

The degradation kinetics of the post-neutralized electrospun chitosan nanofibrous membranes with different dichloromethane/trifluoroacetic ratio

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Introduction

Chitosan solutions are highly viscous and complicated for electrospinning due to presence of free amino groups that makes it a positively charged polyelectrolyte under acidic conditions. Increasing the acid concentration in chitosan solution can influence on the chitosan structure that lead to pure mechanical parameters of membranes and make them quickly degradable in an aqueous environment [1].

Aim

Optimization of chitosan solution for electrospinning in different dichloromethane/trifluoroacetic (TFA/DCM) ratio and assessment of swelling capacity (SC) and weight loss (WL) of electrospun membranes after alkali treatment.

Methods

3.5% (w/v) chitosan solutions (Table 1) were prepared by dissolving in TFA/DCM (7:3 and 9:1, v/v). After electrospinning (Table 2) membranes were neutralized in 1M Na₂CO₃ solution (aqueous). Difference between the wet swollen samples and the dried samples measurements (%) was taken for the determination of SC (1) and WL (2) after submersion in phosphate buffer saline (PBS; pH=7.4) at various time intervals (20 and 60 min for SC and 1 day and 3 days for WL). Calculations were carried out using the following equation:

$$SC(\%) = \frac{W_d - W_s}{W_d} \times 100\% \quad (1)$$

$$WL(\%) = \frac{W_s - W_d}{W_d} \times 100\% \quad (2)$$

where W_s (g) is the weight of the swollen nanofibrous mat and W_d (g) is the weight of the samples after drying at room temperature.

Table 1. Parameters of chitosan solutions

Parameters	Solution 1/2
MW, kDa	890
DD, %	≥90
Viscosity, cP	100-300
Concentration, %	3.5

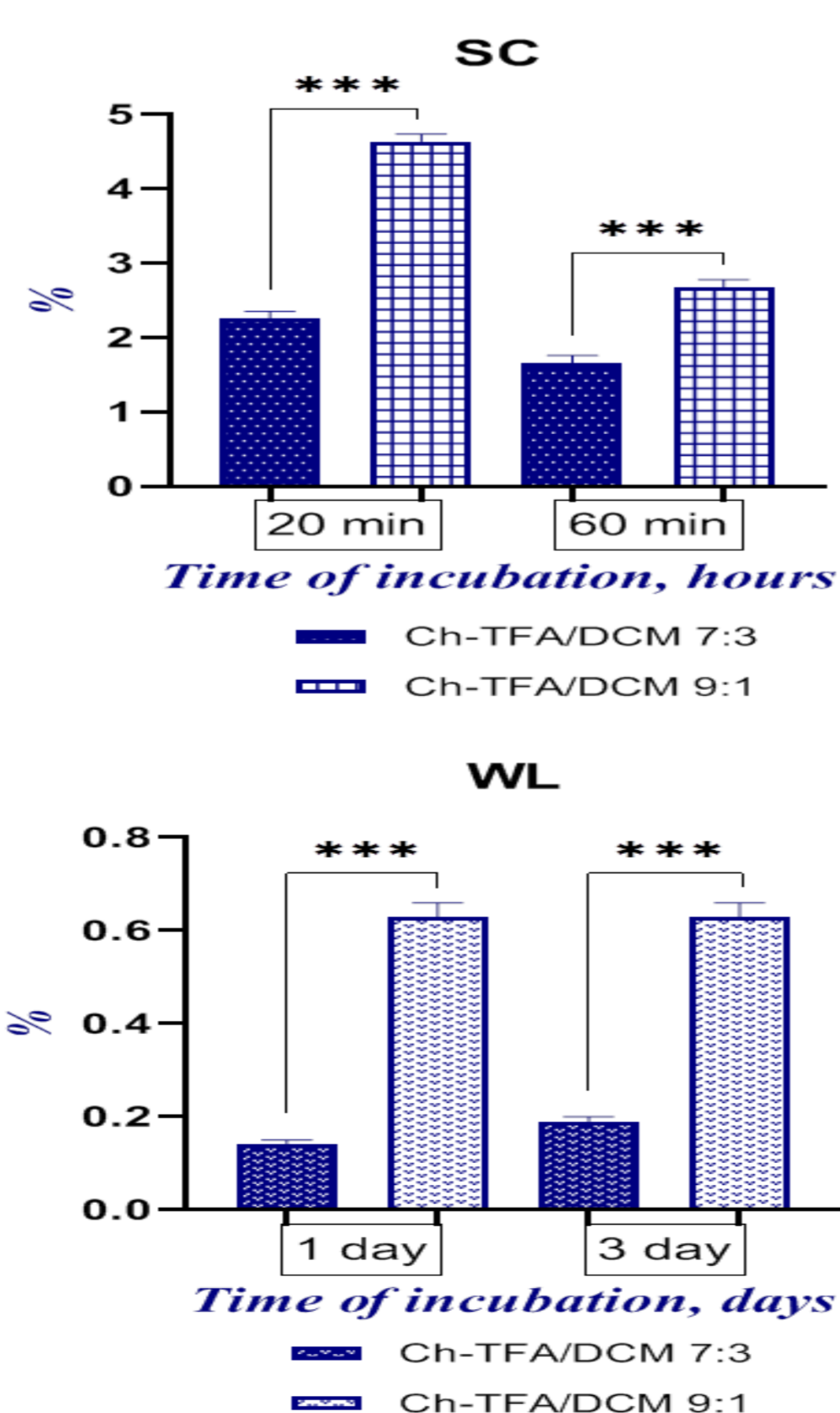
Table 2. Electrospinning parameters

Processing Parameters	
Flow rate, mL/h	5.0
Voltage, kV	30–35
Tip-collector distance, cm	15
Volume of the syringe, mL	10
Inner diameter of the needle, mm	0.69
Rotating speed, rpm	800-1000
Temperature, °C	21–24
Relative humidity, %	<35

Results

Swelling properties of chitosan membranes prepared in 9:1 TFA/DCM ratio were in 2 and 1.5 times higher than of the nanofibers created in 7:3 cosolvents system after 20 and 60 min submersion in PBS.

Weight loss was significantly higher for sample prepared in 9:1 TFA/DCM ratio (p≤0.05) at all time points of experiment.



Conclusion

The nanofibrous membranes fabricated from chitosan solution in 9:1 TFA/DCM ratio possessed greater level of SC and WL that can be explained by the removing bigger amount of TFA and consequently higher weight reduction within neutralization and immersion into PBS during the experiment.

References

- Sencadas V. et al. Determination of The parameters affecting electrospun chitosan fiber size distribution and morphology // Carbohydrate Polymers. – 2012. – 87. – P. 1295–1301.

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