Supplementary Materials: pH-Sensitive Sensors at Work on Poultry Meat Degradation Detection: From the Laboratory to the Supermarket Shelf

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Table S1. Commercial EVOH copolymers under investigation with their ethylene content and MFR.

EVOH type	Ethylene content (mol%)	Melt Flow Rate (MFR)
A	29%	3.8
B	29%	8
C	44%	3.5
D	44%	12

Table S2. Commercial sulfonphthalein pH indicators tested and their logK_a as found in literature. [33,34].

Dye	Name	logK_a	logK_{a1}	logK_{a2}
1	Bromothymol Blue	7.1	-	-
2	Thymol Blue	-	8.9	1.50
3	Bromophenol Blue	3.8	-	-
4	*o*-cresol Red	-	8.20	1.11

Table S3. Optimized pressing parameters for Dye-EVOH@.

Parameter	Optimized value
Polymer mass (mg)	300
Pressure (psi)	2000
Time (s)	30
Temperature (°C)	180

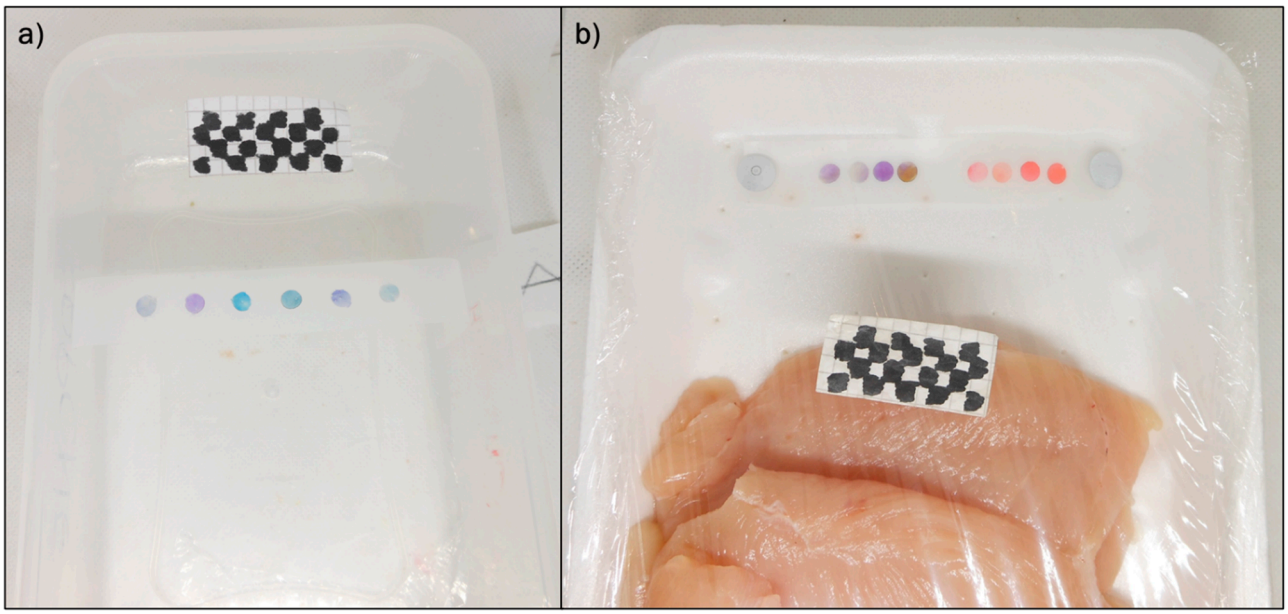


Figure S1. Experimental setup for vapor analysis using synthetic samples for ammonia, acetic acid and phosphate buffer solutions (**a**), or chicken breast slices (**b**). In each picture, the black and white device is used to ensure a reproducible focus point.

Figure S2. Picture of the light box employed to take array photographs. (PULUZ, Photography Light Box, Shenzhen Puluz Technology Limited, Shenzhen, China).

$$TVB - N\ (\frac{mg}{100}g) = \frac{(V_1 - V_0) \times 0.14 \times 2 \times 100}{m}$$

V_1 = Volume of 0.01 M hydrochloric acid solution in ml for sample.

V_0 = Volume of 0.01 M HCL solution in ml for blank (50 ml perchloric acid solution 6%).

m = Weight of sample in g.

Equation S1. TVB-N calculation.

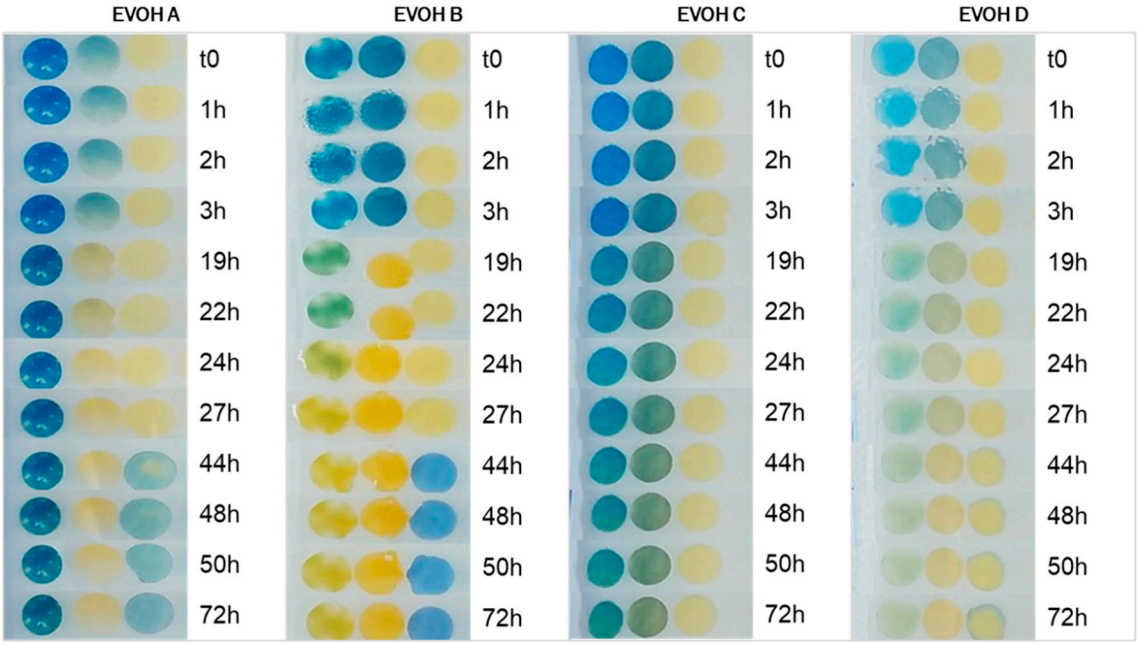


Figure S3. Color evolution over codfish fillets, stored at 4 °C, of Dye-EVOH@ sensors arrays, using EVOH A, B, C and D as solid support. In each array, the sensors are located in the following order from left to right: 1-EVOH@, 2-EVOH@ and 3-EVOH@ (referring to the numeration in Table 2S).

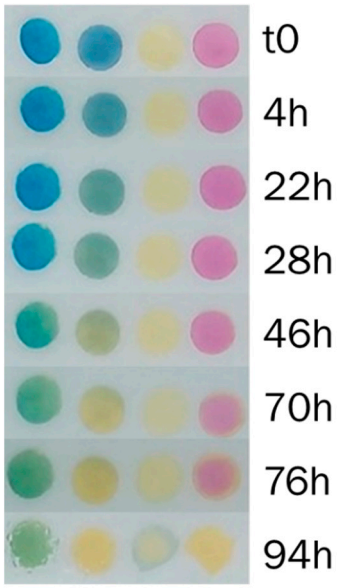


Figure S4. Color evolution over chicken breast slices, stored at 4 °C, of Dye-EVOH@ sensors arrays, using EVOH B. In each array, the sensors are located in the following order from left to right: 1-EVOH@, 2-EVOH@, 3-EVOH@ and 4-EVOH@ (referring to the numeration in Table 2S).

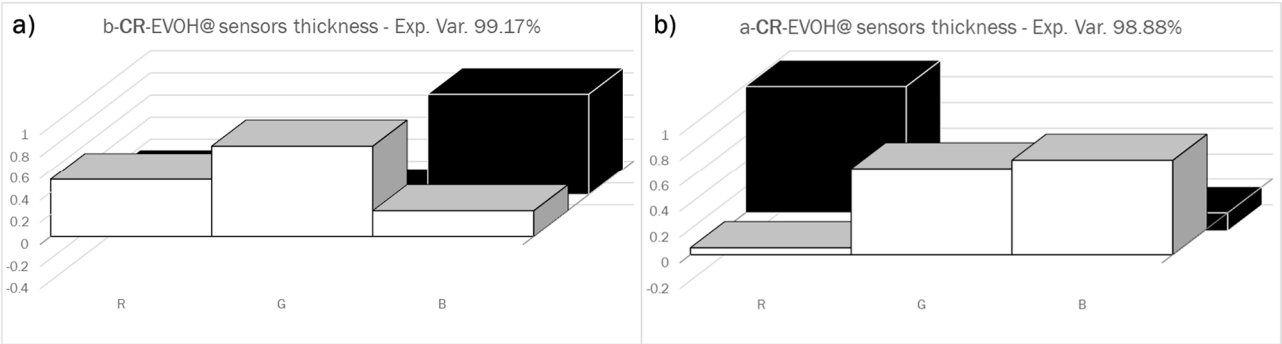


Figure S5. PCA loading plots of the first two components based on RGB triplets of 104 b-CR-EVOH@ (a) and 132 a-CR-EVOH@ (b) sensors of various thicknesses. The loading values on PC1 are in the foreground, and the ones on PC2 are in the background.

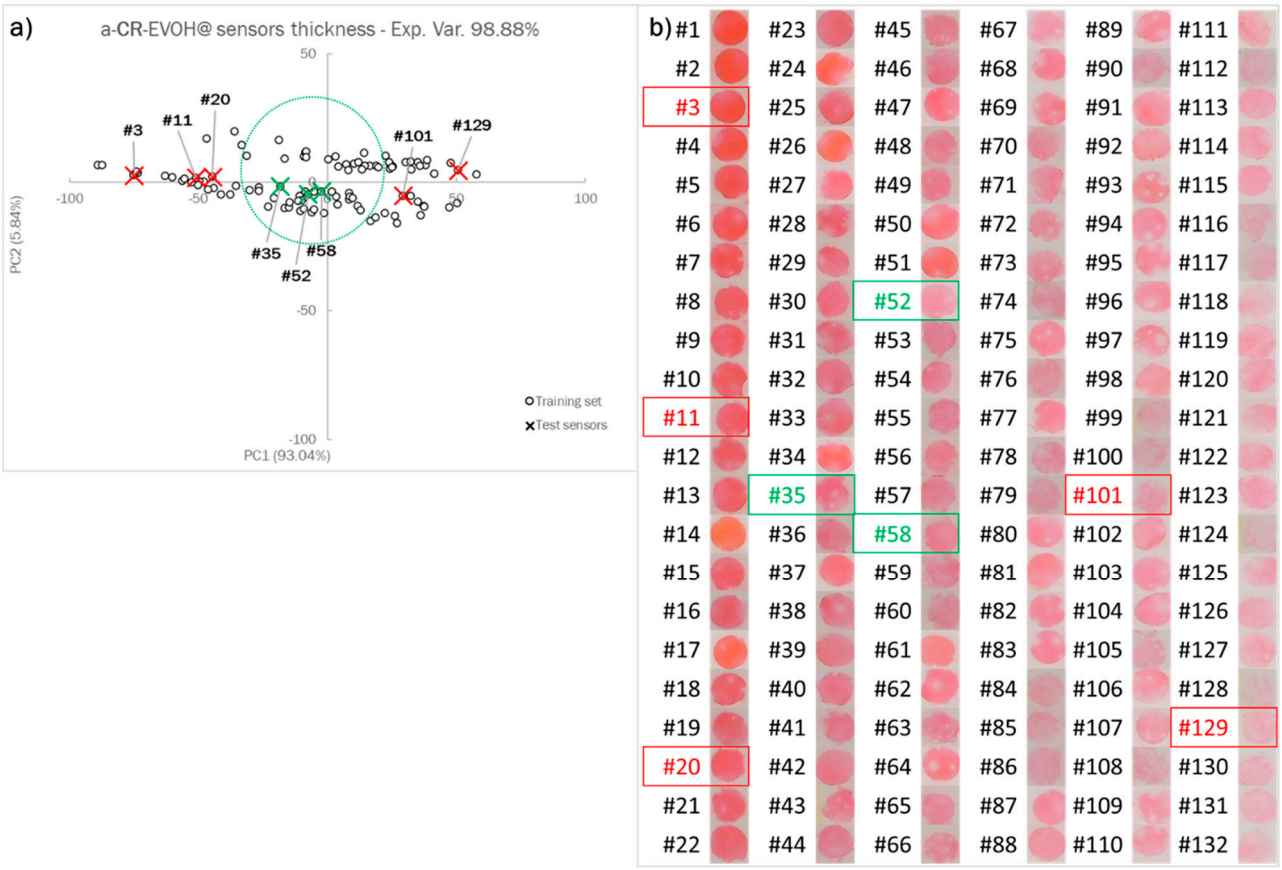


Figure S6. PCA score plot of the first two components based on RGB triplets of 132 sensors of various thicknesses (white circles). The sensors tested for chicken breast slice monitoring are highlighted with green and red Xs, and the suitable thickness range is identified by the green oval (a). Pictures of the 132 sensors used to build the PCA model with the sensors tested for chicken breast slice monitoring highlighted in green and red (b).

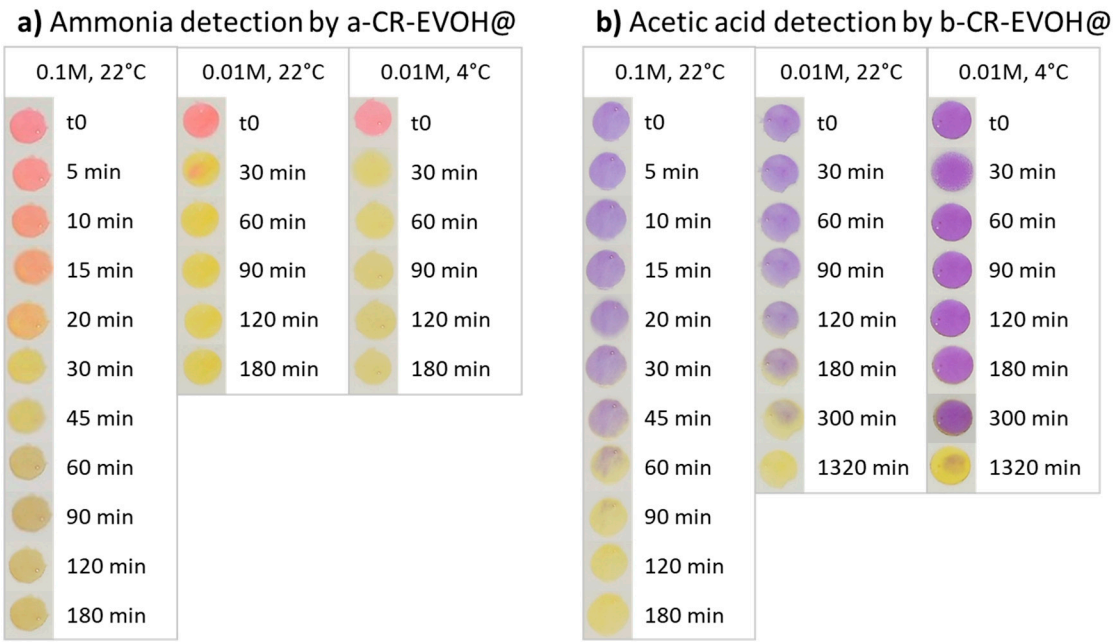
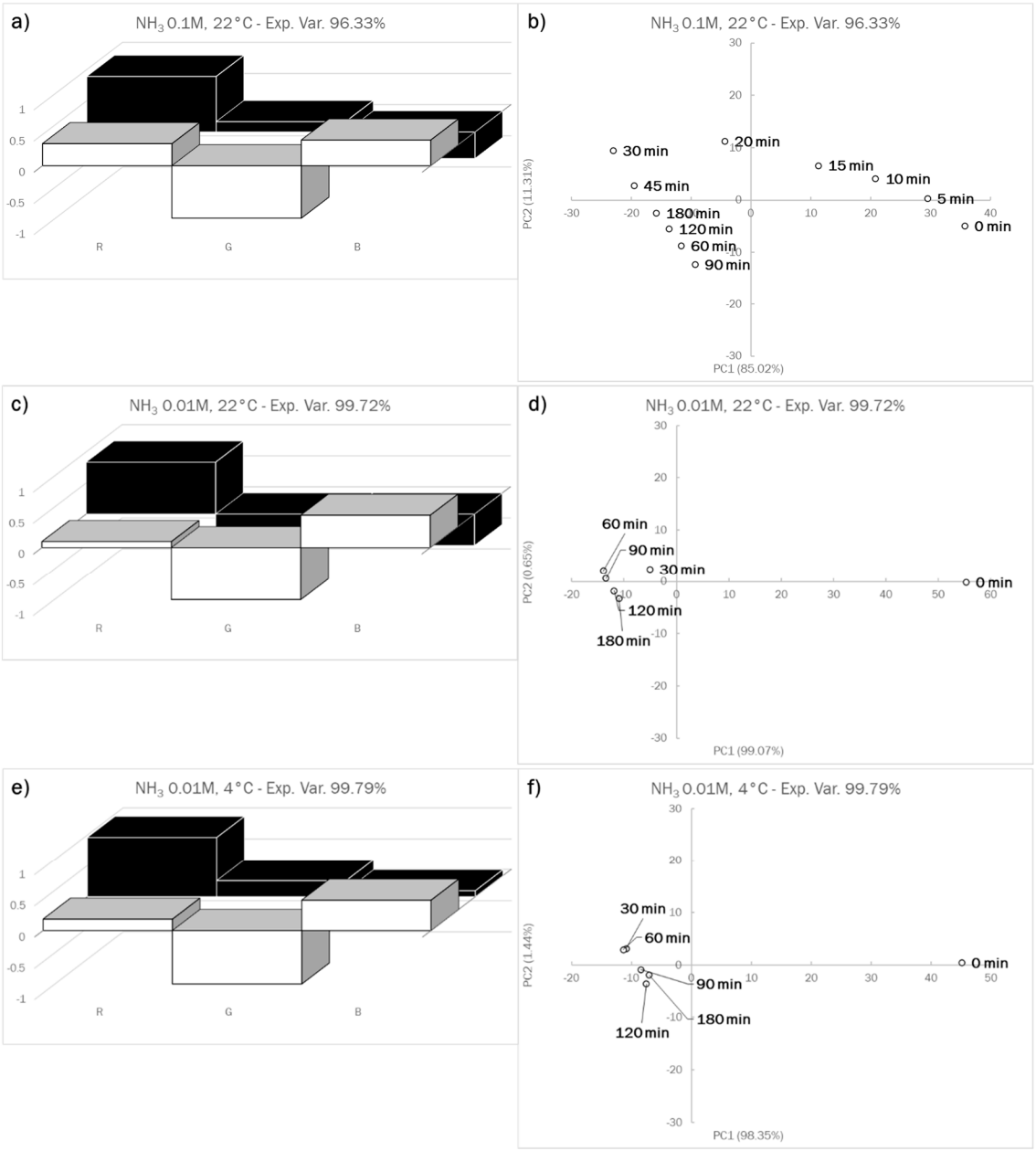


Figure S7. Color evolution of a-CR-EVOH@ sensors over ammonia solutions (a) and of b-CR-EVOH@ over acetic acid solutions (b). Both the vapor-generating compounds are tested at 0.1 M (22°C) and 0.01 M (22°C and 4°C).

Table S4. % Explained variance on PC1, PC2 and PC1 + PC2 per each vapor analysis performed.

n	Vapor-generating solution	T	% Exp. Var. PC1	% Exp. Var. PC2	% Exp. Var. PC1+PC2
1	NH_3 0.1 M	22°C	85.02%	11.31%	96.33%
2	NH_3 0.01 M	22°C	99.07%	0.65%	99.72%
3	NH_3 0.01 M	4°C	98.35%	1.44%	99.79%
4	CH_3COOH 0.1 M	22°C	99.57%	0.41%	99.98%
5	CH_3COOH 0.01 M	22°C	99.60%	0.27%	99.87%
6	CH_3COOH 0.01 M	4°C	91.65%	8.25%	99.90%



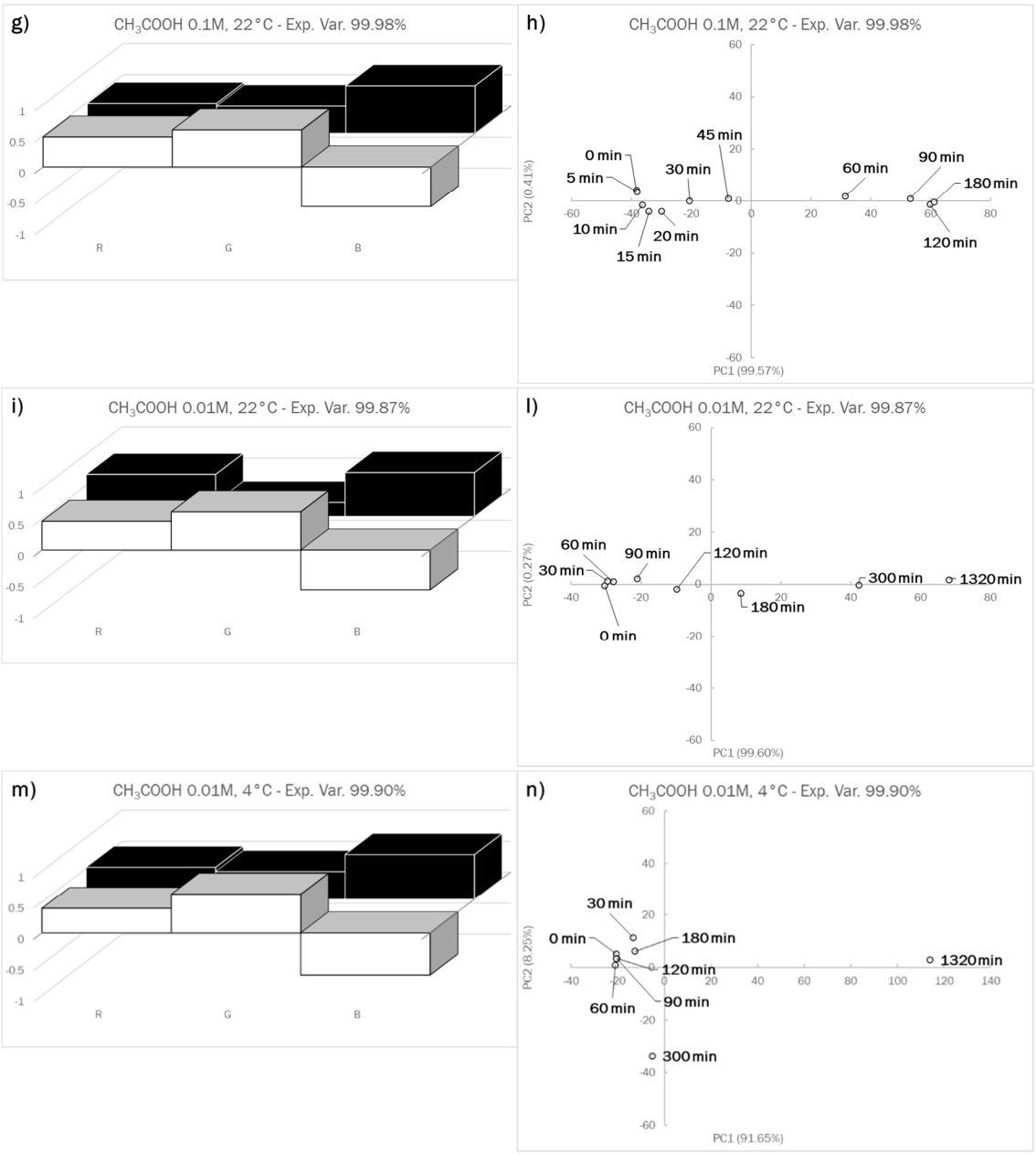


Figure S8. Loading and score plots on the first two principal components for acid and alkaline vapors analyses. The vapor-generating solutions and storage temperature used are NH_3 0.1M at 22°C (a, b), NH_3 0.01M at 22°C (c, d), NH_3 0.01M at 4°C (e, f), CH_3COOH 0.1M at 22°C (g, h), CH_3COOH 0.01M at 22°C (i, l) and CH_3COOH 0.01M at 4°C (m, n). In the loading plots, the loading values on PC1 are in the foreground, and the ones on PC2 are in the background.

$$nED_n = \frac{ED_{i-f} - ED_{n-f}}{ED_{i-f}}$$

$$ED_{i-f} = \sqrt{(Score_i - Score_f)^2} \qquad ED_{n-f} = \sqrt{(Score_n - Score_f)^2}$$

i = first acquisition time; $Score_i$ = score value for the first acquisition time.
n = given acquisition time; $Score_n$ = score value for given acquisition time.
F = last acquisition time; $Score_f$ = score value for the last acquisition time.

Equation S2. Normalized Euclidean Distance calculations.

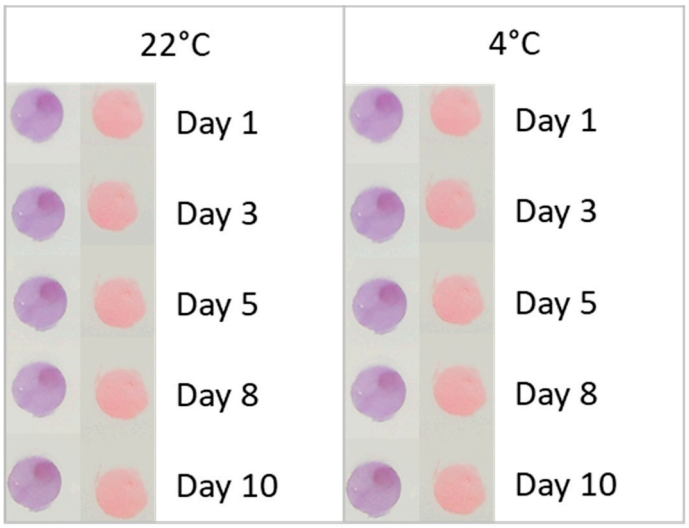


Figure S9. Colour evolution of CR-EVOH@ dual-sensor array exposed to 50 mL phosphate buffer (pH = 7) in a sealed box (1.5 L) during 10-day monitoring at 22 °C and 4 °C. In each array b-CR-EVOH@ is placed on the left and a-CR-EVOH@ on the right.

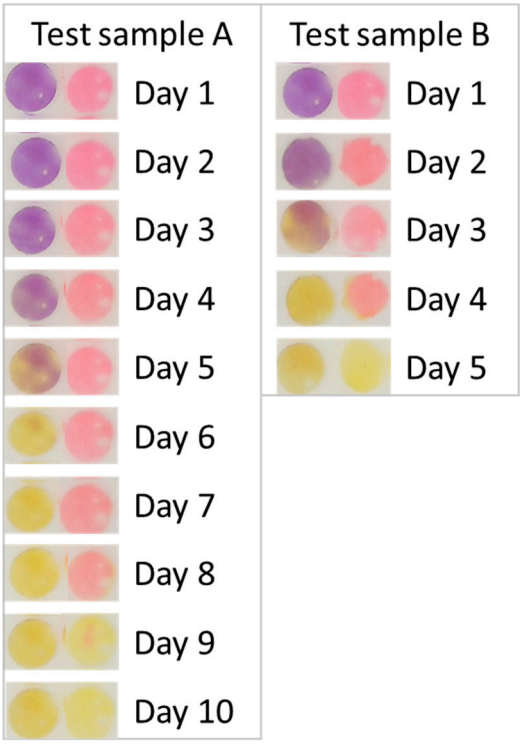


Figure S10. CR-EVOH@ dual-sensor array colour evolution over chicken breast slice samples, belonging to the test set. Test sample A is purchased the same day as the delivery from the supplier, while test sample B is acquired two days after. In each array b-CR-EVOH@ is placed on the left and a-CR-EVOH@ on the right.

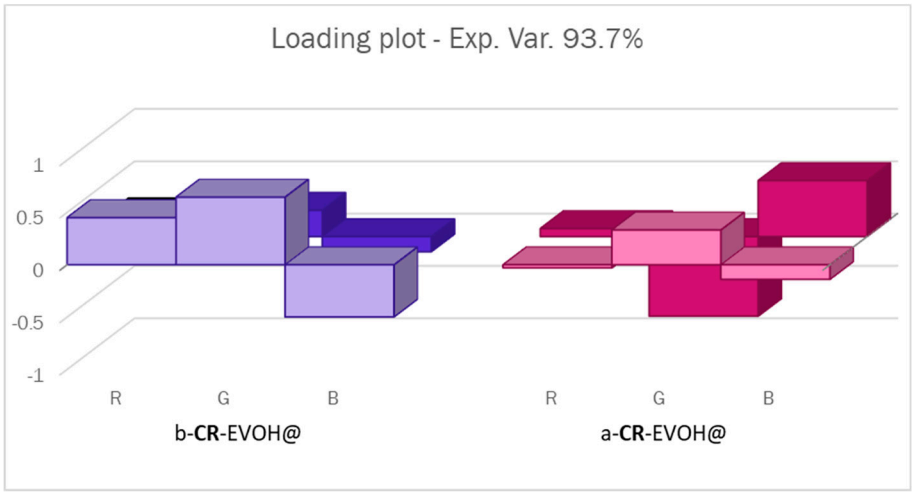


Figure S11. PCA loading plot on the first two principal components for chicken breast slices' freshness. The loading values on PC1 are in the foreground, and the ones on PC2 are in the background.