Influence of pH in the recovery of lactoferrin from whey with ceramic membranes

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1. Introduction

A wide collection of proteins in relatively low concentrations but with an important biological activity is present in bovine whey. Among them, lactoferrin shows strong bacterial and antiviral properties, preventing the growth of pathogenic organisms in the gut, stimulating the immune system and enhancing iron absorption [1]. Lactoferrin recovery from whey is therefore of great interest since it can be used in the development of improved infant formula, functional foods and nutraceuticals. To this end, methods have been devised employing, for instance, surfactant-stabilized microbubbles [2] or ion exchange chromatography [3]. In the field of membrane technology, high performance tangential flow [4] filtration has been suggested as a feasible technique to allow the separation of lactoferrin at industrial scale [5].

In this work, the effect of pH in the selectivity of lactoferrin ultrafiltration through a ceramic membrane with respect to the major whey proteins has been studied. The results obtained are useful to design an optimal strategy to exploit the electrostatic protein–membrane interactions that takes place in this process.

2. Experimental

Acid bovine whey was pre-treated to remove rests of caseins and to decrease its content in calcium salts in order to enhance the flow of permeate. The module used was a 300 kDa tubular ceramic membrane from Tami (France). The mode of operation was continuous diafiltration, which was followed until 4 diavolumes. The pH interval assayed was 5–10. The quantitation of lactoferrin, a-lactalbumin and b-lactoglobulin was determined by HPLC [6].

3. Results and discussion

The yields of lactoferrin, a-lactalbumin and b-lactoglobulin, calculated as the ratio between final retentate concentration and concentration in the original whey are shown in Fig. 1.

It can be seen that at pH = 5 (around the isoelectric point of a-lactalbumin and b-lactoglobulin), more than 90% of the lactoferrin is eluted in the permeate while the other major proteins are practically fully retained. At this pH, both lactoferrin (isoelectric point = 9) and membrane (point of zero charge = 7) are positively charged. On the contrary, a-lactalbumin and b-lactoglobulin are neutral which allows the formation of protein aggregates.
On the other hand, at pH = 10, lactoferrin is fully retained while 60% of the α-lactalbumin and 80% of the β-lactoglobulin is retained. At this pH, lactoferrin is slightly negatively charged, but the membrane and major proteins are strongly negatively charged.

4. Conclusions

The effect of pH in the selectivity of a 300 kDa tubular ceramic membrane has been tested for the separation of lactoferrin from whey. The best resolution has been observed at the extremes of the range studied, 5 and 10, where lactoferrin is obtained in the permeate and in the retentate, respectively.

References


