

Influence of Nutrient Source on Specific Dynamic Action of Pearl Spot, *Etroplus suratensis* (Bloch)

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Abstract

The magnitude of apparent specific dynamic action (SDA), the maximum rate of oxygen consumption and the length of time that the rate of oxygen uptake remained elevated above the prefeeding level were measured in the Pearl Spot, *Etroplus suratensis*, fed isonitrous test diets (D₁ - D₄) with varying nutrient sources. Irrespective of the diets, the metabolic rate increased immediately after feeding and reached the maximum within 3 to 4 hours. The source of nutrients in the diet significantly altered the magnitude of SDA. It was maximum (91.76% and 129.56%) for those fed on diets D₂ and D₃ and minimum 46.47% and 50.30% for those fed on diets D₁ and D₄, respectively.

Introduction

Successful and sustainable culture of finfish and shellfish depends on the use of nutritionally balanced, low-cost and ecofriendly feeds. Feed constitutes more than 50% of the operating expenditure in aquaculture. Protein is the most expensive component of artificial feeds. Unlike in mammals, protein acts both as a structural component and as an energy source in fish and decapods (Brett and Groves 1979) and their dietary protein requirements are higher. However, excess dietary protein not only costs more but also increases the energy cost of assimilation by increasing the specific dynamic action (SDA). Further, the increase in the metabolic rate after feeding has long been recognized as an important factor in water quality management in intensive culture systems. In the production of compound feed for the growing aquaculture industry, there is a constant search for feed ingredients that maximize production of fish while requiring less energy for metabolic activities. Available information on the metabolism of fishes is limited to the influence of major factors like body weight, temperature and feeding frequency (Beamish 1964; Brett 1965; Jobling 1981;

Yager and Summerfelt 1993). Very little information is available on the impact of nutrient source on the metabolism of fishes (Krayukhin 1962; Tandler and Beamish 1981, Cai and Summerfelt 1992; Forsberg and Summerfelt 1992). Pearl Spot, *Etroplus suratensis*, is a promising species for aquaculture. However, empirical information on the metabolic characteristics of Pearl Spot is inadequate for the formulation of efficient compound feeds. The purpose of the present study is to evaluate the effect of nutrient source on SDA of *E. suratensis*.

Materials and Methods

E. suratensis (20-40 g) were acclimatized to ambient laboratory conditions for a period of 15 days. After acclimation, healthy individuals were segregated into four groups and were fed on experimental diets for a period of 21 days. Four isonitrous (40% protein) experimental diets (D₁, D₂, D₃ and D₄) were formulated and prepared following the procedure described by New (1987). Diets D₁, D₂ and D₃ were prepared using fishmeal, silkworm pupae and chicken intestine waste, respectively. Diet D₄ contained trash fishmeal, squid

waste, cuttlefish waste, prawn head waste and fish oil. These diets were balanced by adding rice bran, groundnut oilcake, spirulina, chlorella, wheat flour and vitamins (Table 1).

The influence of nutrient source on SDA of the test fish was measured by a flow-through respiratory chamber (2-liter capacity) following the methods of Job (1955) and Hill and Potter (1970). *E. suratensis* fed for about four hours on their respective diets were placed in the respiratory chamber with low disturbance. Dechlorinated water was allowed to flow through the respiratory chamber and the experiment was conducted at room temperature (28 ± 2°C). During the experimental period, the water flow was adjusted in such a way that the oxygen concentration did not fall below saturation level (5.0 ± 0.5 mg/l). An identical respiratory chamber without test animals was used as the control. Unmodified Winklers method was used for the estimation of dissolved oxygen in the control and experimental chambers (APHA 1975). Samples were collected every hour for a period of 7 hours to measure the metabolic rate. The metabolic rate before feeding the test animals was taken as the prefeeding metabolic rate. The rate of oxygen consumption was calculated by relating the difference in the concentrations of

Table 1. Proportion of various ingredients used in the formulation of isonitrous (40% protein) experimental diets (g).

Ingredients	D ₁	D ₂	D ₃	D ₄
Fish meal	33.2	-	-	-
Silkworm pupae	-	33.85	-	-
Chicken intestine	-	-	32.66	-
Trash fish meal	-	-	-	10.00
Squid meal	-	-	-	16.43
Cuttlefish meal	-	-	-	16.43
Prawn head waste	-	-	-	15.00
Spirulina and chlorella	-	-	-	2.00
Groundnut oil cake	33.2	33.85	33.62	-
Rice bran	15.7	15.15	16.39	17.57
Wheat flour	15.7	15.15	16.39	17.57
Fish oil	-	-	-	3.00
Vitamin mix	-	-	-	2.00

oxygen between the control and the experimental water and the rate of flow of water through the respiratory chamber using the formula given below.

O₂ consumption
(ml O₂/g fish/hour) =

Where,

F = difference in O₂ concentration in control and experimental water

R = rate of flow of water
W = live weight of fish

For the estimation of loss of energy through metabolization, the oxycaloric value of 1 ml O₂ = 20.04 J energy reported by Clifford and Brick (1979) was used.

Results

SDA is generally manifested as a pronounced increase in oxygen uptake immediately following food ingestion. The postfeeding metabolic rate of *E. suratensis* fed on experimental diets is given in Fig. 1. Immediately after feeding, the metabolic rate increased, and reached the maximum level after 3-4 hour of feeding. For instance, *E. suratensis* fed on diet D₁ consumed oxygen at 0.547 ml/g/hour after three hours of feeding against 0.24 ml/g/hour at the prefeeding level. Similarly, oxygen consumption increased from the prefeeding level of 0.189, 0.158 and 0.408 ml/g/hour to 0.552, 0.492 and 0.792 ml/g/hour in D₂, D₃ and D₄ diet fed individuals, respectively. Data

obtained on oxygen uptake was converted to energy spent on metabolic activity using the oxycaloric equivalent of 1 ml O₂ equals 20.04 J energy. The mean pre and postfeeding metabolic energy expended is presented in Table 2. At the prefeeding level, the individuals fed on experimental diets spent 4.80 - 8.17 J/g/hour against the postfeeding energy expenditure of 7.03 - 12.288 J/g/hour. The effect of nutrient source on metabolic energy use was pronounced on the magnitudes of SDA. Those who received diets D₁ and D₄ had the lowest SDA (46.47% and 50.30%, respectively). The magnitudes of 91.76% and 129.56% were recorded for those fed on diets D₂ and D₃, respectively (Table 2).

Discussion

Metabolism includes maintenance cost, SDA and energy cost of an activity. It is well known that fish increase their oxygen consumption after feeding (Elliott 1976; Tandler and

Beamish 1981; Kaushik and Dabrowski 1983; Beamish and Mac-Mohan 1988). The magnitude of the metabolic response to feeding is significant and becomes an important practical consideration. The peak value of oxygen consumption has been reported to increase 100% over prefeeding levels (Brett and Zala 1975). In the present study, the metabolism of *E. suratensis* fed on test diets (D₁ - D₄) reached its peak within 3 - 4 hours after feeding and remained elevated for about 6 - 7 hours. For largemouth bass this postfeeding metabolic rate increase lasted for 12 to 76 hours (Tandler and Beamish 1981). Oxygen consumption of a number of fishes, whether passively (e.g., *Protopterus aethiopicus*) or actively swimming (e.g., *Micropterus salmoides*) is known to increase abruptly to a maximum level after feeding and thereafter decline to prefeeding levels (Beamish 1974). This is associated with the extra energy produced for the transportation of food in the alimentary tract, its digestion, absorption and post absorption metabolic processes related to the ingestion of food. The rate of oxygen uptake is positively related to energy ingested and negatively related to fish weight (Tandler and Beamish 1981).

The duration of the increased metabolic rate varies among fish species and has been shown to be dependent on fish weight, feeding frequency and diet composition (Beamish 1974; Ponniah and Pandian 1977; Brett and Groves 1979; Yager and Summerfelt 1993). The present study suggests that the

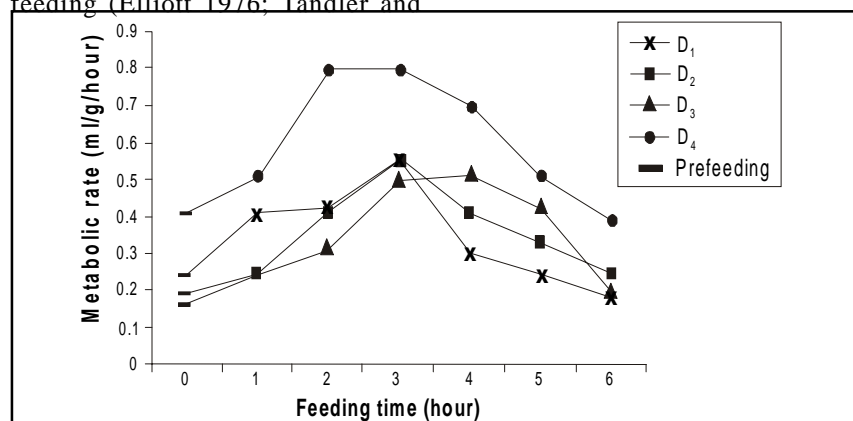


Fig. 1. Postfeeding metabolic rate of *E. suratensis* fed with experimental diets (D₁ - D₄).

apparent SDA of *E. suratensis* is influenced by the source of nutrients in the diets. The magnitude of SDA was minimum (46.47% and 50.30%) for those fed with diets D₁ and D₄ and it was maximum (91.76 and 129.56%) for those receiving diets D₂ and D₃. In terms of water quality management, fishes reared on diets D₂ and D₃ would require two to three times more oxygen than those fed on D₁ and D₄ diets. The higher energy cost of metabolizing diets D₂ and D₃ can be attributed to the nutrient source, namely, silkworm pupae and chicken intestine wastes. This is in accordance with the earlier observation by Krayukhin (1962), for common carp (*Cyprinus carpio*). He found that the oxygen consumption of common carp fed on rapeseed oil meal was 2.58 to 2.67 times higher than the prefeeding level, while it was 2.16 to 2.26 times more for those fed on live *Tubifex* sp. Tandler and Beamish (1981) have also reported that in largemouth bass, *Micropterus salmoides*, the magnitude of SDA was 40.0 ml O₂/meal when fed 0.75 K cal gross energy food containing 100% protein and it was only 9.25 ml O₂/meal, when the same amount of energy food was offered as carbohydrate. The conclusion is that SDA is an important factor in the energy consumption of fish. Its magnitude depends not only on diet composition, meal size, fish weight and level of energy intake, but also the source of nutrients in the diet.

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Table 2. Oxygen consumption and the SDA average of three observations of *E. suratensis* fed on experimental diets.

Diets	Metabolic rates J/g/hour		Magnitude of SDA	
	Prefeeding	Post-feeding	J/g/hour	%
D ₁	4.80	7.03	2.23	46.47
D ₂	3.79	7.27	3.47	91.76
D ₃	3.17	7.27	4.10	129.56
D ₄	8.17	12.288	3.77	50.30

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