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RECIRCULATING AQUACULTURE SYSTEMS AS A SOURCE OF STEROIDS INTO THE ENVIROMENT?

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Fish produce and release numerous chemical substances into the water, including potentially bioactive hormones and their metabolites. In aquaculture several tons of fish are maintained at high stocking densities, which may make these systems a relevant source of steroid hormones into the environment. In addition, in RAS, water is re-used after mechanical and biological treatment and the effluent discharge can be 10-100 times lower as compared to flow-through systems. Therefore, the present study assessed the contribution of RAS as a source of steroid hormones into the environment.

Seven on-growing commercial RAS differing in the rearing species were sampled (Table 1). Water samples were analysed for cortisol, and the sex steroids testosterone, 11-ketotestosterone and 17,20(17,20) through radioimmunoassay analysis (RIA).

All four steroids measured in commercial RAS were detected. Cortisol was found to vary the most between RAS farms suggesting that stress levels are species-dependent. Sexual steroids concentrations were generally low, especially 17,20 which could be explained by the fact that fish sexual maturation is normally avoided in commercial on-growing farms. Overall, steroid excretion rates in RAS were lower than what would be expected based on flow-trough systems, which suggests that steroids are being removed in RAS. Two processes are likely occurring: adsorption on sludge (sedimentation unit) and biodegradation (biofilter). These findings suggest a minor contribution of RAS as a source of steroid hormones in the aquatic environment, which foster the environmental sustainability of these systems.

This research was supported by a grant provided by the Foundation for Science and Technology, Portugal (SFRH/BD/65673/2009).

Table 1. Calculated steroid excretion rates ($\mu\text{g}/\text{ton}/\text{d}$) for fish in RAS and Flow-through systems.

	Recirculating Aquaculture Systems						Flow-through Systems ¹		
	Sole	European eel	Turbot	Pike perch	African catfish	Nile tilapia	C. salmon/ S. trout	Rainbow trout	C. salmon/ S. trout
<i>Fish mass (ton)</i>	20	35	80	6	7	6	55	14	80
<i>Steroids ($\mu\text{g}/\text{ton}/\text{d}$)</i>									
Cortisol	745	47	17	34	11	3	-	-	-
Testosterone	15	31	8	4	12	3	-	170	350
11-ketotestosterone	26	14	3	2	6	1	-	-	-
17,20 β -P	9	4	2	1	1	1	-	-	-

¹ Kolodziej *et al.*, 2004. Dairy Wastewater, Aquaculture, and Spawning Fish as Sources of Steroid Hormones in the Aquatic Environment. Environ. Sci. Technol. 38, 6377-6384.

² Chinook salmon/Steelhead trout