CHAPTER VII
CONCLUSIONS

7.1 Conclusions

Either drug- or vitamin-loaded electrospun fiber mats was successfully prepared by the electrospinning process and was developed as transdermal drug delivery system. With all of the obtained results, it can be concluded that the electrospun fibers have a high potential to be developed as the matrix for the application of TDDS.

7.1.1 Morphological appearance of electrospun fiber mats and cast films

The morphology of the electrospun mats depended on the properties of the drugs or vitamin-containing polymer solutions which, in turn, were affected by the type of the model drugs or vitamins incorporated. Three main factors that affected morphology of the electrospun fiber mats were viscosity, conductivity, and surface tension of the solutions. Cross-sectionally round fibers with smooth surface were fabricated from electrospinning of PVA solution. The average diameter of these fibers was about 130 nm. Beaded fibers were observed when either SS- or DS-containing PVA solution was electrospun. This was because of the high conductivity of the solution. The increase in the solution conductivity was due to the ionization of the sodium carboxylate group upon the dissolution of either SS or DS in water. In contrast, the addition of either NAP or IND in the PVA solution slightly changed the properties of the solution and did not affect the morphology of the resulting fibers.

In the case of electrospun CA fibers, the smooth fibers with the average diameters ranged between 247 and 265 nm were obtained. With the addition of vitamins, the viscosity of the resulting solutions decreased from that of the neat CA solution. The smooth fibers were still obtained without any beaded fiber present.

7.1.2 Advantages of the electrospun fiber mats over the conventional films

For the application of TDDS, there are many advantages of the electrospun fiber mats over the conventional solution-cast films. Firstly, there was no presence of the drug crystals or other kinds of drug aggregates on the surface of both drug-loaded electrospun PVA fibers and vitamin-loaded electrospun CA fibers even

though NAP and IND are both insoluble in PVA solution. This observation indicated that either drugs or vitamins were perfectly included within the electrospun fibers while the aggregation of DS, NAP, IND and Vit-E was clearly observed on the film surface. The aggregation of a drug or vitamin on the film surface caused the unpleasant initial burst release. Secondly, because of the highly porous nature of the electrospun mats, the degree of swelling of the electrospun mats was greater than that of the as-cast films. In addition, the higher release rate of either the drug or vitamin was also obtained from electrospun mats for all experiments since the higher surface area of the electrospun mats allowed either drug or vitamin molecules to diffuse out from the matrix much more conveniently. Finally, the strain at maximum of the as-spun fiber mats was about 10 times as much as that of the as-cast films although the tensile strength was slightly poorer. If these drug or vitamin-loaded as-spun fiber mats are to be developed as transdermal or dermal patches, there is an advantage over the corresponding as-cast films on the dramatic improvement in the flexibility of the obtained patches.

7.1.3 Stability of incorporated drugs and vitamins in the electrospun fiber mats

The application of a high electrical potential to the drug or vitamin-containing solutions did not affect the chemical integrity of either drugs or vitamins. The chemical structures of the released drugs and vitamins were unchanged as confirmed by ^{1}HNMR and HPLC for NSAIDs and vitamins, respectively.

7.1.4 Cross-linking of SS-loaded as-spun PVA fiber mats by glutaraldehyde or glyoxal solution

In an attempt to control the rate of drug released, the electrospun fiber mats of PVA containing SS as the model drug were further cross-linked with the vapor from aqueous solutions of either glutaraldehyde or glyoxal. The results showed that cross-linking slowed down the release of SS from the drug-loaded fiber mats appreciably. Both the rate of release and the total amount of the drug released were decreasing functions of the exposure time interval in the cross-linking chamber. In addition, the cross-linked SS-loaded e-spun PVA fiber mats were non-toxic to normal human dermal fibroblasts regardless of toxicity of the crosslinking agents.

7.2 Recommendations

In this work, it must be noted that the electrospinning setup used only a single syringe which limited the scale of production of electrospun fibers. In order to apply this contribution to the industry, mass production of electrospun fibers is needed. Therefore, a multi-syringe electrospinning set-up may be used to achieve a large quantity of fibers within a short spinning time. By using this set-up, the jet formation, fiber diameter, morphological appearance and arrangement of syringes are needed to be further studied.

It should be noted that the nature of both the drug and the polymer matrix could affect the release characteristic of the drug and the morphology appearance of the obtained fibers. In order to develop this contribution for a specific use of drug delivery system, the drug and the polymer matrix had to be appropriately chosen in order to achieve the suitable release characteristic for specific applications.