Processing of diatomaceous earth after beer filtration process with non-equilibrium plasma

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Utilizing diatomaceous earth for beer filtration is regarded as one of significant technological advancements in brewing in recent years. This recognition stems from diatomaceous earth's distinctive porosity, substantial adsorption capacity, and low density. After filtration process the mass of spent diatomaceous earth significantly exceeds its original weight as it retains some water and other organic components (such as yeast, proteins, and polyphenols). Thus, such a spent diatomaceous earth is considered the primary brewing waste. The present study evaluates the antibacterial potential of non-equilibrium plasma against microorganisms isolated from diatomaceous earth. The treated samples were waste product from the beer filtration process.

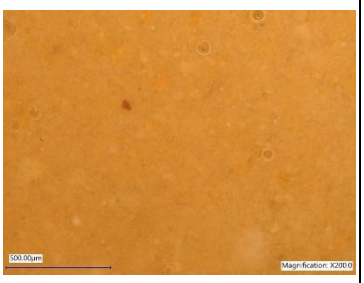
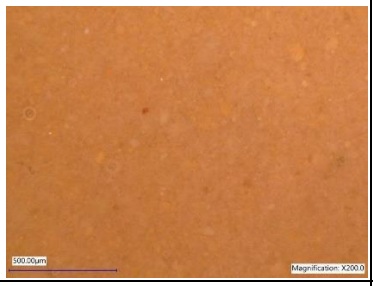
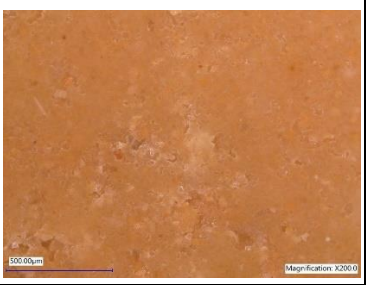
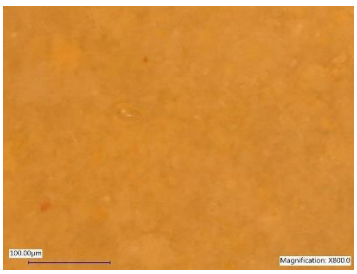
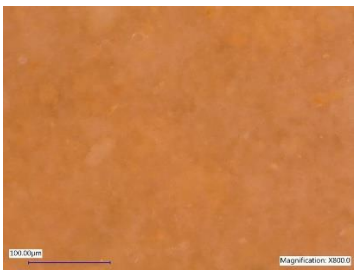
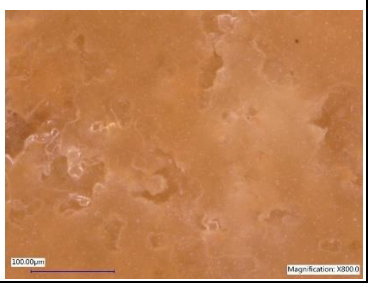
Time min	0	10	30
X200			
X800			

Fig.1: Microscopic imaging of diatomaceous earth before and after non-equilibrium plasma treatment

Non-equilibrium plasma was generated using a Glidearc reactor operating with air [1]. The temperature of the samples after treatment was monitored and it did not exceed 30ºC after 30 min, the plasma treatment.

The effect of plasma on the morphology of the treated material was observed with KEYENCE VHX-5000 optical microscope. Examination of the material's porous surface revealed that material damage resulting from plasma treatment was quite subtle. Visual effects were mostly from drying due to the flow of working gas. Furthermore, the FTIR spectra indicated no alteration in the chemical composition of the material across all treatment durations (5, 10, 20, 25, and 30 min.).

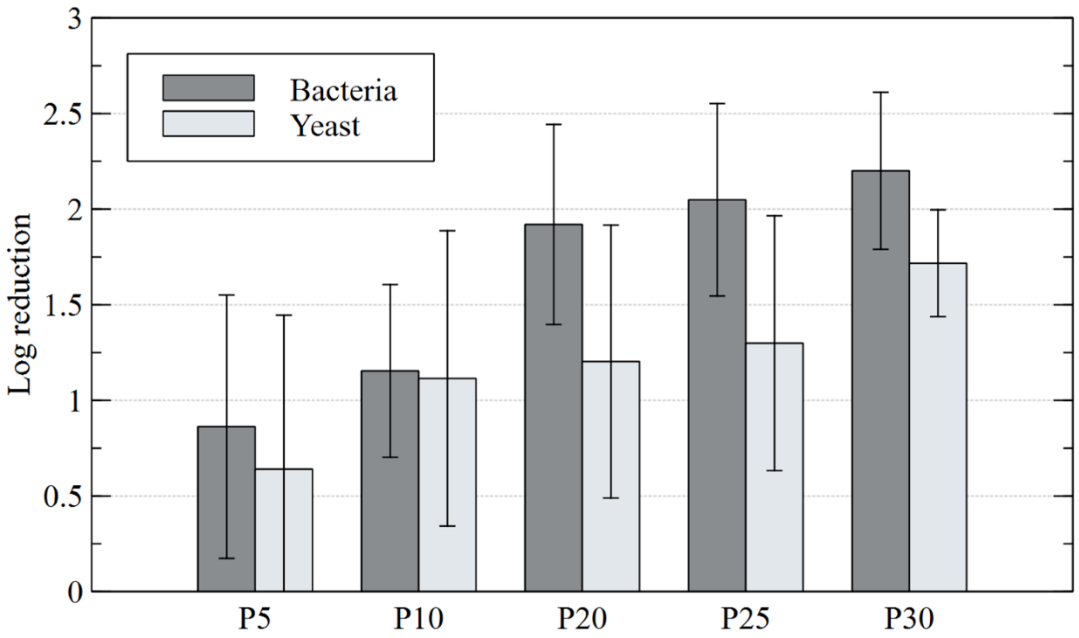


Fig.2: Logarithmic CFU reduction of microorganisms colonizing diatomaceous earth for different plasma treatment times.

Microbiological assessments identified three bacterial strains: *Hafnia alvei, Citrobacter freundii, Citrobacter braakii*. Additionally, three yeast strains: *Saccharomyces cerevisiae, Rhodotorula glutinis, Candida spherica*, were also present in the samples. The disinfection efficacy of plasma treatment was evident even at the shortest duration (5 min.), with its effectiveness increasing over time. Compared to control samples, reductions of 2.2 $\log_{10}$ CFU/g in total bacterial count and 1.72 $\log_{10}$ CFU/g in yeast were observed at a 30-minute exposition time.

References

[1] J. Pawłat, P. Terebun, M. Kwiatkowski, B. Tarabová, Z. Kovalová, K. Kučerová, Z. Machala, M. Janda, K. Hensel, *Plasma Chem Plasma Process* **39**, (2019) 627–642.