

## EFFECT OF DIETARY EE/NFE RATIO ON SENSORIAL TRAITS OF SHI DRUM

Severino SEGATO<sup>a)</sup>, Luca FASOLATO<sup>b)</sup>, Stefania BALZAN<sup>c)</sup>, Carla Azzurra ELIA<sup>a)</sup>, Enrico NOVELLI<sup>c)</sup> and Igino ANDRIGHETTO<sup>b)</sup>

<sup>a)</sup> Dept. of Animal Science, Padova University, Agripolis, Viale dell'Università, 16, 35020 Legnaro (PD), Italy

<sup>b)</sup> Istituto Zooprofilattico delle Venezie, Viale dell'Università, 10, 35020 Legnaro (PD), Italy

<sup>c)</sup> Dept. of Public Health, Comparative Pathology and Veterinary Hygiene, Padova University, Agripolis, Viale dell'Università, 16, 35020 Legnaro (PD), Italy

### ABSTRACT

A four months growth trial was carried out in order to evaluate the quality traits of juvenile shi drum (*Umbrina cirrosa*) fed two isonitrogenous and isoenergetic diets having a different EE/NFE ratio (LOW, 0.7 vs. HIGH, 1.1). Compared to HIGH diet, LOW one was formulated increasing the replacement of fish oil with cereal products and soybean meal. At the end of the feeding trial (2 replicate per dietary treatment), 26 fish for each thesis were sorted according to live weight and submitted to chemical and sensorial analysis. Dietary treatments showed similar productive performance. The relative high inclusion of carbohydrates in substitution of lipids did not affect proximate composition of whole body and dorsal fillet. Among sensorial traits, LOW diet-fed fish evidenced a significant lower trunk exudation and fillet lightness. Results of this research showed that shi drum is a suitable candidate for Mediterranean marine aquaculture and its dietary formulation might include at least the NFE amount tested in this trial.

Key words: aquaculture / fish / shi drum / *Umbrina cirrosa* / animal nutrition / nutrition value / Mediterranean

## VPLIV EE/BNI RAZMERJA V OBROKU NA SENZORIČNE LASTNOSTI KORBELOV

### IZVLEČEK

S štirimesečnim rastnim poskus smo žeeli oceniti lastnosti mladih korbelov (*Umbria cirrosa*), krmljenih z izo-dušičnimi in izo-energijskimi obroki z različnim razmerjem med eterskim ekstraktom (EE) in brezdušičnim izvlečkom (BNI) (LOW 0,7 proti HIGH 1,1). V primerjavi z obrokom HIGH, smo v obroku LOW postopno nadomeščali delež ribjega olja z žitnimi proizvodi in sojo. Na koncu krmnega poskusa (2 ponovitvi za vsak poskus) smo po 26 rib v vsaki skupini razvrstili glede na telesno maso in jih kemično in senzorično analizirali. Različno sestavljeni obroki so dali podobne proizvodne rezultate. Relativno veliko ogljikovih hidratov namesto maščob ni vplivalo na sestavo telesa in hrbtnega fileja. Med senzoričnimi lastnostmi je LOW skupina kazala značilno nižjo izcejo trupa in svetlost fileja. Rezultati raziskave kažejo, da je korbel primerna riba za sredozemsko akvakulturo in da v krmo lahko vključimo vsaj BNI v preučevanih količinah.

Ključne besede: akvakultura / ribe / korbel / *Umbrina cirrosa* / prehrana živali / prehranska vrednost / Mediteran

### INTRODUCTION

In the last decade, common dentex (*Dentex dentex* L.), Mediterranean amberjack (*Seriola dumerili*, Risso), blackspot sea bream (*Pagellus bogaraveo*) and shi drum (*Umbrina cirrosa* L., Sciaenidae) have been proposed as potential candidates for Mediterranean marine aquaculture. However, under conditions of Alto Adriatico Sea, shi drum seems to be the most promising finfish because of its fast growth rate and high feed efficiency (Segato *et al.*, 2005a). Shi drum is

a demersal fish, living on sandy bottom at the maximum depth of 100 m and its area of distribution covers all the Mediterranean Sea, including Black Sea; it may attain a length of 1 m and weight of 12 kg, but exemplars usually caught show lengths between 30 and 80 cm (Mylonas *et al.*, 2000). Regarding rearing conditions, a very limited number of scientific studies on growth performance and diet utilization have been carried out. As for other marine fishes, in order to promote a sustainable aquaculture it is strongly necessary to reduce the level of fish meal and fish oil included in the diet's formulation. A preliminary study of Segato *et al.* (2005b) showed that shi drum is able to tolerate a reduction of the dietary EE/NFE (Ether Extract over N-Free Extract) ratio from 1.5 to 1.0. In addition, a reduction of dietary fish oil content seems to lead to a lower fat deposition both whole body and fillet. The flesh lipid amount affects fillet organoleptic traits (Lopparelli *et al.*, 2004; de Francesco *et al.*, 2007) and the nutritional value in order to satisfy consumer's preference always more addressed to leaner products.

Taking into account the lack of information on the effects of dietary EE substitution level on quality traits of shi drum, the purpose of this study was the evaluation of the influence of EE/NFE ratio effect on reological and sensorial parameters of marketable size shi drum over a rearing period of four months (summer).

## MATERIAL AND METHODS

### Fish rearing conditions and dietary treatments

The trial was carried out in the experimental rearing facility of Bonello (Rovigo, Italy) throughout a 125-day period (June 3–October 7). Four groups of fish were reared in 4.5 m<sup>3</sup> – hemispheric fibreglass tanks inside a glasshouse with natural air circulation. Tanks were supplied with a brackish water flow (on average: pH, 7.9; salinity, 29 ppt; flow rate, 1.2 l·s<sup>-1</sup>) on an open circuit. Water was continuously oxygenated by an oxygen compressor and till the end of September its temperature ranged between 19 and 30 °C. Fish were fed according to two experimental diets (2 replicates per thesis). The isonitrogenous extruded diets were formulated by using market available ingredients and according to a LOW (0.7) and HIGH (1.1) ether extract (EE) to nitrogen-free extract (NFE) ratio (Table 1). The proximate composition of the diets and the dorsal fillet were determined according to AOAC (2000): crude protein (CP, N<sub>kjeldhal</sub>·6.25), ether extract (EE; Soxhlet, diethyl ether) and ash while crude fiber was analysed using the ANKON<sup>TM</sup> methodology, and NFE was calculated by subtracting the difference. Fish were fed by hand until the visual satiation, four times a day and seven days a week. At first the feeding rate was 1.8–2.2% of biomass (live weight, LW) but during the last month of the experimental period, it was progressively reduced to 1.0% of LW due to both decreasing temperature and higher weight of fish.

### Quality evaluation and statistical analysis

At the end of the trial, 26 fish samples (final body weight: 376 ± 12 vs. 382 ± 21 g) from each experimental group were caught and killed after dipping in ice. After 48 h of storage at 2 ± 1 °C, discriminative sensory analysis was carried out on cooked samples by 10 trained tasters. According to Lopparelli *et al.* (2004), gutted trunks were wrapped by aluminium foil and cooked in an electric oven at 165 °C until the fillet core temperature reached 65 °C. Jury evaluation considered the following attributes: trunk compactness, exudation and skin detachment; fillet (white epiaxial muscle) odour, lightness, tenderness, juiciness, marine and salty flavour and taste. The score was expressed on a 9-point scale (1 = low, ..., 9 = high) using the attributes scheduled in Table 2. For tasting each judge considered the same dorsal muscular portion,

avoiding intermuscular adipose deposits. The trial was designed according to a monofactorial design (two levels of dietary treatment). After verifying the normality and variance homogeneity, performance (two replicates for level), chemical ( $n = 14$ ) and sensorial ( $n = 12$ ) data were submitted to one-way ANOVA using the general linear models procedure (PROC GLM) of SAS (2002). All tests were considered significant at  $P < 0.05$ . The level of  $0.05 < P < 0.1$  was considered as a trend.

Table 1. Formulation ( $\text{g}\cdot\text{kg}^{-1}$  of diet) and proximate composition (% of DM) of experimental diets

DIET	LOW	HIGH
EE/NFE	0.7	1.1
Fish meal	430	475
Fish oil	130	165
Soybean meal	200	160
Cereal products	220	180
Vitamin-mineral mix <sup>a</sup>	20	20
Crude protein	48.8	49.3
Crude fat	17.2	20.9
Ash	8.9	9.9
Nitrogen-free extract	24.7	19.6
Crude fiber	0.4	0.3

<sup>a</sup>Vitamin and mineral premix according to NRC (1993) recommendations for marine fish.

## RESULTS AND DISCUSSION

Considering a four-month feeding period, the increased replacement of fish oil (and fish meal) with sources of carbohydrates (cereal products and soybean meal) did not result in any significant difference in growth and feeding efficiency (data not tabulated for brevity). As reported in Table 2, dorsal fillet proximate composition was also unaffected by dietary treatment.

As regards the sensorial evaluation, results showed that a relative low inclusion of dietary lipids did not affect the main quality traits of shi drum, especially for texture and flavour (Table 1). These results were probably due to the similar EE content of whole body (10.5 vs. 11.2% w.w.;  $P > 0.1$ ) and dorsal white muscle (Table 2). However, LOW diet-fed fish evidenced a significant decrease of trunk exudation (3.4 vs. 5.0;  $P < 0.05$ ) and a slightly significant difference for fillet lightness (5.7 vs. 6.4;  $P < 0.10$ ).

Despite the similar whole body moisture and EE content, the lower trunk exudation of LOW thesis than HIGH one may be related to a distinct fat deposition (i.e. celomatic and liver fat) that could result in a different visible level of exudates after the heating procedure (fish where cooked as gutted trunks wrapped in tinfoil paper). As reported by Segato *et al.* (2005a) and Parisi *et al.* (2004), the change in fillet lightness was probably due to a different pigment deposition achieved from vegetable (soybean and maize) ingredients employed to formulate the LOW diet. With regard to this, an interaction between vegetable sources and the pigments of the raw material used in diet formulation has been suggested by several authors (Grigorakis, 2007).

The agreeability of fillet taste tended to be greater in the LOW-fed fish (5.6 vs. 4.7;  $P < 0.10$ ) probably as consequence of the modest inclusion of plant derivates that did not affect

compounds responsible of smell and taste, even marine odour was slightly better discriminate in this dietary treatment.

Table 2. Effect of dietary CF/NFE ratio on dorsal fillet proximate composition (% wet weight) and sensory evaluation of trunk and fillet (lateral dorsal muscle) after heating procedure

DIET CF/NFE	LOW	HIGH	P	SEM
	0.7	1.1		
<b>Dorsal fillet proximate composition</b>				
Moisture, %	76.0	76.2	ns	0.2
Crude protein, % w.w.	20.9	20.3	ns	0.3
Ether extract, % w.w.	1.5	1.9	ns	0.1
<b>Sensorial evaluation <sup>a</sup></b>				
Attribute (discriminating)				
Trunk compactness (compact)	5.7	5.6	ns	0.4
Trunk exudation (exudates)	3.4	5.0	*	0.6
Skin lightness (light)	7.2	7.4	ns	0.9
Skin detachment (detachable)	6.5	7.4	ns	0.7
Fillet odour (marine)	6.7	4.5	*	0.5
Fillet lightness (light)	5.7	6.4	†	0.3
Fillet tenderness (tender)	6.5	5.9	ns	0.5
Fillet juiciness (juicy)	6.1	5.7	ns	0.5
Fillet marine flavour (marine)	4.5	4.1	ns	0.4
Fillet salty flavour (salty)	4.5	4.4	ns	0.3
Fillet taste (agreeable)	5.6	4.7	†	0.3
Fillet overall acceptability (acceptable)	5.1	4.7	ns	0.3

<sup>a</sup> Scale: 1 = low, ..., 9 = high; † = P < 0.1; \* = P < 0.05.

## CONCLUSIONS

- Summarising, a relative low substitution of energy sources from lipids (EE) to nitrogen-free extract (NFE) did not affect growth performance as well as fillet rheological and sensory quality. A slightly decrease in fillet lightness was observed in shi drum fed the diet with higher inclusion of vegetable sources, even if fillet taste agreeability seemed to be improved.
- The use of a lower crude fat dietary content lead to a reduction of productive cost. In addition, the higher inclusion of plant ingredients embraces the challenge of improving the sustainability of aquaculture industry by using more economically viable and environmentally friendly alternative to fish meal and fish oil on which many present aquafeeds are largely based. Besides the environmental and economic standards, the formulation of marine finfish's diet should consider the nutritional properties of the

final product too. As far as the use of fish meal and oil decrease, a lower incidence in fillet highly unsaturated fatty acids (HUFA) occurs reducing its healthy value.

## ACKNOWLEDGEMENTS

This research was supported by grants 5C 137 from the Ministry of Agricultural and Forestry Policies (MIPAF), Roma, Italy.

## REFERENCES

- AOAC. Official Methods of Analysis. 17<sup>th</sup> ed. Washington, DC, Association of Official Analytical Chemists, 2000.
- De Francesco, M./ Parisi G./ Pérez-Sánchez, J./ Gómez-Réqueni, P./ Médale, F./ Kaushik, S.J./ Mecatti, M./ Poli, B.M. Effect of high-level fish meal replacement by plant proteins in gilthead sea bream (*Sparus aurata*) on growth nad body/fillet quality traits. *Aquaculture Nutrition*, 13(2007), 361–372.
- Grigorakis, K. Compositonal and organoleptic qaulity of farmed and wild gilthead sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) and factor affecting it: A review. *Aquaculture*, 272(2007), 55–75.
- Lopparelli, R.M./ Segato, S./ Corato, A./ Fasolato, L./ Andriguetto, I. Sensory evaluation of sea bass (*Dicentrarchus labrax* L.) fed two different fat content diets. *Veterinary Research Communications*, 28(2004), 225–227.
- Mylonas, C./ Georgiou, G./ Stephanou, D./ Atack, T./ Afonso, A./ Zohar, Y. Preliminary data on the reproductive biology and hatchery production of the shi drum (*Umbrina cirrosa*) in Cyprus. *Cahier option Méditerranéennes*, 47(2000), 303–312.
- NRC (National Research Council). Nutrient Requirements of Fish. Washington, DC, National Academy Press, 1993.
- Parisi, G./ de Francesco, M./ Médale, F./ Scappini, F./ Mecatti, M./ Kaushik, S.J./ Poli, B.M. Effect of total replacement of dietary fish meal by plant protein sources on early post mortem changes in the biochemical and physical parameters of rainbow trout. *Vet. Res. Commun.*, 28(2004), 237–240.
- SAS. User's Guide: Statistics. 9.1 ed. Cary, NC, USA, SAS Inst. Inc., 2002.
- Segato, S./ Corato, A./ Fasolato, L./ Andriguetto, I. Effect of the partial replacement of fish meal and oil by vegetable products on performance and quality traits juvenile shi drum (*Umbrina cirrosa* L.). *Italian Journal of Animal Science*, 4(2005a), 159–166.
- Segato, S./ Lopparelli, R.M./ Borgoni, N./ Zanella, L./ Corato, A./ Andriguetto, I. Effect of dietary crude fat to NFE ratio on growth, feed efficiency and quality traits in juvenile shi drum (*Umbrina cirrosa*). *Cahiers Options Méditerranéennes*, 63 (2005b), 27–34.