Bull. Mar. Sci. Fish., Kochi Univ.
No. 18, pp. 33-37, 1998

Dietary amino acids budget for juvenile yellowtail (*Seriola quinqueradiata*)

Tohsiro MASUMOTO[1], Yoshiaki ITOH[2], Toni RUCHIMAT[1], Hidetsuyo HOSOKAWA[1], and Sadao SHIMENO[1]

[1] *Laboratory of Fish Nutrition, Kochi University, Nankoku, Kochi, Japan (Email: tosh@cc.kochi-u.ac.jp)*
[2] *Laboratory of Aquatic Product Utilization, Kochi University, Nankoku, Kochi, Japan*

Abstract: Yellowtail weighing 31.7g was fed 4 levels of fish meal diet for 21 days. Based on the amino acid intake and gain data from the best growth exhibited crude protein content 52% fed fish, the amino acid budget was estimated. Average of each amino acid value showed that about 32% and 57% of intake amino acids were utilized for growth and for as an energy source and maintenance, respectively.

Key words: Yellowtail, amino acids

INTRODUCTION

Protein is principal constituent of the animal tissue and nitrogen components such as nucleic acids, enzymes and peptide hormones. Dietary protein is utilized in fish for maintenance of normal tissue function and growth as well as an energy source. Fish, like other animals, do not have a true protein requirement but have a requirement for a well-balanced mixture of indispensable and dispensable amino acids (Wilson, 1989). Therefore, amino acids rather than protein should be more appropriate for an estimation of dietary protein utilization. In the present study, a feeding trial was conducted to measure amino acid intake and gain. Based on these two parameters, dietary amino acid partition into growth and metabolism was estimated.

MATERIALS AND METHODS

Feed and Feeding

Feeding experiment was conducted to juvenile yellowtail average weight of 31.7g. Those fish were fed diets containing four levels of fish meal (Table 1). The crude protein content of each diet was designated each diet name (e.g., CP52 is crude protein content 52%). Fish were allocated to 800l FRP tank and had been kept with flow-through system (10-12l/min). The water temperature ranged from 24.0-26.1°C, specific gravity was 22.0-24.5, and pH was 7.0-7.5 during the experiment. The fish were hand-fed two times daily

Table 1. Dietary composition of the test diets

	CP31	CP37	CP42	CP52
Brown fish meal	44	51	58	71
Pollock liver oil	20	17	14	9
Others*	17	17	17	17
Cellulose	19	15	11	3
Total	100	100	100	100
Feeding stimulants	0.5	0.5	0.5	0.5
Water	50	50	50	50

* Others contain the following items: α-corn starch (8.5), vitamins (3.0), minerals (2.5), CMC-NA(2.5), Guargum (0.5).

for 7days a week. Fish from each tank was individually weighed every seven days. Fish were fed till satiation. At beginning and end of the feeding, five fish from each tank were taken and pooled for the whole body protein and amino acid content determinations.

Analytical

Whole body of the fish were cut and homogenized. The protein content of the diets and the whole body were determined according to ordinary methods (AOAC, 1984). The amino acid composition of diets and whole body homogenates were hydrolyzed in vacuo in 6 N HCl at 110°C for 22 h, and amino acids were separated and quantified by using amino acid analyzer (Hitachi, Model 835, Hitachi Ltd, Tokyo, Japan). Cystine was determined as cystein and tryptophan was not able to measure in this analytical condition.

RESULTS AND DISCUSSION

The growth and feeding data are shown in table 2. The highest dietary protein level of CP52 exhibited the best growth. The daily wt. gain and protein gain increased as the dietary protein level increased, while the feed conversion ratio decreased as the dietary protein increased. Whole body protein content of the fish at beginning and end from all diets were nearly constant at 19%, therefore this value was used for the protein gain calculation. The daily feeding rate was nearly constant at 4.5%, although CP52 was somewhat lower than other diet groups. The daily protein gain and intake were standardized to 100g body wt. with using the value of the average of initial and final wt.

The amino acid composition of the fish meal and whole body composition of juvenile yellowtail were determined (Table 3). The whole body amino acid composition is listed only one because there were not much difference among the treatments or before and after the feeding trial. Daily amino acid intake (Table 4) and daily amino acid gain (Table 5) were calculated based on the growth response (Table 2) and the amino acid composition (Table 3). Reflecting the amino acid composition of the fish meal, glutamic acid was the highest intake of amino acid following by aspartic acid, lysine, leucine, glycine and alanine in descending order.

Table 2. Growth and feeding date for yellowtail fed the test diets for 21 days

	CP31	CP37	CP42	CP52
Initial wt. (g)	31.7	31.7	31.7	31.7
Final wt. (g)	59.8	61.8	69.5	79.1
Average of initial and final wt. (g)	45.75	46.75	50.60	55.40
Body wt. gain (g)	28.1	30.1	37.8	47.4
Daily wt gain (g/fish/day)	1.34	1.43	1.80	2.26
daily protein gain (g/fish/day)*1	0.255	0.272	0.342	0.429
Feed conversion ratio	1.527	1.448	1.258	1.014
Daily feeding rate (% bw/day)	4.47	4.44	4.48	4.13
Total feed fed (g/fish)	42.909	43.585	47.552	48.064
Daily feed intake (g/fish/day)	2.043	2.075	2.264	2.289
Daily protein intake (g/fish/day)	0.633	0.768	0.951	1.190
Daily protein gain (g/100g bw/day)*2	0.557	0.582	0.676	0.774
Daily protein intake (g/100g bw/day)*3	1.384	1.643	1.879	2.148

*1 Protein content 19% on wet matter basis
*2 Daily protein gain (g/fish/day)×100/(average of initial and final wt.)
*3 Daily protein intake (g/fish/day)×100/(average of initial and final wt.)

Amino acid retention was estimated based on the amino acid intake and gain data (Table 6). The retention of the CP31 was highest at 35.8%, while that of other three dietary groups were similar around 32%.

This implies that dietary amino acid requirement for juvenile are met between CP37 and CP52 when fish meal is used as a protein source.

The retention of histidine and cystine were somewhat higher and lower than other amino acids, respectively. The reason why histidine tended to be higher retention than other amino acids is unknown. Increase of body histidine concentration has also been observed in the course of 30days feeding trial (Masumoto unpubl.), so turnover of histidine may slower compare to other amino acids. On the other hand, cystine had a lower retention than the average retention value. Cysteine was quantified together with cystine in the present study. Lower retention of cystine may result from rapid turnover of cysteine because cysteine toxicity has been reported in rainbow trout (Yokoyama and Sakaguchi, 1996) and cysteine level is generally kept at low level (Yokoyama and Nakazoe, 1992). Such low retention and high turnover rate may be a counteraction for the toxicity of cysteine.

Table 3. Amino acid composition for the brown fish meal and whole body of yellowtail (mg/g protein)

	Fish meal	Whole body
Alanine	61.80	60.17
Arginine	59.16	52.07
Aspartic acid	78.44	69.32
Cystine	4.571	3.27
Glutamic acid	142.76	128.63
Glycine	68.33	66.23
Histidine	23.39	26.58
Isoleucine	34.77	29.32
Leucine	71.42	62.09
Lysine	77.29	69.35
Methionine	31.10	26.72
Phenylalanine	39.46	32.88
Proline	40.44	34.43
Serine	44.54	40.27
Threonine	42.93	38.32
Tyrosine	32.53	29.07
Valine	42.47	35.51

Table 4. Daily amino acid intake (mg/100g bw/day)

	CP31	CP37	CP42	CP52
Alanine	85.53	101.54	116.12	132.75
Arginine	81.88	97.20	111.16	127.08
Aspartic acid	108.56	128.88	147.39	168.49
Cystine	6.33	7.51	8.59	9.82
Glutamic acid	197.58	234.55	268.25	306.65
Glycine	94.57	112.27	128.39	146.77
Histidine	32.37	38.43	43.95	50.24
Isoleucine	48.12	57.13	65.33	74.69
Leucine	98.85	117.34	134.20	153.41
Lysine	106.97	126.99	145.23	166.02
Methionine	43.04	51.10	58.44	66.80
Phenylalanine	54.61	64.83	74.15	84.76
Proline	55.97	66.44	75.99	86.87
Serine	61.64	73.18	83.69	95.67
Threonine	59.42	70.53	80.67	92.21
Tyrosine	45.02	53.45	61.12	69.87
Valine	58.78	69.78	79.80	91.23

Table 5. Daily amino acid gain (mg/100g bw/day)

	CP31	CP37	CP42	CP52
Alanine	33.52	35.02	40.68	46.57
Arginine	29.00	30.30	35.20	40.30
Aspartic acid	38.61	40.35	46.86	53.66
Cystine	1.82	1.91	2.21	2.53
Glutamic acid	71.65	74.86	86.96	99.56
Glycine	36.89	38.54	44.77	51.26
Histidine	14.81	15.47	17.97	20.57
Isoleucine	16.33	17.07	19.82	22.70
Leucine	34.58	36.14	41.97	48.06
Lysine	38.63	40.36	46.88	53.68
Methionine	14.88	15.55	18.06	20.68
Phenylalanine	18.31	19.14	22.23	25.45
Proline	19.18	20.04	23.28	26.65
Serine	22.43	23.43	27.22	31.17
Threonine	21.34	22.30	25.90	29.66
Tyrosine	16.19	16.92	19.65	22.50
Valine	19.78	20.67	24.00	27.48

Table 6. Amino acid retention (%) of yellowtail fed various protein content

	CP31	CP37	CP42	CP52
Alanine	39.19	34.49	35.03	35.08
Arginine	35.42	31.18	31.66	31.71
Aspartic acid	35.57	31.31	31.79	31.85
Cystine	28.83	25.38	25.78	25.82
Glutamic acid	36.26	31.92	32.42	32.47
Glycine	39.01	34.33	34.87	34.92
Histidine	45.73	40.25	40.88	40.95
Isoleucine	33.94	29.88	30.34	30.39
Leucine	34.99	30.80	31.28	31.33
Lysine	36.11	31.79	32.28	32.33
Methionine	34.58	30.43	30.91	30.96
Phenylalanine	33.53	29.51	29.98	30.02
Proline	34.27	30.16	30.63	30.68
Serine	36.38	32.02	32.52	32.58
Threonine	35.92	31.62	32.11	32.16
Tyrosine	35.96	31.65	32.15	32.20
Valine	33.65	29.62	30.08	30.13
Anerage	35.84	31.55	32.04	32.09

Table 7. Dietary amino acid budget for yellowtail fed the CP52 diet

	Intake	Absorption	Gain	Metabolism
Alanine	100	89.70	35.1	54.6
Arginine	100	92.50	31.7	60.8
Aspartic acid	100	89.30	31.8	57.5
Cystine	100	90.30	25.8	64.5
Glutamic acid	100	91.90	32.5	59.4
Glycine	100	92.00	34.9	57.1
Histidine	100	93.00	40.9	52.1
Isoleucine	100	90.20	30.4	59.8
Leucine	100	90.70	31.3	59.4
Lysine	100	93.10	32.3	60.8
Methionine	100	92.20	31.0	61.2
Phenylalanine	100	88.80	30.0	58.8
Proline	100	69.90	30.7	39.2
Serine	100	89.60	32.6	57.0
Threonine	100	88.90	32.2	56.7
Tyrosine	100	90.10	32.2	57.9
Valine	100	85.70	30.1	55.6
Average	100	89.29	32.1	57.2

The dietary amino acid budget was formulated based on the best growth exhibited CP52 (Table 7). The absorption of the amino acids values were utilized the data from Masumoto et al. (1994). Based on the amino acid budget calculation (Table 7), about 89% of the dietary amino acids were absorbed. Out of the 89%, about 32% was retained in the body and 57% was metabolized. Cystine was the highest partitioning in the metabolism because its gain was the lowest. Histidine was lower than average value because its gain value was the highest. On the other hand, proline was the lowest value in the metabolism because its absorption was the lowest.

REFERENCES

Association of Official Analytical Chemicals (AOAC), 1984. Official Methods of Analysis, 14th edn., Association of Official Analytical Chemists, Arlington, VA.

MASUMOTO, T., T. RUCHIMAT, Y. ITO, H. HOSOKAWA and S. SHIMENO, 1996. Amino acid availability values for several protein sources for yellowtail (*Seriola quinqueradiata*). *Aquaculture* **146**: 109-119

YOKOYAMA, M. and J. NAKAZOE, 1992. Accumulation and excretion of taurine in rainbow trout (Oncorhynchus mykiss) fed diets supplemented with methionine, cysteine and taurine. *Comp. Biochem. Physiol.* **102A**: 565-568

YOKOYAMA, M. and M. SAKAGUCHI, 1996. Acute toxic effect of L-cysteine injected into the peritoneal cavity of the rainbow trout. *Fisheries Science* **62**: 660-661

WILSON, R.P., 1989. Amino acids and proteins. In J.E. HALVER (ed.), Fish Nutrition, 2nd edn., Academic Press, New York, pp.111-151

(Accepted 11 September, 1998)