Development and in-vitro evaluation of wet-spun fibers as a potential moist wound care dressing

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Introduction

Moist wound healing is important to facilitate the healing process and it provides ease of application, and enhances the level of life. The beneficial effects of the humid wound climate are to prevent tissues or cells from death by dehydration and accelerated angiogenesis. Newly developed alginate-hyaluronic acid fibers have significant contribution in faster wound healing and controlled drug delivery along with other biomedical applications.

Experimental

Table 1. Experimental design for alginate-hyaluronic acid fibers production.

Sample Symbol	Sodium Alginate (%)	Hyaluronic Acid (%)	Drawing Ratio	Dope Solution Viscosity (cP)	Coagulation bath (CaCl2) (%)
Fiber Produced by First Route					
S1	5.0	0.25	5.0	5500	1.5
S2	5.0	0.5	5.0	5500	1.5
S3	5.0	1.0	5.0	5500	1.5
Fiber Produced by Second Route					
S4	5.0	0.25	5.0	6250	1.5
S5	5.0	0.5	5.0	6900	1.5
S6	5.0	1	5.0	7850	1.5
S7*	5.0	0	5.0	5500	1.5

*control fiber

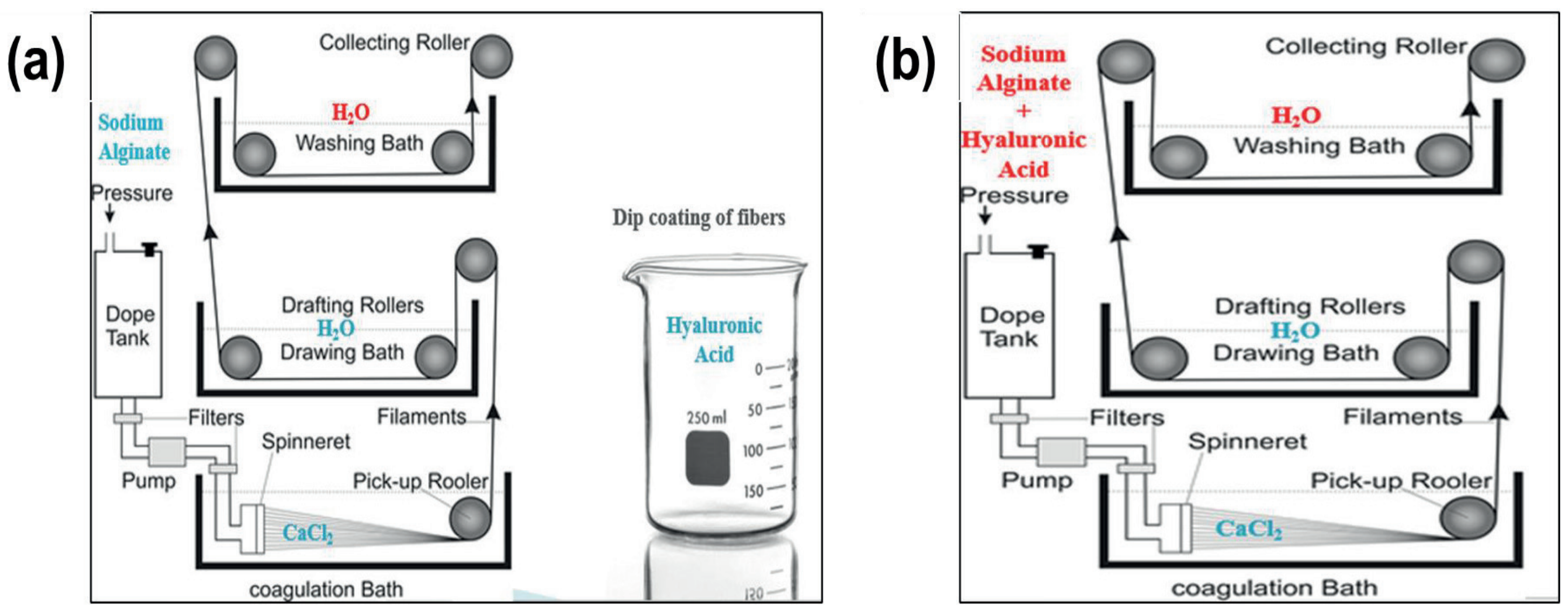

Fig. 1. An illustration of wet extruder machine and methods (a) and (b) used for AHA fiber production.

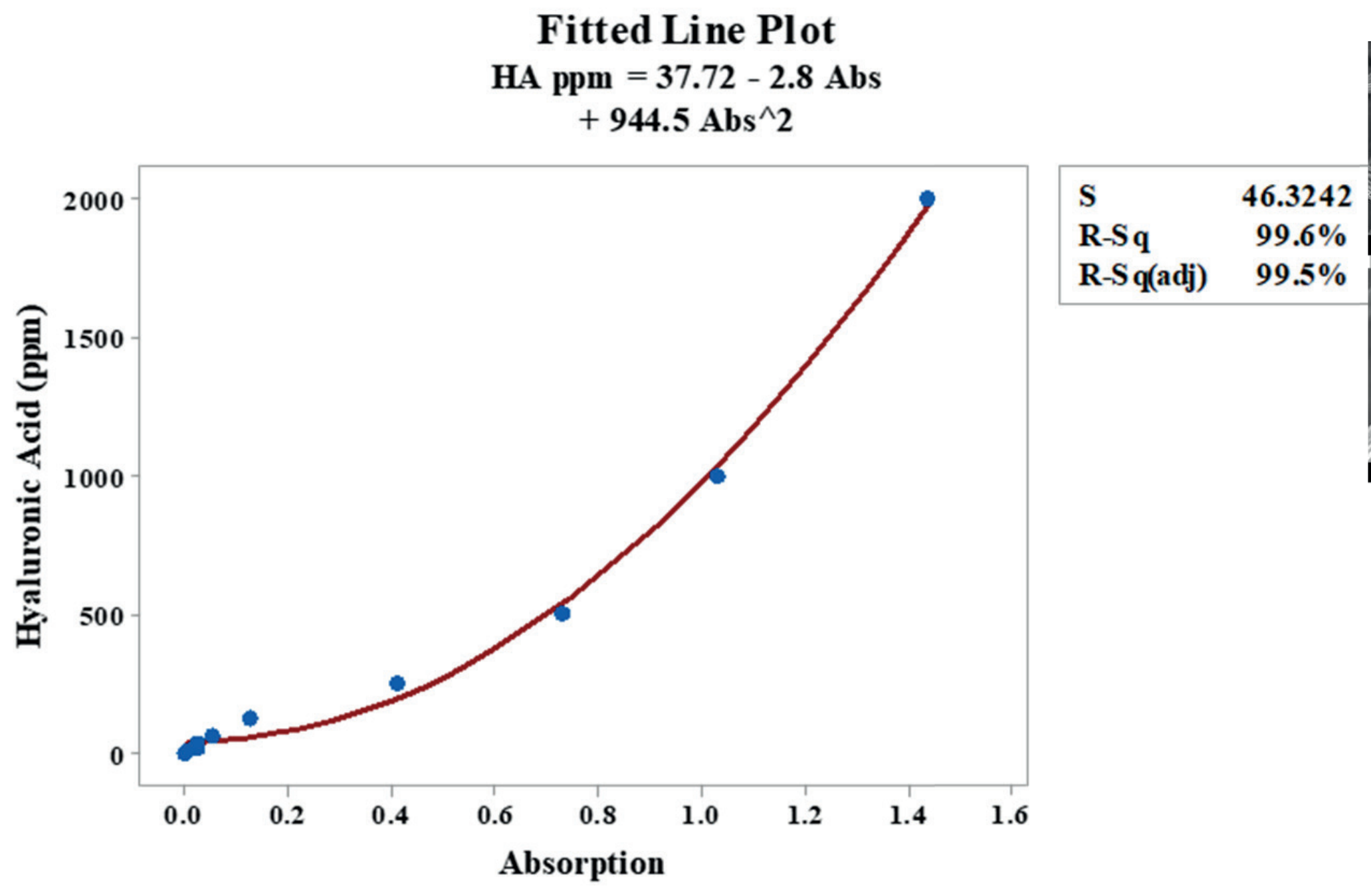

Fig. 2. Fitted line plot and quadratic equation for hyaluronic acid release at 600nm.

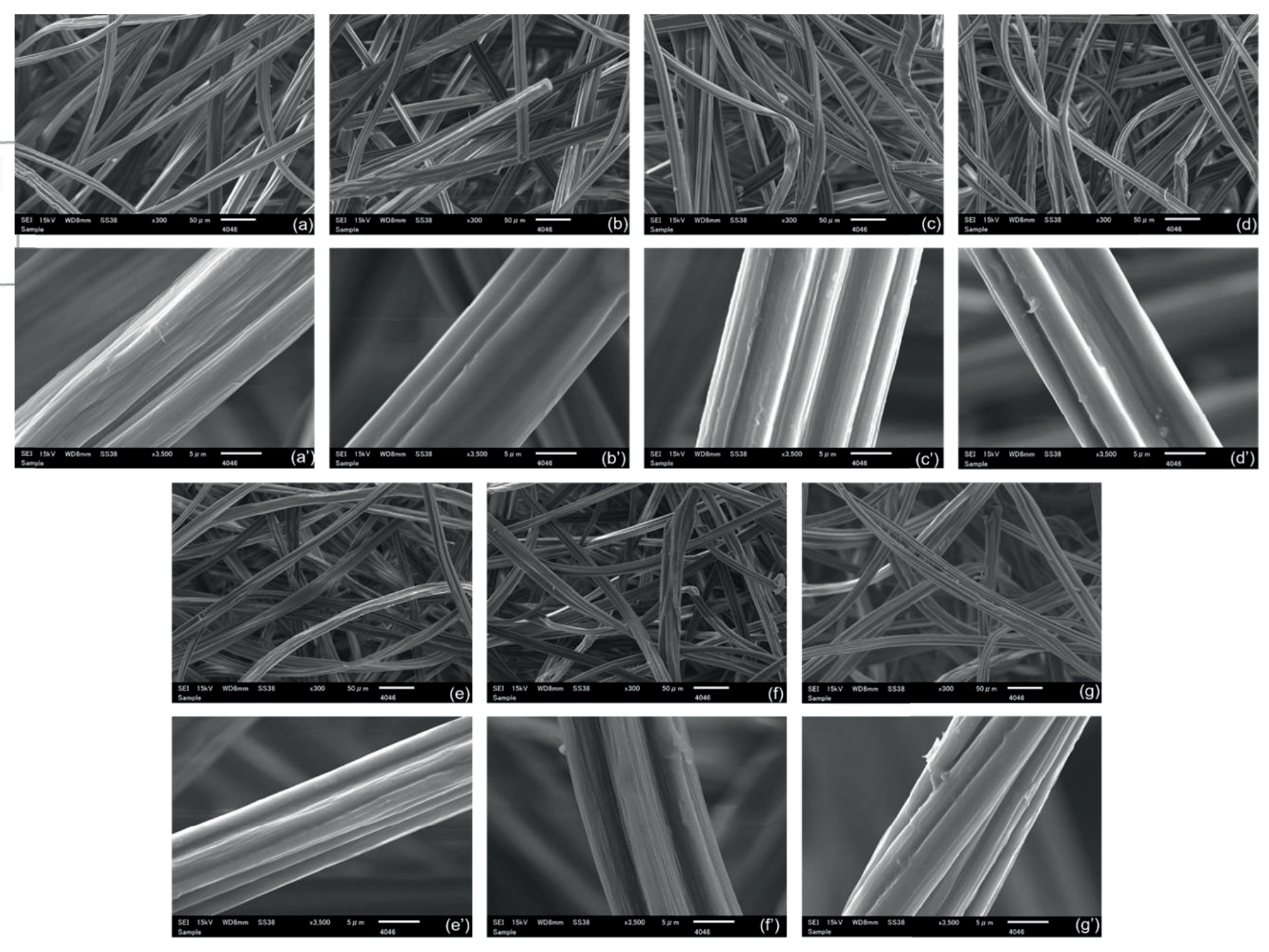

Fig. 3. SEM micrographs of the S1 (a, a'), S2 (b, b'), S3 (c, c'), S4 (d, d'), S5 (e, e'), S6 (f, f'), and S7 (g, g') showing surface striations.

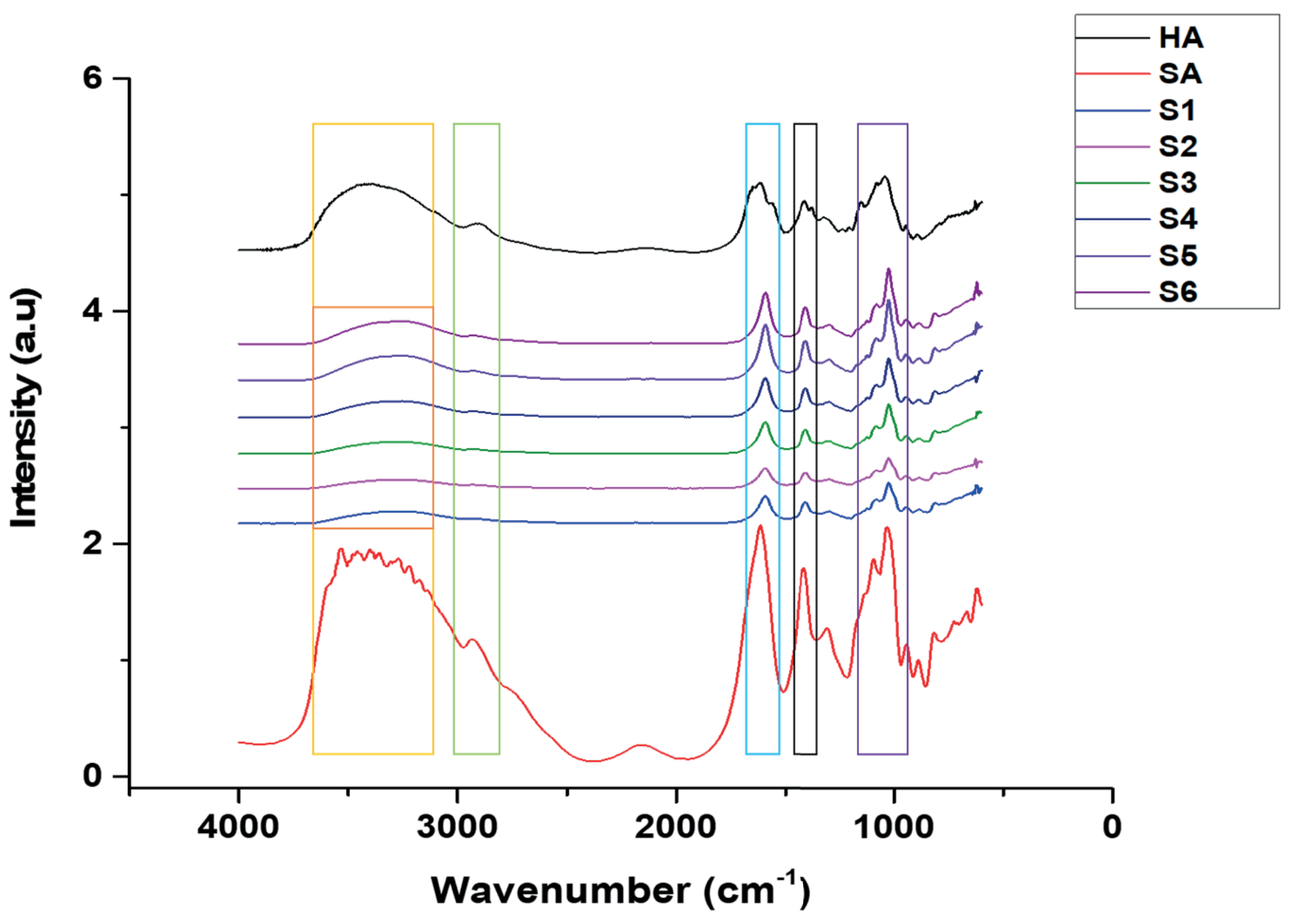

Fig. 4. ATR-FTIR spectra of the Hyaluronic acid, Sodium Alginate and composite AHA fibers.

Results

The results showed that novel fibers produced by the second method have better mechanical performance, high liquid absorption, and swelling percentage with a more controlled release of hyaluronic acid. The novel fibers showed high biocompatibility toward nHDF cell line in in-vitro testing, and the MVTR values (650–800 g/m2/day) are in a suitable range for maintaining a moist wound surface proving to be appropriate for promoting wound healing.

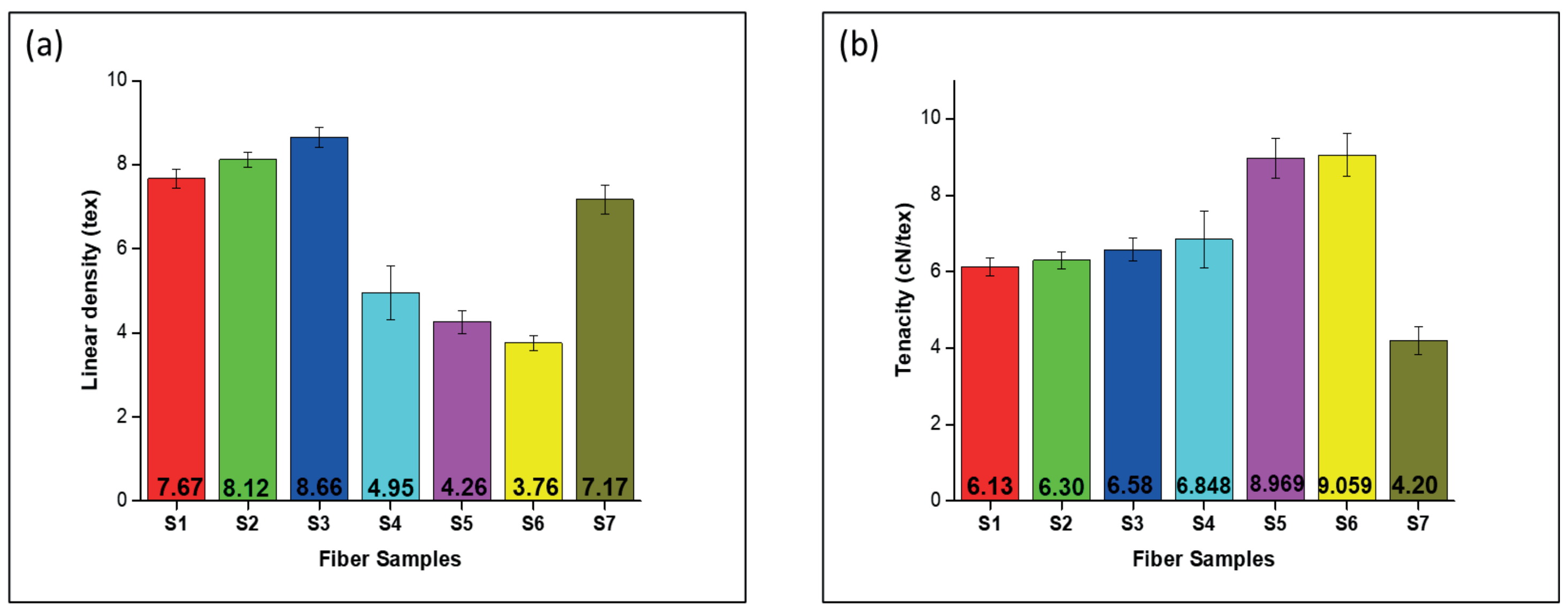

Fig. 5. Linear density (a) and tenacity (b) of the developed AHA fibers and control alginate fiber.

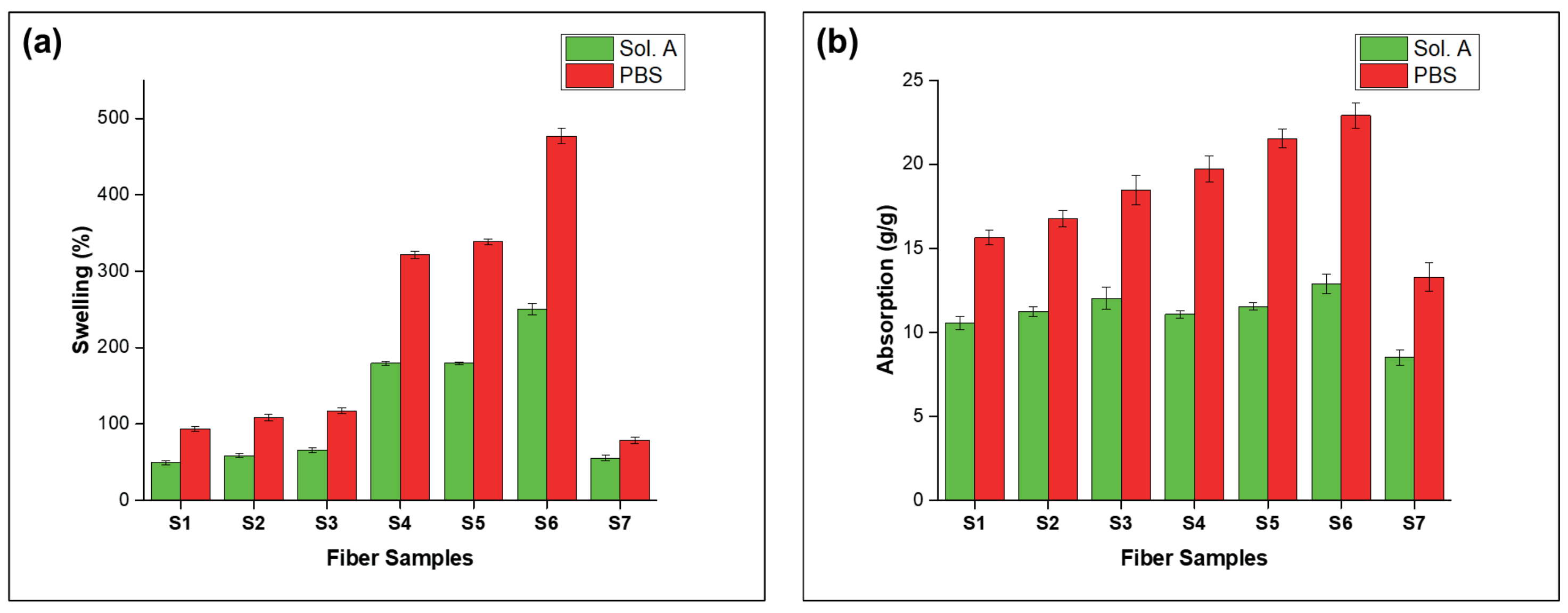

Fig. 6. Swelling percentage (a) and absorption capacity (b) of the developed AHA fibers and control alginate fiber (S7).

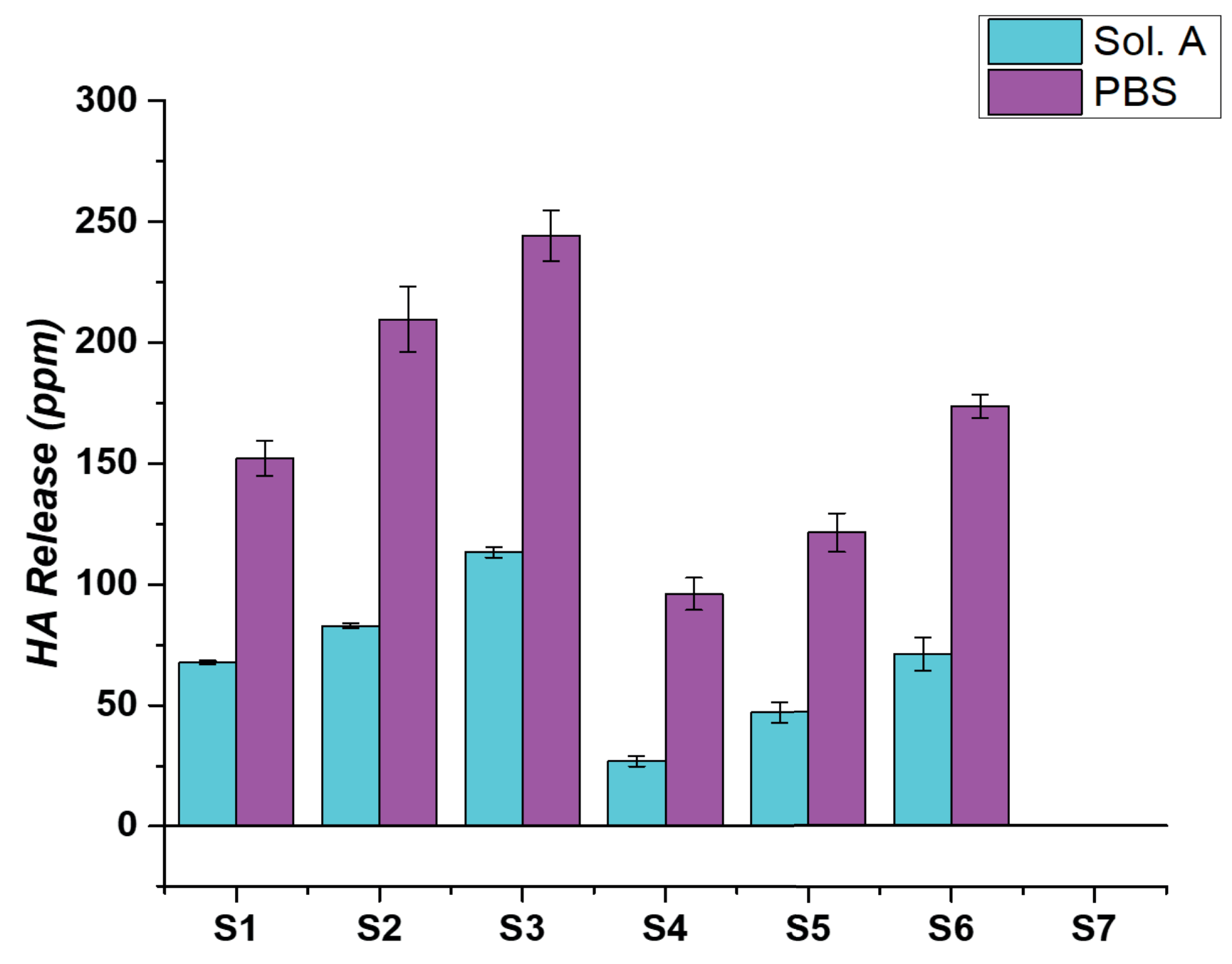

Fig. 7. Release of hyaluronic acid from the composite AHA fibers after 2 hours.

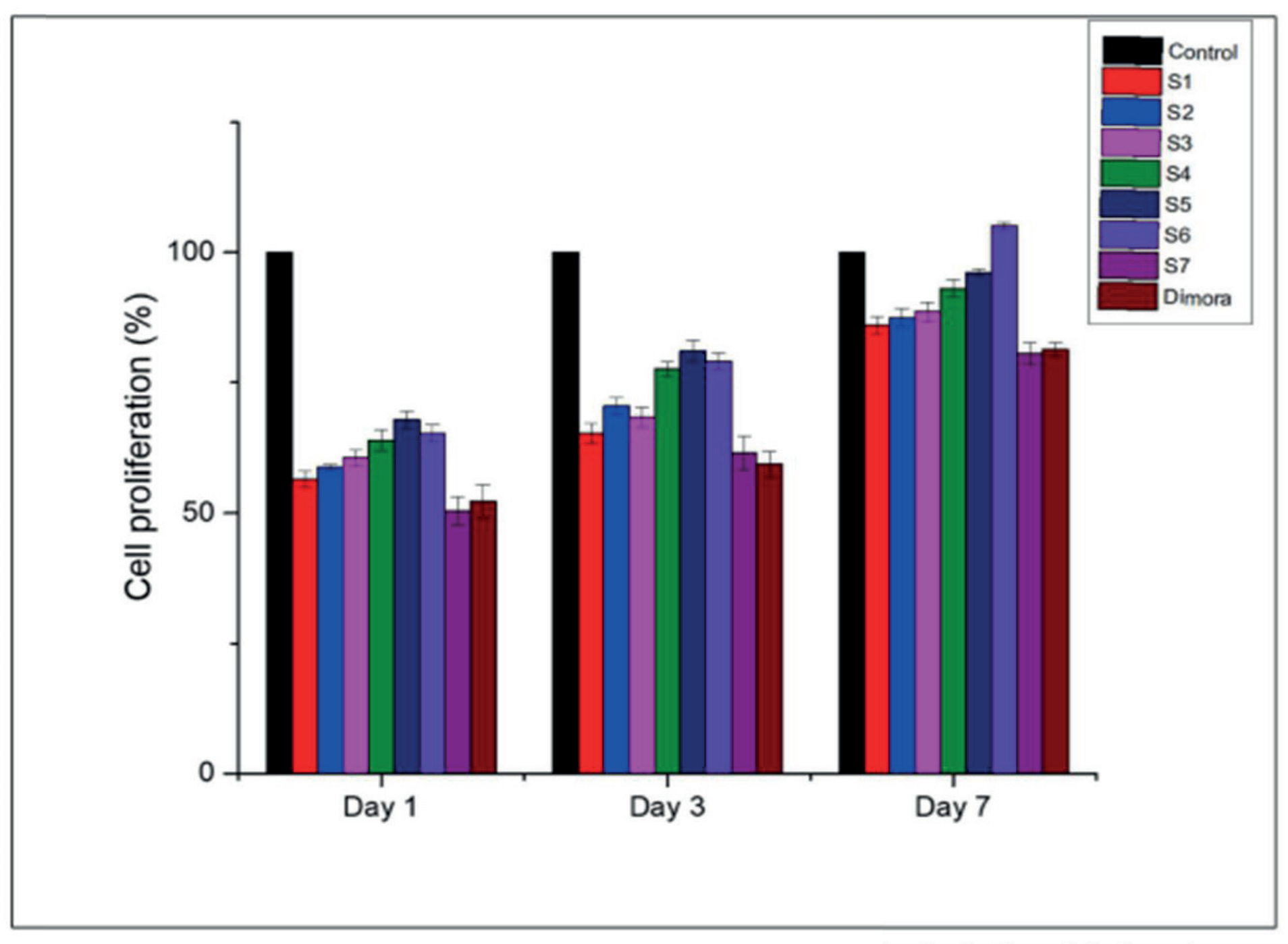

Fig. 8. Cell viability of NIH3T3 fibroblast cells cultured for 1, 3, 5 and 7 days in presence of AHA fibers and control alginate fiber (S7).

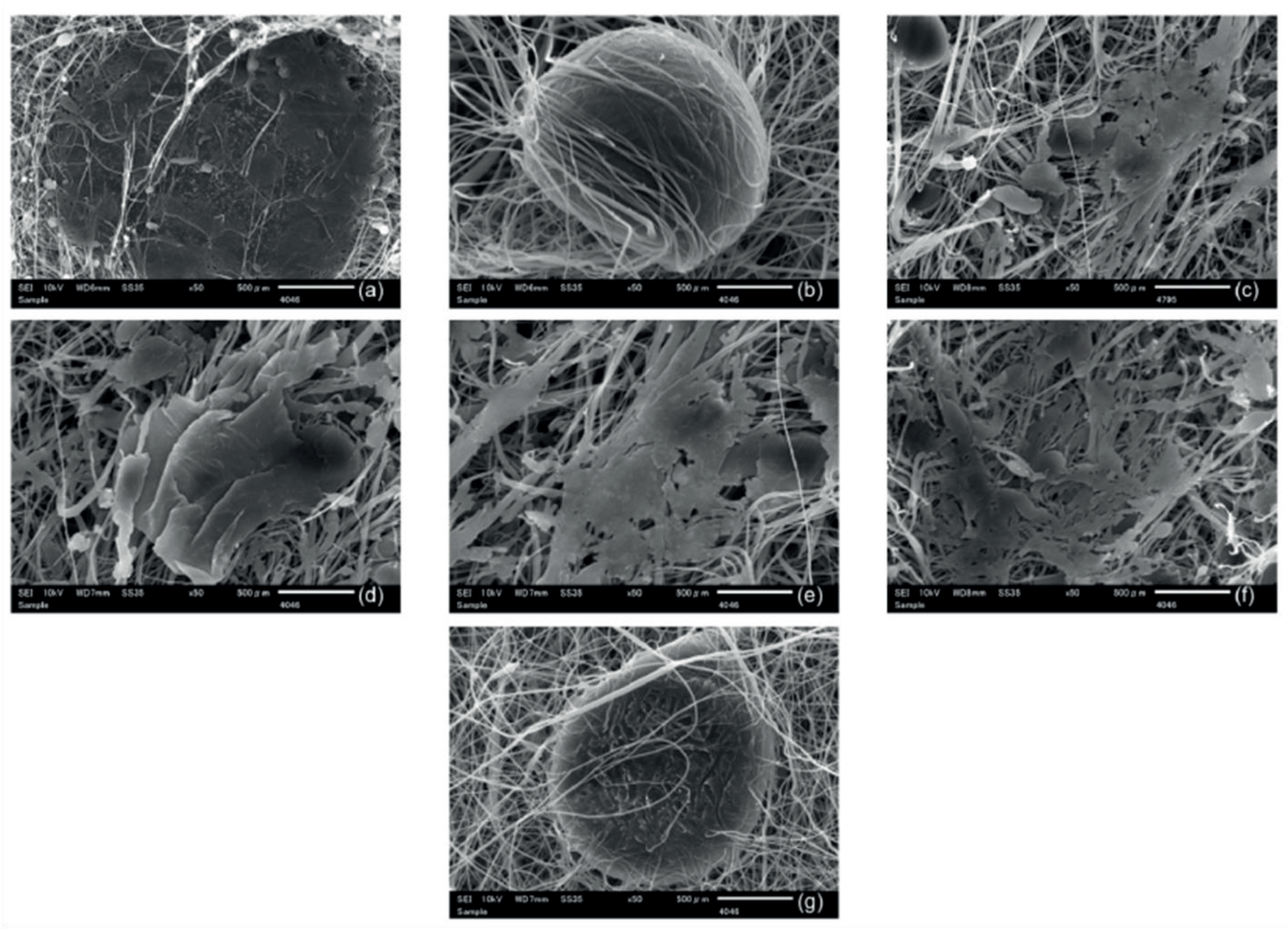

Fig. 9. Cell attachment of NIH 3T3 fibroblast cells cultured for 3 days in presence of AHA fibers and control alginate fiber (S7).

Table 2. ANOVA for responses with respect to hyaluronic acid content.

Factors	Linear density (tex)		Tenacity (cN/tex)		Swelling (%)				Absorbance (%)			
					Sol. A		PBS		Sol. A		PBS	
	P-value	R^2 (%)	P-value	R^2 (%)	P-value	R^2 (%)	P-value	R^2 (%)	P-value	R^2 (%)	P-value	R^2 (%)
Hyaluronic Acid (dip coating)	0.000*	94.53	0.000*	98.42	0.000*	90.66	0.007*	96.04	0.000*	97.21	0.000*	95.21
Hyaluronic Acid (dope mixture)	0000*	98.34	0.000*	96.78	0.003*	89.34	0.000*	87.27	0.000*	91.37	0.000*	89.93

*P-value < 0.05 indicating statistical significance of the factor to response under study, R^2 coefficient of determination.

References

Umar, Muhammad, et al. "Wet-spun bi-component alginate-based hydrogel fibers: Development and in-vitro evaluation as a potential moist wound care dressing." International Journal of Biological Macromolecules 168 (2021): 601-610.

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