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The nutrient releases from sea bass (*Dicentrarchus labrax* Linnaeus, 1758) faeces and food in estuarine Black Sea condition

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Abstract

Phosphorus and nitrogen release from sea bass food and faeces were investigated in estuarine Black Sea water. A rapid increase in phosphorus release was detected in both faeces and food samples for higher temperatures (15-20ºC) in first few days and thereafter it was decreased, but orthophosphate leaching from both faeces and food was slower at low temperature (8ºC). Ammonium release was slow in first few days of experiments but ammonium release increased in later periods and reached highest rate in day 11. Temperature affected the release of ammonium and phosphorus from both fish faeces and food.

Key words: Sea bass, Black Sea, cages, faeces, food, nutrient releases, nitrogen, phosphorus.

Introduction

In The Black Sea coast of Turkey, the aquaculture activities have been performed since 1990 in cage systems. Mainly rainbow trout (*Oncorhynchus mykiss*) is cultured in off-shore cage farms [1], but beside trout, sea bass (*Dicentrarchus labrax*) has been produced in most cage farms in last decades. Environmental effect of cage farms is important for sustainable aquaculture. Due to particulate wastes, aquaculture activities can have a significant effect on the health and quality of sea waters used by fish farming. Faecal pellets and uneaten food are the major sources of solids in cage culture of finfish [2, 3]. Solid waste is dispersed through either the water column or it accumulates on the seabed [2, 3]. The quality and quantity of sediments and the rate of sedimentation in terms of organic matter content varies depending on several factors. Quality of solid waste is strongly related to life stage of the animal, fish health, environmental conditions and level of applied technology for food production. Digestibility of food influences the quality of the solid waste as well.

Commercial sea bass food has high level protein content and may contain 45-55% protein and 15-25% lipids depending on diet formulation [6]. It means that the diet food may have up to 8.8% nitrogen, 2% phosphorus and 30-50% carbon. Phosphorus (P) and nitrogen (N) in farm wastes primarily originate from uneaten foods and faeces. They are responsible for nutrient enrichment in sea water. Fish food and faeces are known to be the main wastes in intensive aquaculture. The wastes from aqua feeds as dust and uneaten food have been reported to be 5-30% [7, 8]. These solid wastes such as uneaten food and faeces may increase the sedimentation and enrich the nutrient pool of the receiving waters [9]. Under suitable conditions (appropriate temperature, pH, etc.) phosphorus and nitrogen could be released from the sediments and may stimulate algal growth [10].

We considered that water temperature should be an important factor that affects leaching rates. Therefore, we compared the ammonium and orthophosphate leaching from the faeces of sea bass (*Dicentrarchus labrax*) to that of food at three temperatures; 20°C, 15°C and 8°C (summer, spring-autumn and winter conditions, respectively).

Materials and Methods

Sea bass *Dicentrarchus labrax* (280-330 g) were fed with commercial diet for one week at 25ºC water temperature. That diet was selected since it is used commonly on fish farms. Fish were reared in fiber glass cylinder-conic tank (150 cm x 75 cm), which was equipped with faeces collector. Fish were fed *ad libitum* every day two times. Uneaten food pellets were siphoned from collector and bottom of trial tanks after feeding. Faeces were taken from faeces collector after feeding several times a day. Collected faeces were dried overnight in an oven at 105ºC. Pooled faeces were used for experiments on nutrient release. Experiments were conducted on the effect of temperatures on the release of nutrients from fish food and faeces. For this purposes, 150 mg faeces or food samples were weighed and placed in 500 ml polypropylene bottle, and 100 ml filtered and autoclaved Black Sea water was added into faeces and food samples. Samples were placed gently into automatic incubators (Nüve ES250, ES500) equipped with cooler. Protein (N x 6.25) and total phosphorus in food and faeces were determined [11]. The seawater used in each experiment was analyzed for initial orthophosphate (PO_4-P) and ammonium (NH_4^+) concentrations. Ammonium and orthophosphate of water samples were analyzed manually with a spectrophotometer (Shimadzu 1800, Kyoto, Japan)[12]. The pH was measured using a pH meter (Orion SA 520).

Experiments for nutrient release from fish food and faeces were performed in triplicates for each time interval in all temperature groups. One-way analysis of variance (ANOVA) was used to compare the release of nutrients from faeces and diet groups. Analyses were performed using SPSS (ver. 13.0) statistical package programs.

Results and Discussion

Phosphorus and nitrogen content of faecal and food samples were given in Table 1. Phosphorus content of faecal and food samples were found as 2.43±0.06% and 1.91±0.05% respectively by dry weight bases. Nitrogen content of faecal and food samples were detected as 2.45±0.09 % and 6.83±0.07% nitrogen by dry weight basis respectively. Our findings showed that sea bass faeces had a higher total phosphorus content and lower nitrogen content than sea bass diet. These results indicated that main phosphorus loss from sea bass is through faeces. Similarly, high rate phosphorus lost through fish faeces was reported in silver perch[10] and in Atlantic salmon[13]. The phosphorus and nitrogen ratio in sea bass diet was 1:3.57 and the P:N ratios in the faeces was 1:1 (weight basis). Our findings supported by previous study of Kibria *et al.*[10] who reported the phosphorus: nitrogen ratio in the diet as 1:6.2-6.5 and in the faeces as 1: 1.6-1.61. Results also showed that nitrogen lost through faeces in sea bass is minimal when compared to phosphorus lost.

Table 3. Ammonium (mg/l) releasing from fish faeces and food in different water temperatures (n = 3; data are presented as mean ± S.E.).

Time	Fish faeces			Fish food		
	Temperatures			Temperatures		
(Day)	8 °C	15 °C	20 °C	8 °C	15 °C	20 °C
1	1.36±0.03	3.20±0.10	4.91±0.22	1.66±0.05	2.64±0.05	4.73±0.07
2	1.93±0.06	3.72±0.04	6.98±0.08	2.23±0.18	2.98±0.07	8.30±0.13
3	3.02±0.03	5.84±0.14	9.78±0.17	3.28±0.15	7.78±0.27	20.10±0.08
5	8.61±0.30	14.10±0.21	20.44±0.44	8.17±0.11	23.77±0.15	44.74±0.24
7	13.07±0.34	21.57±0.43	30.63±0.31	15.76±0.31	56.44±1.25	74.00±0.13
9	24.37±0.25	35.19±0.22	48.66±0.35	33.51±0.45	99.41±0.35	101.88±0.15
11	36.31±0.41	59.94±0.13	71.08±0.15	58.70±0.26	104.10±0.49	108.64±0.24

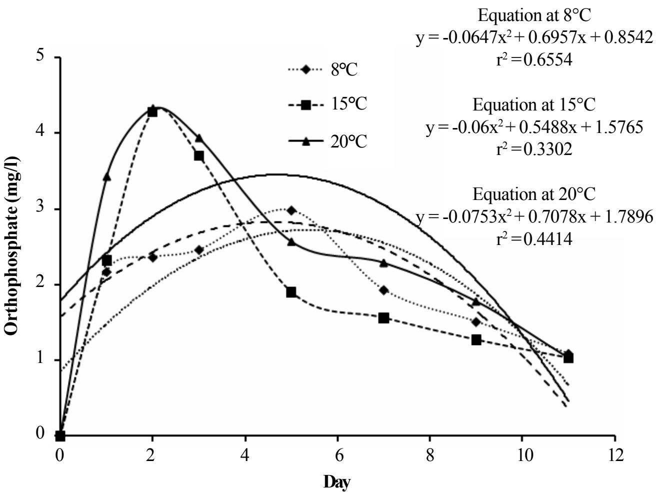

Figure 1. The mean orthophosphate release from fish faeces in three different sea water temperatures for eleven days.

Table 1. Nutrient content of fish food and faeces (Data are presented as mean ± S.E.).

Samples	Variables		
	Crude protein	Nitrogen	Phosphorus
Fish food	42.70±0.46	6.83±0.07	1.91±0.05
Fish faeces	15.34±0.58	2.45±0.09	2.43±0.06

In first few days of our experiments, orthophosphate levels were increased rapidly up to 3-5 mg/l. However orthophosphate level released through both faeces and food was decreased in subsequent days (Figure 1, 2; Table 2). According to Kibria *et al.*[10] this decreasing may be related to bacterial growth. Similarly, rapid increase in orthophosphate was reported by Kibria *et al.* [10]. They reported that orthophosphate was released rapidly from fish faeces and diet in the first few days and then it was decreased. When it comes to ammonia, total ammonium level was low in first few days. However it had reached to higher level in subsequent days in both faeces and diet groups (Fig. 3 and 4; Table 3). Our experiment and previous research results indicated that nutrient release from fish faeces and foods was occurred rapidly and depended to water temperature. Therefore, to avoid nutrient enrichment of water environment, uneaten fish food and fish faeces should be removed quickly. Both Mäkinen *et al.* [14] and Phillips *et al.*[15] stated importance of quick remove of fish waste from environment for avoiding of enrichment of water.

The water temperature was found to be effective on nutrient release from sea bass faeces and food. The high rate of nutrient release was detected in a high temperature groups (20 and 25 Cº) and the low rate was detected at low temperature group (8 ºC) (Fig. 1, 2, 3 and 4). Orthophosphate release was increased in high temperature (20-15 ºC) (Fig. 1 and 2). Similarly, ammonium release was also increased by temperature and time (Figure 3, 4; Table 2). Water temperature pH, oxygen, turbulence and microbial activity of the environment can affect nutrient release [10]. Effect of temperature on ammonium release from fish faeces and diet was also reported by [16]. Additionally, ammonium release through sea bass faeces is lower than uneaten sea bass food. Therefore uneaten sea bass food is major nitrogen source for nutrient enrichment when compare to sea bass faeces. This is also confirmed by previous researches [9-17]. In conclusion, fish food is major nutrient sources in aquatic environment. Therefore the fish food manufactures should minimize phosphorus content of fish diet and farmers should avoid overfeeding.

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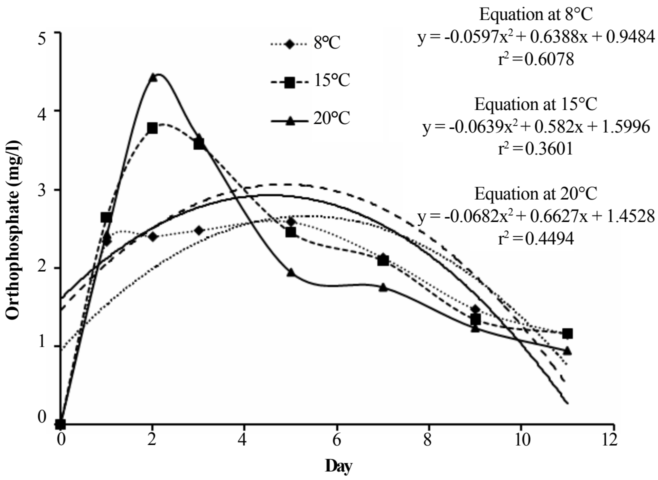

Figure 2. The mean orthophosphate release from fish food in three different sea water temperatures for eleven days.

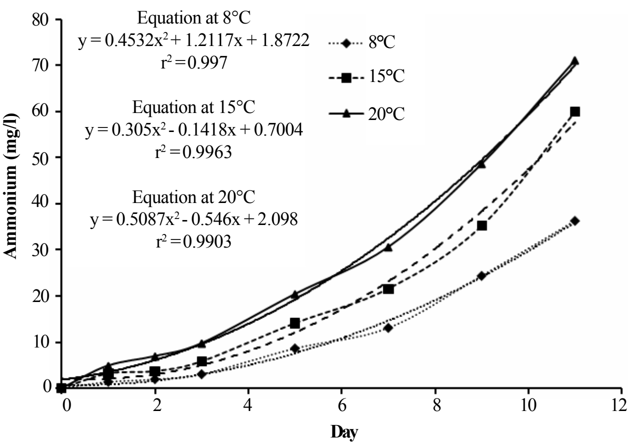

Figure 3. The mean ammonium release from fish faeces in three different sea water temperatures for eleven days.

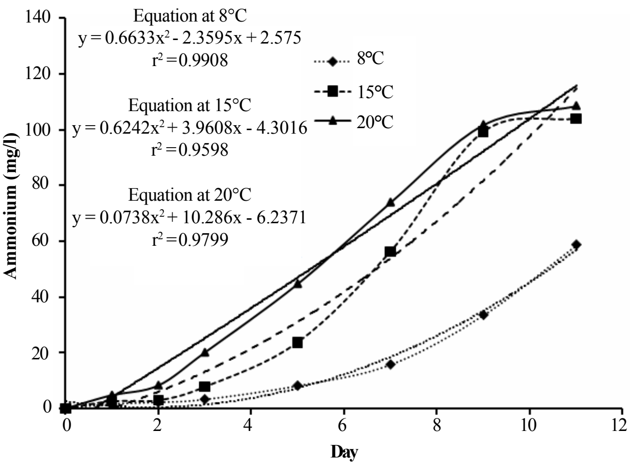

Figure 4. The mean ammonium release from fish food in three different sea water temperatures for eleven days.

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