PREPARATION OF ELASTIN MEMBRANES BASED ON SURFACTANTS AND SEPARATION MECHANISM

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ABSTRACT. The influence of a classical surfactant – palmitoyl-glycylglycine and bola amphiphilic – demecarium bromide upon the elastin membrane preparation and separation mechanism of turmeric from aqueous solutions was studied by: UV-VIS spectroscopy, scanning electron microscopy, dynamic light scattering and separation rates. The tensile strength and hydrophobic property were improved by introducing a surfactant (classic or bola). In this research the influence of surfactants upon the microporous structure and retention of turmeric from aqueous solutions was studied. The biomembranes were produced by a casting-solvent evaporation technique. The elastin powder was dissolved in a water-acetic acid (70:30 v/v) solution with and without plasticizer: glycerol and surfactant (classic or bola), constant continuous stirring for 5-7 hrs. at 60°C, then degassed the solution for 2 hrs. The solution was poured and afterwards maintained in the oven at 45-55°C for 5-8 hrs. Ecological biomembranes are obtained from a biodegradable biopolymer – elastin, and can be used successfully in removing turmeric from wastewaters.
KEY WORDS: elastin biomembranes, surfactants (classical and bolaform), separation mechanisms of turmeric from aqueous solutions

PREPARAREA MEMBRANELOR DIN ELASTINĂ PE BAZĂ DE SURFACTANȚI ȘI UN MECANISM DE SEPARARE

REZUMAT. Influența unui surfactant clasic – palmitoil glicilglicină și a unei bolaamfifile – bromură de demecariu asupra preparării membranei din elastină și a mecanismului de separare a curcumei din soluții apoase a fost studiată prin: spectroscopie UV-VIS, microscopie electronică de scanare, împrăștierea dinamică a luminii și ratele de separare. Rezistența la tracțiune și capacitatea hidrofobă au fost îmbunătățite prin introducerea unui surfactant (clasic sau bola). În această cercetare a fost studiată influența surfactanților asupra structurii microporoase și a gradului de retenție a curcumei din soluții apoase. Biomembranele au fost produse printr-o tehnică de turnare-evaporare a solventului. Pulberea de elastină a fost dizolvată într-o soluție de apă-acid acetic (70:30 v/v) cu și fără plastifiant: glicerol și surfactant (clasic sau bola), agitare continuă constantă timp de 5-7 ore, la 60°C, apoi s-a degazat soluția timp de 2 ore. Soluția a fost turnată și apoi menținută în etuvă la 45-55°C timp de 5-8 ore. Biomembranele ecologice sunt obținute dintr-un biopolimer biodegradabil – elastină și pot fi utilizate cu succes la îndepărtarea curcumei din apele uzate.
CUVINTE CHEIE: biomembrane din elastină, agenți tensioactivi (clasici și bola), mecanisme de separare a curcumei din soluții apoase

PRÉPARATION DE MEMBRANES D'ÉLASTINE À BASE DE TENSIOACTIFS ET MÉCANISME DE SÉPARATION

RÉSUMÉ. L'influence d'un surfactant classique – palmitoyl-glycylglycine et une bola amphiphile – bromure de démécarium sur la préparation de la membrane d'élastine et le mécanisme de séparation du curcuma des solutions aqueuses a été étudiée par : spectroscopie UV-VIS, microscopie électronique à balayage, diffusion dynamique de la lumière et taux de séparation. La résistance à la traction et la propriété hydrophobe ont été améliorées par l'introduction d'un tensioactif (classique ou bola). Dans cette recherche, l'influence des tensioactifs sur la structure microporeuse et la rétention du curcuma des solutions aqueuses a été étudiée. Les biomembranes ont été produites par une technique de coulée/évaporation du solvant. La poudre d'élastine a été dissoute dans une solution eau-acide acétique (70 : 30 v/v) avec et sans plastifiant : glycérol et tensioactif (classique ou bola), agitation continue constante pendant 5-7 h. à 60°C, puis la solution a été dégazée pendant 2h. La solution a été versée et ensuite maintenue dans le four à 45-55°C pendant 5-8 heures. Les biomembranes écologiques sont obtenues à partir d'un biopolymère biodégradable – l'élastine et peuvent être utilisées avec succès pour éliminer le curcuma des eaux usées.
MOTS CLÉS : biomembranes d'élastine, tensioactifs (classiques et bolaformes), mécanismes de séparation du curcuma des solutions aqueuses

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INTRODUCTION

Sustainable biopolymers are favorable resources for improving innovative biomaterials with vast potential in various fields of application. Elastin is a protein such as collagen, keratin, etc [1-5]. Hydrolyzed elastin powder is extracted from pork tendons by biotechnology and is amphipathic, hydrophilic and lipophilic, which makes it compatible with most of the ingredients. It is a fiber protein made up of polypeptide subunits and one of the most important structural proteins in the human body.

Like other biopolymers, elastin is composed of simple amino acids, especially: leucine, glycine and proline.

The elastin powder was dissolved in a water-acetic acid (70:30 v/v) solution with and without plasticizer: glycerol and surfactant, constant continuous stirring for 5-7 hrs. at 60°C, then degassed the solution for 2 hrs. The solution was poured and afterwards maintained in the oven at 45-55°C for 5-8 hrs, Figure 1.

These conditions allow the elastin molecules from solution to be structured and to form intermolecular bonds without any cross-linking agent.

A new procedure was proposed in this research, for obtaining elastin membranes based on tensides, by a casting-solvent evaporation technology and is presented in Figure 1.

In this research elastin membranes are obtained by a uniform casting of the solution with: elastin powder/water-acetic acid/glycerol/surfactant (classical or bolaform) on a glass plate. Elastin membranes were prepared using or not a plasticizer-glycerol and surfactant such as palmitoyl-glycylglycine or demecarium bromide.

The surfactants are involved in the membrane processes, influencing flow through polymeric porous media, cleaning of membranes during the process and after use or modifying the microstructure of the disperse system for separation. The influence of surfactants on the microporous structure and the mechanism retention of turmeric from aqueous solutions were studied.

The surfactant-turmeric mixed aqueous solutions were obtained by varying the turmeric and surfactant concentration and characterized by: UV-VIS spectroscopy, dynamic light scattering, and scanning electron microscopy.

EXPERIMENTAL

Materials and Methods

In order to obtain elastin membranes, the following materials have been used: elastin and turmeric powder, palmitoyl-glycylglycine and acetic acid from Sigma-Aldrich; demecarium bromide and glycerol from SERVA Feinbiochemica GmbH & Co.

The following equipment was used in this research:

- a "SEM QUANTA 200" equipment from FEI company, with EDAX coupled. The samples for SEM investigations were prepared by slow evaporation in clean atmosphere at room temperature;
- a Zetasizer-nano "MALVERN" equipment, with measuring range between 0.3 nm-60.0 microns and zeta potential determination with an accuracy of +/-2%;
- an UV-VIS spectrophotometer JASCO (model 918).

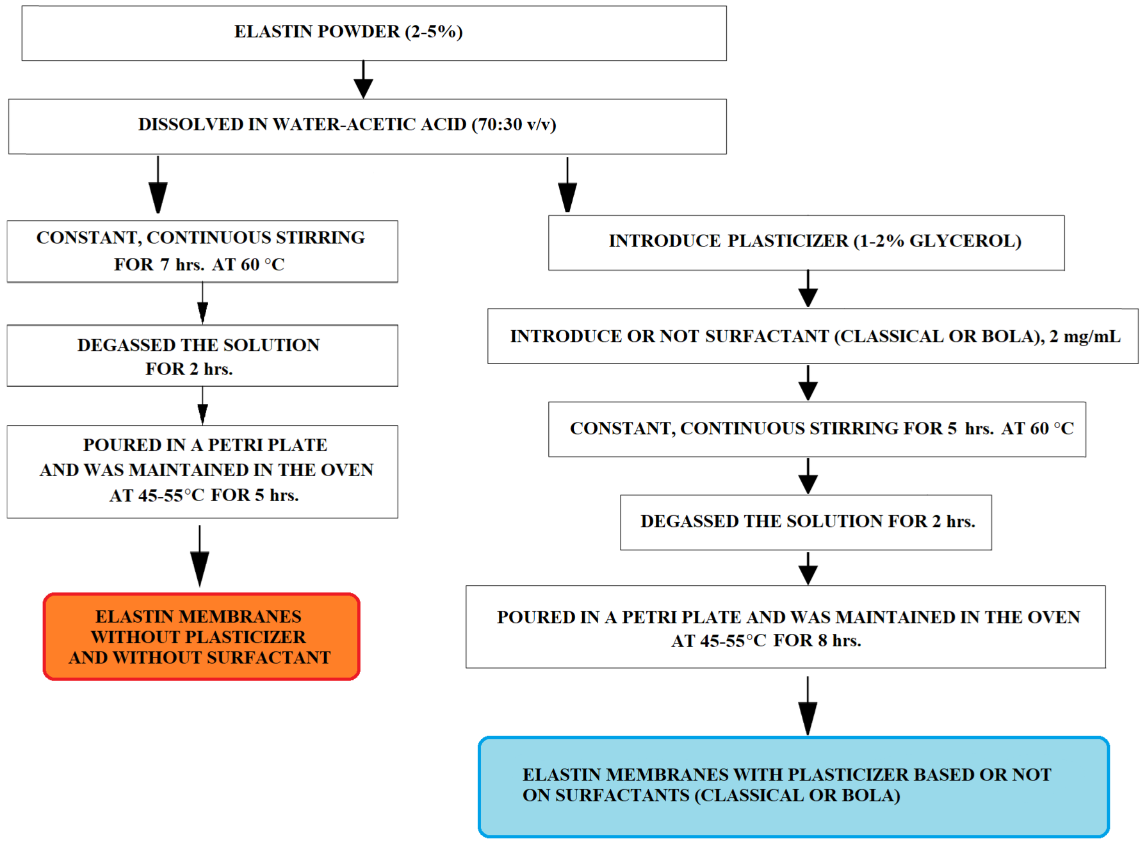
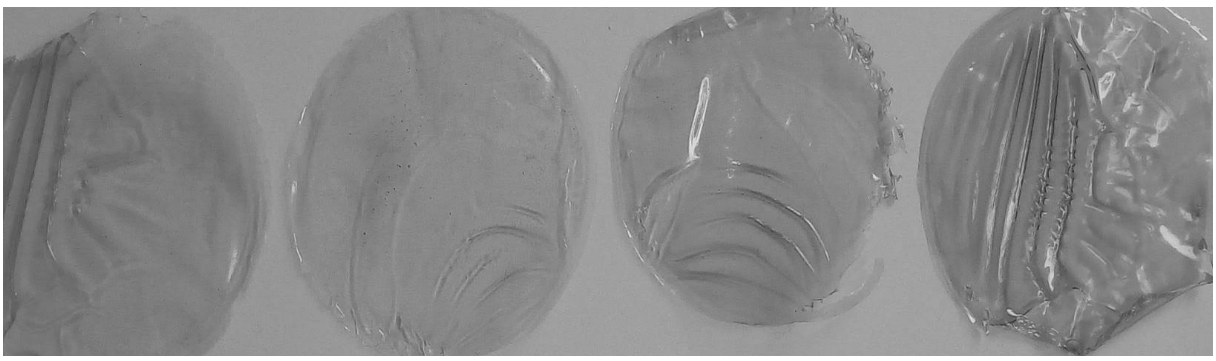


Figure 1. Technological flow for obtaining elastin membranes with and without plasticizer – glycerol-based or not for surfactants (classic or bola)

RESULTS AND DISCUSSIONS

Obtaining Biomembranes Based on Surfactants (Classic or Bola)

The images of elastin biomembranes obtained were shown in Figure 2.



a) b) c) d)

Figure 2. Images of: a) elastin membrane without plasticizer and surfactant; b) elastin membrane with plasticizer, c) elastin membrane with plasticizer and bola surfactant, d) elastin membrane with plasticizer and classic surfactant

This research focused on studying the separation mechanism of turmeric from aqueous solutions through the elastin membranes obtained based on surfactants (or not).

Characterization of Elastin Biomembranes Based or Not on Surfactants (Classic or Bola)

SEM images of the surface elastin membranes based on surfactants after retention of turmeric from aqueous solutions give information on the surface morphology of the membranes.

The surface of the elastin membranes based on surfactants consists of pores of varying sizes, as compared to classical membranes with uniform distribution of pores. Cross-sections of the membranes were prepared to assess the internal structure. Cross-sections were cut using a scalpel and fractured.

The compression of the structure is visible in Figure 3. Elastin membranes based on surfactants consist of a finger-like microsubstructure (Fig. 3. c, d).

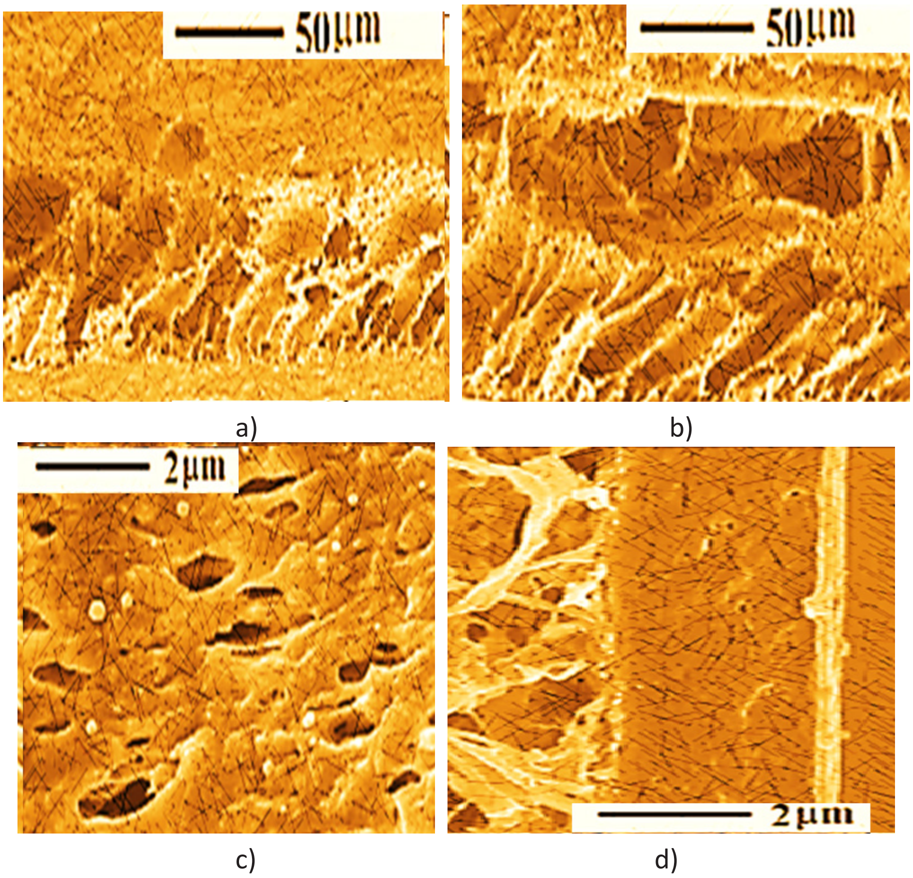


Figure 3. SEM images of cross-sections for elastin membranes after retention of turmeric from aqueous solutions for: a) elastin membrane without plasticizer and surfactant; b) elastin membrane with plasticizer; c) elastin membrane with plasticizer and bola surfactant; d) elastin membrane with plasticizer and classic surfactant

SEM image for turmeric from aqueous solution, retained on the elastin membrane with plasticizer and bola surfactant is shown in Figure 4.

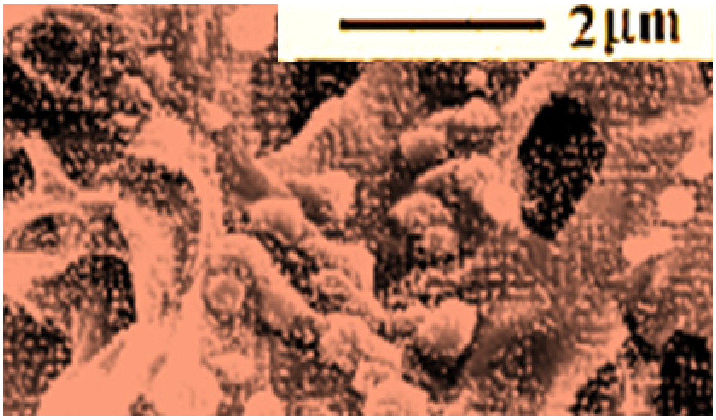


Figure 4. SEM image for turmeric from aqueous solution, retained on the elastin membrane with plasticizer and bola surfactant

The influence of surfactants upon the microporous structure and retention of turmeric from aqueous solutions from different concentrations was presented in Figure 5.

By UV-VIS spectroscopy at λ=420 nm, characteristic for fingerprint spectrum of turmeric in water, the dependence of the normalized flux - J/J_0 and retention - R of turmeric vs. concentration was determined.

The retention and normalized flux for turmeric solutions through membranes were calculated for elastin membrane with plasticizer and surfactants (classical or bola).

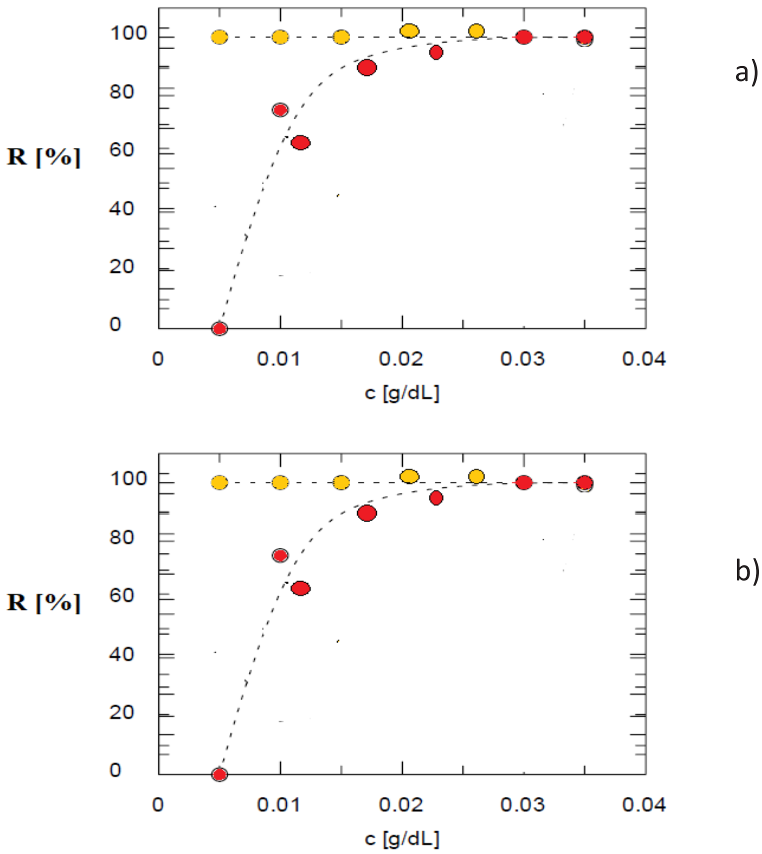


Figure 5. Dependence of retention (R ·····): a) of the normalized flux (J/J_0 —) b) of turmeric in water vs. concentration for: o – elastin membrane with plasticizer and bola surfactant and o – elastin membrane with plasticizer and classical surfactant

From Fig. 5 we observed for both membranes with surfactant the retention of turmeric of 100%. For elastin membrane with plasticizer and bola surfactant, we have a gradual increase and then a level of retention for turmeric and for the membrane with classical tenside is only a uniform retention around the value 100%.

The turmeric in aqueous solutions for different concentrations was characterized by dynamic light scattering. Dynamic light scattering test showed the 2 types of associates: nano and micro level The size, percentage of the particles, and Zeta potential were determined (indicating their stability).

The particles of turmeric in aqueous solutions for different concentrations, have sizes ranging between 50-80 nm and also aggregate at 2 µm-50 µm.

CONCLUSIONS

The conducted research has led to the following results:

- SEM microscopy examination showed unusual flat sheet elastin membranes based on surfactants (classical or bola).
- The presence of surfactants in the composition of the membranes formed was emphasized in order to maintain the ecology and membrane performances. Surfactants in the casting solution alter the size, as well as the density of pores and the roughness of the elastin membranes surface. The surfactants analyzed, yield membranes with small and dense pores and with smooth surface. Also, elastin membranes-based surfactants influenced the separation rates of the turmeric in aqueous solutions with different concentrations.
- Ecological membranes are obtained from a biodegradable biopolymer and can be successfully used in turmeric separation from water. The current European Community strategy related to the maintenance of the health of population, quality of life, and of the environment encourages the separation of organic pollutants through membranes.

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