Absorption of amino acids from the human mouth*

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Summary. Certain amino acids were transported across buccal mucosa in vivo by a carrier-mediated process. Metabolic loss of L-amino acids from the mouth in a 5 min test period was negligible. The buccal mucosal transport process was stereospecific for most L-amino acids tested. The uptake of L-methionine and L-leucine showed a tendency to saturation with increasing substrate concentration. The absorption of L-leucine, L-isoleucine and L-methionine as single amino acids was inhibited in the presence of each other suggesting at least one common transport mechanism. Administration of equimolar amounts of amino acids revealed a specific pattern of absorption that could be classified into fast, intermediate, and slow groups. Absorption of some amino acids was at least partly dependent on the presence of sodium ions in the luminal solution. In conclusion, our studies demonstrate that the human buccal mucosa is permeable to L-amino acids in a selective manner, and may resemble absorption pattern similar to other locations of the gastrointestinal tract.

Keywords: Amino acids – Absorption – Mouth – Buccal mucosa

Introduction

Classical studies by Schanker (Schanker, 1962) demonstrated that the human buccal cavity is lined with mucous membranes, which, like the lining of the entire alimentary canal behaves as a lipoidal barrier to the passage of drugs and other solutes. This finding stimulated the use of human buccal cavity for the administration of several drugs (Beckett and Hossie, 1971). However, only a limited studies have been done to correlate the characteristics of the buccal mucosa

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with other locations of the gastrointestinal tract, in relation to absorption of substances other than drugs. To date, the buccal mucosa has been shown to exhibit absorption properties for several drugs (Schanker, 1962), sodium dependent uptake of D-glucose, D-galactose, and 3-O-methyl-D-glucose (Manning and Evered, 1976), sodium-dependent uptake of ascorbic acid (Sadoogh-Abasian and Evered, 1979), and facilitated diffusion of nicotinamide and nicotinic acid (Evered et al., 1980). The amino acid antibiotic D-cycloserine was absorbed by passive diffusion (Evered, 1972), a feature consistent with its absorption across the rat small intestine in vitro (Wass and Evered, 1972), and the rat colon (Sprake and Evered, 1979). Here we report the role of human buccal mucosa as a transport site for the uptake of mixtures of protein amino acids, and some single amino acids such as methionine, leucine, and isoleucine.

Methods

Buccal absorption measurement

The method of measuring buccal absorption (Beckett and Hossie, 1971) was modified by using the following buffer solution for preparing the test solution containing amino acids: NaCl, 118.5 mmol/l; KCl, 4.7 mmol/l; KH$_2$PO$_4$, 1.2 mmol/l; MgSO$_4$·7H$_2$O, 1.2 mmol/l; citric acid, 1.8 mmol/l; NaHPO$_4$·12H$_2$O, 6.2 mmol/l; CaCl$_2$, 1.9 mmol/l; pH 6.0 ± 0.05. To study the effect of omitting sodium ions they were replaced by potassium ions in a modified buffer solution: KCl, 123.2 mmol/l; KH$_2$PO$_4$, 1.2 mmol/l; MgSO$_4$·7H$_2$O, 1.2 mmol/l; K$_2$HPO$_4$, 6.2 mmol/l; citric acid, 1.8 mmol/l; CaCl$_2$, 1.9 mmol/l; pH 6.0 ± 0.05. Samples (25 ml) of these solutions containing the test amino acids were pre-incubated at 37°C for 5 min and circulated inside the mouth by the cheeks and tongue about once a second for 5 min. The solution was then expelled into a beaker and the mouth rinsed for 5 s with 10 ml of pre-incubated buffer without added amino acids. This washing was expelled into the same beaker and the total volume measured. The pH was checked and the solution diluted to 50 ml with buffer solution. A portion of the mixed solution was centrifuged at 3000 g at room temperature for 20 min, to remove insoluble material. This 5 min contact time was at the upper linear part of a progress curve. At the beginning of each test a buccal “blank” consisting of 25 ml of buffer solution at 37°C but without amino acids, was circulated in the mouth for 5 min. The solution was then expelled into a beaker and the mouth rinsed for 5 s with 10 ml of pre-incubated buffer without added amino acids. This washing was expelled into the same beaker and the total volume measured. The pH was checked and the solution diluted to 50 ml with buffer solution. A portion of the mixed solution was centrifuged at 3000 g at room temperature for 20 min, to remove insoluble material. This 5 min contact time was at the upper linear part of a progress curve. At the beginning of each test a buccal “blank” consisting of 25 ml of buffer solution at 37°C but without amino acids, was circulated in the mouth for 5 min. The mouth was rinsed with 10 ml fresh buffer for 10 s. This “blank” solution and the washings were pooled, diluted and centrifuged as before. Buccal “blank” solutions, and saliva collected freshly, were deproteinised using picric acid (Stein and Moore, 1954).

Buccal absorption of amino acids was measured with equimolar mixtures at initial concentrations of 2, 4 and 8 mmol/l. These conditions facilitated comparison with perfusion studies of human small intestine at these concentrations (Adibi and Gray, 1967). Buccal test samples were analyzed as soon as possible after collection but it was necessary to eliminate possible storage artifacts. After dilution to a suitable concentration for analysis (0.1 mmol/l) 0.1 M HCl samples were stored at 4°C and at −20°C and analyzed at intervals of 0, 1, 2 and 3 days. Possible loss by bacterial metabolism was investigated: 25 ml portions of buffer