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ASSESSMENT OF THE INFLUENCE OF PHARMACEUTICAL SUBSTANCES ON WATER BODIES AND CALCULATION OF THEIR CONCENTRATIONS ON THE EXAMPLE OF DICLOFENAC

Yermakovych I., *PhD*
Shevchenko K., *student*
National University of Civil Defence of Ukraine, Kharkiv, Ukraine

The entrance of pharmaceutical substances (PhS) into water bodies and their negative impact on the environment, including living organisms, has been proven by many research. The methods for identification these substances are very complicated and analytical equipment costs hundreds of thousands of hryvnias. Therefore, the development of a method for calculating PhS concentrations in surface and sewage waters as one of the tools for ecological monitoring is an extremely relevant task.

In the countries of the European Union, 3 pharmaceutical substances: diclofenac, 17-Beta-estradiol (E2) (estrone (E1)) and 17-Alpha-ethinylestradiol (EE2) are included in Decision 2015/495 / EC of the watch list content in natural waters [1].

Polluted sewage by PhS in a big city is generated by three types: the first - as a result of treating patients in a hospital (hospital); the second - in treating diseases, hospitalized patients who are assigned to certain outpatient departments and take drugs for a certain period of time (outpatient) and the thirdly - patients who are treated independently (at home). For calculation the annual mass of PhS entering into the treatment plant of the biological treatment complex "Dikanevka" (Kharkiv), the following formula was used:

$$M_{рік} = \left(K_в \cdot m_в + K_д \cdot m_д\right) \cdot n \cdot h \cdot \left(1 + \eta\right), \quad (1)$$

where $К_в$, $К_д$ – average annual number of patients in the study area among the population of adults and children; $m_в$, $m_д$ – daily defined dose of a pharmaceutical substance for adults and children; h – excretion rate of PhS from the body; n – average duration of treatment, days; η – average percentage of patients treated outpatients.

PhS enter into the city sewer only from outpatients, and unregistered patients. Thus, the annual mass of each PhS was calculated by the following formula:

$$M_{рік} = \left(K_в \cdot m_в \cdot \left(1 - k_в\right) + K_д \cdot m_д \cdot \left(1 - k_д\right)\right) \cdot n \cdot h + \left(K_в \cdot m_в + K_д \cdot m_д\right) \cdot n \cdot h \cdot \eta, \quad (2)$$

where $М_{рік}$ – mass of PhS entering into treatment plant, g/year; $k_в$, $k_д$ – average percentage of patients treated at hospital (adults and children); $К_в$, $К_д$ – average annual number of patients in the study area among the population of adults and

children; $m_в$, $m_д$ – daily defined dose of a pharmaceutical substance for adults and children; h – excretion rate of PhS from the body; n – average duration of treatment; η – average percentage of unregistered patients.

The daily mass of PhS, which entering into water bodies after urban treatment facilities, was calculated by the formula (3):

$$M_{доб} = \frac{M_{рік}}{365} \cdot \mu, \quad (3)$$

where μ – seasonal variations of morbidity.

For calculations, data was used from published sources of information, according to which the average water consumption in river Lopan was 4.5 m^3/s, capacity of biological treatment complex "Dikanevka" (Kharkiv) - 700000 m^3/d [3].

For estimation the number of PhS entering into river Lopan through the urban sewer, the annual report of the morbidity of the population in Kharkiv was used (for 2011). In this case, there was considered the period of the seasonal epidemic of diseases, when the daily number of patients was increased by about three times compared with the average annual.

According to the calculations according to formulas (1) - (3), the daily mass of diclofenac entered into river Lopan with an epidemiological situation is – 399.07 g.

Data of the calculated concentrations of diclofenac into surface waters formed after the discharge of treated wastewater at the treatment facilities of Kharkiv are given in table. 1.

According to the table 1, during the epidemic of the disease, the calculated concentrations of diclofenac in river Lopan downstream of the place of sewage discharge coincide with those measured and calculated by other researchers.

Table. 1. Comparative analysis of calculated and measured diclofenac concentrations in natural and wastewater

Title PhS	C^1_{cal} in water of outlet from the treatment plant, 10^{-6}g/l		C^2_{mes} in river Lopan, Kharkiv, 10^{-6}g/l	C^2_{mes} in wastewaters, 10^{-6}g/l, reference
	Kharkiv	reference		
DIC	0.37	0.2-0.4 [3]	0.235-0.653 [3]	0.25-0.45 [2]

Notes: C^1_{cal} – calculated concentration; C^2_{mes} – measured concentration

A comparative analysis of the calculated and measured concentrations of diclofenac in natural and wastewaters shows a very good conformity.

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