Inclusion and Removal of Pharmaceutical Residues from Aqueous Solution Using Water- Insoluble Cyclodextrin Polymers

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Introduction

An increasing number of chemical compounds in the environment have been identified as endocrine disruptors using *in vitro* and *in vivo* bioassays. These include pesticides, industrial chemicals, pharmaceutical and natural hormones.

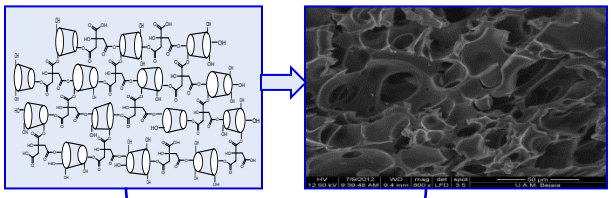
Among of endocrine disruptors, progesterone is a natural hormone usually used as a drug to control the reproductive function and for postmenopausal therapy. This substance has been detected in wastewater, drinking water and agricultural watershed **[1]** and it was identified as an endocrine disruptor for several body at trace concentrations [ng/l] for human and wildlife such as nematodes **[2].**

Insoluble cyclodextrin polymers can be obtained using cyclodextrins as complex molecules and bi or polyfunctional substances as cross-linking agents such as diiocyanate **[3]** and epichlorohydrin **[4]**.

In this paper, novel insoluble β-cyclodextrin polymers **[5]** were used to remove progesterone from aqueous solution. The effects of several operating variables were studied and these polymers were also characterized by using scanning electronic microscopy and FT-IR analysis before and after extraction. This study provides a valuable example for the removal of progesterone trace from water.

Material

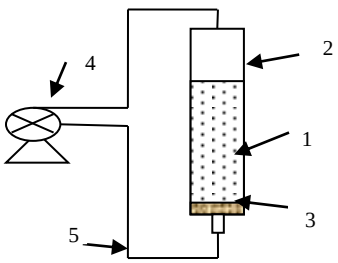
Insoluble cyclodextrin polymers (PolyCyc®) were received from Start-Up In-Cyclo®. The progesterone was purchased from Sigma-Aldrich (France) and used without further purification.



The SEM features at 800 magnification clearly reveal the nature of the surface of the dry polymer. It's like to a sponge with thick homogeneous and smooth cavities.

Methods

1: Solution of progesterone
2: Column
3: PolyCyc®
4: Peristaltic pump
5: Collector



Experimental set-up for the progesterone extraction with PolyCyc® in column procedure.

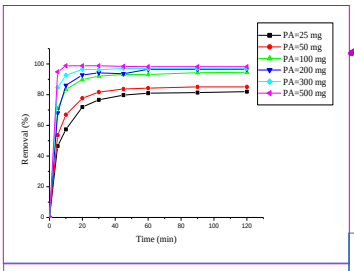
Adsorption tests were carried out with an experimental apparatus consisting of a continuous up flow column with a volume of 125 ml.

Various amounts of insoluble cyclodextrin polymers were charged and then, 60 ml of progesterone wastewater solution were supplied to the column and circulated at different liquid velocities for 2 hours.

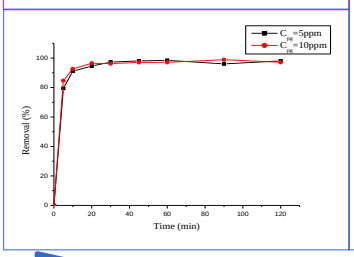
At different intervals, 800 µl of solution were taken and measured by UV/VIS spectrophotometry at 250 nm.

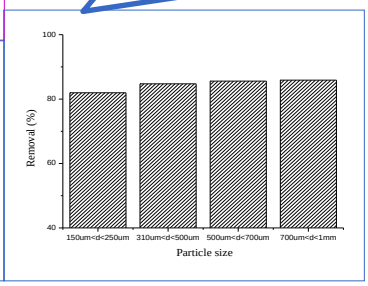
Results and discussion

The adsorption capacity increase with increase of adsorbent amount

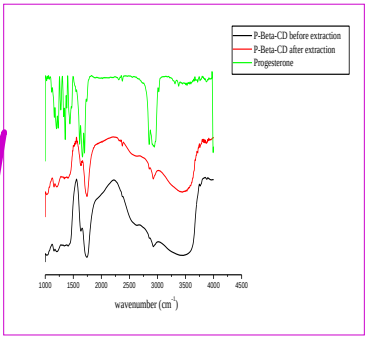


Increasing in particle size of the polymer lets to increase of progesterone removal. Thus, the polymers with high particle size make adsorption sites easily accessible





Extraction capacity of progesterone by β-cyclodextrin polymers is related to a concentration gradient



The disappearance stretching bands of progesterone in cyclodextrin polymer spectral can be explained by the dissociation of the intermolecular hydrogen bonds of progesterone through inclusion complexation

Conclusion

❑ To remove progesterone from aqueous solution, PolyCyc® exhibited a short adsorption time and a high adsorption capacity which reach 100% at optimal conditions.

❑ The adsorption mechanism is essentially based on the formation of inclusion complexes with cyclodextrin units.

❑ Cyclodextrin polymer is an innovative tool for drinking water treatment

References

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