Predicting the production of waste products in the high density culture of sharptooth catfish *(Clarias gariepinus)*

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Abstract

The production of waste products by the sharptooth catfish (Clarias *gariepinus)* was measured under high density controlled laboratory conditions. The waste products that were investigated were ammonia nitrogen, nitrite nitrogen. nitrate nitrogen and suspended solids. A flow-through system with a 360l tank was used to keep 67 cattish (average mass = 550 g). Water temperature was kept constant at 24"C. The system was, subjected to a continuous light cycle, and the Feeding level was 20 g-kg-1 d-'. Water samples were taken at regular intervals throughout the feeding cycle and analysed for the above-mentioned metabolic wastes. The measured concentrations were transformed mathematically into metabolic waste production per unit biomass. The resulting data compare favourably with similar data for other species published elsewhere. It was found, however, that the production was somewhat prolonged. The size distribution of the suspended solids (SS) was investigated to facilitate easier removal of this metabolic waste from systems. The results were that *52'%* of the SS did not pass a 300 um sieve while 17% passed through a 100 um sieve. The balance of the SS fell between these two sizes. This investigation also showed that there were two types of SS that had to bo removed: the first type had a fine granular appearance while the second was mucoid. No attempt was made to differentiate between these two types during this investigation. A model calculation illustrates the prediction of the accumulation of wastes in high-density aquaculture systems.

Introduction

The African sharptooth catfish *(Clarias gariepinus)* is an extremely suitable aquaculture species and is successfully cultured in many parts of the world. This species has a wide tolerance for various environmental conditions, is highly fecund and high yields (12.5 to 100 t-ha-'a-1) may be obtained under intensive conditions (Hecht et al., 1988). In South Africa, catfish is raised in eathern ponds with slow water exchange rates. However, the country lies in a semi-arid region in which rainfall and water bodies are unevenly distributed. Expanding demand due to rapid population increase and demographic changes will result in water becoming increasingly scarce in many parts of South Africa. Greater pollution loads and reduced flows in the country's rivers due to expanding demand, will in future place additional pressure on the already limited water resources (DWAF, 1993). In future we will have to depend to a larger extent on the recycling of water for aquacultural purposes and treatment of water from flow-through systems to comply with the effluent standards of Department of Water Affairs and Forestry. High density culture of *Clarias gariepinus* combined with the required high feeding rates may lead to severe water quality problems in high density aquaculture systems. Critical water quality variables in recirculation high-density aquaculture systems are usually low dissolved oxygen and waste products such as suspended solids (SS), ammonia and nitrite. Under such conditions it is therefore essential to manage water quality to ensure optimal survival and production of the species. If waste production levels (per biomass production unit) are known, it is possible to predict the accumulation rates of the metabolic wastes for this species in a high-density aquaculture system.

Although the feed consumed by fish is effectively assimilated, a measurable percentage (1 to 35 %) is excreted as faeces (Du Preez and Cockroft 1988). This assimilated food is then utilised for growth and reproduction while a significant portion is expended during the respiration process and excreted as urinary waste (Du Preez et al., 1990). The waste products in an effectively closed system, therefore, originate from the feed which is added to the system. Furthermore, the faeces produced as well as the feed not consumed by the fish are the major SS constituents in the high-density system.

The toxicity of the ammonia depends largely on the concentration of un-ionised ammonia (Heath, 1987). The ammonium ion is generally non-toxic to fish while un-ionised ammonia is highly toxic. Futhermore some of the ammonia may serve as substrate for the production of nitrite which is also highly toxic (Boyd, 1982). High un-ionised ammonia levels in the water affect osmoregulation of cultured fish and reduce internal iron concentrations. Ammonia may also damage gills, reduce the oxygen transport ability of the blood and the oxygen consumption rates of tissues, while sublethal concentrations may cause histopathological changes in many tissues (Boyd, 1982).

The toxic effects of nitrite are damage to gill tissue and impairment of oxygen transport. If nitrite is absorbed by fish, it reacts with haemoglobin to form methaemoglobin which is not an effective oxygen carrier. The continued absorption of nitrite can therefore lead to tissue hypoxia and cyanosis (Boyd, 1982). High SS levels may also affect the health of the fish. The gills of fish become thickened and proliferated when subjected to high SS levels. Under severe conditions this can be lethal (Alabaster and Lloyd, 1980).

The production of wastes by *Clarias gariepinus* under high density loading conditions had, as far as could be determined, not been measured systematically. Hogendoornetal. (1983), however, studied the food utilisation efficiency of *Clarias* and using this, Bovendeur et al. (1987) concluded that when uneaten feed was

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