Stomach Acid and Megavitamins

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Persons requiring megavitamin B3 therapy may have suffered prolonged deficiency of the vitamin relative to their individual needs. Bicknell and Prescott (1953) found that a result of such deficiency is a poor production of stomach hydrochloric acid, HCI. Keuter (1959) found that a vitamin deficiency may be the result of prolonged poor absorption due to an insufficient production of HCI. Whatever its origin, the low output of HCI may in turn interfere with the absorption of the therapeutic vitamins and with digestion of the high-protein meals which are part of the therapy (Davis, 1965). Thus, a determination of stomach acid production, or of the amount of supplemental acid needed in the individual case, would seem to-be an important part of Orthomolecular therapy.

A deficiency of endogenous stomach acid is usually compensated by oral intake of dilute HCI (typical dose 1 tsp. of 10 percent soln.), or glutamic acid (typical dose 4 to 5 capsules), or vinegar (Davis, 1965). The principal digestive enzyme of the stomach, pepsin, functions best at a high acidity, one with a pH of 2.0, although some activity occurs at lower acidities, down to a pH of 4.02 (Houssay, 1955; Boyer, 1960; Laidler, 1958). In the normal stomach, the acidity builds up gradually to a pH around 1.5 (Houssay, 1955). The acid supplements, when required, should bring the stomach acidity to well within the working range of pepsin and preferably to a pH of 2. To do this, the supplements must supply all the acid neutralized by the stomach contents as well as enough to acidify the liquid taken with the meal.

After a meal the stomach will contain 20 g or more of protein (if it is a high-protein meal) and 1 or more g of vitamin B3, both of which will buffer the stomach acid by absorbing the free hydrogen ion from the HCI. Although the mass of vitamin present may be a tenth or less of the mass of protein, it could contribute a significant part of the buffering action and create a need for extra acid supplementation. This paper reports the results of a theoretical and experimental study of this question.

Protein absorbs the free hydrogen ion at the side chain and end chain amide groups, forming -NH3 + out of -NH2. On the other hand, niacinamide and niacin

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The pH scale of acidity is an inverse logarithmic scale with the neutral point near 7. The more acid solution has the lower pH, and a pH difference of one unit means a ratio of acidities of 10 times. A pH of 2.0 represents 10 times the acidity of a pH 3.0 soln. Water has a pH of 7.

should absorb mainly at the nitrogen in the pyridine ring. The latter absorption should be much stronger than that in protein because of resonance within the pyridine ring which distributes the ionic charge from the hydrogen among the ortho and para positions as well as the nitrogen (Pauling, 1960).

Two models for the normal stomach were used: the first was simply a beaker of HCI solution with a pH of 2.0; the second was like the first, but approximately 100 mg of pepsin was added. The second model was used when measuring the acid absorption of protein and Linodil, since hydrolysis with pepsin might increase the acid uptake.

A 500 mg tablet of niacinamide was added to 50 ml of the HCI solution and allowed to dissolve completely while measuring the acidity with an electronic pH meter. The pH rose to 4.0. A measured volume of standard 1N HCI was added slowly to restore the acidity to the original pH of 2.0. The added HCI is replacing the acid neutralized by the niacinamide.

Similar measurements were made for niacin, Linodil, and a soy protein concentrate comprising 90 percent protein. The results, normalized for 1 g samples, are shown in Table 1. They confirm the expected strong alkaline action of niacin and niacinamide at normal stomach acidity. Niacin absorbs about half as much H+ ion as does niacinamide. The latter in fact totally absorbs one H+ ion for each molecule. Both these common forms of the vitamin absorb many times more acid than does protein. Evidently Linodil does not hydrolyze much in the presence of pepsin and acid, since it absorbs very little acid after one hour in solution. Hydrolysis would free the niacin portion of Linodil.

The neutralization of glutamic acid by niacinamide was studied in a similar way. One #1 capsule of the acid dissolved in 50 ml of water gave a pH of 2.0. Addition of 500 mg of niacinamide lowered the acidity to pH 3.3. Capsules of glutamic acid were then dissolved successively until the acidity was restored. Table 2
summarizes the observations. As many as four capsules are needed to restore completely the acidity of the solution with only one 500 mg tablet of niacinamide added.

TABLE 1

Buffering Action of Protein and Vitamin B3 on Simulated Stomach Acid

Sample	**Amount HC1 neutralized at pH 2.0**	
1 gram each	**mg**	**Teaspns 10% Soln.**
Niacinamide	300	0.6
Niacin	140	0.3
Linodil	14	
Soy protein	40	0.08

TABLE 2

Neutralization of Glutamic Acid by Niacinamide

Number Capsules of Glutamic Acid	**Amount of Niacinamide**	**Acidity of 50ml soln. (pH units)**
1	**0**	**2.0**
1	**.5g**	**3.3**
2	**.5**	**2.9**
3	**.5**	**2.5**
4	**.5**	**2.2**
5	**.5**	**2.0**

The optimum acid supplementation for a person who produced no acid himself, taking a high-protein meal with therapeutic vitamin B3, can be estimated from the tables. For example, 2 g of niacinamide taken with 20 g of protein would need 2.8 teaspoons of 10 percent HCI solution for optimum acidity (pH = 2.0), although somewhat less may still provide adequate pepsin activity. By comparison, about 20 capsules of glutamic acid would be needed. Linodil requires no additional acid supplements.

White vinegar, which has a pH of 2.3 when undiluted, may be a useful alternative to HCI for acidifying the protein,

although it is not very effective in acidifying niacinamide. From the data in Table 1 and the known ionization constant for acetic acid, one can estimate that a pH around 3.0 may be obtained with a typical protein meal supplemented with a half cup of vinegar. At this acidity the activity of pepsin would be about 25 percent of its maximum, at pH 2.0 (Laidler, 1958).

In a final experiment, 30 ml of undiluted vinegar was added to 10 ml of water containing 500 mg of niacinamide. This brought the pH down from 4.4 to only 3.3. From Table 2, the same acidity would be obtained with just one capsule of glutamic acid, which in turn is less effective than HCI, for the same volume. Clearly it would be impractical to attempt to acidify a median dose of 2 g niacinamide using vinegar when the stomach produced no acid itself.

Stomach acidity may be an important factor in vitamin absorption. Keuter (1959) found, in one case, that a vitamin B-complex deficiency of 17 years' duration was relieved by addition of HCI supplement alone, where vitamin supplementation had previously failed. Pauling et al. (1973) found a wide range of niacinamide absorption rates among healthy volunteers: the lowest rate seen was 3 percent and the highest 20 percent. Could the poor absorption in some subjects be due to low stomach acidity? Could the poor response of some patients to megavitamin therapy have a similar cause? Further research in this area might yield valuable information.

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