

## Supporting Information

# Violacein-containing chitosan as light-sensitive, antioxidant and antibacterial hydrogels towards sustainable food packaging

*Othmane Dardari,<sup>a</sup> Nadia Katir,<sup>a</sup> Mohamed Koubaa,<sup>b</sup> and Abdelkrim El Kadib.<sup>a,c,\*</sup>*

<sup>a</sup> *Euromed University of Fes, UEMF, Morocco.*

<sup>b</sup> *Université de Technologie de Compiègne, ESCOM, TIMR (Integrated Transformations of Renewable Matter), Centre de recherche Royallieu, CS 60 319, 60 203 Compiègne, Cedex, France*

<sup>c</sup> *Hassan II Academy of Science and Technology, Rabat, Morocco.*

*\* Corresponding author: A. El Kadib (E-mail: a.elkadib@ueuromed.org)*

## Table of Contents

**Fig. S1.** FTIR spectra of pristine chitosane film, violacein and violacein containing chitosan films (**CS@Vio<sup>X%</sup>-f**).

**Fig. S2.** XRD pattern of **CS@Vio<sup>X%</sup>-f**

**Fig. S3.** Thermal properties a) TGA and b) DTG curve of **CS-f**, **CS@Vio<sup>3%</sup>-f** and **CS@Vio<sup>10%</sup>-f**

**Fig. S4.** UV-Vis spectroscopy of **CS-f** and **CS@Vio<sup>10%</sup>-f**

**Fig. S5.** Assessment of UV protection properties of **CS@Vio<sup>X%</sup>-f**

**Fig. S6.** Transparency and UV protection of **CS** and **CS@Vio<sup>X%</sup>-f**, calculated according to the thickness of each film.

**Table S1.** The calculated UV protection rates, transparency and thickness of **CS** and **CS@Vio<sup>X%</sup>-f**.

**Fig. S7.** Photographs of a) colonies formed and b) Inhibition zone of *S. aureus* and *E. coli* Bacterial Growth after treatment for 24 h with **CS@Vio<sup>X%</sup>-f** (X =1, 3, 5 and 10%)

**Fig. S8.** Visible appearance of typical sample untreated and treated with chitosan alone (**CS-s**), violacein alone (**Vio-s**), and (**CS@Vio10%-s**).

**Fig. S9.** Photoluminescence quenching test for **CS@Vio<sup>X%</sup>-Cu<sup>1%</sup>-f** (X =1, 3, 5 and 10%)

**Fig. S10.** Percentage of degradation of **CS@Vio<sup>X%</sup>-f** films (X =1, 3, 5 and 10%) exposed to soil environment after 5 weeks of incubation time.

**Fig. S1.** FTIR spectra of pristine chitosane film, violacein and violacein containing chitosan films (CS@Vio<sup>X%</sup>-f) with X=1, 3, 5 and 10%.

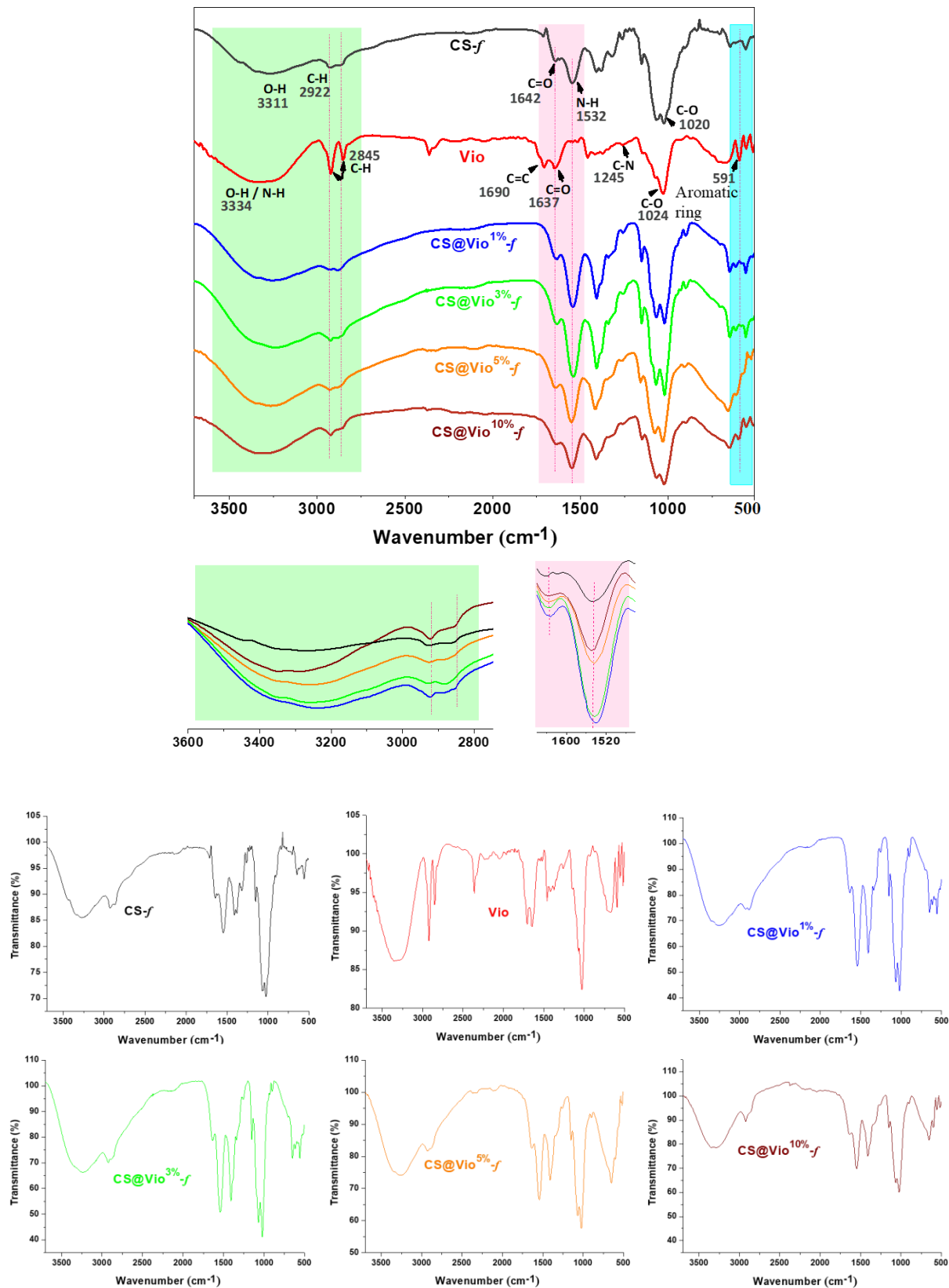
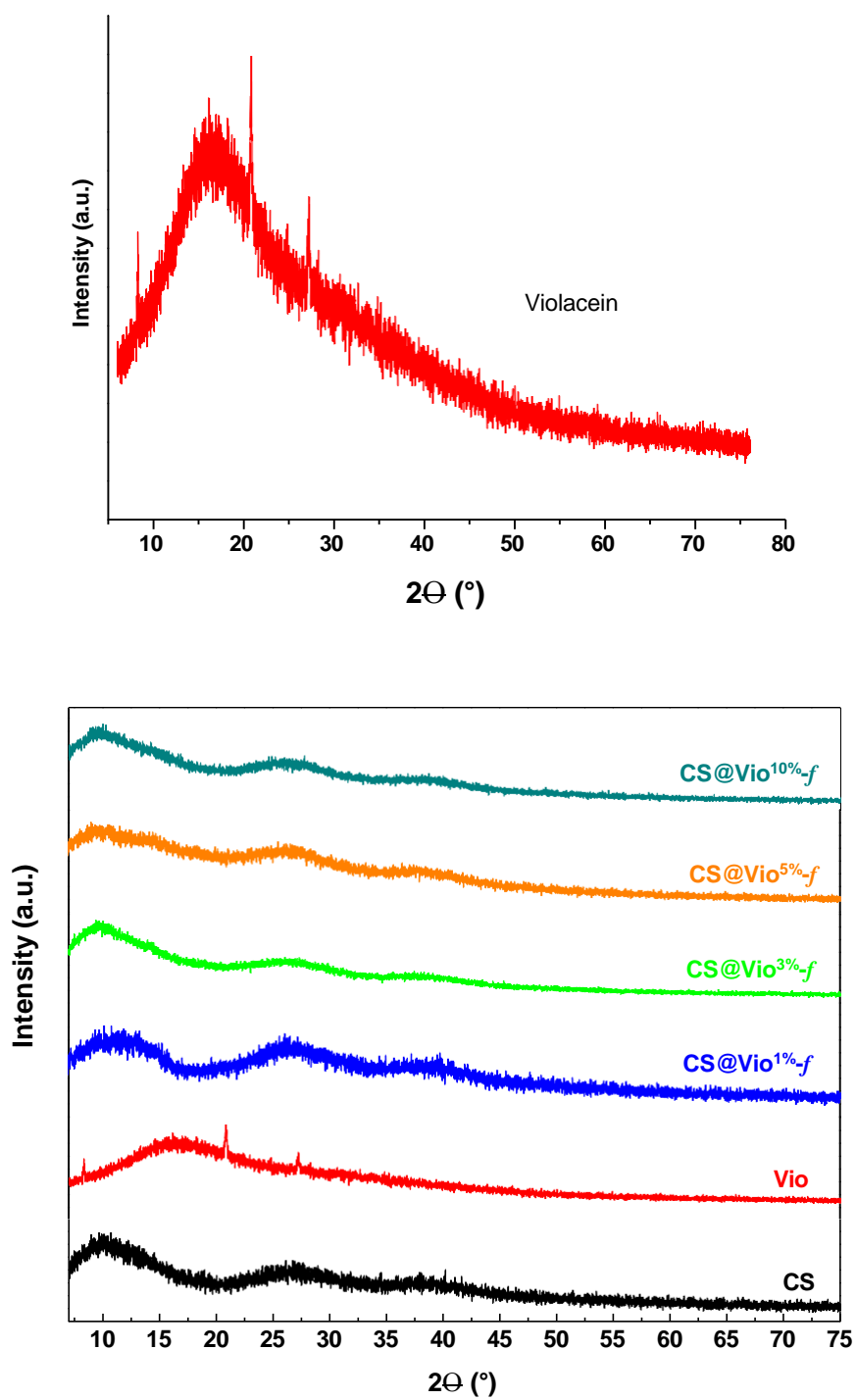


Fig. S2. XRD pattern of violacein and CS@Vio<sup>X%-f</sup> (X = 0, 1, 3, 5 and 10%)



**Fig. S3.** Thermal properties a) TGA and b) DTG curve of **CS-*f***, **CS@Vio<sup>3%</sup>-*f*** and **CS@Vio<sup>10%</sup>-*f***

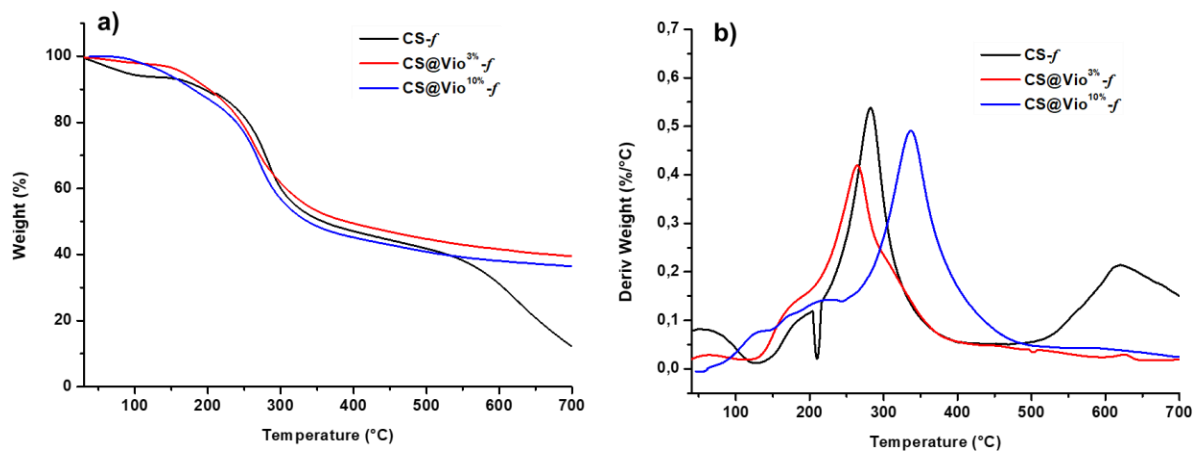


Fig. S4. UV-Vis spectroscopy of CS-*f* and CS@Vio<sup>10%</sup>-*f*

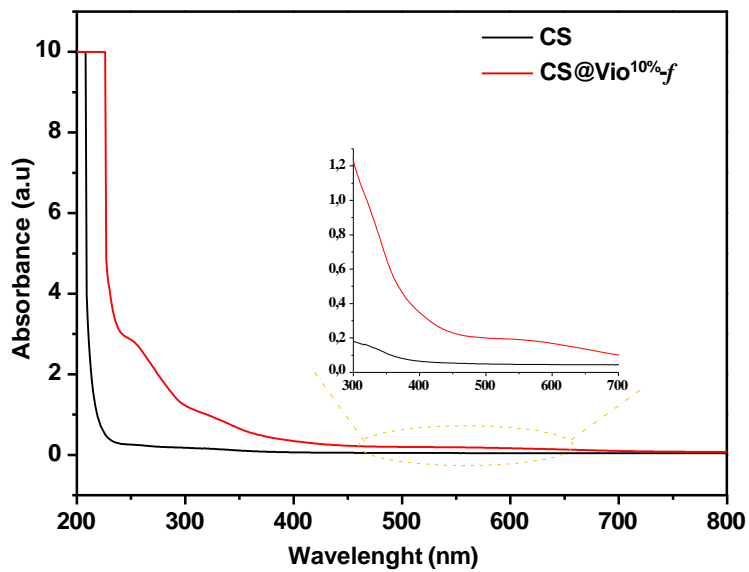
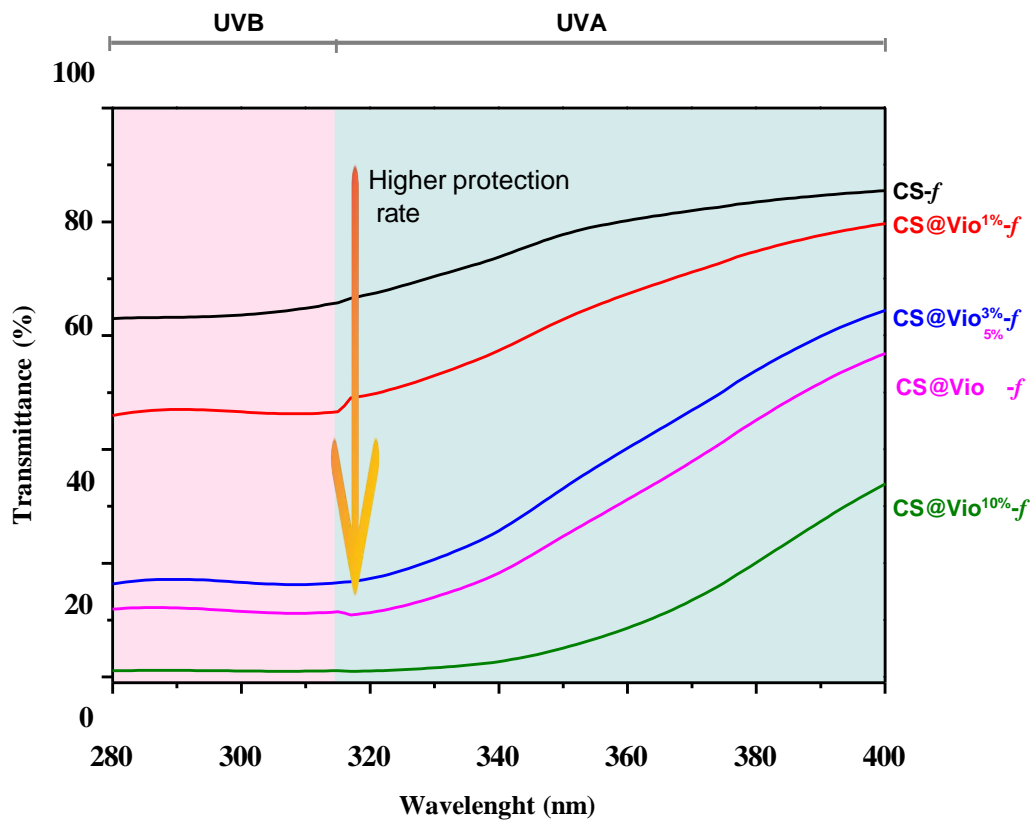
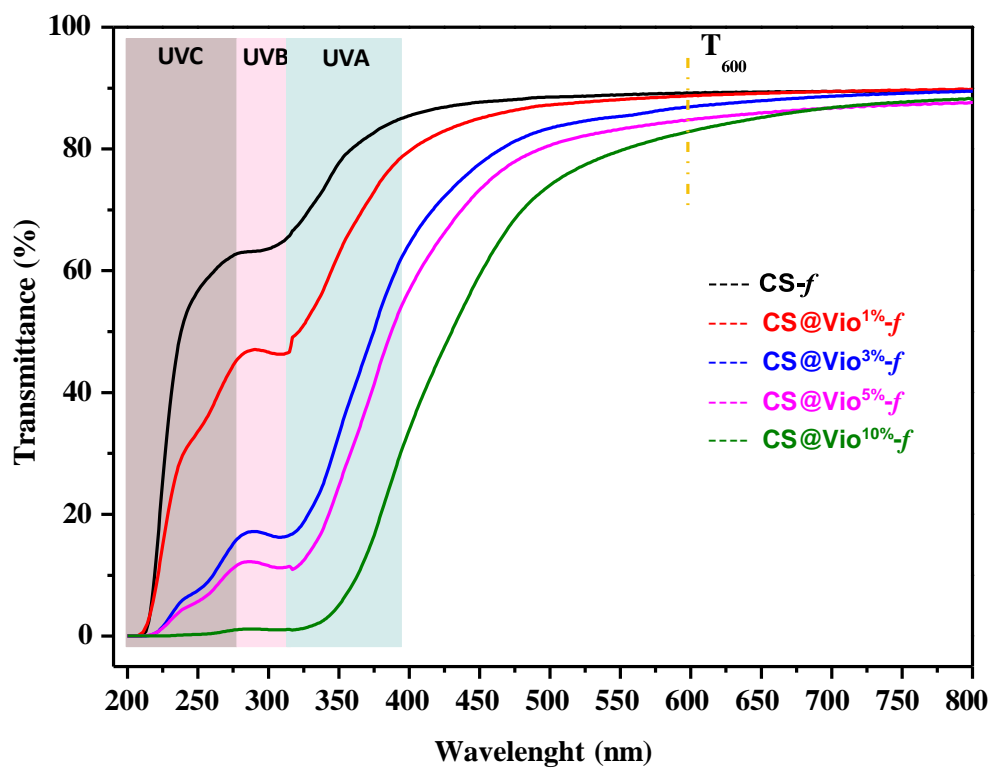


Fig. S5. Assessment of UV protection properties of CS@Vio<sup>X%</sup>-f (X = 0, 1, 3, 5 and 10%)



**Fig. S6.** Transparency and UV protection of CS and CS@Vio<sup>X%</sup>-f, calculated according to the thickness of each film.



**Table S1.** The calculated UV protection rates, transparency and thickness of CS and CS@Vio<sup>X%-f</sup> (X = 0, 1, 3, 5 and 10%).

	UV-A	UV-B	Transmittance		Thickness ( $\mu\text{m}$ )	Density ( $\text{g}/\text{cm}^3$ )
	protection	protection	( $T_{660}$ )	Transparency		
	rate	rate	(%)			
	(%)	(%)				
CS	$22.9 \pm 0.9^a$	$36.8 \pm 2.2^a$	$89.43 \pm 0.08^a$	$1.17 \pm 0.03^a$	$43.6 \pm 1.24^a$	$0.69 \pm 0.02^a$
CS@Vio <sup>1%-f</sup>	$34.6 \pm 1.3^b$	$53.5 \pm 1.3^b$	$89.23 \pm 0.04^a$	$1.07 \pm 0.02^b$	$47 \pm 1.63^{ab}$	$0.71 \pm 0.03^b$
CS@Vio <sup>3%-f</sup>	$60.4 \pm 0.5^c$	$83.7 \pm 0.6^c$	$88.13 \pm 0.01^b$	$1.02 \pm 0.006^{cd}$	$54.6 \pm 2.06^b$	$0.77 \pm 0.01^c$
CS@Vio <sup>5%-f</sup>	$68.2 \pm 1.7^d$	$88.6 \pm 1.9^d$	$86.2 \pm 0.04^{cd}$	$0.91 \pm 0.05^{de}$	$72 \pm 0.81^c$	$0.84 \pm 0.01^d$
CS@Vio <sup>10%-f</sup>	$87.8 \pm 1.2^e$	$98.9 \pm 2.5^e$	$85.54 \pm 0.11^d$	$0.77 \pm 0.1^e$	$91.5 \pm 1.13^d$	$0.91 \pm 0.02^e$

The values in the same column followed by the same letter are not significantly different ( $p < 0.05$ ).

Protection against UV-A and UV-B rays and transparency are calculated according to the following equation:

$$\text{- UV protection rate (\%)} = 100 - \text{UV transmittance (\%)} \quad (1)$$

$$\text{- UV-A transmittance} = (T_{310} + T_{320} + T_{330} + T_{340} + T_{350} + T_{360} + T_{370} + T_{380} + T_{390} + T_{400})/10 \quad (2)$$

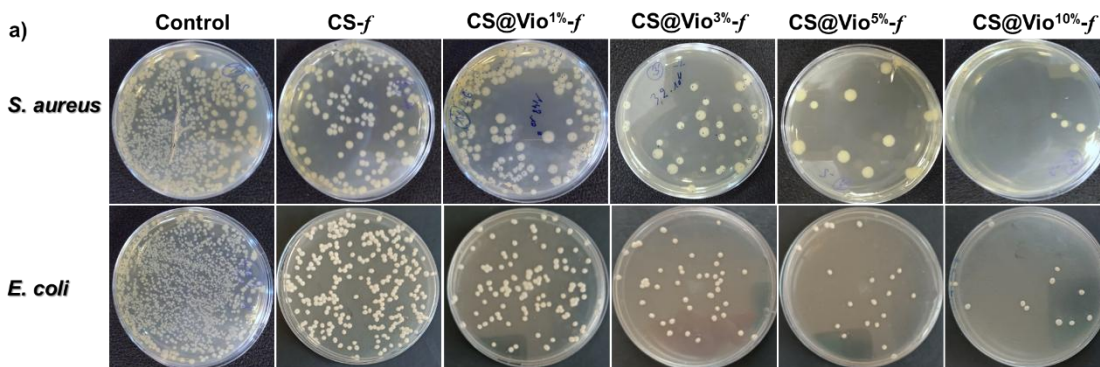
$$\text{- UV-B transmittance} = (T_{280} + T_{290} + T_{300} + T_{310})/4 \quad (3)$$

$$\text{- Transparency} = -\text{Log}(T_{660}) / x \quad (4)$$

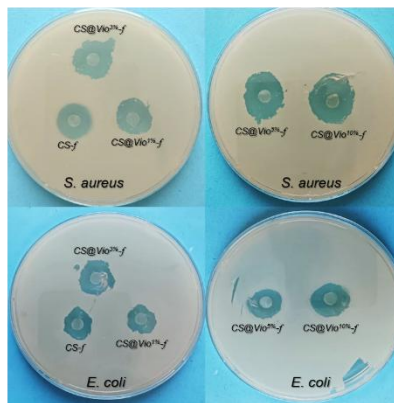
Where  $T_\lambda$  indicates UV transmittance value obtained at  $\lambda$  wavelength (nm), and x is the film thickness (mm).

**Fig. S7.** Photographs of a) colonies formed and b) Inhibition zone of *S. aureus* and *E. coli*

Bacterial Growth after treatment for 24 h with **CS@Vio<sup>X%</sup>-f** (X =1, 3, 5 and 10%)



b)



**Fig. S8.** Visible appearance of typical sample untreated and treated with chitosan alone (CS-s), violacein alone (**Vio-s**), and (CS@Vio10%-s)

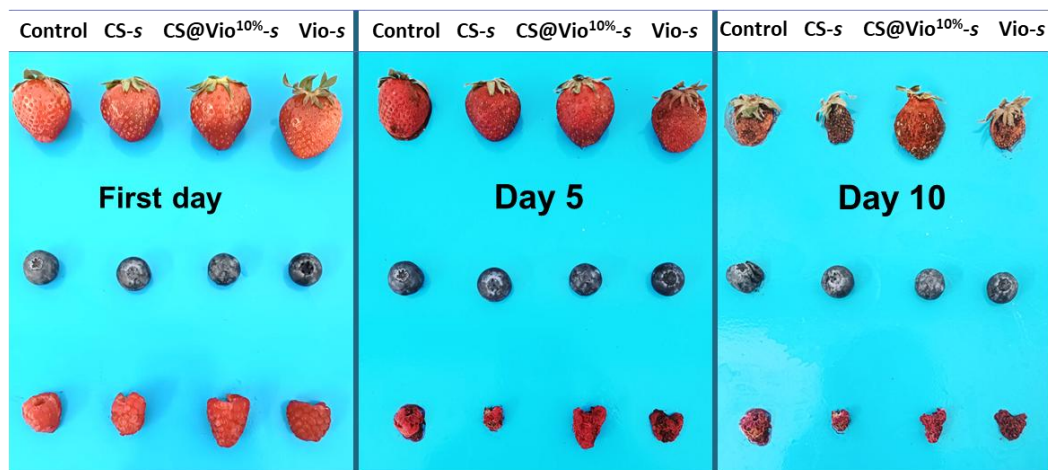
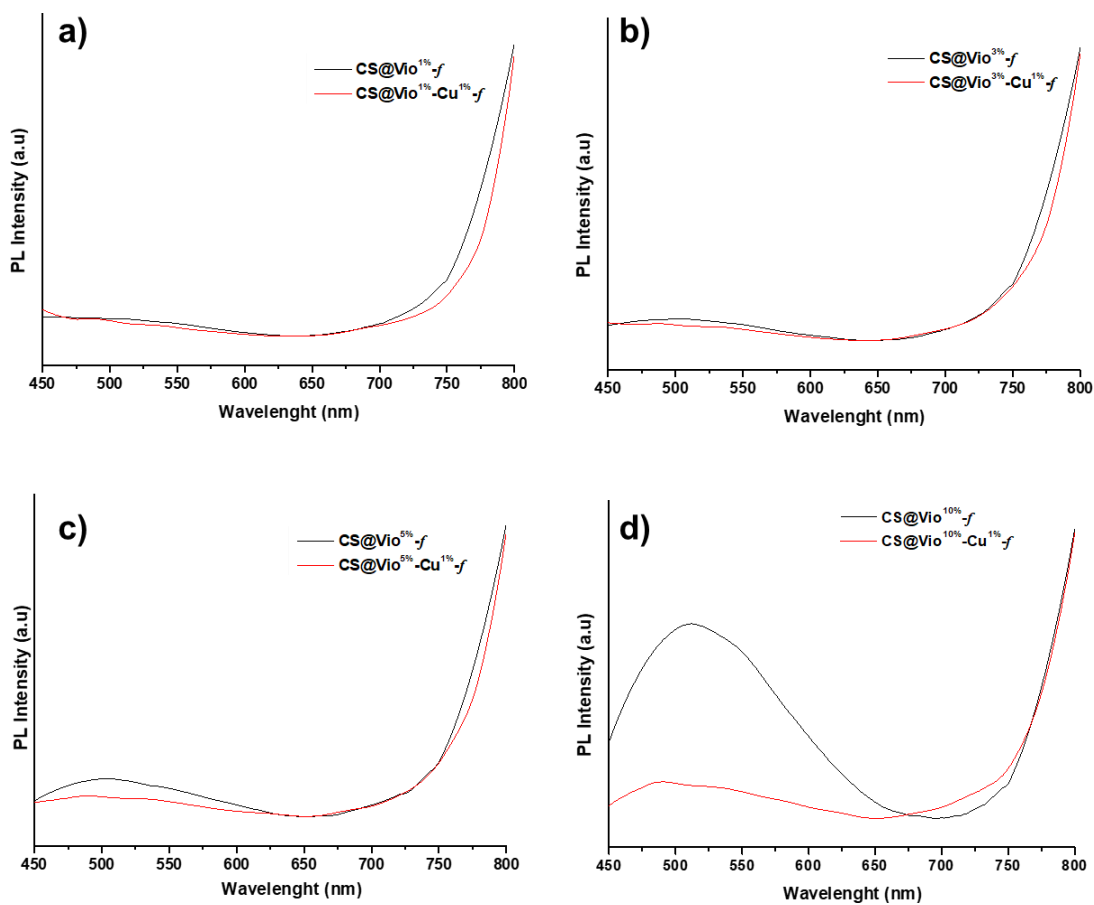


Fig. S9. Photoluminescence quenching test for  $\text{CS@Vio}^{\text{X}\%}\text{-Cu}^{\text{1}\%}\text{-f}$  (X = 1, 3, 5 and 10%)



**Fig. S10.** Percentage of degradation of **CS@Vio<sup>X%</sup>-f** films (X = 1, 3, 5 and 10%) exposed to soil environment after 5 weeks of incubation time.

