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COMPARATIVE ANALYSIS OF NOVEL BIOREMEDIATION METHODS FOR PHARMACEUTICAL WASTEWATER TREATMENT

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Development rate of the industrial production of pharmaceuticals is making a problem of wastewater treatment from pharmaceutical waste more and more actual. Reason is pharmaceutical industries dispose lots of water that cannot be used afterwards, if it was not purified beforehand due the presence of drug components in it. By draining it away without any clear rules, we make the resulting wastewater very complex in its composition. Here is why our goal was to compare new ways of pharmaceutical wastewater bioremediation that have prospect to gain wider use in the future. According to goal, we performed a literature review and found two different ways of bioremediation which can be applied for treatment of the pharmaceutical wastewater: using bacteria and using fungi.

The first group of scientists suggests bioremediation with a help of widely known bacteria *Bacillus subtilis* [1]. They demonstrate that these bacteria are able to purify wastewater on average from 83% of all nitrates, phosphates, but also from magnesium, calcium, cooper and zinc which is present there. The only crucial disadvantage is time bacteria spend to perform cleaning, as it is stated and proved experimentally that this high result can be obtained only after 2 weeks of bacterial action. According to the first research, we can conclude that it is possible to purify water from heavy metals, that are present in pharmaceutical wastewater by using bacteria *Bacillus subtilis* for this purpose; the fact of using bacteria open big possibilities to their characteristics modification as these bacteria are considered quite simple model objects. Bacterial modification may lead to decrease in their toxicity and increase in their reproduction, as the more bacteria we will have, the faster a purification will be.

The second group of scientists states that white-rot fungi can also be used in a bioremediation of wastewater which is polluted by pharmaceuticals [2]. Though authors do not prove the efficiency experimentally, they point out that fungi have a plenty of degradation capacities: hyphal morphology, ability to make reactive oxygen species (hydroxyl radical, hydrogen peroxide, and superoxide anion), and a possession of extracellular and intracellular enzymatic machinery. Authors also give their own fungal strategy which may be used in order to treat the pharmaceutical wastewater in a sewage system of buildings and note that enzymatic action of a wide range of white-rot fungi is able to treat water

from this kind of waste with a high level of effectiveness, as white-rot fungi are able to perform the bioremediation under broad pH conditions unlike bacteria which require mostly neutral pH and are relatively cheap in price. Two fungal species that also grow in Ukraine are demonstrated and idea to use them for two different kinds of pharmaceuticals treatment is proposed. According to the second research, we can conclude that fungi can be used for bioremediation of pharmaceutical wastewater both on site of drug production and site where people use final product; they have greater efficiency than bacteria, are relatively cheap and can grow under broad pH, yet their enzymes are not studied in great detail, so we can expect even more beneficial fungi (or combinations of them) to be found soon.

In our work we also want to give some advice to the Ukrainian pharmaceutical manufacturers:

- Investigate *Bacillus subtilis* for pharmaceutical wastewater treatment, its impact on human health.
- Find out which other white-rot fungi species (or their mixtures) show the highest wastewater purification efficiency and start to use them as they seem promising due to price and effectiveness.
- Take both of methods in consideration to lower the level of water pollution with pharmaceuticals.

As a result, the comparative analysis of novel bioremediation methods which are used in pharmaceutical wastewater treatment was conducted. To implement it the global situation with water pollution by the pharmaceutical wastewater was analyzed firstly. After that the comparative analysis of new bioremediation methods which can be used for pharmaceutical wastewater treatment was done. And finally, recommendations to pharmaceutical industries how to treat water pollution were given. We strongly think that this topic will get more attention in the nearest future or water pollution with the pharmaceutical waste will become even more problem to modern society than it is nowadays.

References

1. Kehinde, L.I., Adekanmi, A.A., Ahmad, L.K., Akinkunmi, O.O., Tomi, O.B., Ajewole, O.M., 2022. Bioremediation of Waste Water from Pharmaceutical Industry by Bacteria (*Bacillus subtilis*). *Journal of Environmental Issues and Climate Change* 1, 38–50.
2. Akerman-Sanchez, G., Rojas-Jimenez, K., 2021. Fungi for the bioremediation of pharmaceutical-derived pollutants: A bioengineering approach to water treatment 4, 100071. **DOI:** <https://doi.org/10.1016/j.envadv.2021.100071>