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Development of new polymer carriers based on Sodium Alginate (SA), Poly Vinyl Alcohol (PVA) and Dextran (DEX).

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Abstract : In this work, microparticles based on binary and ternary mixtures of sodium alginate, dextran and/or polyvinyl alcohol polymers were prepared, by the ionotropic gelation method, and then tested using curcumin (Cur) as active ingredient. The different elaborated microparticles (pristine and loaded), were characterized by thermogravimetric analysis (TGA), Fourier transform infrared spectroscopy (FTIR) and UV-Visible spectrophotometry. Their morphology and size were examined by scanning electron microscopy. Their swelling behavior and release properties were also evaluated. The obtained results indicate that the introduction of dextran within the alginate matrix improved the properties of the microparticles but did not deliver the active ingredient to the colon. On the other hand, the introduction of PVA within the CA matrix improved the properties of the microparticles, prevented their erosion and allowed the delivery of curcumin to the colon.

Keywords : Microencapsulation **,** Curcumin , CA/PVA/DEX microparticles , Ionotropique Gelation , Drug release.

I- Introduction

The pharmaceutical industry has greatly evolved over the past decades and the concept of controlled release has allowed the development of formulations that ensure the delivery of active ingredients from the site of administration to the site of release. SA microcapsules have been widely used as drug carriers for oral administration due to their multiple advantages. However, they have major drawbacks such as low encapsulation efficiency, abrupt drug release and degradation in the intestinal environment before reaching the site of action (colon). The objective of the present work is to prepare new polymeric vectors, with biocompatibility and good response to external environmental stimuli, based on SA/DEX/PVA blend for the microencapsulation of curcumin with proven values in the treatment of colon cancer.

II- Materials and methods

-Preparation of microparticles by the ionotropic gelation method :

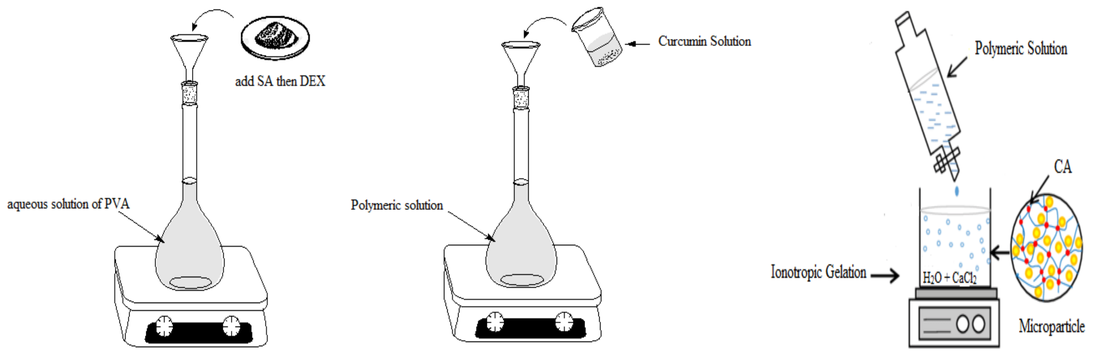


Fig. 01 : Preparation of loaded microparticles.

The microparticles were whased twice then air-dried.

III- Results and discussion

- FTIR Spectroscopy

Fig, 02 shows the FTIR spectra of the different samples.

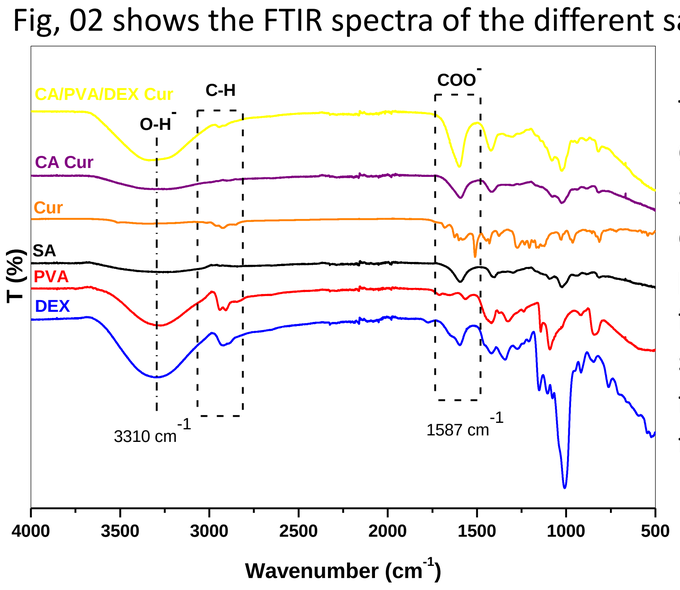


Fig. 02 : FTIR Spectra of samples.

The FTIR spectrum of CA/PVA/ DEX Cur (70/20/10 Cur) microparticles shows the coexistence of the characteristic bands of the three pure polymers which have almost the same functional groups, as well as a slight shift of the bands confirming the formation of hydrogen bonds in this ternary mixture.

- Thermogravimetric analysis TGA

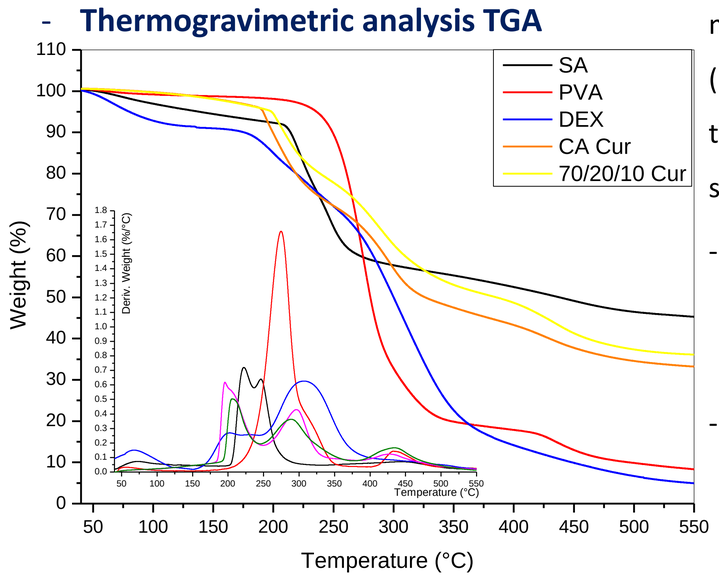


Fig. 03 : TGA and DTGA thermograms of samples.

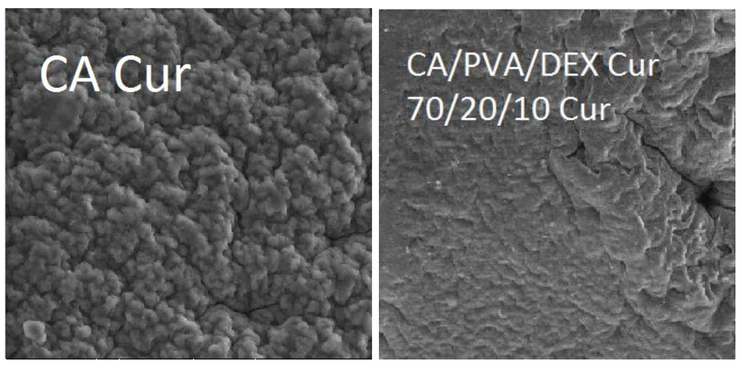
The TGA and DTGA thermograms of the microparticles (CA/PVA/DEX Cur) (70/20/10 Cur) plotted in Fig. 03 show that the latter degrades in three main steps.

- The first step corresponds to the preliminary decomposition of CA and DEX.
- The second loss of mass is attributed to the main degradation of DEX, PVA and CA leading to the formation of carbonaceous compounds and the mineral compound calcium carbonate CaCO3.

- The last degradation step related to these microparticles is dominated by the total decomposition of the main chains of PVA and CA and the carbonization process of both polymers.

- SEM analysis

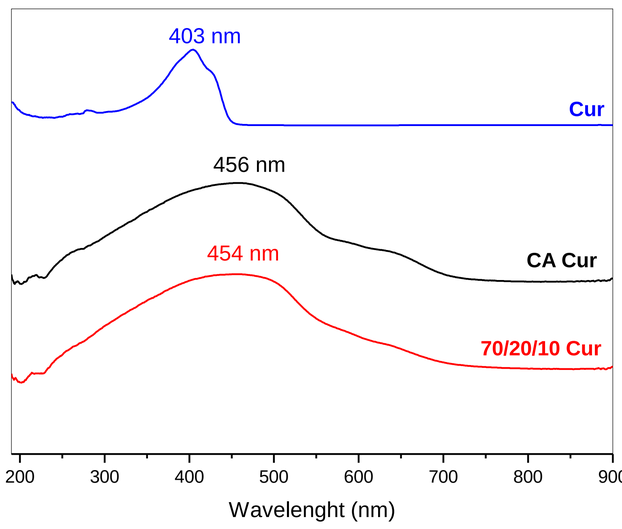
Fig. 04 display the SEM micrographs of loaded microcapsules



The microparticles have a homogeneous, compact structure, a pseudo-spherical shape and a very rough surface.

Fig. 04 :Scanning electron micrograph of CA Cur and 70/20/10 Cur mixture.

- UV-Visible Spectroscopy



UV-visible absorption spectroscopy was used to highlight the presence of curcumin in the loaded microparticles.

From Fig. 05, it can be seen that the spectrum of curcumin in the solid state showed an intense peak around 404 nm characteristic of the chromophore groups of curcumin.

Fig. 05 : UV Spectra of Cur and Loaded samples.

- Swelling study of pristine CA and CA/PVA/DEX 70/20/10 microbeads

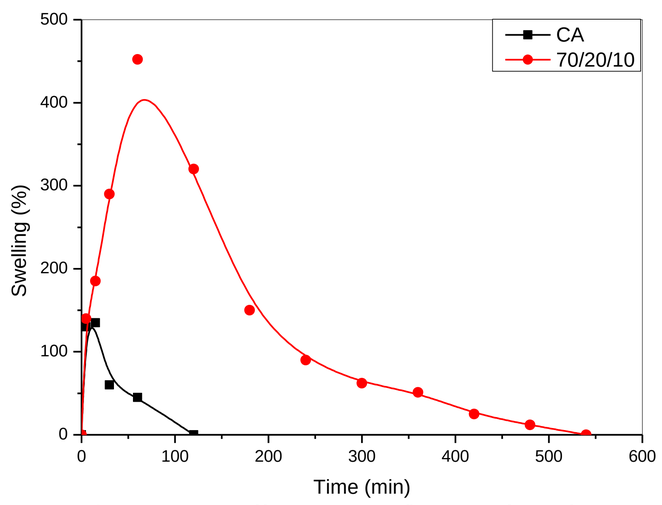


Fig. 06 : Swelling rate of virgin beads in Simulated Colon Fluid.

In order to overcome the shortcomings encountered with CA microparticles, another attempt was made by introducing PVA and DEX within the SA matrix. Fig. 06 shows the plots obtained in the SCF. The 70/20/10 sample swells very rapidly to 452% and starts to decrease after 1 h of residence, giving them a good release of curcumin in the colon. The total degradation of the microparticles is reached only after 9 hours of treatment in this buffer medium.

- Behavior of loaded microparticles in the digestive tract

Table 01 : Release rate of Cur in different pH media (%)

	CA Cur	CA/PVA/DEX Cur 70/20/10
SGF	8,6 %	0 %
SIF	91,4 %	90,5 %
SCF	0 %	9,5 %

The obtained results show that CA Cur microcapsules disintegrate in the SIF before reaching the colon while the 70/20/10 Cur formulation was able to deliver the Cur to the colon even though the % remains low.

Conclusion

Finally, we conclude that CA/PVA/DEX microparticles are good candidates for targeted application because they can deliver the active ingredient to the colon. However their properties need to be further improved.