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Estrogen removal through adsorption on carbon materials prepared from biomass wastes: A review

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Scientific topic: Porous materials for energy and environment

Due to the rapid urbanization and industrialization of our world, inadequate waste disposal into land and aqueous matrices has been a deepening environmental and health concern. Substances such as pharmaceuticals, heavy metals, pesticides, surfactants, and petroleum derivatives can be classified as emerging pollutants, thanks to their ever-growing presence and accumulation in the biosphere, especially in water bodies and even in our domestic drinking water[1]. Many of these emerging pollutants can also be classified as micropollutants, since they can harm living beings in very low concentrations, in the magnitude of micrograms per liter (µg/L) or nanograms per liter (ng/L)[2]. An especially worrying class of micropollutants are endocrine disruptors, which are compounds that act directly and deregulate the endocrine system in both humans and animals. Endocrine disruptors can consist of natural hormones, such as estrone (estrogen E1), 17β-estradiol (estrogen E2), and estriol (estrogen E3), or synthetic, such as 17α-ethinylestradiol (estrogen EE2), that owing to their nature as micropollutants, are not easily removed by conventional treatment processes in water and sewage treatment plants, leading to them becoming dangerous emerging pollutants[3]. In this work, a bibliographic review was carried out regarding adsorption studies aiming the removal of estrogens through biomass-based adsorbent materials. The review focused mainly on the selection of several features namely: the type of adsorbate and adsorbent, activation method, adsorption capacity, equilibrium, and kinetic mechanisms. Hence, selected relevant literature studies are summarized in Table 1.

Table 1: Selected adsorption studies from literature and the respective main results

Estrogens	Adsorbent	Activation	Adsorption capacity (mg/g)	Isotherm Model	Kinetic Model	Ref.
E1, E2	Banana peal	No activation	0.387 – 0.420	Freundlich	PSO	4
EE2	Palm kernel shell	Carbonization	1.68	Langmuir	General	5
E1, E2, E3	Walnut shell	Pyrolysis	0.80 – 2.80	Freundlich	PSO	6
E2	Corn straw	Pyrolysis	99.8	Langmuir	PSO	7
E2	Wood sawdust	K_2FeO_4 + pyrolysis	99.67 – 133.45	Langmuir	PSO	8

Table 1 presents a few selected studies from a wide variety of works related to this topic published in recent years, with wood sawdust activated by potassium ferrate and pyrolysis showing the best adsorption capacities.

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