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Effect of Seasonal Change and Different Commercial Feeds on Proximate Composition of Sea Bream (*Sparus aurata*)

Mustafa Yıldız[1,*], Erdal Şener[1], Metin Timur[1]
[1] Istanbul University, Faculty of Fisheries, Department of Aquaculture, Ordu Cad., No: 200, 34470, Laleli, Istanbul, Turkey.

* Corresponding Author: Tel.: +90. 212 455 57 00/16446; Fax: +90. 212 5140379;
E-mail: mstar@istanbul.edu.tr

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Abstract

The effects of seasonal change and commercial feeds used in Aegean Sea fish farms were investigated on major quality parameters, such as condition factor, viscerosomatic index, hepatosomatic index, visceral lipid, liver lipid and fillet composition in sea bream, *Sparus aurata* (349.2 g average body weight). The crude protein levels in the feeds A (pelleted), B (extruded), C (pelleted) and D (extruded) were similar (45%) ($P>0.05$), and lipid content in extruded feeds were significantly higher (20.5%) than pelleted feeds (13.3%) ($P<0.05$). Body composition of the fish was affected ($P<0.05$) by the feeds whereas the condition factor was not ($P>0.05$).

The fillet lipid content, lipid deposition in liver, total lipid level in visceral organs (without liver), the hepatosomatic index and viscerosomatic index of the fish fed the extruded feeds were significantly higher ($P<0.05$) than the fish fed the pelleted feeds. The hepatosomatic index and viscerosomatic index and the lipid accumulation in the fillet and the liver of the cultured fish were significantly higher ($P<0.05$) than the wild fish in the same area. There was a positive correlation between the seasonal seawater temperature and the lipid deposition in the fillet ($r = 0.62$, $P<0.05$) and visceral organs ($r = 0.87$, $P<0.01$) of the wild and cultured fish. There was a higher negative correlation ($r = - 0.83$, $P<0.01$) between the water temperature and the lipid deposition in the liver of cultured fish. There was no significant difference ($P>0.05$) between the crude protein levels in the fillet of the cultured and wild sea bream in summer. There were significant differences ($P<0.05$) in the fillet of cultured fish groups. Finally, the proximate compositions in the commercial feeds used in the sea farms of the Aegean region were found sufficient for sea bream. Furthermore, the higher fat level in the extruded feeds did not show negative effects on the proximate composition of the fish fillet.

Key words: Sea bream, *Sparus aurata*, commercial feeds, nutrition, body composition, seasonal effects.

Introduction

The sea bream is one of the most important cultured sea fish in Mediterranean countries. It is considered as a popular fish because of its delicious taste and nutritive values. The recent intensive production rate of sea bream is increased owing to the improvement of culture technology. In Turkey, the total production of sea bream was started as 442 tones in 1986 and then it was reached to 16,700 tones in 2003 (FAO, 2005).

One of the possible ways to sustain the future of intensive aquaculture is to develop the quality feed in order to meet the increasing demand of that species so that important developments would be made on the production of fish feeds. Following the expansion in the use of the extrusion technique in feed production, the extruded feeds which contain high level of fat are started to use widely in feeding of cultured marine fish species (Autin, 1997; Lanari *et al.*, 1999). It was reported that these feeds directly affect the body composition of fish (Aksnes *et al.*, 1997; Vergara *et al.*, 1999; Şener *et al.*, 2000; Yıldız and Şener, 2003).

The water temperature is one of the most important factors that affect growth rate of fish (Shepherd and Bromage, 1996; Guinea and Fernandez, 1997; Person-Le Ruyet *et al.*, 2004). The sea bream can survive at the temperatures ranging from 6-32ºC. However, the best growth rate occurs at temperatures between 23-27ºC (Barnabe, 1990). The metabolism of fish increases in summer and decreases in winter (Goddard, 1996; Guinea and Fernandez, 1997; Bureau *et al.*, 2002). In other words, the water temperature affects the body composition of fish (Wassef and Shehata, 1991; Touhata *et al.*, 1998).

The present study was conducted to investigate the effects of seasonal change and commercial feed on body composition of cultured sea bream.

Materials and Methods

Materials

Cultured sea bream, *Sparus aurata* (average weight, 363.2±15.6 g) and commercial feed samples were obtained from four fish farms in the Aegean coast of Turkey during summer, winter and spring seasons in 2004. Wild sea bream (average weight, 276.3±11.6 g) were caught in the same region and in the same seasons. Cultured sea bream were fed with commercial pelleted and extruded (6-8 mm) feeds. The average seawater temperature was measured 15ºC in winter, 18ºC in spring and 27ºC in summer for cultured and wild fish. During the experiment, water

salinity was between 35‰ and 38‰. The farms which used different commercial feeds classified with letters A, B, C and D, respectively. Feeds A and C (6-8 mm) were pelleted and produced in Turkey, and the feeds B and D (6-8 mm) were extruded imported feeds. Fish were fed in winter and summer with extruded feeds and pelleted feeds respectively by approximately 0.5% and 1.2%; and 0.8% and 1.8% of the body weight per day. Feed samples and three sea breams were obtained from each fish farm seasonally. Similarly, a sample consists of three sea breams which were caught in the farm area. Fish samples were killed and packaged with black nylon bags (packed into an insulated polystyrene box with dry ice) and then they were transported to the faculty laboratory. The samples were kept at –30ºC prior to the analysis.

Calculated of Some Biological Indexes

Body mass, body length, and organ mass were recorded to evaluate the condition factor (CF) = (100 x [total body weight (g)] / [total body length (cm)]^3), the hepatosomatic index (HSI) = (100 x [liver weight (g)] / [total body weight (g)]) and the viscerosomatic index (VSI) = (100 x [viscera weight (g)] / [total body weight (g)]) (Ricker, 1979).

Chemical Analysis

The proximate composition of commercial feeds and experimental fish were analyzed at the Istanbul University, Faculty of Fisheries laboratory and TÜBİTAK Marmara Research Center, Food Science and Technology Research Institute laboratories. Analyses of the experimental feeds (moisture, crude protein, crude fat, crude fiber, and ash and nitrogen free extract) were determined according to standard method AOAC (1995).

Three fishes from each group were filleted; these fillets are blended separately prior to proximate analysis. Chemical analyses of the experimental fish were performed using the following procedures: dry matter in an oven at 105ºC for 12 h; ash by incineration in a muffle furnace at 550ºC for 16 h; crude protein (N x6.25) by the Kjeldahl method after acid digestion; crude lipid in fillets and livers by petroleum ether extraction in a soxhlet system. All analyses were performed in duplicate.

Statistics

All data were presented as means ± standard error. The SPSS software (version 11.5) was used for statistical analysis. Comparisons among sampling were made by one-way analysis of variance (ANOVA), at 5% confidence level using Duncan's test. Correlation coefficients were considered significant at $P<0.01$ and $P<0.05$ (Zar, 1984).

Results

Diets

The proximate composition of the commercial feeds fed to cultured sea bream is given in Table 1. There were not significant differences among the proximate composition in seasonally obtained samples of the same brand feeds. Therefore, the data are presented as the average amounts. The moisture percentages in the experimental feeds were the highest in the feed A and the lowest in the feed D ($P<0.05$). The crude protein and crude fiber percentages in the feed groups were not different between experimental feeds ($P>0.05$). The crude fat percentages in the extruded feeds were significantly higher than that in the pelleted feeds ($P<0.05$). In contrast, the nitrogen free extract in the extruded feeds was markedly lower than pelleted feeds ($P<0.05$). The ash percentages of experimental feeds ranged from 8.5% to 11.7% ($P<0.05$).

Fish

The values of total length, live weight, condition factor, viscerosomatic index and hepatosomatic index

Table 1. Chemical composition of the commercial feeds*

	Feed groups **			
	A (Pelleted)	B (Extruded)	C (Pelleted)	D (Extruded)
Chemical composition (%)				
Moisture	9.8±0.67^{a}	8.7±0.34^{ab}	8.7±0.46^{ab}	7.9±0.40^{b}
Crude protein	44.9±0.71^{a}	44.6±0.26^{a}	45.4±0.18^{a}	45.1±0.31^{a}
Crude fat	14.0±0.36^{b}	20.4±0.41^{a}	12.6±0.26^{c}	20.6±0.24^{a}
Ash	8.7±0.17^{b}	11.7±0.33^{a}	10.8±0.45^{a}	8.5±0.32^{b}
Crude fiber	3.2±0.45^{a}	2.7±0.36^{a}	2.6±0.34^{a}	2.5±0.22^{a}
NFE***	19.3±0.55^{a}	11.8±1.10^{c}	19.4±0.50^{a}	15.5±0.69^{b}

*: Results represent means ±standard error, n=6.
**: Feeds A, B, C and D were used by different fish farms, respectively. These feeds were produced by different commercial company.
***: Nitrogen free extract.
Results in each row with different superscript letters were significantly different ($P<0.05$). Means were tested by ANOVA and ranked by Duncan's multiple range test.

of the fish are shown in Table 2. The average live weight of the cultured and wild fish was 367.4 g and 207.2 g, respectively. The live weight of fish in the group B was accidentally higher than other fish groups in summer (P<0.05). Wild fish weight was markedly lower than cultured fish in summer (P<0.05). However, difference of live weight between cultured and wild fish was low in winter and spring seasons. The condition factor was the lowest (1.3) in the wild fish in the winter (P<0.05). The hepatosomatic index and viscerosomatic index of the cultured fish were significantly higher than those of the wild fish (P<0.05). Despite the increased in hepatosomatic index of the cultured fish in winter, the viscerosomatic index were markedly decreased (P<0.05). Fish fed with extruded feed D showed higher levels hepatosomatic index than the fish fed with pelleted feeds in winter and spring seasons (P<0.05). There was positive correlation between the fat percentage in the commercial feeds and both of viscerosomatic index (r = 0.52; P<0.01) and hepatosomatic index (r = 0.47; P<0.05).

The proximate composition of the fish fillets and the lipid percentage in the visceral organs (stomach, intestine, gonads, spleen and kidney) and the liver are presented in Table 3. The moisture percentage in the wild fish was significantly higher than that in the cultured fish, whereas the lipid percentage was markedly lower than the cultured fish in the three seasons (P<0.05). The moisture percentage in the fish fillets in winter was significantly higher than in the other seasons (P<0.05). In contrast, the lipid percentage in the fish fillets was markedly decreased in winter (P<0.05). The lipid percentage in the fillets of fish fed with extruded feeds was significantly higher than the other fish groups in the three seasons (P<0.05). A positive correlation (r = 0.54; P<0.01) was found between the crude fat percentage in the feeds and lipid percentage in the fish fillets. The crude protein content in the fillets of fish fed with feed A was significantly higher than fish fed with feed D in summer and winter (P<0.05). The crude protein percentage in the fish fillets was not affected by seasonal changes (P>0.05). The ash content in the fish fillets changed between 1.3 and 2.1%.

The lipid percentage in the visceral organs of the all experimental fish groups was the highest in summer and the lowest in winter (P<0.05). However, the lipid percentage in the wild fish fillets was significantly lower than that in the cultured fish fillets in the three seasons (P<0.05). The lipid percentage of the cultured fish liver was the highest in winter and the lowest in summer (P<0.05). In contrast, the lipid percentage in the liver of the wild fish did not change by the seasonal changes (P>0.05). There was positive correlation between the crude fat percentage in the feeds and the lipid percentage in the visceral organs r = 0.25 (P<0.01) or in the liver r = 0.49 (P<0.05).

Table 2. Condition factor, viscerosomatic index and hepatosomatic index of cultured and wild sea bream fed commercial feeds at different seasons *

Seasons and fish groups**	Total length (cm)	Live weight (g)	Condition factor	Viscerosomatic index	Hepatosomatic index
Summer					
Wild	23.7±0.3^{fg}	240.9±8.1^{f}	1.8±0.0^{b}	9.5±0.6^{bc}	0.8±0.1^{ef}
A	28.2±0.3^{bc}	415.8±6.2^{b}	1.8±0.1^{b}	12.4±2.0^{ab}	1.2±0.0^{def}
B	31.9±1.6^{a}	615.9±11.4^{a}	1.9±0.2^{ab}	12.5±1.2^{ab}	1.3±0.2^{cdef}
C	26.0±0.5^{cdef}	307.7±5.1^{d}	1.7±0.1^{b}	9.7±0.2^{bc}	1.2±0.2^{cdef}
D	27.5±0.5b^{c}	395.2±10.3^{b}	1.9±0.1^{ab}	15.0±0.4^{a}	1.6±0.2^{bcde}
Winter					
Wild	27.5±0.3^{bc}	267.2±8.3^{e}	1.3±0.0^{c}	8.2±0.3^{c}	0.6±0.1^{f}
A	22.6±0.5^{g}	221.1±7.7^{f}	1.9±0.1^{ab}	10.6±0.6^{bc}	1.9±0.2^{bc}
B	26.9±0.5^{bcde}	390.3±6.9^{bc}	2.0±0.1^{ab}	11.4±0.7^{b}	2.1±0.3^{ab}
C	28.5±0.5^{a}	390.6±4.0^{bc}	1.7±0.1^{b}	9.5±1.5^{bc}	1.9±0.1^{bcd}
D	27.5±0.5^{bc}	362.6±5.1^{c}	1.7±0.1^{b}	11.9±0.5^{b}	2.9±0.3^{a}
Spring					
Wild	25.5±0.6^{def}	320.8±11.4^{d}	1.9±0.1^{ab}	10.7±0.4^{bc}	1.5±0.1^{bcde}
A	24.6±0.2^{efg}	295.0±2.3^{de}	2.0±0.1^{ab}	11.3±0.5^{b}	1.8±0.1^{bcd}
B	25.9±0.5^{def}	397.5±6.0^{b}	2.3±0.1^{a}	11.6±0.4^{b}	1.8±0.3^{bcd}
C	24.8±0.3^{efg}	296.0±9.1^{de}	1.9±0.0^{ab}	10.7±0.5^{b}	1.3±0.3^{cdef}
D	24.7±0.4^{efg}	320.9±7.5^{d}	2.1±0.1^{ab}	11.5±0.5^{b}	2.3±0.6^{ab}

*: Results represent means ±standard error, n=3.
**: Fish A, B, C and D were cultured by different fish farms, respectively. These fish were fed feeds A, B, C and D, respectively.
Results in each column with different superscript letters were significantly different (P<0.05). Means were tested by ANOVA and ranked by Duncan's multiple range test.

Table 3. The proximate composition of the fillets, the lipid percentage in the visceral (stomach, intestine, gonads, spleen, kidney without liver) and liver of cultured and wild fish at different seasons*

Seasons and fish groups**	Moisture	Crude protein	Crude lipid	Ash	Visceral lipid	Liver lipid
Summer						
Wild	70.3±1.7^{bcd}	19.5±0.4^{abcd}	8.1±0.1^{e}	1.6±0.0^{bcd}	29.7±0.6^{f}	6.2±0.1^{j}
A	67.9±1.3^{efg}	20.5±0.2^{a}	10.0±0.2^{c}	1.3±0.3^{d}	67.5±1.4^{a}	10.8±0.1^{i}
B	65.4±0.3^{h}	20.1±0.2^{abcd}	11.9±0.3^{b}	2.1±0.1^{a}	58.2±1.2^{c}	14.9±0.1^{g}
C	69.6±0.2^{cde}	19.5±0.3^{bcd}	9.7±0.2^{c}	1.8±0.2^{ab}	36.4±1.2^{e}	12.3±0.1^{h}
D	67.5±0.4^{fg}	19.1±0.7^{d}	11.5±0.1^{b}	1.5±0.0^{bcd}	61.0±0.4^{b}	16.1±0.1^{f}
Winter						
Wild	76.9±0.2^{a}	19.1±0.2^{d}	1.4±0.0^{i}	1.4±0.1^{cd}	5.7±0.1^{n}	6.1±0.1^{j}
A	70.2±0.2^{bcd}	20.5±1.1^{a}	7.0±0.1^{g}	1.7±0.2^{abc}	9.0±0.1^{m}	21.8±0.2^{e}
B	70.9±1.1^{bcd}	19.9±0.1^{abcd}	7.3±0.1^{fg}	1.6±0.2^{bcd}	21.8±0.1^{i}	40.6±1.2^{a}
C	71.3±1.3^{bcd}	20.3±0.3^{ab}	6.3±0.1^{h}	1.8±0.0^{ab}	6.4±0.1^{n}	24.2±0.4^{d}
D	70.1±0.5^{bcd}	19.3±0.2^{cd}	9.0±0.1^{d}	1.4±0.1^{cd}	12.4±0.1^{k}	31.4±0.3^{b}
Spring						
Wild	71.9±0.1^{b}	19.1±0.1^{d}	6.9±0.1^{g}	1.8±0.1^{ab}	23.5±0.2^{hı}	5.4±0.1^{j}
A	69.1±0.3^{def}	20.1±0.2^{abcd}	8.7±0.2^{d}	1.6±0.0^{bcd}	37.3±0.4^{e}	16.7±0.2^{f}
B	66.0±0.8^{gh}	19.1±0.2^{d}	13.0±0.2^{a}	1.7±0.1^{abc}	27.1±0.2^{g}	29.4±0.2^{c}
C	69.9±0.3^{bcde}	19.8±0.1^{abcd}	7.7±0.1^{ef}	1.6±0.1^{bcd}	24.8±0.2^{h}	17.2±0.3^{f}
D	65.4±1.4^{h}	20.2±0.1^{abc}	11.9±0.3^{b}	2.0±0.1^{a}	39.9±0.5^{d}	29.8±0.4^{c}

*: Results represent means ±standard error, n=3.
**: Fish A, B, C and D were cultured by different fish farms, respectively. These fish were fed feeds A, B, C and D, respectively.
Results in each column with different superscript letters were significantly different (P<0.05). Means were tested by ANOVA and ranked by Duncan's multiple range test.

Also, there was a high positive correlation between the liver lipid percentage and the hepatosomatic index level (r = 0.87; P<0.01).

It was found that there was positive correlation between seawater temperature and the lipid percentage in the fish fillets (r = 0.62, P<0.05) and visceral organs (r = 0.87, P<0.01). In contrast, there was a high negative correlation between seawater temperature and the lipid percentage in the cultured fish liver (r = -0.83, P<0.01).

Discussion

In Turkey, some specific feeds are being used at farm to meet the demand for sea bream aquaculture. The feed composition and the seasonal changes, especially water temperature may influence the proximate composition of fish body.

The sea bream also needs proteins for development and growth as the other carnivorous fish species (NRC, 1983; Goddard, 1996; Watanabe, 1996). The protein requirement of fish is affected by the quality of protein in feeds (Sanchez-Muros *et al.*, 2003; Gomez-Requeni *et al.*, 2004), the composition of feed, size of the fish, water temperature, salinity and stocking density (NRC, 1983).

The dietary fats are the source of the energy, essential fatty acids (EFA) and fat-soluble vitamins (A, D, E and K) needed for the growth and development of fish. The fat is an important energy source for all fish species (De Silva and Anderson, 1995; Goddard, 1996; Watanabe, 1996; Sargent *et al.*, 2002), while carnivorous fish species such as sea bream use less carbohydrate compared to omnivorous or herbivorous fish species (Wilson, 1994; Peres *et al.*, 1999).

The balance between the amount of energy and protein in the diet is important because a deficiency in non-protein (fats and carbohydrates) energy means that part of the protein will be broken down for energy. Therefore, the protein amount becomes insufficient to meet its main purpose in the fish (NRC, 1983; Peres *et al.*, 1999).

Previous studies showed that the minimum protein content had to be 40% (Gomez-Requeni *et al.*, 2003), the optimum lipid content was between 14 (Sanchez-Muros *et al.*, 2003) and 22% (Vergara *et al.*, 1999) for the adult sea bream feeds, and the maximum carbohydrate content was 20% (Wilson, 1994). However, the researches on the sea bream nutrition presented that the maximum fat content in the feeds was 12% (Guinea and Fernandez, 1997; Asknes *et al.*, 1997). The results of proximate composition of feeds used in our study were adequate for sea bream and these results agree with the cited above researches.

By using the extruded feeds in marine aquaculture, the fat content in sea bream feeds increased to 28%. On the other hand, Vergara *et al.* (1999) stated that the optimum development and growth of 70-400 g weighed sea bream occurred by the usage of feeds including 22% fat and 48% protein. It was also reported that better growth was found at

17% crude fat, 46% crude protein level (Company *et al.*, 1999), whereas, in another study revealed that feed including 14% crude fat, 45% crude protein and 20% carbohydrates showed better growth performance (Sanchez-Muros *et al.*, 2003). In the present study, good results were obtained i.e. the average protein content and the fat content were 45% and 20.5% in extruded feeds, respectively, while they were 45% and 13.3% in the pelleted feeds. These results agree with the previous research values.

The studies on the sea bream nutrition were presented that increasing fat percentage in the diets increased the lipid percentage in the fish body (Weatherup *et al.*, 1997; Yıldız and Şener, 1997; Peres and Oliva-Teles, 1999; Şener *et al.*, 2000; Yıldız and Şener, 2003; Company *et al.*, 1999). The high fat content in the diets increased the viscerosomatic index, hepatosomatic index, and the lipid content in the liver and visceral organs (Company *et al.*, 1999). In our research, we also found that the liver lipid content, lipid deposition in visceral organs, the hepatosomatic and viscersomatic indexes of the fish fed with extruded feeds were higher than the fish fed with pelleted feeds.

Şener *et al*, (2000) showed that there was not a significant difference between the protein percentages in the flesh of rainbow trout fed 45% crude protein and 17% lipid or 42% crude protein and 12% lipid. Similarly, in our study, fish fed the feeds with the same percentage of protein had the same percentage of protein in their fillets.

Wassef and Shehata (1991) found that the protein and lipid contents in the fish flesh of wild sea bream in the summer were higher than those in the winter and the moisture percentage were lower. In addition, the ash content does not differ according to seasonal changes. In the present study, the protein and ash contents of wild or cultured fish fillet were not affected by seasonal changes. However, in winter, the lipid percentage of fish fillet and visceral organs were decreased; the lipid percentage in the liver was increased.

In the present study, the fillet lipid content of the wild fish during summer season was slightly higher and the reason for this situation may be the increase of live nutrients with the increase in temperature of the seawater. The similar findings in the cultured fish can be explained by the increase in the amount of feed consumed by the fish because of the increase in the metabolism of the fish according to temperature increase in spring and summer. Similarly, it was reported that the lipid percentage in the wild fish fillet was higher in summer than in winter for Norwegian herring (*Clupea harengus* L.) (Hamre *et al.*, 2003). In contrast, Touhata *et al.* (1998) reported that the lipid percentage of fish fillet was not affected by seasonal changes but the moisture percentage increased and the crude protein percentage was decreased in summer.

Increase of the HSI and the lipid percentage in the liver of cultured sea bream can be explained by the decrease in the liver metabolism because of lower temperatures in the winter. Similar results were obtained by Grigorakis *et al.* (2002).

In summary, it was determined that the sea bream farmers in Aegean region of Turkey used pelleted and extruded feeds produced by different feed manufacturers. The proximate composition of experimental feeds was found to be sufficient for aquaculture of sea bream. The high lipid contents in the fish fillets, visceral organs and liver were increased due to the high fat percentage in the extruded feeds. These results of this study showed that the experimental feeds do not affect the proximate composition of the sea bream fillet.

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