

SUPPLEMENTARY MATERIAL

Biodiesel production

GENERAL INFORMATION			
Injection volume		1 µl	
Acquisition mode		Scan	
Low mass		35	
High mass		500	
OVEN			
Initial temp.	180°C	Maximum temp.	350°C
Initial time	20 min	Equilibration time	0,50 min
RAMPS:			
Rate	Final temp.		Final time
10	300°C		30 min
Run time		62 min	
FRONT INLET			
Mode	Split	Initial temp.	250°C
Split Ratio	200 at 1	Pressure	7,16 psi
Split flow	108,4 ml/min	Gas saver	Helium
Total flow	111,1 ml/min	Saver flow	20 ml/min
Saver time		2 min	
COLUMN			
Capillary column			
Model number		Agilent 19091S-433	
HP-5MS 5% Phenyl Methyl Siloxane			

Max temperature	325°C
Nominal length	30 m
Nominal diameter	250 µm
Nominal film thickness	0,25 µm
Mode	constant flow
Initial flow	0,5 ml/min
Nominal init. Pressure	7,16 psi
Average velocity	28 cm/sec

Table S1. GC device technical conditions and specifics

a) GC analysis of the biodiesel produced from virgin olive oil

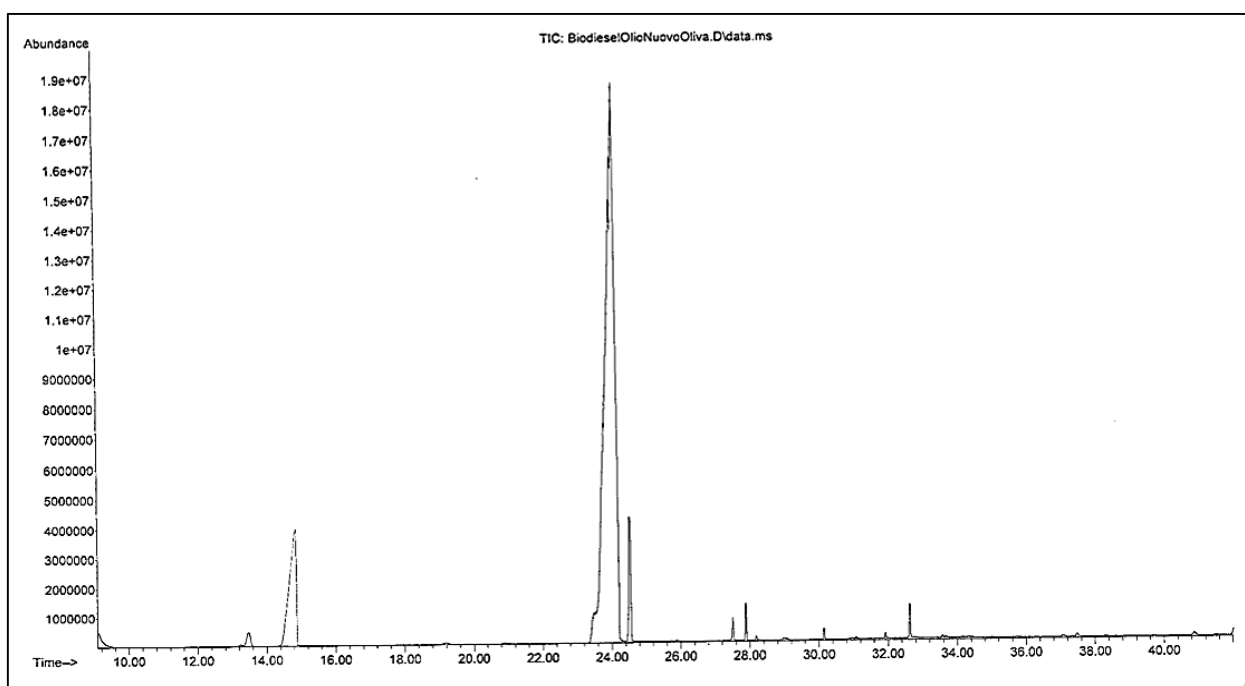


Figure S1: GC of biodiesel from virgin olive oil ($T = 60^{\circ}\text{C}$, molar TG:M = 1:5, cat = 0.6 w/w)

Peak #	R.T. min	First scan	Max scan	last scan	PK TY	peak height	corr. Area
1	13,239	388	402	408	M7	64557	4354051
2	13,470	409	424	439	M4	469793	37374667

3	14,844	504	557	612	M	4038103	551844171
4	19,187	949	976	1007	M5	62382	6460694
5	20,882	1126	1139	1161	M5	41202	3623895
6	24,170	1373	1457	1475	M	19813944	3609499355
7	24,532	1479	1491	1508	M2	4319468	167455908
8	27,509	1769	1779	1784	M	813411	19828972
9	27,885	1808	1815	1823	M	1285583	27101837
10	30,140	2027	2033	2041	M	40753	8404450
11	31,068	2119	2122	2126	M	67587	1326835
12	31,917	2200	2204	2211	M2	201447	4124582
13	32,626	2266	2272	2281	M	1235903	26484802

Table S2: GC data of biodiesel from virgin olive oil ($T = 60^{\circ}\text{C}$, molar TG:M= 1:5, cat =0.6 w/w)

corr. % max	% of total	Symbol	Saturation state	FAME common name
0,12%	0,097%	C16	Insaturated	Palmitoleic Acid (7)
1,04%	0,837%	C16	Insaturated	Palmitoleic Acid (11)
15,29%	12,351%	C16	Saturate	Palmitic Acid
corr. % max	% of total	Symbol	Saturation state	FAME common name
0,18%	0,145%	C17	Insaturated	Margaroleic Acid
0,10%	0,081%	C17	Saturate	Margaric Acid
100%	80,788%	C18	Insaturated	Oleic Acid
4,64%	3,748%	C18	Saturate	Stearic Acid
0,55%	0,444%	C20	Insaturated	Eicosenoic Acid
0,75%	0,607%	C20	Saturate	Arachidic Acid
0,23%	0,188%	C22	Saturate	Behenic Acid
0,04%	0,030%	C23	Saturate	Tricosanoic Acid
0,11%	0,092%	C24	Saturate	Tetracosanoic Acid
0,73%	0,593%	-	-	Squalene

Table S1: FAME in biodiesel produced from virgin olive oil ($T = 60^{\circ}\text{C}$, molar TG:M= 1:5, cat =0.6 w/w)

b) GC analysis of the biodiesel produced from rapeseed oil

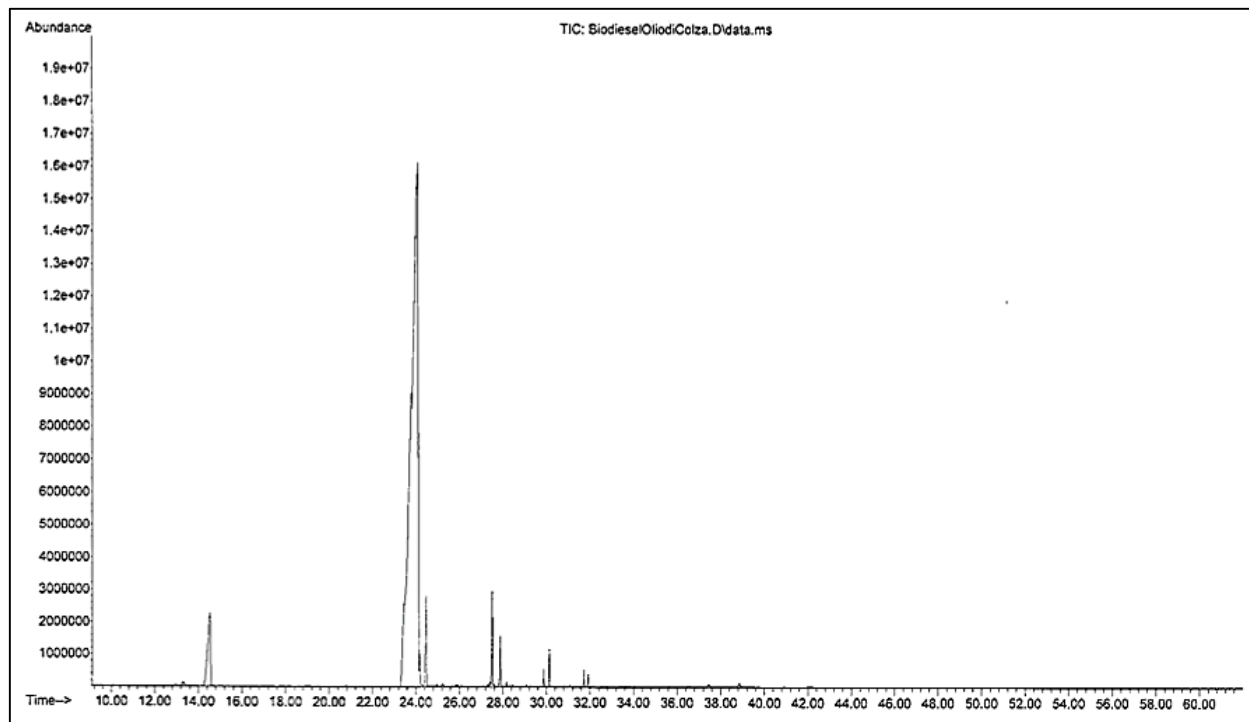


Figure S2: GC of biodiesel from virgin rapeseed oil ($T = 60^{\circ}\text{C}$, molar TG:M= 1:5, cat =0.6 w/w)

Peak #	R.T. min	First scan	Max scan	last scan	PK TY	peak height	corr. Area
1	9,539	33	45	54	M10	10504	596446
2	10,054	87	94	107	M3	16880	878581
3	12,722	338	352	362	M6	28101	1911749
4	12,936	363	372	381	M3	54191	3748029
5	13,308	394	408	432	M5	132804	9725178
6	13,771	439	453	468	M5	10912	981874
Peak #	R.T. min	First scan	Max scan	last scan	PK TY	peak height	corr. Area
7	14,525	491	526	551	M2	2289357	209144536
8	19,015	933	959	978	M2	25228	2795734
9	20,785	1110	1130	1152	M5	22565	2166984
10	23,574	1369	1399	1399	M2	3399838	349281298
11	24,088	1400	1449	1454	M5	17147287	3,224E+09
12	24,177	1455	1457	1461	M	1033313	24241706

13	24,462	1473	1485	1492	M	2872343	88205815
14	24,962	1527	1533	1539	M2	75595	2348466
15	25,232	1547	1559	1568	M3	82194	4153501
16	25,847	1613	1618	1622	M2	77274	1994550
17	25,926	1623	1626	1635	M2	51421	1513776
18	27,397	1764	1768	1771	M2	139691	3115707
19	27,508	1771	1779	1783	M	3102847	72356671
20	27,585	1783	1786	1790	M2	78805	1699013
21	27,798	1803	1807	1809	M2	94647	1961205
22	27,871	1809	1814	1821	M	1625690	35257299
23	29,079	1924	1930	1935	M	58779	1352236
24	29,875	2001	2007	2012	M	550277	10802996
25	30,134	2025	2032	2040	M2	1182848	23517557
26	31,718	2179	2185	2197	M	538715	11832743
27	31,913	2200	2204	2211	M2	414222	8851181
28	36,51	2637	2647	2655	M7	39201	1656130
29	37,444	2727	2737	2756	M4	83949	4424143
30	38,847	2860	2873	2899	M3	124559	6671295

Table S2: GC data of biodiesel from virgin rapeseed oil ($T = 60^{\circ}\text{C}$, molar TG:M= 1:5, cat =0.6 w/w)

corr. % max	% of total	Symbol	Saturation state	FAME common name
0,02%	0,02%	C9	insaturated (6)	nonanoic acid
0,03%	0,02%	C15	-	pentadecanoic acid
0,06%	0,05%	C15	di-insaturated (7-10)	esadecanoic acid
0,12%	0,09%	C15	tri-insaturated (7-10-13)	esadecanoic acid
0,30%	0,24%	C16	insaturated (9)	palmitoleic acid
0,03%	0,02%	C16	insaturated (7)	palmitoleic acid
6,49%	5,09%	C16	saturated	palmitic acid
0,09%	0,07%	C17	insaturated	margaroleic acid
0,07%	0,05%	C17	saturated	margaric acid
10,83%	8,50%	C18	di-insaturated (9-12)	linoleic acid
100,00%	78,42%	C18	insaturated	oleic acid
0,75%	0,59%	C18	tri-insaturated (9-12-15)	linoleic acid
corr. % max	% of total	Symbol	Saturation state	FAME common name
2,74%	2,15%	C18	saturated	stearic acid
0,07%	0,06%	C18	tri-insaturated	linoleic acid

0,13%	0,10%	C18	tri-unsaturated	linoleic acid
0,06%	0,05%	C19	unsaturated (9)	nonadecanoic acid
0,05%	0,04%	C19	unsaturated (10)	nonadecanoic acid
0,10%	0,08%	C20	di-unsaturated	eicosanoic acid
2,24%	1,76%	C20	unsaturated	eicosanoic acid
0,05%	0,04%	C20	unsaturated	eicosanoic acid
0,06%	0,05%	C18	hydroxylated	9-hydroxy octadenoic acid
1,09%	0,86%	C20	saturated	arachidic acid
0,04%	0,03%	C21	saturated	margaroleic acid
0,34%	0,26%	C22	mono-unsaturated	margaroleic acid
0,73%	0,57%	C22	saturated	behenic acid
0,37%	0,29%	C24	unsaturated	myristic acid
0,27%	0,22%	C24	unsaturated	myristic acid
0,05%	0,04%	C28	-	crinosterol
0,14%	0,11%	C28	-	methyl cholesterol
0,21%	0,16%	C29	-	stigmastenol

Table S3: FAMES in biodiesel produced from virgin rapeseed oil ($T=60^{\circ}\text{C}$, molar TG:M= 1:5, cat =0.6 w/w)

c) GC analysis of the biodiesel produced from sunflower oil

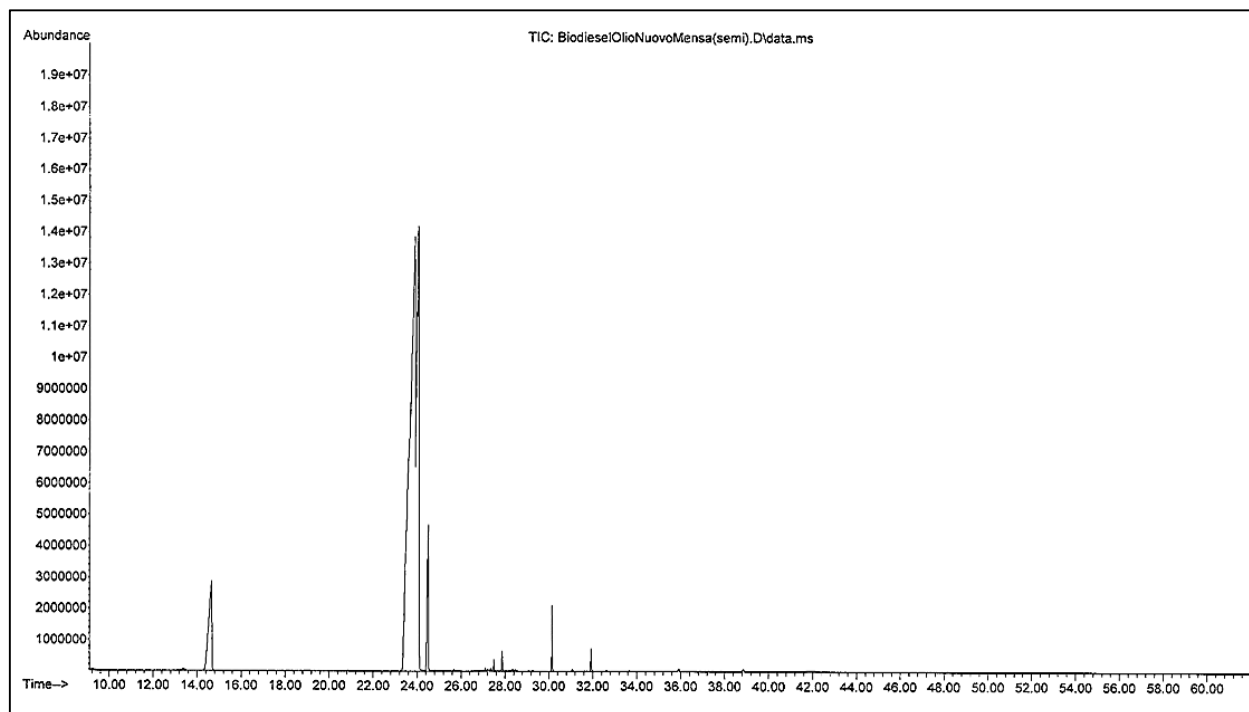


Figure S3: GC of biodiesel from virgin sunflower oil ($T=60^{\circ}\text{C}$, molar TG:M= 1:5, cat =0.6 w/w)

Peak #	R.T. min	First scan	Max scan	last scan	PK TY	peak height	corr. Area
1	10,12	92	101	110	M4	13298	638346
2	13,165	381	395	404	M4	10720	767027
3	13,381	405	415	435	M6	65702	4783440
4	14,651	498	538	584	M	2878311	290515516
5	19,098	955	967	989	M	10351	1164455
6	20,828	1117	1134	1155	M5	17152	1544964
7	23,883	1374	1429	1431	M	13926908	2,322E+09
8	24,053	1432	1445	1455	M2	14213977	1,082E+09
9	24,504	1474	1489	1504	M	4813421	178414604
10	24,87	1520	1524	1529	M4	20985	762628
11	25,668	1595	1601	1610	M2	65946	2300104
12	27,092	1734	1738	1743	M	121345	2940092
13	27,495	1770	1777	1782	M	391499	9481985
14	27,873	1804	1814	1821	M	657118	15147347
15	30,144	2028	2033	2047	M	2118595	42591756
16	31,066	2115	2122	2132	M	80807	1930162
17	31,917	2199	2204	2218	M2	733704	14234943
18	32,619	2268	2272	2278	M	32127	800261
19	33,663	2368	2373	2378	M4	19007	551146
20	35,193	2580	2590	2607	M	88688	323800
21	38,852	2861	2873	2894	M4	75853	4212311

Table S4: GC data of biodiesel from virgin sunflower oil ($T = 60^{\circ}\text{C}$, molar TG:M= 1:5, cat =0.6 w/w)

corr. % max	% of total	Symbol	Saturation state	FAME common name
0,03%	0,02%	C15	saturated	pentadecanoic acid
0,03%	0,02%	C16	saturated	palmitoleic acid
0,21%	0,12%	C16	insaturated (9)	palmitoleic acid
12,51%	7,30%	C16	saturated	palmitic acid
0,05%	0,03%	C17	insaturated	margaroleic acid
0,07%	0,04%	C17	saturated	margaric acid
100,00%	58,34%	C18	di-insaturated (9-12)	linoleic acid
46,59%	27,18%	C18	insaturated	oleic acid
7,68%	4,48%	C18	saturated	stearic acid
0,03%	0,02%	C18	di-insaturated	linoleic acid
0,10%	0,06%	C18	di-insaturated (6-9)	linoleic acid

0,13%	0,07%	C18	di-insaturated (8-11)	linoleic acid
0,41%	0,24%	C20	insaturated	eicosanoic acid
0,65%	0,38%	C20	saturated	eicosanoic acid
1,83%	1,07%	C22	saturated	behenic acid
corr. % max	% of total	Symbol	Saturation state	FAME common name
0,06%	0,05%	C23	saturated	tricosanoic acid
0,61%	0,36%	C24	saturated	tetracosanoic acid
0,03%	0,02%	-	-	squalene
0,02%	0,01%	C26	saturated	2-esacosanoic acid
0,14%	0,08%	-	-	vitamin E
0,18%	0,16%	C29		stigmasterol

Table S5: FAMES in biodiesel produced from virgin sunflower oil ($T = 60^{\circ}\text{C}$, molar $\text{TG:M} = 1:5$, $\text{cat} = 0.6 \text{ w/w}$)

d) GC analysis of the biodiesel produced from waste sunflower oil

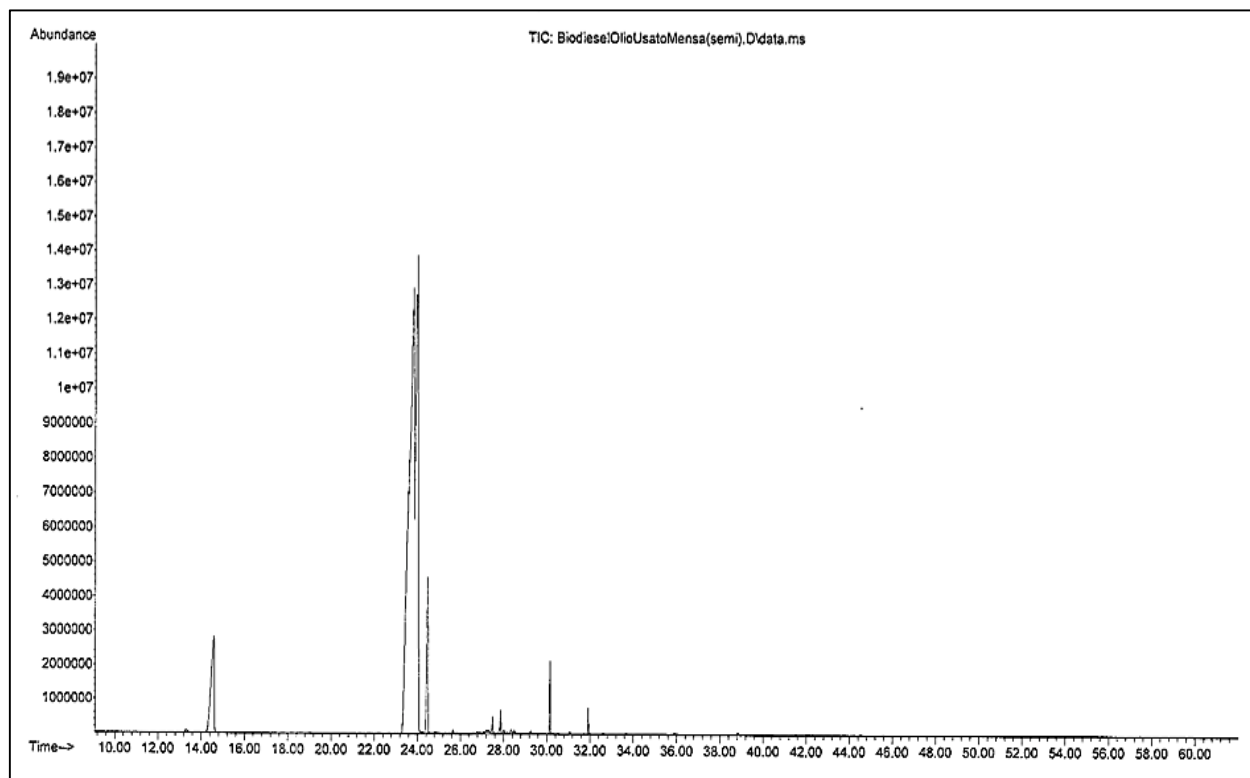


Figure S4: GC of biodiesel from waste sunflower oil ($T = 60^{\circ}\text{C}$, molar $\text{TG:M} = 1:5$, $\text{cat} = 1.2 \text{ w/w repl. 1/3}$)

Peak #	R.T. min	First scan	Max scan	last scan	PK TY	peak height	corr. Area
1	9,542	34	45	53	M	5696	351349

2	10,059	86	95	106	M4	12366	659381
3	13,101	376	388	397	M4	12909	959800
4	13,307	397	408	429	M5	78545	5735825
5	14,577	492	531	559	M2	2847521	294749543
6	19,025	944	960	982	M2	12514	1415760
7	20,779	1110	1129	1152	M5	18112	1739406
8	23,844	1372	1425	1428	M2	12940525	2,23E+09
9	24,026	1428	1443	1449	M	147721612	1,116E+09
Peak #	R.T. min	First scan	Max scan	last scan	PK TY	peak height	corr. Area
10	24,479	1473	1486	1495	M	4603143	178856327
11	24,787	1510	1516	1519	M3	34118	1037623
12	24,852	1519	1522	1527	M3	33262	1068108
13	24,962	1528	1533	1538	M5	26039	945126
14	25,656	1593	1600	1608	M2	132794	4668628
15	26,78	1705	1708	1711	M3	66121	1828709
16	27,2	1742	1749	1752	M6	97235	3647098
17	27,489	1773	1777	1781	M	513379	12002655
18	27,801	1803	1807	1810	M3	174402	4564988
19	27,866	1810	1813	1818	M	694724	14934646
20	30,141	2026	2033	2047	M	2223813	43206239
21	31,064	2117	2122	2127	M	82428	1807788
22	31,915	2199	2204	2213	M	781572	15214711
23	32,615	2269	2271	2275	M	24357	517598
24	33,664	2368	2373	2376	M2	19837	516925
25	35,934	2583	2592	2601	M2	47359	3059294
26	38,844	2863	2873	2885	M5	56625	3202608

Table S6: GC data of biodiesel from waste sunflower oil ($T = 60^{\circ}\text{C}$, molar TG:M= 1:5, cat =1.2 w/w, repl. 1/3)

corr. % max	% of total	Symbol	Saturation state	FAME common name
0,02%	0,01%	C9	insaturated	nonanoic acid
0,03%	0,17%	C15	saturated	pentadecanoic acid
0,04%	0,02%	C16	insaturated (7)	palmitoleic acid
0,26%	0,15%	C16	insaturated (9)	palmitoleic acid
13,22%	7,48%	C16	saturated	palmitic acid
0,06%	0,04%	C17	insaturated	margaroleic acid
0,08%	0,44%	C17	saturated	margaric acid

100,00%	56,56%	C18	di-insaturated (9-12)	linoleic acid
50,00%	28,31%	C18	insaturated	oleic acid
8,02%	4,54%	C18	saturated	straric acid
0,05%	0,03%	C18	di-insaturated (6-9)	linoleic acid
0,05%	0,03%	C18	di-insaturated (11-14)	linoleic acid
0,04%	0,02%	C18	di-insaturated(8-11)	linoleic acid
0,21%	0,12%	C18	di-insaturated (7-10)	linoleic acid
0,08%	0,05%	C18	tri-insaturated	linoleic acid
0,16%	0,09%	C18	di-insaturated	eicosanoic acid
0,54%	0,30%	C20	insaturated	9-hydroxy octadenoic acid
0,20%	0,12%	C18	hydroxylated	eicosanoic acid
0,67%	0,38%	C20	saturated	behenic acid
1,94%	1,10%	C22	saturated	tricosanoic acid
corr. % max	% of total	Symbol	Saturation state	FAME common name
0,08%	0,05%	C23	saturated	tetracosanoic acid
0,68%	0,39%	C24	saturated	tetracosanoic acid
0,02%	0,01%	-	-	squalene
0,20%	0,01%	C26	saturated	2-esacosanoic acid
0,14%	0,08%	-	-	vitamin E
0,14%	0,08%	C29	-	stigmasterol

Table S7: FAMES in biodiesel produced from waste sunflower oil ($T = 60^{\circ}\text{C}$, molar $\text{TG:M} = 1:5$, $\text{cat} = 1.2 \text{ w/w}$, repl. 1/3)

Microalgae fed with wastewater rich in glycerol

Figure S5: Calibration curves at a) 430 nm; b) 480 nm; c) 650 nm; d) 680 nm; e) overall, at steps of 10 nm

Figure S6: Estimated growth curves at different wavelengths (each own calibration curve); a) 430 nm, b) 480 nm, c) 650 nm, d) 680) nm

Figure S7: Estimated growth curves at different wavelengths (using the overall calibration curve); a) 430 nm, b) 480 nm, c) 650 nm, d) 680) nm e) global spectrum

Figure S8: Online measured parameters during microalgae cultivation.