

A New Simple Method to Evaluate Feeding Effect for Yellowtail *Seriola quinqueradiata*^{*1,*2}

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A new simple method, based on a feeding experiment using one group of juvenile yellowtail *Seriola quinqueradiata*, was developed to facilitate the evaluation for feeding effect in aquatic animals. The paste pellet of any one of the commercial eel feed formulated (control sample) and the eel feed added a feeding chemical stimulant (test sample) was daily alternately given to the fish for six days. We checked the validity of the new simple method by comparison with two feeding methods: the new simple method, alternate feeding experiment by one group of the fish above-mentioned and the ordinary method, separate feeding one by two groups, namely one group for giving only control sample and the other group for only test one. The difference of daily average feeding ratio between control and test samples was ascertained to be almost the same in both the feeding experiments. The alternate feeding experiment as the new simple method presented was more simple and convenient than the separate feeding experiment as the ordinary method.

1 Introduction

The chemical stimulants, namely activators and inhibitors involved in the exploratory and feeding behaviors of aquatic animals have been reviewed.¹⁾ The majority of the chemical stimulants have been fairly identified and demonstrated to be widely distributed in the water extract of various food substances. However, these chemical stimulants, especially activator has not almost been conducted in respect of the application for artificial feed for aquaculture, fishery and sport fishing. This reason is the hesitation of applying directly laboratory results to practice. Furthermore intermediate experiments between laboratory and field experiments are also a few.^{2,3)}

In the laboratory or intermediate experiments, two groups or more of test animal as the ordinary method are usually used to evaluate the feeding effect.^{2,3)} Namely one group is used for giving only control sample and the other group is used for only test sample. This method needs for collaborative efforts of maintenance rearing the test animal and in some cases makes vaguely the evaluation of feeding effect owing to the variation of individuals used.

水産大学校研究業績 第1526号, 1995年8月25日受付.

Contribution from National Fisheries University, No.1526. Received Aug. 25, 1995.

*1平成6年度日本水産学会春季大会(東京)にて発表.

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In this context, to reduce the maintenance of the test animal and to facilitate the evaluation of feeding effect in the laboratory experiment, the alternate feeding experiment as the new simple method, which gives alternately any one of control sample and test one to only one group of the test animal daily was developed using juvenile yellowtail *Seriola quinqueradiata*.

2 Materials and Methods

2.1 Test Animal and Test Tanks

Juvenile yellowtail (6.2cm and 4.0g in average fork length and body weight at the procurement, respectively) were obtained from Senzaki Station of Aquaculture in Yamaguchi Prefecture. They were introduced into a stock aquarium and acclimatized. The maintenance of the test animal was the same as described in the previous paper.⁴⁾ Namely, the animal was once daily fed to satiation at 11:00 with a commercial eel feed manufactured by Nihonhaigoushiryō Co.

A test tank was a commercial conical polyvinyl vessel (50 l) provided with an aerator, a tube for water supply, and a siphon for water drain. Five test animals acclimatized were introduced into each test tank and reared in running seawater (500 ml/min) with the commercial eel feed formulated above-mentioned unless otherwise stated.

2.2 Feeding Chemical Stimulants

Five amino acids used as feeding chemical stimulants are as follows: arginine (Arg), lysine (Lys), and histidine (His) as feeding attractants for yellowtail *S. quinqueradiata*⁴⁾; cysteic acid (CysA) as feeding repellent for oriental weatherfish *Misgurnus anguillicaudatus*⁵⁾; glutamic acid (Glu) as probable feeding neutral substance for the yellowtail.⁴⁾ Furthermore three commercial feeding chemical stimulants were also used (Table 1). Each of feeding chemical stimulants was dissolved in 0.75ml of water at concentration of 0, 0.5, 1.0, and 5.0% as dry matter to 1 g of the powder of the commercial eel feed described above. The paste pellet as test sample was prepared from each mixture using a chopper to granulate. Accordingly the pellet contains 0, 0.29, 0.57, and 2.9% as wet matter of each stimulant, respectively.

Table 1. Components of three commercial stimulants

Components	Stimulants		
	Sample A	Sample B	Sample C
	(Content to dry matter, %)		
Amino acid and oligopeptide	30	30	0
Nucleotide and its related compound	10	0	85
Carbohydrate	40	50	15
Ash	20	20	0

2.3 Feeding Experiment

The paste pellet was daily fed to satiation within 10 min (11:00-11:10) and the ratio (%) of daily average feeding amount to average body weight was estimated. In some cases, the test animal puffed the pellet ate at near final time of experiment. This feeding behavior was judged to be a sign of satiation in the fish. Accordingly to estimate the net feeding amount, the numbers of the puffed pellets were counted and the net feeding amount was compensated using the weight of one pellet determined beforehand. The feeding effect, namely the feeding ratio (%) was presented as a percentage of the daily average feeding amount to the average body weight at the start of each experiment of series. The growth ratio was also of supplementary presented as the ratio of average body weight at the end of each experiment of series to that at the initial experiment.

Feeding experiments were conducted as two follows: one feeding experiment, *i.e.*, separate feeding one as ordinary method was used in two groups, control and test ones. Namely any one of two groups was fed with the pellet without chemical stimulant (control sample) or with chemical stimulant of each concentration (test sample) for 6 days. The other feeding experiment, *i.e.*, alternate feeding one as new method was used in only one group, control-test one. Namely one group was daily alternately fed with any one of the pellet without chemical stimulant and the pellet with chemical stimulant for 6 days.

3 Results and Discussion

3.1 Establishment of New Method

The feeding effect, feeding ratio (%) by the ordinary and the new methods was shown in Figs 1 and 2, respectively, in addition to the growth ratio. From the results of both Figs 1 and 2, it is obvious that in any one of amino acids and their different concentrations the difference of feeding ratio in the ordinary method is the same manner of that in the new method. This finding strongly supports that the new method using one group of test animal applies to an evaluation of the feeding effect. Furthermore the new method also provides with the reduction of maintenance labor, the simplicity of feeding experiment, and the facility of evaluation of feeding effect without the physiological status between two groups or more, in comparison with the ordinary method.

Apart from these methods, it is of great worthy that three specimens used as feeding attractants also play an important role in feeding stimulants, judging from both Figs 1 and 2. The activities as the stimulants were generally high in Arg, low in His, and intermediate in Lys in the present paper. Meanwhile the activities as the attractants were high in His, low in Lys, and intermediate in Arg in the previous paper.⁴⁾ From these results it is, however, clear that the activities as stimulants are, to some extent, different from those as attractants.

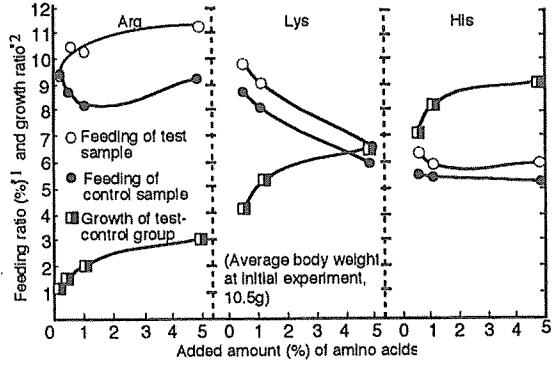
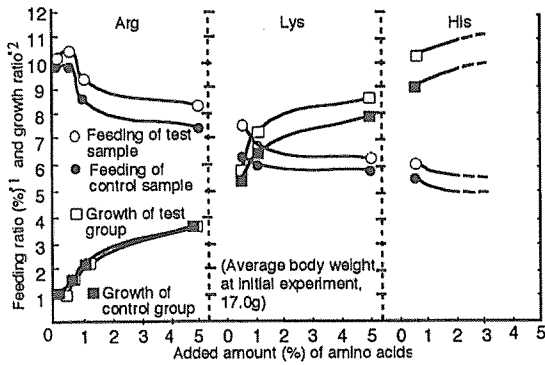


Fig. 1. Feeding effect of amino acids as attractants by the ordinary method (separate feeding experiment).
 *¹The percentage of average feeding amount (g) to average body weight at the start of each experiment of series.
 *²The ratio of average body weight (g) at the end of each experiment of series to average body weight (g) at the initial experiment.

Fig. 2. Feeding effect of amino acids as attractants by the new method (alternate feeding experiment).
 *¹ and *² Legends as Fig. 1.

3.2 Validity of New Method

To ascertain the validity of the new method established, successive feeding experiment of three attractant specimens described above at same concentration was conducted as shown in Fig. 3. The difference of feeding ratio between control and test samples was significantly demonstrated irrespective of the concentrations used. Furthermore feeding experiment using Arg as attractant⁴, and CysA as repellent⁵ and Glu as neutral substance⁴ at three steps of concentrations was

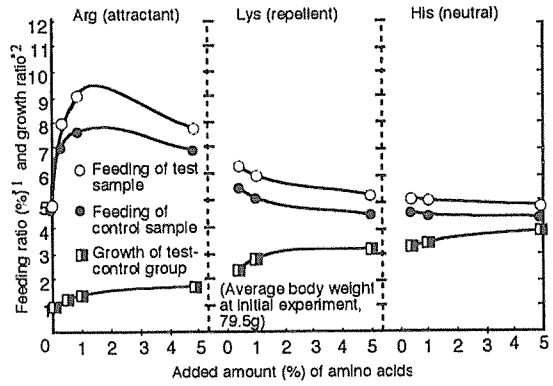
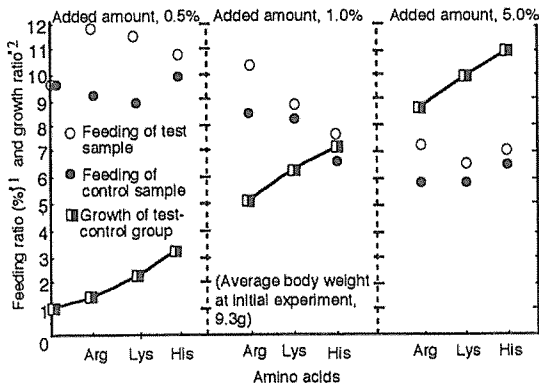


Fig. 3. Feeding effect between amino acids as attractants by the new method.
 *¹ and *² Legends as Fig. 1.

Fig. 4. Feeding effect between amino acids as attractant, repellent, and neutral substance by the new method.
 *¹ and *² Legends as Fig. 1.

conducted as shown in Fig. 4. Among these three amino acids, the feeding ratio of only Arg was expectedly high. However the feeding ratio of CysA was intermediate and that of Glu was low. These results indicate that both CysA and Glu also stimulates the feeding of yellowtail. Namely the repellent (CysA) for oriental weatherfish and the neutral substance (Glu) for yellowtail are involved in feeding stimulation for yellowtail.

3.3 Feeding Effect of Commercial Stimulants

Three commercial stimulants derived from beer yeast were used for the new method. However, the feeding experiment hereupon was conducted on the order from the high added amount to the low added one in each experiment of series, in contrast with the order in the feeding experiment described above. The results were shown in Fig. 5. The feeding effect of Stimulants A, B, and C was high, moderate, and low, respectively. Namely it is obvious that Stimulant A containing both amino acids and nucleic acid-related compounds (ref. Table 1) strongly stimulates the feeding of yellowtail. This finding suggests that both amino acids and nucleic acid-related compounds collaborately play an important role in the feeding of yellowtail. Because the attractivity for yellowtail remarkably increases in the combinations of two or three amino acids or nucleic acid-related compounds than in their single compound.^{6,7)}

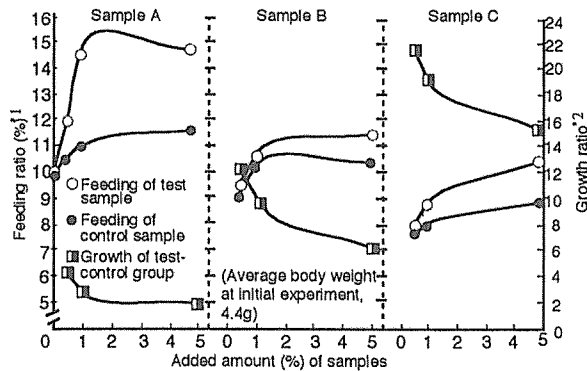


Fig. 5. Feeding effect of three commercial stimulants by the new method.

*1 and *2 Legends as Fig. 1. The feeding experiment hereupon was conducted on the order from the high added amount to the low added one, in contrast with the experiment conducted on the order as Figs 1-4.

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ブリ稚魚に対する摂餌効果の新判定法

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ブリ稚魚5尾1群のみを用いて、市販養鰻飼料の対照餌とその飼料にアミノ酸を添加した飼料餌を、交互に6日間投餌して、日間摂餌量を求めた。この新判定法と、対照群と試験群を用いる通常の判定法との比較検討を併せて行った。これら2判定法の比較によって、摂餌量はほぼ似通った傾向を示すことが認められた。このため、さらに同一の濃度でアミノ酸の種類を変えた連続実験と市販の摂餌促進物質について調べ、判定法の妥当性を確認した。このように新判定法は通常の判定法と比べて、簡便性が優れていることが明らかとなった。