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Some Effects of Borate Upon Reducing Sugars.

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In a study of urines from diabetic dogs, it was noted that boric acid interferes with the determination of glucose by Folin's¹ method. Losses of 7.5% to 13% were found in 2 hour urines to which saturated boric acid solution was added. Other alkaline copper methods also gave low values with glucose solutions containing boric acid as well as with fructose, galactose, maltose and lactose, but not with arabinose. Boric acid does not interfere with the oxidation of glucose by Barfoed's reagent.

The oxidation of glucose, galactose, arabinose and maltose by alkaline iodine solutions is retarded by the presence of borate.

The low specific rotation of glucose in the presence of borax observed by Rimbach and Weber² and by Murchhauser³ is due to the formation of an ester between the borate ion and glucose which decomposes on the addition of a strong acid to give an excess of α glucose. This mutarotates to the normal equilibrium value.

¹ Folin, O., and Peck, E. C., *J. Biol. Chem.*, 1919, xxxviii, 287.

² Rimbach, E., and Weber, O., *Z. f. Physikal. Chem.*, 1905, li, 477.

³ Murchhauser, H., *Biochem. Z.*, 1923, cxxxviii, 6.

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Myostatic Contracture and Other Changes in the Extensibility of Skeletal Muscle.

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By myostatic contracture we mean to designate a condition of permanent shortening in resting muscle, which is maintained in the entire absence of nerve impulses, the muscle having acquired, usually as the result of prolonged immobility, a new and shorter than normal resting length. Familiar examples are the contractures which limit the movement of joints after prolonged immobilization in plaster casts, the permanent shortening of muscles after division of their

tendons, the parietic contractures due to the unequal paralysis of antagonistic muscle groups in anterior poliomyelitis and multiple neuritis and the rigidity seen in the latter stages of local tetanus.

Muscles in myostatic contracture have approximately normal elasticity, but their ductility, *i. e.*, their tendency to undergo permanent elongation when stretched, is greatly reduced.

The muscle tested was the gastrocnemius of the white rat with sciatic nerve cut but circulation intact. The muscle was stretched with loads increasing by 10 gm. intervals with 2 minute cycles of stretching and rest. A weight of 10 gm. was applied for 1 minute and removed for 1 minute, then 20 gm. was applied for 1 minute and removed for 1 minute and so on up to 100 gm.

In the first set of experiments the muscles were exposed to the air at room temperature while being stretched. Under these conditions a series of 10 normal muscles gave an average permanent elongation of 3.08 mm.; 10 muscles in contracture 15 days after section of the *tendo achillis* gave an average permanent elongation of 1.33 mm.; and 9 muscles in tetanus contracture gave an average permanent elongation of 1.28 mm. This marked decrease in ductility is not due to fibrosis. Histological sections of these muscles show no increase in connective tissue and only slight changes in the muscle fibers, such as a blurring of the cross striations. There are no structural changes which could account for the decreased ductility. It is possible that there may be an accumulation of lactic acid, and preparations are being made to determine the amount of this substance in these muscles. But it would seem that the contracture depends on some more subtle chemico-physical change in the muscle; because ligation of the artery, supplying a muscle in tetanus contracture will usually, though not always cause a sudden and marked though rather transient increase in its ductility. A suggestion of how the increased acidity which follows in the wake of the anemia might cause a relaxation is given by the next series of experiments.

In order to meet the obvious objections against working with a muscle exposed to the air at room temperature, other experiments were conducted with the muscle immersed in Ringer's solution at 37° C. This fluid had a pH of 7.8. In it a normal muscle was much less ductile than when exposed to the air and gave a permanent deformation of only 1.41 mm. A muscle, immersed in a liter of this same standard Ringer to which there had been added 6 cc. .012 N HCl, bringing the pH to 7.6, was even less ductile than that stretched in fluid with a pH of 7.8. The addition of 16 cc. of .012 N HCl to 1000 cc. of standard Ringer gave a fluid with a pH of approximately 7.3; and in this a muscle stretched very much as

when exposed to the air, giving a permanent deformation of 3.1 mm. The addition of 19 cc. of .012 N HCl to 1000 cc. of standard Ringer gave a pH of approximately 7.2 and in this a muscle stretched more than when exposed to the air, giving a permanent deformation of 5.8 mm.

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Variations in the ductility of muscle, expressed in mm. of permanent elongation caused by stretching. Since stress and time were the same in all experiments, the differences shown here were due to differences in the condition of the muscles.

Stretched in air at room temperature		Stretched in Ringer's fluid at 37°C	
3.08 mm. Normal M. tendon	1.33 mm. Contraction after	1.41 mm. Normal M. Ringer's pH 7.8	0.76 mm. Normal M. Ringer's + 6 cc. .012 N HCl = pH 7.6
	1.28 mm. Tetanus contraction	3.18 mm. Artery ligated tetanus	3.1 mm. Normal M. Ringer's + 16 cc. .012 N HCl = pH 7.3+
			5.8 mm. Normal M. Ringer's + 19 cc. .012 N HCl = pH 7.2

It is, therefore, apparent that the ductility of muscle is influenced by relatively slight changes in the hydrogen ion concentration of the fluid with which it is bathed. It is obvious that these observations may have an important bearing on the problem of tonus and the function of muscles as organs for the maintenance of posture.

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The Lactic Acid Content of Resting Mammalian Muscle.

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(Introduced by P. A. Shaffer.)

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The amount of lactic acid present in resting, atonic mammalian muscle is very low—10 to 20 mg. per 100 gm. of tissue. We have obtained values from 10.5 to 50 mg. by freezing *in situ* the gastrocnemius of guinea pigs with CO₂ snow. The animals were anesthetized with amytal and the muscles dissected as free from surrounding structures as possible without disturbing the nerve and