Journal of the Association of Arab Universities for Basic and Applied Sciences (2016) **20**, 1–7

University of Bahrain

Journal of the Association of Arab Universities for Basic and Applied Sciences

www.elsevier.com/locate/jaaubas
www.sciencedirect.com

ORIGINAL ARTICLE

Aspects on respiratory physiology of cultured Sea bream, *Sparidentex hasta* (Valenciennes 1830), Kingdom of Bahrain

Khadija Zainal

Department of Biology, College of Science, University of Bahrain, P.O. Box 32038, Kingdom of Bahrain

Received 17 November 2014; revised 22 May 2015; accepted 1 June 2015
Available online 29 June 2015

KEYWORDS

Respiration;
Bahrain;
Sobaity;
Sea bream;
Aquaculture;
Sublethal oxygen

Abstract Cultured fish Sea bream, *Sparidentex hasta* collected from the National Mariculture Center (NaMaC) at Ras Hayan in the Kingdom of Bahrain, were subjected to extreme low dissolved oxygen concentrations under controlled experimental conditions for 24 h and continued up to three consecutive days. The metabolic rate as represented by oxygen consumption rate (mg/l/g/h), was measured using intermittent computerised respirometry system. The fish responded in general, by irregular and low metabolism. Elevated ventilation in gills was observed in order to intake more oxygen from surrounding water. An increase in oxygen consumption rate was recorded at different stress levels including initial handling and movements as well as at the onset of hypoxia. Similar findings were obtained for the level at which fish mortality attained 100% representing lethal points.

The fish regulatory ability to withstand declining oxygen concentration in the water was limited. A typical steep straight line relationship was found between oxygen consumption rate and oxygen concentration indicating a non regulatory ability and extreme in-tolerance to hypoxia. Therefore, the fish is considered as oxy-conformer, i.e., unable to continue metabolism at anaerobic condition. Correlation between minimum (basic) oxygen consumption rate and body weight was of non-linear form. The present study provides comparative data to base on for further prospective related studies on juvenile Sea bream and other fish species.

1. Introduction

Sparid fishes are widely distributed and commercially significant for both fisheries and aquaculture industry around the world (Pavlidis and Constantinos, 2011). This group inhabit tropical and temperate coastal waters (Bauchot and Smith, 1984). Sea bream, *Sparidentex hasta* (locally known as Sobaity) has been reported as the only species in the genus *Sparidentex* by FAO-FishStatPlus (2008), however, a new sparid species *Sparidentex jamalensis* has been recently recorded from mangrove swamps in Pakistan (Siddiqui and Rafaqat, 2014). *S. hasta* is a native species to the Arabian Gulf waters within Bahraini, Kuwaiti, Saudi Arabia, Omani and Qatari waters. It is known as Sobaity Sea bream or Silvery Sea bream. It is also widely distributed along the western Indian Ocean and

E-mail address: Kzainal@uob.edu.bh
Peer review under responsibility of University of Bahrain.

http://dx.doi.org/10.1016/j.jaubas.2015.06.001

coasts of India (Bauchot and Smith, 1984). In addition, according to the FAO-FishStat Plus (2008), the worldwide production of the sparidae fish was 693,732 metric tons in 2006. Approximately, 35% of that contribution was produced by aquaculture. *S. hasta* is a pelagic fish. It was selected in the National Mariculture Centre to enhance local fish stock and fisheries in the Arabian Gulf as well.

Sea bream has been successfully cultured at NaMaC in the Kingdom of Bahrain. The fish is maintained in well aerated tanks and fed three times to satiation or at 3% of their body weight (NaMaC information leaflet). Eggs are provided with adequate aerations and sterile re-circulating sea water connected to sand filtering system. Larvae are fed on live food organisms by gradually weaning from the artificial diet. Following 40 days, larvae are transported to incubation tanks where they can be harvested at regular intervals. During this time, the fingerlings (2–4 cm total length) are separated according to their sizes and are either exported, released into the sea or left to grow. The adults from these batches were used in the present experimental studies.

Tharwat and Al-Gaber (2006), reported an average length of 30 + 2.3 cm; average weight of 190 + 4 g, and a minimum size at sexual maturity of about 24 cm for *S. hasta* in the natural waters of the Arabian Gulf. A maximum total length of 50 cm has also been recorded by Randall (1995), however, *S. hasta* and other sparid fishes may grow up to 75 cm (Karam, 2011).

The metabolic requirements of cultured species are important at all stages of fish life cycle in order to maximise the optimum conditions for growth (Nerici et al., 2012). The metabolic rate represented as oxygen consumption rate for investigated species will provide information concerning the development of an oxygen management strategy under farming conditions.

The present study is the first initiation experimental study on *S. hasta* metabolic rates as represented by oxygen consumption rates at normal levels of oxygen availability (active, routine and resting), as well as under stress conditions (hypoxia and anoxia). The present study aimed to determine the oxygen requirements of the adult individuals of *S. hasta* and to verify tolerance under limited oxygen conditions.

2. Materials and methods

Twenty four Sea bream fishes were obtained from the Mariculture centre at Ras Hayan-Bahrain during 2009 and 2013. At the centre, the adult fishes were kept in tanks under controlled conditions with temperature ranging between 15 and 32 °C and oxygen concentration of about 5–6 mg l^{-1}. These fishes were originated from brood-stock eggs, spawned in captivity as mentioned above.

At the Department of Biology laboratory in the University of Bahrain, fish individuals were maintained in well aerated re-circulated sterile artificial seawater at fixed room temperature of 20 °C and salinity of around 40–45‰. The photoperiod system was adjusted using an automatic timer set at 12:12 light and dark times respectively. Fishes were fed on commercial feed obtained from the Mariculture centre except one day prior to the experimentation. The water level in the aquarium was regulated manually.

The volume of the respiratory chambers and tubing was reduced to the minimum in order to achieve a gradual reduction in oxygen concentration during the measurement phase. Fish individuals collected during 2009 were weighing between 7.57 and 70.9 g., with total length between 74 and 165 mm. The fish individuals collected during 2013 were slightly larger with weight range (36.5–97.6 g) and total length of 13.5–180 mm. Fish gender was determined by dissection at the end of each experiment.

2.1. Respirometry arrangement and data analysis

Initially, the experimental fish were allowed at least one day to acclimatise in the respirometer and were unfed at least for 24 h prior to the experiment to avoid effects of the specific dynamic action (Atsunobu and Toshiomi, 1973; Jobling, 1981).

The experimental set up was based on a computerised intermittent flow through system (Forstner, 1983; Steffensen et al., 1984; Steffensen, 1989; Kaufman et al., 1989). Fig. 1a shows a photograph and Fig. 1b a diagram of the respirometry setup used in the present study. Different sizes chambers were used to accommodate different sizes of fish (male and females). The ratio of fish volume to the chamber volume was adjusted so that the reduction in the dissolved oxygen is not too fast (Steffensen, 1989). The chamber was placed in a larger reservoir water tank at the ambient oxygen level, salinity and temperature. The oxygen electrode incubated in a holder was also submerged in the tank. The tank and all the tubing were cleaned on a weekly basis or as soon as the experiment was ended. The chamber was moved from side to side to get rid of any air bubbles before recording.

A total of 77 experiments were conducted and were continued up to a minimum of 24 h and a maximum of three days. Out of the total, 34 experiments were run under controlled normoxic conditions (normal ambient oxygen concentration) whereas, 43 experiments were run under hypoxic condition (progressively reducing ambient oxygen concentrations). If a fish survived at first exposure, it was exposed again to the hypoxic condition (extremely low oxygen concentration but not to a total lack of oxygen). Anoxic exposure (i.e., total lack of oxygen) experiments were also conducted in order to investigate survival rate at the extreme condition. Fully recovered individuals were returned to the maintenance tank. If they showed a sign of recovery after 2–5 weeks, they were examined once more in normoxia and hypoxia series of experiments as required otherwise, they were discarded.

The oxygen consumption per unit time was determined for each fish individual at normoxia (active and resting), stressed (hypoxic) and back to normal (recovered). Each experiment lasted for a maximum of 4–5 days provided that the fish behaviour was considered relaxed. At the end of each run, the experimental fish was weighed; total length was measured and moved back into well aerated maintenance aquarium tanks, fed and observed for survival.

Normoxia measurement of the oxygen consumption rate during the closed phase was continued until the oxygen concentration was dropped from 100% to around 80–90%. The treating period of 15 min was followed by a flushing period of another 15 min. These recordings were continued over night and up to three days during which, the oxygen level was not allowed to drop below 80% level. The experiments were stopped once the oxygen consumption declined to a low rate that was stable for at least 12 h indicating the best possible recordings of the basic level (resting).