One Health, One Photosensitiser: Hydroxypropyl-γ-cyclodextrin-Curcumin-based Photodynamic Inactivation across Abiotic Surfaces, Food Matrices and a Porcine Skin Model

Supplementary Materials

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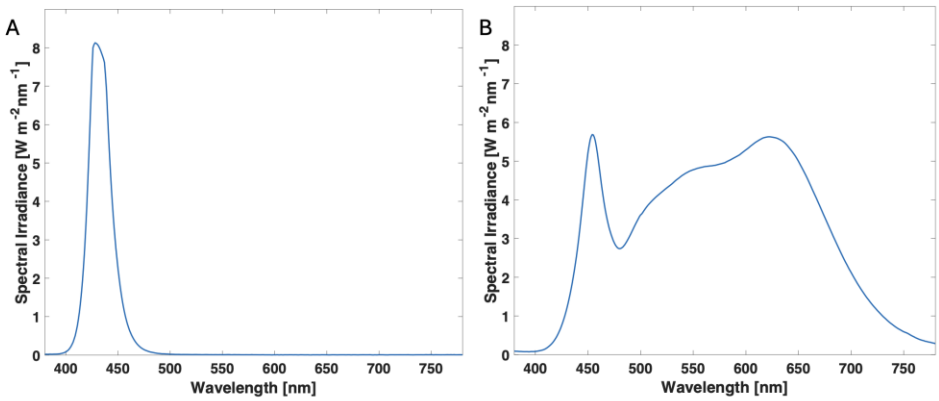


Figure S1. Emission spectra of used lamps. LED array with main wavelength at 435 nm (A) and white light broad emission LED lamp (B). Given are spectral irradiances across the visible light range.

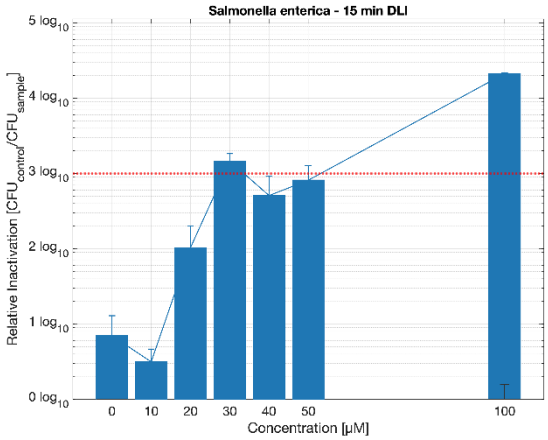


Figure S2. Mean relative inactivation of *Salmonella enterica* at increased DLI. PDI treatment with increasing concentrations of CD-Cur, drug-to-light interval (DLI) of 15 min and

illumination at 435 nm LED light at 50 J/cm^2. Compared to results with DLI = 0 min (see main text, Figure 2), the relative inactivation is lower.

Table S1. Results overview of liquid culture experiments (435 nm, 50 J/cm^2 for bacteria and 7.5 J/cm^2 for *C. auris*). Given are mean counted CFU/mL and standard deviation as well as relative inactivation and standard deviation for all evaluated samples.

concentration CD-Cur	CFU/mL	stan. dev. (CFU/mL)	relative inactivation	stan. dev. (rel. inact.)
		***Escherichia coli* - K12**		
0 µM dark	5.55×10^7	5.98×10^7	1.00×10^00	0.00×10^0
100 µM dark	9.75×10^6	6.08×10^6	2.07×10^0	1.22×10^0
0 µM	9.37×10^6	5.92×10^6	3.89×10^0	3.98×10^0
10µM	2.84×10^5	4.00×10^5	8.98×10^2	1.04×10^3
20 µM	2.83×10^5	4.01×10^5	3.82×10^4	2.80×10^4
30 µM	3.15×10^4	4.42×10^4	2.38×10^5	3.25×10^5
40 µM	1.55×10^4	2.09×10^4	9.55×10^4	1.06×10^5
50 µM	6.11×10^3	7.71×10^3	4.37×10^4	3.84×10^4
100 µM	6.57×10^2	4.81×10^2	6.61×10^3	9.12×10^3
		***Escherichia coli* - ATCC 25922**		
0 µM dark	1.17×10^8	2.99×10^7	1.00×10^0	0.00×10^0
100 µM dark	1.38×10^8	2.74×10^7	8.42×10^{-1}	6.15×10^{-2}
0 µM	1.05×10^8	1.52×10^7	1.10×10^0	1.50×10^{-1}
10µM	2.03×10^5	1.64×10^5	4.23×10^5	5.97×10^5
30 µM	2.40×10^2	2.98×10^2	4.38×10^7	6.09×10^7
50 µM	1.75×10^3	2.47×10^3	6.87×10^7	5.33×10^7
100 µM	9.40×10^1	1.32×10^2	6.88×10^7	5.31×10^7
		***Salmonella enterica* (DLI = 0 min)**		
0 µM dark	3.28×10^7	7.67×10^6	1.00×10^0	0.00×10^0
100 µM dark	2.59×10^7	4.58×10^6	1.25×10^0	2.41×10^{-1}
0 µM	3.01×10^7	2.21×10^7	1.41×10^0	6.67×10^{-1}
10µM	1.60×10^7	3.30×10^6	1.63×10^1	2.53×10^1
20 µM	2.44×10^6	3.35×10^6	6.41×10^2	9.17×10^2
30 µM	1.44×10^5	2.25×10^5	6.83×10^3	6.78×10^3
40 µM	1.08×10^4	1.43×10^4	1.10×10^4	8.14×10^3
50 µM	4.96×10^4	9.13×10^4	4.53×10^4	4.67×10^4
100 µM	6.20×10^2	1.26×10^2	5.39×10^4	1.39×10^4
		***Salmonella enterica* (DLI = 15 min)**		
0 µM dark	1.85×10^7	1.08×10^7	1.00×10^0	0.00×10^0
100 µM dark	1.91×10^7	3.00×10^5	9.81×10^{-1}	5.82×10^{-1}
0 µM	1.41×10^7	1.35×10^7	6.98×10^0	5.91×10^0
10µM	9.62×10^6	7.95×10^6	3.15×10^0	1.49×10^0
20 µM	6.45×10^5	4.98×10^5	1.03×10^2	9.66×10^1
30 µM	1.16×10^4	4.41×10^3	1.46×10^3	3.77×10^2
40 µM	5.61×10^4	2.43×10^4	5.10×10^2	4.13×10^2
50 µM	2.25×10^4	5.02×10^2	8.13×10^2	4.62×10^2

100 µM	8.67×10^{2}	4.93×10^{2}	2.11×10^{4}	4.27×10^{2}
		Candidozyma auris		
0 µM dark	1.01×10^{9}	9.60×10^{8}	1.00×10^{0}	0.00×10^{0}
100 µM dark	1.76×10^{9}	1.53×10^{9}	7.02×10^{-1}	3.76×10^{-1}
0 µM	1.21×10^{9}	1.34×10^{9}	2.98×10^{9}	4.61×10^{9}
10µM	1.72×10^{9}	3.44×10^{9}	4.20×10^{8}	7.04×10^{8}
50 µM	0.00×10^{0}	0.00×10^{0}	1.01×10^{9}	9.60×10^{8}
100 µM	0.00×10^{0}	0.00×10^{0}	1.01×10^{9}	9.60×10^{8}

Table S2. Results overview of PDI of *Escherichia coli* on plastic foil (broad spectrum white light, 100 J/cm^2). Given are mean counted CFU/mL and standard deviation as well as relative inactivation and standard deviation for all evaluated samples.

concentration CD-Cur	CFU/mL	stan. dev. (CFU/mL)	relative inactivation	stan. dev. (rel. inact.)
		***Escherichia coli* - K12 on plastic foil**		
0 µM dark	2.11×10^{7}	1.28×10^{7}	1.00×10^{0}	0.00×10^{0}
100 µM dark	2.13×10^{7}	1.93×10^{7}	1.64×10^{0}	9.17×10^{-1}
0 µM	5.11×10^{7}	6.99×10^{7}	5.23×10^{0}	6.24×10^{0}
30 µM	8.10×10^{6}	7.19×10^{6}	2.92×10^{1}	4.51×10^{1}
50 µM	4.17×10^{6}	4.13×10^{6}	9.22×10^{0}	1.08×10^{1}
100 µM	1.59×10^{5}	1.90×10^{5}	2.22×10^{3}	3.32×10^{3}

Table S3. Results of light toxicity evaluation (435 nm at different radiant exposures, no photosensitiser) of *Escherichia coli* on plastic and metal plates. Given are mean counted CFU/mL and standard deviation as well as relative inactivation and standard deviation for all evaluated samples.

radiant exposure 435 nm	CFU/mL	stan. dev. (CFU/mL)	relative inactivation	stan. dev. (rel. inact.)
		***Escherichia coli* ATCC 25922 on plastic plates**		
0 J/cm²	3.53×10^{5}	6.13×10^{4}	1.00×10^{0}	0.00×10^{0}
5 J/cm²	2.09×10^{5}	9.30×10^{4}	1.95×10^{0}	5.72×10^{-1}
15 J/cm²	4.07×10^{4}	1.51×10^{4}	9.41×10^{0}	1.99×10^{0}
25 J/cm²	3.74×10^{4}	1.76×10^{4}	1.11×10^{1}	3.59×10^{0}
50 J/cm²	3.50×10^{2}	2.50×10^{2}	1.81×10^{3}	1.11×10^{3}
		***Escherichia coli* ATCC 25922 on metal plates**		
0 J/cm²	2.04×10^{5}	7.55×10^{4}	1.00×10^{0}	0.00×10^{0}
5 J/cm²	3.47×10^{4}	2.73×10^{4}	1.09×10^{1}	6.40×10^{0}
15 J/cm²	1.12×10^{4}	9.66×10^{3}	4.72×10^{1}	3.38×10^{1}
25 J/cm²	7.33×10^{3}	7.17×10^{3}	4.10×10^{2}	3.90×10^{2}
50 J/cm²	1.00×10^{0}	0.00×10^{0}	2.04×10^{5}	7.55×10^{4}

Table S4. Results overview of PDI of *Escherichia coli* on various abiotic surfaces (435 nm, 25 J/cm^2). Given are mean counted CFU/mL and standard deviation as well as relative inactivation and standard deviation for all evaluated samples.

concentration CD-Cur	CFU/mL	stan. dev. (CFU/mL)	relative inactivation	stan. dev. (rel. inact.)
		***Escherichia coli* - ATCC 25922 on ceramics**		
0 µM dark	1.48×10^5	5.09×10^4	1.00×10^0	0.00×10^0
100 µM dark	1.46×10^4	1.66×10^4	2.87×10^1	1.68×10^1
0 µM	3.30×10^2	2.58×10^2	3.79×10^4	5.31×10^4
30 µM	1.00×10^0	0.00×10^0	1.48×10^5	5.09×10^4
50 µM	1.00×10^0	0.00×10^0	1.48×10^5	5.09×10^4
100 µM	1.00×10^0	0.00×10^0	1.48×10^5	5.09×10^4
		***Escherichia coli* - ATCC 25922 on metal**		
0 µM dark	1.69×10^5	1.51×10^5	1.00×10^0	0.00×10^0
100 µM dark	7.37×10^2	6.95×10^2	1.80×10^4	2.52×10^4
0 µM	1.02×10^4	8.44×10^3	3.06×10^1	2.47×10^1
30 µM	1.00×10^0	0.00×10^0	1.69×10^5	1.51×10^5
50 µM	1.00×10^0	0.00×10^0	1.69×10^5	1.51×10^5
100 µM	1.00×10^0	0.00×10^0	1.69×10^5	1.51×10^5
		***Escherichia coli* - ATCC 25922 on plastic**		
0 µM dark	3.19×10^5	1.40×10^5	1.00×10^0	0.00×10^0
100 µM dark	3.20×10^4	1.01×10^4	9.57×10^0	1.82×10^0
0 µM	7.73×10^4	2.50×10^4	3.97×10^0	5.33×10^{-1}
30 µM	1.00×10^0	0.00×10^0	3.19×10^5	1.40×10^5
50 µM	1.00×10^0	0.00×10^0	3.19×10^5	1.40×10^5
100 µM	1.00×10^0	0.00×10^0	3.19×10^5	1.40×10^5

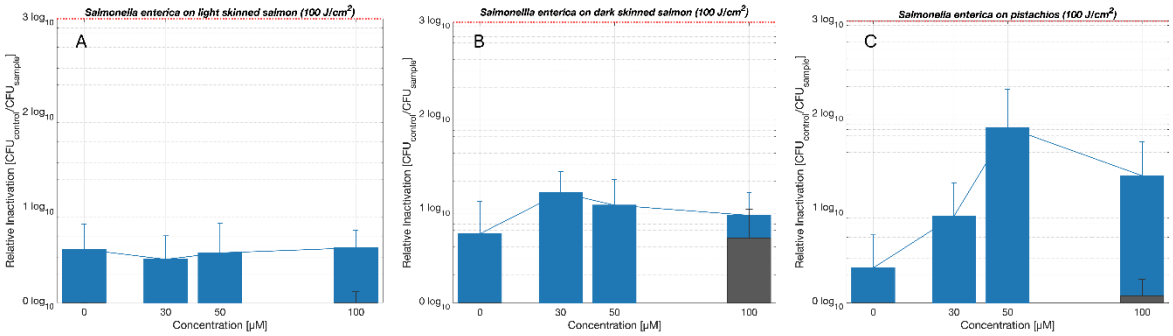


Figure S3. *Salmonella enterica* decontamination on foodstuff at 100 J/cm^2. Light skinned salmon (A), dark skinned salmon (B), and pistachios (C). Samples were decontaminated using increasing concentrations of CD-Cur and were illuminated with 435 nm LED light at 100 J/cm^2. Given is the relative inactivation expressed as log $_{10}$steps calculated from ($CFU_{control}$/ CFU_{sample}) . Grey bars at 100 µM indicate dark controls treated at respective CD-Cur concentration but restricted from light. The red dashed line indicates the threshold corresponding to a 3 log $_{10}$reduction.

Table S5. Temperatures measured on pistachio and salmon skin samples upon exposure to the 435 nm LED array between 0 and 205 minutes (equivalent to 300 J/cm^2).

exposure time to 435 nm LED array [min]	Temperature [°C]	stan. dev.	Temperature [°C]	stan. dev.
	Pistachios		Salmon skin	
0	22.25	0.55	21.95	0.85
30	27.55	0.05	26.40	1.00
60	28.80	0.00	26.55	1.05
90	30.05	0.25	26.60	1.10
120	31.20	0.60	27.45	0.85
150	32.30	0.70	27.55	0.95
180	32.45	0.75	27.65	0.85
205	32.85	0.65	27.80	0.90

Table S6. Results overview of PDI of *Salmonella enterica* on different foodstuffs (435 nm, 200 J/cm^2). Given are mean counted CFU/mL and standard deviation as well as relative inactivation and standard deviation for all evaluated samples.

concentration CD-Cur	CFU/mL	stan. dev. (CFU/mL)	relative inactivation	stan. dev. (rel. inact.)
		***Salmonella enterica* on light skinned salmon**		
0 µM dark	2.09×10^6	8.05×10^5	1.00×10^00	0.00×10^0
100 µM dark	2.06×10^6	6.35×10^5	1.19×10^00	7.75×10^{-1}
0 µM	2.90×10^5	3.39×10^5	3.26×10^1	2.99×10^1
30 µM	2.53×10^5	3.34×10^5	2.72×10^2	3.86×10^2
50 µM	4.96×10^4	4.26×10^4	8.27×10^2	1.30×10^3
100 µM	1.86×10^5	1.90×10^5	3.65×10^1	4.31×10^1
		***Salmonella enterica* on dark skinned salmon**		
0 µM dark	3.40×10^6	2.10×10^6	1.00×10^0	0.00×10^0
100 µM dark	2.29×10^6	1.95×10^6	1.79×10^0	9.14×10^{-1}
0 µM	3.28×10^5	3.57×10^5	3.23×10^1	3.43×10^1
30 µM	8.27×10^4	1.07×10^5	1.79×10^2	1.71×10^2
50 µM	5.92×10^4	2.56×10^4	9.74×10^1	1.10×10^2
100 µM	8.13×10^4	5.06×10^4	6.25×10^1	4.90×10^1
		***Salmonella enterica* on pistachios**		
0 µM dark	3.15×10^6	3.00×10^6	1.00×10^0	0.00×10^0
100 µM dark	2.56×10^6	1.42×10^6	1.39×10^0	9.73×10^{-1}
0 µM	9.74×10^4	1.30×10^5	2.43×10^2	4.03×10^2
30 µM	3.46×10^4	5.74×10^4	3.33×10^3	5.81×10^3
50 µM	7.66×10^4	1.44×10^5	1.52×10^3	2.21×10^3
100 µM	2.90×10^4	2.63×10^4	1.69×10^3	3.08×10^3

Table S7. Preliminary experiments of PDI of *Candidozyma auris* on porcine skin using different concentrations of CD-Cur without the addition of 1% HEC and two different radiant exposures (37.5 and 75.0 J/cm^2). No relevant inactivation was observed when CD-Cur was applied topically without the hydrogel formulation.

concentration CD-Cur	CFU/mL	relative inactivation
	***Candidozyma auris* on porcine skin (37.5 J/cm^2, no HEC, *n* = 2)**	
0 µM dark	2.20×10^6	1.00×10^0
500 µM dark	3.50×10^6	6.26×10^{-1}
0 µM	3.80×10^6	7.15×10^{-1}
10µM	3.70×10^6	5.98×10^{-1}
50 µM	1.48×10^6	2.14×10^0
100 µM	2.01×10^6	1.18×10^0
	***Candidozyma auris* on porcine skin (75.0 J/cm^2, no HEC, *n* = 1)**	
0 µM dark	8.60×10^5	1.00×10^0
500 µM dark	1.00×10^6	8.60×10^{-1}
0 µM	1.14×10^6	7.54×10^{-1}
50 µM	2.43×10^5	3.54×10^0
100 µM	1.00×10^5	8.60×10^0
500 µM	1.79×10^5	4.80×10^0

Table S8. Results overview of PDI of *Candidozyma auris* on porcine skin (435 nm, 75 J/cm^2). Given are mean counted CFU/mL and standard deviation as well as relative inactivation and standard deviation for all evaluated samples.

concentration CD-Cur	CFU/mL	stan. dev. (CFU/mL)	relative inactivation	stan. dev. (rel. inact.)
		***Candidozyma auris* on porcine skin**		
0 µM dark	1.29×10^6	4.40×10^5	1.00×10^0	0.00×10^0
0 µM dark + 2 mM EDTA	8.18×10^5	2.08×10^5	1.58×10^0	4.28×10^{-1}
500 µM dark	1.84×10^6	1.72×10^6	1.01×10^0	3.48×10^{-1}
500 µM dark + 2 mM EDTA	1.82×10^6	1.39×10^6	9.74×10^{-1}	4.11×10^{-1}
100 µM	1.22×10^6	5.16×10^5	1.43×10^0	$1.^5 \times 10^0$
100 µM + 2 mM EDTA	9.40×10^5	2.45×10^5	1.46×10^0	7.46×10^{-1}
100 µM	6.65×10^5	4.92×10^5	2.83×10^0	1.93×10^0
500 µM	4.35×10^4	3.18×10^4	9.95×10^1	1.36×10^2
500 µM + 2 mM EDTA	2.08×10^4	1.49×10^4	2.56×10^2	3.93×10^2