烏腳病盛行地區養殖魚貝類砷物種分析研究

The Study on Arsenic Species Analysis of Aquaculture Fish and Bivalve in Blackfoot Disease Hyperendemic Area

中文摘要

本研究利用實驗室現有砷物種實驗分析方法與儀器設備發展魚貝類萃取條件及大分子有機砷物種砷酸甜菜鹼（arsenobetaine）實驗分析方法。並探討台灣西南沿海烏腳病盛行地區養殖池水砷物種及魚貝類砷物種之相關性。烏腳病盛行地區嘉義縣布袋鎮、義竹鎮與台南縣北門鎮及學甲鎮四個地方爲採集魚類樣品地區。魚類樣本爲吳郭魚（mouthbreeder, Oreochromis mossambicus ）。養殖貝類主要採集牡蠣（oyster, Crassostrea gigas）及文蛤（hard clam, Meretrix lusoria），養殖文蛤主要以嘉義縣布袋鎮爲收樣地區，牡蠣樣本以安平、布袋、東港、香山、東石及王功等地點爲採集區域。除了魚貝類樣本外，另收集養殖池池水樣本。魚貝類樣品利用索式萃取法萃取砷物種後，以高效能液相層析儀連結氫化器與原子吸收光譜儀分析魚類樣品中三價砷（arsenite）、五價砷（arsenate）、單甲基砷酸（monomethylarsinic acid）及雙甲基砷酸（dimethylarsonic acid）含量。利用高效能液相層析儀連接裂解劑、紫外光、氫化器與原子吸收光譜儀分析魚貝類樣品中之砷酸甜菜鹼。24 %養殖池水樣本砷濃度高於飲用水標準，四個地區養殖池水無機砷含量以北門最高，布袋次之。單變項迴歸分析發現魚肉三價砷及總砷濃度隨著池水中無機砷濃度增高而增高，魚體愈大，從養殖池水中累積五價砷愈多。複迴歸模式分析發現，魚肉中三價砷量與池水無機砷濃度呈顯著正相關，魚肉中五價砷量與魚體大小呈顯著正相關。布袋地區牡蠣中三價砷濃度顯著高於安平。三類樣品中，吳郭魚砷酸甜菜鹼佔總砷百分比最高。牡蠣無機砷含量佔總砷百分比最低平均値爲 1.67 %。吳郭魚與文蛤都取樣自養殖池，但吳郭魚單甲基砷酸及雙甲基砷酸佔無機砷及代謝物濃度百分比高於文蛤，而吳郭魚三價砷佔無機砷及代謝物濃度百分比低於文蛤，表示吳郭魚代謝能力比文蛤佳。同樣是雙貝類，文蛤中三價砷佔無機砷及代謝物濃度百分比高於牡蠣，可能文蛤從養殖池水累積無機砷比牡蠣多。較低等動物無法將無機砷轉換，容易累積無機砷。

英文摘要

A study was carried out to develop the extraction method and determine arsenic species in the main varieties of aquaculture seafood in blackfoot disease hyperendemic areas. Besides, the relationship between arsenic species of aquaculture ponds and marine arsenic species was explored. Biota samples were extracted with methanol/water (1/1) by Soxhlet extraction apparatus. The extracts were evaporated to dryness by cold evaporator, dissolved again in water, and filtered through C18 column. The concentrations of Arsenite, arsenate, monomethylarsonic acid (MMA), and dimethylarsinic acid (DMA) of extracts were measured by high performance liquid chromatography linked to hydride generator and atomic absorption spectrometry (HPLC-HG-AAS). Moreover, arsenobetaine was analyzed by HPLC-ultra violet (UV)-HG-AAS. The concentrations of arsenic species were determined in 71 mouthbreeder (oreochromis mossambicus) and 26 hard clam (meretrix lusoria) samples that were aquacultured in Putai, Ichu, Peimen, and Hsuehchia areas. Oyster (Crassotrea gigas) samples were collected from Putai, Anping, Hsiangshan, Tungshih, Tungkang, and Wangkung areas. The concentrations of arsenic species in biota samples and aquaculture pond water were analyzed. There were twenty-four percentage of aquaculture ponds arsenic concentrations higher than the standard of Drinking Water Act. The arsenic concentrations of Putai and Peimen pond water were higher than those of Ichu and Hsuehchia. Total arsenic and inorganic arsenic levels of aquaculture fish were lower than oyster and hard clam. Arsenite concentration in fish was significantly correlated with inorganic arsenic concentration in pond water. Arsenate level in fish was significantly correlated with the body length, width and weight of fish. Comparing the arsenic species with oyster, fish and hard clam, the inorganic percentage of total arsenic in oyster was lowest, and arsenobetaine percentage of total arsenic in fish was highest. Arsenite concentration of oyster collected from Putai was higher than that from Anping. Although fish and hard clam were collected from aquaculture ponds, the percentage of MMA and DMA relative to the sum of arsenic and its metabolites in fish was higher than in hard clam. The percentage of arsenite relative to the sum of arsenic and its metabolites in fish was lower than in hard clam. These results suggested that arsenic metabolic capability of fish was better than that of hard clam. The percentage of arsenite in bivalve, such as hard clam and oyster, relative to the sum of arsenic and its metabolites in hard clam was higher than that in oyster. It suggested that arsenic concentration of hard clam cultured in aquaculture ponds was higher than oyster bred in ocean. The inferior marine animals accumulate inorganic arsenic easily because their metabolism capabilities are fairly low.