

Identification of regions containing free water in hydrated matrix tablets made of sodium alginate

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Introduction

Alginates are natural polymers which are extracted from marine algae. They are linear polysaccharides consisting of β -D-mannuronic acid (M) and α -L-guluronic acid (G) residues. Most of the pharmaceutical applications of alginates are related to hydrogel formation. For this reason, studies that allow to elucidate the mechanisms of interaction between polymer chains and water molecules are of high priority for the understanding of these polymers functionality. The purpose of this work was to identify the regions containing free water in hydrated matrix tablets made of sodium alginate.

Materials

Sodium alginate (Protanal LF 240 D, Batch No. S13455, FMC BioPolymers, USA);

AQUAMETRIC Composite 5 for volumetric analysis (Panreac AppliChem, Spain);

Methanol according to Karl Fischer (Panreac AppliChem, Spain);

Methanol for UHPLC (Panreac AppliChem, Spain)

The distilled water was used to prepare the samples containing sodium alginate for both KF and DSC measurements.

Equipment

EXSTAR DSC 7020 apparatus (SII NanoTechnology Inc.)

Karl-Fischer titration equipment (Metrohm, USA)

Analytical weight (Sartorius, Germany)

EKO laboratory tablet press (Korsch-Erweka, Germany)

Home-made device for tablet hydrating and cutting layers

Methods

Tablets preparation

12 mm, round flat faced tablets of pure sodium alginate were preped using EKO laboratory tablet press.

Karl-Fischer titration

The samples for Karl-Fischer titration were prepared in a home-made device which allows unilateral hydration of the tablet. The device contains a micrometric screw which allows moving up the tablet in the holder to the required height and cutting a slice for further analysis. At specific timepoint (1, 2, 3, 4 h), the device was removed from the medium, the slices were cut and weighted on analytical weight. In such a way 5 slices (of 1 mm each) were obtained. The samples were then put into flasks, filled with methanol, introduced into ultrasounds in order to extract total water amount existing in the sample and measured following Karl-Fischer protocol. The results are shown as the water content (%) in each slice of the hydrated tablet.

Differential scanning calorimetry (DSC)

The samples were prepared by mixing sodium alginate and distilled water in a mortar in appropriate ratio to obtain final sample weight: 5g. At once 10-15 mg of each sample were put into an aluminum pan, sealed and measured in the temperature program: cooling run at 5°C/min from 20°C to -50°C and heating run at 10°C/min from -50°C to 70°C.

Results and discussion

We observed that above 40% of water content, the DSC peak presenting the free water appeared in both cooling (data not shown) and heating run (Fig.2). Furthermore, unfreezing and freezing bound water was observed up to the concentration of 40%. The water content of 40% corresponded to the second slice of hydrated tablet according to KF experiment (Fig. 1). In this way we identified the regions (the first and the second slice) which contained free water in hydrated matrix of sodium alginate.

Conclusion

In the present work we used KF method to determine the distribution of water content in the hydrated matrix tablets made of sodium alginate with a spatial resolution of 1mm. Additionally, we used DSC to figure out whether the free water exists in the sodium alginate-water mixtures containing rising water concentrations. Combining both methods served to identify the regions containing free water in hydrated matrix tablets made of sodium alginate.

References

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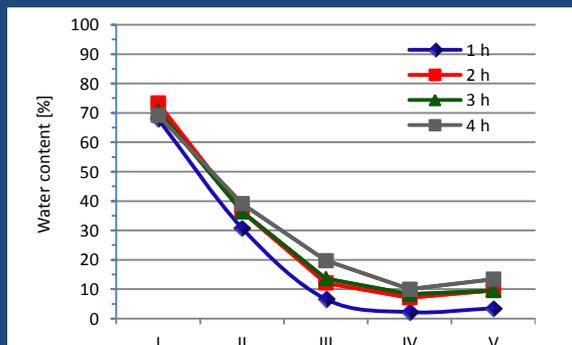


Figure 1. Water content change according to the distance from the tablet surface (I – most external layer, V – most internal layer).

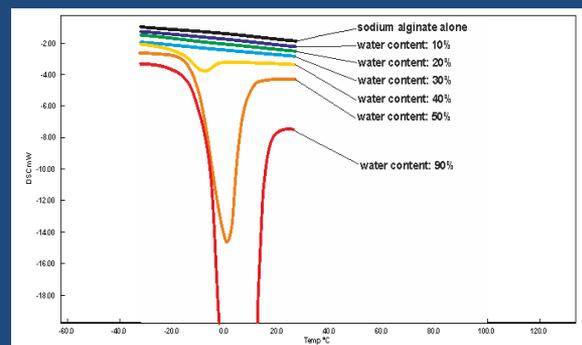


Figure 2. DSC curves of water-sodium alginate mixtures with different concentrations of water in heating run (endothermic process).