EFFECT OF DIETARY LIPIDS ON LARVAL GILTHEAD SEA BREAM (*SPARUS AURATA, L.*) BEHAVIOUR

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Introduction

Determination of normal pattern of behaviour in fish larvae has been pointed out as a powerful tool to study larval development, since delays in the appearance of those patterns or abnormal deviations in behaviour in certain individuals or patches of larvae may constitute an effective non-invasive indicator of health, development and maturity of these individuals. Many different types of behaviour, such as schooling, seem to relay more on the proper development of central nervous system than on alterations of sensorial and swimming organs (Masuda y Tsukamoto, 1998) and since dietary essential fatty acids (EFA) are necessary for the normal development of nervous system and sensory organs, variations in the dietary level of such fatty acids would markedly affect behaviour. For instance, larval eye and brain fatty acid composition clearly reflected that of the diet (Navarro *et al.*, 1993) in seabass larvae, whereas in yellow tail larvae dietary docosahexaenoic acid (DHA) has been shown to affect ontogeny of schooling behaviour as well as brain development (Ishizaki *et al.*, 2001). DHA and other essential fatty acids have been shown to be determinant of growth and survival performance also in gilthead seabream larvae. Thus, increasing dietary n-3 highly unsaturated fatty acids (HUFA) either in live food or in microdiets larvae improves larval growth, survival and stress resistance (Izquierdo, 1996; Sargent *et al.*, 1999). Since very few studies have been aimed to determine the ontogeny of behaviour in gilthead seabream, the effect of dietary fatty acids on behaviour of this larvae is also unknown. For all that, the aim of this study was to establish the appearance of behavioural answers to different type of stimulus along the early larval development of gilthead sea bream, as well as to determine the effect feeding different lipid sources and essential fatty acids on such behaviour pattern.

Materials and methods

Sparus aurata larvae were fed rotifers (*Brachionus plicatilis*) enriched with either fish oil (FO rotifers), soybean oil (SBO rotifers), linseed oil (LSO rotifers) or rapseed oil (RSO rotifers) in 100 l tanks, each treatment assayed by four replicates. Swimming speed of larvae from all groups was measured on days 6, 10, 16 and 19 after hatching, in a 1 L glass beaker (10 cm in diameter) covered by a black vinyl sheet. Larvae were video-recorded using a Sony digital video camera DCR-TRV27. After recording for 90 s without disturbance, the fish was scared by sound and stimuli to introduce a startle response. This procedure was repeated using 5 individuals of each replicate. Frame by frame video analysis was conducted to calculate cruise swimming speed recording and burst swimming speed. Cruise swimming speed was estimated based on the 10 s video recording from 30 s after the recording was started. The movement of the fish was traced on an overhead projector transparency sheet, and this distance was divided by the time taken (10 s) obtaining the cruise swimming speed (Masuda *et al.*, 1998).

Results and discussion

Growth results showed that the different vegetal oil sources used to replace the fish oil as dietary lipids, negatively affect the growth in larvae of gilthead sea bream. Larvae fed FO rotifers showed a significant ($P<0.05$) increase in growth in comparison with larvae from the other treatments, which could be related with the higher n-3 HUFA and DHA levels of FO rotifers in agreement with other authors results (Izquierdo, 1996). Larval composition also showed similar n-3 HUFA and particularly DHA contents in FO larvae with respect to the initial larvae and in opposition. Fatty acids composition in both central nervous system and eyes, revealed a retention of n-3 HUFA, particularly DHA, even in larvae fed rotifers low in these fatty acids, confirming their importance for the development of such tissues.

Regarding behaviour of larvae fed FO rotifers, swimming activity before stimulus (cruise swimming) was low during the first 10 days and markedly increased from day 16, denoting the higher development of nervous system along the previous days. Reaction after a sonorous stimulus (burst swimming speed) appeared as early as day 6 after hatching and was about 10 times that of cruise swimming before the stimulus. Reaction after a visual stimulus appeared later, at day 10 after hatching, being about 10 times that of cruise speed, but increased from day 16 being from there always higher than that after sonorous stimulus, in agreement with the eye development (Roo, 1999).

Swimming activity before stimulus was significantly reduced by feeding rotifers enriched with vegetable oils. Despite reaction against sonorous stimulus was not affected by feeding vegetable oils, appearance of reaction after visual stimulus was delayed to day 19th in larvae fed LSO rotifers and it was also delayed and reduced by feeding the other vegetable oils. Higher burst swimming speed in larvae fed LSO is in agreement with the higher response to acute stress found in juveniles of the same species fed with linseed oil (Montero et al., 2003).

In conclusion, reduction in the rotifer EFA content, by enrichment them with vegetal oils, affects larval normal behaviour, reducing cruise speed, and particularly delaying the appearance of the visual stimulus, suggesting a delay in the functional development of brain and vision, in agreement with the minor EFA and DHA found in eyes and brains of these larvae.

References

Ishizaki, Y., Masuda, R., Uematsu, K., Shimizu, K., Arimoto, M. y Takeuchi, T. 2001. The effect of dietary docosahexaenoic acid on schooling behaviour and brain development in larval yellowtail. Journal of Fish Biology. 58, 1691-1703.

Izquierdo, M.S. 1996. Essential fatty acid requirements of cultured marine fish larvae. Aquaculture Nutrition. 2, 183-191.

Montero, D., Kalinowski, T., Obach, Robaina, L., Tort, L., Caballero, M.J., e Izquierdo, M.S. 2003. Vegetable lipid sources for gilthead seabream (*Sparus aurata*): effects on fish health. Aquaculture 225: 353 - 370.

Masuda, R. y Tsukamoto, K. 1998. The ontogeny of schooloing behaviour in the striped jack. J. Fish. Biol. 52: 485-493.

Navarro, J.C., Batty, R.S., Bell, M.V., Sergent, J.R. 1993. Effects of dietary fatty acids on the fatty acid composition of neiral and visual tissues of fish larvae. En: World Aquaculture'93 Int. Conf. Torremolinos. España.

Roo, F. 1999. Effect combined of feeding with the quality and intensity of the light on the growth and development of visual system of gilheaed larvae Sparus aurata in conditions of intensive culture. Thesis Master. University of the Palmas de Gran Canaria. Spain.

Sargent, J., McEvoy, L., Estevez, A., Bell, G., Bell, M., Henderson, J., Tocher, D. 1999. Lipid nutrition of marine fish during early development. Current status and future directions. Aquaculture. 179, 217-229.