CHAPTER 5

Conclusion

During this study, electrospun fibers using water-soluble polymer were produced by electrospinning and developed for use as a fast dissolving dosage form. Propolis, a natural product collected by honeybees, was used as active ingredient. This product was selected due to its effective antibacterial activity against *S. mutans*, the major pathogen responsible for dental caries, as it is capable to induce biofilm formation on the tooth surface. It has been proven that it is possible to develop propolis electrospun fibers to orally fast dissolving fibers for use as part of an oral healthcare product.

PVP K90 was chosen as a polymer base for fast dissolving electrospun fibers in this study. 8-10% (w/v) of PVP K90 was the optimum concentration that produced smooth and uniform fibers, in size ranging from 0.40-0.65 μm. The electrospinning technique conditions were as follows. A feeding rate of 2 mL/h, a distance between needle tip and collector of 15 cm, an electrical voltage of 15 kV. Propolis-PVP electrospun fibers were successfully prepared using the electrospinning technique. Propolis incorporated up to 5% (w/v) in a PVP K90 polymer solution, can produce smooth, uniform and electrospun fibers, free of beads. 1% (w/v) Tween 80 was used as wetting agent for improved wettability of electrospun fibers, which were incorporated into the fibers. Small amounts of additives, such as menthol, thymol, methyl salicylate and eucalyptus oil, were used as flavoring agents.

XRD and DSC revealed that all the materials in the electrospun fibers were in an amorphous state. FT-IR spectra suggest that PVP K90 and propolis have good compatibility. The propolis in the fibers was distributed continuously in the electrospun fibers, thus giving good uniformity of the propolis content.

Propolis-PVP electrospun fibers can be disintegrated and dissolved in small amounts of water. Propolis can also be released from electrospun fibers and perform antibacterial activities against *S. mutans* when tested by the agar diffusion method. The inhibition zone was observed when tested with a concentration of propolis from electrospun fibers with an equivalent of 10 MIC and above. By using propolis-PVP electrospun fibers that contained a propolis concentration at sub-MIC level, a decrease of adhesion of *S. mutans* to a smooth glass surface was evident including a reduction of vital *S. mutans* in plaque. Electrospun fibers of 5% (w/v) propolis with 8% (w/v) PVP electrospun fibers with or without additives and Tween 80, were tested at a concentration of propolis equivalent to 0.6 MIC; 1 MIC was able to reduce with more than 50% the adherence of *S. mutans* to a smooth glass surface. Propolis electrospun fibers demonstrated antibacterial activities against *S. mutans* and had an inhibitory effect on the formation of *S. mutans* biofilm as could be observed through optical micrographs and a SEM. When compared with other commercial mouthwash solutions, it appeared that propolis extract in electrospun fibers at 0.6 and 1 MIC was more effective than mouthwash solutions containing natural essential oils as active ingredients; although these were free from chemical antiseptic substances, they were anyway less effective than the mouthwash solutions containing some chemical substances as antiseptic agents.

In conclusion, the present study has demonstrated that propolis-PVP electrospun fibers can be used as fast dissolving fibers to control *S. mutans* in oral cavities due to the antimicrobial activity of propolis, the decrease of *S. mutans* and reduction in adhesion of *S. mutans* to a smooth surface, the initial stage of plaque formation. Electrospun fibers of water-soluble polymer as PVP K90, which have small diameters ranging in size from nano to micrometer and feature a large surface area, provided a fast dissolving property. Moreover, PVP 90 facilitated the release of insoluble propolis from these electrospun fibers thus revealing antibacterial activity when these fibers dissolve in water.

From the structure of electrospun fibers which were contained PVP K90 that fibers belong the small diameter ranging in size from nanometer to micrometer of water soluble fibers and a large surface area provided fast dissolving property and improved the dissolving property including provided the releasing of propolis from electrospun

fibers. Thus, orally fast dissolving propolis-PVP electrospun fibers can be used as an alternative anticariogenic agent, and in a new solid dosage form.