ABSTRACT

Nanomembrane wound care dressings are quite interesting and important growing in the medical textiles. Because of unique properties as high surface area to volume ratio, film thinness, nano scale fibre diameter, porosity, light weight, nanomembranes are used in wound care dressings.

Wound dressing with electrospun nanomembrane can meet the requirements such as higher gas permeation and protection of wound from infection and dehydration. The electrospun membrane kept exudates fluid from the wound area and inhibited the invasion of exogenous microorganisms because of the fine pores. There is a particular advantage to this system because of the possibility of delivering uniform, highly controlled doses of antibiotics at the wound area by taking advantage of the high surface-to-volume ratio of the nanomembrane system. Six different types of nanomembrane have been developed for special wound care dressings in this research work.

Nine different types of p (HEMA) drug free nanomembranes were developed by altering the electrospinning process parameters and optimized. Ketoprofen drug has been loaded into the optimised p (HEMA) nanomembrane. From the morphological characteristics, it was observed that, as the concentration of the p (HEMA) solution increases from 6 wt% to 13 wt%, the fibre formation ability increased proportionately. Antibacterial activity showed that drug loaded nanomembrane retained its biological functionality even after subjected on to a high electrical voltage. The drug
release was completed after 20 minutes in pH 7.5 medium. On the other hand, drug release of 78% was observed in pH 4.5 and 54% was measured for pH 1.2. The drug dissolution was faster in neutral medium than acidic medium.

Electrospinnining variables such as, 15 kilovolt power supply, 1.2 millilitre/hour flow rate and tip to collector distance of 12 centimeter have been optimised for the production of p (HEMA)/chitosan nanomembranes with three different blend ratios of 80:20, 60:40 and 40:60. Amongst the three different p (HEMA): chitosan blend ratio, the uniform structure of nanomembranes was formed at the blend ratio of 60:40. The tensile characteristics, antimicrobial activity and swelling capacity of the p(HEMA)/chitosan blend nanomembrane with 60:40 ratio is found satisfactory for wound dressings applications. It was found that the water uptake decreased from 355 to 275% when the blend ratio of p (HEMA)/chitosan changed from 80:20 to 40:60. At ratio of 60:40 p (HEMA)/chitosan nanomembranes exhibited excellent bacterial inhibition growth than that of 80:20.

Electrospinnining variables such as, 20 kilovolt power supply, 0.8 millilitre/hour flow rate and tip to collector distance of 15 centimeter have been optimised for the production of p (HEMA)/sodium alginate nanomembranes with ratios ranges from 80:20 to 50:50. The morphology of p (HEMA)/sodium alginate blended nanomembrane presented uniform fibre structure with increasing alginate ratio from 80:20 to 50:50. The results confirm that among various blend proportions of p (HEMA)/sodium alginate, the nanomembranes developed using the combination of 50:50 ratio, resisted
the bacterial growth at 56% when compared to control. When the blend proportion increased from 80:20 to 50:50, the moisture vapour transmission rate also increased proportionately from 2430 to 2750 g/m²/24 hour. The p(HEMA)/sodium alginate (50:50) nanomembrane substrates showed cytotoxicity activity against the cell line found to have “None” reactivity and hence graded as “0” as far as cytotoxicity is concerned. p (HEMA)/sodium alginate wound dressing do not causes any skin irritation even after 72 hours of contact with the wound.

Nine different nylon-6 nanomembranes have been produced with six different solution concentration and three different levels of spinning variable based on Taguchi orthogonal array experimental design. From these variables, 20 kilovolt power supply, 1.5 milliliter/hour flow rate and tip to collector distance of 10 centimeter and 16 wt% solution concentration have been optimized for the production of nylon-6 nanomembranes. Nylon 6 polymer solution concentration of 16 wt% was blended with PCL polymer solution concentrations at different blend ratios ranges in between 90:10 to 10:90. At 80:20 nylon 6/PCL blend ratio only the homogeneous solutions have been obtained. Six different nylon-6/PCL nanomembranes have been produced. From all combinations, sample (nylon-6/PCL nanomembrane with concentration of 16%/12%) is produced without any beads on the surface, hence uniform nanomembranes were produced.

Multilayer wound dressings have been produced using polyester spun lace nonwoven as a wound contact layer, bamboo spunlace nonwoven as absorbing layer with one, two, three layers and nylon 6/PCL electrospun
nanomembrane as back layer. Multilayer wound dressings made of single absorbing layer has air permeability values higher than that of other two layers by about 8%. Water vapour transmission of single absorbing layer is also much higher as compared to other two layers. The extents of difference from three absorbing layers are 35% in the case of single absorbing layer and 30% for two absorbing layers. The difference in water absorption ability between these layers from single absorbing layer is the order of 30%, 22% for three layers, two layers respectively. Multi layer wound dressings also exhibit excellent antibacterial activity against both gram positive and gram negative bacteria. The study has shown that multi layer wound dressings do not cause any skin irritation even after 72 hours of contact with the wound.

Nine different PVA nanomembranes have been produced with three different levels of spinning variable and optimized. PVA polymer solution concentration of 12 wt% was blended with silver nitrate polymer solution concentrations (1% - 2%) at four different blend ratios 80:20, 70:30, 60:40 and 50:50. PVA/silver nitrate nanomembrane (70:30) is produced without any beads on the surface and hence uniform nanomembranes were produced. With increase in the concentration of silver nitrate in PVA i.e from 1.0 to 2%, moisture vapour transmission values increased from 3080 to 3160 g/m²/24 hour. PVA/ silver nitrate, nanomembranes completely arrested the bacterial growth (100%) when compared to control. The PVA/silver nitrate nanomembrane substrates produced in this study were found to have “Mild” reactivity and graded as “2” as far as cytotoxicity is concerned.