303 increasing nanoparticle concentration up to 2 wt%. This may be due to the hydrophobic character
304 of sulfur nanoparticles. However, as the concentration was increased further up to 3 wt% for
305 ALG/SNP3, the value decreased, which is again attributed to the aggregation effect of
306 nanoparticles (Fig. 1d) in the polymer matrix. Due to the aggregation of the hydrophobic sulfur
307 particles, a specific hydrophobic patch is formed in the film, and a hydrophilic patch is also
308 formed in a portion where sulfur is not present. These hydrophilic areas tend to interact with the
309 water molecules, hence, rendering increased hydrophilicity to the film.
310
311 **Table 2.** Tensile properties, WVP, and WCA of alginate-based nanocomposite films.

Film	Thickness (μm)	TS (MPa)	EB (%)	EM (GPa)	WVP ($\times 10^{-9}$ g·m/m^2·Pa^1·s^1)	WCA (deg.)
ALG	58.4 ± 0.9^{a}	58.5 ± 0.8^{a}	7.5 ± 0.1^{a}	0.96 ± 0.1^{a}	1.48 ± 0.18^{c}	56.1 ± 1.3^{a}
ALG/SNP1	60.2 ± 1.1^{ab}	60.3 ± 0.9^{b}	6.9 ± 0.8^{a}	1.81 ± 0.1^{b}	0.97 ± 0.10^{ab}	58.9 ± 1.6^{ab}
ALG/SNP2	61.7 ± 0.8^{b}	65.5 ± 1.5^{c}	6.1 ± 0.9^{a}	1.99 ± 0.2^{b}	0.87 ± 0.09^{a}	59.2 ± 1.2^{b}
ALG/SNP3	63.2 ± 1.4^{b}	63.8 ± 1.2^{c}	6.8 ± 0.9^{a}	1.85 ± 0.2^{b}	1.18 ± 0.11^{b}	57.6 ± 1.4^{ab}

312 Each value is the mean of three replicates with the standard deviation. Values in the same
313 column with different letters are significantly different ($p < 0.05$).
314
315 3.4 Mechanical properties
316 The thickness and mechanical properties of neat alginate and alginate nanocomposite films are
317 shown in **Table 2.** The thickness of the nanocomposite films was found to be significantly higher
318 as compared to the neat alginate film, and it increased with increasing concentration of SNPs.
319 However, the difference in thickness of the three nanocomposite films was not found to be