Haematological Parameters and Respiratory Function in Diploid and Triploid Far Eastern Catfish, *Silurus asotus*

Dong-Won Seol¹, Soo-Yeon Im¹, Woo June Hur¹, Min Ouk Park¹, Dong Soo Kim², Jae-Yoon Jo² and In-Seok Park¹

¹Division of Marine Environment and Bioscience, Korea Maritime University, Busan 606-791, Korea
²Department of Aquaculture, Pukyong National University, Busan 608-737, Korea

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ABSTRACT

Haematological features pertaining to aerobic capability were compared between diploid and triploid specimens of the Far Eastern catfish, *Silurus asotus*. No significant differences between diploids and triploids were found for the haematocrit value, total haemoglobin, and mean corpuscular haemoglobin concentration, while the mean corpuscular volume, mean corpuscular haemoglobin, and plasma glucose concentration were significantly higher in triploids than in diploids, and the number of red blood cells was significantly lower in triploids than in diploids. The oxygen consumption rate did not differ significantly between diploid and triploid fish (*P > 0.05*). Nevertheless, the respiratory frequency was higher in triploids than in diploids (*P < 0.05*). Triploids were characterized by a lower concentration of circulating blood cells, and aquaculture practice should consider the need for a lower surface to volume ratio.

Key words: diploid, triploid, haematological parameter, respiratory function, *Silurus asotus*.

INTRODUCTION

The induction of triploidy has been achieved in a number of different freshwater and marine fish species (Thorgaard, 1983; Benfey, 1989; Ihssen et al., 1990; Felip et al., 2001). The main benefit of triploidy is sterility condition. Sterility allows organism to avoid the metabolic costs of sexual maturation, result in continued somatic growth in triploid fish, with maintenance of flesh quality during the period when diploids sexually mature. In addition, sterility prevents fish mortality related to spawning (Utter et al., 1983; Ihssen et al., 1990; Mair, 1993; Benfey, 1999). Because of these advantages, the induction and rearing of triploid fish have been practiced in the aquaculture of several economically relevant species (Hulata, 2001). Furthermore, sterile triploid fish are unable to breed and contribute to the local gene pool if they escape from the confinement. By conferring in the desired introduction of exotic fish species for a limited purpose, triploidy can serve as an effective method by which to reduce or eliminate the environmental risks of genetically modified organisms (Kim et al., 1994; Dunham and Devlin, 1999).

Numerous studies have demonstrated that erythrocyte
cellular and nuclear dimensions are increased, and number of erythrocytes are decreased in triploids (Benfey, 1999). Therefore, it is easy to distinguish between diploid and triploid fish by assessing the size and number of erythrocytes, which are reduced in triploidy in proportion to the erythrocyte size (Benfey and Sutterlin, 1984; Benfey, 1999). In sweetfish, *Plecoglossus altivelis*, triploid specimens had larger erythrocytes and lower erythrocytes number than diploid specimens, and also showed higher hematological parameters (mean corpuscular volume and mean content of haemoglobin) and oxygen consumption was higher triploid than diploid (Aliah et al., 1991).

An important consequence of increased nuclear and/or cellular volume in triploid fish is the resulting decrease in the ratio of surface area to volume. This could affect processes limited by surface area, such as nutrient and metabolite exchange, passive and active ion exchange, and membrane binding of hormones and other messengers. Due to decreased cell numbers, this decrease in the ratio of surface to volume also applies to whole tissues and organs as well (Benfey, 1999). A second important consequence of increased nuclear and/or cellular volume is that, depending on the shape of the cell and its nucleus, the internal transport and diffusion distance may be increased. This could affect processes such as signal transduction from the cell surface to the nucleus, and resultant production and movement of RNA and proteins within and outside of the nucleus and cell (Benfey, 1999). Some of these potential disadvantages of triploid cells may be offset by the energetic advantages arising from reduced production and maintenance of cellular membranes and from the smaller relative surface area across which ionic and osmotic gradients must be maintained (Benfey, 1999).

The Far Eastern catfish, *Silurus asotus* (Linnaeus) (order Siluriformes, family Siluridae), distributing widely throughout the Northeast Asia, is an important species in Korean freshwater aquaculture (Im et al., 2001; Kim et al., 2001). However, there are two major limitations in culturing of this species. Firstly, there is a sex-related dimorphism in the growth rate, i.e. the females grow much faster than males (Kim et al., 2001). The sex-related size difference leads to difficulty in effective stock management and also frequently results in severe cannibalism in farms during the early stages of life. Secondly, the precocious maturation prior to the fish reaching marketable size necessitates an extended cultivation period beyond sexual maturity. Upon attaining sexual maturity, these fish begin to experience reduced growth and decreased feed efficiency (Choi et al., 1992). Therefore, the induction of triploidy offers fast-growth and an added value due to the increased production of large-sized Far Eastern catfish.

Therefore, the purpose of the present study was to investigate the haematological characteristics in relation to the efficiency of metabolism-related growth and respiratory function in the transport of oxygen by erythrocytes to tissue in triploid and diploid Far Eastern catfish.

**MATERIALS AND METHODS**

**Animals**

Triploid induction of Far Eastern catfish, *Silurus asotus*, was carried out according to the method of Kim et al. (2001). Mature females were induced to spawn using a single intraperitoneal (IP) injection of 1,000 IU of human chorionic gonadotropin (hCG, Sigma, USA) per kg body weight (BW). Sperm were also obtained by scissoring the surgically removed testes of males that had been given an IP injection of hCG at 500 IU/kgBW. Eggs were fertilized with sperm diluted in saline using the wet method. Five minutes after fertilization, they were rapidly rinsed to remove excess sperm and were immediately submitted to a cold-shock treatment (4°C) for 60 min to prevent the extrusion of the second polar body. Untreated fertilized eggs were used as diploid controls.

Diploid and triploid of the Far Eastern catfish were cultivated by the method of Choi and Kim (1996). Diploid and triploid fish were reared in 45 ℓ tanks, under the same hydrological conditions. Water temperature was maintained at 24 ± 1.5°C and the mean water oxygen concentration was kept close to saturation level (mean: 9.4 ± 0.3 mg/ℓ). Fish were periodically sampled and their ploidy was determined by flow-cytometric assessment of the nuclear DNA content in erythrocytes or fin cells (Colombo et al., 1995; Francescon et al., 2004). Specimens were used at 100 days post-hatching, and had an average body