Fillet yield, proximate composition and mineral contents in Indian spiny halibut *Psettodes erumei* caught from the coastal waters of Bushehr (Persian Gulf)

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Abstract

The objective of this study was to assess fillet yield, proximate composition and mineral contents of the Indian spiny halibut *(Psettodes erumei*) during different seasons. Fish samples (female = 100 and male = 100) were caught from the coastal waters of Bushehr province and body weight and length were taken to predict fillet weight and yield. Large differences in the fillet yield were observed between seasons. The highest fillet yield (49.4%) was obtained in the samples collected in autumn while samples collected in spring had the lowest yield (42.1%). There was a linear relationship between fish length and fillet weight while no significant correlation was found between fillet yield and body measurements (weight and length). The fat content of Indian spiny halibut was < 1.2% throughout the sampling period. Based on the results, fish collected in all seasons except spring for fillets may lead to a higher production with no significant difference between two sexes.

Keywords: Fillet yields, *Psettodes erumei*, Proximate composition, Persian Gulf.

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Introduction

Indian spiny halibut, *Psettodes erumei* occurs on muddy and sandy bottom to a depth of 100 m. It reaches maximum length of about 60 cm and feeds on benthic animals (Carpenter, 1997) and is considered as an important commercial marine fish caught through bottom trawling (Yasemi et al. 2008). World production of flatfishes in the year 2005 was reported as 900012 tones (FAO Fishstat Database, 2005). In Iran capture production of flatfishes during the years 1997 to 2008 was between 2149 and 3942 tones (Iranian Fisheries Organization, 2008). Most of the productions are offered to the markets as fresh products. In different fish species prediction of fillet yields from body measurement, e.g. weight and total length have been studied (Bosworth et al. 1998; Cibert et al. 1999; Rutten et al. 2004; Sang et al. 2009; Bauer and Schlott, 2009). Fillet yield is regarded as an important trait for the improvement of fish production efficiency (Flick et al. 1990). In recent years the consumption of processed and frozen food has increased because consumers prefer convenience foods requiring less preparation time. Moreover the economic importance of marketing fish as packaged fillets product has grown drastically (Saldanha et al. 2008). There is still limited information on the fillets yield and weight in Indian spiny halibut in literature. Therefore the objective of the present study was to obtain information on the fillet weight and yield in Indian spiny halibut, and its correlation with body measurements (body length and weight).

Material and Methods

Sample preparation

Samples of *Psettodes erumei* (female = 100 and male = 100) were purchased from local markets in Bushehr province (Southern Iran). The fish were transported to the laboratory with flake ice in ratio of 1:1 in boxes. Upon arrival, the fish were deheaded, eviscerated, skinned and washed with tap water several times to remove adhering blood and slime. Then they were cut into four fillets based on the standard filleting method (FAO, 1989).. In this method the fish were cut from head to tail into two slices and then they were cut again in order to make four fillets for the black and also the white side.

Data collection

Fillet weight (without skin) was recorded as grams and fillet yield was calculated as F%=(Fw/Bw) ×100, where Fw was the fillet weight and Bw was the body weight in grams. Fish weight and total length were measured to the nearest ±0.1 g and ± 0.1cm, respectively. Waste yield was calculated similar to fillet yield as waste yield % = (Ww/Bw) × 100, where Ww is the waste (including viscera, skin, bone and head) weight.

Proximate composition and mineral analyses

For calcium content determination, the samples of whole fillet were homogenized and digested in $HNO_3/HClO_4$ (Kacar, 1972). Then calcium contents were measured by atomic absorption spectrophotometer (AAS) using a Varian Spectra atomic absorption spectrophotometer model A-400.

Phosphorus (P) was measured by a spectrophotometer and expressed as

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mg/kg. Moisture was determined by drying the samples in an oven (Heraeus, D-63450, Hanau, Germany) at 105 °C to a constant weight (AOAC, 2005); lipids were extracted with chloroform (chloroform extracted lipid) by using an automatic Soxtec system (FOSS, SoxtecTM 2050, Höganäs, Sweden); crude ash was determined by incineration in a muffle furnace (Isuzu, Tokyo, Japan) at 600°C for 3 h (AOAC, 2005); crude protein was determined by the Kjeldahl method (N × 6.25) using an automatic Kjeldahl system (230-Hjeltec Analyzer, Foss Tecator, Höganäs, Sweden) (AOAC, 2005).

Statistical analysis

Fillet yield and waste yield between males and females were analyzed by an unpaired t-test. Differences in the fillet weight or yield and waste weight or yield with body measurements between different seasons were analyzed by ANOVA test followed by Duncan multiple range tests, and the difference between genus (female and male) was investigated by Independent sample T test Correlations between body size (weight and length) and fillet weight and yield were analyzed by Pearson's coefficient for linear regression (r). The differences were considered significant at P<0.05. All data were expressed as mean±S.E.M.

Results

Information on fillet weight and yields between seasons are shown in table 1. As shown in the table, fish samples collected in winter significantly had the highest weight and total length (P<0.05).

Table 1: means (±SE) of weight (W) and total length (TL) fillet weight and yield, waste weight and yield of Indian spiny halibut (n= 30 for each season)

parameter	Spring	Summer	Autumn	Winter
TL (cm)	40.23±0.48[a]	42.69±0.96[a]	40.67±0.79[a]	47.04±1.66[b]
W (g)	1034±51.89[a]	1229±111.6[a]	1004±60.35[a]	1701±171.7[b]
Fillet (g)	422.7±9.36[a]	588±49.2[b]	495±28.7[a]	832.4±81.2[c]
Fillet yield (%)	42.1±1.47[a]	48.12±0.45[b]	49.4±0.46[b]	49±0.84[b]
Waste (g)	612±49.7[a]	641.5±63[a]	509±32.4[a]	869.5±92[b]
Waste yield (%)	57.9±1.5[b]	51.87±0.45[a]	50.6±0.46[a]	50.9±0.84[a]

Fillet yield was higher in the fish samples collected in summer, autumn and winter (P<0.05) than that obtained in spring. Waste weight and yield were significantly higher in the samples collected in spring than the values found in other seasons (P<0.05). In females body length was higher than that of males but the difference was not significant, but their body weight and fillet weights were significantly higher (P<0.05). In spite of significant differences in fillet weight between males and females, fillet yields did not vary between two sexes (Table 2).

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Table 2: Means (±SE) of weight (W) and total length (TL) fillet weight and yield, waste weight and yield of Indian spiny halibut between males and females (n= 15 for each sex)

	spring		Summer		Autumn		Winter	
parameter	**male**	**female**	**male**	**female**	**male**	**female**	**male**	**female**
TL (cm)	40.2±0.5[a]	40.5±0.6[a]	40.9±0.8[a]	46±1.8[b]	39±1.7[a]	42±0.5[a]	39.5±0.4[a]	50.3±1.7[b]
W (g)	1038±61.5[a]	1023±97[a]	1045±68[a]	1571±257[a]	880±97[a]	1129±50[b]	999±51[a]	2003±193[b]
Fillet (g)	429±10.6[a]	397±15.3[a]	507±35[a]	738±108[a]	431±47[a]	560±20[b]	493±31.5[a]	978±91[b]
Fillet yield (%)	42.7±1.6[a]	39.6±3.2[a]	48.3±0.3[a]	47.6±1.1[a]	49±0.7[a]	50±0.65[a]	49.2±1.0[a]	48.9±1.1[a]
Waste (g)	608.5±59[a]	626±93[a]	538±33[a]	833±150[a]	449±51[a]	569±1.9[a]	506±22[a]	1025±106[b]
Waste yield (%)	57.2±1.6[a]	60.3±3.2[a]	52±0.3[a]	52.3±1.1[a]	51±0.7[a]	50±0.7[a]	50.7±1.0[a]	51±1.0[a]

In table 5, information on the weight and length of the Indian spiny halibut caught in different seasons are shown. The maximum length of males (46±0.81 cm) and females (58.5±1.75cm) was observed in summer and winter respectively, while in autumn and winter, males and females respectively showed the lowest length. On the other hand, the maximum weight of males was observed in spring (1781±61g) while females had the highest weight in winter (3075±193g). Significant positive correlation between body weight and length and between body measurements (both length and weight) and fillet weight was observed but no such relationship was found between fish size (length and weight) and fillet yield (Table 3 A-D).

Table 3: Linear correlation coefficient between body measurements and fillet weight in Indian spiny turbot collected in different seasons

Spring

Trait Correlation/spring	**Body weight**	**Fillet weight**	**Fillet yield**
Body length	0.347	0.662	-0.229
Body weight		0.315	-0.895
Fillet weight			0.072

summer

parameter Correlation/summer	**Body weight**	**Fillet weight**	**Fillet yield**
Body length	0.951	0.955	-0.324
Body weight		0.993	-0.398
Fillet weight			0.296

Autumn

Trait Correlation/autumn	**Body weight**	**Fillet weight**	**Fillet yield**
Body length	0.959	0.965	-0.048
Body weight		0.984	-0168
Fillet weight			0.003

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winter

Trait Correlation/winter	**Body weight**	**Fillet weight**	**Fillet yield**
Body length	0.978	0.965	-0.091
Body weight		0.986	-0.096
Fillet weight			0.057

Table 4: The contents of protein, lipid, ash, moisture, calcium and phosphorus in the fillets of Indian spiny halibut in different seasons. Data are expressed as Mean ±S.D. (n= 15 for each season)

	Spring	**Summer**	**Autumn**	**Winter**
Protein (%)	20.05 ± 0.17^{a}	21.62 ± 1.29^{a}	12.16 ± 0.24^{b}	12.47 ± 0.54^{b}
Lipid (%)	1.04±0.0b	0.98 ± 0.04^{ab}	1.12 ± 0.03^{ab}	1.13 ± 0.07^{a}
Ash (%)	1.33 ± 0.01^{a}	1.24 ± 0.07^{ab}	1.25 ± 0.07^{ab}	1.09 ± 0.06^{b}
Moist (%)	74.07 ± 0.87^{c}	76.10 ± 0.34^{b}	78.35 ± 0.43^{a}	78.52 ± 0.51^{a}
Calcium (mg/kg)	676 ± 18.3^{a}	717 ± 58.01^{a}	697 ± 17.37^{a}	738 ± 49.2^{a}
Phosphor (mg/kg)	784 ± 6.18^{a}	711 ± 40.16^{a}	706 ± 34.24^{a}	579 ± 33.93^{b}

Results on the proximate composition and mineral contents of Indian spiny halibut fillets are shown in table 4. The mean lipid contents of the fish decreased from 1.04%±0.0 in spring to 0.98%±0/04 in summer, and then a slight increase was observed in autumn and winter (between 1.12-1.13%). The protein contents of fish in spring and summer was significantly higher than that of autumn and winter (P<0.05). Although phosphorus contents did not show any significant differences between seasons, however samples collected in winter, had the lowest (P<0.05) levels of 579 mg/kg. Calcium contents varied between 676 and 738 mg/kg with no significant differences between seasons.

Discussion

Fillet yield in the current study was 42-49%, which is relatively high. Fillet yield was calculated as 35.7% in Nile tilapia (*Oreochromis niloticus L.*) (Rutten et al. 2004), 35.6% in river catfish *(Pangasianodon hypophthalmus)* (Sang et al. 2009), 48.92% in pike (*Esox lucius L*) and 51.26% in rapfen *(Aspius aspius L)* (Zmijewski et al. 2006). In the study by Argue et al. (2003), fillet yields in channel catfish (*Ictalurus punctatus*) and blue catfish (*Ictalurus furcatus*) were 42.5 and 44.4% respectively. In cultured Bluefin tuna, (*Thunnus thynnus*) fillet yield was calculated as 73% (Oksuz, 2010).

It is well known that some biological factors such as size, sex, species and feeding can affect fillet yields (Alinezhad, 2004). Mean fillet yield of *Psettodes erumei* in the present study is within the ranges (42.9-48%) found in other flatfishes (FAO, 1989).

Fillet yield was lower in the samples collected in spring than those obtained in other times of the year, which could be due to the presence of full grown ovaries in the body, resulting in higher waste production in this season compared to other times of the year (Hoseinzadeh-Sahafi, 2007).

Table 5: Values for some biological measurements of Indian spiny halibut throughout the study (n= 100 for each season)

parameter	Spring		Summer		Autumn		Winter	
	male	female	male	female	male	female	male	female
Max TL (cm)	44	42	46	53	43.5	46.5	40.5	58.5
Min TL(cm)	37	39	36	41	31.5	40.5	38	38.5
Mean TL(cm)	40.17±0.58	40.45±0.6	40.94±0.81	45.96±1.8	39.15±1.3	42.2±0.55	39.5±0.48	50.2±1.7
Max W (g)	1781	1251	1510	2640	1295	1515	1175	3075
Min W (g)	778	830	708	909	422	928	833	914
Mean W (g)	1037.6±61.5	1023.2±96.7	1045.3±67.5	1571.2±256.7	879.9±96.9	1128.8±50.4	998.6±50.8	2003.2±193.5

Higher fillet and waste weight in female samples collected in summer, autumn and winter could be due to higher size of the samples, however as indicated in table 3 there is no significant difference in fillet yield between these times.

Many studies used body measurements as selection criteria related to fillet yield in order to improve fillet yield (Bosworth et al. 1998; Cibert et al., 1999). In this study significant correlation between body weight or length and fillet yield was not observed, indicating that fillet yield is independent of size (Bauer and Schlott, 2009). Similar to this study, strong linear relationship between body measurements and fillet weight was observed in Nile tilapia, but such relationships with fillet yield were weak and non-significant (Rutten et al., 2004). Bosworth et al. (1998) and Cibert et al. (1999) also concluded that correlation between body weight and fillet weight is generally high but on the contrary such correlation between body weight and fillet yield is generally low.

Fish are subjected to considerable environmental changes and fluctuations in availability and compositions of feed throughout the year, which will affect their muscle composition (Olsson, et al 2003). During the rapid oocyte growth phase, proteins and lipids are transferred to the developing oocytes from the muscles (Gokce, 2004). Similarly in this study low levels of lipids which were observed in the early spring, coincide with the reproductive season. This may be explained by the consumption of energy reserves and also reduced food intake by the fish during the reproductive season. Fatty acid-value increasing from minimum in autumn to maximum in summer were reported by Olgunoglu et al. (2010). The fat content of Indian spiny halibut was < 1.2% throughout the sampling period. Based on the classification by Suriah et al. (1995), Indian spiny halibut can be classified as lean fish with lipid content below 5%. The lipid content in this study is higher than the values reported for Atlantic halibut *(Hippoglossus*

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hippoglossus) (Olsson et al. 2003) and is in the ranges (0.9–3.0%) reported by Huang (1990). It is well known that variations in the muscle chemical composition of marine fish species are closely related to nutrition, living area, size, catching season, as well as environmental conditions (Erkan and Ozden, 2007).

The total content of minerals in the raw flesh of marine fish and invertebrates is in the range of 0.6–1.5% wet weight. Calcium and Phosphorus are necessary for optimal bone development, being required during childhood and growing stages to prevent rickets and osteomalacia. (Erkan and Ozden, 2007). In this study calcium contents varied between 676 and 738 mg/kg with no significant differences between seasons. Calcium contents of Indian spiny halibut are well in the ranges reported in other studies. Calcium values of 220–230 mg/kg have been reported by Orban et al. (2000) for sea bream. Tahvone et al. (2000) found 44–1158 mg/kg of Calcium in Baltic herring. The contents of calcium for blue whittling (Martınez-Valverde et al., 2000) and European perch (Orban et al. 2007) were 177 mg/kg and 463– 854 mg/kg respectively. Indian spiny halibut fillets contained phosphorus levels of 579 to 784 mg/kg within the sampling period.

The values reported for rainbow trout (*Oncorhynchus mykiss*) was 3378 mg/kg (Gokoglu et al., 2004) and between 2150–2310 mg/kg in European perch (*Perca fluviatilis*) (Orban et al., 2007). It is well known that variations in the mineral compositions of marine foods is closely related to seasonal and biological differences (species, size, dark/white muscle, age, sex and sexual maturity), area of catch, processing method, food source and environmental conditions (water chemistry, salinity, temperature and contaminant) (Erkan and Ozden, 2007). In conclusion due to relatively high fillet yield in Indian spiny turbot, this species is a good candidate to produce fillets.

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