CHAPTER 4

CONCLUSIONS

The main purposes of this study are to improve physico-mechanial properties of CMMS and to evaluate its pharmaceutical property as a gelling agent. The alcohol tolerability of a CMMS was improved by cross-linking reaction. Seven CL-MBs were synthesized from MB in a single-step procedure with MCA and DCA, using the well-known *Williamson* reaction. Both, carboxymethylation and cross-linking were then carried out simultaneously, using the W*illiamson* etherification reaction. This was done by adding MCA for carboxymethylation and DCA for cross-linking, stirring the mixture at 70^{o}C for 60 min. The finished powders of CMMS, cross-linked MB and CL-MBs were obtained as light yellowish, fine powders. The CL-MBs yield were between 95.67-97.75%. The appearance of 7 conditions of CL-MBs were opposite from the native MB. They were light yellowish, fine powder and fine-grained. They were soluble in cold water to be gelatinous. The gelling was flexible, transparent, of high strength and homogeneous more than native mungbean starch paste at the same concentration with observation. On the other hands, cross-linked MB was insoluble in cold water, difficult to disperse in the solvent, thus the precipitation was rapidly. The DS value of CL-MBs ranged between 0.2121 and 0.2456. The DS value was linked with the intensity of the carbonyl group peak, determined by FT-IR analysis. The FT-IR was confirmed that DCA was not given the carbonyl group substitution to the side-chain of native mungbean starch. The morphology of CL-MBs were analyzed using SEM, was showed an SEM image similar to native MB as kidney-shaped image with smooth surface. The formation of a grooved surface can be observed on the starch granules with CL-MB-5, CL-MB-7, CL-MB-8, CL-MB-9 and CL-MB-10. The grooved surface was far below the surface, extending far downward when the concentration was increased. The X-ray diffractograms of CL-MBs exhibit a slightly decrease in the signal intensity, corresponding to a bit decrease in the crystalline polymorph of native mungbean starch (no significance). The strong diffraction peaks at 15.25, 17.43 and 23.05°2θ, agreed with C-type crystalline starches. The moisture content of modified starched became lower compared with its native starch. The CL-MB-7 was shown the least dampness. The sequential of moistness was CL-MB-7 < CL-MB-8 < CL-MB-9 < CL-MB-10 < CL-MB-5 < CL-MB-4 < CL-MB-1. These were still in the specification of modified starch. CL-MB-7, CL-MB-8, CL-MB-9 and CL-MB-10 showed the FSC values higher than CMMS, cross-linked MB and the four commercial polymers. The CL-MB-7 had completely swelled after 180 min. and had swollen to 100 times its starting weight. The pH of 1, 3 and 5%w/v CL-MBs paste were 6.8-7.4. The rheological profile of CL-MBs revealed a pseudoplastic with thixotropic behavior that very important behavior when using as a gelling agent. The rheograms of CL-MBs showed an increase in solution viscosity compared to that of CMMS. Under accelerated condition, the characteristics of CL-MBs gel were not different from those of CMMS gel. The clarity, pH and viscosity of 1%w/v CL-MBs gel were unchanged at 30%v/v EtOH compared to those in water. The viscosity of CL-MBs solutions after subjecting to heating-cooling cycles remained 2 times higher than that of CMMS at the same concentration. CL-MBs were used as gelling agent to substitute of commercial gelling agent in NM gel formulation. The formulation from CL-MB-8 showed the best formulation. CL-MB-7, CL-MB-8 and CL-MB-9 exhibited good gel characteristics, which suggested the potential use of CL-MBs as a new gelling biopolymer for pharmaceutical application to formulate NM gel.

NM gel was formulated by the order of mixing. NM was used as an active ingredient. DMSO was a penetrate enhancer and a solvent, liked DEB 96. Propylene glycol was used as a humectant and TEA as a pH adjuster. Paraben conc. was added as a preservative. The recrystallization of NM was manifested in the formulation with CP as a gelling agent but these problems were unaffected to SCMC and CL-MBs. NM gel formulations were stored at 8°C, 45°C and RT, and underwent a HC stability. The color of the gel bases prepared from CL-MB-7, CL-MB-8 and CL-MB-9 were unchanged and were stable than that of SCMC. The NM gel formulations were an amber-colored gel and unchanged after the stability test. They were still as a gel appearance and none of the gel separation phenomenon. After the stability test, the pHs of NM gel formulations were slightly changed but they was still in range. The image of NM gel formulations were not difference from gel bases at a 40X magnification. The rheograms of gel bases and NM gel formulations, presented a pseudoplastic flow with thixotropy. The NM gel formulations were stable at all conditions and the best viscosity was shown by NM-2. The NM-2 had completely released after 180 min and the released profile was unchanged after the stability test. Therefore, the NM-2 exhibited the best NM gel formulation with greater released profile under accelerated conditions, preparated by using CL-MB- 8 as a gelling agent.

From the experiments, CL-MBs can be used as a new gelling biopolymer for pharmaceutical application instead the commercial polymers.