

## Supplementary Materials

Relative enthalpies (H) and Gibbs free energy (G) in kcal/mol for the cyclization process. The relative energies are calculated taking **IIb** as the reference. The solvent values are also reported in Fig. 6.

	Gas Phase		Solvent	
	$\Delta H$	$\Delta G$	$\Delta H$	$\Delta G$
<b>IIb</b>				
TS1	7.5	18.1	7.8	23.8
<b>IIc vs IIb</b>	4.5	5.0	9.3	10.7
TS2	15.5	17.8	16.2	17.0
<b>IId vs IIc</b>	12.6	14.7	14.4	14.9
<b>IIe vs IIb</b>	8.3	10.2	7.9	11.3
<b>IIb</b>				
TSdirect	15.0	17.4	36.9	39.2
<b>IIe vs IIb</b>	8.3	10.2	7.9	11.3
<b>IIf vs IIb</b>	2.1	-6.9	-0.4	-9.7

Rate constants  $k(T=298K)$  calculated within the TST framework using either the Wigner or the Skodje&Truhlar transmission coefficients.  $k$  are given in  $L.mol^{-1}.s^{-1}$  and  $s^{-1}$  for bimolecular and unimolecular, respectively.

		$k^{TST}$	$\kappa^W(T)$	$\kappa^{ST}(T)$	$k^{TST/W}$	$k^{TST/ST}$
HAT	$ArOH + CH_3O^{\bullet} \rightarrow ArO^{\bullet} + CH_3OH$	$5.7 \times 10^5$	1.3	1.0	$7.5 \times 10^5$	$5.7 \times 10^5$
	$ArOH + \bullet CH_2OH \rightarrow ArO^{\bullet} + CH_3OH$	$2.7 \times 10^{-2}$	4.0	148.2	$1.1 \times 10^{-1}$	$4.0 \times 10^0$
Addition	$ArOH + \bullet CH_2OH \rightarrow \mathbf{Ia}$	$6.7 \times 10^{-1}$	1.1	1.1	$7.1 \times 10^{-1}$	$7.1 \times 10^{-1}$
	$ArOH + \bullet CH_2OH \rightarrow \mathbf{IIa}$	$3.0 \times 10^0$	1.1	1.1	$3.3 \times 10^0$	$3.3 \times 10^0$
Reactions of the second stage (cyclisation)	$\mathbf{IIb} + CH_2OH \rightarrow \mathbf{IIc} + CH_3OH$	$2.3 \times 10^{-5}$	2.0	1.0	$4.5 \times 10^{-5}$	$2.3 \times 10^{-5}$
	$\mathbf{IIc} \rightarrow \mathbf{IId}$	$2.2 \times 10^0$	1.2	1.3	$2.7 \times 10^0$	$2.7 \times 10^0$
	$\mathbf{IIb} \rightarrow \mathbf{IIe}$ (direct)	$1.2 \times 10^{-16}$	1.0	1.0	$1.2 \times 10^{-16}$	$1.2 \times 10^{-16}$
Isomerisation	$\bullet CH_2OH + CH_3OH \rightarrow CH_3O^{\bullet} + CH_3OH$	$8.5 \times 10^6$	1.3	1.4	$1.1 \times 10^7$	$1.2 \times 10^7$

$\Delta H$ ,  $\Delta G$  and  $\Delta G^\ddagger$  (kcal/mol) values obtained for the dimerization process for different dimers (*keto* and *enol* forms). Calculations were performed in the gas phase as well as in the presence of the PCM solvent.

Dimer	Form	Gas Phase			Solvent			
		$\Delta H$	$\Delta G$	$\Delta G^\ddagger$	$\Delta H$	$\Delta G$	$\Delta G^\ddagger$	$k^{\text{TST}}$
4-O-5	<i>Keto</i>	-5.0	8.3	41.2	-0.1	15.7	47.9	$5.0 \times 10^{-23}$
	<i>Enol</i>	-32.9	-19.6		-26.1	-10.7		
5-5'	<i>Keto</i>	1.4	14.6	47.9	4.5	17.2		
	<i>Enol</i>	-47.1	-33.3		-41.3	-25.8		
$\alpha$ -O-4	<i>Keto</i>	-9.2	4.2	39.5	-3.3	10.2	45.2	$4.7 \times 10^{-21}$
	<i>Enol</i>	-31.3	-17.7		-21.0	-5.5		
$\alpha$ -5	<i>Keto</i>	-3.7	9.5		0.4	12.9		
	<i>Enol</i>	-44.0	-30.2		-37.3	-21.4		
$\alpha$ - $\alpha'$	<i>Keto</i>	-6.9	6.9		-3.2	9.8		
	<i>Enol</i>	-41.1	-26.9		-18.5	-4.6		

BDEs (kcal/mol) of the 4-OH of ferulic acid (**1**) and the radiolytic compounds (**2**, **3** and **4/5**), in the gas phase and in the presence of the PCM solvent (calculated at the PCM-B3P86/6-31+G(d,p) and PCM-B3LYP/6-31+G(d,p) levels). The BDEs obtained for the acidic OH group of the four different compounds are higher than 100kcal/mol (data not shown). The last column contains the DPPH scavenging (inhibition percentage at a concentration of  $10^{-3}$  M).

Compounds	B3P86			B3LYP			%DPPH scavenging (standard deviation)
	Gas phase	Water	MeOH	Gas phase	Water	MeOH	
<b>1</b>	85.4	83.3	85.4	81.5	79.2	81.3	92.0 (1.1)
<b>2</b>	86.1	83.3	84.7	82.3	79.5	80.6	35.7 (0.8)
<b>3</b>	87.1	84.1	86.3	83.3	80.0	82.2	23.6 (0.3)
<b>4/5</b>	86.8	83.5	85.8	83.0	79.4	81.7	61.3 (1.1)

$^1\text{H}$  (400 MHz) and  $^{13}\text{C}$  (100 MHz) NMR data spectra and correlations observed in COSY, HMQC, and HMBC of compounds in  $(\text{CD}_3)_2\text{CO}/\text{TMS}$ ;  $\delta$  ppm ( $J$  Hz)

## Compound 2

### Compound 2

Position	$^1\text{H}$	COSY	$^{13}\text{C}$	
			Jmod/HMQC	HMBC
aromatic ring				
1'			127.6	
2'	6.65 d (1.5)		115.3	C-4'; C-6'; C-3
3'			150.1	
4'			154.9	
5'	6.48 d (9.2)	H-6'	116.8	C-1' ; C-3'
6'	6.61 dd (8.2 ; 2.5)	H-5' ; H-2'	122.0	C-2' ; C-4' ; C-3
3'-OCH <sub>3</sub>	3.68 s		56.8	
aliphatic moiety				
1			181.6	
2	2.56 dd (17.1 ; 8.6)	H-3 ; 2-CH <sub>2</sub>	48.2	C-1 ; C-3 ; C-1'
3	3.72 m	H-2 ; 2-CH <sub>2</sub>	54.0	C-1 ; C-2 ; 2-CH <sub>2</sub> OH ; C-1' ; C-2' ; C-6'
	3.20 m	H-2 ; 2-CH <sub>2</sub>	54.0	C-1 ; C-2 ; 2-CH <sub>2</sub> OH ; C-1' ; C-2' ; C-6'
2-CH <sub>2</sub> OH	3.43 t (8.3)	H-2 ; 2-CH <sub>2</sub>	63.3	C-1 ; C-2 ; C-3
	4.19 t (8.6)	H-2 ; 2-CH <sub>2</sub>	63.3	C-1 ; C-2 ; C-3

$^1\text{H}$  NMR exhibited (i) three aromatic protons detected at 6.65 ppm (H-2'), 6.48 ppm (H-5') and 6.61 ppm (H-6') and assigned to an asymmetric ring, (ii) three signals corresponding to aliphatic protons, one oxymethylene group (4.19 ppm, 3.43 ppm, 2-CH<sub>2</sub>OH), one methylene group (3.72 ppm, 3.20 ppm, H-3) and one methine group linked to a carbonyl (2.56 ppm, H-2), and (iii) a methoxyl group (3.68 ppm) linked to the aromatic ring. Positions of all protons were confirmed by  $^1\text{H}$ - $^1\text{H}$  COSY NMR.

$^{13}\text{C}$  Jmod highlighted eleven signals: five were assigned to the aliphatic moiety and six to aromatic ring. The aliphatic moiety was formed by one quaternary carbonyl (181.6 ppm, C-1), one tertiary C-linked carbon (48.2 ppm, C-2), one secondary C-linked carbon (54.0 ppm, C-3), one secondary O-linked carbon (63.3 ppm, 2-CH<sub>2</sub>OH) and one primary O-linked carbon (3.68 ppm, 3'-OCH<sub>3</sub>). The aromatic units were constituted by three quaternary carbons, two O-linked (150.1 ppm, C-3' et 154.9 ppm, C-4'), one C-linked (127.6 ppm, C-1') and by three

tertiary carbons (115.3 ppm, C-2'; 116.8 ppm, C-5' et 122.0 ppm). Positions of all carbons were identified by HMQC and HMBC. Finally, **2** was identified as 2-hydroxymethyl-3-[2-methoxy-4-hydroxyphenyl]propanoic acid.

### Compound 3

#### Compound 3

Position	<sup>1</sup> H	COSY	<sup>13</sup> C	
			Jmod/HMQC	HMBC
aromatic ring				
1'			132.2	
2'	7.02 br s	H-6'	111.5	C-3 ; C-4' ; C-6'
3'			146.8	C-1' ; C-5'
4'			148.7	C-2' ; C-6'
5'	6.80 br s	H-6'	116.0	C-1' ; C-3'
6'	6.80 br s	H-5' ; H-2'	120.5	C-3 ; C-2' ; C-4'
3'-OCH <sub>3</sub>	3.86 s		56.4	
butyrolactone				
1			176.9	
2	2.82 dd (17.1 ; 8.6)	H-2 ; H-3	36.3	C-1 ; C-3 ; C-4 ; C-1'
	2.68 dd (17.1 ; 9.8)	H-2 ; H-3	36.3	C-1 ; C-3 ; C-4 ; C-1'
3	3.79 br quin (8.4)	H-2 ; H-4	41.9	C-1 ; C-2 ; C-4 ; C-1' ; C-2' ; C-6'
4	4.60 t (8.3 ; 8.2)	H-3 ; H-4	74.7	C-2 ; C-3 ; C-1'
	4.19 t (8.6)	H-3 ; H-4	74.7	C-2 ; C-3 ; C-1'

<sup>1</sup>H and <sup>13</sup>C Jmod NMR data exhibited similarities between **2** and **3**, actually both compounds possess the same aromatic ring. The difference between these two compounds was the presence of a pentagonal ring for **3** with one quaternary carbonyl (176.9 ppm, C-2) and two methylene groups: one C-linked (2.82 ppm, 2.68 ppm, H-2) and one O-linked (4.60 ppm, 4.19 ppm, H-4). The <sup>1</sup>H-<sup>1</sup>H COSY, <sup>1</sup>H-<sup>13</sup>C HMQC, <sup>1</sup>H-<sup>13</sup>C and HMBC correlations confirmed that **3** was 3-(3-methoxy-4-hydroxyphenyl)- $\gamma$ -butyrolactone.

## Compounds 4/5

### Compound 4

Position	<sup>1</sup> H	COSY	<sup>13</sup> C	
			Jmod/HMQC	HMBC
aromatic ring				
1'			130.2	
2'	6.94 d (2.0)	H-6'	112.9	C-3 ; C-4' ; C-6'
3'			148.4	C-1' ; C-5'
4'			146.8	C-2' ; C-6'
5'	6.80 d (8.2)	H-6'	116.0	C-1' ; C-3'
6'	6.74 dd (8.2 ; 2.0)	H-2' ; H-5'	121.4	C-3 ; C-2' ; C-4'
3'-OCH <sub>3</sub>	3.82 s		56.3	
butyrolactone				
1			177.9	
2	3.03 ddd (11.0 ; 7.0 ; 4.0)	H-7 ; 2-CH <sub>2</sub> OH	48.1	C-4 ; C-1'
3	3.89 ddd (11.8 ; 6.8 ; 5.1)	H-8 ; H-10	44.6	C-1 ; 2-CH <sub>2</sub> OH ; C-2' ; C-6'
4	4.59 dd (8.8 ; 6.8)	H-7	73.4	C-2 ; C-1'
	4.52 dd (8.8 ; 3.6)	H-7	73.4	C-2 ; C-1'
2-CH <sub>2</sub> OH	3.62 dd (10.8 ; 4.0)	H-7	59.7	C-1 ; C-3
	3.43 dd (10.6 ; 7.0)	H-7	59.7	C-1 ; C-3

### Compound 5

Position	<sup>1</sup> H	COSY	<sup>13</sup> C	
			Jmod/HMQC	HMBC
aromatic ring				
1'			131.2	
2'	7.09 d (1.9)	H-6'	112.0	C-3 ; C-4' ; C-6'
3'			148.8	C-1' ; C-5'
4'			147.0	C-2' ; C-6'
5'	6.81 d (8.1)	H-6'	116.1	C-1' ; C-3'
6'	6.85 dd (8.1 ; 1.9)	H-5' ; H-2'	121.4	C-3 ; C-2' ; C-4'
3'-OCH <sub>3</sub>	3.86 s		56.4	
butyrolactone				
1			177.5	
2	2.87 dt (7.9 ; 3.3)	H-7 ; 8-CH <sub>2</sub> OH	50.4	C-4 ; C-1'
3	2.80 dd (10.5 ; 8.4)	H-8 ; H-10	43.4	C-1 ; 2-CH <sub>2</sub> OH ; C-2' ; C-6'
4	4.53 dd (8.8 ; 3.6)	H-7	72.7	C-2 ; C-1'
	4.16 dd (10.3 ; 8.7)	H-7	72.7	C-2 ; C-1'
2-CH <sub>2</sub> OH	3.95 dd (11.1 ; 3.0)	H-7	58.8	C-1 ; C-3
	3.66 dd (10.8 ; 3.5)	H-7	58.8	C-1 ; C-3

<sup>1</sup>H and <sup>13</sup>C Jmod NMR of **4** and **5** demonstrated the same aromatic ring than **2** and **3**, and the same tetrahydrofuran ring than **3**, except the presence of a hydroxymethyl group linked to

the tetrahydrofuran ring for **4/5** (see Table). Compounds **4** and **5** both correspond to 2-hydroxy-3-(3-methoxy-4-hydroxyphenyl)- $\gamma$ -butyrolactone.

Slight differences were observed between **4** and **5**, i.e. [(11.0; 4.0 for H-2) and (11.8; 6.8 for H-3)] and [(7.9; 3.3 for H-2) and (10.5; 8.4 for H-3)] for **4** and **5**, respectively. Additionally these two compounds exhibited different retention times (12 and 13 min for **4** and **5**, respectively) and retarding factors (0.64 and 0.58 for **4** and **5**, respectively). Such differences allowed us to conclude that **4** and **5** are diastereoisomers.