DOCTORAL THESIS

Reclamation of wastewater for polyculture of freshwater fish

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Reclamation of Wastewater for Polyculture of Freshwater Fish

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ABSTRACT

The main objective of the present study is to investigate the feasibility of reclaiming wastewater in ponds for polyculture of the freshwater fish. A series of eight ponds (Au Tau pond system) were constructed at Au Tau Fisheries Office, Hong Kong Agriculture and Fisheries Department. Water was pre-treated in the first four ponds (S1~A2) by providing sedimentation and aeration, the effluent from A2 was introduced into the remaining four ponds (C1~C4) for fish culture. Fries of six species of freshwater fish including silver carp (*Hypophthalmichthys molitrix*), big head (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idellus*), tilapia (*Oreochromis mossambicus* × *O. niloticus*), common carp (*Cyprinus carpio*) and black bass (*Micropterus salmoides*), were stocked in the ponds (C1~C4) during November, 1993~February, 1994. During fish culture period, 1/4 of normal fish feed (peanut cake) were used in the fish ponds.

The results of monitoring of the pond water physico-chemical and microbiological qualities showed that the removal of Biochemical oxygen demand (BOD), total ammonia-nitrogen (total ammonia-N) and ortho-phosphate (ortho-P) in ponds (S2~C4) was satisfactory with the average removal efficiencies of 73.5%, 93.4% and 82.7% respectively, while more than 99% of pathogen indicators (total coliform, fecal coliform and *E. coli*) were removed. The removal efficiencies of ammonia-N and ortho-P in ponds S2~A2 varied with climate: ammonia-N removal was positively correlated ($p<0.05$) with air temperature while ortho-P was negatively correlated ($p<0.05$) with rainfall, and the activity of algae and bacteria in ponds seemed to play an important role in ammonia-N and ortho-P removal. Up to 97% total coliform, 95% fecal coliform and 95% *E. coli* were removed in S2 (the 2nd sedimentation pond). In S2, the concentrations of the coliform bacteria correlated with ($p<0.05$) the concentrations of dissolved oxygen (DO), BOD, total ammonia-N and ortho-P, while the removal efficiencies of fecal coliform and *E. coli* were positively correlated ($p<0.05$) with solar radiation. Algae seemed to play an important role in coliform bacteria removal.

The results of monitoring of fish growth performance in ponds (C1~C4) were satisfactory. All fish (except grass carp) grew to marketable size within nineteen months. In addition to the supplied fish feed, fish also fed on the natural food developed in the ponds, and the fish specific growth rates (except black bass) were positively ($p<0.05$) correlated to the concentrations of organic matter and nutrient in water which suggested that organic matter and nutrient in ponds affected fish growth through the food web in ponds. The N conversion to fish flesh from fish feed was 10.3% which was in the range reported in other studies (5~25%). The total carbon contents in the sediments of fish ponds did not change significantly ($p<0.05$), but the significant increase of N ($p<0.05$) seemed to derive from the input of fish feed and N fixation.

The six species of fish cultured in ponds C1~C4 were safe for human consumption, according to the standards set by the International Commission on Microbiological Specifications for Foods (ICMSF) on bacterial contents in fish and the legislation set by Hong Kong Government on trace metal contents in fish. It was demonstrated that trace metal contents ($\mu g\ fish^{-1}$) in fish flesh were allometric. Chromium, Ni and Pb were undetectable in fish flesh, while Cu, Zn and Cd contents in fish flesh increased with the increase of body size (weight or length) ($p<0.05$ or $p<0.1$). Bioaccummulation of trace metals occurred in the organisms at the lower level of the foodweb, except for Cu concentration in mosquito fish.

The ammonia-N levels of the secondary effluents from Yuen Long and Shek Wu Hui sewage treatment plants were higher than the Environmental Protection Department (EPD) standard for the reuse of the effluents for fish culture, and the toxicity test using *Gambusia affinis* demonstrated that high ammonia concentration in water was the main reason for the fish death. The optimum algal growth occurred in 25% Yuen Long and 50% Shek Wu Hui sewage effluents, and the trace metal (Zn, Cd) and ammonia contents in water seemed to the main toxicants.

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