Journal of Animal and Veterinary Advances 8 (11): 2360-2362, 2009
ISSN: 1680-5593

The First Data on the Saddleback Syndrome in Cultured Gilthead Sea Bream (*Sparus aurata* L.) by MIP-MPR Method

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INTRODUCTION

The gilthead sea bream *Sparus aurata* (L.) is commonly cultivated in the Mediterranean countries and Turkey. As well reported in many other teleosts, propagation of sea bream is associated with an increased incidence of skeletal malformations, especially those associated with the vertebral column in the adult (Paperna, 1978; Barahona-Fernandes, 1982; Francescon *et al*., 1988). In aquaculture, one of the most questionable problems is the high rate of body deformities during larval and juvenile stage of fish (Afonso *et al*., 2000; Andrades *et al*., 1996). The main reason and progression of such skeletal malformations in cultivated fish is uncertain and, despite their relatively high frequency in farmed fish, also these deformities usually caused render the product unsalable of the cultured fish. Nevertheless, saddleback syndrome (SBS) was expressed as a lack of one to all the hard spines of the dorsal fin, accompanied by shape, number and position abnormalities of the related pterygiophores (Koumoundouros *et al*., 2001). Besides, it was firstly presented in cultured tilapia, *Oreochromis aureus* by Tave *et al*. (1983) then also been reported in the promising candidate species such as common dentex *Dentex dentex* and white sea bream *Diplodus sargus* (Koumoundouros *et al*., 2001; Sfakianakis *et al*., 2003). The main goal of this study is to describe SBS in adult of gilthead sea bream in Turkey, the Southwest of the Aegean Sea. Additionally, highly-sensitive MIP-MPR (Multiplanar reconstruction) method was firstly used for determination of this deformity and also compared with the traditional X-ray geometric method in this species.

This study was carried out in private cage farm between September 2005 and May 2006. Experimental fish were collected from seven cage farms in different regions. Although, 74.880 numbers of fish were investigated and also SBS was observed in only 10 fish with the same deformity level.

The X-ray (Siemens Seldix 550; 2 kV 3.5 mAS) geometric and MIP-MPR (Toshiba Asetion Spiral BT; 120 kV to 120 mAQ 10 mm pitch 1000 m sec^{-1} Wl = 141, WW = 251) methods were used for determination of SBS syndrome. Also, the obtained images were photographed with digital camera Nikon Coolpix 5000.

Growth of experimental fish during the period of study is described in Fig. 1. The growth parameters (total length and weight) of both SBS and normal fish were determined as 22.59±1.15 cm, 215.50±6.28 g and 24.98±1.80 cm, 245.88±7.50 g, respectively. It is found that SBS fish were demonstrated approximately 20% lower growth than normal fish. Additionally, X-ray and high resolution MIP-MPR images were shown in Fig. 2. The dorsal spines and pterygiophores were not detected in SBS fish in spite of detected in normal fish. In all 10 specimens, it was observed that dorsal fin of fish was deformed with lack of almost all spines and rays (only 2 or 3 rays at the posterior dorsal fin existed) by X-ray method. Also in detailed investigations with MIP-MPR method, it was determined that only predorsal, spines and rays were not deformed but also lacks of all distal and proximal pterygiophores were assigned. On the other hand, all the other skeletal components were defined normal such as vertebral column and caudal fin.

As reported by several researchers, saddleback syndrome was characterized by an abnormality of the dorsal-ventral profile, which was linked up the lack of only one to even all of the dorsal spines, rays and pterygiophores (Koumoundouros *et al*., 2001; Boglione *et al*., 2001; Sfakianakis *et al*., 2003). It has also been reported in many fish species, under different culture (Koumoundouros *et al*., 2001) or natural environmental conditions (Browder *et al*., 1993). Although, several abnormalities and deformations have been indicated at the larval and juvenile stage of *S. aurata* (Koumoundouros *et al*., 1997; Boglione *et al*., 2001), but no study has been carried out about SBS in this species under culture conditions.

In the current study, it was not detected dorsal distal radials, spines, rays and pterygiophores in SBS fish. Also, several researchers reported that SBS affected the body shape of the fish, as shown by thin-plate spline leading to

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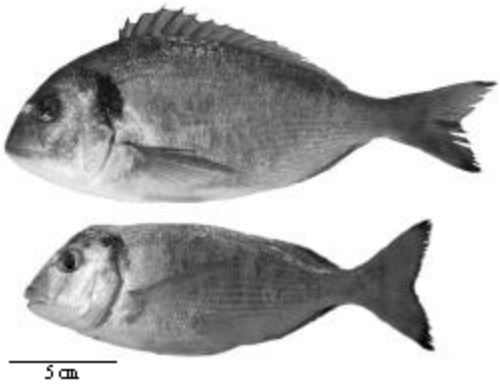

Fig. 1: The appearance of normal and SBS syndrome in *S. aurata*. Scale bar is 5 cm

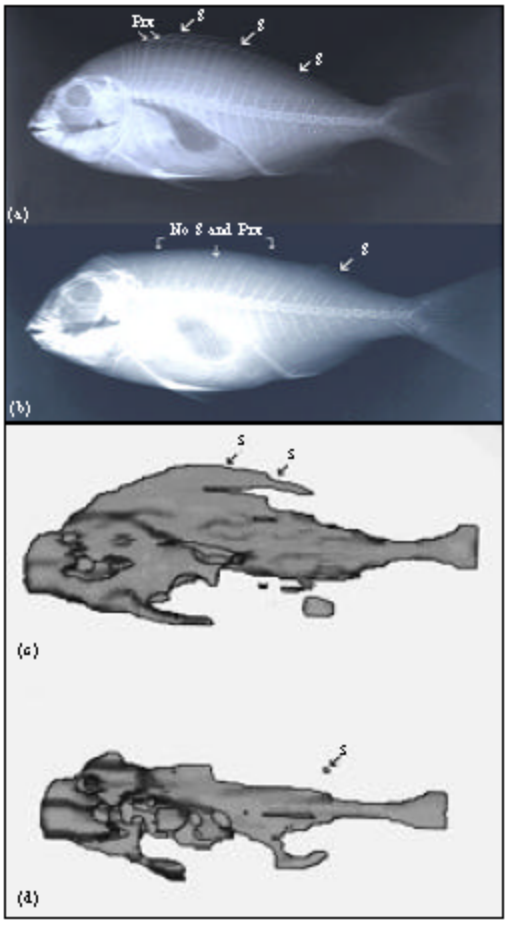

Fig. 2: a and b) Contrasting of normal and SBS fish images by X-ray and c and d) high resolution MIP-MPR. S: Spine; Prx: Proximal pterygiophore

the shallowest mid-body and narrowest anterior part than others (Nagano *et al*., 2007). These observations were shown parallel with these results. In this study, it was more clearly observed that predorsal and proximal pterygiophores were not formed. Especially in results of MIP-MPR method, it was more clearly observed that predorsal and proximal pterygiophores were not formed. Additionally, it could be possibly determined SBS syndrome in fish in 3 dimensions.

Moreover, the reason of low percentage of this syndrome might be selection and/or sorting of deformed juvenile fish were performed repeatedly using different methods before stocking in cages. On the other hand, according to Kocour *et al*. (2006), Murakami *et al*. (2004) and Setiadi *et al*. (2006) results, fin deformities might be negatively affected survival, growth and weight development. As described by Paperna (1978) and Andrades *et al*. (1996), it was indicated that deformed fish could be showed lower growth than normal fish. In similar, it is found that SBS fish were presented relatively lower growth rate in cage conditions in this study. It is well documented that several physiological, environmental and nutritional factors have been concerned with deformation problem during larval and juvenile development stages of cultured freshwater and marine fish. These factors include especially phosphorus and other micronutrient (vitamin A, C and D) deficiencies, stress infectious diseases, physicochemical conditions, mechanical lesions during larval stage and high temperature and water quality during egg incubation (Divanach *et al*., 1996; Lall and Lewis-McCrea, 2007).

As described by Sfakianakis *et al*. (2003), under certain nutritional inadequacy, between proximal pterygiophore-neural process and adjacent tendons-muscles could be occurred skeletal deformities. Furthermore, Koumondouros *et al*. (2001) reported that saddleback syndrome in *Dentex dentex* could cause by environmental stress (quality in larval food and feeding conditions). As well reported by several studies, we thought that SBS observed fish could be exposed by nutritional imbalances including vitamins deficiency or excess such as vitamins C and A in especially their early developmental stages (Afonso *et al*., 2000; Setiadi *et al*., 2006). Also, it is considered that abiotical and environmental conditions of cages could not be the reason of SBS formation, as all of these parameters were measured continuously for other attending studies and they did not change suddenly in this area.

It is well known that variation in female fish may affect genetic variations such as egg size and quality and it is important to upward effecting heritability. As described by Kirpichnikov (1981) and Kocour *et al*. (2006), it was supported that several fin abnormalities could be based on genetics in fish. Also, skeletal abnormalities can also be caused by genetic factors such as mutations, hybridization or inbreeding (Sadler *et al*., 2001). The present study firstly illustrates of saddleback syndrome in gilthead sea bream under cage culture

conditions with X-ray and MIP-MPR method as a new approach to determine the skeletal and fin deformities. In this case, further studies should be focused that what the really causative factors (in respect to nutritional and/or genetic) of SBS and what the critical role of abiotical factors about this syndrome from larval stage until cage conditions.

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