Removing diclofenac by using low cost adsorption materials

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Introduction

The last couple of years micropollutants have caused a lot of damage to our ecosystem. Especially medicines have made a lot of impact . 90% of our prescription drugs eventually end up in our waste water. Fish who live in water with diclofenac in it, get kidney, gout and liver damage. We decided to try to adsorb diclofenac out of water by using low cost adsorption materials.
We chose to focus on diclofenac specifically, because it is one of the most harmful and most prescribed medicines in the Netherlands.

Question

How can we remove diclofenac using low cost adsorption materials?

Method

To get the diclofenac out of the water we decided to use adsorption. To do that we tried out different materials that could be used as an adsorbant. We used organic materials such as sunflower oil and plastic beads. There where two different kinds of set ups We had our reactor and we used little glass bottles. We used the little glass bottles to test different kinds of adsorbents. We would put the adsorption material and the solution consisting of water and diclofenac in a bottle. We shook the bottles and took samples, let them rest for a week and take samples again. The material that had the best results we used in the big reactor.

Our reactor experiments took one week. In order to get enough stirring, we had several ideas. After some tests we decided to use an airlift reactor. That is because we wanted the solution to mix constantly.

So we did 6 experiments in total:

1. A test experiment with Styrofoam and Moringa Seeds.
2. A reactor experiment with Moringa Seeds.
3. A small test with a plastic bottle.
4. A batch experiment with sunflower seeds, sunflower oil, linen seeds, activated carbon, a membrane and plastic beads.
5. An experiment to compare the use of sunflower oil and sunflower seeds.
6. A reactor experiment with sunflower oil.

In all the experiments we used demi water and we also used 10 mg/ liter diclofenac for every experiment.

Figure 1: Airlift reactor

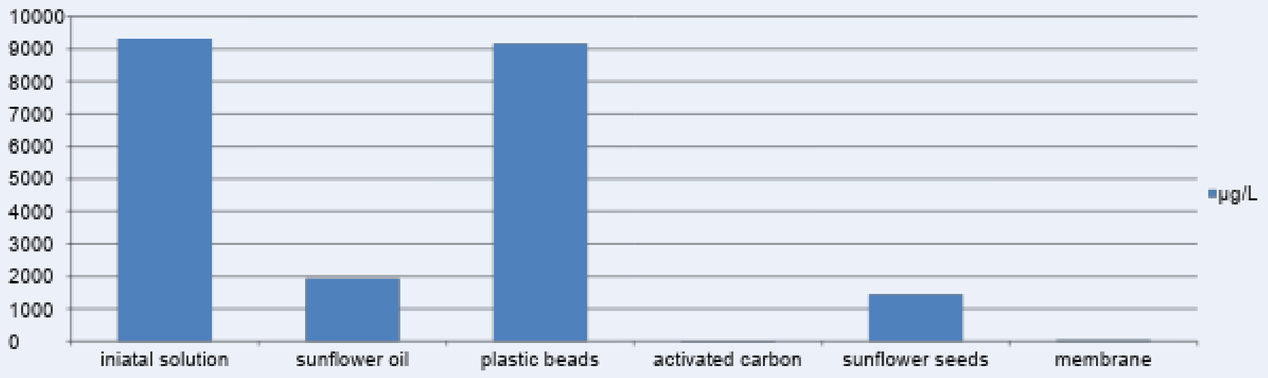
Results

1. Styrofoam+diclofenac
   - week 1: 11 mg/L*
   - week 2: 9,54 mg/L*
   - Moringa seeds+diclofenac
     - week 1: 4,35 mg/L*
     - week 2: 1,15 mg/L*
   - Diclofenac
     - week 1: 11 mg/L*
2. Moringa+diclofenac: 2,9 mg/L*
3. (no results given)
4. (figure 3)
5. Results not clear. It was not possible to measure the amount of diclofenac in the sunflower oil. Sunflower seeds started rotting which resulted in that we could not measure this either.
6. Our second reactor experiment with sunflower did not give us any results because all the water in the reactor evaporated.

**mg diclofenac per liter water*

Figure 2: Experiment 1

Figure 3: Results experiment 4



Conclusion

For our first little test we used Styrofoam and Moringa Seeds. The Styrofoam did not adsorb the diclofenac, but the Moringa Seeds did very well. So we put moringa seeds in the big reactor. the problem here was that the moringa seeds rot. Because of this we were not able to get any results from this experiment.

After this we did another small test with 7 different materials (figure 3). In this diagram you see the results of six of them. We were not able to get results from the seventh adsorbent, Linnen seeds, because plants started to grow and the water turned very slimy. As for the other tests you can see that active charcoal and the membrane we used worked the best. A very good alternative however are the sunflower seeds and the sunflower oil, furthermore you can see that the plastic beads did not really work

Future

In the future we would like to try different medicines like paracetamol and maybe the birth control pill. It would be interesting to find a material that could adsorb different materials at once. We would also like to use actual waste water, we will probably face new problems once we do that. Maybe the oil will not adsorb the diclofenac as well or the oil will adsorb things we don't want it to adsorb.