Abstract

There is a concern on the removal of ferminizing chemicals during the drinking water treatment processes. This study investigated the removal of seven estrogenic chemicals during the drinking-water-treatment (DWT) processes from seven plants in Taiwan between July 2007 and May 2008 using solid phase extraction (SPE) and ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS). The analytes were estrone (E_1), 17β-estradiol (E_2), estriol (E_3), 17α-ethynylestradiol (EE_2), bisphenol-A (BPA), 4-tert-octylphenol (OP) and 4-nonylphenol (NP). We found that geometric mean concentrations of steroid estrogen (E_1, E_2, EE_2 and E_3), BPA, OP and NP in raw water were 0.08–0.36 ng/L, 0.67 ng/L, 2.61 ng/L and 87 ng/L, respectively, which were higher than those in finish water, which were 0.05–0.33 ng/L, 0.23 ng/L, 1.31 ng/L and 69 ng/L, respectively. Besides, the detection rate of steroid estrogen, BPA, OP and NP in raw water were 0.0%–18.8%, 33.3%, 33.3% and 81.3%, respectively, which were higher than those in finished water, which were 0.0%–12.5%, 0%, 8.3% and 56.3 %, respectively. The observations revealed that drinking-water treatment processes could eliminate steroid estrogen, BPA and OP in low concentrations effectively, and decrease the levels of NP in raw water.

Mean concentrations of NP at each water treatment processes (raw water, sedimentation, rapid filtration and finished water) in spring were 307 ng/L, 294 ng/L, 208 ng/L, and 189 ng/L respectively, which were significantly higher than those in autumn 208 ng/L, 106 ng/L, 52 ng/L, and 58 ng/L, respectively and those in winter 189 ng/L, 59 ng/L, 62 ng/L, and 39 ng/L, respectively ($p < 0.05$). In addition, the elimination rate of NP after whole treatment processes in spring, summer, autumn and winter were 31%, 20 %, 45% and 61%, respectively.

According the absorption of these chemicals were 50% and 100% respectively, the estimated mean levels of estrogen equivalents (EQ) for 19–64 years old males were 2.31–2.32 ng/L and 4.61–5.76 ng/L, respectively, which were 1.5–21.6 fold lower than normal circulating plasma levels of E_2, which were 10–50 ng/L; Moreover, the estimated mean plasma levels of EQ for 19–64 years old females were 2.86–2.89 ng/L and 4.62–5.71 ng/L, respectively, which were 3.0–122.4 fold lower than normal circulating plasma levels of E_2, which were 20–350 ng/L, revealing the risk of consumption with drinking water were low.

Key words: estrogenic chemicals, drinking water treatment, solid–phase extraction, ultra-performance liquid chromatography-tandem mass spectrometry, 17β-estradiol, estrogen equivalents (EQ)