Aquaculture 278 (2008) 171–174

Contents lists available at ScienceDirect

Aquaculture

journal homepage: www.elsevier.com/locate/aqua-online

Short communication

Larval rearing of barramundi (*Lates calcarifer*) in saline groundwater

G.J. Partridge [a,b,*], A.J. Lymbery [b], D.K. Bourke [a]

[a] *Aquaculture Development Unit, Challenger TAFE, Fremantle, Australia*
[b] *Fish Health Unit, Centre for Fish and Fisheries Research, Murdoch University, Murdoch, Australia*

ARTICLE INFO

Article history:
Received 6 September 2007
Received in revised form 6 March 2008
Accepted 13 March 2008

Keywords:
Barramundi
Lates calcarifer
Larval rearing
Inland saline groundwater
Potassium deficiency

ABSTRACT

Barramundi (*Lates calcarifer*) larvae were reared from 2 to 25 days post hatch in 14‰ saline groundwater with either no potassium supplementation (38% K-equivalence) or full potassium supplementation (100% K-equivalence). Growth, survival and swimbladder inflation of these larvae were compared against those grown in control treatments of seawater (32‰) and seawater diluted to 14‰. Those reared in saline groundwater with 38% K-equivalence exhibited complete mortality within 2 days, while those held in groundwater with full supplementation survived at a rate equal to both control treatments (pooled average 51.1 ± 0.5%). At 25 days post hatch, there was no significant difference in larval length or dry weight between those grown in the 14‰ control treatment and those in the saline groundwater with full potassium supplementation. There were no significant differences in swim bladder inflation between any of the surviving treatments (average 93.3 ± 2.5%). This is the first description of rearing barramundi larvae both in low salinity seawater and in saline groundwater and demonstrates that the requirement for potassium by larval barramundi is higher than for juveniles of the same species.

1. Introduction

The potential of saline ground water sources for culturing marine and estuarine finfish has received significant interest in Australia in recent years (Allan et al., 2001; Ingram et al., 2002; Doupé et al., 2003; Partridge et al., 2008). This interest has primarily stemmed from a desire to make productive use of the approximately 5.8 million hectares of agricultural land degraded through secondary salinisation (NLWRA, 2001).

Barramundi (*Lates calcarifer*) is an ideal aquaculture candidate due to its high regard and rapid growth, and has been cultured successfully in Australia since the 1980s (MacKinnon, 1989). Its ability to tolerate salinities from freshwater (Rasmussen, 1991) to at least 55‰ (Shirgur and Siddiqui, 1998), also makes it a worthy candidate for culture in inland saline water, where salinity varies both locally and regionally (Mazor and George, 1992). The ability to ongrow barramundi in such water sources has been demonstrated with successful pilot-scale production (Partridge et al., 2006).

In addition to ongrowing, inland saline groundwater has potential for hatchery production of barramundi and other candidate species such as mulloway (Doroudi et al., 2006). Barramundi are currently produced exclusively in coastal hatcheries using seawater; however, production in saline groundwater has several potential advantages. Local hatchery production would reduce transport costs, and/or allow vertical integration of inland saline farms. Inland saline areas have an abundance of cheaper, less environmentally sensitive land with fewer competing interests than coastal land (Doupé et al., 1999) and isolation of inland hatcheries from pathogens and parasites found naturally in coastal water could facilitate the production of disease-free certified stock (Allan et al., 2001; Partridge et al., 2008).

The deficiency of potassium in inland saline groundwater restricts its use for mariculture (Forsberg et al., 1996; Fielder et al., 2001; Shakeeb-Ur-Rahman et al., 2005). The effects of this deficiency on juvenile barramundi have been described (Partridge and Creeper, 2004; Jain et al., 2006; Partridge and Lymbery, 2008), however, the effect on larvae is unknown. This paper describes the production of barramundi larvae in potassium-deficient groundwater with a salinity of 14‰. Larval survival, growth and swimbladder inflation were measured in this groundwater source with and without potassium supplementation and compared against control treatments of seawater (32‰) and seawater diluted to 14‰.

2. Materials and methods

Saline groundwater was obtained from a bore in Northam, Western Australia (31°39′S, 116°40′E), approximately 100 km from the coast, and trucked to the Aquaculture Development Unit's (ADU) marine hatchery facility in Fremantle. The concentrations of 24 ions found in seawater were measured in the groundwater using inductively coupled plasma atomic emission spectroscopy (Varian Vista AX CCD Simultaneous ICP-AES). The concentration of chloride ions was determined via flow injection analysis using a method modified from the APHA (2005). The potassium concentration of the water source was 38% of that found in seawater of equivalent salinity (i.e.

* Corresponding author. Aquaculture Development Unit, Challenger TAFE, Fremantle, Australia. Tel.: +61 8 9239 8032; fax: +61 8 9239 8081.
E-mail address: gavin.partridge@challengertafe.wa.edu.au (G.J. Partridge).

0044-8486/$ – see front matter.
doi:10.1016/j.aquaculture.2008.03.023

Table 1
Ionic composition (mgL^{-1}) of saline groundwater (14‰), seawater diluted to 14‰ and the percentage difference in composition between the two

		Saline groundwater 14‰	Seawater 14‰	Groundwater as % of seawater
Major ions	Chloride	7800	7862	99%
	Sodium	3600	4504	80%
	Magnesium	630	539	117%
	Sulphur	230	378	61%
	Calcium	190	172	110%
	Potassium	61	159	38%
	Strontium	2.8	33.5	8%
	Boron	0.98	1.86	53%
Minor ions	Molybdenum	0.012	0.004	287%
	Zinc	<0.002	0.002	–
	Arsenic	<0.01	0.002	–
	Vanadium	<0.001	0.001	–
	Aluminium	<0.01	0.001	–
	Barium	0.056	0.001	6696%
	Iron	<0.002	0.0008	–
	Nickel	<0.004	0.001	–
	Copper	<0.001	0.0002	–
	Chromium	<0.001	0.0001	–
	Manganese	0.49	0.0001	585,870%
	Selenium	0.03	0.0001	35,870%
	Cadmium	<0.0006	0.00004	–
	Cobalt	0.002	0.00002	9565%
	Lead	<0.01	0.000	–
	Tin	<0.02	0.000004	–

38% K-equivalence) (Table 1). Of the other major ions, strontium, boron and sulphur were also deficient (Table 1) and sodium, magnesium and calcium were within 20% of equivalent salinity seawater.

Barramundi larvae were grown in four different water treatments: unsupplemented, 14‰ saline groundwater; saline groundwater with full potassium supplementation (100% K-equivalence of 14‰ seawater, 160 mgL^{-1}); undiluted seawater (32‰); and seawater diluted to 14‰. Potassium supplemented groundwater was prepared by the addition of potassium chloride. The ADU hatchery's seawater bore (32‰) was used for the two seawater control treatments, with that at 14‰ obtained by dilution with dechlorinated tap water. Each of the four treatments were tested with five replicates. All 180 L replicate tanks were held within a water bath maintained at 28°C. Photoperiod was maintained at 12L: 12D with a surface light intensity of 170 lux.

Barramundi larvae were stocked at mouth opening, i.e. at two days post hatch (2 DPH; 2.43±0.03 mm TL) at 20 larvae L^{-1} after a 4-h acclimation period from seawater. The flow-through larviculture tanks were supplied with treatment water stored in header tanks at the rate of 150 mL min^{-1}. *Chlorella* (Super-fresh V12, Pacific Trading Co, Japan) was maintained at 500,000 cells mL^{-1} in each tank for the first 18 days. Rotifers enriched with Rotiselco–ALG (INVE, Belgium) were fed twice daily (0830 and 1500) at 10 rotifers mL^{-1} between 2 and 5 DPH, 20 mL^{-1} between 6 and 13 DPH and 10 mL^{-1} between 14 and 18 DPH. *Artemia* metanauplii enriched with DHA SuperSelco (INVE, Belgium) were fed to larvae four times daily (0830, 1100, 1300 and 1530) at 10 mL^{-1} day^{-1} between 13 and 19 DPH, decreasing by 1 mL^{-1} day^{-1} thereafter. Weaning (Gemma Micro 300, Skretting, Australia) commenced on 16 DPH at the feeding rate of 1 g 1000 $larvae^{-1}$ day^{-1}, increasing daily by 0.5 g 1000 $larvae^{-1}$.

Subsamples of five larvae per tank were taken every 2 to 3 days. Total length (TL) was measured to 0.1 mm under a stereo microscope using a calibrated eye piece graticule and the presence or absence of an inflated swimbladder was recorded. At the completion of the trial on 25 DPH, all fish were counted, their TL measured, then dried for 24 h at 75 °C to determine their dry weight. Treatment means were compared with one way ANOVA and differences detected using Tukey's HSD test. Statements of significance refer to the 0.05 level.

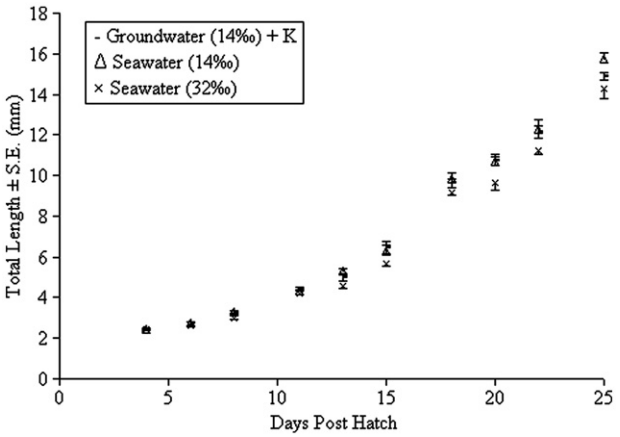

Fig. 1. Growth of larval barramundi in a potassium-supplemented, saline groundwater source (14‰), seawater (32‰) and seawater diluted to 14‰.

3. Results and discussion

Barramundi larvae died within 2 days in unsupplemented saline groundwater. At the end of the trial, survival rates in the remaining three treatments were 46.2±7.2% (14‰ seawater), 52.0±1.6% (supplemented groundwater) and 55.0±3.7% (32‰ seawater), with no significant differences between these treatments. This rate of survival is similar to that obtained in commercial barramundi hatcheries (Bosmans et al., 2004).

The tolerance of marine fish larvae to salinities less than seawater is species specific. Fielder et al. (2005), for example, achieved 7% survival of snapper (*Pagrus auratus*) larvae reared in 15‰ seawater, compared to approximately 25% for those reared within the optimum salinity range of 20 to 35‰. Australian bass (*Macquaria novemaculeata*), on the other hand, exhibits no significant difference in survival when reared at 10 or 30‰ (Battaglene and Talbot, 1990).

The growth of larvae in the three surviving treatments is shown in Fig. 1. At every sampling point from 4 DPH, the total length of larvae in the seawater control (32‰) was less than those grown in the other two treatments. At the end of the trial, the length of those larvae grown in full-strength seawater (14.3±0.5 mm) was significantly less (P=0.042) than those grown in 14‰ seawater (15.7±0.3 mm) (Fig. 2). A similar pattern of larval dry weight was seen between treatments at 25 DPH, with those grown at 32‰ (6.4±0.5 mg) being smaller than those cultured in both seawater at 14‰ (8.9±1.1 mg) and potassium

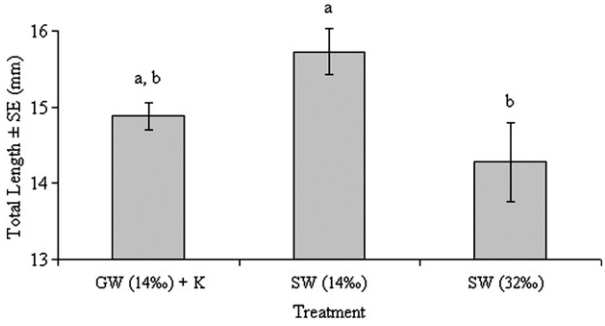

Fig. 2. Final total length (mm±SE) of barramundi larvae at 25 DPH. Those columns sharing the same letter are not significantly different (P>0.05). GW=groundwater. SW=seawater.