

**EFFECT OF CADMIUM ON EMBRYONIC AND
LARVAL DEVELOPMENT OF CLIMBING
PERCH, *Anabas testudineus* (Bloch 1792)**

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I WOULD LIKE TO DEDICATE THIS DISSERTATION TO
MY BELOVED FATHER ABDUL GHANI BIN AWANG AND
MOTHER ZAITON BINTI SULONG

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu
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Anabas testudineus (BLOCH, 1792)**

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School : Fisheries and Aquaculture Sciences

Early developmental stages of fish are particularly sensitive to many contaminants in water. For instance, heavy metals such as cadmium (Cd) affect many developmental processes in fish. The present study was undertaken to investigate the effect of cadmium exposure during embryogenesis and endogenous feeding stage of climbing perch. Our results show that 24-h LC₅₀ of cadmium for embryo and larvae were 0.931 µM and 45.68 µM, respectively. Embryos were later exposed to sublethal concentration of cadmium (0.3, 0.7, 1.0, 1.3, 1.6 and 2.0 µM) to determine the hatching success, time of hatching and type of physical malformations. Hatching success was significantly reduced ($p < 0.05$) in the treated group in dose dependent pattern where significant differences were found at 1.0 µM and higher compared with the control group. However, the time of hatching was not affected ($p > 0.05$). Malformations in embryos such as imbalanced of perivitelline space, less swelling, coagulated eggs, lack of tail, yolk sac oedema and undeveloped head and tail were observed at cadmium concentrations of 1.6 and 2.0 µM. Egg diameter, yolk diameter and perivitelline space area showed a significant difference between control and exposed groups ($p < 0.05$).

A significant reduction ($p < 0.05$) in the survival rate of the larvae after 24 h cadmium exposure was further observed at 52 and 104 μM of exposed groups. Larvae at both concentrations displayed gross morphological abnormalities (i.e. notochordal abnormality, C-shaped body, yolk sac oedema, malformations of the eyes). The total length, body length, yolk sac volume, eye diameter and mouth height measurements conducted at 0, 12, 24 h post hatching showed a significant decrease at dosage $\geq 16 \mu\text{M}$ ($p < 0.05$) in contrast to 0 h. Total protein content in the whole embryos in groups exposed to cadmium decreased as the cadmium concentrations increased where the differences reached a statistical significance in other stages as compared with morula stage and control ($p < 0.05$). In larvae exposed to cadmium, the total protein significantly decreased with the difference reached a statistical significance at 26, 52 and 104 μM ($p < 0.05$). These results indicated high sensitivity of climbing perch embryos to cadmium compared with the endogenous feeding stage. The adverse effects of cadmium possibly vary at different developmental stages of climbing perch.

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**KESAN KADMIUM KE ATAS PERINGKAT PERKEMBANGAN
EMBRIO DAN LARVA IKAN PUYU,
Anabas testudineus (BLOCH, 1792)**

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Tahap perkembangan ikan pada peringkat awal adalah sangat sensitif kepada bahan pencemar di dalam air. Sebagai contoh, logam berat seperti kadmium (Cd) memberi kesan kepada banyak proses perkembangan ikan. Kajian ini telah dijalankan untuk mengkaji kesan pendedahan kadmium semasa peringkat embriogenesis sehingga ke peringkat pemakanan endogenous bagi ikan puyu. Keputusan awal kajian menunjukkan bahawa LC_{50-24} jam bagi embrio dan larva ikan adalah $0.93 \mu\text{M}$ dan $45.68 \mu\text{M}$. Pendedahan embrio pada kepekatan submaut kadmium ($0.3, 0.7, 1.0, 1.3, 1.6$ and $2.0 \mu\text{M}$) akan menentukan keberjayaan penetasan, tempoh masa penetasan dan jenis kecacatan fizikal. Kadar keberjayaan penetasan berkurang dengan ketara ($p < 0.05$) pada kumpulan yang dirawat di mana terdapat perbezaan yang signifikan pada dos $1.0 \mu\text{M}$ dan lebih tinggi berbanding dengan kumpulan kawalan. Walau bagaimanapun, tempoh masa penetasan tidak terjejas ($p > 0.05$). Jenis kecacatan pada embrio yang diperhatikan adalah seperti ruang perivitelline yang tidak seimbang, kurang bengkak, telur menjadi keras, ekor memendek, pendarahan pada kantung yolka dan perkembangan kepala dan ekor yang tidak lengkap pada kepekatan kadmium 1.6 dan $2.0 \mu\text{M}$. Diameter telur, diameter kantung yolka dan ruang perivitelline menunjukkan perbezaan yang signifikan antara kumpulan kawalan dan kajian ($p < 0.05$).

Berlaku pengurangan yang signifikan ($p < 0.05$) kepada survival larva ikan selepas 24 jam didedahkan kepada kadmium pada kepekatan 52 dan 104 μM . Larva pada kepekatan ini turut mengalami keabnormalan morfologi (keabnormalan pada tulang, badan berbentuk C, pendarahan pada kantung yolka, kecacatan mata). Panjang keseluruhan, panjang badan, isipadu kantung yolka, diameter mata dan ukuran ketinggian mulut pada larva pada 0, 12, 24 jam selepas penetasan menunjukkan penurunan ketara pada dos $\geq 26 \mu\text{M}$ ($p < 0.05$) berbanding dengan 0 jam. Jumlah protein embrio pada kumpulan terdedah kepada kadmium menurun apabila kepekatan kadmium meningkat di mana wujud perbezaan min secara statistik dalam peringkat perkembangan lain berbanding dengan peringkat morula dan kumpulan kawalan ($p < 0.05$). Larva ikan yang terdedah pada kadmium, juga menunjukkan jumlah penurunan protein dengan ketara dengan dimana mencapai perbezaan statistik pada 26, 52 dan 104 μM ($p < 0.05$). Keputusan ini menunjukkan tahap sensitiviti yang lebih tinggi pada peringkat embrio ikan puyu terhadap kadmium berbanding dengan peringkat pemakanan endogenous. Kesan kadmium bertindak secara berbeza pada tahap perkembangan yang berbeza pada ikan puyu.