

How are steroid hormone transformation products metabolised in a natural wastewater treatment system? Identification through a “suspect screening” approach

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Objective

Only a small part of the growing number of contaminants of emerging concern (CECs) released into the environment is known to the scientific community and can be studied with current monitoring techniques. Steroid hormones, both of natural and synthetic origin, are included among the CECs due to their persistence and tendency to bioaccumulate. These compounds are introduced into wastewater treatment plants and undergo numerous transformations whose mechanisms are still unclear, leading to the formation of little-known transformation products (TPs). In this work, two hormones of natural origin – testosterone and cortisone – and one synthetic – levonorgestrel – were selected. The objective of this study is to identify the main TPs of these compounds along a natural wastewater treatment system combining wastewater ponds and constructed wetlands (CW), in order to assess their presence and potential removal.

Methods

Three sampling points (inlet, pond effluent and CW effluent) of a combined macrophyte pond- CW system in Tafira (Gran Canaria, Spain) were selected for the collection of water samples. A solid-phase extraction was conducted on the samples using a hormone-specific molecularly imprinted polymer, more selective than the traditional sorbent phases. The samples were then analysed with UHPLC-MS-QToF, and a ‘suspect-screening’ approach was adopted for the identification of TPs, based on the use of MS-DIAL software, accurate m/z ratios between precursor ions and fragments and their retention times.

Results

Taking testosterone, levonorgestrel and cortisone as starting compounds, numerous TPs were identified. In addition, it was verified that certain complex molecules were only present in the first steps of the wastewater treatment system: androst-1,4,9(11)-triene-3,17-dione and 3 α -5 β -tetrahydronorgestrel were only identified in the inlet, whereas boldione, boldenone and 5 α -dihydrolevonorgestrel were present in inlet and pond effluent. Smaller molecules such as 9,17-dioxo-1,2,3,4,10,19-hexanorandrostan-5-oic acid were only found in the effluent.

Conclusions

Numerous TPs of three important steroid hormones were identified showing how these compounds change within a wastewater treatment plant. It was also demonstrated how these contaminants are partially removed by a natural wastewater treatment systems, improving water quality at low cost and with easy maintenance.

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