Z. Ernährungswiss. 16, 12–17 (1977)

ISSN 0044–264

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Effect of authentic and natural vitamin C and carotene on amino acid absorption

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With 5 tables

(Received October 20, 1976)

Introduction

The rate of intestinal absorption of amino acids is of major importance in nutrition, particularly the essential ones. Many factors operate and affect this process of amino acid absorption. Among these factors is the interaction of other dietary constituents as carbohydrates, fatty acids, minerals and vitamins. Vitamins in particular play a major role in several metabolic processes in the body. Although several studies were performed on the effect of carbohydrates (5, 4, 7) on amino acid absorption, little could be traced dealing with the effect of vitamins, particularly the natural form.

It is felt of value to study how far the process of intestinal amino acid absorption is affected in presence of vitamin C or carotene as derived from authentic or natural sources.

Materials and methods

The present study was carried out on normal white albino rats of body weight ranging from 140–240 gm. These animals comprised both sexes and to ensure the absence of nutritional disorders, their blood haemoglobin concentration and plasma total proteins were estimated (see table 1). These animals were categorised into 18 groups each of 5.

Table 1. Body weight, plasma total proteins, and blood hemoglobin of rats used in this experiment.

Groups	Body weight g.%	Plasma proteins g.%	Blood Hb g.%
1. Glycine	151–235 186 ± 7.28	6.40–8.12 7.06 ± 3.03	14.04–17.82 15.43 ± 0.43
2. Lysine	140–221 173.5 ± 8.8	6.16–7.83 6.83 ± 0.18	14.04–17.55 15.53 ± 0.34
3. Methionine	150–240 205.7 ± 7.65	6.10–7.50 6.71 ± 0.22	13.77–17.55 15.92 ± 0.39

The rate of absorption of three amino acids namely, glycine, lysine and methionine was tested alone and in combination with either ascorbic acid or carotene derived from authentic or natural sources, as orange, parsley, or pepper juices.

Rate of intestinal amino acid absorption was evaluated by giving each rat an oral dose of the tested amino acid equivalent to 0.5 gm./rat. The elevation in the level of plasma total amino acids was followed during intervals of ½, 1, 2 and 3 hours following the orally administered dose. To test the effect of added vitamins, 50 mg. of vitamin C or 0.2 mg. of carotene were added to the amino acid dose. Carotene was given dissolved in corn oil. When vitamin C or carotene were supplied from vegetables or fruits (orange, parsley, and pepper), 5 ml. of the juice was given twice to the rats before the day of experimentation. Another 5 ml. was given with the dose.

Hemoglobin concentration was estimated as described by *Wong* (8). Plasma total proteins was done according to the procedure of *Wootton* (9). Total free amino acids was estimated by the method of *Ya Pin Lee* (19).

Results

The blood hemoglobin concentration ranged from 13.77–17.82 with a mean value of 15.63 g.%. Plasma total proteins amounted to 6.1–8.12 (mean 6.87 g.%).

Oral administration of each of the amino acids tested resulted in an elevation in the level of the total amino acids reaching its maximum at ½ an hour interval in case of lysine, at 1 hour interval in case of glycine and at 2 hour interval in case of methionine. This was followed by a

Table 2. Fasting plasma total amino acid level and its values 1, 2, and 3 hours after the given dose of glycine either alone or with different compounds.

Compounds	Plasma total amino acids (mg.%)				absorption index
	fast	1 hour	2 hour	3 hour	
1. Alone	45–77.5 59.5 ± 5.68	60–175 122.5 ± 18.2	75–140 98 ± 10.6	50–137.5 101 ± 17.78	2.1
2. Ascorbic acid	30–75 51.5 ± 8.5 > 0.2	67.5–140 108 ± 12.6 > 0.3	145–180 162.5 ± 6.0 > 0.005	67.5–155 115.5 ± 16.2 > 0.3	3.1
3. Carotene	40–65 49 ± 9.5 > 0.1	70–195 137 ± 24.7 > 0.1	80–202.5 134 ± 22.5 > 0.1	52.5–75 62.5 ± 5.7 > 0.1	3.0
4. Orange	40–67.5 56.2 ± 4.2 > 0.4	220–290 255 ± 15.6 > 0.005	100–290 182.5 ± 36.4 > 0.025	45–100 69 ± 9.4 > 0.1	4.5
5. Parsley	30–62.5 44 ± 5.55 > 0.05	65–122 95 ± 11.7 > 0.2	35–135 77 ± 19.6 > 0.3	37.5–85 56 ± 19.6 > 0.3	2.1
6. Pepper	40–67.5 57 ± 4.9 > 0.4	62.5–220 112.5 ± 28.6 > 0.4	60–70 64.1 ± 3.0 > 0.01	60–97.5 84 ± 12.1 > 0.3	2.0

Table 3. Fasting plasma total amino acid level and its values ½, 1, 2, and 3 hours after the given dose of lysine either alone or with different compounds.

Compound	Plasma total amino acids (mg.%) fast	½ hour	1 hour	2 hour	3 hour	absorption index
1. Alone	37.5–42.5 41 ± 1.0	50–80 63 ± 5.4	42.5–67.5 53 ± 4.1	35–62.5 50.5 ± 5.0	37.5–80 59 ± 8.12	1.5
2. Ascorbic acid	40–45 43 ± 1.3 > 0.2	60–80 72 ± 5.6 > 0.2	60–120 94 ± 12.6 > 0.01	80–180 116.5 ± 16.9 > 0.005	45–87.5 73 ± 7.3 > 0.1	2.7
3. Carotene	42.5–50 46 ± 1.3 > 0.01	60–80 72 ± 3.3 > 0.1	52.5–80 66 ± 4.4 > 0.05	55–65 59.5 ± 2.3 > 0.1	30–75 56 ± 8.2 > 0.4	1.6
4. Orange	37.5–55 44 ± 3.6 > 0.2	47.5–115 72.5 ± 14.7 > 0.3	62.5–67.5 64.3 ± 1.2 > 0.025	57.5–74 62.8 ± 2.9 > 0.05	42.5–112.5 70.5 ± 11.5 > 0.2	1.6
5. Parsley	37.5–75 63 ± 7.1 > 0.01	74–100 81.6 ± 5.0 > 0.025	67.5–80 75.5 ± 2.8 > 0.005	85–95 90.5 ± 1.7 > 0.005	50–74 61.9 ± 5.6 > 0.4	1.4
6. Pepper	50–74 58.5 ± 4.3 > 0.005	50–115 78.5 ± 14.1 > 0.2	50–87.5 71.3 ± 6.1 > 0.005	60–80 69.5 ± 3.7 > 0.01	52.5–60 56.1 ± 1.9 > 0.5	1.3

Table 4. Fasting plasma total amino acid level and its values 1, 2, and 3 hours after the given dose of methionine either alone or with different compounds.

Compound	Plasma total amino acids (mg.%)				absorption index
	fast	1 hour	2 hour	3 hour	
1. Alone	30–37.5 34.5 ± 1.8	82.5–115 97 ± 7.4	102–120 111.4 ± 3.1	70–107 92.4 ± 8.1	3.2
2. Ascorbic acid	30–67.5 50.5 ± 8.3 > 0.1	113–200 160.5 ± 16.9 > 0.005	107.5–200 152.5 ± 19.1 > 0.025	60–140 103.5 ± 15.0 > 0.3	3.2
3. Carotene	45–65 52.5 ± 3.5 > 0.005	47–62.5 53 ± 8.8 > 0.005	62.5–82.5 72.5 ± 1.0 > 0.005	40–45 41.5 ± 1.0 > 0.005	1.4
4. Orange	47.5–67.5 53.5 ± 3.8 > 0.005	70–102.5 83.5 ± 6.1 > 0.1	65–100 87.4 ± 6.7 > 0.005	60–92.5 72 ± 5.9 > 0.025	1.6
5. Parsley	32.5–70 51.5 ± 6.4 > 0.025	70–125 78.5 ± 14.8 > 0.2	97.5–135 122 ± 8.3 > 0.2	30–100 62.5 ± 14.1 > 0.05	2.4
6. Pepper	35–55 46 ± 3.3 > 0.01	65–142.5 90.5 ± 13.6 > 0.4	80–192.5 188 ± 20.3 > 0.025	52.5–140 78.5 ± 16.0 > 0.3	3.4

decrement in the level of total amino acids till it reached a value somewhat higher than the fasting level after 3 hours from the orally administered dose.

As shown in tables 2, 3 and 4 and as revealed from the calculated absorption index, addition of ascorbic acid caused enhancement to absorption of the three tested amino acids. Carotene affected the absorption of these three amino acids variably. It hindered the absorption of methionine, did not affect lysine absorption and enhanced the absorption of glycine.

When pepper, parsley, and orange juices were successively added to each of the amino acids, the effect on absorption was variable. Orange juice markedly enhanced glycine absorption, while it hindered methionine and was not effective to lysine. Pepper juice enhanced absorption of methionine and glycine but not lysine. Parsley juice exerted similar effect on intestinal amino acid absorption as pepper.

Discussion

The choice of these amino acids was done to represent essential as lysine and methionine, the first being a basic amino acid and the latter to represent sulphur amino acids. Glycine was selected to represent non-essential amino acids.

It was observed that the maximum of absorption was reached at different intervals. This may indicate that these three amino acids are absorbed at different sites of the small intestine, and that lysine is

absorbed more near to the proximal part of the small intestine than other two amino acids. The tolerance curve of lysine showed that the maximum is followed by a gradual decrease till the second hour, then the level elevated again. Such behaviour may indicate that this amino acid is absorbed in more than one site of absorption in the intestine.

As indicated from absorption index (maximum level of plasma amino acids/fasting level), ascorbic acid enhanced absorption of amino acids tested particularly methionine (tables 2, 3 and 4). No previous data could be traced in the available literature illustrating the effect of ascorbic acid on amino acid absorption. However, in 1957, *Huisman* found that amino-aciduria was markedly increased in scorbutic infants. He reported that vitamin-C therapy could correct such state of hyperaminoaciduria. Later, in 1969, *Bares* et al. considered that data they obtained concerning the excretion of free amino acids and ammonia to be indicative for some degree of general aminoaciduria in scorbutic guinea pigs. According to *Milne*, (3), most routs of amino acid absorption existing in the renal tubules are similar to those in the intestine. The process of hyperaminoaciduria results from failure of absorption of these amino acids from the renal tubules in scorbutic subjects. Similarly, between renal tubular and intestinal absorption of amino acids may suggest a similar role of ascorbic acid in both sites. Recently, *Scott* and *Friedenthal*, (6), found that one of the mechanisms responsible for transport of neutral amino acids to the cornea is markedly stimulated by ascorbate. They found that leucine transport system is coupled to an electron transport system that utilizes ascorbate as substrate or electron donor.

It is worth to note that addition of ascorbic acid to each of the tested amino acids shifted the maximum to the two hours interval in case of glycine and lysine. This may indicate that the effect of the added ascorbic acids is not only restricted to its enhancing action, but also to prolongation of the extent of absorption.

The addition of carotene to the amino acid doses brought about variable effect to different amino acids. Our finding in this respect is difficult to interpret. It is assumed that carotene may be either of no role in absorption of certain amino acids as lysine or it may form a complex with the amino acid that hinders its absorption as in methionine or it may be participating in one of the stages of absorption and transport as in glycine.

The effect of the three juices used towards different amino acids was variable. Addition of pepper, parsley, or orange to the lysine dose did not affect its rate of intestinal absorption. Pepper juice enhanced absorption of methionine in contrast to orange and parsley. The effect of pepper juice in this respect may be due to its high content of vitamin C and low carotene relative to the two other juices. This goes parallel with our finding in the authentic samples where ascorbic acid enhanced methionine absorption while carotene hindered it. Orange juice, which contains less amounts of vitamin C, and higher amounts of carotene relative to pepper inhibits methionine absorption. Parsley, the richest in vitamin-C content among the three juices and markedly rich in carotene, hindered methionine absorption. It is suggested that the hindering action is attributed to its high content of carotene.

Table 5. Fasting level of plasma total amino acids and its values 1, 2, and 3 hours after glycine dose alone or with citric acid.

Compound	Plasma total amino acids (mg.%)				absorption index
	fast	1 hour	2 hour	3 hour	
1. Alone	32–40	120–128	100–128	96–136	
	36	124	114	116	3.4
2. Citric acid	32–40	184–240	136–232	104–104	
	36	212	184	104	5.9

When the three juices were added successively to the glycine dose, the most pronounced enhancing action was observed in case of orange juice, which is relatively poor in vitamin C. Orange being of the citrus family is known to be markedly rich in critic acid content. This drew our attention to test the effect of citric acid on glycine absorption. A preliminary experiment was carried out in the same way as previously described. The results obtained proved that citric acid actually enhanced glycine absorption (table 5). The marked enhancing action of orange juice to glycine absorption may be thus attributed to its citric acid content.

Addition of ascorbic acid to amino acid therapy is recommended to enhance their intestinal absorption. Again, ascorbic acid or ingredients rich in this vitamin are useful for better utilization of proteins.

Summary

The effect of vitamin C or carotene either from authentic or natural sources on absorption of lysine, glycine and methionine was evaluated. Results revealed that maximum absorption of these amino acids was reached at different intervals from the orally given dose. Addition of ascorbic acid enhanced amino acid absorption and this effect was maximum in case of methionine. Carotene brought about variable effect to the three amino acids tested. Pepper, parsley, or orange juices did not affect the extent of intestinal lysine absorption. Pepper juice enhanced absorption of methionine in contrast to orange and parsley. Glycine absorption was markedly enhanced by addition of orange juice.

Ascorbic acid suppelementation to dietary constituents is recommended for better utilization of proteins.

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