Electronic Supplementary Material (ESI) for Green Chemistry.

Promote the performance of Co-hydrothermal liquefaction for mixed algae strains by Maillard reaction

Chao Zhang, Xiaohan Tang, Lili Sheng, Xiaoyi Yang*

School of Energy and Power Engineering, Energy and Environment International Center, Beihang University, 37 Xueyuan Road, Haidian District, Beijing, P. R. China

Address: 37 Xueyuan Road, Haidian District, Beijing, P.R. China, 100191

Tel.: +86-01-82317346

Fax: +86-01-82317346

Email: yangxiaoyi@buaa.edu.cn

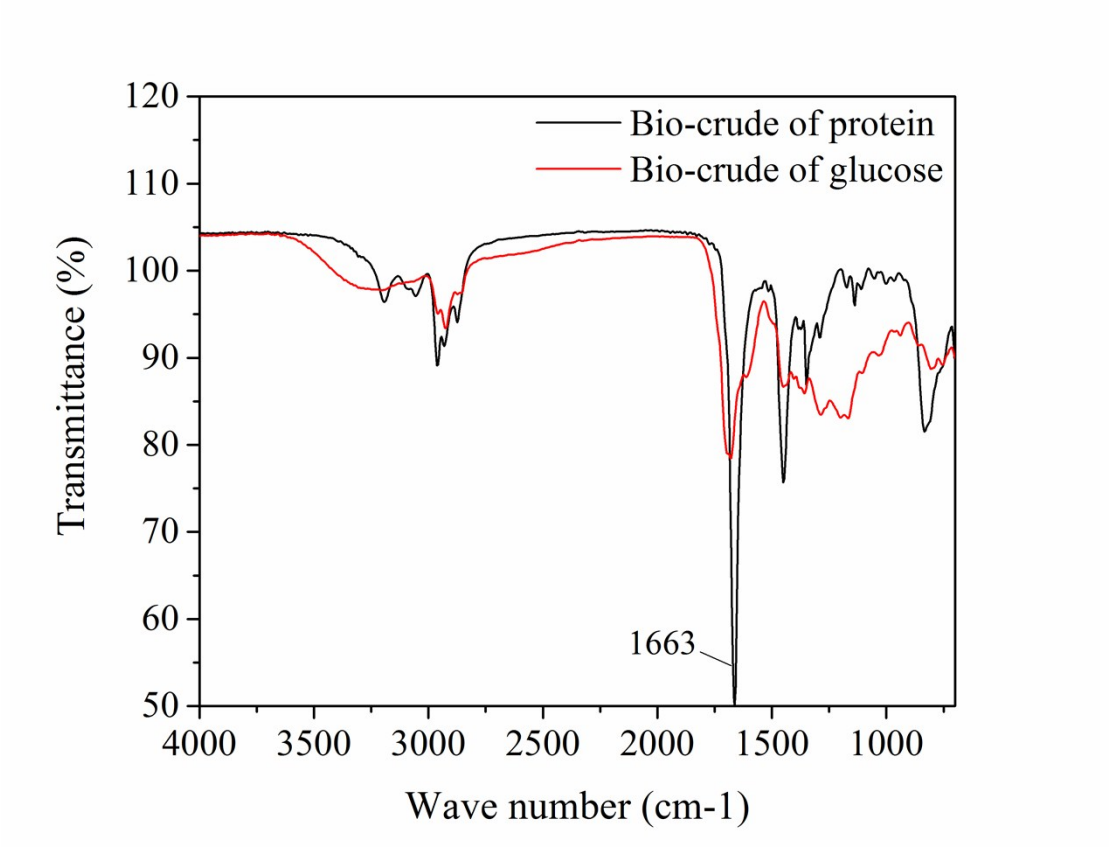

Figure 1 FTIR spectrum of bio-crude generated from protein and glucose

Table 1 The pH value of aqueous after HTL for the soy protein and glucose at different contions

NO	Substrate	Ratio between protein and glucose	Temperature	pH
1	Glucose		280	1~2
2	Protein		280	9~10
3	Protein&Glucose	1:1	160	<5.4
4	Protein&Glucose	1:1	200	<5.4
5	Protein&Glucose	1:1	240	6.5
6	Protein&Glucose	1:1	280	7.5
7	Protein&Glucose	0.5:1	280	6.4
8	Protein&Glucose	1.5:1	280	7.4
9	Protein&Glucose	2:1	280	7.3
10	Protein&Glucose	3:1	280	8.2
11	Protein&Glucose	4:1	280	8.2
12	Protein&Glucose	5:1	280	8.3

Table 2 The chamical compounds and bio-crude yields of different model compounds and microalgae

NO	Substrate	Carbohydrate content (%)	Protein content(%)	Lipid content(%)	P/G	Oil yield
1	Glucose	100.00	0.00	0.00	0.00	1.29
2	Protein	0.00	100.00	0.00	*	20.44
3	Glucose&protein	20.00	80.00	0.00	4.00	21.97
4	*Spi*	10.80	48.50	5.89	4.49	29.20
5	*Nan*	12.40	36.40	19.05	2.94	37.90
6	*Spi&Nan*	11.60	42.45	12.47	3.66	28.96
7	*Spi*&Glucose	19.72	43.65	5.30	2.21	30.37
8	*Nan*&Protein	11.16	42.76	17.14	3.83	27.23
9	*Nan*&*Spi*&glucose	29.28	33.96	9.98	1.16	32.55

Table 3 The chamical compounds and bio-crude yields data for Figure 5

Substrate	Carbohydrate content (%)	Protein content (%)	lipid content (%)	P/G	biocrude yield (%)	Reference
Glucose	100.00	0.00	0	0	1.29	
Glucose&protein	20.00	80.00	0	4	21.97	
Spi	10.80	48.50	5.89	4.49	29.20	
Nan	12.40	36.40	19.05	2.93	37.90	
Spi&Nan	11.60	42.45	12.47	3.65	28.96	
Spi&glucose	19.72	43.65	5.3	2.21	30.37	
Nan&Protein	11.16	42.76	17.14	3.83	27.23	
Nan&*spi*&glucose	29.28	33.96	9.98	1.15	32.55	
Nanochloropsis gaditana	19.20	43.90	25.1	2.28	34.4	1
Nanochloropsis Sp.	21.00	64.00	5.00	3.04	32.60	2
Swine manure	37.00	25.00	22.00	0.67	30.20	3
Dunaliella tertiolecta	20.16	32.13	22.17	1.59	36.90	4
Scenedesmus almeriensis	16.00	37.50	21.90	2.34	40.80	1
Nannochloropsis sp.	12.00	52.00	28.00	4.33	43.00	5
Spirulina	21.00	64.00	5.00	3.04	32.60	3
S. platensis	30.21	48.36	13.30	1.60	41.00	6
C. protothecoides	29.00	11.00	53.00	0.37	49.00	7
Scenedesmus Sp.	31.00	50.00	8.00	1.61	41.00	7

Reference

1 D.L. Barreiro, C. Zamalloa, N. Boon, W. Vyverman, F. Ronsse, W. Brilman, W. Prins, Bioresour. Technol., 2013, **146**, 463-471

2 P.J. Valdez, J. G. Dickinson, P.E. Savage, Energy Fuel, 2011, **25,** 3235-3243

3 D.R. Vardon, B.K. Sharma, J. Scott, G. Yu, Z. Wang, L. Schideman, Y. Zhang, T.J. Strathamn, Bioresour. Technol., 2011, **102,** 8295-8303

4 S. Zou, Y. Wu, M. Yang, C Li, J. Tong, Energy Environ. Sci., 2010, **3,** 1073-1078

5 T.M. Brown, P. Duan, P.E. Savage, Energy Fuel, 2010, **24,** 3639-3646

6 U.Jena, K.C. Das, Energy Fuel, 2011, **25,** 5472-5482

7 P. J. Valdez, V. J. Tocco, P.E. Savage, 2014, Bioresour. Technol., 2014, **163,** 123-127

Table 4 FTIR functional group composition of bio-crude from HTL of Spi&Nan and Spi&Nan&Glucose

Wave number	Group	Class of compound
2926	C-H stretching	Alkanes
2853	C-H stretching	Alkanes
1669	C=O stretch	Ketones, aldehydes, carboxylic acids
1453	C-H stretch	alkanes

Table5 The profile of bio-crude oil of different model compounds and microalgae.

Group	Nan at 280	Spi at 280	Nan& Spi at 280	Nan& Protein at 280	Spi&Glucose at 280	Spi&Nan&Glucose at 280	Glucose at 280	Protein at 280	Glucose& Protein at 280
Fatty acids	45.45	7.6	17.78	34.2	9.74	20.32			0
Hydrocarbons	10.75	1.52	11.96	9.26	5.03	5.2	1.96	0.09	0
Alkylamides	16.31	10.17	14.13	14	13.11	15.73		16.5	15.98
Pyrroles/alkylporroles	2.54	7.9	0.5	3.63	4.41	4.71		5.24	5.72
Sterols	3.13			2	1.05	2.87			0
Cyclic ketones	0.24	2.18	0.39	3.77	1.97	3.65	20.13	5.49	1.28
DKP derivatives(diketopiperazins)	2.52	11.08	3.13	1.72	6.52	6.62		23.18	15.63
Phenols	0.67	4.16	5.17	1.8	8.62	2.24	17.09		4.96
Benzenes and alkylbenzens	0.11	0.69	3.36	0.61	1.18	2.17	19.37	7.01	2.37
Pyridines	0.58	1.94	1.98	0.91	1.92	1.57			0
piperidines		0.21	0.64		1.34			2.25	0
Pyrrolidinone	0	1.8	0.97	0.94	1	0.97	0	11.45	11.2
Aromatic amines and amides	0.49	15.28	15.31	5.16	5.76	1.42		1.97	8.97
Indole derivatives	0.41	4.35		0.61	3.53	2.83		2.82	0.64
Pyrazines	0.81	2.42	2.82	2.52	6.53	4.95		0.97	3.97
Oxygenated compounds	0.73	6.22	0.36	0.54	7.26	5.7	7.94		8.02
Alkynitriles	0.26	0.21	0.9	1.03			3.54	4.01	1.15
Others	15	22.27	20.6	17.32	21.04	19.06	29.97	19.02	20.1

Table6 The GC-MS results for Nan at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
15.349	Dodecanoic acid	200.178	000143-07-7	0.23%	Fatty acids
19.011	Tetradecanoic acid	228.209	000544-63-8	4.74%	Fatty acids
22.656	Hexadecanoic acid, methyl ester	270.256	000112-39-0	0.22%	Fatty acids
23.331	cis-9-Hexadecenoic acid	254.225	1000333-19-5	15.66%	Fatty acids
23.961	n-Hexadecanoic acid	256.24	000057-10-3	20.56%	Fatty acids
28.286	6-Octadecenoic acid	282.256	1000336-66-8	1.45%	Fatty acids
37.545	Succinic acid, 2-decyl ethyl ester	286.214	1000349-42-1	2.60%	Fatty acids
3.156	2-Butene, 2,3-dimethyl-	84.094	000563-79-1	0.16%	Hydrocarbons
14.416	1-Pentadecene	210.235	013360-61-7	0.39%	Hydrocarbons
17.649	Heptadecane	240.282	000629-78-7	0.26%	Hydrocarbons
20.487	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	0.51%	Hydrocarbons
20.602	1-Methoxy-3-(2-hydroxyethyl)nonane	202.193	070928-44-8	0.14%	Hydrocarbons
20.762	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	1.00%	Hydrocarbons
21.615	Dodecane, 2-cyclohexyl-	252.282	013151-82-1	0.88%	Hydrocarbons
22.158	Cyclopentylcyclohexane	152.157	001606-08-2	0.55%	Hydrocarbons
23.44	2-Undecene, (E)-	154.172	000693-61-8	6.86%	Hydrocarbons
24.081	Tetradecanamide	227.225	000638-58-4	0.97%	Alkylamides
24.819	N-Methyldodecanamide	213.209	027563-67-3	0.61%	Alkylamides
25.929	Octanamide, N,N-dimethyl-	171.162	001118-92-9	0.28%	Alkylamides
28.698	9-Octadecenamide, (Z)-	281.272	000301-02-0	1.66%	Alkylamides
29.259	Hexadecanamide	255.256	000629-54-9	3.37%	Alkylamides

29.585	Octanamide, N,N-dibutyl-	255.256	1000308-43-9	1.68%	Alkylamides
30.163	N-Methyldodecanamide	213.209	027563-67-3	2.92%	Alkylamides
30.672	N,N-Dimethyldecanamide	199.194	014433-76-2	0.57%	Alkylamides
31.25	Octanamide, N,N-dimethyl-	171.162	001118-92-9	1.96%	Alkylamides
33.917	9-Octadecenamide, (Z)-	281.272	000301-02-0	0.43%	Alkylamides
34.855	Dodecanamide, N,N-diethyl-	255.256	003352-87-2	1.14%	Alkylamides
47.175	Acetamide, N-(2-phenylethyl)-	163.1	000877-95-2	0.71%	Alkylamides
38.763	9-Hexadecenoic acid, pyrrolidide	307.288	1000336-02-4	0.65%	Pyrroles/alkylporroles
39.318	13-Methylpentadecanoic acid, pyrrolidide	309.303	1000336-17-6	1.61%	Pyrroles/alkylporroles
43.598	9-Octadecenoic acid, pyrrolidide	335.319	1000336-15-9	0.16%	Pyrroles/alkylporroles
7.493	Pyrrolidine, 2-butyl-1-methyl-	141.152	003447-03-8	0.12%	Pyrroles/alkylporroles
45.149	Cholest-4-ene	370.36	016732-86-8	0.66%	Sterols
45.412	Cholest-5-ene	370.36	000570-74-1	0.40%	Sterols
46.339	Cholesta-3,5-diene	368.344	000747-90-0	0.17%	Sterols
46.419	Cholesta-3,5-diene	368.344	000747-90-0	0.87%	Sterols
51.197	Cholesterol	386.355	000057-88-5	1.02%	Sterols
10.256	2-Piperidinone	99.068	000675-20-7	0.24%	Cyclic ketones
18.776	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	0.74%	DKP derivatives
30.369	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	0.96%	DKP derivatives
33.488	Cyclo-(l-leucyl-l-phenylalanyl)	260.152	007280-77-5	0.61%	DKP derivatives
43.192	2,5-Piperazinedione, 3,6-bis(phenylmethyl)-	294.137	002308-61-4	0.21%	DKP derivatives
6.972	Phenol	94.042	000108-95-2	0.34%	Phenols
8.534	Phenol, 4-methyl-	108.058	000106-44-5	0.32%	Phenols
3.505	Toluene	92.063	000108-88-3	0.11%	Benzenes and alkylbenzens

7.767	Pyridine, 5-ethyl-2-methyl-	121.089	000104-90-5	0.16%	Pyridines
9.873	3-Pyridinol, 6-methyl-	109.053	001121-78-4	0.22%	Pyridines
11.779	2-Methyl-5-(3-methylbutyl)pyridine	163.136	052535-39-4	0.19%	Pyridines
11.332	Caprolactam	113.084	000105-60-2	0.19%	Aromatic amines and amides
15.137	[1,1'-Biphenyl]-4-amine	169.089	000092-67-1	0.30%	Aromatic amines and amides
11.91	Indole	117.058	000120-72-9	0.23%	Indole derivatives
13.192	1H-Indole, 5-methyl-	131.073	000614-96-0	0.18%	Indole derivatives
23.057	5,10-Diethoxy-2,3,7,8-tetrahydro-1H,6H-dipyrrolo[1,2-a;1',2'-d]pyrazine	250.168	1000190-75-5	0.81%	Pyrazines
19.28	2-Pentenoic acid, 3,4-dimethyl-, ethyl ester	156.115	1000197-38-1	0.73%	Oxygenated compounds
22.055	Hexadecanenitrile	237.246	000629-79-8	0.26%	Alkynitriles

Table7 The GC-MS results for Spi at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
23.903	n-Hexadecanoic acid	256.24	000057-10-3	6.55%	Fatty acids
24.361	n-Hexadecanoic acid	256.24	000057-10-3	0.14%	Fatty acids
34.615	9,12-Octadecadienoic acid, methyl ester, (E,E)-	294.256	002566-97-4	0.90%	Fatty acids
20.487	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	0.34%	Hydrocarbons
17.655	Heptadecane	240.282	000629-78-7	1.18%	Hydrocarbons
29.265	Hexadecanamide	255.256	000629-54-9	2.56%	Alkylamides
30.192	N-Methyldodecanamide	213.209	027563-67-3	3.95%	Alkylamides
31.291	Octanamide, N,N-dimethyl-	171.162	001118-92-9	2.65%	Alkylamides
22.914	l-Valine, n-propargyloxycarbonyl-, tetradecyl ester	395.304	1000323-31-6	1.00%	Alkylamides
39.336	Eicosanoic acid, pyrrolidide	365.366	1000336-10-3	2.45%	Pyrroles/alkylporroles
43.496	Pyrrolidine, 1-(1-oxo-9,12-octadecadienyl)-	333.303	056630-36-5	0.40%	Pyrroles/alkylporroles
7.436	1-Butylpyrrolidine	127.136	000767-10-2	0.57%	Pyrroles/alkylporroles
37.568	Octanoic acid, morpholide	213.173	1000306-92-1	4.49%	Pyrroles/alkylporroles
31.376	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	0.67%	DKP derivatives
34.232	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(phenylmethyl)-	244.121	014705-60-3	1.07%	DKP derivatives
40.669	2,5-Piperazinedione, 2-(2-methylthio)ethyl-6-benzyl-	278.109	104011-96-3	0.28%	DKP derivatives
41.115	2,5-Piperazinedione, 2-(2-methylthio)ethyl-6-benzyl-	278.109	104011-96-3	0.14%	DKP derivatives
43.284	2,5-Piperazinedione, 3,6-bis(phenylmethyl)-	294.137	002308-61-4	0.42%	DKP derivatives
44.234	2,5-Piperazinedione, 3,6-bis(phenylmethyl)-	294.137	002308-61-4	0.43%	DKP derivatives
30.467	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	2.13%	DKP derivatives
33.082	Cyclo-(l-leucyl-l-phenylalanyl)	260.152	007280-77-5	4.11%	DKP derivatives

10.279	2-Piperidinone	99.068	000675-20-7	0.50%	DKP derivatives
33.585	2,5-Piperazinedione, 3-(phenylmethyl)-	204.09	005037-75-2	1.34%	DKP derivatives
5.713	2-Cyclopenten-1-one, 2-methyl-	96.058	001120-73-6	0.23%	Cyclic ketones
19.194	1,3-Cyclohexanedione, 2-(2-phenylethyl)-	216.115	062264-41-9	0.65%	Cyclic ketones
20.241	2,5-Cyclohexadien-1-one, 3,5-dihydroxy-4,4-dimethyl-	154.063	002065-00-1	0.56%	Cyclic ketones
21.615	5,6,7,8-Tetrahydro-thiazolo[5,4-c]azepin-4-one	168.036	1000317-75-4	0.75%	Cyclic ketones
38.803	2-Pyrrolidinone[1,5-c].beta.-carboline	226.111	032283-51-5	0.40%	Pyrrolidinone
10.6	2,5-Pyrrolidinedione, 3-ethyl-1,3-dimethyl-	155.095	013861-99-9	0.80%	Pyrrolidinone
21.117	Hydantoin, 1-butyl-	156.09	033599-32-5	0.60%	Pyrrolidinone
7.069	Phenol	94.042	000108-95-2	1.51%	Phenols
8.643	Phenol, 4-methyl-	108.058	000106-44-5	1.05%	Phenols
10.091	Phenol, 4-ethyl-	122.073	000123-07-9	0.28%	Phenols
23.617	2-Hydroxy-naphthoic acid, methyl ester	202.063	000947-65-9	1.31%	Phenols
18.433	Benzeneethanol, 3-chloro-	156.034	005182-44-5	0.69%	Benzenes and alkylbenzens
7.716	Pyridine, 2-ethyl-5-methyl-	121.089	018113-81-0	0.87%	Pyridines
13.118	Quinoline, 4-methyl-	143.073	000491-35-0	0.49%	Pyridines
12.379	4-Methoxypyridine-N-oxide	125.048	001122-96-9	0.58%	Pyridines
4.746	Piperidine, 1-ethyl-	113.12	000766-09-6	0.21%	Piperidine
10.039	5-Azauracil	113.023	000071-33-0	0.74%	Pyrimidine
11.344	Caprolactam	113.084	000105-60-2	0.59%	Aromatic amines and amides
11.859	Benzeneethanamine, N-(1-methylethylidene)-	161.12	010433-34-8	0.70%	Aromatic amines and amides
14.788	Acetamide, N-(2-phenylethyl)-	163.1	000877-95-2	0.81%	Aromatic amines and

					amides
5.422	Cyclohexylamine, N-ethyl-	127.136	005459-93-8	0.24%	Aromatic amines and amides
8.746	Benzenamine, 2-ethyl-6-methyl-	135.105	024549-06-2	0.34%	Aromatic amines and amides
15.143	[1,1'-Biphenyl]-4-amine	169.089	000092-67-1	0.20%	Aromatic amines and amides
49.938	D-Tryptophan	204.09	000153-94-6	0.28%	Aromatic amines and amides
9.284	Cycloheptylamine	113.12	005452-35-7	0.75%	Aromatic amines and amides
13.055	4-Morpholinepropanamine	144.126	000123-00-2	0.72%	Aromatic amines and amides
14.462	Formamide, N-(2-phenylethyl)-	149.084	023069-99-0	1.21%	Aromatic amines and amides
23.291	l-Proline, N-butoxycarbonyl-, isohexyl ester	299.21	1000313-66-7	2.57%	Aromatic amines and amides
23.446	l-Proline, N-allyloxycarbonyl-, butyl ester	255.147	1000313-64-9	1.50%	Aromatic amines and amides
34.873	4-(3,4-Dihydro-2H-quinolin-1-yl)-4-oxo-butyric acid hydrazide	247.132	315673-61-1	1.48%	Aromatic amines and amides
51.495	Tryptophan, 1-(1,1-dimethylallyl)-, L-	272.152	020880-68-6	0.59%	Aromatic amines and amides
20.779	l-Proline, N-propoxycarbonyl-, propyl ester	243.147	1000313-69-8	3.30%	Aromatic amines and amides

11.945	Indole	117.058	000120-72-9	1.43%	Indole derivatives
13.221	1H-Indole, 6-methyl-	131.073	003420-02-8	0.82%	Indole derivatives
24.138	9H-Pyrido[3,4-b]indole	168.069	000244-63-3	0.99%	Indole derivatives
48.474	3-Allyl-5-(1H-indol-3-ylmethyl)-2-thioxo-imidazolidin-4-one	285.094	1000296-92-3	0.51%	Indole derivatives
49.721	4-Pentenoic acid, 2-(3-indolylmethyl)-, methyl ester	243.126	1000263-47-6	0.60%	Indole derivatives
4.323	Pyrazine, methyl-	94.053	000109-08-0	0.31%	Pyrazines
5.771	Pyrazine, 2,5-dimethyl-	108.069	000123-32-0	0.39%	Pyrazines
5.856	Pyrazine, ethyl-	108.069	013925-00-3	0.16%	Pyrazines
7.27	Pyrazine, 2-ethyl-5-methyl-	122.084	013360-64-0	0.17%	Pyrazines
23.074	5,10-Diethoxy-2,3,7,8-tetrahydro-1H,6H-dipyrrolo[1,2-a;1',2'-d]pyrazine	250.168	1000190-75-5	1.39%	Pyrazines
15.177	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-	180.115	015356-74-8	0.22%	Oxygenated compounds
18.542	Furan, 2-methyl-5-(methylthio)-	128.03	013678-59-6	1.77%	Oxygenated compounds
33.808	Diethyl ethylidenemalonate	186.089	001462-12-0	0.91%	Oxygenated compounds
41.67	Cyclohexanecarboxylic acid, tetradecyl ester	324.303	1000279-54-2	0.60%	Oxygenated compounds
47.65	Succinic acid, hexyl 2-phenylethyl ester	306.183	1000325-03-7	2.72%	Oxygenated compounds
22.067	Hexadecanenitrile	237.246	000629-79-8	0.21%	Alkynitriles

Table8 The GC-MS results for Spi&Nan at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
18.965	Tetradecanoic acid	228.209	000544-63-8	0.78%	Fatty acids
23.634	n-Hexadecanoic acid	256.24	000057-10-3	12.39%	Fatty acids
28.195	Oleic Acid	282.256	000112-80-1	3.19%	Fatty acids
39.313	Tetradecanoic acid, pyrrolidide	281.272	1000336-16-1	0.98%	Fatty acids
28.67	6-Octadecenoic acid	282.256	1000336-66-8	0.44%	Fatty acids
11.813	Pentadecane	212.25	000629-62-9	2.80%	Hydrocarbons
14.754	Hexadecane	226.266	000544-76-3	2.97%	Hydrocarbons
17.031	Heptadecane	240.282	000629-78-7	0.78%	Hydrocarbons
17.638	Heptadecane	240.282	000629-78-7	0.66%	Hydrocarbons
24.43	Eicosane	282.329	000112-95-8	0.62%	Hydrocarbons
27.028	Octadecane	254.297	000593-45-3	0.53%	Hydrocarbons
19.394	Octadecane	254.297	000593-45-3	1.24%	Hydrocarbons
19.635	Hexadecane, 2,6,10,14-tetramethyl-	282.329	000638-36-8	0.55%	Hydrocarbons
34.844	Tetracosane	338.391	000646-31-1	0.95%	Hydrocarbons
15.887	Octadecane	254.297	000593-45-3	0.20%	Hydrocarbons
26.856	Pentacyclo[7.5.0.0(2,8).0(5,14).0(7,11)]tetradeca-3,12-diene	184.125	077300-31-3	0.34%	Hydrocarbons
39.822	Nonadecane	268.313	000629-92-5	0.32%	Hydrocarbons
29.19	Hexadecanamide	255.256	000629-54-9	5.19%	Alkylamides
30.135	N-Methyldodecanamide	213.209	027563-67-3	2.43%	Alkylamides
33.894	9-Octadecenamide, (Z)-	281.272	000301-02-0	1.52%	Alkylamides
29.551	N-Methyldodecanamide	213.209	027563-67-3	1.03%	Alkylamides
31.245	Octanamide, N,N-dimethyl-	171.162	001118-92-9	1.75%	Alkylamides

34.729	Octanamide, N,N-dibutyl-	255.256	1000308-43-9	1.57%	Alkylamides
35.782	Non-7-enoic acid, dimethylamide	183.162	1000187-26-5	0.63%	Alkylamides
43.598	Pyrrolidine, 1-(1-oxo-7-octadecenyl)-	335.319	056600-01-2	0.50%	Pyrroles/alkylporroles
30.352	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	1.20%	DKP derivatives
33.053	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(phenylmethyl)-	244.121	014705-60-3	1.26%	DKP derivatives
33.459	Cyclo-(l-leucyl-l-phenylalanyl)	260.152	007280-77-5	0.66%	DKP derivatives
21.226	Hydantoin, 1-butyl-	156.09	033599-32-5	0.97%	Pyrrolidinone
5.765	2-Cyclopenten-1-one, 2-methyl-	96.058	001120-73-6	0.39%	Cyclic ketones
35.387	Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-	340.24	000119-47-1	1.87%	Phenols
38.008	Triphenylphosphine oxide	278.086	000791-28-6	0.65%	Phenols
7.127	Phenol	94.042	000108-95-2	0.34%	Phenols
20.894	Phenol, 3,5-dimethoxy-	154.063	000500-99-2	2.32%	Phenols
3.51	Toluene	92.063	000108-88-3	0.63%	Benzenes and alkylbenzens
18.502	Benzene, 1-chloro-2-ethoxy-	156.034	000614-72-2	2.73%	Benzenes and alkylbenzens
7.865	Pyridine, 5-ethyl-2-methyl-	121.089	000104-90-5	0.90%	Pyridines
7.436	3-Pyridinamine, 2,6-dimethyl-	122.084	003430-33-9	0.23%	Pyridines
19.051	Quinoline, 2,4-dimethyl-, 1-oxide	173.084	014300-12-0	0.85%	Pyridines
8.86	Piperidine, 3,5-dimethyl-	113.12	035794-11-7	0.64%	Piperidine
22.879	l-Proline, N-butoxycarbonyl-, heptyl ester	313.225	1000313-66-9	4.66%	Aromatic amines and amides
23.171	L-Proline, N-valeryl-, hexyl ester	283.215	1000345-48-3	5.50%	Aromatic amines and amides
13.226	Oxalic acid, monoamide, N-allyl-, undecyl ester	283.215	1000309-76-0	0.57%	Aromatic amines and

					amides
20.579	l-Proline, N-propoxycarbonyl-, pentyl ester	271.178	1000313-70-1	4.57%	Aromatic amines and amides
3.156	Pyrazine	80.037	000290-37-9	0.50%	Pyrazines
4.409	Pyrazine, methyl-	94.053	000109-08-0	1.11%	Pyrazines
32.915	Piperazine, 1-n-propyl-4-[4-phenbutyl]-	260.225	1000129-00-5	0.64%	Pyrazines
7.39	Pyrazine, 2-ethyl-5-methyl-	122.084	013360-64-0	0.24%	Pyrazines
5.868	Pyrazine, 2,5-dimethyl-	108.069	000123-32-0	0.33%	Pyrazines
20.745	4-Methyl-dodec-3-en-1-ol	198.198	1000192-41-0	0.36%	Oxygenated compounds
21.918	Hexadecanenitrile	237.246	000629-79-8	0.33%	Alkynitriles
11.95	Benzyl nitrile	117.058	000140-29-4	0.57%	Alkynitriles

Table9 The GC-MS results for Nan&Protein at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
23.846	n-Hexadecanoic acid	256.24	000057-10-3	13.20%	Fatty acids
23.274	cis-9-Hexadecenoic acid	254.225	1000333-19-5	8.60%	Fatty acids
28.264	6-Octadecenoic acid	282.256	1000336-66-8	5.97%	Fatty acids
19.023	Tetradecanoic acid	228.209	000544-63-8	2.91%	Fatty acids
24.006	n-Hexadecanoic acid	256.24	000057-10-3	1.46%	Fatty acids
22.147	Fumaric acid, cis-hex-3-enyl nonadecyl ester	464.387	1000348-87-4	0.78%	Fatty acids
21.609	E-6-Octadecen-1-ol acetate	310.287	1000130-94-7	0.75%	Fatty acids
15.423	Dodecanoic acid	200.178	000143-07-7	0.20%	Fatty acids
22.65	Hexadecanoic acid, methyl ester	270.256	000112-39-0	0.33%	Fatty acids
20.756	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	3.80%	Hydrocarbons
17.644	Heptadecane	240.282	000629-78-7	1.31%	Hydrocarbons
14.508	Pentadecane	212.25	000629-62-9	0.94%	Hydrocarbons
20.476	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	0.86%	Hydrocarbons
14.411	1-Tridecene	182.203	002437-56-1	0.67%	Hydrocarbons
15.887	Hexadecane	226.266	000544-76-3	0.71%	Hydrocarbons
11.773	1-Tridecene	182.203	002437-56-1	0.41%	Hydrocarbons
11.882	Tridecane	184.219	000629-50-5	0.35%	Hydrocarbons
18.256	cis-2-Methyl-7-octadecene	266.297	035354-39-3	0.20%	Hydrocarbons
30.158	N-Methyldodecanamide	213.209	027563-67-3	3.10%	Alkylamides
29.248	Hexadecanamide	255.256	000629-54-9	3.09%	Alkylamides
31.262	N,N-Dimethyldecanamide	199.194	014433-76-2	2.40%	Alkylamides
34.861	Dodecanamide, N,N-diethyl-	255.256	003352-87-2	1.64%	Alkylamides

29.58	Cyclobutanecarboxamide, N,N-dibutyl-	211.194	1000308-59-6	1.57%	Alkylamides
28.71	9-Octadecenamide, (Z)-	281.272	000301-02-0	1.27%	Alkylamides
25.923	Octanamide, N,N-dimethyl-	171.162	001118-92-9	0.29%	Alkylamides
33.923	9-Octadecenamide, (Z)-	281.272	000301-02-0	0.38%	Alkylamides
35.776	9-Octadecenamide, N,N-dimethyl-	309.303	003906-30-7	0.24%	Alkylamides
39.324	Pyrrolidine, 1-(1-oxopentadecyl)-	295.288	056630-55-8	2.11%	Pyrroles/alkylporroles
38.769	9-Hexadecenoic acid, pyrrolidide	307.288	1000336-02-4	0.73%	Pyrroles/alkylporroles
34.06	Tetradecanoic acid, pyrrolidide	281.272	1000336-16-1	0.55%	Pyrroles/alkylporroles
43.598	Pyrrolidine, 1-(1-oxo-9-octadecenyl)-, (Z)-	335.319	004637-54-1	0.24%	Pyrroles/alkylporroles
46.402	Cholesta-3,5-diene	368.344	000747-90-0	0.61%	Sterols
51.191	Cholesterol	386.355	000057-88-5	0.60%	Sterols
45.132	Cholest-4-ene	370.36	016732-86-8	0.51%	Sterols
45.395	Cholest-5-ene	370.36	000570-74-1	0.29%	Sterols
30.415	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	1.14%	DKP derivatives
18.656	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	0.58%	DKP derivatives
23.417	2-Hydroxy-3,5,5-trimethyl-cyclohex-2-enone	154.099	004883-60-7	2.53%	Cyclic ketones
5.736	2-Cyclopenten-1-one, 2-methyl-	96.058	001120-73-6	0.64%	Cyclic ketones
19.349	5,5,8a-Trimethyldecalin-1-one	194.167	1000195-96-1	0.59%	Cyclic ketones
13.06	N-[2-Hydroxyethyl]succinimide	143.058	018190-44-8	0.64%	Pyrrolidinone
9.524	2,5-Pyrrolidinedione, 1-ethyl-	127.063	002314-78-5	0.30%	Pyrrolidinone
8.649	Phenol, 4-methyl-	108.058	000106-44-5	0.68%	Phenols
7.098	Phenol	94.042	000108-95-2	0.53%	Phenols
35.405	2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-	340.24	000119-47-1	0.40%	Phenols
10.062	Phenol, 4-ethyl-	122.073	000123-07-9	0.19%	Phenols
3.51	Toluene	92.063	000108-88-3	0.37%	Benzenes and alkylbenzens

5.45	Styrene	104.063	000100-42-5	0.24%	Benzenes and alkylbenzens
11.801	2-Methyl-5-(3-methylbutyl)pyridine	163.136	052535-39-4	0.19%	Pyridine
7.796	Pyridine, 5-ethyl-2-methyl-	121.089	000104-90-5	0.72%	Pyridine
36.984	1,3-Benzenediamine, 4-chloro-	142.03	005131-60-2	1.41%	Aromatic amines and amides
47.621	Oxalic acid, monoamide, N-(2-phenylethyl)-, heptyl ester	291.183	1000309-80-5	1.15%	Aromatic amines and amides
34.272	Cyclobutanecarboxamide, N,N-diheptyl-	295.288	1000308-60-1	0.89%	Aromatic amines and amides
8.826	Benzenamine, 2-ethyl-6-methyl-	135.105	024549-06-2	0.82%	Aromatic amines and amides
19.189	Hex-5-enamide, N-(2-phenylethyl)-	217.147	1000262-31-4	0.68%	Aromatic amines and amides
15.16	[1,1'-Biphenyl]-3-amine	169.089	002243-47-2	0.21%	Aromatic amines and amides
11.95	Indole	117.058	000120-72-9	0.61%	Indole derivatives
4.363	Pyrazine, methyl-	94.053	000109-08-0	0.93%	Pyrazine
5.891	Pyrazine, ethyl-	108.069	013925-00-3	0.40%	Pyrazine
7.355	Pyrazine, 2-ethyl-5-methyl-	122.084	013360-64-0	0.34%	Pyrazine
7.396	Pyrazine, trimethyl-	122.084	014667-55-1	0.26%	Pyrazine
5.811	Pyrazine, 2,5-dimethyl-	108.069	000123-32-0	0.59%	Pyrazine
47.175	4-Hexadecenoic acid, 2-methoxy-, methyl ester	298.251	040924-23-0	0.54%	Oxygenated compounds
24.819	Hexanal, O-methyloxime	129.115	056292-95-6	0.52%	Alkynitriles
41.773	4,4-dimethyl-2-(1-hydroxy-heptadec-8-enyl)-	351.314	1000293-23-3	0.50%	Alkylamides

Table10 The GC-MS results for Spi&Glucose at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
23.823	n-Hexadecanoic acid	256.24	000057-10-3	5.60%	Fatty acids
28.246	Oleic Acid	282.256	000112-80-1	3.45%	Fatty acids
34.58	9,12-Octadecadienoic acid, methyl ester, (E,E)-	294.256	002566-97-4	0.69%	Fatty acids
10.165	1-Hexene, 5-methyl-	98.11	003524-73-0	0.59%	Hydrocarbons
14.405	1-Pentadecene	210.235	013360-61-7	0.30%	Hydrocarbons
14.502	Pentadecane	212.25	000629-62-9	0.83%	Hydrocarbons
15.887	Hexadecane	226.266	000544-76-3	0.66%	Hydrocarbons
17.638	Heptadecane	240.282	000629-78-7	1.63%	Hydrocarbons
20.464	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	0.37%	Hydrocarbons
9.833	2-Methyl-1-nonene	140.157	002980-71-4	0.65%	Hydrocarbons
21.225	l-Valine, N-allyloxycarbonyl-, decyl ester	341.257	1000323-39-3	1.17%	Alkylamides
29.248	Tetradecanamide	227.225	000638-58-4	2.35%	Alkylamides
30.152	N-Methyldodecanamide	213.209	027563-67-3	3.23%	Alkylamides
31.262	Octanamide, N,N-dimethyl-	171.162	001118-92-9	3.30%	Alkylamides
33.905	9-Octadecenamide, (Z)-	281.272	000301-02-0	0.64%	Alkylamides
34.844	Dodecanamide, N,N-diethyl-	255.256	003352-87-2	1.85%	Alkylamides
35.771	9-Octadecenamide, N,N-dimethyl-	309.303	003906-30-7	0.59%	Alkylamides
33.098	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(phenylmethyl)-	244.121	014705-60-3	1.31%	Pyrroles/alkylporroles
39.307	Hexadecanoic acid, pyrrolidide	309.303	1000336-15-2	1.87%	Pyrroles/alkylporroles
43.587	9-Octadecenoic acid, pyrrolidide	335.319	1000336-15-9	0.37%	Pyrroles/alkylporroles
34.214	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-	244.121	014705-60-3	0.85%	Pyrroles/alkylporroles

7.453	(phenylmethyl)- Cholestan-3-amine, N,N,4,4-tetramethyl-, (3.beta.,5.alpha.)-	443.449	054498-47-4	1.05%	Sterols
8.82	.alpha.-Methyl-.alpha.-propylsuccinimide	155.095	001497-19-4	0.64%	Pyrrolidinone
9.518	2,5-Pyrrolidinedione, 1-ethyl-	127.063	002314-78-5	0.36%	Pyrrolidinone
5.725	2-Cyclopenten-1-one, 2-methyl-	96.058	001120-73-6	0.93%	Cyclic ketones
22.908	1,2-Cyclopentanedione, 3,3,5,5-tetramethyl-	154.099	020633-06-1	1.04%	Cyclic ketones
10.342	2-Piperidinone	99.068	000675-20-7	0.54%	DKP derivatives
23.28	2,5-Piperazinedione, 3,6-bis(2-methylpropyl)-	226.168	001436-27-7	4.21%	DKP derivatives
30.432	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	1.76%	DKP derivatives
7.132	Phenol	94.042	000108-95-2	0.98%	Phenol
8.689	Phenol, 4-methyl-	108.058	000106-44-5	1.03%	Phenol
20.876	Phenol, 3,5-dimethoxy-, acetate	196.074	023133-74-6	2.42%	Phenol
23.629	p-Hydroxybiphenyl	170.073	000092-69-3	0.83%	Phenol
26.747	3-(4-Hydroxyphenyl)propionic acid, trimethylsilyl ester	238.103	1000352-43-0	0.67%	Phenol
33.018	3',4'-Difluoroacetophenone	156.039	000369-33-5	2.68%	Phenol
5.45	Styrene	104.063	000100-42-5	0.86%	Benzenes and alkylbenzens
12.82	Naphthalene, 1,2,3,4-tetrahydro-1,1,6-trimethyl-	174.141	000475-03-6	0.32%	Benzenes and alkylbenzens
4.283	Pyridine, 2-methyl-	93.058	000109-06-8	0.35%	Pyridine
7.744	Pyridine, 2-ethyl-5-methyl-	121.089	018113-81-0	1.57%	Pyridine
3.539	1-(Piperidin-2-ylmethyl)piperidine	182.178	081310-55-6	0.95%	piperidines
4.769	Piperidine, 1-ethyl-	113.12	000766-09-6	0.39%	Piperidine
10.102	5-Azauracil	113.023	000071-33-0	0.85%	Pyrimidine

8.774	Benzenamine, N-ethyl-3-methyl-	135.105	000102-27-2	0.67%	Aromatic amines and amides
10.474	6-Aminoindoline	134.084	015918-79-3	0.32%	Aromatic amines and amides
11.212	Benzenamine, 3,5-dimethyl-	121.089	000108-69-0	0.68%	Aromatic amines and amides
11.778	Acetamide, N-(4-methylphenyl)-	149.084	000103-89-9	0.30%	Aromatic amines and amides
14.811	Acetamide, N-(2-phenylethyl)-	163.1	000877-95-2	0.75%	Aromatic amines and amides
23.091	l-Prolylglycine, n-butoxycarbonyl-, butyl ester	328.2	1000322-62-7	1.93%	Aromatic amines and amides
33.539	Benzamide, N-4-piperidinyl-	204.126	033953-37-6	1.10%	Aromatic amines and amides
11.95	Indole	117.058	000120-72-9	1.15%	Indole derivatives
13.226	1H-Indole, 3-methyl-	131.073	000083-34-1	0.63%	Indole derivatives
23.989	9H-Pyrido[3,4-b]indole, 1-methyl-	182.084	000486-84-0	1.37%	Indole derivatives
24.184	9H-Pyrido[3,4-b]indole	168.069	000244-63-3	0.37%	Indole derivatives
4.328	Pyrazine, methyl-	94.053	000109-08-0	2.40%	Pyrazine
5.776	Pyrazine, 2,5-dimethyl-	108.069	000123-32-0	1.95%	Pyrazine
5.868	Pyrazine, ethyl-	108.069	013925-00-3	0.66%	Pyrazine
7.287	Pyrazine, 2-ethyl-6-methyl-	122.084	013925-03-6	0.56%	Pyrazine
7.332	Pyrazine, 2-ethyl-5-methyl-	122.084	013360-64-0	0.52%	Pyrazine
8.631	Pyrazine, 3-ethyl-2,5-dimethyl-	136.1	013360-65-1	0.44%	Pyrazine
9.289	Pentanal, 3-methyl-	100.089	015877-57-3	0.90%	Oxygenated

					compounds
15.172	2(4H)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-	180.115	015356-74-8	0.54%	Oxygenated compounds
18.559	Thiophene, 2-methoxy-5-methyl-	128.03	031053-55-1	3.19%	Oxygenated compounds
21.592	Cyclohexanol, 2-methyl-5-(1-methylethyl)-, (1.alpha.,2.beta.,5.alpha.)-	156.151	000499-69-4	0.92%	Oxygenated compounds
33.762	Diethyl ethylidenemalonate	186.089	001462-12-0	0.79%	Oxygenated compounds
34.735	2-(3-Methyl-undec-3-enyl)-[1,3]dioxolane	240.209	1000193-12-3	0.92%	Oxygenated compounds

Table11 The GC-MS results for glucose at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
15.887	Hexadecane	226.266	000544-76-3	1.17%	Hydrocarbons
17.632	Undecane	156.188	001120-21-4	0.79%	Hydrocarbons
5.805	2-Cyclopenten-1-one, 2-methyl-	96.058	001120-73-6	4.55%	Cyclic ketones
4.609	2-Cyclopenten-1-one	82.042	000930-30-3	7.46%	Cyclic ketones
6.903	2-Cyclopenten-1-one, 3-methyl-	96.058	002758-18-1	4.30%	Cyclic ketones
11.618	Cyclonon-4-ynone	136.089	037079-60-0	0.59%	Cyclic ketones
12.385	2-Cyclohexen-1-one, 5-methyl-2-(1-methylethyl)-	152.12	005113-66-6	3.22%	Cyclic ketones
3.516	Toluene	92.063	000108-88-3	12.23%	Benzenes and alkylbenzens
15.95	Diethyl Phthalate	222.089	000084-66-2	3.47%	Benzenes and alkylbenzens
17.46	4-Methyl-3-phenyl-6-pyridin-2-yl-5,6-dihydro-4H-[1,2,4,5]oxatriazine	254.117	148758-57-0	1.39%	Benzenes and alkylbenzens
35.364	Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-	340.24	000119-47-1	19.37%	Phenols
8.065	1-Methoxy-1,4-cyclohexadiene	110.073	002886-59-1	1.57%	Oxygenated compounds
4.048	1,3-Propanediol, 2,2-diethyl-	132.115	000115-76-4	0.53%	Oxygenated compounds
5.879	Furan, 2-ethyl-5-methyl-	110.073	001703-52-2	4.58%	Oxygenated compounds
6.188	2H-Pyran-2-one, 6-heptyltetrahydro-	198.162	000713-95-1	1.26%	Oxygenated compounds
3.899	Formamide, N-(cyanomethyl)-	84.032	005018-27-9	1.80%	Alkynitriles
14.067	Benzonitrile, 2,4-dimethoxy-	163.063	004107-65-7	1.74%	Alkynitriles

Table12 The GC-MS results for prortein at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
5.805	3-Heptyne	96.094	002586-89-2	0.09%	Hydrocarbons
11.469	Caprolactam	113.084	000105-60-2	0.56%	Alkylamides
18.347	N,4-Diethyl-4-octanamine	185.214	071275-08-6	2.54%	Alkylamides
20.768	4-Heptanone, dimethylhydrazone	156.163	014090-58-5	5.36%	Alkylamides
22.685	1-Butanamine, 3-methyl-N,N-bis(3-methylbutyl)-	227.261	000645-41-0	6.46%	Alkylamides
7.882	1-Butanamine, 2-methyl-N-(2-methylbutylidene)-	155.167	054518-97-7	1.58%	Alkylamides
3.184	N-(2-Cyanoethyl)-pyrrole	120.069	043036-06-2	0.40%	Pyrroles/alkylporroles
5.467	1-Butylpyrrolidine	127.136	000767-10-2	1.86%	Pyrroles/alkylporroles
7.498	Pyrrolidine, N-(3-methyl-3-butenyl)-	139.136	1000161-49-0	2.98%	Pyrroles/alkylporroles
30.255	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	1.74%	DKP derivatives
31.159	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	1.34%	DKP derivatives
32.973	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(phenylmethyl)-	244.121	014705-60-3	5.32%	DKP derivatives
34.134	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(phenylmethyl)-	244.121	014705-60-3	0.80%	DKP derivatives
18.399	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	1.44%	DKP derivatives
18.885	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	1.11%	DKP derivatives
22.822	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(2-methylpropyl)-	210.137	005654-86-4	2.20%	DKP derivatives
22.913	2,5-Piperazinedione, 3,6-bis(2-methylpropyl)-	226.168	001436-27-7	1.14%	DKP derivatives
23.074	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(2-methylpropyl)-	210.137	005654-86-4	8.08%	DKP derivatives
20.424	Hydantoin, 1-butyl-	156.09	033599-32-5	10.19%	Pyrrolidinone
21.054	Hydantoin, 1-butyl-	156.09	033599-32-5	1.26%	Pyrrolidinone
17.14	2(1H)-Pyridinone, 1-(2-methylphenyl)-	185.084	054774-86-6	0.27%	Cyclic ketones
7.224	Pyrrolidin-2-one, 5-heptyl-	183.162	002405-92-7	2.02%	Cyclic ketones

9.839	Cyclopentanone, 2,2-dimethyl-	112.089	004541-32-6	0.91%	Cyclic ketones
12.665	2,3,4-Trimethyl-isoxazol-5(2H)-one	127.063	007713-68-0	0.52%	Cyclic ketones
13.152	2,3,4-Trimethyl-isoxazol-5(2H)-one	127.063	007713-68-0	0.59%	Cyclic ketones
13.558	4-Hydroxy-3,5,5-trimethylcyclohex-2-enone	154.099	014203-59-9	1.18%	Cyclic ketones
35.37	Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-	340.24	000119-47-1	3.71%	Phenols
3.516	Toluene	92.063	000108-88-3	1.40%	Benzenes and alkylbenzens
14.468	Benzonitrile, 2,4,6-trimethyl-	145.089	002571-52-0	0.29%	Benzenes and alkylbenzens
15.944	Diethyl Phthalate	222.089	000084-66-2	0.48%	Benzenes and alkylbenzens
19.188	Benzene, (4-methyl-4-pentenyl)-	160.125	006683-49-4	1.13%	Benzenes and alkylbenzens
4.454	Pyrazine, methyl-	94.053	000109-08-0	0.59%	Pyrazines
7.401	Pyrazine, 2-ethyl-6-methyl-	122.084	013925-03-6	0.16%	Pyrazine
8.666	Pyrazine, 2,6-diethyl-	136.1	013067-27-1	0.22%	Pyrazine
4.952	Piperidine, 1-ethyl-	113.12	000766-09-6	0.51%	Piperidine
8.711	Piperidine, 1-pentyl-	155.167	010324-58-0	0.77%	Piperidine
12.162	1-Benzoyl-2-(pyrrolidinomethyl)piperidine	272.189	1000225-57-6	0.85%	Piperidine
3.808	Piperidine, 1-methyl-	99.105	000626-67-5	0.12%	Piperidine
9.301	Cycloheptylamine	113.12	005452-35-7	1.20%	Aromatic amines and amides
33.373	Cyclo-(l-leucyl-l-phenylalanyl)	260.152	007280-77-5	0.77%	Aromatic amines and amides
12.024	Indole	117.058	000120-72-9	0.55%	Indole derivatives

23.943	9H-Pyrido[3,4-b]indole, 1-methyl-	182.084	000486-84-0	0.63%	Indole derivatives
13.06	4(1H)-Quinazolinone, 2,3-dihydro-6,7-dimethoxy-3-[2-(4-morpholinyl)ethyl]-2-thioxo-	351.125	1000319-86-6	0.88%	Indole derivatives
13.238	1H-Indole, 5-methyl-	131.073	000614-96-0	0.76%	Indole derivatives
23.165	l-Valine, n-propargyloxycarbonyl-, pentadecyl ester	409.319	1000323-31-7	4.01%	Alkynitriles

Table13 The GC-MS results for protein&glucose at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
7.882	1-Butanamine, 2-methyl-N-(2-methylbutylidene)-	155.167	054518-97-7	1.24%	Alkylamides
22.896	N,N'-Dibutyl-N,N'-dimethyl-succinamide	256.215	097856-78-5	1.53%	Alkylamides
23.068	L-Proline, N-(3-cyclopentylpropionyl)-, isobutyl ester	295.215	1000346-40-8	8.50%	Alkylamides
23.16	L-Leucine, N-cyclopropylcarbonyl-, methyl ester	213.136	1000282-55-2	4.15%	Alkylamides
30.095	Cyclohexanecarboxamide, N-decyl-N-methyl-	281.272	1000308-52-2	0.56%	Alkylamides
4.203	1H-Pyrrole, 1-ethyl-	95.073	000617-92-5	0.26%	Pyrroles/alkylporroles
5.479	1-Butylpyrrolidine	127.136	000767-10-2	1.31%	Pyrroles/alkylporroles
7.235	1H-Pyrrole-1-ethanamine, tetrahydro-.alpha.-methyl-	128.131	1000351-26-6	1.13%	Pyrroles/alkylporroles
7.516	Pyrrolidine, 1-methyl-2-octyl-	197.214	003447-06-1	1.93%	Pyrroles/alkylporroles
10.274	Pyrrolidine, 1-acetyl-	113.084	004030-18-6	0.46%	Pyrroles/alkylporroles
13.06	10-Methyl-undecanoic acid, pyrrolidide	253.241	1000336-15-7	0.63%	Pyrroles/alkylporroles
30.238	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	1.77%	DKP derivatives
32.961	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(phenylmethyl)-	244.121	014705-60-3	5.52%	DKP derivatives
18.342	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	1.79%	DKP derivatives
18.88	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	1.16%	DKP derivatives
19.189	Pyrimidine-2,4,6(1H,3H,5H)-trione, 1-(2-phenylethyl)-	232.085	251468-79-8	0.77%	DKP derivatives
21.043	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	1.31%	DKP derivatives
22.822	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(2-methylpropyl)-	210.137	005654-86-4	2.74%	DKP derivatives
31.159	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	0.57%	DKP derivatives

18.37	1,3,5-Triazine-2,4(1H,3H)-dione, 6-(ethylamino)-	156.065	002630-10-6	1.80%	*
3.184	Pyrimidine, 2-methoxy-	110.048	000931-63-5	0.66%	*
5.799	2-Cyclopenten-1-one, 2-methyl-	96.058	001120-73-6	0.41%	Cyclic ketones
13.552	4-Hydroxy-3,5,5-trimethylcyclohex-2-enone	154.099	014203-59-9	0.87%	Cyclic ketones
20.413	Hydantoin, 1-butyl-	156.09	033599-32-5	10.61%	Pyrrolidinone
9.541	2,5-Pyrrolidinedione, 1-ethyl-	127.063	002314-78-5	0.59%	Pyrrolidinone
35.37	Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-	340.24	000119-47-1	4.96%	Phenols
3.522	Toluene	92.063	000108-88-3	2.37%	Benzenes and alkylbenzens
7.441	1,4-Benzenediamine, 2-methyl-	122.084	000095-70-5	0.75%	Aromatic amines and amides
22.673	2-Hydrazino-4-methyl-6-methylthiopyrimidine	170.063	001899-58-7	6.42%	Aromatic amines and amides
8.855	Benzenamine, 2-ethyl-6-methyl-	135.105	024549-06-2	0.56%	Aromatic amines and amides
9.301	Cycloheptylamine	113.12	005452-35-7	1.24%	Aromatic amines and amides
17.146	1,7-Trimethylene-2,3-dimethylindole	185.12	005825-43-4	0.27%	Indole derivatives
23.944	9H-Pyrido[3,4-b]indole, 1-methyl-	182.084	000486-84-0	0.37%	Indole derivatives
4.432	Pyrazine, methyl-	94.053	000109-08-0	2.07%	Pyrazine
5.868	Pyrazine, 2,5-dimethyl-	108.069	000123-32-0	0.47%	Pyrazine
7.35	Pyrazine, 2-ethyl-6-methyl-	122.084	013925-03-6	0.49%	Pyrazine
7.396	Pyrazine, 2-ethyl-5-methyl-	122.084	013360-64-0	0.35%	Pyrazine
8.66	Pyrazine, 3-ethyl-2,5-dimethyl-	136.1	013360-65-1	0.59%	Pyrazine
20.768	1,4-Dioxaspiro[4.5]decane, 6-methylene-	154.099	023153-81-3	6.08%	Oxygenated compounds
32.813	Diethyl ethylidenemalonate	186.089	001462-12-0	1.94%	Oxygenated compounds
12.036	Benzyl nitrile	117.058	000140-29-4	0.63%	Alkynitriles
12.168	1-Pyrrolidinebutyronitrile	138.116	035543-25-0	0.53%	Alkynitriles

Table14 The GC-MS results for Nan&Spi&glucose at 280°C

Retention time(min)	Name	Molecule weigt	CAS NO.	Relative Area	Group
23.863	n-Hexadecanoic acid	256.24	000057-10-3	16.72%	Fatty Acids
19	Tetradecanoic acid	228.209	000544-63-8	2.05%	Fatty Acids
28.241	Octadec-9-enoic acid	282.256	1000190-13-7	1.56%	Fatty Acids
20.751	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	1.91%	Hydrocarbons
20.464	2-Hexadecene, 3,7,11,15-tetramethyl-, [R-[R*,R*-(E)]]-	280.313	014237-73-1	0.56%	Hydrocarbons
14.411	1-Pentadecene	210.235	013360-61-7	0.54%	Hydrocarbons
17.638	Heptadecane	240.282	000629-78-7	1.02%	Hydrocarbons
35.765	9-Octadecenamide, N,N-dimethyl-	309.303	003906-30-7	0.33%	Hydrocarbons
14.502	Pentadecane	212.25	000629-62-9	0.29%	Hydrocarbons
20.585	Bicyclo[3.1.1]heptane, 2,6,6-trimethyl-, (1.alpha.,2.beta.,5.alpha.)-	138.141	006876-13-7	0.54%	Hydrocarbons
29.23	Hexadecanamide	255.256	000629-54-9	3.56%	Alkylamides
30.146	N-Methyldodecanamide	213.209	027563-67-3	2.97%	Alkylamides
31.25	Octanamide, N,N-dimethyl-	171.162	001118-92-9	2.95%	Alkylamides
34.838	Octadecanamide, N-butyl-	339.35	004219-50-5	1.94%	Alkylamides
28.681	9-Octadecenamide, (Z)-	281.272	000301-02-0	1.45%	Alkylamides
33.894	9-Octadecenamide, (Z)-	281.272	000301-02-0	0.56%	Alkylamides
41.75	2-Oxazoline, 4,4-dimethyl-2-(1-hydroxy-heptadec-8-enyl)-	351.314	1000293-23-3	0.55%	Alkylamides
21.466	l-Proline, N-propoxycarbonyl-, ethyl ester	229.131	1000313-69-7	0.62%	Alkylamides
30.667	N,N-Dimethyldecanamide	199.194	014433-76-2	0.72%	Alkylamides
7.87	1-Butanamine, 2-methyl-N-(2-methylbutylidene)-	155.167	054518-97-7	0.41%	Alkylamides
21.162	l-Proline, N-propoxycarbonyl-, pentyl ester	271.178	1000313-70-1	1.39%	Pyrroles/alkylporroles
39.301	Hexadecanoic acid, pyrrolidide	309.303	1000336-15-2	1.74%	Pyrroles/alkylporroles

9.415	1H-Pyrrole, 2,3,4,5-tetramethyl-	123.105	001003-90-3	0.31%	Pyrroles/alkylporroles
10.388	1H-Pyrrole, 2-ethyl-3,4,5-trimethyl-	137.12	069687-79-2	0.73%	Pyrroles/alkylporroles
38.752	9-Hexadecenoic acid, pyrrolidide	307.288	1000336-02-4	0.54%	Pyrroles/alkylporroles
51.18	Cholesterol	386.355	000057-88-5	1.16%	Sterols
51.712	Vitamin E	430.381	000059-02-9	0.84%	Sterols
45.12	Cholest-4-ene	370.36	016732-86-8	0.44%	Sterols
46.385	Cholesta-3,5-diene	368.344	000747-90-0	0.42%	Sterols
18.656	2,5-Piperazinedione, 3-methyl-6-(1-methylethyl)-	170.106	022160-42-5	2.41%	DKP derivatives
30.381	2,5-Piperazinedione, 3-benzyl-6-isopropyl-	246.137	014474-71-6	1.48%	DKP derivatives
33.07	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(phenylmethyl)-	244.121	014705-60-3	1.28%	DKP derivatives
21.271	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	0.62%	DKP derivatives
19.177	3,6-Diisopropylpiperazin-2,5-dione	198.137	005625-44-5	0.82%	DKP derivatives
8.826	2,5-Pyrrolidinedione, 1-methyl-	113.048	001121-07-9	0.68%	Pyrrolidinone
9.518	2,5-Pyrrolidinedione, 1-ethyl-	127.063	002314-78-5	0.29%	Pyrrolidinone
5.725	2-Cyclopenten-1-one, 2-methyl-	96.058	001120-73-6	1.16%	Cyclic ketones
22.135	2-Cyclohexen-1-one, 4,5-dimethyl-	124.089	005715-25-3	0.92%	Cyclic ketones
21.592	6,6-Dimethyl-cyclooct-4-enone	152.12	1000194-10-0	0.85%	Cyclic ketones
17.146	2(1H)-Pyridinone, 1-(2-methylphenyl)-	185.084	054774-86-6	0.41%	Cyclic ketones
6.777	2-Cyclopenten-1-one, 3-methyl-	96.058	002758-18-1	0.31%	Cyclic ketones
8.654	Phenol, 4-methyl-	108.058	000106-44-5	1.14%	Phenols
7.127	Phenol	94.042	000108-95-2	0.80%	Phenols
35.387	Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-	340.24	000119-47-1	0.30%	Phenols
14.811	4-Nitrobenzoic acid, 10-undecenyl ester	319.178	1000281-86-3	0.51%	Benzens and alkybenzenes
36.955	9-[1-Hydroxy-2-dibutylaminoethyl]-10-methylphenanthrene	363.256	050666-12-1	1.23%	Benzenes and

					alkylbenzens
5.456	Styrene	104.063	000100-42-5	0.43%	Benzens and alkybenzenes
7.75	Pyridine, 5-ethyl-2-methyl-	121.089	000104-90-5	0.98%	Pyridines
6.211	Pyridine, 2,5-dimethyl-	107.073	000589-93-5	0.32%	Pyridine
4.294	Pyridine, 2-methyl-	93.058	000109-06-8	0.27%	Pyridine
23.097	Neomenthylamine	155.167	007231-40-5	0.79%	Aromatic amines and amides
8.774	p-Isopropylaniline	135.105	000099-88-7	0.63%	Aromatic amines and amides
11.95	Indole	117.058	000120-72-9	0.87%	Indole derivatives
13.146	Quinoline, 3-methyl-	143.073	000612-58-8	0.63%	Indole derivatives
24.229	1H-Pyrido[2,3-b]indole	168.069	000244-76-8	0.31%	Indole derivatives
16.877	1,7-Dimethylene-2,3-dimethylindole	171.105	031401-55-5	0.30%	Indole derivatives
13.226	1H-Indole, 3-methyl-	131.073	000083-34-1	0.37%	Indole derivatives
5.879	Pyrazine, ethyl-	108.069	013925-00-3	0.35%	Indole derivatives
5.782	Pyrazine, 2,5-dimethyl-	108.069	000123-32-0	1.57%	Pyrazines
4.34	Pyrazine, methyl-	94.053	000109-08-0	1.51%	Pyrazines
7.338	Pyrazine, 2-ethyl-5-methyl-	122.084	013360-64-0	0.95%	Pyrazines
7.292	Pyrazine, 2-ethyl-6-methyl-	122.084	013925-03-6	0.58%	Pyrazine
15.887	Hexadecane	226.266	000544-76-3	0.34%	Pyrazine
37.516	Cyclohexanecarboxylic acid, octyl ester	240.209	089611-20-1	3.86%	Oxygenated compounds
32.91	1H-Cyclopenta[a]pentalen-7-ol, decahydro-3,3,4,7a-tetramethyl-, acetate	264.209	057984-03-9	0.99%	Oxygenated compounds

33.505	1H-Cyclopenta[a]pentalen-7-ol, acetate	decahydro-3,3,4,7a-tetramethyl-,	264.209	057984-03-9	0.85%	Oxygenated compounds