

Supplementary Data

Unraveling the Interactions in Fast Co-pyrolysis of Microalgae Model Compounds via Pyrolysis–GC/MS and Pyrolysis–FTIR Techniques

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Figure S1. Snapshot of Pyroprobe®-FTIR Setup with Brill cell.

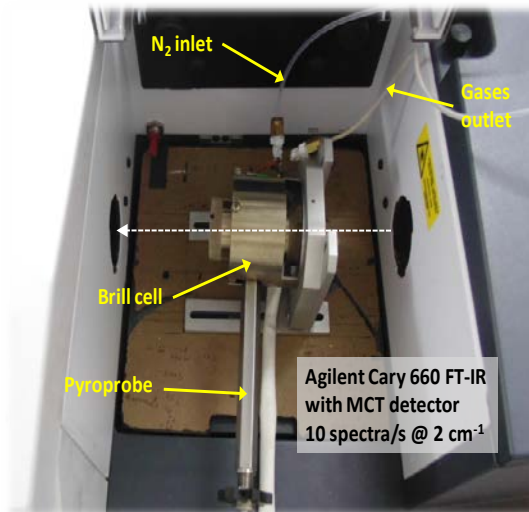
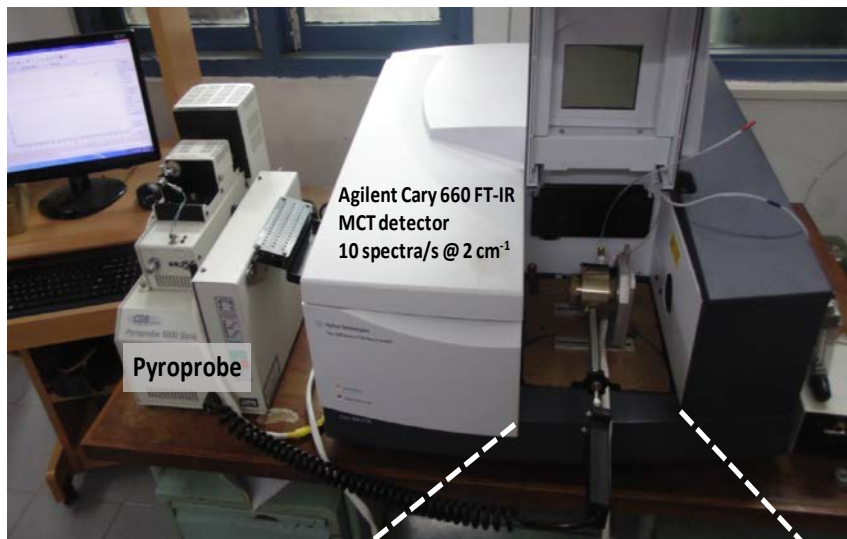


Table S1. Composition of pyrolysates obtained from BSA at 500 °C.

Compounds	Selectivity%
Carbonyl Compounds = 6.02±0.09	
Propanal, 2-methyl	0.48±0.10
Butanal, 2-methyl-	0.33±0.06
2,4-Heptadienal, 2,4-dimethyl	1.07±0.04
2-Heptyl-5-methylcyclopentanone	1.56±0.06
1,4-Cyclohexanedione	1.17±0.36
Heptadeca-5,8-dione	0.49±0.08
2,6-Naphthalenedione, octahydro-1,1,8a-trimethyl-, trans-	0.37±0.14
1-Oxaspiro[4.5]decan-7-one, 2,10,10-trimethyl-6-methylene, (R*,S*)-(.+.)-	0.55±0.23
Amides/Nitriles = 8.15±0.40	
9-Octadecenamide, (Z)-	1.01±0.10
Benzamide, 4-ethyl-N-allyl-	1.05±0.07
Hexadecanamide	1.21±0.18
Propanitrile, 2-methyl-	0.30±0.04
Pentanitrile, 4-methyl-	0.90±0.15
Benzeneacetonitrile	1.27±0.48
Benzenepropanenitrile	1.83±0.11
3-(2-Hydroxy-6-oxo-1-cyclohexenyl)propionitrile	0.58±0.09
Aromatic Compounds = 22.09±1.3	
Toulene	7.68±0.42
Benzene, Ethyl-	0.74±0.15
Styrene	1.10±0.45
Benzene, (2-methylpropyl)-	0.25±0.01
Benzene, [(2,2-dimethylcyclopropyl)methyl]-	4.75±0.25
Benzene, 1,1'-(1,2-ethanediyl)bis-	1.65±0.04
Benzene, 1,2-dimethoxy-4-methyl-	0.50±0.08
2-Benzylcyclohexanone	0.66±0.18
Phenol	1.61±0.28
Phenol, 4-methyl-	3.15±0.54
Carboxylic Acids = 2.82±0.50	
Octanoic acid	2.82±0.50
Esters = 3.82±0.53	
Formic acid, 2-methylpropyl ester	1.15±0.25
Fumaric acid, di(2-methylallyl) ester	0.54±0.16
L-Proline, N-(phenylacetyl)-, heptyl ester	0.65±0.02
L-Proline, N-valeryl-, hexadecyl ester	1.48±0.28
Hydrocarbons = 2.84±0.31	
1,3-Butadiene, 2-methyl-	1.62±0.28
1-Pentadecene	0.39±0.07
Cholesta-3,5-diene	0.42±0.09

(1-Ethylonyl)cyclohexane	0.41±0.09
N-containing cyclic compounds = 42.26±2.36	
Indole	1.24±0.10
1H-Indole, 3-methyl	1.69±0.08
Pyridine	0.44±0.09
2-Methyl-6-propylpyridine	0.48±0.05
Piperidine, 1-(cyanoacetyl)-	1.25±0.46
Dimethyl-(1H-pyrrol-3-ylmethyl)-amine	0.41±0.00
Bicyclo[2.2.1]hept-2-en-2-amine, N,N-dimethyl-	0.69±0.07
1-Naphthalenemethanamine	1.32±0.19
Ethyl 3-amino-3-(1-naphthyl)propanoate	0.74±0.12
2-Pyrrolidinone, 1-ethenyl-	3.83±0.19
2-Piperidinone	0.38±0.06
2-Isopropyl-1-(4-nitrophenyl)but-3-en-1-ol	1.45±0.06
Pyrrolidine, 1-(cyanoacetyl)-	0.25±0.04
7-Methyl-6-oxo-1,3-diazaadamantane	0.28±0.11
Cyclohexanamine, N-(2,3,4-trimethylhex-3-enylidene)-, N-oxide	0.76±0.05
Pyrazine, 2-methoxy-3-(1-methylpropyl)-	0.5±0.00
Quinoline, 2-sec-butyl-	1.62±0.02
2,9-Dimethyldecahydroquinol-4-one	1.10±0.06
5,7-Dimethyl-1,3-diazaadamantan-6-one oxime	1.16±0.18
Carbaminic acid, N-(4-amino-6-ethylaminopyrimidin-5-yl)-	1.53±0.67
N-Acetyl-.alpha.-methyl-4-ethynyl-2-thiazolemethanamine	1.51±0.43
7-Methyl-6-oxo-1,2,3,4-tetrahydro-6H-pyrimido[1,2-a]pyrimidine	1.00±0.16
5-(Nonylsulfonyl)-1H-1,2,4-triazol-3-ylamine#	1.41±0.03
Pyridine, 1-acetyl-1,2,3,4-tetrahydro-5-(2-piperidinyl)-	0.37±0.03
5-isopentyl-2-methoxy-3-methylpyrazine	2.23±0.27
Uric acid	0.83±0.14
1-Hydroxy-2,2,5,5-tetramethyl-2,5-dihydro-1H-imidazole-4-carbaldehyde methylhydrazone#	0.92±0.35
5-Pyrimidinecarboxylic acid, hexahydro-5-(1-methylethyl)-2,4,6-trioxo-	0.72±0.39
Cyclo(leucylpropyl)	8.33±0.51
Glycyl-L-tyrosine	1.49±0.17
4-Morpholineacetonitrile, .alpha.-phenethylidene-	2.33±0.15

Table S2. Composition of pyrolysates obtained from SO at 500 °C.

Compounds	Selectivity%
Alcohols = 5.53±0.59	
Cyclohexanemethanol, 4-methylene-	0.25±0.01
Cyclopentanepropanol, 2-methylene-	0.22±0.10
3-Decyn-2-ol	0.89±0.09
5,7-Undecadien-1-ol	0.25±0.0
1-Dodecanol	0.42±0.08
cis-7-Tetradecen-1-ol	0.74±0.19
5-Nonadecen-1-ol	0.87±0.06
1-Dodecanol, 3,7,11-trimethyl-	0.23±0.04
Oleyl alcohol	0.76±0.18
11-Hexadecyn-1-ol	0.45±0.03
n-Tetracosanol-1	0.46±0.01
Aldehydes/Ketone = 6.67±0.44	
2-[(Octyloxy)methyl]cyclobutanone	2.09±0.12
5-Ethylidenehexahydro-2(1H)-pentalenone	0.2±0.01
3A,7A-Epoxy-1H-inden-1-one, hexahydro-	1.11±0.02
Camphenone, 6-	0.3±0.11
Tricyclo[4.2.2.0 1,5]decan-4-one	0.95±0.20
6-Propenyl-bicyclo[3.1.0]hexan-2-one	1.56±0.62
2-Cyclohexen-1-one, 4,5-dimethyl-	0.46±0.02
Carboxylic acids = 33.73±2.27	
Decanoic acid	4.49±1.29
Linoleic acid	0.30±0.06
n-Hexadecanoic acid	7.89±0.31
Ocatadecanoic acid	21.05±3.17
Esters = 16.97±3.34	
Acetic acid, non-3-enyl ester	0.25±0.00
3-Dodecen-1-ol, acetate, (E)-	0.64±0.24
6-Tridecenoic acid, 13-(2-cyclopenten-1-yl)-, methyl ester	0.22±0.12
cis-7-Tetradecen-1-yl acetate	0.84±0.02
Octadecanoic acid, 2-propenyl ester	1.09±0.59
Propyl linoleate	5.97±1.34
cis-11,14-Eicosadienoic acid, methyl ester	0.39±0.11
Glycidol stearate	0.23±0.09
Propyleneglycol monooleate	2.32±0.64
9-Octadecenoic acid, 1,2,3-propanetriyl ester, (E,E,E)-	0.56±0.12
Eicos-9-ene-1,20-diacetate	2.87±0.52
Methyl 5,11,14-eicosatrienoate	0.87±0.26
Stigmast-5-en-3-ol, oleate	0.72±0.08
Hydrocarbons = 29.50±3.23	
1,7-Nonadiene, 4,8-dimethyl-	0.28±0.03
1-Undecene	0.74±0.25

3-Nonen-5-yne, 4-ethyl-	0.71±0.13
(3E,5Z)-1,3,5-Undecatriene	1.03±0.22
6-Butyl-1,4-cycloheptadiene	1.73±0.03
cis-4-Methyl-exo-tricyclo[5.2.1.0(2.6)]decane	0.46±0.02
2,4-Dodecadiene, (E,Z)-	0.23±0.04
1-Tetradecene	0.45±0.04
7-Hexadecyne	0.52±0.06
1-Tetradecene	0.69±0.06
Cyclopentene, 1-octyl-	0.36±0.09
7-Tetradecyne	1.05±0.15
1-Hexadecene	0.30±0.02
Pentadecane	0.24±0.06
1,13-Tetradecadiene	0.65±0.03
3-Heptadecene, (Z)-	1.24±0.13
1-Nonadecene	1.17±0.08
2-Butene	1.15±0.04
Bicyclo[2.1.0]pentane	1.49±0.30
1-Hexene	1.46±0.51
1,3-Cyclohexadiene	0.64±0.23
Bicyclo[3.1.0]hexane	0.69±0.33
Cyclopentane, 1,2-dimethyl-	1.06±0.35
Cyclohexene, 3-methyl-	0.83±0.04
1,4,9-Decatriene, (E)-	0.51±0.07
1-Octene	0.55±0.04
2-Octene, (Z)-	0.79±0.10
Cyclohexane, ethenyl	0.30±0.04
1,3-Octadiene	1.1±0.07
1-Nonene	0.55±0.05
Cyclooctene	2.09±0.13
1,3-Nonadiene, (E)-	0.33±0.11
Cyclopentene, 1-butyl	0.34±0.02
1,9-Decadiyne	0.28±0.08
1-Decene	0.5±0.13
4,6-Decadiene	0.19±0.03
2-Methyl-1-nonene-3-yne	0.35±0.09
Cyclopentane, decyl-	0.23±0.06
1,3-Cyclopentadiene	0.47±0.03
Cyclopentene, 1-methyl-	0.78±0.02
2-Heptene	0.23±0.08
Vinylcyclopentane	0.42±0.06
1,3-Cyclohexadiene, 5-butyl-	0.32±0.02

Table S3. Composition of pyrolysates obtained from BSA and SO mixtures at 500 °C.

Compounds	Selectivity%		
	BSA:SO (2:1)	BSA:SO (1:1)	BSA:SO (1:2)
Alcohols			
3-Penten-1-ol, (E)-	1.74±0.21	1.29±0.01	1.65±0.30
1-Nonanol		0.19±0.01	
1-Hexadecanol	0.15±0.01	0.43±0.01	
1-Naphthalenol, decahydro-4a-methyl-		0.46±0.04	
1,4-Benzenediol, 2,3,5-trimethyl-		0.2±0.04	
(Z)6-Pentadecen-1-ol	0.72±0.04		0.34±0.02
Oleyl Alcohol			0.21±0.00
Ethanol, 2-(9,12-octadecadienyloxy)-, (Z,Z)-			1.98±0.01
2-Propylcyclohexanol	0.62±0.07		
1-Octadecanol	0.75±0.20		
Total alcohols	3.98±0.50	2.57±0.00	4.18±0.30
Aldehydes/ Ketones			
2(1H)-Naphthalenone, octahydro-, trans-		1.24±0.08	
Camphenone, 6-		0.49±0.02	0.51±0.04
6-Propenylbicyclo[3.1.0]hexan-2-one	0.69±0.18	0.64±0.01	1.04±0.11
spiro[3.7]Undeca-5,7-dien-1-one		0.33±0.04	
2,4-Heptadienal, 2,4-dimethyl-		0.55±0.00	
Oxacycloheptadec-8-en-2-one		0.57±0.01	
Heptadeca-5,8-dione		0.46±0.22	
9-t-Butyltricyclo[4.2.1.1(2,5)]decane-9,10-diol		0.44±0.00	
3-Methyl-3-vinylcyclohexanone			0.54±0.06
Cyclohexanebutanal, 2-methyl-3-oxo, cis-2,7-			0.46±0.00
Bis(spirocyclopropane)bicyclo[2.2.1]heptan-5-one	0.26±0.03		
1-Oxaspiro[5.5]undec-3-en-2-one, 4-methoxy-	0.96±0.03		
2(1H)-Benzocyclooctenone, decahydro-4A-methyl-, trans-(-)-	0.29±0.11		
Z-12-Tetradecenal	0.24±0.01		
Total aldehydes/ketones	2.44±0.05	4.72±0.18	2.55±0.02
Amides/ Nitriles			
Octanamide		0.22±0.04	
Hexadecanamide	3.08±0.19	2.69±0.06	1.83±0.34
9-Octadecenamide, (Z)-	4.36±0.45	4.2±0.07	3.70±0.64
Octadecanamide	0.44±0.07	0.54±0.01	0.48±0.09
Tetradecanamide	0.94±0.01		
Pentanenitrile, 4-methyl-	0.25±0.03	0.27±0.01	

Benzenepropanenitrile	0.68±0.21	0.89±0.02	
Hexadecanenitrile		0.20±0.08	0.26±0.01
9-Octadecynenitrile	0.86±0.02	0.95±0.07	1.04±0.12
Oleanitrile	1.39±0.11	0.92±0.15	1.51±0.05
Pentadecanenitrile	0.47±0.11		
Total amides/nitriles	12.47±0.36	10.88±0.04	8.82±1.27
Aromatic compounds			
Benzene		0.48±0.01	
Benzene, methyl-	3.23±0.49	3.74±0.06	1.9±0.28
Benzene, ethyl-	0.33±0.09	0.55±0.01	
Benzene, 1,1'-(1,2-ethanediyl)bis-	0.27±0.22	0.54±0.16	
Benzene, propyl-	0.17±0.04	1.68±0.03	
Phenol	0.72±0.01		
Phenol, 3-methyl-	0.55±0.13	1.68±0.03	
Total aromatic compounds	5.27±0.91	6.99±0.22	1.9±0.28
Carboxylic acids			
n-Hexadecanoic acid	6.25±0.43	2.22±0.01	6.17±0.47
Octadecanoic acid	4.55±0.06	4.47±0.09	
Octanoic acid	4.65±0.25		0.93±0.57
Decanoic acid			0.38±0.02
Tetradecanoic acid	0.46±0.01		
Total carboxylic acids	15.91±0.64	6.69± 0.09	7.48±0.12
Esters			
2-Buten-1-ol, 3-methyl-, acetate	1.88±0.13	0.95±0.01	0.89±0.1
Methyl ricinoleate		0.48±0.04	
5-Tetradecen-1-ol, acetate, (Z)-		1.19±0.08	
Octadecanoic acid, 2-propenyl ester	3.74±0.36	1.5±0.44	1.97±0.55
Propyl linoleate	20.85±4.62	23.37±1.97	31.80±2.09
Isopropyl linoleate		0.36±0.23	
3-Dodecen-1-ol, acetate, (E)-	2.7±0.01		0.89±0.12
9,12-Octadecadienoic acid (Z,Z)-, phenylmethyl ester			0.26±0.05
5-Dodecen-1-ol, acetate, (Z)-	1.71±0.04		0.87±0.01
Stigmast-5-en-3-ol, oleate	1.33±0.01		0.53±0.02
Isopropyl palmitate	3.72±0.05		
Total esters	35.93±4.32	27.85±2.29	37.21±2.65
Hydrocarbons			
2-Butene	1.07±0.05	1.16±0.04	1.09±0.28
1-Hexene	1±0.18	0.89±0.14	1.21±0.51
1-Heptene	0.28±0.01	0.38±0.03	0.76±0.23
1-Octene	0.25±0.04	0.23±0.02	0.39±0.04
1,3-Octadiene	0.27±0.06	0.26±0.03	0.56±0.21
2-Octene, (Z)-			0.29±0.04

2,6-Octadiene			0.3±0.1
1-Nonene	0.2±0.04		0.3±0.03
1,3-Nonadiene, (E)-			0.24±0.04
1-Decene	0.16±0.0		0.37±0.04
3-Decyn-2-ol			0.51±0.06
1,7-Octadiene, 2-methyl-6-methylene-			0.28±0.04
1-Undecene	0.25±0.06	0.31±0.06	0.45±0.09
1-Hexadecyne		0.19±0.0	
(3Z,5E)-1,3,5-Undecatriene	0.54±0.06	0.62±0.03	1.02±0.15
1-Tridecene	0.2±0.03	0.2±0.0	0.43±0.03
2,4-Dodecadiene, (E,Z)-	0.22±0.03	0.31±0.03	
1-Tetradecene		0.65±0.01	0.24±0.02
1-Pentadecene	0.33±0.04	0.53±0.05	0.51±0.01
Dodecane, 2-methyl-		0.25±0.01	
1,4,9-Decatriene, (E)-			0.29±0.04
3-Nonen-5-yne, 4-ethyl-			0.36±0.06
1-Hexadecene	0.37±0.01		0.75±0.02
(8E,10Z)-1,8,10-Hexadecatriene#			0.51±0.01
1,15-Hexadecadiene			0.54±0.03
1,E-8,Z-10-Hexadecatriene			0.42±0.08
(6E,11Z)-1,6,11-Hexadecatriene#			0.3±0.11
1-Heptadecene	0.27±0.04	0.23±0.03	
9-Octadecyne	0.56±0.14		0.59±0.06
3-Heptadecene, (Z)-	1.04±0.11	0.85±0.01	1.36±0.05
Z-5-Nonadecene			0.28±0.06
Heptadecane	0.18±0.06	1.08±0.01	
6-Butyl-1,4-cycloheptadiene	0.99±0.09	1.12±0.11	1.74±0.03
Cyclododecene		0.54±0.08	
Bicyclo[8.2.0]dodecane, 11,11-dimethyl-			
1,3-Cyclohexadiene			0.47±0.12
Bicyclo[3.1.0]hexane			0.32±0.12
Bicyclo[5.1.0]octane			1.55±0.12
Cyclopentene, 1-butyl-			0.25±0.08
Cyclohexene, 1-(1-butenyl)-			0.42±0.19
Bicyclo[4.2.0]oct-1-ene, 7-endo-ethenyl-			0.63±0.19
Propylidencyclohexane			0.44±0.11
Bicyclo[2.2.2]oct-2-ene, 1,2,3,6-tetramethyl-			0.25±0.11
Cyclododecyne			0.5±0.03
Bicyclo[6.4.0]dodeca-9,11-diene			0.29±0.04
Cyclohexane, 1-methylene-3-(1-methylethyl)-, (R)-			0.26±0.07
Tricyclo[5.2.1.0(1,5)]dec-2-ene			0.31±0.05
Cyclodecene			0.55±0.04
Cyclohexadecane	0.38±0.09		0.45±0.0

Cycloundecene(Z)	0.32±0.08		
Cyclohexene, 3-(3-methyl-1-butenyl)-, (E)-	0.61±0.01		
Cyclopentene,1-heptyl-	0.25±0.04		
Total hydrocarbons	9.74±0.76	9.8±0.17	22.78±3.01
N-containing cyclic compounds			
1H-Indole, 3-methyl-	0.83±0.01	0.45±0.02	
1H-Indole, 4-(3-methyl-2-butenyl)-		0.36±0.07	
1H-Indole, 4-(3-methyl-2-butenyl)-	0.25±0.06		
Cyclooctylidene-(2-phenylaziridin-1-yl)amine	1.19±0.31	0.98±0.13	
Benzene, 1-isocyano-2-methyl-		0.55±0.08	
2,9-Dimethyldecahydroquinol-4-one		0.42±0.08	
Pyrimido[1,2-a]azepine, 2,3,4,6,7,8,9,10-octa-hydro-		1.66±0.11	
2,3-Dihydro-2,2,4-trimethyl-1,4-benzoxazep-ine		0.34±0.01	
Gephyrotoxin 207a	0.64±0.04	1.12±0.21	
1-Hydroxy-2,2,5,5-tetramethyl-2,5-dihydro-1H-imidazole-4-carbaldehyde methylhydrazone#		0.29±0.06	
Cyclo(leucylprolyl)	1.18±0.91	4.78±0.0	
3-(1-Azepanyl)-3-oxopropanenitrile	0.54±0.06		
Total N-containing cyclic compounds	4.63±0.62	10.95±0.17	
Others			
4,7-Ethano-1H-indene, octahydro-		0.63±0.04	
4-Pentylphenyl 4-(4-pentylcyclohexyl)cyclohexanecarboxylate		4.16±0.05	6.36±1.37
Benzoic acid, 2-[(1,2-dihydro-2-oxo-4-pyrimidinyl)amino]-		0.83±0.18	
9,10-Epoxy-4,8-ethanocyclohepta[c]furan-1,3-dione, hexahydro-, (3ar,4-trans,8-trans,8a-cis,9-.xi.,10.xi.)-			0.33±0.09
3-Methyl-3,3A,4,6A-tetrahydro-2(1H)-pentalen-one			0.40±0.02
3A,7A-Epoxy-1H-Inden-1-one, hexahydro-			0.72±0.13
Ethyl 3-amino-3-(1-naphthyl)propanoate		0.35±0.01	
1,7-octadien-3-amine, 2,7-dimethyl-	0.18±0.01		0.27±0.03
	0.18±0.01	5.97±0.44	8.08±0.96

Table S4. Composition of pyrolysates obtained from PS at 500 °C.

Compounds	Selectivity%
Alcohols = 13.68±0.22	
3-Penten-1-ol, (Z)-	0.82±0.00
1-Octanol	0.13±0.04
1-Pentanol, 2,2,4-trimethyl-	0.69±0.08
1-Decanol	0.46±0.04
1-Tridecanol	0.13±0.06
1,2-Cyclopentanediol, 3-methyl-	11.45±0.37
Aldehydes/ Ketones = 3.92±0.52	
3-Buten-2-one, 3-methyl-	0.25±0.01
2,3-Pentanedione	0.17±0.02
2-Cyclopenten-1-one	0.28±0.03
1,2-Cyclooctanedione	0.32±0.02
2-Cyclopenten-1-one, 3-methyl-	0.83±0.11
1,2-Cyclopentanedione, 3-methyl-	1.1±0.17
Cyclopentadecanone, 2-hydroxy-	0.97±0.45
Aromatic Compounds = 0.58±0.12	
Benzene	0.1±0.0
Benzene, ethenyl-	0.48±0.12
Carboxylic acid = 8.04±2.35	
Dodecanoic acid	0.5±0.12
Tetradecanoic acid	4.8±1.12
n-Hexadecanoic acid	2.74±1.10
Esters = 24.31±1.83	
2-Propenoic acid, methyl ester	0.35±0.02
Carbamic acid, methyl-, 3-methylphenyl ester	0.35±0.01
Phenylmethanediol dipropoate	0.38±0.10
Cyclopropanecarboxylic acid, nonyl ester	21.48±0.40
Pentanoic acid, heptadecyl ester	0.67±0.10
Furan derivatives = 2.1±0.34	
Furan, 2-methyl	1.1±0.01
Furan,2,5-dimethyl-	0.21±0.02
2-Ethenylfuran	0.11±0.01
2-Furancarboxaldehyde	0.68±0.33
Other oxygen containing compounds = 2.42±0.29	
1,4-Dioxadiene	0.49±0.07
Oxonane	1.35±0.36
cis-2,3-epoxyheptane	0.58±0.00
Anhydrosugars = 31.08±3.37	
2,3-Anhydro-d-mannosan	2.91±0.09
.beta.-d-Glucopyranoside, methyl	2.18±0.04
1,6-anhydro-.beta.-d-Glucopyranose (levoglucosan)	19.35±3.20

1,6-Anhydro-.beta.-d-Glucofuranose	6.65±0.25
Hydrocarbons = 2.69±0.14	
1,3-Butadiene	0.17±0.01
1,3-Cyclopentadiene	0.35±0.01
1,3-Cyclohexadiene	0.21±0.03
1-Octene	0.16±0.08
3-Hexene,E-	0.32±0.05
(2E,4E)-2,4-Octadiene #	0.32±0.13
Octane	0.13±0.00
1-Tridecene	0.15±0.01
Squalene	0.70±0.06
Cholesta-3,5-diene	0.18±0.04

Table S5. Composition of prolysates obtained from BSA and PS mixtures at 500 °C.

Compound	Selectivity%		
	BSA-to-PS mass ratio 2:1	BSA-to-PS mass ratio 1:1	BSA-to-PS mass ratio 1:2
Alcohols			
Cyclobutylmethanol	2.56±0.27	1.64±0.52	3.57±0.31
1-Butanol, 3-methyl-		0.39±0.02	
1-Undecanol		0.5±0.01	
1-Dodecanol		0.63±0.01	
2-Hexen-1-ol, 2-ethyl-			1.01±0.13
Oleyl Alcohol			0.41±0.05
Total alcohols	2.56±0.27	3.15±0.54	4.99±0.61
Carbonyl Compounds			
3-Buten-2-one, 3-methyl-		0.31±0.09	0.39±0.08
Cyclopentanone		0.19±0.02	
2-Butanone, 3,3-dimethyl-		1.46±0.01	0.45±0.23
2-Cyclopenten-1-one, 2-hydroxy-3-methyl-	0.83±0.25	2.35±0.12	1.39±0.41
2-Pentadecanone		0.33±0.05	
Decanal	0.51±0.18		
2-Acetylcyclopentanone	0.3±0.11		
Cyclohexanone	0.32±0.09		
Cyclohexanone, 2-ethyl-	0.17±0.02		
8-Hexadecenal, 14-methyl-, (Z)-			
Total carbonyl compounds	2.13±0.27	4.64±0.19	2.23±0.78
Amides/Nitriles			
Hexadecanamide		0.99±0.06	2.34±0.24
cis-11-Eicosenamide			0.81±0.09
9-Octadecenamide	2.99±0.06		0.38±0.02
13-Docosenamide, (Z)-			0.48±0.13
Decanamide-	0.93±0.03		
Hexadecanamide	1.86±0.23		
Pentanenitrile, 4-methyl-	0.47±0.03	0.38±0.04	0.13±0.02
Oleanitrile		0.45±0.02	
Benzenepropanenitrile	1.54±0.54		0.53±0.06
Oleanitrile			0.18±0.02
Benzene, 1-isocyano-2-methyl-	0.75±0.08		
Hexadecenitrile	0.7±0.07		
Oleanitrile	0.36±0.04		
Total amides/nitriles	9.60±0.23	1.82±0.08	4.85±0.43
Aromatic compounds			
Toluene	6.5±0.37	2.4±0.12	3.27±0.33
Benzene, ethyl-	0.7±0.29	0.53±0.1	0.3±0.13
Styrene	0.80±0.11	0.44±0.04	0.57±0.30

Benzene, 3-butenyl-		0.25±0.04	
Benzene, 1,1'-(1,2-ethanediyl)bis- 3-(2-Methyl-propenyl)-1H-indene	0.75±0.32 6.05±0.48		0.19±0.02
Phenol	0.77±0.08	0.67±0.01	0.5±0.03
Phenol, 4-methyl-		1.39±0.02	0.7±0.24
Phenol, 3-propyl-	1.18±0.16		
Total aromatic compounds	16.75±1.94	5.68±0.01	5.53±0.83
Carboxylic acids			
Octanoic Acid	8.53±1.41	4.2±0.17	4.64±1.11
Octadecanoic acid		0.9±0.03	2.66±0.34
Oleic acid		2.31±0.01	
n-Hexadecanoic acid		2.61±0.09	6.89±0.63
Tetradecanoic acid			0.82±0.09
18-Nonadecenoic acid			3.67±0.46
6-Octadecenoic acid, (Z)-	2.95±0.39		5.78±0.82
Total carboxylic acids	11.48±2.01	10.02±0.3	24.46±1.98
Esters			
1,2-Benzenedicarboxylic acid, mono(2- -ethylhexyl) ester		0.25±0.03	0.41±0.04
Carbonic acid, isobutyl octadecyl ester			0.23±0.03
Hexadecanoic acid, 1-methylethyl ester			0.6±0.04
Tetradecanoic acid, 2,3-dihydroxypropyl Ester			0.96±0.1
Octadecanoic acid, 2-propenyl ester			0.27±0.03
n-Propyl 9,12-hexadecadienoate			0.54±0.05
Benzoic acid, 2-ethylhexyl ester		3.19±0.02	
Total esters		3.44±0.03	3.01±0.21
Hydrocarbons			
2-Butene	0.99±0.14	0.75±0.03	0.66±0.20
1,3-Cyclopentadiene	0.59±0.03	0.35±0.04	0.56±0.35
1,3-Cyclohexadiene	0.29±0.08	0.2±0.03	
1-Hexene	0.29±0.09	0.37±0.05	0.36±0.11
1,11-Tridecadiene		0.74±0.31	
1-Tridecene	0.33±0.06		0.32±0.08
1-Tetradecene	0.38±0.19		0.69±0.07
1-Pentadecene			0.32±0.02
1-Hexadecene	0.37±0.09		
Cholesta-3,5-diene	1.51±0.57	1.01±0.01	3.24±0.47
1-Nonadecene		0.63±0.02	
1-Heptadecene	0.38±0.11		0.23±0.04
2-Hexadecene, 3,7,11,15-tetramethyl-, Cycloexene, 1-methyl-5-(1-methylethenyl)-			0.90±0.06 0.97±0.09
Delta-neocloven			0.25±0.01
Cyclopentadecane			0.43±0.03

6-Methyl-2-cyclohexene	0.36±0.06		
Total hydrocarbons	5.2±0.83	4.05±0.35	8.93±0.92
N-containing cyclic compounds			
1H-Indole		0.32±0.06	0.45±0.03
1H-Indole, 4-methyl-	1.16±0.32		0.63±0.06
1H-Pyrrole	0.7±0.14	0.72±0.03	0.68±0.07
Cyclo(leucylpropyl)	8.3±0.50	3.01±0.04	4.98±0.63
2-(Aminomethyl)-3,3,5-trimethylcyclopentan-amine#		5.8±1.08	
Gephyrotoxin 207a	1.44±0.66	3.38±0.03	0.53±0.06
1-Oxaspiro[4.5]dec-3-ene-4-carboxamide, 3-methyl-2-oxo-		4.58±0.51	3.11±0.32
3-Amino-7-methyl[1,2,4]triazolo[4,3-A]-pyrimidin-5-ol		1.81±0.21	
2,3-Dihydro-2,2,4-trimethyl-1,4-benzoxazepine		3.28±0.61	
1,3-Butanedione, 1-(1,3,5-trimethyl-1H-pyrazol-4-yl)-		1.31±0.03	
Carbaminic acid, N-(4-amino-6-ethylamino-pyrimidin-5-yl)-		1.05±0.10	
4-[2-(2-Amino-6-oxo-1-cyclohexen-1-YL)-2-oxoethyl]-2,6-piperidinedione#		1.85±0.23	
Pyrrolidine, 1-(cyanoacetyl)-			0.17±0.08
5-Methyl-1,3-diazaadamantan-6-one			0.47±0.05
2,7-Dimethyl-3,5,7,8-tetrahydro-4,6-pteridine-dione			0.42±0.02
Pyridine, 1-acetyl-1,2,3,4-tetrahydro-5-(2-piperidinyl)-			0.4±0.03
3,4-Pyridinediamine			
Indolizine	1.41±0.25		
1-Acryloylpyrrolidine	0.77±0.50		
2-Pyrazoline, 1,3,4-trimethyl-	0.59±0.04		
5-Methyl-1,3-diazaadamantan-6-one	0.52±0.13		
Acetone (4-hydroxy-6-methyl-2-pyrimidinyl)hydrazone#	1.04±0.11		
Acetamide, N-(2-diethylaminocarbonylthio)phenyl-	0.2±0.03		
1,5-Diazacyclononan-2,6-dione	4.1±0.29		
2-Acetylpyrazolidin-5-spirocyclopentane	3.38±0.25		
Pyrimido[1,2-a]azepine, 2,3,4,6,7,8,9,10-octahydro-	2.36±0.37		
7-Methyl-6-oxo-1,2,3,4-tetrahydro-6H-pyrimido[1,2-a]pyrimidine	0.34±0.03		
Total N-containing cyclic compounds	26.31±1.33	27.11±1.32	11.84±1.22
Anhydrosugars			
2,3-Anhydro-d-mannosan	6.46±0.24	6.98±0.73	10.12±1.83
D-Allose	5.51±0.51	7±0.81	
Methyl 2,3-isopropylidene- 4,6-dimethyl-		2.55±0.31	

alpha.-d-mannoside			
1,6-Anhydro-.beta.-D-glucofuranose			3.87±0.41
.alpha.-D-Glucopyranose, 4-O-.beta.-D-galactopyranosyl-			2.83±0.32
Total anhydrosugars	11.97±0.83	16.53±1.72	16.82±2.01
Others			
Furan, 2-methyl-	1.41±0.28	1.26±0.01	1.23±0.46
Furan, 2,5-dimethyl-	0.24±0.02	0.32±0.11	0.41±0.23
Cholesterol	0.66±0.36	0.4±0.03	
Pentane, 1,1'-oxybis-		6.63±1.36	
4-Propionyloxytetradecane			
1,6-Pentalenedione, hexahydro-			0.16±0.01
1-Methoxydecane			0.82±0.09
Cholest-5-ene, 3-methoxy-, (3.beta.)-			0.43±0.04
Cholesterol			1.72±0.12
1-Propene, 2-methoxy-	0.58±0.22		
	2.89±0.51	8.61±1.43	4.77±0.89

Table S6. Composition of pyrolysates obtained from SO and PS mixtures at 500 °C.

Compounds	Selectivity%		
	SO:PS (2:1)	SO:PS (1:1)	SO:PS (1:2)
Alcohols			
3-Buten-1-ol, 2-methyl-	1.88±0.19	1.72±0.04	1.65±0.11
3-Cyclohexene-1-methanol	0.18±0.02	0.34±0.14	
3-Decyn-2-ol	0.46±0.07		0.38±0.01
1-Dodecanol	0.26±0.0	0.27±0.03	0.21±0.01
n-Pentadecanol			0.38±0.13
1-Hexadecanol		0.74±0.11	
9,12-Octadecadien-1-ol, (Z,Z)-		0.32±0.01	
n-Pentadecanol	1.14±0.18	1.25±0.21	0.75±0.13
1-Undecanol			0.42±0.0
9,12-Octadecadien-1-ol, (Z,Z)-		0.29±0.06	
14-Methyl-8-hexadecyn-1-ol #	0.47±0.0	0.28±0.06	
4a(2H)-Naphthalenol, octahydro-, trans-	0.75±0.33	0.95±0.06	
Stigmast-5-en-3-, (3.beta.)-	0.41±0.04	0.38±0.0	0.29±0.02
Total alcohols	5.55±0.43	6.54±0.30	4.08±0.15
Carbonyl Compounds			
2-Cyclopenten-1-one, 2-hydroxy-3-methyl-			0.44±0.0
Bicyclo[3.2.1]-3-octen-6-on,4,7-dimethyl (endo)			0.22±0.06
5-Ethylidenehexahydro-2(1H)-pentalenone		0.23±0.01	
Bicyclo[3.3.0]octan-3-one, 7-ethylidene-	0.22±0.01		
Camphenone, 6-	0.57±0.16	0.57±0.16	0.26±0.03
6-Propenylbicyclo[3.1.0]hexan-2-one	0.66±0.08	0.73±0.02	0.48±0.04
Spiro[3.7]undeca-5,7-dien-1-one	0.26±0.01	0.3±0.0	0.32±0.04
9,17-Octadecadienal, (Z)-	0.41±0.00	0.54±0.04	0.64±0.42
cis-9-Hexadecenal	0.29±0.04	0.33±0.02	0.47±0.11
2-Hydroxycyclopentadecanone #	3.53±0.34	2.09±0.32	2.64±0.17
Cyclopentadecanone			0.21±0.04
11-Hexadecynal		0.49±0.01	
Total carbonyl compounds	5.94±0.04	5.28±0.18	5.68±0.23
Carboxylic acids			
2-Cyclopentene-1-undecanoic acid		0.25±0.05	
3-Decenoic acid		0.36±0.01	0.26±0.04
n-Decanoic acid	0.97±0.14	0.68±0.01	0.44±0.0
Tetradecanoic acid	2.44±0.42	0.63±0.06	1.67±0.05
Pentadecanoic acid	0.64±0.44	0.26±0.14	0.62±0.0
6-Octadecenoic acid, (Z)-		0.45±0.05	
n-Hexadecanoic acid	8.87±0.61	7.72±0.50	6.62±0.68
Octadecanoic acid	33.27±2.27	32.64±0.52	30.14±0.62
Linoleic acid	3.24±0.18	3.39±0.0	3.25±0.11

Oleic acid			3.58±0.13
Total carboxylic acids	49.43±0.12	46.38±1.19	44.91±2.81
Aromatic compounds			
Toulene	0.38±0.01		
Esters			
3-Dodecen-1-ol, acetate, (E)-	0.78±0.07	0.72±0.10	0.6±0.11
cis-7-Tetradecen-1-ol acetate		0.33±0.0	0.73±0.0
5-Dodecen-1-ol, acetate, (Z)-	0.75±0.01	0.91±0.09	0.64±0.01
Propyl oleate	5.50±0.55		6.14±0.28
Methyl stercolate	1.23±0.04		1.04±0.08
Allyl stearate	1.80±0.15	9.05±0.24	1.57±0.31
Hexadecanoic acid, 2-hydroxy-1,3-propanediyl ester	0.38±0.04		0.2±0.11
Methyl (9Z,12Z)-9,12-heptadecadienoate			0.22±0.0
Methyl 6,9-octadecadienoate		0.27±0.05	0.24±0.01
Stearic anhydride		0.27±0.03	0.23±0.04
Ethyl (9Z,12Z)-9,12-octadecadienoate #	0.25±0.01	0.69±0.09	0.42±0.04
9-Hexadecenoic acid, octadecyl ester, (Z)-	1.06±0.0		
Propyl linoleate			2.11±0.31
Total esters	11.43±0.06	12.24±0.12	14.14±1.35
Hydrocarbons			
1,3 Butadiene	0.77±0.08	0.59±0.28	0.65±0.04
1,3-Cyclopentadiene	1.09±0.18	0.88±0.02	1.12±0.01
Bicyclo[2.1.0]pentane	0.41±0.0	0.45±0.06	
1-Hexene	1.52±0.13	1.82±0.29	
1,3-Cyclohexadiene	0.42±0.06	0.66±0.25	
Bicyclo[3.1.0]hexane	0.28±0.08	0.44±0.13	0.17±0.07
1-Heptene	0.7±0.21	0.88±0.05	0.47±0.02
Cyclohexene, 3-methyl-	0.31±0.0	0.56±0.30	0.32±0.04
1-Octene	0.39±0.02	0.46±0.08	0.26±0.0
2-Octene, (Z)-	0.34±0.16	0.55±0.05	0.24±0.07
1,3-Octadiene	0.66±0.32	0.66±0.01	0.52±0.01
Nonene	0.31±0.03	0.34±0.01	0.25±0.03
Cyclooctene	1.05±0.07	1.06±0.06	0.82±0.1
1,3-Nonadiene, (E)-	0.26±0.04	0.29±0.03	0.18±0.02
Cyclopentene, 1-butyl-	0.18±0.0	0.19±0.0	0.15±0.01
1-Decene	0.31±0.05	0.36±0.04	0.2±0.03
Cyclohexane, 1-butenylidene-	0.35±0.25	0.23±0.04	
Bicyclo[4.2.0]oct-1-ene, 7-endo-ethenyl-	0.38±0.18	0.25±0.02	0.17±0.03
7-Methylbicyclo[4.2.0]octane	0.22±0.04		0.20±0.04
4-Dodecen-2-yne, (E)-		0.79±0.0	
1,7-Nonadiene, 4,8-dimethyl-	0.18±0.05		
1-Undecene	0.38±0.04	0.48±0.01	0.27±0.01
Undec-3-ene		0.54±0.02	

3-Nonen-5-yne- 4-ethyl-	0.55±0.04	0.57±0.02	
5,7-Dodecadiene, (Z,Z)	0.68±0.08	0.74±0.01	0.54±0.04
6-Butyl-1,4-cycloheptadiene	0.45±0.02	0.65±0.11	0.32±0.03
(3E,5Z)-1,3,5-Undecatriene	0.38±0.03	0.39±0.01	0.24±0.04
6-Butyl-1,4-cycloheptadiene	1.08±0.09	1.12±0.03	0.77±0.13
2,4-Dodecadiene, (E,Z)-	0.19±0.01	0.2±0.01	0.22±0.03
1-Tetradecene	0.76±0.01	0.69±0.03	0.56±0.02
Cyclopentene, 1-octyl-	0.19±0.04	0.21±0.01	0.19±0.06
Cyclohexene,3-hexyl-	0.34±0.05	0.34±0.04	
7-Pentadecyne	0.22±0.04	0.26±0.01	
1-Hexadecene	1.03±0.01	0.17±0.01	0.15±0.0
1-Pentadecyne		0.43±0.01	
Cyclohexene,1-hexyl-	0.58±0.0		
(8E,10Z)-1,8,10-Hexadecatriene #			0.39±0.0
Heptadecane	0.32±0.08	0.40±0.02	0.23±0.11
1-Heptadecyne	0.41±0.06		0.33±0.0
9-Octadecyne	0.28±0.07		0.36±0.16
Hexadecane, 2,6,10,14-tetramethyl-	0.69±0.0	0.86±0.0	0.1±0.0
6(E),8(E)-Heptadecadiene			0.75±0.07
9-Eicosyne			3.23±0.24
6,9-Heptadecadiene	0.18±0.0	0.25±0.08	
Z,Z,Z-4,6,9-Nonadecatriene	0.45±0.04	0.73±0.01	
Squalene			0.34±0.23
Cholesta-3,5-diene	0.96±0.50		0.29±0.09
Total hydrocarbons	20.25±1.93	20.59±1.27	15.0±0.73
Anhydrosugars			
2,3-Anhydro-D-galactosan			0.78±0.05
2,3-Anhydro-D-mannosan	0.91±0.1	1±0.14	1.56±0.20
1,6-anhydro-β-D-Glucopyranose (levoglucosan)	1.66±0.17	1.21±0.26	2.96±0.20
1,6-anhydro-β-D-Glucofuranose		1.74±0.23	4.42±1.1
Total anhydrosugars	2.57±0.3	3.95±0.36	9.72±0.72
Others			
9,10-Epoxy-4,8-ethanocyclohepta[c]furan-1,3-dione, hexahydro-, (3ar,4-trans,8-trans,8a-cis,9.xi.,10.xi.)-	0.22±0.06	0.26±0.01	0.17±0.0
Tetrahydrofuran-2-ol, 3,4-di[1-butenyl]-			0.78±0.08
Ethanol, 2-(9,12-octadecadienyloxy)-, (Z,Z)	0.68±0.03	0.70±0.08	0.46±0.09
	0.9±0.04	0.96±0.08	1.41±0.07

Table S7. Composition of pyrolysates obtained from ternary mixture of BSA, SO and PS at 500 °C.

Compounds	Selectivity%
Alcohols	
3-Penten-1-ol, (Z)-	3.42±0.17
3-Decyn-2-ol	0.39±0.24
9,12-Octadecadien-1-ol, (Z,Z)-	0.90±0.06
1-Hexadecanol	1.69±0.15
Total alcohols	6.4±0.01
Aldehydes/ketones	
3-Methyl-1,2-cyclopentanedione	0.63±0.06
6-Propenyl-bicyclo[3.1.0]hexan-2-one	0.78±0.13
Cyclohexanone, 2,3,3-trimethyl-2-(3-methylbutyl)-	1.18±0.05
Total carbonyl compounds	2.59±0.23
Amides/Nitriles	
Hexadecanamide	0.35±0.22
9-Octadecenamide, (Z)-	3.13±0.43
Octadecanamide	0.33±0.15
9-Octadecynenitrile	0.66±0.26
Oleanitrile	1.37±0.05
Tetradecanenitrile	0.41±0.07
Total amides/nitriles	6.25±1.11
Aromatic compounds	
Toluene	2.68±0.45
Carboxylic acids	
Octanoic acid	3.11±0.01
n-Decanoic acid	0.43±0.35
9-Octadecenoic acid (Z)-	1.43±0.03
Linoleic acid	0.41±0.08
Tetradecanoic acid	1.35±0.04
Pntadecanoic acid	0.25±0.01
n-Hexadecanoic acid	11.24±0.74
Total carboxylic acids	18.22±1.07
Esters	
5-Dodecen-1-ol, acetate, (Z)-	2.66±0.03
Methyl hexadec-9-enoate	1.46±0.08
i-Propyl 11,12-methylene-octadecanoate	3.75±0.24
iso-Propyl 9-.cis.,11-.trans.-octadecadienoate	0.84±0.07
Octadecanoic acid, 2-propenyl ester	0.43±0.06

9-Octadecenoic acid (Z)-, 2,3-dihydroxypropyl ester	2.63±0.06
Total esters	11.77±0.53
Hydrocarbons	
2-Butene	1.51±0.35
1-Hexene	2.16±0.21
1-Heptene	0.87±0.06
1-Octene	0.51±0.01
1,3-Octadiene	0.76±0.05
1,3-Nonadiene, (E)-	0.42±0.08
1-Undecene	0.46±0.04
2,4-Dodecadiene, (E,Z)-	0.44±0.04
1-Tridecene	0.3±0.04
1-Pentadecene	0.93±0.04
1-Pentadecyne	0.57±0.03
1,E-8,Z-10-Hexadecatriene	0.53±0.46
9-Octadecyne	0.21±0.04
9-Eicosyne	0.57±0.03
1-Heptadecene	0.47±0.01
3-Heptadecene, (Z)-	2.64±0.21
Heptadecane	1.72±0.20
1-Nonadecene	3.43±0.14
Squalene	1.84±0.18
Cholesta-3,5-diene	1.15±0.21
Cyclooctene	1.72±0.07
Cyclopentene, 1-butyl-	0.59±0.23
Cyclohexane, 1-butenylidene-	0.65±0.15
Bicyclo[4.2.0]oct-1-ene, 7-endo-ethenyl-	0.71±0.06
1,3-Cyclohexadiene, 5-ethyl-	0.84±0.08
6-Butyl-1,4-cycloheptadiene	1.77±0.11
Cyclododecyne	0.88±0.18
1,3-Cyclopentadiene	1.17±0.07
Cyclohexene, 1-decyl-	0.64±0.06
Total hydrocarbons	30.43±1.02
N-containing cyclic compounds	
1H-Pyrrole, 1-pentyl-	0.24±0.05
1,3-Diazadamantan-6-one, 5,7-dimethyl-	1.11±0.15
1-Butanamine, N-[1-(2-pyridinyl)ethylidene]-	0.51±0.02
Total N-containing cyclic compounds	1.86±0.19
Anhydrosugars	
2,3-anhydro-d-mannosan	1.69±0.22
1,6-anhydro-β-D-glucofuranose (levoglucosan)	2.89±0.33

Total anhydrosugars	4.58±0.10
Others	
9,10-Epoxy-4,8-ethanocyclohepta[c]furan-1,3-dione, hexahydro-, (3ar,4-trans,8-trans,8a-cis,9.xi.,10.xi.)-	0.24±0.09
3-carene-10-al	0.83±0.07
Ethanol, 2-(9,12-octadecadienyloxy)-, (Z,Z)-	0.73±0.07