CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The silk sericin/PVA/clay aerogel, the new foam like material, was successfully developed via freeze-drying technique. Due to the limitation of neat clay aerogel, the fragility of neat clay aerogel restricted the augmentation of its applications. To overcome this problem, silk sericin and poly(vinyl alcohol) were applied to improve the mechanical properties. The dominant morphology of silk sericin/PVA/clay aerogel was the "house of cards" structure. In detail, the lamellar morphology with interconnected pore was obviously observed with the pore size was greater than 100 μm which the distance between layer and the thickness were depend on the clay and silk sericin contents. The clay bentonite was powerfully affected on both thermal and mechanical properties. The increment of clay content exhibited the improving of mechanical properties owing to the high reinforcing efficiency and aspect ratio of clay bentonite which introduce the stiffness structure for the biocomposites. The presence of ferric ion (Fe^{3+}) in the octahedral sheet of bentonite was the main factor to accelerate the thermal decomposition of the silk sericin/PVA/clay aerogel resulted in the reducing of thermal stability. At 8 wt% of clay, the clay loading was excess leading to the inhomogeneous structure with more power to accelerate decomposition causing the inferior mechanical and thermal properties. The silk sericin content vastly increased the mechanical and thermal properties. The enhancement of mechanical properties occurred from the higher number of strong hydrogen bond between silk sericin, PVA and silanol groups of clay bentonite. The anti-oxidation properties of silk sericin indicated the inhibition of the oxidation of ferric ion of clay resulted in the higher thermal stability. The influences of clay and silk sericin on the properties of glutaraldehyde cross-linked silk sericin/PVA/clay aerogel were in the same trend as uncross-linked aerogel. The chemical cross-linked by glutaraldehyde exhibited the excellent modulus aerogel with the improving around 50% compared with uncross-linked. For the thermal

stability, the cross-linked reaction and the glutaradehyde concentration was not significantly affected.

Silk sericin was cooperated with clay aerogel on account of the efficiency to promote cell growth and cell differentiation. The glutaraldehyde cross-linked silk sericin/PVA/clay aerogel had the potential to be used as scaffold for tissue engineering in order to use in periodontitis due to the appropriate pore size and good biological activities. The cross-linked silk sericin/PVA/clay aerogel exhibited the swelling ratio around 800-1300% related to the high porosity and large pore size observed by FE-SEM. The swelling ratio decreased with the increasing of silk sericin, clay and glutaraldehyde contents. The *in vitro* direct contact test suggested the cytocompatibility of the cross-linked aerogel in all composition. Additionally, the MTT assay used to confirm biocompatibility and cytotoxicity revealed that different in silk sericin content, glutaraldehyde concentration and species of silk presented the slightly different in cell viability and mitochondria activities. The species of silk exhibited the most effect on the cell viability owing to the different in total amino acid composition in each species. Nang Lai species showed the most enhancements in cell growth and cell viability because of the highest methionine and cysteine content.

The optimum condition was found in aerogel in the composition of clay 6wt%, silk sericin 4 wt% and glutaraldehyde at 5 µl/ml. Because in this composition presented the optimum in mechanical, thermal properties and the lowest maximum swelling ratio. The most suitable scaffold should be C6PVA5SS1 0.5GT using Nang Lai species due to the high biological activities.

7.2 Recommendations

a) In this research, the inhomogeneous structure of aerogel still observed because of the high viscous clay gel precursor. The suitable clay content should be equal or lower than 6 wt% of clay.

b) The freezing method is another factor to obtain the homogenous structure. To be used as 3D-scaffold, the freezing by using the solid CO_2 in water under the oscillation using the shaker bath is the effective way to obtain the suitable pore dispersion.

c) Beside the 3D scaffold, cross-linked silk sericin/PVA/clay aerogel can be used for the drug delivery system owing to its porosity. The silk sericin/PVA/clay aerogel can expand the application to another field. For example, the biodegradable absorbent material, the insulation material, smart package etc.