9(2):026-031 (2015)

Journal of FisheriesSciences.com

E-ISSN 1307-234X

ORIGINAL ARTICLE/ORİJİNAL ÇALIŞMA

FULL PAPER TAM MAKALE

A STUDY ON FEEDING PREFERENCES OF JUVENILE FLOUNDER (*Platichthys flesus*)

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Received: 18.11.2013 / Accepted: 26.03.2014 / Published online: 01.07.2014

Abstract: Flounder (*Platichthys flesus*), which is a suitable fish species for aquaculture, has market value in Turkey. However, its larval feeding characteristics at breeding stage need to be identified. This study aims to establish preferences of flounder among different feed options and their consumption amounts based on number of feeding and feeding times. In the present study, chironomid and mosquito larvae utilized as food sources in the nature by fish and commercially produced granule feed were given to the flounder singly and as a mixture. While the fish consumed all the food sources, chironomid larvae and mosquito larvae were notably preferred and in mixed feeding, chironomid larvae consumption increased whereas mosquito larvae consumption decreased. In conclusion, food preference of flounder was determined to comprise the living organisms fitting in its feeding behavior and habitat, therefore, they notably preferred chironomid larvae, which shows the feature of motility on the ground.

Keywords: Flounder (*Platichthys flesus*), Live food, Feed consumption, Food preference

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Introduction

Flounder (*Platichthys flesus*) is a species of Pleuronectidae order, which is spread in the less salty waters of Western Europe from White Sea to the Mediterranean and Black Sea (Nielsen, 1986). The species is a flat fish species of economic value for Black Sea (Aarnio et al., 1996; Aydın, 2012). Studies on breeding of flounder started in the 1960s in Japan and in 1970s in England and France, but facussed mainly the solve and studies for breeding turbot (*Psetta maxima*) after 1997 (Matsuoka, 1996; Yiğit, 2001).

The studies with flounder in Turkey included trials on transfer, from the wild to culture works adaptation and feeding, breeding requirements, juvenile production, reproduction characteristics, egg development, revealing of exterior abnormalities seen in reproduction performance and hatchery production (Ergün & Yalçın, 2006; Aydın et al., 2011; Aydın, 2012). In aquaculture, larvae of especially several fish species require live food. Knowing feeding habits and food preferences of interested fish species is important especially for growth and survival of juvenile fish (Aarnio, 2000; Ghosh et al., 2003).

The study seeks to determine feed prefer and consumption amounts of the flounder based on use of different feed options such as chironomid larvae, mosquito larvae and pelleted feed.

Materials and Methods

The fish were captured in June (2010) by seines and trawl nets in the estuarine zone where Sırakaraağaçlar Creek flows into the sea at 10 km west of Sinop province. The fish were brought alive to Sinop University, Aquaculture Faculty Research Center, and stocked in adaptation tanks for 15 days.

15 fish with an average weight of 0.48±0.03 g and average length of 36.11±0.77 mm were stocked individually in the system composed of plastic containers of 10 lt. with continuous aeration. Three replications in order to determine individual consumption of the fish was placed in each group only one fish. Chironomid (*Chironomous* sp.) and mosquito larvae (*Culex* sp.) was obtained from the water channel coming from the research center. Chironomid larvae (phase 4; 10-12 mm), mosquito larvae (phase 4, instar IV; 6-7 mm) and pellet feed (0.8-1 mm) were used for nutrition. The dimension of the prey according to the dimensions of the mouth opening of the fish was determined.

The study was conducted three repeated as in five groups of three different feeding times [Morning (G_{mo}), Noon (G_{no}), Evening (G_{ev}), Morning-Evening ($G_{mo\text{-}ev}$), Morning-Noon-Evening ($G_{mo\text{-}no\text{-}ev}$)] under natural lighting regime. In order to standardize the fasting state in the fish, feed was not given for 24 hours following placing in the trial tanks. The feed were given singly [120 chironomid larvae (P_{CLF}), 120 mosquito larvae (P_{MLF}) and 120 pellet feed (P_{GF})] and as a mixture [120 chironomid larvae + 120 mosquito larvae + 120 pellet feed (P_{MF})] for 7 days.

Feeding took place at 09^{00} in the morning, at 13^{00} at noon and at 17^{00} in the evening. After 3 hours from feeding, the feed were counted and collected, consumed feed amounts were calculated and average feed consumption amounts (±SD) were determined (Ghosh et al., 2003). Temperature, pH and dissolved oxygen values were measured in-situ three times a day with a WTW branded device. In the study, the difference between the groups was determined by one-way anova analysis and significance of the difference was determined by Duncan's multiple comparison test. IBM SPSS 21.0 programme was used in the calculations.

Results and Discussion

No difference was seen in temperature, pH and dissolved oxygen values ($p>0.05$) (Table 1).

Death was not observed in the groups during the study. Food consumptions of the groups in single and mixed feeding regimes are given in Table 2 and Table 3.

Table 1. Average temperature, pH and dissolved oxygen values between the periods

Period	Temperature (°C)	pH	Dissolved Oxygen (mg/lt)
P_{CLF}	24.10±0.48[a]	8.68±0.24[a]	7.02±0.18[a]
P_{MLF}	24.31±0.66[a]	8.55±0.21[a]	7.29±0.24[a]
P_{GF}	25.15±0.65[a]	8.42±0.36[a]	7.26±0.28[a]
P_{MF}	24.22±0.74[a]	8.74±0.38[a]	7.44±0.09[a]

Values expressed with same exponential letters in the same row are statistically not different from each other (p<0.05).

Table 2. Average feed consumption amounts of the groups in single feeding regime (number)

Period	G_{mo}	G_{no}	G_{ev}	G_{mo-ev}	$G_{mo-no-ev}$
P_{CLF}	18.62±2.55[a]	27.47±3.69[ab]	36.19±4.87[b]	25.71±4.16[ab]	43.05±5.51[b]
P_{MLF}	66.52±5.62[a]	87.90±4.77[b]	91.67±4.86[b]	77.52±4.78[ab]	78.76±4.19[ab]
P_{GF}	4.24±1.29[b]	2.17±0.91[a]	*	5.00±1.23[b]	6.57±1.63[b]

Values expressed with different exponential letters in the same row are statistically different from each other (p<0.05). * No feed intake.

Table 3. Average food consumption amounts of the groups in mixed feeding regime (number)

Period		G_{mo}	G_{no}	G_{ev}	G_{mo-ev}	$G_{mo-no-ev}$
P_{MF}	CLF	50.38±4.37[b]	32.26±2.92[a]	34.86±3.75[a]	54.95±5.22[b]	34.05±3.40[a]
	MLF	13.48±2.60[a]	16.26±1.49[a]	15.26±1.63[a]	22.45±2.12[b]	26.91±2.30[b]
	GF	2.25±1.18[a]	1.33±0.21[a]	*	1.09±0.91[a]	4.81±1.51[b]

Values expressed with different exponential letters in the same column are statistically different from each other (p>0.05). * No feed intake.

There was irregularity between the days in chironomid consumption in G_{mo} and G_{no} groups and there was regular feed intake in G_{ev}, G_{mo-ev} and $G_{mo-no-ev}$ groups. As a result of the analysis conducted between the groups on daily chronomid larvae consumption amounts, the difference between the groups G_{mo} and G_{ev} and $G_{mo-no-ev}$ was significant (p<0.05). Consumption of chironomid larvae was higher particularly in the evening meals compared to other meals. Moreover, consumption of chironomid larvae in aggregate was the highest in $G_{mo-no-ev}$ group and the lowest in G_{mo} group.

Mosquito larvae consumption was regular in all groups. In G_{mo}, G_{no} and G_{ev} groups, mosquito larvae consumption for the first three days was lower compared to the other days whereas in G_{mo-ev} and $G_{mo-no-ev}$ groups, mosquito larvae consumption increased regularly. As a result of the statistics conducted between the groups on daily mosquito larvae consumption amounts, the difference between the groups G_{mo} and G_{no} and G_{ev} was e significant (p<0.05). Average mosquito consumption amount during the feeding period was the highest in G_{ev} group and the lowest in G_{mo} group.

In feeding with pellet feed, no consumption was observed in G_{ev} group whereas consumption in other groups was irregular. In this feeding period in which individual preferences became prominent due to failure to adapt to granule feed, the difference in daily granule feed consumption amounts between G_{no} group and other groups was significant (p<0.05).

In mixed feeding, chironomid larvae consumption increased in G_{mo} and G_{mo-ev} groups (p<0.05), mosquito larvae consumption decreased in all groups (p<0.05), and in feeding with granule feed, the difference between consumption amounts was insignificant (p>0.05).

While studies of adaptation to the feed having different ration characteristics with different live food options in feeding were conducted, very little information is available on their feeding especially in lagoons with hard water character since flounder is a species that is characterized as an alternative species.

Feed intake of the fish varies depending on its hunting character, quality, density, physical attractiveness and length of the feed. In several studies, it is reported that some fish preferred mosquito larvae due to behavioral characteristics of the feed (Kumar et al., 2008; Devi & Jauhari, 2011). Flounder shows a character of staying steady in natural environment but making sudden movement towards the feed during hunting (Yiğit, 2001). It is reported that artificial food and other alternative food sources are used at the time when feed intake from outside starts in larva culture of several fish species (Legendre et al., 1995). Furthermore, it is stated that granule feed prepared so as to satisfy feed requirements of fish larvae and juveniles could not be utilized due to non-development of adaptation to the granule feed or problems suffered with respect to digestion of the feed (Kowen et al., 2001). Ergün and Yalçın (2006) reported that flounder did not prefer granule feed initially; therefore, mortality rate was high.

In the nature, chironomid larvae are motile on the ground whereas mosquito larvae have limited motility on the surface (Titmus & Bodcock, 1981; Real et al., 2000; Bat & Akbulut, 2001; Özkan, 2006). Mosquito larvae are utilized in feeding of various fish species for use in biologic struggle (Fletcher et al., 1993; Lardeux et al., 2002; Yıldırım & Karaçuha, 2007).

Benthic invertebrates take an important part in feeding of juvenile fish that live in the bottom during the entire of or several periods of their lifespan (Fischer & Eckmann, 1997). Chironomid larvae are reported to be a feed source that lives in lower substrates, has an important potential of live food, is preferred for its wriggling movements, has a high and rich nutrition content (55.7% raw protein and 9.7% fat) and is easy to digest for juvenile fish (Steffens, 1960; James et al., 1993; Branco et al., 1997; Bogut et al., 2007; Ferrington et al., 2008).

Mattila & Bonsdorff (1998), conducted a study to determine the predator behavior of the flounder on *Macoma balthica* and *Bathyporeia pilosa* species, stated that giving the two feed separately or in combination did not make difference on consumption amount, but increases in the total feed amount by increased consumption amount.

In breeding of bullhead (*Silurus glanis*) (Ronyai and Ruttkay, 1990), juvenile burbot (*Lota lota*) (Hofmann & Fischer, 2003) and channel bullhead (*Ictalurus punctatus*) larvae (Mulligan et al., 2010), chironomid larvae are one of the important live food sources and can be used as live food. Adamek et al. (2007) reported that sturgeon (*Acipenser baerii*) larvae preferred chironomid larvae, and could be utilized in alternative feed rations.

Manna et al. (2008) stated that guppy (*Poecilia reticulata)* preferred *c*hironomid and tubifex larvae as live food. Gupta & Banerjee (2009) reported that goldfish (*Carassius auratus*) showed high preference towards live food compared to artificial feed, and the most preferred one among the live food was chironomid larvae.

In the lagoons which are among the natural habitats of flounder, it was reported that a substantial part of the benthic macro invertebrates consisted of chironomid larvae (Çamur-Elipek et al., 2010; Özkan et al., 2010). Preferences of juvenile flounder were copepod up to 45 mm, and oligochaeta, amphipoda and chironomid between 45 and 101 mm (Aarnio et al., 1996). Flounder mostly fed with benthic organisms (Aarnio, 2000). Nissling et al. (2007) reported that juvenile flounder over 40 mm mostly preferred oligochaeta and chironomidae species.

Conclusion

In the present study, chironomid and mosquito larvae, which are utilized as feed source by the fish in the nature, and commercially produced granule feed were used and consumption amounts and food preferences were tried to be determined based on number of meals and meal times of the flounder. The obtained data suggest that flounder preferred chironomid larvae more compared to mosquito larvae and granule feed. In all groups, chironomid larvae and mosquito larvae were notably preferred whereas in mixed feeding chironomid larvae consumption increased and mosquito larvae consumption decreased. The fish significantly prefer the chironomid larvae that has the feature of motility on the ground at every meal.

The studies conducted that chironomid larvae, which are rapidly digested and reported to be a good protein source (Özkan, 2006), are one of live food sources preferred for their motile behavior in the water and easily available for demersal species such as flounder, and can be utilized in alternative feed rations.

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