Supporting Information

Efficient biomass antibacterial film with plant essential oil components for fruit packaging and preservation

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1.1 Release rate of characteristic components in LPEO:

The release rate of the essential oil was determined using a UV spectrophotometer at a wavelength of 210 nm. The LPEF-50 composite membrane was immersed in 4 mL of anhydrous ethanol and agitated on a shaker. This process was repeated sequentially to establish five experimental groups with immersion times of 2, 4, 6, 8, 10, and 12 hours. The extracted solutions were diluted at an appropriate ratio, transferred to a quartz cuvette, and analyzed by UV spectroscopy. The content of the essential oil was calculated based on a standard calibration curve, and the release rate was determined using the following formula:

$$Rr = \frac{c\,N\,V_0\,M}{m\,V}$$

The cumulative release rate of the essential oil (*Rr*, %) was calculated according to the following equation. In this equation, *c* represents the essential oil concentration (μL mL^{-1}) determined from the standard curve, *N* is the dilution factor of the extracted solution, V_0 is the volume of the extraction solvent (mL), *M* is the total mass of the film (mg), *m* is the mass of the film sample immersed (mg), and *V* is the volume of essential oil (μL) incorporated into the film during its preparation.

Supplementary figures

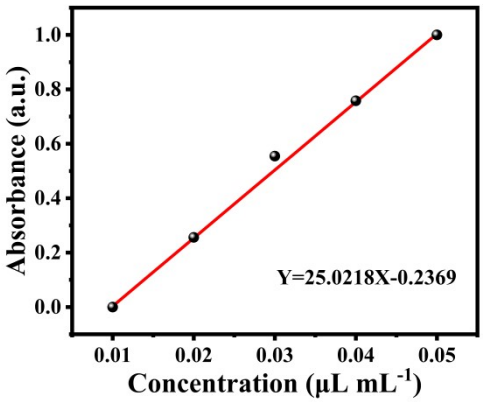

Fig. S1 Standard absorbance curve of essential oils at 210 nm.

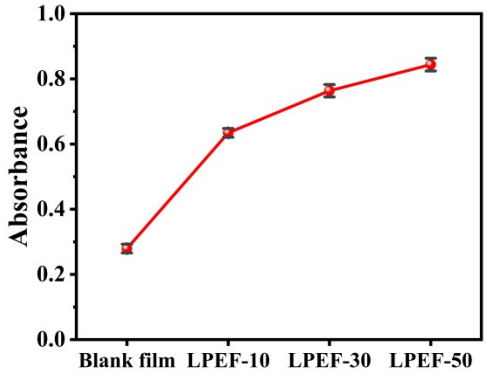

Fig. S2 Absorbance at 600 nm of the blank and LPEF composite films. (Data are expressed as mean ± SD (n = 3). *$p < 0.05$, independent samples t-test.)

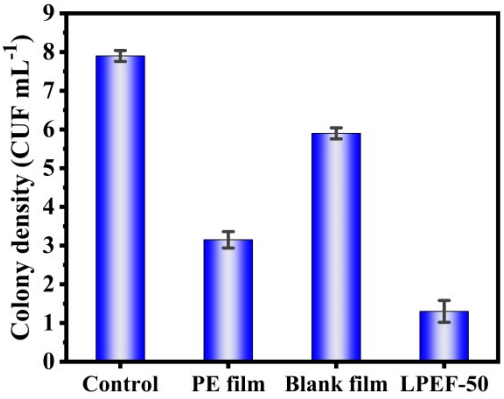

Fig. S3 Bacterial load in green grapes after 7-day preservation under different conditions. (Data are expressed as mean ± SD (n = 3). *$p < 0.05$, independent samples t-test.)

Supplementary table

Table S1 Antibacterial performance of LPEO characteristic components (96-well plate method).

Concentration (μL mL^{-1}))	25	12.5	6.25	3.12	1.56	0.78	0.39	0.19	0.097	0.048	MIC	MBC
1	0.112	0.134	0.176	0.356	0.383	0.350	0.384	0.379	0.392	0.420	0.113	0.15
2	0.116	0.126	0.198	0.339	0.358	0.378	0.409	0.410	0.410	0.461	0.111	0.128
3	0.120	0.115	0.213	0.372	0.386	0.401	0.398	0.442	0.430	0.430	0.107	0.113
Mean	0.116	0.130	0.195	0.355	0.375	0.376	0.397	0.403	0.410	0.47	0.110	0.130

Table S2 Properties data of the blank and LPEF composite films.

Sample	Maximum force (N)	Tensile strength (MPa)	Elastic modulus (MPa)	Elongation at break fracture (%)	Water contact angle
Blank film	1.0912	2.0991	60.0920	7.3459	0
LPEF-10	1.0518	3.2251	150.9513	3.6719	20.3
LPEF-30	1.5493	3.8254	136.1635	6.7385	22.1
LPEF-50	3.0284	6.3728	19.3188	25.2976	26.2