Sustainable Food Technology

Electronic Supplementary Information

A sustainable viscosity-sensitive isoliquiritigenin-based molecular sensor for liquid food safety inspection

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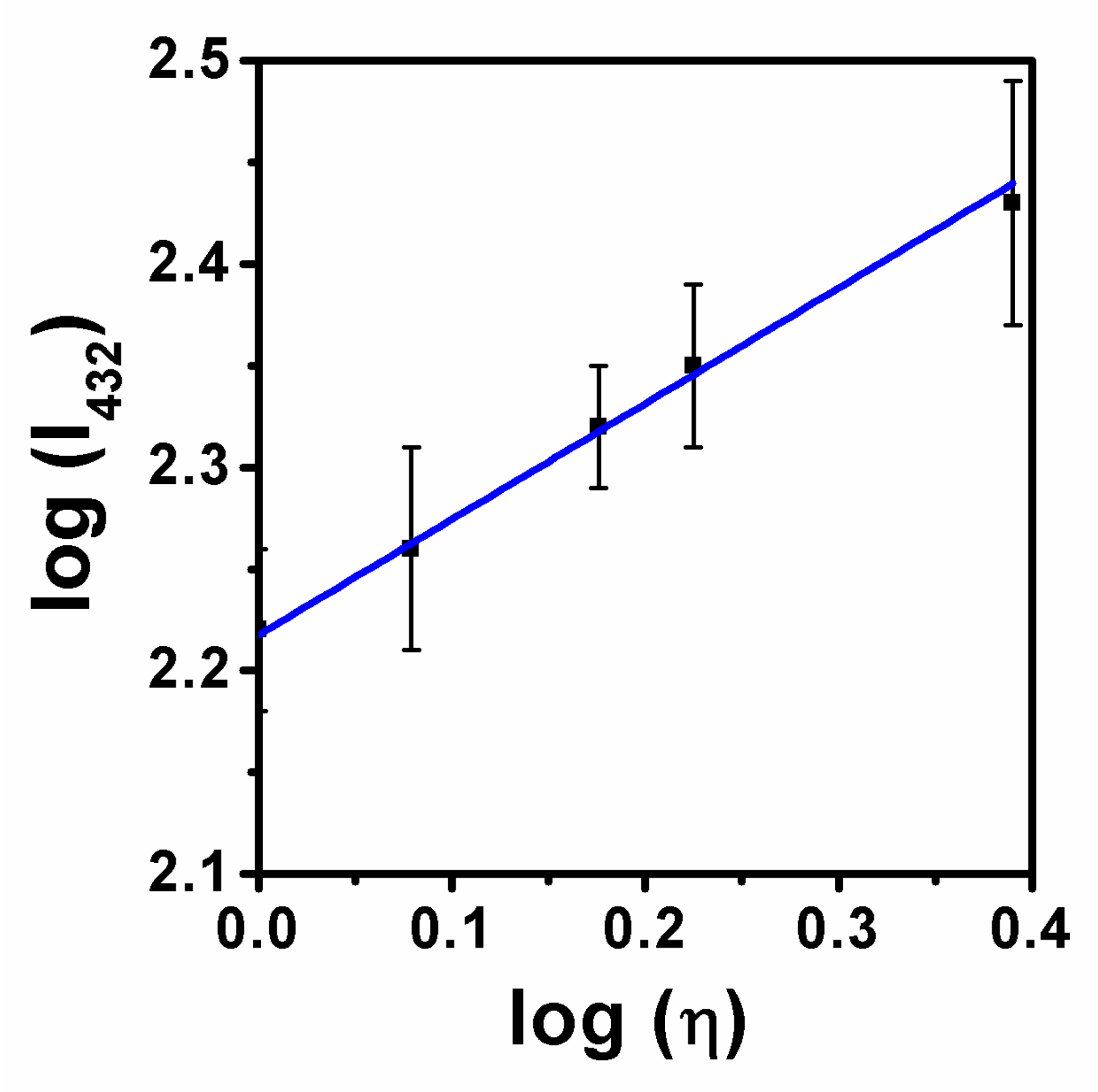


Fig. S1 Detection limit of the natural molecular sensor isoliquiritigenin.

The calibration curve was first obtained from the plot of log (I_{432}) as a function of log (η). Then the regression curve equation was obtained for the lower viscosity part.

The detection limit = 3 × *S.D.*/*k*

Where *k* is the slope of the curve equation, and *S.D.* represents the standard deviation for the log (I_{432}) of natural molecular sensor isoliquiritigenin.

log (I_{432}) = 1.823 + 0.533 × log (η) (R^2 = 0.990)

log (LOD) = 3 × 0.016/0.533 = 0.091

LOD =10^0.091 =1.233 cP

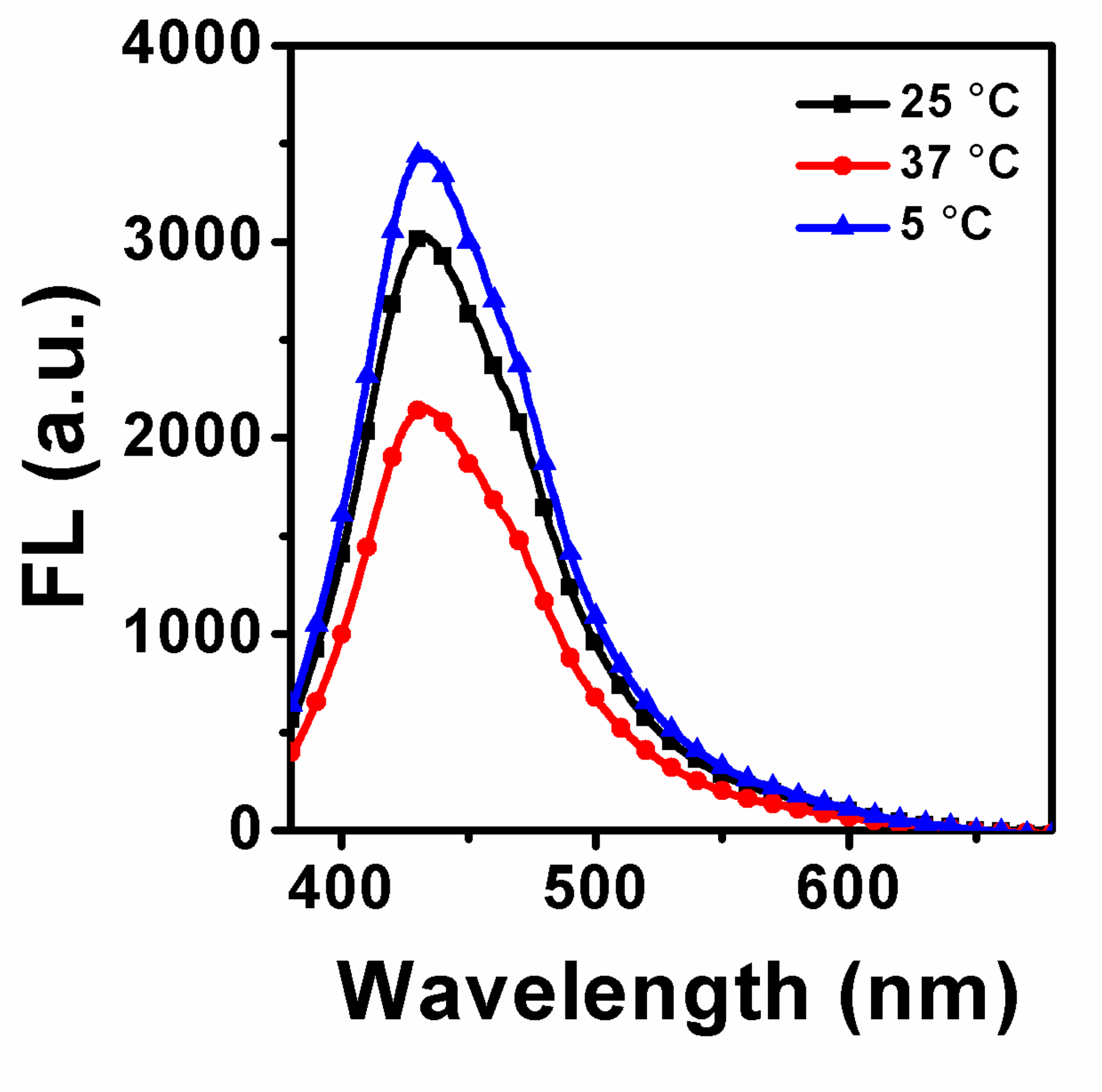


Fig. S2 Fluorescence spectra of the natural molecular sensor isoliquiritigenin (10 μM) in glycerol under different temperatures, including the ambient temperature (25 °C), higher storage temperature (37 °C), and lower storage temperature (5 °C).

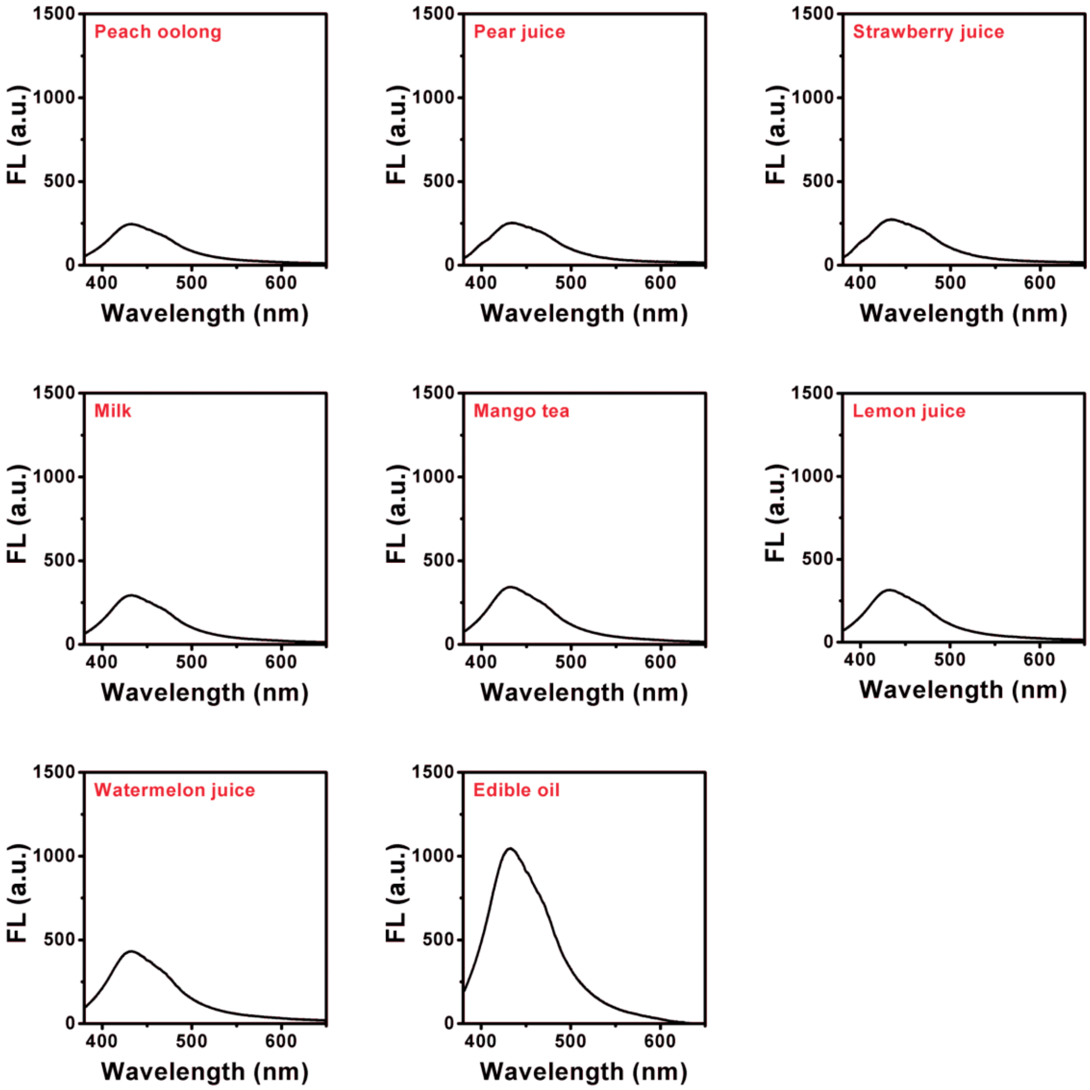


Fig. S3 Fluorescence spectra of the natural molecular sensor isoliquiritigenin (10 μM, containing 1% DMSO) in eight kinds of common liquid food, including peach oolong, pear juice, strawberry juice, milk, mango tea, lemon juice, watermelon juice and edible oil, λ_{ex}=350 nm.

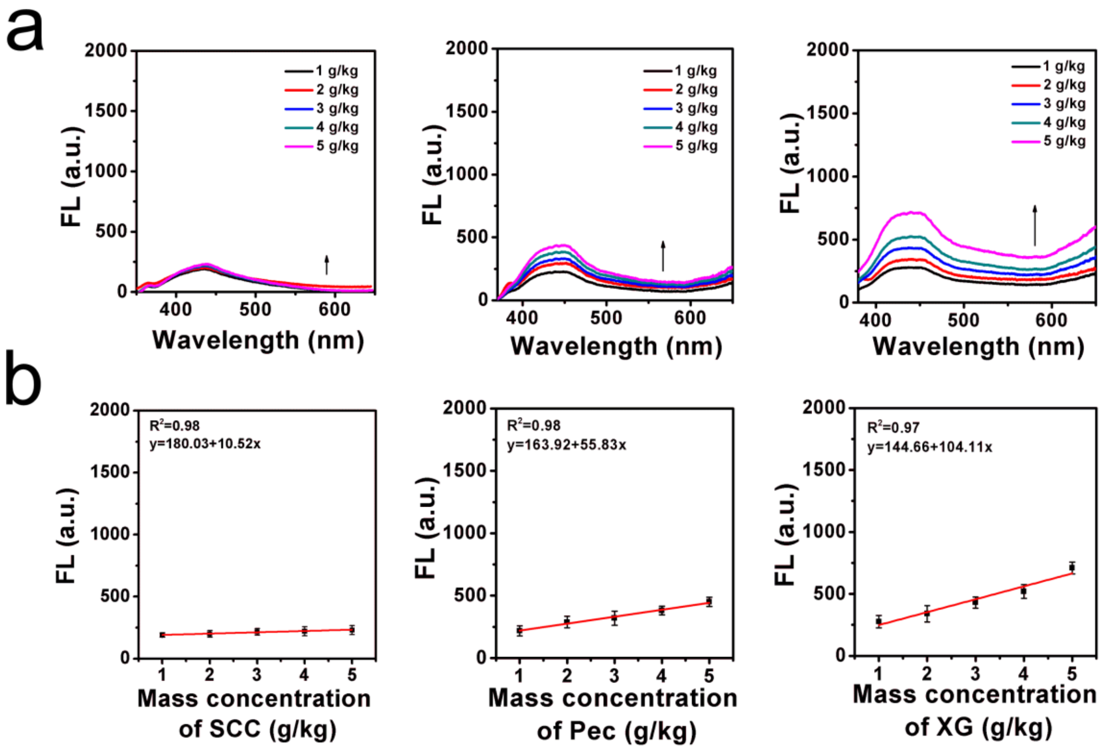


Fig. S4 (a) Fluorescence spectra of the natural molecular sensor isoliquiritigenin in the presence of various mass amounts of sodium carboxymethyl cellulose (SCC), pectin (Pec) and xanthan gum (XG). (b) Fluorescence intensity of the natural molecular sensor isoliquiritigenin at emission peak and fitting line with the existence of various mass amounts of SCC, Pec, and XG. The concentration of the isoliquiritigenin = 10 μM, λ_{ex}=350 nm.

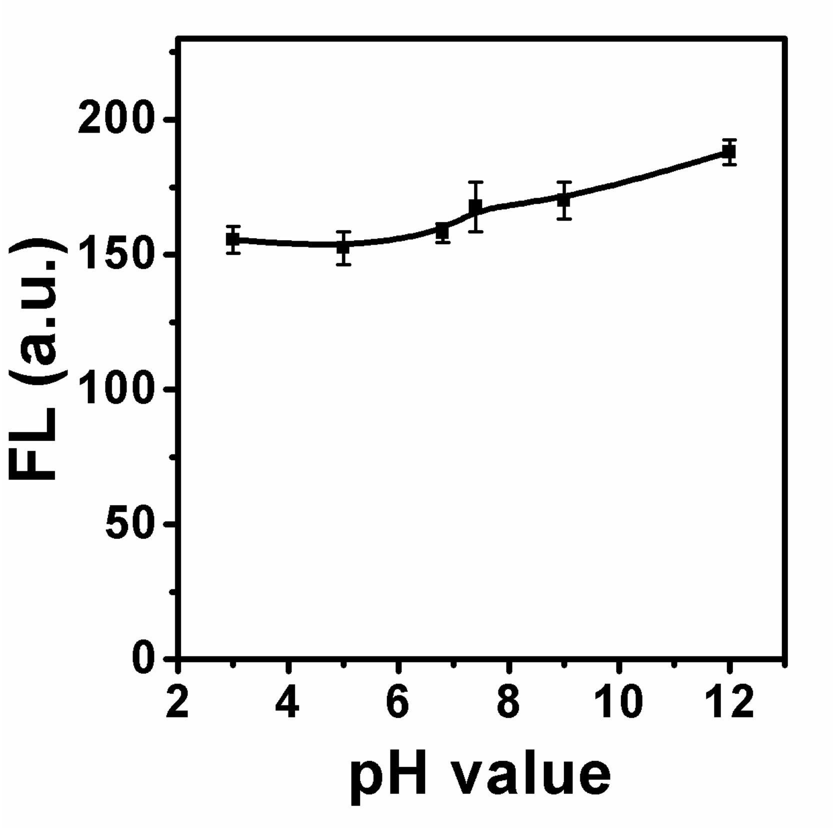


Fig. S5 Fluorescence emission intensity of the natural molecular sensor isoliquiritigenin (10 μM) at 432 nm under various pH values (containing 1% DMSO) in low viscosity water, λ_{ex}=350 nm.

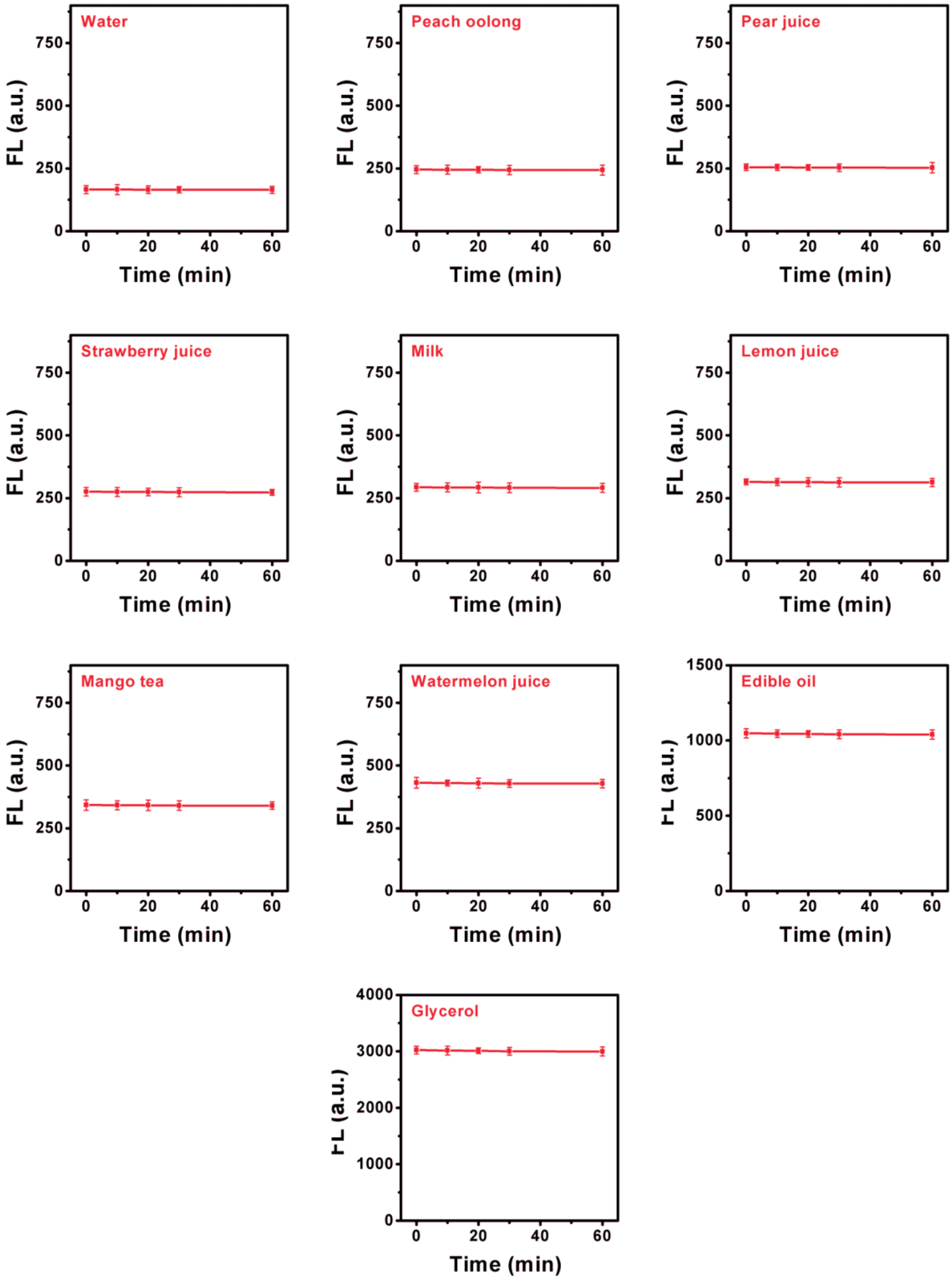


Fig. S6 Photo-stability analysis of the natural molecular sensor isoliquiritigenin in water, glycerol and other eight kinds of common liquid food (containing 1% DMSO). All samples were tested under continuous light irradiation with a 430 nm UV lamp.

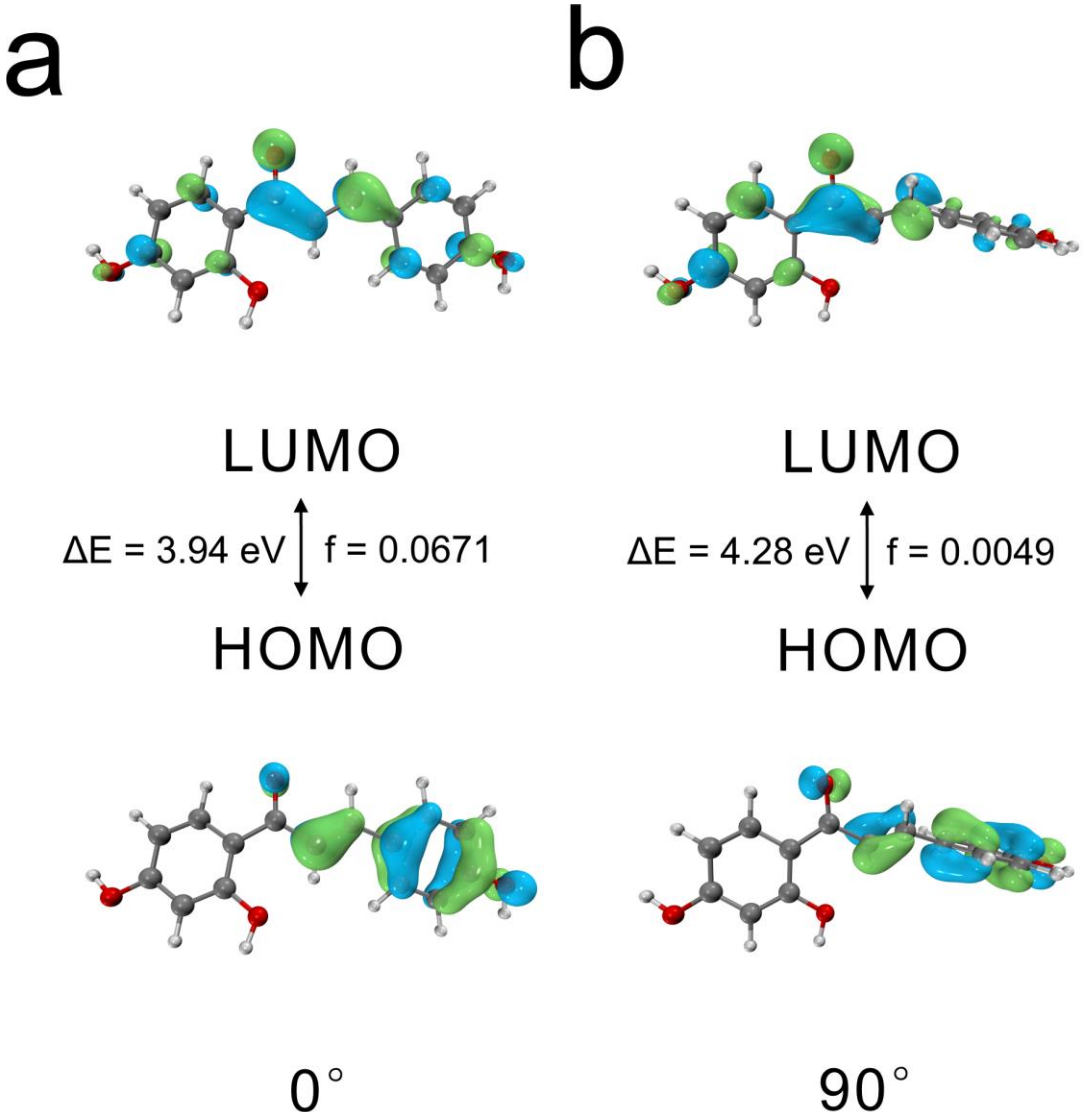


Fig. S7 Optimized molecular structures and calculated molecular orbital energy levels of the HOMO and LUMO of isoliquiritigenin based on B3LYP/6-31G basis set.

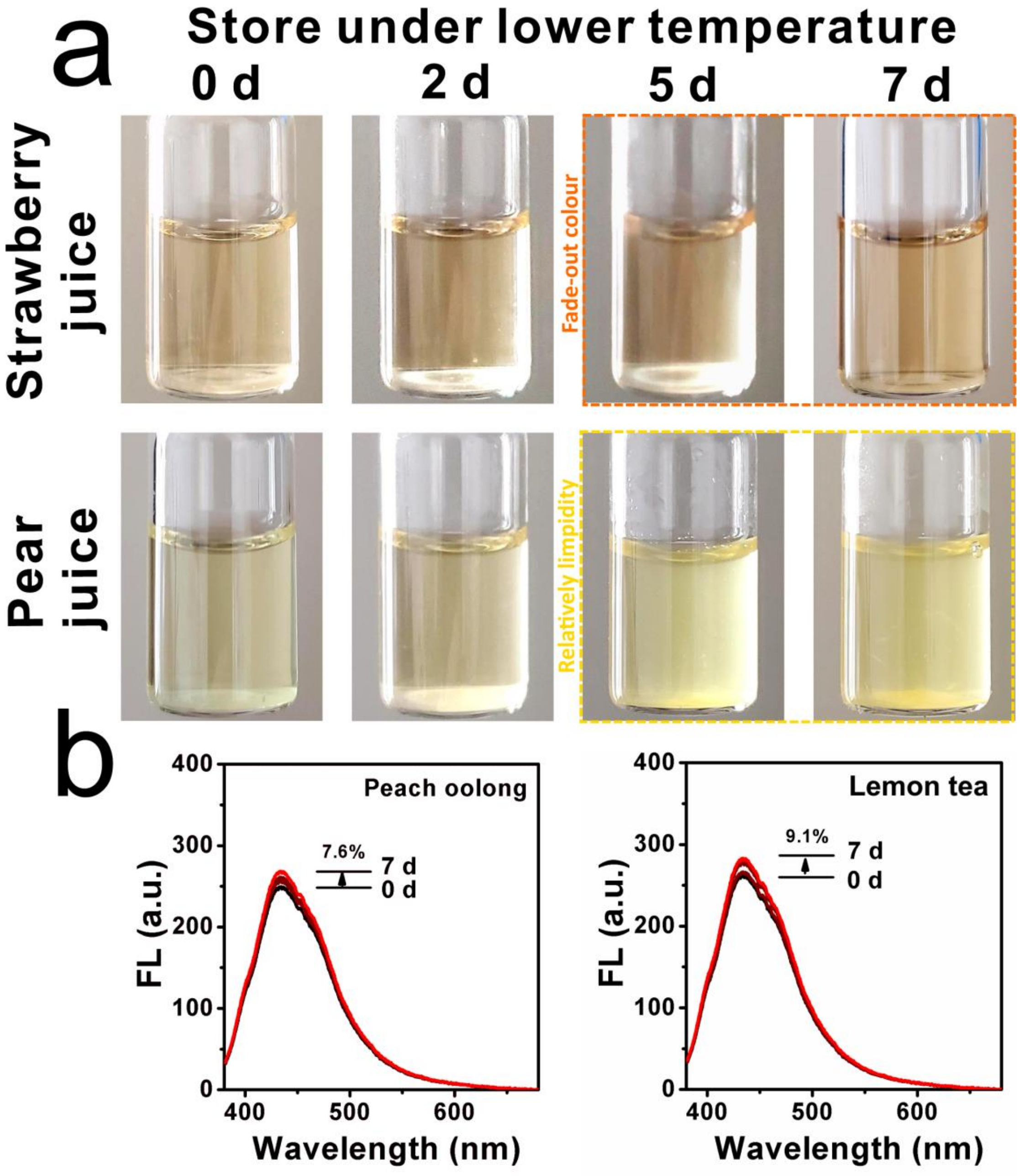
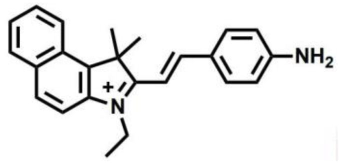
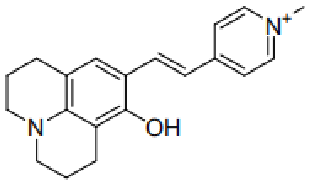
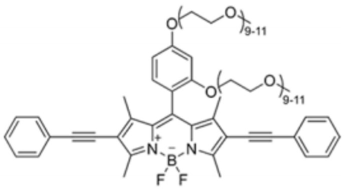
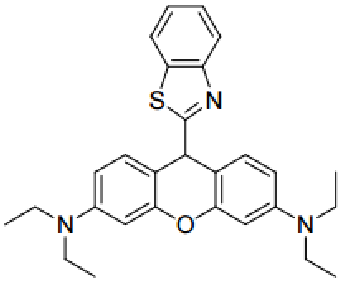
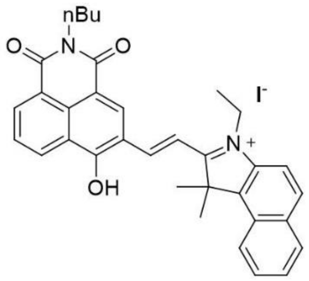
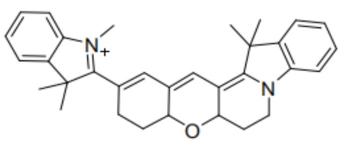
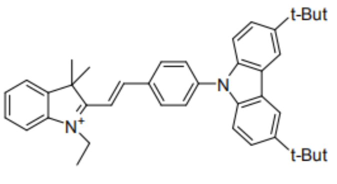
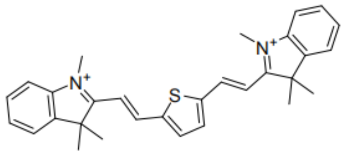
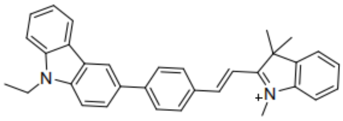
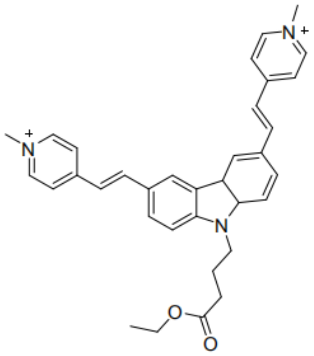
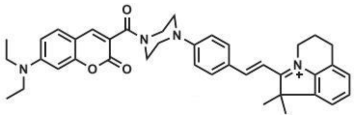
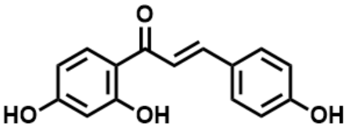


Fig. S8 (a) Digital images of the peach oolong and lemon tea stored under lower temperatures (5 °C) for varying times (from 0 to 7 days). (b) Corresponding fluorescence spectra in peach oolong and lemon tea at different time intervals. Concentration of ILG = 10 μM, λ_{ex}=350 nm.

Table S1. Comparison of the representative fluorescence-based dyes for viscosity detection reported in recent years.

Probe	Sources	Stokes shift*	Application	Reference
	Artificial synthesis	72 nm	Biological system, living cells.	1
	Artificial synthesis	90 nm	Biological system, living cells.	2
	Artificial synthesis	20 nm	Biological system, living cells.	3
	Artificial synthesis	35 nm	Biological system, living cells, in vivo.	4
	Artificial synthesis	55 nm	Biological system, living cells.	5
	Artificial synthesis	20 nm	Biological system, living cells, rat slice.	6
	Artificial synthesis	83 nm	Biological system, living cells.	7

	Artificial synthesis	70 nm	Biological system, living cell.	8
	Artificial synthesis	90 nm	Biological system, living cell, zebrafish, mice.	9
	Artificial synthesis	90 nm	Biological system, living cell.	10
	Artificial synthesis	60 nm	Biological system, living cell.	11
	Natural product	52.5 nm	Liquid food, food spoilage analysis.	This work

* The stokes shift herein was obtained from the absorption and emission measured in the glycerol.

Table S2. Viscosity values of the liquids determined by a viscometer and fluorescent spectrometer.

Liquids	Viscosity (cP)	Calculated (cP)
Peach oolong	1.85	1.88
Pear juice	2.00	2.01
Strawberry juice	2.50	2.46
Milk	2.91	2.98
Lemon juice	3.50	3.55
Mango tea	4.25	4.14
Watermelon juice	7.50	7.42
Edible oil	68.10	68.00

Table S3. Photo-physical properties of the molecular sensor polydatin in different solvents.

Solvents	Dielectric constant (ε)	η (cP)	Absorption λ_{ab} (nm)	Emission λ_{em} (nm)
Glycerol	45.8	956.0	383.1	432.2
Water	78.5	1.0	378.2	434.2
Toluene	2.4	0.6	361.7	411.5
Methanol	32.6	0.6	372.9	430.2
THF	7.4	0.5	363.8	419.3
Ethanol	24.9	1.2	369.1	425.3
Acetonitrile	37.5	0.4	372.3	429.0
EA	6.1	0.4	366.3	421.2
DMF	36.7	0.8	372.1	428.4
DMSO	46.8	2.1	376.3	432.4

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