Baltimore, The Williams and Wilkins Company, 1932, 126.