Appendix

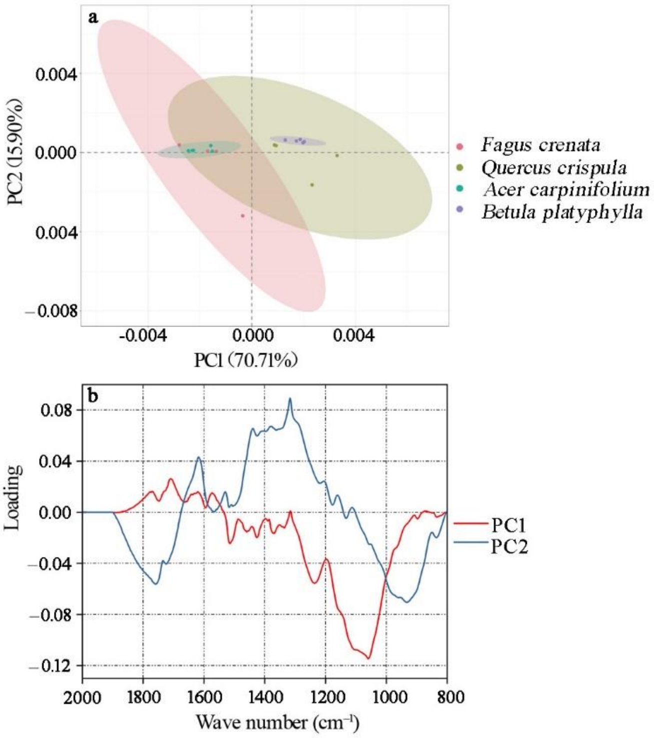

Fig. S1 Principal component analysis (PCA) of Fourier Transform Infrared (FTIR) spectra from litter of *Fagus crenata*, *Quercus crispula*, *Acer carpinifolium*, and *Betula platyphylla*. (a) Biplot resulting from PCA. (b) Line chart for loadings. The largest loadings are at C-O stretching in polysaccharides, aromatic skeletal vibrations combined with C-H, aromatic skeletal vibrations plus C=O stretch and C=O stretch in unconjugated ketone carbonyl, being the main responsible for the variation in PC1.

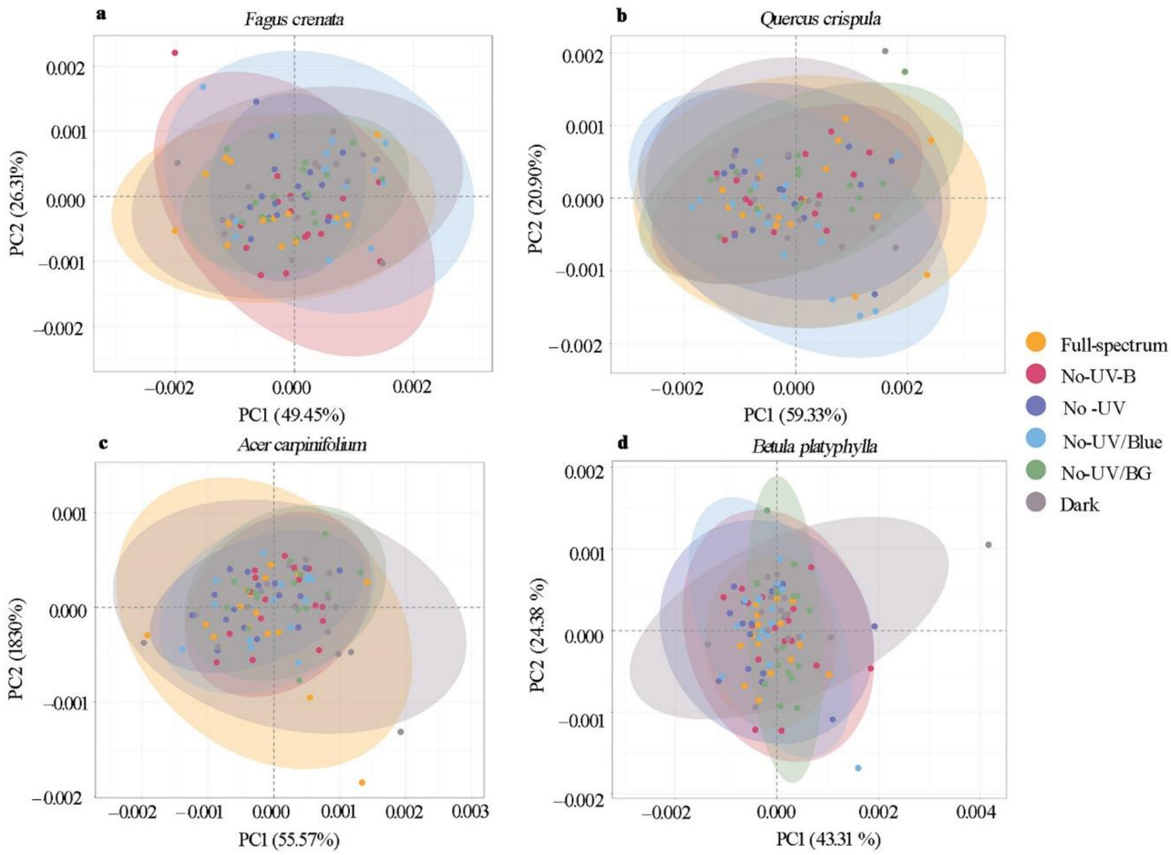

Fig. S2 Principal component analysis (PCA) of FTIR spectra of litter in the understory under spectral-attenuation treatments: Full-spectrum (transmitting > 280 nm); No-UV-B (transmitting > 315 nm); No-UV (transmitting > 400 nm); No-UV/Blue (transmitting > 500 nm); No-UV/BG (transmitting > 580 nm); Dark (no light). (a) *Fagus crenata*, (b) *Quercus crispula*, (c) *Acer carpinifolium*, and (d) *Betula platyphylla*.

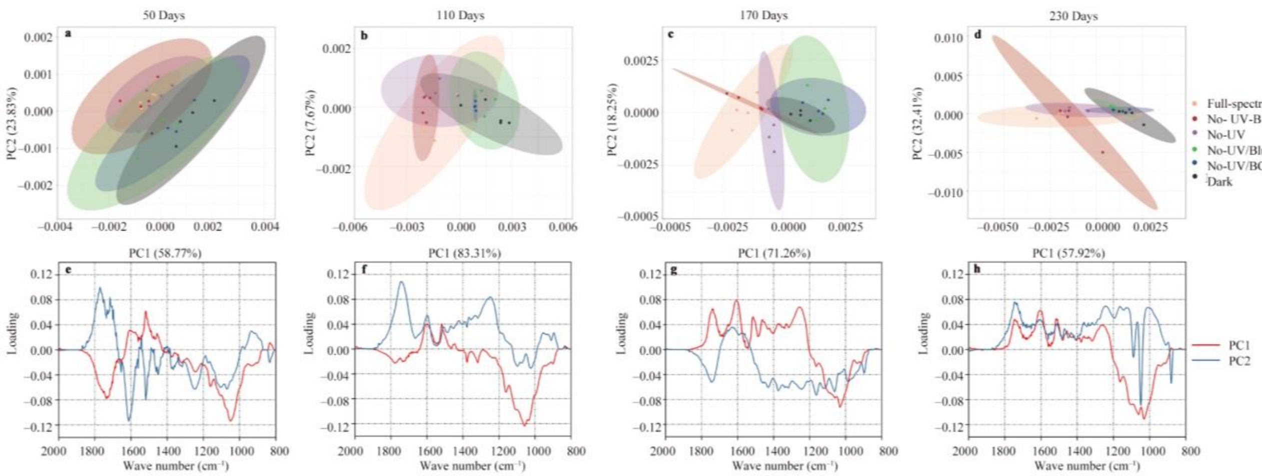

Fig. S3 Principal component analysis (PCA) of FTIR spectra of *Fagus crenata* litter in the forest gap at 50 days, 110 days, 170 days and 230 days under spectral-attenuation treatments: Full-spectrum (transmitting > 280 nm); No-UV-B (transmitting > 315 nm); No-UV (transmitting > 400 nm); No-UV/Blue > (transmitting > 500 nm); No-UV/BG (transmitting > 580 nm); Dark (no light). (a)–(d) Biplot resulting from PCA. (e)–(h) Line chart for loadings. The largest loadings are at polysaccharide characteristic region and lignin region, being mainly responsible for the variation in PC1.

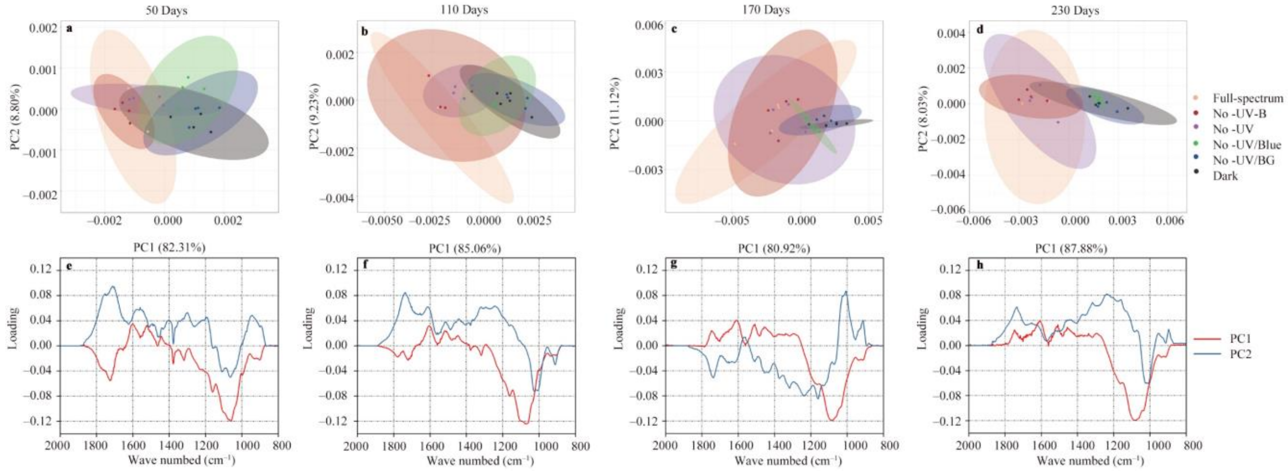

Fig. S4 Principal component analysis (PCA) of FTIR spectra of *Acer carpinifolium* litter in the forest gap at 50 days, 110 days, 170 days and 230 days under spectral-attenuation treatments: Full-spectrum (transmitting > 280 nm); No-UV-B (transmitting > 315 nm); No-UV (transmitting > 400 nm); No-UV/Blue (transmitting > 500 nm); No-UV/BG (transmitting > 580 nm); Dark (no light). (a)–(d) Biplot resulting from PCA. (e)–(h) Line chart for loadings. The largest loadings are at polysaccharide characteristic region and lignin region, being mainly responsible for the variation in PC1.

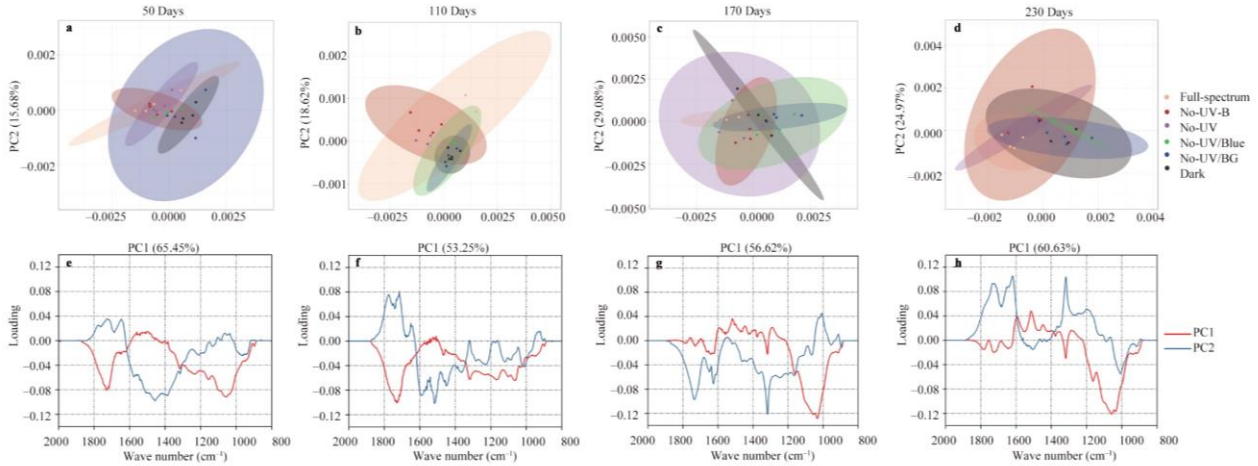

Fig. S5 Principal component analysis (PCA) of FTIR spectra of *Quercus crispula* litter in the forest gap at 50 days, 110 days, 170 days and 230 days under spectral-attenuation treatments: Full-spectrum (transmitting > 280 nm); No-UV-B (transmitting > 315 nm); No-UV (transmitting > 400 nm); No-UV/Blue (transmitting > 500 nm); No-UV/BG (transmitting > 580 nm); Dark (no light). (a)–(d) Biplot resulting from PCA. (e)–(h) Line chart for loadings. The largest loadings are at polysaccharide characteristic region, C=O stretch in unconjugated ketone carbonyl region, and lignin region, being mainly responsible for the variation in PC1.

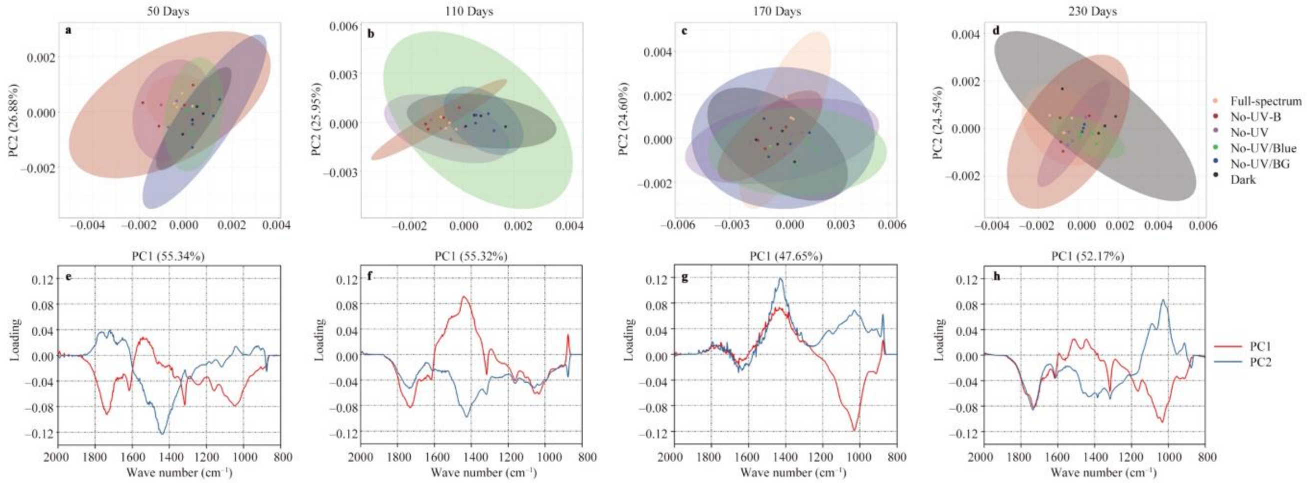

Fig. S6 Principal component analysis (PCA) of FTIR spectra of *Betula platyphylla* litter in the forest gap at 50 days, 110 days, 170 days and 230 days under spectral-attenuation treatments: Full-spectrum (transmitting > 280 nm); No-UV-B (transmitting > 315 nm); No-UV (transmitting > 400 nm); No-UV/Blue (transmitting > 500 nm); No-UV/BG (transmitting > 580 nm); Dark (no light). (a)–(d) Biplot resulting from PCA. (e)–(h) Linechart for loadings. The largest loadings are at polysaccharide characteristic region, C=O stretch in unconjugated ketone carbonyl region and lignin region, being mainly responsible for the variation in PC1.

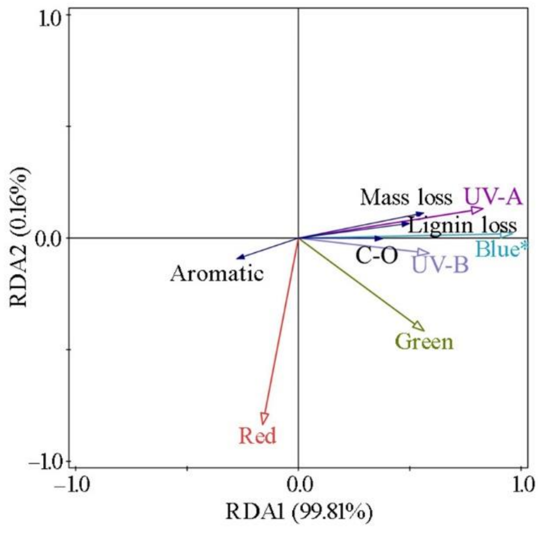

Fig. S7 Redundancy analysis (RDA) biplot of all species showing the relationship between mass/lignin loss, molecular structure and spectral composition; Mass loss, Lignin loss, Aromatic (lignin aromatic C) and C-O (C-O stretching in polysaccharides) are indicated by solid-headed blue arrows pointing in the direction of increasing values; spectral regions, including UV-B, UV-A, Blue, Green and Red, are indicated by the open-headed arrow pointing in the direction of increasing values. The relative effects of measured spectral compositions (as shown in Table S2) on litter decomposition were analyzed using the Monte Carlo permutation test (forward selection, 999 permutations). Spectral regions in the model are indicated with asterisks (P < 0.05). Detailed RDA results refer to Table S2.

Table S1 Wave numbers of Fourier Transform Infrared (FTIR) vibration frequencies of common plant carbohydrates reported in the literature for solid phase substances.

Wave number (cm^{-1})	Molecular structure	Compound	Reference
1170–950	C-O stretching in polysaccharides or polysaccharide-like substances	Polysaccharides	(Madari et al. 2006)
1430–1422	aromatic skeletal vibrations combined with C-H in-plane deform	Lignin	(Faix 1991)
1470–1450	C-H deformation (methyl and methylene) in monolignols Aliphatic C-H	Lignin	(Saparrat et al. 2010)
1515–1505	Aromatic skeletal vibration of lignin	Lignin	(Saparrat et al. 2010)
1600–1593	aromatic skeletal vibrations plus C=O stretch; S>G; G condensed > G etherified	Lignin	(Faix 1991)
1620–1600	aromatic skeletal vibration plus C=O stretching	Lignin	(Madari et al. 2006)
1660–1630	C=O (carbonyl groups), adsorbed O-H, conjugated C=O, amide I	Pectin, cellulose, protein	(Madari et al. 2006)
1738–1709	C=O stretch in unconjugated ketone, carbonyl	ketone, carbonyl	(Faix 1991)

Table S2 Effects of individual spectral regions on mass loss, lignin loss, lignin aromatic C and C-O stretching in polysaccharides. Mass loss, lignin loss, lignin aromatic C and C-O stretching in polysaccharides were treated as response variables, spectral compositions as explanatory variables.

Score summary	Statistic	Eigenvalues	Explained variation (%, cumulative)	Pseudo-canonical correlation	Explained fitted variation (%, cumulative)
All species	Axis 1	0.14	14.25	0.38	99.81
	Axis 2	0.00	14.28	0.11	99.97
	Axis 3	0.00	14.28	0.08	100.00
Fagus crenata	Axis 1	0.60	59.7.0	0.78	99.86
	Axis 2	0.00	59.77	0.19	99.97
	Axis 3	0.00	59.79	0.24	100.00
Quercus crispula	Axis 1	0.23	23.85	0.50	99.56
	Axis 2	0.00	23.95	0.34	99.98
	Axis 3	0.00	23.95	0.04	100.00
Acer carpinifolium	Axis 1	0.73	72.69	0.86	99.97
	Axis 2	0.00	72.71	0.18	99.99
	Axis 3	0.00	72.71	0.21	100.00
Betula platyphylla	Axis 1	0.19	19.34	0.51	92.00
	Axis 2	0.02	20.95	0.26	99.62
	Axis 3	0.00	21.02	0.21	100.00

Table S3 The Monte Carlo permutation test method (permutations=999 times) was used to analyzed the significance of each spectral region ($P < 0.05$). F, permutation-F values; *P*, permutation-*P* values; *P*(adj), Bonferroni Test -*P* values. Values in bold indicate statistically significant differences ($P < 0.05$).

Species	Name	UV-B	UV-A	Blue	Green	Red
	Explains %	1.10	<0.10	**13.10**	<0.10	<0.10
	Contribution %	7.90	0.10	**91.80**	<0.10	0.10
All Species	**F**	4.90	<0.10	**56.30**	<0.10	<0.10
	P	0.03	0.83	**0.002**	0.95	0.80
	P(adj)	0.07	0.95	**0.003**	0.95	0.87
	Explains %	**2.90**	<0.10	**56.50**	0.10	0.30
	Contribution %	**4.80**	<0.10	**94.40**	0.20	0.50
Fagus crenata	**F**	**6.50**	0.10	**121.00**	0.30	0.60
	P	**0.02**	0.78	**0.002**	0.62	0.46
	P(adj)	**0.04**	0.78	**0.003**	0.76	0.61
	Explains %	3.40	1.00	**19.40**	<0.10	0.20
	Contribution %	14.20	4.00	**80.90**	<0.10	0.80
Quercus crispula	**F**	4.00	1.10	**21.90**	<0.10	0.20
	P	0.04	0.30	**0.002**	0.95	0.65
	P(adj)	0.10	0.50	**0.005**	0.95	0.81
	Explains %	**5.90**	<0.10	**66.30**	0.40	<0.10
	Contribution %	**8.10**	<0.10	**91.20**	0.60	<0.10
Acer carpinifolium	**F**	**19.40**	<0.10	**181.00**	1.50	<0.10
	P	**0.002**	0.97	**0.002**	0.25	0.81
	P(adj)	**0.005**	0.97	**0.003**	0.41	0.97
	Explains %	0.60	0.30	**16.70**	2.80	0.60
	Contribution %	3.00	1.30	**79.30**	13.40	3.00
Betula platyphylla	**F**	0.70	0.30	**18.20**	3.10	0.70
	P	0.49	0.76	**0.002**	0.04	0.48
	P(adj)	0.53	0.76	**0.01**	0.09	0.61