Electronic Supplementary Material (ESI) for Green Chemistry.
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Title: Biobased sunscreen fabrication using Zn-porphyrins from engineered *Corynebacterium glutamicum*

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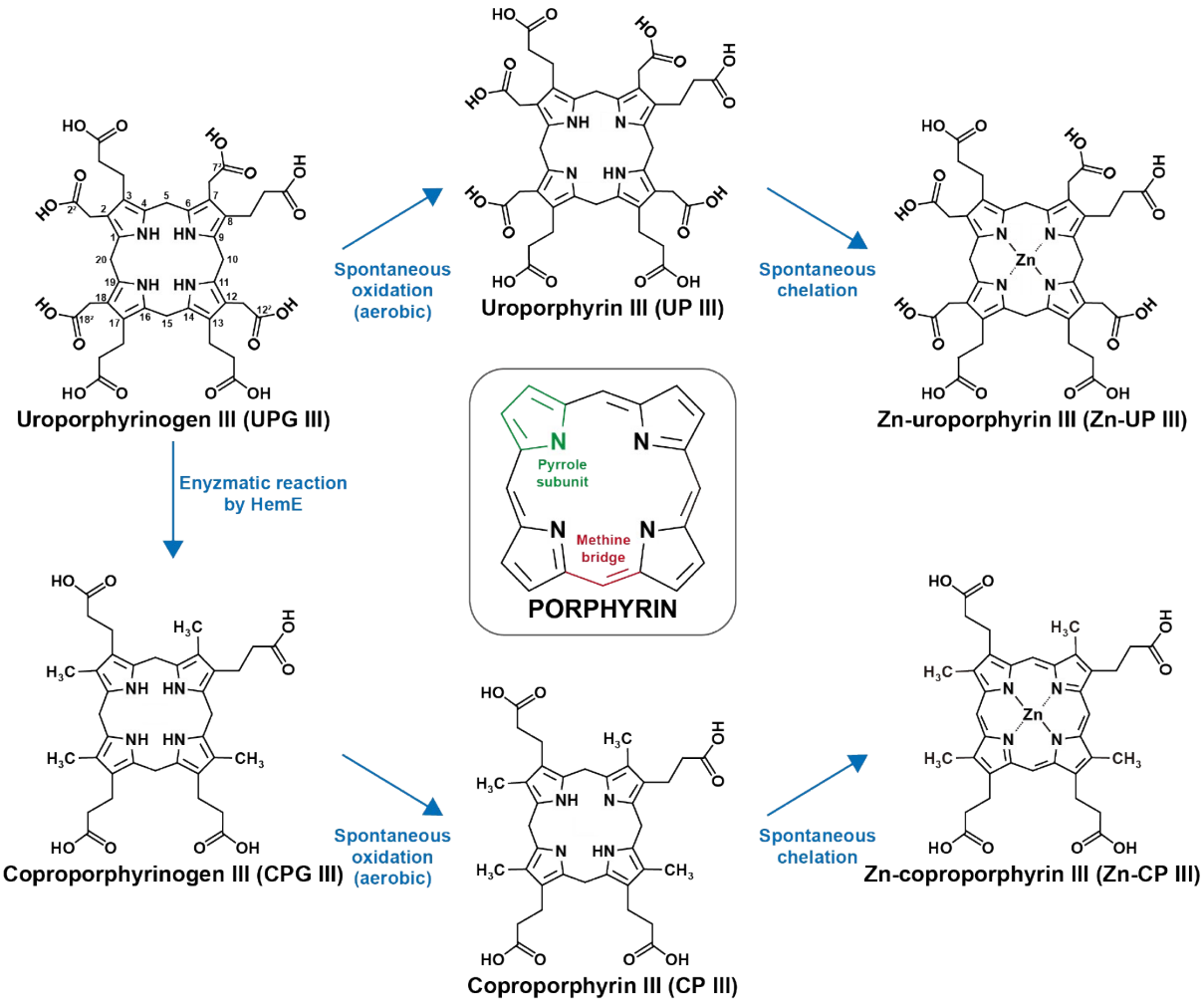

Fig. S1 Chemical structures of porphyrins including UPG III, CPG III, UP III, CP III, Zn-UP III, and Zn-CP III.

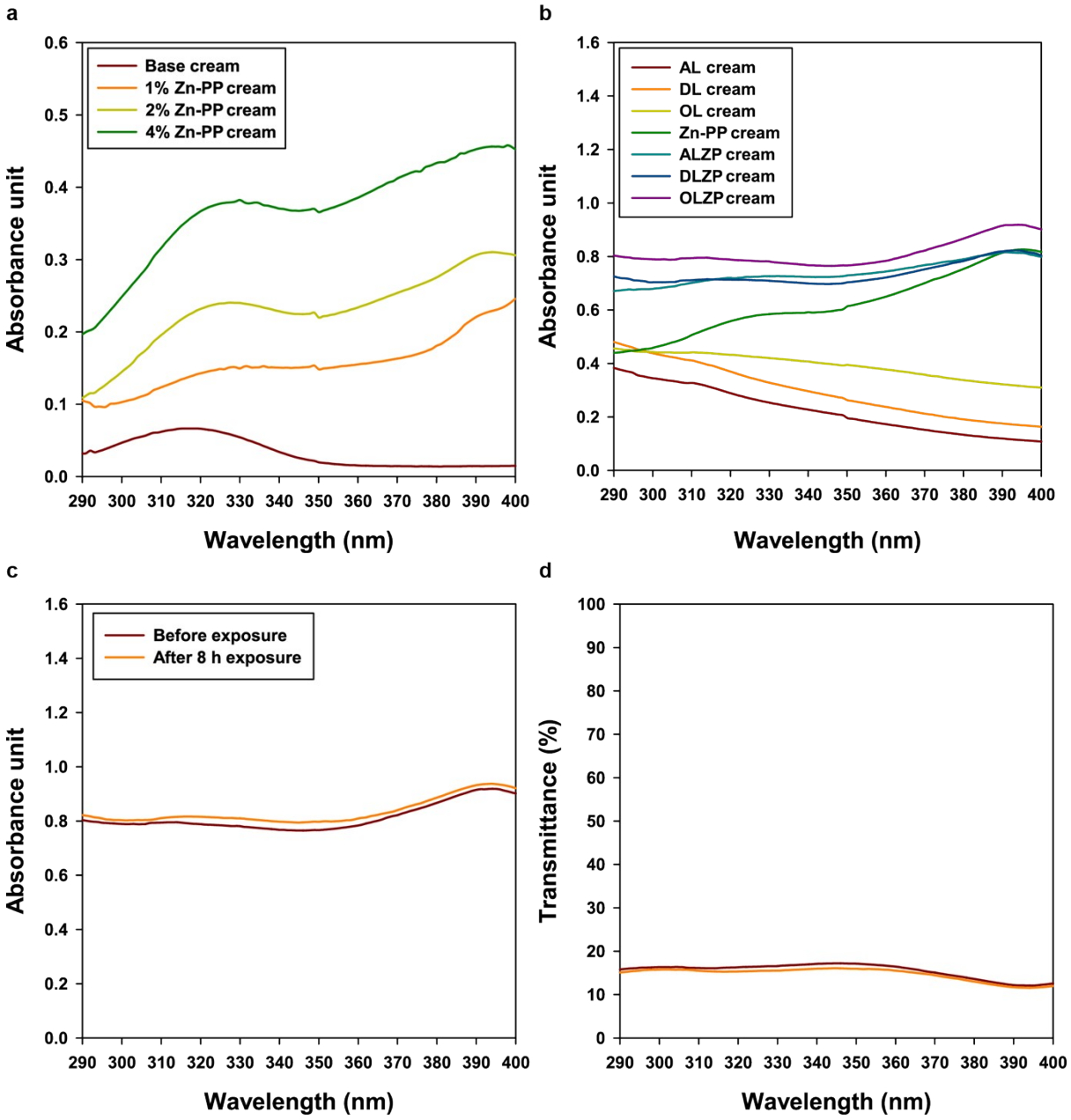

Fig. S2 Sunscreen performance of the creams including Zn-PPs and/or several lignins against UV light. (a) UV absorbance (290 nm to 400 nm) of the creams containing 1, 2, and 4% Zn-PPs were measured. (b) UV absorbance of the creams containing 4% each lignin, such as AL, DL, and OL, and/or 4% Zn-PPs were measured. (c) UV absorbance and (d) transmittance of the creams containing 4% OL and Zn-PPs were measured before or after 8 h UV exposure. The experiments were conducted three times.

Table S1 Plasmids and strains constructed in this study.

Plasmids and Strains	**Characteristics**	**Reference**
Plasmid		
pEKEx2	*C. glutamicum-E. coli* shuttle vector, P_{tac}, lacI, Kan^R, pBL1 ori	Lab stock
pEKEx2::ALDt	pEKEx2 carrying *hemA*^{M}*, hemL*, and *dtxR* genes	[1]
pEKEx2::ALSDtE	pEKEx2 carrying *hemA*^{M}*, hemL*, *alaS*, *dtxR*, and *hemE* genes	[2]
pMTC	*C. glutamicum-E. coli* shuttle vector, P_{tac}, Amp^R, CmR^R, pCG1 ori	Lab stock
pMTC-HrtBA	pMTC carrying *hrtB* and *hrtA* genes from *C. glutamicum*	This study
Strains		
E. coli DH5α	$F^–$, *deoR*, *endA1*, *gyrA96*, *hsdR17*(rk^-mk^+), *recA1*, *relA1*,*supE44*, *thi-1*, Δ(*lacZYA-argF*)*U169*, (Phi80*lacZ*delM15)	Invitrogen
C. glutamicum ATCC 14067	L-glutamate producing strain	ATCC
ALDt-c	*C. glutamicum* ATCC 14067 harboring pEKEx2::ALDt and pMTC	This study
ALDt-Hr	*C. glutamicum* ATCC 14067 harboring pEKEx2::ALDt and pMTC-HrtBA	This study
ALSdtE-c	*C. glutamicum* ATCC 14067, harboring pEKEx2::ALSDtE and pMTC	This study
ALSDtE-BA	*C. glutamicum* ATCC 14067, harboring pEKEx2::ALSDtE and pMTC-HrtBA	This study

Table S2 The contents of UP III, CP III, Zn-UP III, and Zn-CP III in the supernatant of each fermentation or purification sample.

Strain (Condition)	Content (%)			
	UP III	CP III	Zn-UP III	Zn-CP III
ALSDtE-c (Flask)	19.5%	80.5%	N.D. [a]	N.D.
ALSDtE-Hr (Flask)	28.6%	71.4%	N.D.	N.D.
ALSDtE-c (Flask with ETB10 and $ZnSO_4$)	N.D.	N.D.	21.5%	78.5%
ALSDtE-Hr (Flask with ETB10 and $ZnSO_4$)	N.D.	N.D.	64.2%	35.8%
ALSDtE-c (Flask with ETB25 and $ZnSO_4$)	N.D.	N.D.	24.6%	75.4
ALSDtE-c (Flask with ETB50 and $ZnSO_4$)	N.D.	N.D.	25.6%	74.4
ALSDtE-c (Flask with ETB100 and $ZnSO_4$)	N.D.	N.D.	25.6%	74.4%
ALSDtE-c (Fed-batch)	N.D.	N.D.	28.9%	71.1%
ALSDtE-c (Fed-batch with ETB)	N.D.	N.D.	77.6%	22.4%
ALSDtE-c (Purified from fed-batch)	N.D.	N.D.	29.8%	70.2%

[a] N.D. means "not detected".

Table S3 The molecular weights of the lignins used in this study.

Lignins	Number average molecular weight (Mn)	weight average molecular weight (Mw)
Alkaline lignin (AL)	6478	12097
Delkaline lignin (DL)	7471	19917
Olganosolv lignin (OL)	10057	22753

Table S4 The *in vitro* SPF value of OLZP at 0 h and after 8 h.

Cream	SPF (0 h)	SPF (8 h)
OLZP	6.21 ± 0.69	6.47 ± 0.55

References

1. Y. J. Ko, Y. C. Joo, J. E. Hyeon, E. Lee, M. E. Lee, J. Seok, S. W. Kim, C. Park and S. O. Han, *Sci. Rep.*, 2018, **8**.
2. Y. J. Ko, M. Kim, S. K. You, S. K. Shin, J. Chang, H. J. Choi, W. Y. Jeong, M. E. Lee, D. H. Hwang and S. O. Han, *Metab. Eng.*, 2021, **66**, 217-228.