# Competitive adsorption of Cr(VI) and Zn(II) ions in aqueous medium applying a biosorbent based on *Saccharomyces cerevisiae* residues and ferromagnetic nanoparticles

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## Introduction

The term “biosorption" indicates the occurrence of an adsorption mechanism using biomasses from microbial organisms, plants, animals, or their derivative products. *Saccharomyces cerevisiae* from the sugar and alcohol industry is a biomass of significant potential for biosorption (JOSÉ et al., 2019; DEBS et al., 2019), low added value, and great availability in nature. Such residues are favorable for the process because they contain active sites that can perform the adsorption process of pollutants in contaminated environments. Due to the importance of water resources, pollution in aqueous matrices stands out due to the highly adverse impacts. Emerging pollutants, such as heavy metals, dyes, drugs, and pesticides, are primarily responsible for effluent contamination since they cannot be degraded naturally, becoming harmful to living beings when they accumulate (GEISSEN et al., 2015).

## Goals

This work proposes the use of yeast biomass (YB), its magnetic nanomodified form (YB-MNP), and magnetite (MNP) for comparison purposes. All materials were tested for Cr(VI) and Zn(II) simultaneous adsorption in aqueous medium.

## Material and Methods

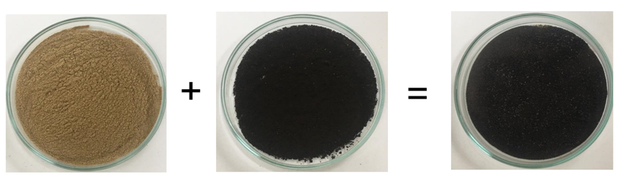
### Synthesis of magnetite (MNP) and nanocomposite (YB-MNP)

30 min

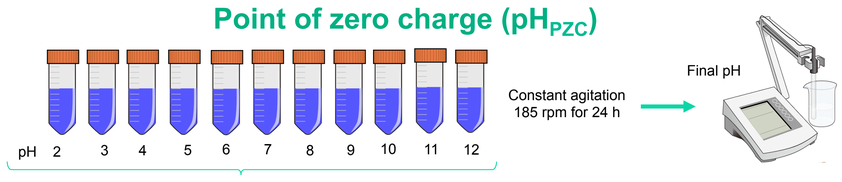
$$Fe^{2+}_{(aq)} + 2Fe^{3+}_{(aq)} + 8OH^{-}_{(aq)} \rightarrow Fe_3O_{4(s)} + 4H_2O_{(l)}$$

30 min; 80 °C

$$Fe_3O_{4(s)} + YB_{(s)} \rightarrow YB - Fe_3O_{4(s)}$$

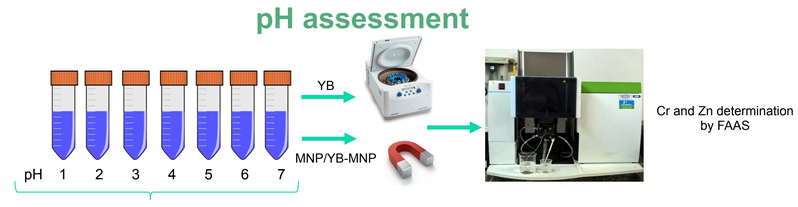



### Point of zero charge ($pH_{PZC}$)



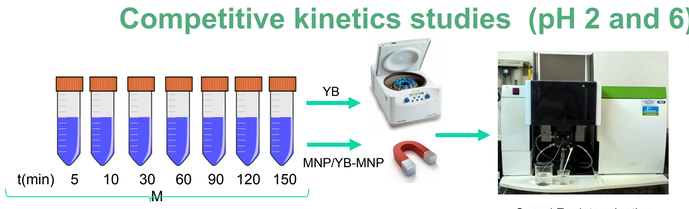

10 mg of YB or YB-MNP and 10 mL of NaCl 0,1 mol/L. n=3.

### pH assessment



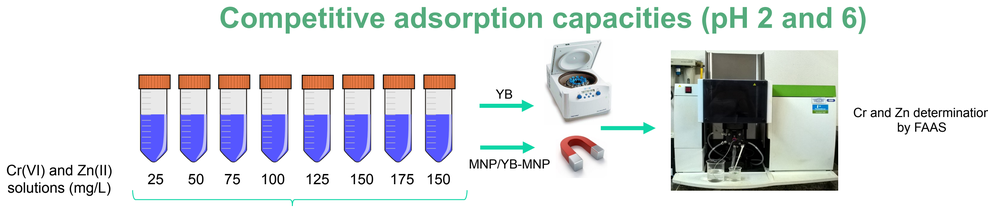

100 mg/L Cr(VI) and Zn(II); constant agitation for 10 min; 2,5 g/L dosage of YB, MNP, or YB-MNP, n = 3.

### Competitive kinetics studies (pH 2 and 6)




100 mg/L Cr(VI) and Zn(II) in pH 2 or 6; constant agitation for 10 min; 2,5 g/L dosage of YB, MNP, or YB-MNP, n = 3.

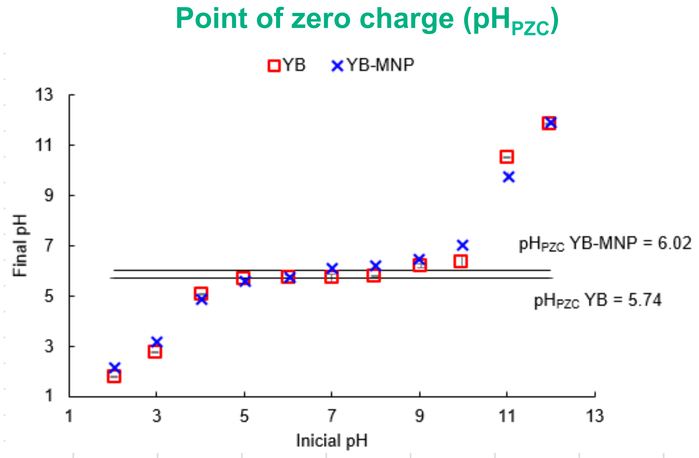
### Competitive adsorption capacities (pH 2 and 6)




Constant agitation for 10 min; 2,5 g/L dosage of YB, MNP, or YB-MNP and the bielemental solutions (Cr(VI) and Zn(II)) in increasing concentrations (25, 50, 75, 100, 125, 150, 175 and 200 mg/L of each ion in pH 2 or 6, n = 3.

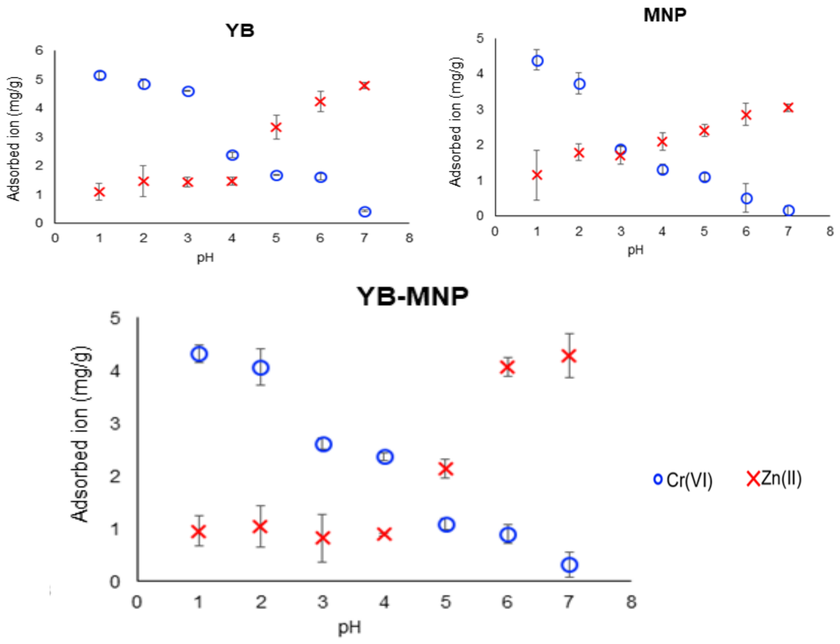
## Results and Discussion

### Point of zero charge ($pH_{PZC}$)



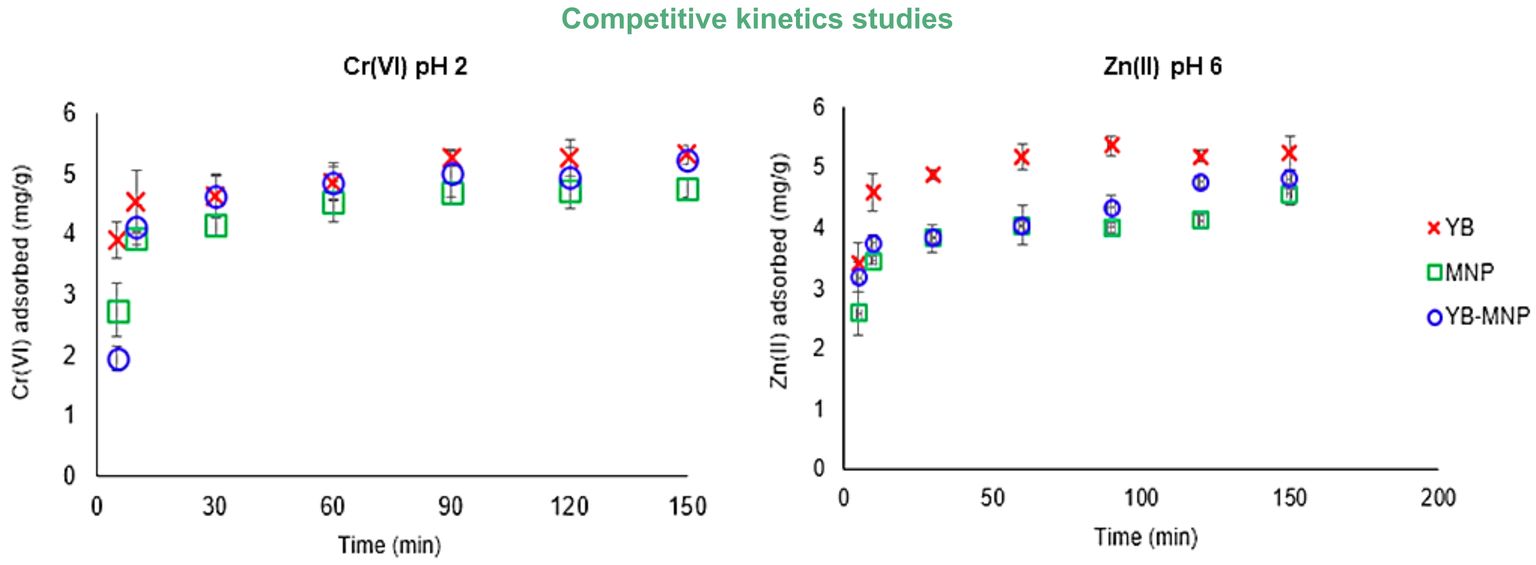

Point of zero charge ($pH_{PZC}$) using 1.0 g/L dosage of *in natura* (YB) and magnetic bionanocomposite (YB-NP) with 0.1 mol/L NaCl solution at 2-12 pH range n = 2.

### pH assessment



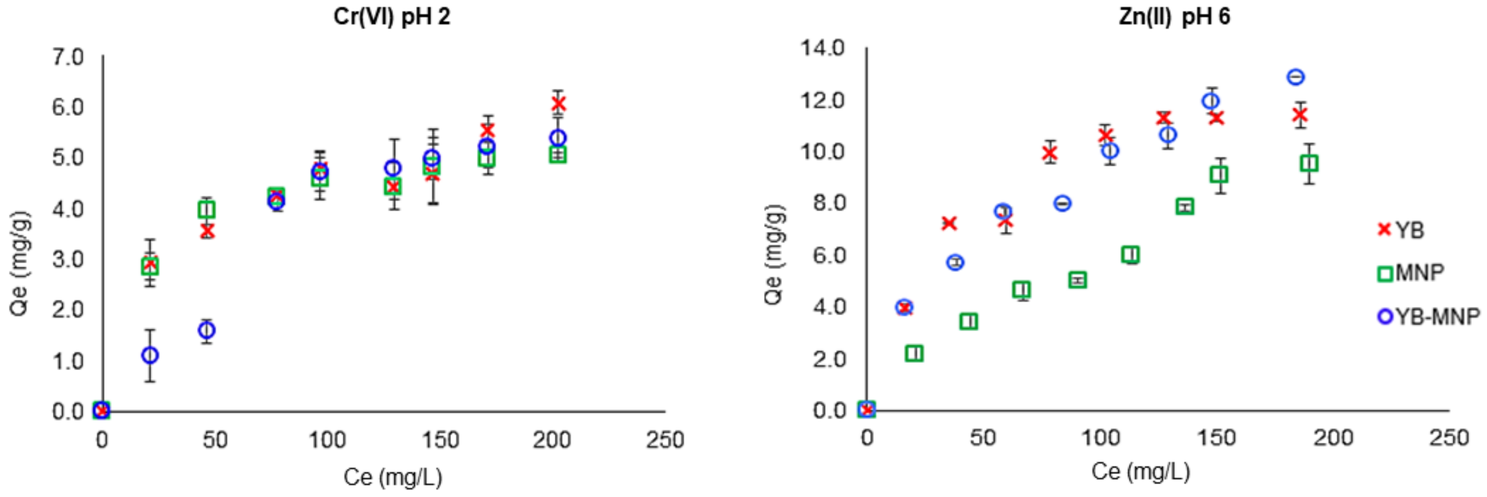

Effect of pH on Cr(VI) and Zn(II) sorption efficiency by yeast biomass (YB), ferromagnetic nanoparticles (MNP) and magnetic bionanocomposite (YB-MNP) using a 100 mg/L solution of Cr(VI) and Zn(II) with 2.5 g/L dosage. n-=3.

### Competitive kinetics studies




Kinetics studies of Cr(VI) and Zn(II) on competitive adsorption of Cr(VI) at pH 2 and Zn(II) at pH 6. The adsorbents used were yeast biomass (YB), ferromagnetic nanoparticles (MNP) and magnetic bionanocomposite (YB-MNP) using a dosage of 2.5 g/L of YB, MNP or YB-MNP with a 100 mg/L solution of Cr(VI) and Zn(II). n=3.

### Competitive adsorption capacities




Experimental data on competitive adsorption of Cr(VI) at pH 2 and Zn(II) at pH 6. The adsorbents used were yeast biomass (YB), ferromagnetic nanoparticles (MNP) and magnetic bionanocomposite (YB-MNP) using a dosage of 2.5 g/L of YB, MNP or YB-MNP and bielemental crescent solutions of 25-50 -75-100-125-150-175-200 mg/L of Cr(VI) and Zn(II). n=3.

## Conclusions

The competitive sorption capacities of Cr(VI) and Zn(II) was evaluated at pH 2 and 6. The best results were obtained in the adsorption of Zn(II) at pH 6 (11.42 mg/g for YB, 9.54 mg/g for MNP and 12.86 mg/g for YB-MNP), and in the adsorption of Cr(VI) at pH 2 (6.07 mg/g for YB, 5.04 mg/g for MNP and 5.37 mg/g for YB-MNP). Thus, all the proposed materials showed promising results for the decontamination of aquatic environments containing Zn(II) and Cr(VI), mainly YB-MNP, as it is a modified biological waste, in order to incorporate magnetic properties, which have the same main purpose to facilitate the removal of material from the medium after the process of removing the contaminants.

## References

Debs, K. B. et al. Oil spill cleanup employing magnetite nanoparticles and yeast-based magnetic bionanocomposite. J*ournal of Environmental Management*, v. 230, p. 405-412, 2019.
Geissen, V. et al. Emerging pollutants in the environment: A challenge for water resource management. *International Soil and Water Conservation Research*. v. 3, n. 1. p. 57–65, 2015.
José JC, Debs KB, Labuto G, Carrilho ENVM (2019) Synthesis, characterization and application of yeast-based magnetic bionanocomposite for the removal of Cu(II) from water. Chem Eng Commun 206(11): 1581–1591.

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