The Relation Between the Bicarbonate Concentration in Blood Plasma and in Brain Tissue

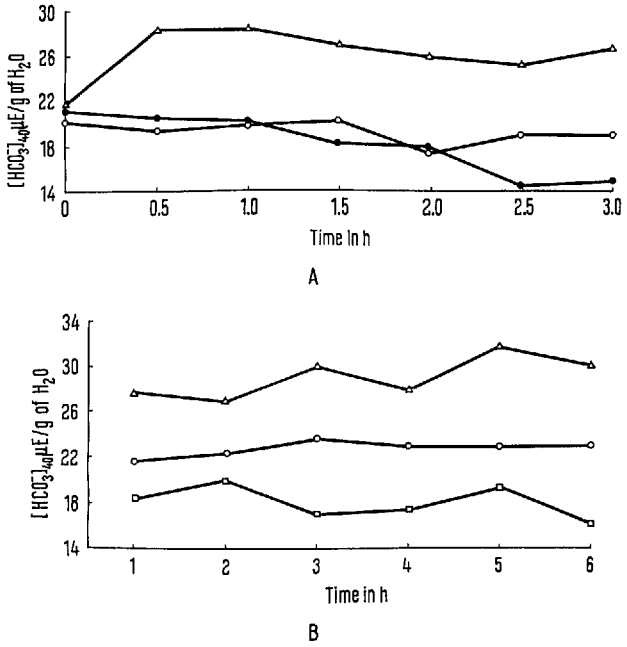
The study of the acid-base metabolism of tissues, utilizing the distribution of weak acids, is based on the analytical scheme originally developed for muscle tissue[1,2]. The analysis requires that there is a diffusion equilibrium for the buffer anions between blood plasma and the extracellular fluid of the tissue and, further, that the chloride ions, which are taken to indicate the extracellular space, are really confined to that space. These requirements seem to be at least partly fulfilled for muscle tissue but there is no evidence to support the application of the basic assumptions to brain tissue. Thus, the chloride ions seem to be partly confined to intracellular brain spaces, and simple ions like chloride, sodium, and potassium do not reach a thermodynamic equilibrium between blood plasma and tissue water for several hours[3,4]. There has, however, been no information regarding net fluxes of bicarbonate ions or hydrogen ions between blood plasma and brain tissue. The present investigation was therefore undertaken to study whether such fluxes do occur after changes in the bicarbonate concentration of blood plasma, as induced by peritoneal lavage.

Methods. Two types of experiment were performed. In one type, Nembutal-anaesthetized male rats, weighing between 250 and 350 g, were tracheotomized and a polyethylene cannula was inserted into the femoral artery. Each rat was then given 3 ml per 100 g of body weight of one of the following solutions intraperitoneally: (1) 130 m*M* NaCl + 25 m*M* $NaHCO_3$ + 5 m*M* KCl ('blank'), (2) 160 m*M* NaCl, (3) 160 m*M* $NaHCO_3$. Every 30 min, pH, pCO_2 and standard bicarbonate were determined in arterial blood with the micromethod described by Siggaard Andersen et al.[5]. Every 30 min, up to maximally 3 h, one rat from each group was frozen in liquid nitrogen and the total carbon dioxide content of brain tissue was determined with the method developed in the laboratory[6].

In the other type of experiment, non-anaesthetized rats were injected intraperitoneally every 2 h with the same dose of either solution (1) or (3). In addition, another group was injected with a solution containing 100 m*M* NH_4Cl + 60 m*M* NaCl. Every hour, up to maximally 6 h, one rat from each group was anaesthetized and prepared as described above. After 15 min, two determinations were made of the acid-base parameters in arterial blood, whereafter the total carbon dioxide content of the tissue was determined in the usual way.

Results. In all of the groups a comparison was made between the standard bicarbonate concentration in arterial blood plasma (the bicarbonate concentration at 40 mm Hg in pCO_2) and the standard bicarbonate concentration in the water phase of the brain tissue after correction for the blood content of the tissue (see [7]). The Figure (A and B) shows the changes induced in the standard bicarbonate of blood plasma after administration of the different solutions. It is seen that in both types of experiments, variations in standard bicarbonate of up to 10–15 mE/l were obtained. In the Table the corresponding standard bicarbonate values for the tissue phase have been compiled. It is seen that in spite of large variations in the bicarbonate concentration in the blood there were no significant changes of the bicarbonate concentration of the tissue phase. The same lack of relation between the standard bicarbonate concentration in the blood and that in the tissue phase was found in hypercapnic rats, i.e. rats given 10% carbon dioxide during a 3 h period of equilibration with the experimental solutions.

Discussion. The present experiments clearly show that the bicarbonate ions or the hydrogen ions cannot be in diffusion equilibrium between blood plasma and the chloride space of the brain. Thus, the chloride space of the



The change in plasma standard bicarbonate concentration (mE/l) after intraperitoneal injections of one of the following solutions into anaesthetized (A), or non-anaesthetized (B) rats: 0.130 m*M* NaCl + 0.025 m*M* $NaHCO_3$ + 0.005 m*M* KCl ('blank', unfilled circles), 0.160 m*M* NaCl (filled circles), 0.160 $NaHCO_3$ (triangles) or 0.100 m*M* NH_4Cl + 0.060 m*M* NaCl (squares). Note the marked differences obtained in the standard bicarbonate concentration of blood plasma, as contrasted with the absence of such changes in the brain tissue (Table).

Standard bicarbonate values for brain tissue in μE/g of tissue water after correction for the amount of blood in the tissue. Values given are mean values ± standard deviation of the mean

	'Blank'	NaCl	$NaHCO_3$	NH_4Cl
Awake	14.01 ± 0.23		14.25 ± 0.17	14.15 ± 0.36
Anaesthetized	14.02 ± 0.23	13.73 ± 0.28	13.48 ± 0.20	
10% CO_2	13.97 ± 0.34		14.20 ± 0.19	13.90 ± 0.31

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brain constitutes more than 30% of the tissue weight. In the present experiments, the changes brought about in the arterial bicarbonate concentration were around 10 mE/kg, which should have changed the bicarbonate concentration of the water phase of the tissue about 3 μE/g of tissue water, had there been such a diffusion equilibrium. The experiments are only compatible with two possibilities: (1) The bicarbonate ions and the hydrogen ions of blood plasma are in diffusion equilibrium with an extracellular space which is so small (probably less than 5% of the tissue weight) that the present technique cannot detect the induced changes in extracellular bicarbonate. (2) Anatomical or functional barriers prevent free diffusion of bicarbonate ions and hydrogen ions between blood plasma and the existing extracellular space[8].

Zusammenfassung. Die Frage des passiven Transportes von HCO_3^-- und H^+-Ionen zwischen Blutplasma und Gehirngewebe wurde untersucht. Die Blutkonzentration dieser Ionen wurde durch intraperitoneale Injektionen variiert und der Gesamt-CO_2-Gehalt des Gehirngewebes nach 1–12 h bestimmt. Es ergab sich keine signifikante Änderung im Gesamt-CO_2-Gehalt des Gewebes, obwohl der Standardbikarbonatgehalt des Blutes mit 10–13 mE/l verändert wurde.

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Mannan from the Extracellular Surface of *Candida albicans* Berkhout

From the surface of cellular membranes of the pathogenic yeast *Candida albicans* Berkhout, strain number 109[1,2], extracellular surface polysaccharide was isolated in such a way that after the removal of the cultivating medium the cells were washed with warm water under constant microscopic control. The wash waters were centrifuged, dialyzed and precipitated with alcohol. The precipitated polysaccharide was freed from protein[3] and after lyophilization obtained as a nitrogen-free white powder in yields of 2.5–3% calculated on dry yeast material. The homogeneity of the isolated polysaccharide was determined by free electrophoresis in borate buffer (pH 9.3).

On hydrolysis the polysaccharide gave as the only sugar D-mannose identified by paper chromatography[4,5], paper electrophoresis using borate buffer and by the preparation of the *p*-nitrophenylhydrazone[6].

Water soluble extracellular surface mannan had an average polymer degree of 36 and showed a specific rotation $[\alpha]_D^{20} = +56°$. After methylation[7,8] and hydrolysis of the mannan, the following derivatives were obtained: 2,3,4,6-tetra-o-methyl-, 3,4,6-tri-o-methyl- and 3,4-di-o-methyl-D-mannose. The individual methyl ethers were identified by thin layer chromatography on silica gel using the system isopropylalcohol-ethyl acetate-water (1:4:2.5), and their relative amounts determined according to HAY[9] were in the ratio of 1:3:1.

Periodate oxidation used 1.08 mol of sodium metaperiodate giving 0.2 mol of formic acid for each mol of anhydromannose. The polyaldehyde formed by periodate oxidation was reduced and hydrolysed. Glycerol was found to be the only polyalcohol[10] present in the hydrolysates. The results of the periodate oxidation supported the conclusions drawn from the methylation analysis. From the decrease in optical rotation after acid hydrolysis and from the infrared spectrum[11] it was found that in the extracellular surface mannan α-glycoside bonds are present.

On the basis of the above experimental data, the mannan from the extracellular surface of *Candida albicans* is a branched polysaccharide composed of D-mannopyranose units bound by α-1-2 and α-1-6 bonds. It is not identical with the intracellular mannan isolated by BISHOP[12] from the cellular walls of *Candida albicans* in that it shows a lower degree of branching.

A full report of this work will be published in Chemické zvesti.

Zusammenfassung. Aus der Oberfläche der Zellmembranen von *Candida albicans* Berkhout wurde ein Mannan isoliert, das aus D-Mannose aufgebaut ist. Durch Methylierung und anschliessende saure Hydrolyse wurde bewiesen, dass es sich um ein verzweigtes Mannan mit α-1-2- und α-1-6-Bindungen handelt.

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