

## Supporting Information

### **Insights of melanoidin conversion into fluorescent nanoparticles in the Maillard reaction**

Dongmei Li,<sup>a,b,c</sup> Yisha Xie,<sup>a,b,c</sup> Xiaokang Na,<sup>a,b,c</sup> Yao Li,<sup>a,b,c</sup> Chengbo Dai,<sup>a,b,c</sup> Yulian Li<sup>a,b,c</sup> and Mingqian Tan<sup>\*a,b,c</sup>

*<sup>a</sup>School of Food Science and Technology Polytechnic University, Qinggongyuan1, Ganjingzi District, Dalian 116034, Liaoning, People's Republic of China*

*<sup>b</sup>National Engineering Research Center of Seafood, Dalian 116034, Liaoning, People's Republic of China*

*<sup>c</sup>Engineering Research Center of Seafood of Ministry of Education of China, Dalian 116034, Liaoning, People's Republic of China*

\*Corresponding author (Tel & Fax: +86-411-86318657, E-mail: M. Tan, [mqtan@dlpu.edu.cn](mailto:mqtan@dlpu.edu.cn), ORCID: 0000000275350035)

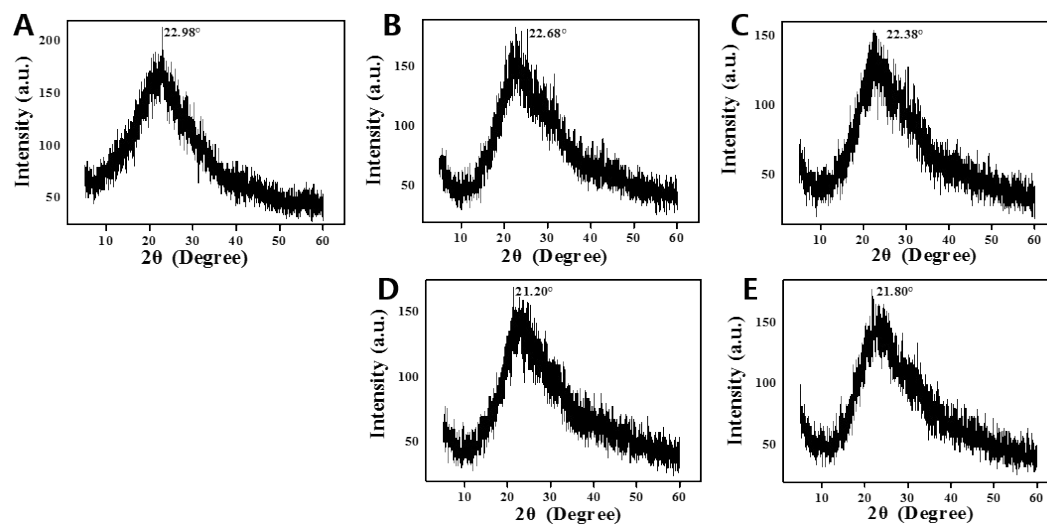


Fig.S1. XRD patterns of melanoidin (A), and FNPs derived from melanoidin hydrothermally treated for 2 h (B), 4 h (C), 6 h (D) and 8 h (E), respectively.

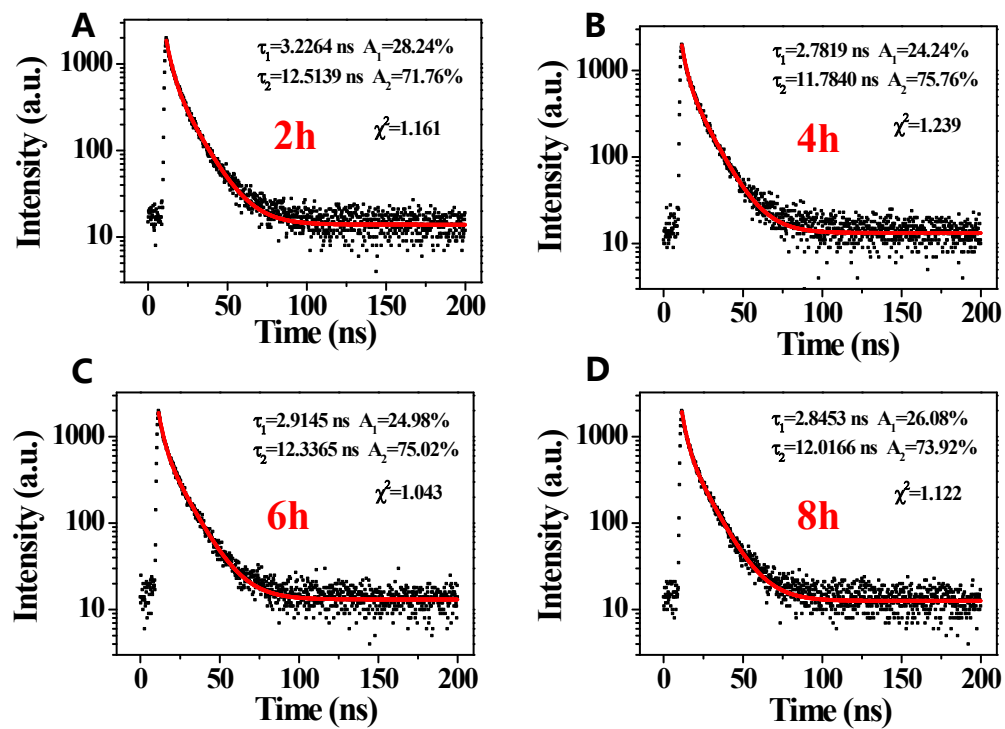


Fig. S2. Fluorescence decay curves fitted using a two-exponential function of FNPs derived from melanoidin hydrothermally treated for (A) 2 h, (B) 4 h, (C) 6 h, and (D) 8 h.

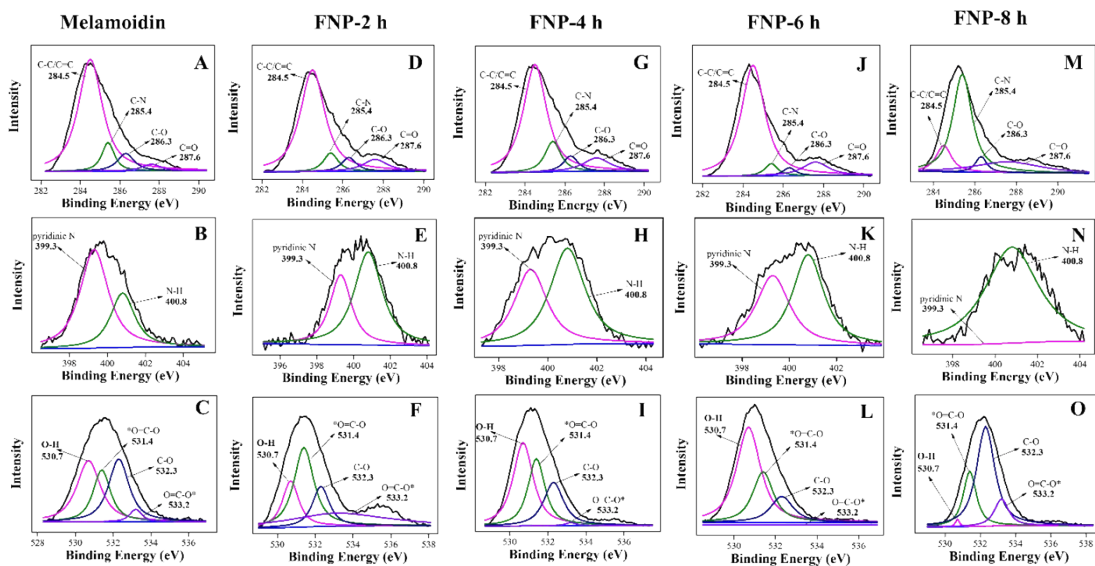


Fig. S3. High resolution  $C_{1s}$ (A),  $N_{1s}$ (B),  $O_{1s}$  (C) spectra of melamoidin, and high resolution  $C_{1s}$ (D, G, J, M),  $N_{1s}$ (E, H, K, N),  $O_{1s}$  (F, I, L, O) spectra of FNPs derived from melamoidin hydrothermally treated for 2 h (D, E, F), 4 h (G, H, I), 6 h (J, K, L), and 8 h (M, N, O).

Table S1. Fluorescence quantum yield of melanoidin (0 h) and FNPs derived from melanoidin hydrothermally treated for 2 h, 4 h, 6 h and 8 h.

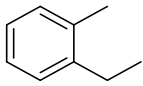
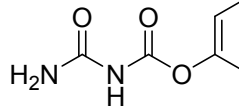
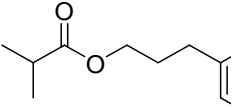
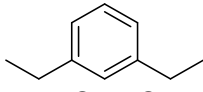
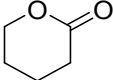
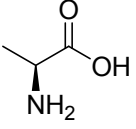
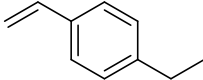
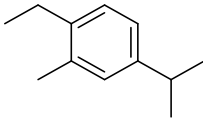
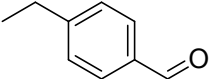
Substance	Excitation (nm)	Yield (%)	Fluorescence lifetime (ns)
melanoidin	470	0.33	NA
FNP-2 h	380	9.27	9.89
FNP-4 h	370	10.53	9.60
FNP-6 h	380	11.41	9.90
FNP-8 h	380	11.92	9.62

**Table S2.** Percentage of surface elements of melanoid and FNPs derived from melanoid at 2 h, 4 h, 6 h, and 8 h, and corresponding molar ratio of  $O_{1s}/C_{1s}$ ,  $N_{1s}/C_{1s}$  obtained from XPS and molar ratio of O/C, N/C, and H/C from total elemental analysis.

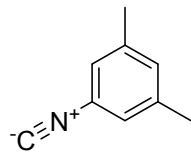
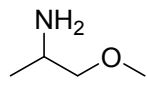
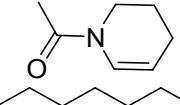
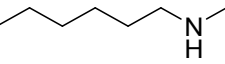
Substance	Surface elemental analysis by XPS					Total elemental analysis						
	$C_{1s}$ (%)	$N_{1s}$ (%)	$O_{1s}$ (%)	$O_{1s}/C_{1s}$	$N_{1s}/C_{1s}$	C(%)	N(%)	O(%)	H(%)	O/C	N/C	H/C
Melanoidin	77.41	8.04	14.56	0.14	0.09	58.58	9.78	24.68	6.95	0.32	0.14	1.42
FNP-2 h	69.82	6.83	23.35	0.25	0.08	43.71	8.50	40.14	7.64	0.69	0.17	2.10
FNP-4 h	69.21	5.23	23.49	0.25	0.07	42.51	9.32	41.14	7.02	0.72	0.19	1.98
FNP-6 h	65.61	7.30	24.65	0.28	0.09	43.63	9.61	39.20	7.55	0.67	0.19	2.08
FNP-8 h	58.13	5.09	32.47	0.42	0.07	43.30	9.64	40.00	7.06	0.69	0.19	1.96

Table S3. Pyrolysis products measured with GC-MS of melanoidin and FNPs from melanoidin after 0, 2, 4, 6 and 8 h hydrothermal treatment.

Number	RT (min)	Name	Molecular Formula	Structural Formula	Melanoidin	FNP-2 h	FNP-4 h	FNP-6 h	FNP-8 h
1	2.30	Carbamic acid, monoammonium salt	CH <sub>6</sub> N <sub>2</sub> O <sub>2</sub>		+	+	+	+	+
2	2.31	Hydrazinecarboxamide	CH <sub>5</sub> N <sub>3</sub> O		+	-	+	+	-
3	3.20	Cyclobutanol	C <sub>4</sub> H <sub>8</sub> O		-	+	-	-	-
4	4.24	Acetamide, 2-cyano-	C <sub>3</sub> H <sub>4</sub> N <sub>2</sub> O		-	-	+	-	-
5	4.37	Bicyclo[3.2.0]hepta-2,6- diene	C <sub>7</sub> H <sub>8</sub>		-	-	-	+	+
6	7.34	Ethylbenzene	C <sub>8</sub> H <sub>10</sub>		-	+	+	+	+
7	8.29	2-Hexanamine, 5-methyl-	C <sub>7</sub> H <sub>17</sub> N		-	-	+	-	-
8	8.42	Ethylene oxide	C <sub>2</sub> H <sub>4</sub> O		-	+	-	-	-
9	9.70	Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O		-	+	+	-	-

10	9.73	Benzene, 1-ethyl-2-methyl-	$C_9H_{12}$		-	+	+	+	+
11	10.20	Allophanic acid, phenyl ester	$C_8H_8N_2O_3$		-	-	-	+	-
12	10.42	Propanoic acid, 2-methyl-, 3-phenylpropyl ester	$C_{13}H_{18}O_2$		-	+	-	-	-
13	11.49	Benzene, 1,3-diethyl-	$C_{10}H_{14}$		-	+	-	+	+
14	11.64	2H-Pyran-2-one, tetrahydro-	$C_5H_8O_2$		-	+	-	-	-
15	11.70	Alanine	$C_3H_7NO_2$		-	-	+	-	-
16	12.12	Benzene, 1-ethenyl-4-ethyl-	$C_{10}H_{12}$		-	+	-	-	-
17	12.45	Benzene, 1-ethyl-2-methyl-4-(1-methylethyl)	$C_{11}H_{16}$		-	+	-	-	+
18	13.40	Benzaldehyde, 4-ethyl-	$C_9H_{10}O$		-	+	+	-	-




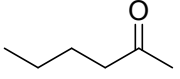
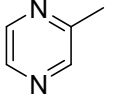
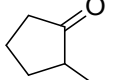
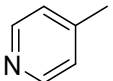
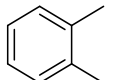
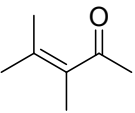
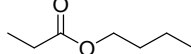
19	13.70	3,5-Xylyl isocyanide	C <sub>9</sub> H <sub>9</sub> N		-	-	-	+	-
20	13.77	2-Propanamine, 1-methoxy-	C <sub>4</sub> H <sub>11</sub> NO		-	-	-	+	-
21	13.80	Pyridine, 1-acetyl-1,2,3,4-tetrahydro-	C <sub>7</sub> H <sub>11</sub> NO		-	-	+	-	-
22	16.46	n-Hexylmethylamine	C <sub>7</sub> H <sub>17</sub> N		-	-	+	-	-

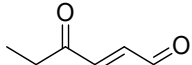
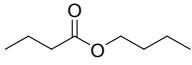
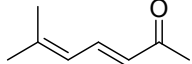
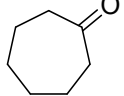
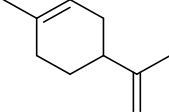
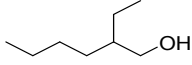
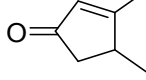
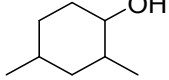
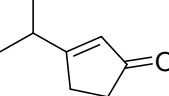
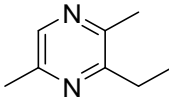
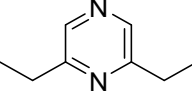
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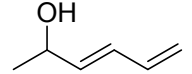
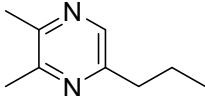
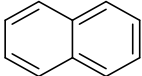
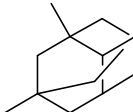
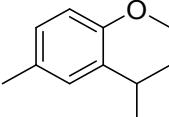
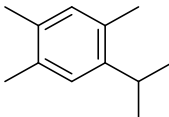
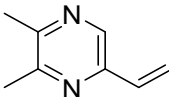
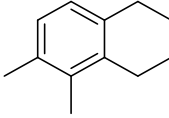
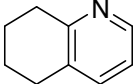
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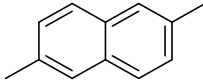
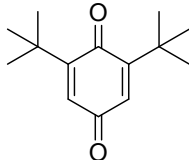
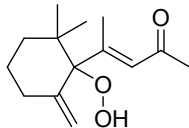
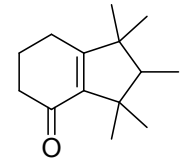
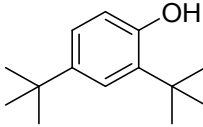
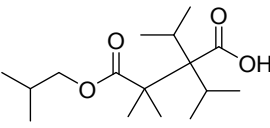
RT: retention time

Table S4. GC-MS analysis results of pyrolysis solution after 0, 2, 4, 6 and 8 h hydrothermal treatment of melanoidin.

Number	RT (min)	Name	Molecular Formula	Structural Formula	0 h	2 h	4 h	6 h	8 h
1	4.14	Pyridine	C <sub>5</sub> H <sub>5</sub> N		-	-	-	+	+
2	4.96	2-Hexanone	C <sub>6</sub> H <sub>12</sub> O		-	+	+	+	-
3	5.78	Methyl-pyrazine	C <sub>5</sub> H <sub>6</sub> N <sub>2</sub>		-	+	+	+	+
4	6.31	2-Methyl-cyclopentanone	C <sub>6</sub> H <sub>10</sub> O		-	+	+	+	+
5	6.89	4-Methyl-pyridine	C <sub>6</sub> H <sub>7</sub> N		-	-	-	+	-
6	7.00	o-Xylene	C <sub>8</sub> H <sub>10</sub>		+	-	-	-	-
7	7.68	3,4-Dimethyl-3-penten-2-one	C <sub>7</sub> H <sub>12</sub> O		-	+	-	-	-
8	8.10	Propanoic acid, butyl ester	C <sub>7</sub> H <sub>14</sub> O <sub>2</sub>		+	-	-	-	-

9	9.48	(E)-4-Oxohex-2-enal	C <sub>6</sub> H <sub>8</sub> O <sub>2</sub>		-	-	+	-	-
10	10.75	Butanoic acid, butyl ester	C <sub>8</sub> H <sub>16</sub> O <sub>2</sub>		+	-	-	-	-
11	10.87	(E)-6-Methyl-3,5-heptadien-2-one	C <sub>8</sub> H <sub>12</sub> O		-	+	+	+	+
12	11.24	Cycloheptanone	C <sub>7</sub> H <sub>12</sub> O		-	+	+	+	+
13	11.75	Limonene	C <sub>10</sub> H <sub>16</sub>		+	-	-	-	-
14	11.77	2-Ethyl-1-hexanol	C <sub>8</sub> H <sub>18</sub> O		-	+	+	+	+
15	12.05	3,4-Dimethyl-2-cyclopenten-1-one	C <sub>7</sub> H <sub>10</sub> O		-	+	+	+	+
16	12.06	2,4-Dimethyl-cyclohexanol	C <sub>8</sub> H <sub>16</sub> O		-	-	+	+	+
17	12.82	3-(1-Methylethyl)-2-cyclopenten-1-one	C <sub>8</sub> H <sub>12</sub> O		-	+	+	-	-
18	13.29	2,5-Dimethyl-3-ethyl-pyrazine	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>		-	+	+	-	-
19	13.51	2,6-Diethyl-pyrazine	C <sub>8</sub> H <sub>12</sub> N <sub>2</sub>		-	+	+	+	-

20	14.08	Nonanal	C <sub>9</sub> H <sub>18</sub> O		+	+	-	+	+
21	14.21	3,5-Hexadien-2-ol	C <sub>6</sub> H <sub>10</sub> O		-	-	-	-	+
22	15.79	2,3-Dimethyl-5-n-propyl-pyrazine	C <sub>9</sub> H <sub>14</sub> N <sub>2</sub>		-	+	+	-	-
23	16.40	Naphthalene	C <sub>10</sub> H <sub>8</sub>		-	+	-	+	-
24	17.73	1,3,4-Trimethyladamantane	C <sub>13</sub> H <sub>22</sub>		-	+	-	-	-
25	17.83	1-Methoxy-4-methyl-2-(1-methylethyl)-benzene	C <sub>11</sub> H <sub>16</sub> O		-	+	-	-	+
26	18.24	1,2,4-Trimethyl-5-(1-methylethyl)-benzene	C <sub>12</sub> H <sub>18</sub>		-	-	-	-	+
27	18.41	(Z)-2,3-Dimethyl-5-(1-propenyl)-pyrazine	C <sub>9</sub> H <sub>12</sub> N <sub>2</sub>		-	+	-	-	-
28	18.42	1,2-Diethyl-3,4-dimethylbenzene	C <sub>12</sub> H <sub>18</sub>		-	-	+	+	-
29	18.66	5,6,7,8-Tetrahydroquinoline	C <sub>9</sub> H <sub>11</sub> N		-	-	+	+	+

30	22.82	2,6-Dimethyl-naphthalene	$C_{12}H_{12}$		+	+	+	+	-
31	24.18	2,6-Bis(1,1-dimethylethyl)-2,5-cyclohexadiene-1,4-dione	$C_{14}H_{20}O_2$		+	-	-	-	-
32	24.18	4-(1-Hydroperoxy-2,2-dimethyl-6-methylene-cyclohexyl)-pent-3-en-2-one	$C_{14}H_{22}O_3$		-	-	+	+	-
33	25.14	1,2,3,5,6,7-Hexahydro-1,1,2,3,3-pentamethyl-4H-inden-4-one	$C_{14}H_{22}O$		-	+	-	-	-
34	25.15	2,4-Di-tert-butylphenol	$C_{14}H_{22}O$		+	-	-	+	+
35	27.20	Pentanoic acid, 2,2,4-trimethyl-3-carboxyisopropyl, isobutyl ester	$C_{16}H_{30}O_4$		+	-	+	-	-

+: detected

-: not detected

RT: retention time