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DEVELOPMENT OF CERAMIC ULTRAFILTRATION MEMBRANE FOR APPLICATION IN SURFACTIN RECOVERY

Renata Vicente [1]*, Cristiano José de Andrade [1], Débora de Oliveira [1], Alan Ambrosi [1]

[1] *Department of Chemical and Food Engineering, Federal University of Santa Catarina (UFSC), Santa Catarina, Brazil*
** Corresponding author's email address: vicenterenata19@gmail.com*

ABSTRACT

Surfactin is one of the most industrially relevant surfactants of biological origin, given its high surfactant activity, as well as specific biological properties. Its production requires several processing steps for separation and purification from the culture medium. Membrane-based processes are interesting for the downstream processing of biotechnological products, and ceramic membranes have advantages such as greater chemical resistance and useful life in comparison to polymeric membranes, in addition to being less susceptible to organic fouling, common in several areas. The objective of this work was to develop and characterize ceramic membranes, for subsequent purification of surfactin produced from cassava wastewater as an alternative culture medium. First, alumina suspensions were prepared, and porous tubes were obtained by molding using the centrifugal casting technique, drying, and sintering. The membrane was evaluated in relation to linear and diametrical retraction, morphology, apparent porosity, hydraulic permeance, BSA protein retention, and surfactin purification. The prepared ceramic membrane showed a negligible permeate flux reduction when purifying the surfactin up to a volume reduction factor equal to 2, when the process was completed. The low reduction in the permeate flow indicates that the process can be driven to a volume reduction factor greater than that obtained until it is necessary to interrupt it for cleaning. The ceramic membrane was able to retain 91.5% of the surfactin present and obtain a purity of 35.2%. For a greater degree of surfactin purity, additional strategies must be adopted.

Keywords: Inorganic membrane. Biosurfactant. Purification.

1 INTRODUCTION

Surfactin is produced by *Bacillus* sp. through fermentative processes and is considered one of the most industrially relevant biosurfactants due to its high surface activity and specific biological properties, such as antibiotic, antiviral, anticancer, antifungal, and anti-inflammatory action. However, factors such as the high production cost, especially with separation and purification, and the low productivity of the biosurfactant, make its production on an industrial scale difficult. Therefore, the development of efficient and economical separation and purification processes is fundamental for industries that depend on this unit operation, mainly in the biotechnological area. Membrane processes have gained prominence, as they present low operational energy demand, high efficiency, and selectivity. Membranes can be developed from different materials, geometries, and production methods. Ceramic membranes have advantages such as greater chemical and thermal resistance, longer life cycles, and less susceptibility to organic-based fouling than polymeric membranes.

Therefore, this work aimed to develop ceramic membranes aimed at purifying surfactin produced using cassava as a low-cost cultivation medium.

2 MATERIAL & METHODS

To prepare the membranes, a ceramic suspension was prepared by mixing alpha-alumina (particle size 0.3-0.6 µm), binder, dispersant, and antifoam in distilled water. The suspension was added to tubular molds, which were rotated at 8,000 rpm for 15 minutes, and then the supernatant (water) was poured out. The tubes were allowed to dry for 3 days at 70% humidity and 22 °C. Then, the green tubes were sintered at 1275 °C for 1.5 h. The porous tubes were tested for linear and diametrical shrinkage, morphology, apparent porosity, and performance analysis, such as hydraulic permeance and BSA protein retention, and, finally, applied to the purification of surfactin present in a fermentation broth of cassava wastewater.

3 RESULTS & DISCUSSION

The membranes showed linear and diametrical shrinkage of approximately 9% during drying step, which was sufficient to remove the tubes from the molds, and a further shrinkage of approximately 6% during sintering, totaling 15% shrinkage. From scanning electron microscopy analysis, it was possible to notice that a hierarchical structure was formed along the cross section, composing a very homogeneous selective layer with the smallest alumina particles inside the tube, and larger particles as it approaches to the outer surface, producing larger pores that facilitate permeation (Fig. 1). The membrane presented satisfactory apparent porosity (43.8%), similar to data reported in the literature.

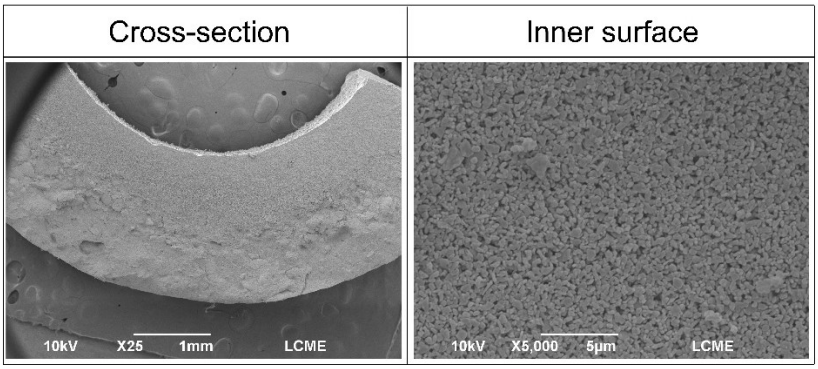

Figure 1 Micrograph of the cross-section and internal surface of the membrane

The membrane presented a water permeance of 86 $L \cdot h^{-1} \cdot m^{-2} \cdot bar^{-1}$, corroborating data found in the literature for ceramic ultrafiltration membranes prepared using the same technique. The rejection of BSA protein was greater than 90%, indicating that, based on the particle size of this protein, the membrane has a molecular mass cutoff of ~67 kDa.

The filtration of a fermentation broth was carried out until a volume reduction factor of 2. This process lasted 12h and kept the permeate flow stable (Fig. 2), indicating that the process could be carried out for a longer time. The membrane was able to retain 91.5% of the surfactin present in the fermentation broth, although a low purity of 35% was obtained due to the high amount of protein that was rejected with the surfactin.

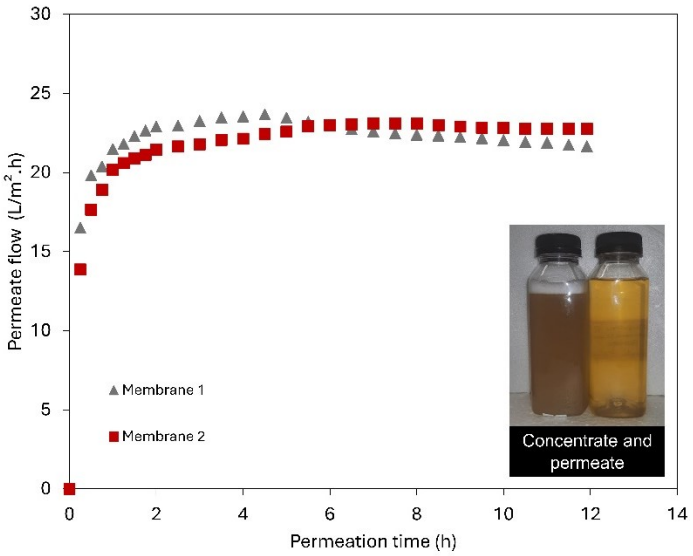

Figure 2 Permeate flux in relation to permeation time during the surfactin purification process.

4 CONCLUSION

The application of ceramic membrane is a promising strategy for continuous surfactin purification. The ceramic membrane produced in this work did not show a significant drop in permeate flux, which indicates absence or very low fouling in the membrane. Therefore, the process could be continued for long periods. Furthermore, a second purification step could be applied to remove proteins.

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