Plasma Free Amino Acid Contents in Healthy Thai Subjects

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Abstract

This preliminary investigation determined the plasma amino acid concentrations in 136 healthy subjects. The subjects were divided into four groups according to their ages: gr 1; 1-3 years, gr 2; 4-11 years, gr 3; 12-19 years and gr 4; 20-45 years.

Comparing among the groups, the results showed that in younger children (age 1-3 years) the essential amino acids were slightly lower than the other groups. A wide range for most amino acids were observed. The ratio of essential (EAA): non-essential amino acid (NEAA) in very young children (1-3 years) was lower than children, adolescents and adults. These ratios were normal (> 0.5).

The data have been compared with those from several studies performed in normal healthy subjects of different age groups, races and dietary habits. The results showed that most of the mean values of individual amino acid were higher than others except cystine. The EAA: NEAA ratio of each age group was comparable with other reports. The mean values of plasma amino acids and EAA:NEAA ratio in healthy subjects were determined for diagnosis, follow-up and prognosis of malnourished condition, abnormal amino acid metabolism and as a reference for other purposes.

Key word : Plasma Amino Acids, Healthy Thai

Protein malnutrition is still a problem among Thai people especially in low socioeconomic groups. Since animal protein which supplies complete amino acids pattern is less available for these people and the amino acid imbalance may be found. There seems to be sufficient evidence from other studies that protein content of the diet affects the concentration of most amino acids in plasma. Ear-

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lier studies have reported that the increase of concentration of various amino acids in plasma after ingestion of differing high protein meals was proportional to the amount of amino acids in the meal (1). Among individual receiving low protein diet, the essential amino acids are reduced and some non-essential amino acids are increased in plasma(2). The levels of amino acids serve as a valuable indicator of protein nutritional status and the pathology of some diseases which related to growth and development. Rampai et al, studied the plasma amino acid patterns in 22 normal Thai subjects and in patients with renal failure(3). The decrease of several essential amino acid (EAA) concentrations as well as the increase of certain non-essential amino acid (NEAA) concentrations have been observed in patients with renal failure(3). So far, little is known about plasma amino acid patterns in healthy Thai subjects. Therefore, there is a need for a preliminary investigation to determine the range and average values of each amino acid in healthy subjects of various age groups. This study was conducted to obtain the quantitative content of individual amino acid and compared with the references reported by several investigators done in other countries.

Table 1. Plasma free amino acid and EAA : NEAA ratio in healthy Thai subject of different age groups.

Amino acids mg/dl	Gr. 1 (1-3yrs, n=10)		Gr. 2 (4-11yrs, n=31)		Gr. 3 (12-19yrs, n=22)		Gr. 4 (20-45yrs, n=73)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Taurine	2.74 ± 0.68	1.87-4.15	2.59 ± 0.48	1.41-3.67	2.46 ± 0.53	0.98-3.59	2.05 ± 0.77	0.67-5.13
Aspartic acid	0.53 ± 0.22	0.29-1.12	0.59 ± 0.09	0.37-0.72	0.53 ± 0.11	0.24-0.73	0.42 ± 0.18	0.05-1.13
Threonine*	1.26 ± 0.34	0.93-1.88	1.82 ± 0.32	1.31-2.61	1.91 ± 0.39	1.11-2.59	1.73 ± 0.38	0.94-2.62
Serine	1.94 ± 0.49	1.55-3.25	2.27 ± 0.27	1.77-2.85	2.08 ± 0.24	1.69-2.55	1.85 ± 0.35	1.20-3.37
Proline	1.64 ± 0.83	1.56-2.84	2.08 ± 0.63	1.29-4.35	2.37 ± 0.77	1.49-4.37	2.04 ± 0.62	1.10-3.90
Glutamic acid	3.20 ± 1.06	2.11-5.49	2.58 ± 0.40	1.77-3.53	2.69 ± 0.86	0.81-4.48	3.19 ± 1.88	0.40-5.11
Citrulline	0.49 ± 0.15	0.25-0.78	0.58 ± 0.13	0.33-0.83	0.54 ± 0.12	0.36-0.80	0.49 ± 0.21	0.14-1.42
Glycine	2.27 ± 0.68	1.62-3.55	2.95 ± 0.42	2.15-2.08	2.63 ± 0.42	1.77-3.23	2.34 ± 0.52	1.48-4.03
Alanine	3.99 ± 1.57	2.41-6.83	4.15 ± 0.83	2.94-6.03	4.67 ± 1.01	2.82-6.58	3.53 ± 0.84	2.17-5.54
α amino n-butyric acid	0.18 ± 0.12	0.14-0.33	0.22 ± 0.04	0.14-0.31	0.20 + 0.05	0.09-0.32	0.20 + 0.09	0.04-0.42
Valine*	2.88 ± 1.02	1.67-5.17	3.09 ± 0.39	2.33-3.95	3.43 ± 0.62	2.58-4.77	2.88 ± 0.59	1.73-4.45
Cystine	0.67 ± 0.13	0.37-0.85	0.18 ± 0.14	0.06-0.85	0.19 ± 0.10	0.10-0.50	0.53 ± 0.50	0.04-2.08
Methionine*	0.42 ± 0.22	0.24-0.92	0.63 ± 0.15	0.46-1.12	0.57 ± 0.08	0.37-0.68	0.57 ± 0.20	0.26-1.40
Isoleucine*	0.89 ± 0.21	0.56-1.20	1.33 ± 0.16	1.06-1.64	1.34 ± 0.32	0.57-1.90	1.03 ± 0.31	0.45-1.86
Leucine*	1.91 ± 0.92	1.02-4.22	2.16 ± 0.20	1.73-2.60	2.34 ± 0.40	1.65-3.10	2.03 ± 0.62	1.20-5.28
Tyrosine	1.30 ± 0.48	0.86-2.53	1.35 ± 0.18	1.00-1.73	1.27 ± 0.18	0.43-1.74	1.13 ± 0.28	0.66-2.02
Phenylalanine*	1.26 ± 0.57	0.72-2.78	1.37 ± 0.16	1.04-1.73	1.36 ± 0.18	0.89-1.80	1.20 ± 0.34	0.68-2.69
Ornithine	1.15 ± 0.42	0.85-2.83	1.26 ± 0.36	0.64-1.84	1.36 ± 0.37	0.57-2.59	1.35 ± 0.49	0.68-3.16
Lysine*	2.47 ± 1.03	1.39-5.08	3.60 ± 1.72	2.55-7.84	3.22 ± 0.42	2.19-4.16	3.22 ± 0.69	1.72-5.46
Histidine	1.35 ± 0.32	0.93-1.99	1.74 ± 0.61	1.33-3.14	1.53 ± 0.17	1.23-1.78	1.36 ± 0.31	0.72-2.74
Tryptophan*	1.22 ± 0.49	0.34-1.76	1.36 ± 0.92	0.77-2.24	1.01 ± 0.37	0.51-1.67	1.18 ± 0.48	0.30-2.25
Arginine	1.30 ± 0.88	0.95-3.03	2.09 ± 0.61	0.98-3.17	2.35 ± 0.56	1.60-3.84	1.98 ± 0.58	0.95-4.95
Total EAA	12.31		15.36		15.18		13.84	
Total NEAA	22.75		24.63		24.87		22.46	
Ratio EAA : NEAA	0.54		0.62		0.61		0.62	

*Essential amino acid

Table 2. Comparison of plasma free amino acids and EAA : NEAA ratio of very young children (gr. 1) with other studies.

Amino acids mg/dl	Present study 1-3yrs, n=10		Vis et al[7] 9m-2yrs, n=20		Ghadimi et al[8] 4m-2.6yrs, n=9	Westall et al[9] 1-5yrs
	Range	Mean	Range	Mean	Mean	Mean
Taurine	1.87-4.15	2.74	0.24-1.14	0.61	0.83	0.91
Aspartic acid	0.29-1.12	0.53	0.00-0.12	0.03	0.17	0.04
Threonine	0.93-1.88	1.26	0.39-1.52	0.71	1.40	1.13
Serine	1.55-3.25	1.94	0.25-1.81	0.97	1.14	1.07
Proline	1.56-2.84	1.64	0.59-2.13	1.32	1.88	2.13
Glutamic acid	2.11-5.49	3.20	0.68-4.27	1.98	1.32	-
Citrulline	0.25-0.78	0.49	-	-	0.41	0.25
Glycine	1.62-3.55	2.27	0.42-2.31	1.28	1.14	1.07
Alanine	2.41-6.83	3.99	0.88-2.79	1.95	2.26	1.89
α amino n-butyric acid	0.14-0.33	0.18	0.00-0.18	0.05	0.29	0.22
Valine	1.67-5.17	2.88	0.67-3.07	1.49	2.60	2.88
Cystine	0.37-0.85	0.67	0.00-1.49	0.15	0.50	-
Methionine	0.24-0.92	0.42	0.04-0.43	0.31	0.18	0.25
Isoleucine	0.56-1.20	0.89	0.34-1.23	0.58	1.01	0.91
Leucine	1.02-4.22	1.91	0.59-2.03	0.98	1.64	1.53
Tyrosine	0.86-2.53	1.30	0.20-2.21	0.82	0.97	1.24
Phenylalanine	0.72-2.78	1.26	0.38-1.14	0.66	0.88	0.76
Ornithine	0.85-2.83	1.15	0.13-1.14	0.53	1.29	0.67
Lysine	1.39-5.08	2.47	0.66-2.11	1.27	3.32	0.67
Histidine	0.93-1.99	1.35	0.37-1.74	0.99	1.60	0.91
Tryptophan	0.34-1.76	1.22	-	-	-	0.82
Arginine	0.95-3.03	1.30	0.19-1.13	0.54	0.39	0.77
Total EAA		12.31		6	11.03	8.95
Total NEAA		22.75		11.22	14.19	11.17
Ratio EAA : NEAA		0.54		0.53	0.78	0.8

SUBJECT AND METHOD

The study was conducted at Research Center, Ramathibodi Hospital and informed consent was obtained prior to the study. Investigation was carried out on a total of 136 healthy subjects. The adult subjects were the staffs and personnel of Research Center while the young ones were their children. They were divided into 4 groups according to their ages of life stage. Group 1, 2, 3, and 4 consisted of 10, 31, 22, and 73 subjects, aged from 1-3, 4-11, 12-19 and adults 20-45 years old respectively. The subjects were on their normal diet intake.

Fasting blood specimens (3.0 ml) were used for quantitative analysis. Plasma was preferrable because clotting of blood may cause small losses of some amino acids[4]. Blood samples were collected in a centrifuge tube with EDTA anticoagulant. The plasma was immediately separated by centrifugation and deproteinized at once by adding 45 mg SSA (sulfosalicylic acid) to 1.0 ml plasma. The supernatant was separated and 50 ul was injected to the analyzer. The free amino acid concentrations in the supernatant were analyzed by ion exchange chromatography using different pH buffers. The amino acids emerging from the column were quantitatively determined by mixing with ninhydrin to develop a proportional purple blue color. The remaining samples were stored at -20°C if not immediately analyzed after deproteinization.

Table 3. Comparison of plasma free amino acids and EAA : NEAA ratio of Thai children (gr. 2) with other studies.

Amino acids mg/dl	Present study 4-11yrs, n=31		Scriver et al[10] 3-10yrs, n=9		Brodehl et al[11] 2-13yrs, n=12	Brodehl et al[11] Children* n=10
	Range	Mean	Range	Mean	Mean	Mean
Taurine	1.41-3.67	2.59	0.71-1.44	1.00	-	0.61
Aspartic acid	0.37-0.72	0.59	0.00-0.33	-	0.21	0.07
Threonine	1.31-2.61	1.82	0.50-1.13	0.90	1.73	1.84
Serine	1.77-2.85	2.27	0.78-1.70	-	1.27	1.21
Proline	1.29-4.35	2.08	0.34-3.68	1.22	2.05	1.96
Glutamic acid	1.77-3.53	2.58	0.34-3.68	1.62	-	0.65
Citrulline	0.33-0.83	0.58	-	-	-	0.42
Glycine	2.15-2.80	2.95	0.88-1.67	1.25	1.65	1.71
Alanine	2.94-6.30	4.15	1.22-2.72	2.09	2.42	3.23
α amino n-butyric acid	0.14-0.31	0.22	-	-	-	0.20
Valine	2.33-3.95	3.09	1.50-3.32	1.90	2.12	2.65
Cystine	0.06-0.85	0.18	1.08-1.85	1.44	1.05	1.17
Methionine	0.46-1.12	0.63	0.16-0.24	0.21	0.24	0.34
Isoleucine	1.06-1.64	1.33	0.37-1.10	0.56	0.58	0.73
Leucine	1.73-2.60	2.16	0.73-2.33	1.11	1.19	1.55
Tyrosine	1.00-1.73	1.35	0.56-1.29	0.78	0.83	0.94
Phenylalanine	1.04-1.73	1.37	0.43-1.01	0.69	0.78	0.82
Ornithine	0.64-1.84	1.26	0.36-1.14	0.44	0.61	0.73
Lysine	2.55-7.84	3.60	1.04-2.21	1.62	1.91	2.62
Histidine	1.33-3.14	1.74	0.37-1.32	0.85	1.24	1.23
Tryptophan	0.77-2.24	1.36	-	-	-	1.10
Arginine	0.98-3.17	2.09	0.40-1.50	0.92	1.49	1.47
Total EAA		15.36		6.99	8.55	11.65
Total NEAA		24.63		10.77	12.82	15.6
Ratio EAA : NEAA		0.62		0.65	0.67	0.75

* Age not specified, 5 females and 5 males

Analytical procedure

Model 121 M, ion exchange chromatography amino acid analyzer (Beckman Instruments) was used for physiological fluid and hydrolysate analysis. The procedures were adopted from automatic dual column method. The improvements in the dual column method procedure enabled all the amino acids to obtain high resolution. The greatly increase sensitivity made the quantitative determination of the nanomole amounts of amino acids in 50 ul supernatant. The acidic and the neutral amino acids were separated in the long column and the basic amino acids on the short column. The sodium buffers were employed and the separation of asparagine and glutamine were recovered quantitatively as aspartic and glutamic acids respectively. Deionized water was employed for making buffers. The ninhydrin color reagent was prepared under nitrogen atmosphere and hydrindantin was added to prevent oxidation. The color intensities derived from the reaction of amino acids eluted from the columns with ninhydrin reagent were recorded at 440 and 570 nm. The complete analysis through arginine (last peak) required 3.5-4.0 hour per sample.

Table 4. Comparison of plasma free amino acids and EAA : NEAA ratio of Thai adolescents (gr. 3) with other study.

Amino acids mg/dl	Present study 12-19yrs, n=22		Nyphan et al[12] 5-17yrs, n=39
	Range	Mean	Mean
Taurine	0.98-3.59	2.46	0.86
Aspartic acid	0.24-0.73	0.53	0.39
Threonine	1.11-2.59	1.91	1.42
Serine	1.69-2.55	2.08	3.95
Proline	1.49-4.37	2.37	2.71
Glutamic acid	0.81-4.48	2.69	2.74
Citrulline	0.36-0.80	0.54	-
Glycine	1.77-3.23	2.63	1.82
Alanine	2.82-6.58	4.67	3.01
α amino n-butyric acid	0.09-0.32	0.20	-
Valine	2.58-4.77	3.43	2.23
Cystine	0.10-0.50	0.19	0.89
Methionine	0.37-0.68	0.57	0.33
Isoleucine	0.57-1.90	1.34	0.80
Leucine	1.65-3.10	2.34	1.32
Tyrosine	0.93-1.74	1.27	1.03
Phenylalanine	0.89-1.80	1.36	1.01
Ornithine	0.57-2.59	1.36	0.93
Lysine	2.19-4.16	3.22	2.54
Histidine	1.23-1.78	1.53	1.37
Tryptophan	0.51-1.67	1.01	0.98
Arginine	1.60-3.84	2.35	1.67
Total EAA		15.68	10.63
Total NEAA		24.87	21.37
Ratio EAA : NEAA		0.61	0.50

RESULTS

The combined list of range and mean values for plasma amino acids in fasting subjects of all groups are shown in Table 1. The sequence of amino acids were arranged in order of their elution from the column and expressed as mg/dl. The plasma free EAA concentrations and the ratio of EAA:NEAA of group 1 were generally lower than the other groups (0.54 *vs* 0.62, 0.61, 0.62). In children (gr. 2, 4-11years), adolescents (gr. 3, 12-19 years) and adults (gr. 4, 20-45years) the mean of plasma free amino acid concentrations and the ratio of EAA:NEAA were almost the same.

The results were compared with other studies as shown in Table 2, 3, 4 and 5. Most of the free amino acid levels especially essential amino acid in all groups of Thai people were higher than other studies except for cystine which was lower. The composition of dietary intake may plays a role in differences of plasma amino acid concentration of these different population[1].

The EAA and NEAA ratio for each age group was compared with other studies. For age 1-3 years, it was comparable with Vis et al[7] (0.54 *vs* 0.53) but slightly lower than Ghadimi et al[8] and Westall et al[9], 0.54 *vs* 0.78 and 0.8, respectively (Table 2). For age 4-11 years, the ratio was agreed well with Scriver et al[10] and Brodehl et al[11] even the sum of EAA and NEAA were higher in Thai group (Table 3). For adolescents (Table 4), the mean of total EAA of Thai population was higher than Nyphan et al[12] which made

Table 5. Plasma free amino acid contents in gr. 4 and the study of many researchers.

Amino acids mg/dl	Present study 20-45yrs, n=73		Dickinson et al[13] Adults, n=8		Adults, n=76* 39 M + 37 F		Adults** n=30	Paulucci et al[6] 20-30yrs, n=10
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Taurine	0.67-5.13	2.05	0.70-1.73	0.83	0.34-2.10	0.79	0.40-1.72	-
Aspartic acid	0.05-1.13	0.42	Tr[1]. - 0.72	0.22	0.00-0.32	0.10	0.01-0.15	0.35
Threonine	0.94-2.62	1.73	1.22-2.93	1.94	0.94-2.30	1.54	0.91-2.31	1.67
Serine	1.20-3.37	1.85	0.68-2.03	1.18	0.77-1.76	1.21	0.80-1.72	1.38
Proline	1.10-3.90	2.04	1.28-5.14	2.71	0.21-2.82	0.85	1.19-3.34	2.79
Glutamic acid	0.40-5.11	3.19	0.25-1.73	0.86	1.17-3.87	2.12	0.29-1.38	2.41
Citrulline	0.14-1.42	0.49	0.21-0.97	0.53	-	0.50	-	0.30
Glycine	1.48-4.03	2.34	1.08-3.66	1.74	0.90-4.16	1.78	1.50-2.00	1.85
Alanine	2.17-5.54	3.53	2.22-4.47	3.07	1.87-5.89	2.99	1.90-4.21	3.76
α amino n-butyric acid	0.04-0.42	0.20	0.10-0.24	0.17	0.08-0.36	0.21	0.10-0.36	0.19
Valine	1.73-4.45	2.88	1.36-2.66	1.99	1.65-3.71	2.50	1.97-3.70	2.81
Cystine	0.04-2.08	0.53	1.15-3.37	1.77	0.20-2.02	1.05	1.68-2.60	-
Methionine	0.26-1.40	0.57	0.23-0.39	0.32	0.09-0.59	0.34	0.16-0.45	0.31
Isoleucine	0.45-1.86	1.03	0.46-1.15	0.71	0.48-1.28	0.83	0.52-1.30	0.75
Leucine	1.20-5.28	2.03	0.93-1.78	1.32	0.98-2.30	1.45	1.02-2.31	1.72
Tyrosine	0.66-2.02	1.13	0.65-1.13	0.91	0.39-1.58	0.94	0.40-1.50	1.11
Phenylalanine	0.68-2.69	1.20	0.63-1.92	0.95	0.61-1.45	0.88	0.63-1.21	1.03
Ornithine	0.68-3.16	1.35	0.43-1.67	0.92	0.39-1.40	0.79	0.40-0.85	1.47
Lysine	1.72-5.46	3.22	2.11-3.09	2.54	1.21-3.48	2.24	1.53-3.02	2.54
Histidine	0.72-2.74	1.36	0.97-1.45	1.24	0.49-1.66	1.15	0.50-1.51	1.24
Tryptophan	0.30-2.25	1.18	0.51-1.49	0.98	-	-	Trace	-
Arginine	0.95-4.95	1.98	0.86-2.63	1.43	0.37-2.40	1.30	0.70-2.44	1.00
Total EAA		13.84		10.75		9.78		10.83
Total NEAA		22.46		17.58		15.78		17.85
Ratio EAA : NEAA		0.62		0.61		0.62		0.61

*Data from nine laboratories compiled by Dickinson et al.[13]
**Data from six laboratories compiled by Soupart et al.[2]
[1]Trace

the EAA:NEAA ratio slightly increased (0.61 *vs* 0.50). The data of EAA:NEAA ratio of the adult group was comparable with the other studies (Table 5) and also the study in Thai adults, control subject by Ramphai et al[3].

DISCUSSION

From the literatures[5] there were 26 well identified free amino acids found in human plasma of which only 22 were present in measurable amounts in this study. In the study of Soupart et al only 20 amino acids were detected in measurable amounts and 6 being present only as traces[5].

On comparison among Thai groups the following differences may be observed (Table 1). The average concentrations in general was a bit lower in younger children (1-3 years), particularly the EAA concentrations which made the decreased of EAA:NEAA ratio (0.54). It was agreed well with Vis et al[7], stated that in 20 children of different races found that there was no difference observed among 15 black and 5 white children. This data confirmed with of Shih VE. who stated that, in general, children in the active growth stage have slightly lower concentrations of the EAA[4]. Paulocci et al, also found that the mean concentration of the most amino acids in plasma of children was lower than that of the adults even though the protein intake per kg body weight was higher in children[6]. This may indicates more avid transport into the tissues during the period of growth[6]. The wide range of variation was observed in younger children and adults. In children (gr. 2, 4-11years), adolescents (gr. 3, 12-19 years) and adults (gr. 4, 20-45 years) the mean of amino acid concentrations were very close except for the lower level of cystine

in gr. 2 and 3. This might be due to differences in dietary consumption of different population. The ratio of EAA:NEAA was similar (0.62 *vs* 0.61 *vs* 0.62) for these 3 groups.

The total amino acids, both EAA and NEAA, were higher in Thai population when compared with others. This may explain by the differences of dietary composition[1]. The ratios of EAA:NEAA of different age groups for Thai population were compared with others. Most of the data were comparable and in the level of normal value[2].

SUMMARY

The plasma free amino acid levels have been determined by ion exchange chromatography in order to obtain the range and mean values of healthy Thai subjects. The data obtained have been compared with those data from several studies performed in normal subjects of different age groups, sexes, races and people with different dietary habits. A wide range for most amino acids was observed. The mean values of individual amino acid of Thai population were higher than other studies except for cystine. The differences in dietary pattern may affects the plasma amino acid pattern. Lower ratio of EAA : NEAA was found in very young children compared with other age groups. The normal plasma amino acid contents and the ratio of EAA : NEAA for different age groups were evaluated for the purpose of diagnosis, follow-up and prognosis of treatment of some diseases related to protein and amino acid metabolism.

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การศึกษาระดับกรดอะมิโนในพลาสม่าของคนไทยที่มีสุขภาพดี

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การศึกษาวัดระดับกรดอะมิโนในพลาสม่าของคนไทยปกติ จำนวน 136 ราย โดยแบ่งเป็น 4 กลุ่มตามอายุ กลุ่มที่ 1 อายุ 1-3 ปี กลุ่มที่ 2 อายุ 4-11 ปี กลุ่มที่ 3 อายุ 12-19 ปี และกลุ่มที่ 4 อายุ 20-45 ปี เมื่อเปรียบเทียบระดับของกรดอะมิโนในพลาสม่าทั้ง 4 กลุ่ม พบว่ากลุ่มเด็กอายุ 1-3 ปี จะมีค่าความเข้มข้นของกรดอะมิโนจำเป็นต่ำกว่ากลุ่มอื่นๆ มีอัตราส่วนของกรดอะมิโนจำเป็นต่อกรดอะมิโนไม่จำเป็นต่ำกว่ากลุ่มเด็กโต วัยรุ่นและกลุ่มผู้ใหญ่ และอัตราส่วนนี้ถือว่าเป็นอัตราส่วนปกติ (มากกว่า 0.5) เมื่อเปรียบเทียบค่าต่าง ๆ ของกรดอะมิโนกับการศึกษาของผู้อื่นที่อายุใกล้เคียงกัน พบว่าค่าเฉลี่ยของกรดอะมิโนแต่ละชนิดส่วนใหญ่จะมีค่าสูงกว่ารายงานของคนอื่นที่มีเผ่าพันธุ์และพฤติกรรมการบริโภคต่างกัน ยกเว้นกรดอะมิโน cystine ทั้งนี้อาจมีผลมาจากการบริโภคอาหารที่แตกต่างกันของกลุ่มประชากรที่นำมาเปรียบเทียบ อัตราส่วนระหว่างกรดอะมิโนจำเป็น : กรดอะมิโนไม่จำเป็นในแต่ละกลุ่มอายุให้ผลใกล้เคียงกับการศึกษาของคนอื่น สรุปได้ว่าการศึกษาหาค่าเฉลี่ยของกรดอะมิโนแต่ละชนิดและอัตราส่วนระหว่างกรดอะมิโนจำเป็นต่อกรดอะมิโนไม่จำเป็นในคนไทยที่มีสุขภาพดี สามารถใช้เป็นค่ามาตรฐานในการทำนายติดตามและดูผลของการรักษาในคนที่มีภาวะทุพโภชนาการหรือมีความผิดปกติของเมตาบอลิซึมของกรดอะมิโนต่าง ๆ ของคนไทยได้

คำสำคัญ : กรดอะมิโนในพลาสม่า, คนไทยที่มีสุขภาพดี

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