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De-emulsification of wastewater using chitosan

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Abstract
Large amout of liquid effluents are daily generate by dairy industries, the formation of a stable oi-in-water emulsion may occur, making difficult the oil separation. This project aimed to understand the action mechanism of chitosan with different molecular weights on the de-emulsification of oil in water emulsions for application on the treatment of wastewater from dairy products. Obtained results showed that de-emulsification using chitosan was not expressive for oil separation, however, induced whey protein separation from aqueous phase.

Key words:
De-emulsification, Chitosan, Effluent Treatment.

Introduction

Water used in food processing generates large amount of liquid effluents, which must be treated before released in hydric receptors (MATOS et al, 2010). Among the food industries, the contribution of dairy products in water pollution is quite significant, milk processing generates considerable pollutant load, due to the presence of a large number of organic compounds in suspension (MENDES et al., 2006). In this effluent, the formation of a stable oil-in-water emulsion may occur, making difficult the oil separation. For the removal of emulsified oil, it is necessary to promote emulsion breakdown by the addition of coagulants and/or flocculating polymers, aiming the system destabilization and phase separation (SCHONS, 2008).
Chitosan have been widely used in studies to treat effluents (MOURA, 2006), it provides a great capacity for complexing colloidal substances and can be used as a flocculant agent in water treatment. Chitosan flocculating capacity is due to polyelectrolyte elimination of electrostatic charges and to the hydrophobic interactions with adjacent particles (KIMURA, 2001).
Understanding action mechanisms of chitosan could help developing a method to make easier phase separation and recovery of wastewater. Therefore, this project aimed to identify the stabilization mechanisms of model emulsions similar to those observed in dairy production in order to understand how chitosan with different molecular weights would act and enhance oil separation from emulsified effluents.

Results and Discussion

Residue samples of dairy production (cheese and ricotta) were analyzed and characterized for protein, lipid, ashes, pH, moisture, size distribution, rheology, optical microscopy and zeta potential. This characterization allowed choosing the emulsion composition, which would later be prepared to simulate the conditions observed in practice. In addition, low and high molecular weight chitosans were characterized by FT-IR, zeta potential and size measurements. The rheological properties of high oleic sunflower oil were evaluated by flow curves.
In order to understand the role of each component on emulsion stability, simple emulsions were prepared with aqueous phase composed by isolated whey protein or chitosan with different molecular weights. Afterwards, mixed emulsions were prepared with aqueous phase composed of protein and chitosan for simulating the process used in real effluent treatment. Emulsions were evaluated for phase separation, optical and fluorescence microscopies. The protein content of emulsions lower phases was quantified. Interfacial tension measurements were also performed to evaluate the tension between emulsion phases interface.
Results suggested that the stabilization mechanism of emulsions were more related to interfacial tension of phases than to continuous phase viscosity, since the observed viscosity was too low to retain oil droplets.
Chitosan used for de-emulsification did not demonstrate a relevant separation of oil as showed phase separation analysis, however, interesting results were observed regarding the whey protein concentration on aqueous phase. Fluorescence microscopy and protein quantification of mixed emulsion phases indicated that there was a decrease in protein concentration of the emulsion bottom phases as the chitosan concentration was increased. These results suggest chitosan could be used to reduce BOD and COD of dairy effluents. About chitosan molecular weight (MW), the higher the MW, the greater was the affinity to oil phase and so the emulsion was more stable, as observed in micrographs.

Conclusions

Chitosan with different molecular weights used in model emulsions did not show a relevant index of oil separation, however, induced whey protein separation from aqueous phase. This application can be very positive for dairy effluent treatments.
Obtained results allowed to increase the understanding of de-emulsification behavior and phases separation of effluents using chitosan. Moreover, it contributed to enrich knowledge and future research in this area.

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