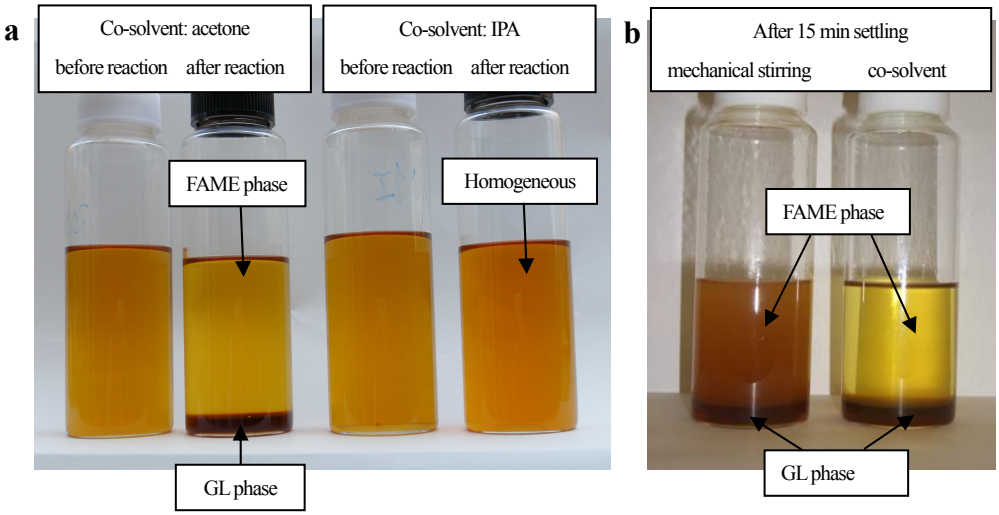
SUPPLEMENTARY DATA

Analytical methods:

Reactants and products were determined by HPLC (Shimadzu LC-6A HPLC with refractive index detector: RID 10A). The column used was a Cadenza CD-C18. The mobile phase was an acetone/acetonitrile mixture: 70/30 v/v, with a flow rate of 0.4 mL/min. Standard chemicals triolein, diolein, monoolein and methyl oleate were used for the quantification of TG, DG, MG, and FAME. 2 mL samples were taken from the reaction vessel and neutralized by 1 mL of 5% H_3PO_4 aqueous solution to stop the reactions. About 100 mg of sample was diluted in 10 mL of the mobile phase solute with hexadecane as inner standard (2mg/mL), and 20 μL of sample was injected into the HPLC.

Methanol concentrations in solvents and reaction mixtures were determined by gas chromatography using a thermal conductivity detector. The column was a stainless steel column (2mm φ × 2 m) packed with Gasukuropack54 (60/80) mesh and the temperatures of the column and the injection were 110 °C and 250 °C, respectively. The carrier gas was He, with a flow rate of 40 mL min^{-1}.

The specific gravities of FAME solution were determined by measuring 10 mL of FAME in co-solvents (FAME:solvent = 2:1, v/v) at 20 °C. The specific viscosities of FAME solution (FAME:solvent = 2:1, v/v) at 20 °C were measured with an Ostwald viscometer and shown as the ratio to that of water at 20 °C.



Photograph S1 a) Formation of FAME and GL in acetone or in IPA co-solvent. Before reaction, the solution consisted of waste cooking oil, methanol and acetone or IPA, where the molar ratio of methanol to oil was 4.5:1. After reaction with KOH catalyst in acetone, FAME and GL were formed, where the FAME phase included acetone and the GL phase included methanol and KOH. On the other hand, after reaction with KOH catalyst in IPA, FAME and GL were formed homogeneously so that the FAME phase included methanol, KOH, IPA and GL. **b)** Separation of FAME and GL after 15 min settling of the reaction products produced by the mechanical stirring method or by the acetone co-solvent method. In the case of the conventional mechanical stirring method, the FAME phase was turbid, because a number of small droplets of GL existed in the FAME phase. Therefore, the separation of FAME and GL was complete after more than 300 min settling.

Table S1. Relative viscosity and density of mixtures of FAME with different solvents at 15 °C

Mixture*	Density (g cm^{-3})	Relative viscosity
Water	1.00	1.00
FAME + dimethyl ether	0.8202	1.69
FAME + acetonitrile	0.8311	2.02
FAME + acetone	0.8395	1.83
FAME + isopropanol	0.8456	4.13
FAME + tetrahydrofuran	0.8797	2.63
FAME (from waste cooking oil)	0.8797	0.885

Notes: * The mixing ratio of the FAME/solvent was 2/1 by weight.

Table S2. Properties of biodiesel produced from Cat fish oil at pilot plant scale with a capacity of 300 L/ batch under the condition: molar ratio of methanol to oil, 4.5:1; acetone to oil, 25 wt.%; KOH catalyst to oil, 0.5 wt.%; temperature, 25 ^{o}C.

Test parameter	Unit	Result	JIS K2390		Test method
			Min.	Max.	
Total ester	mass%	97.5	96.5	−	EN 14103
MG	mass%	0.40	−	0.80	EN 14105
DG	mass%	0.10	−	0.20	EN 14105
TG	mass%	<0.01	−	0.20	EN 14105
Free GL	mass%	<0.01	−	0.02	EN 14105
Total GL	mass%	0.21	−	0.25	EN 14105
Acid value	mgKOH g^{-1}	0.08	−	0.5	JIS K2501
Iodine value	g I_2/ 100 g	67.0	−	120	JIS K0070
Methanol	mass%	<0.1	−	0.20	EN 14110
Water content	mg kg^{-1}	380	−	500	JIS K2275

Notes: this table gives the certified quality of our biodiesel product analyzed by an authorized analysis organization, just for demonstrating its quality.
JIS: Japanese Industrial Standard for biodiesel and testing method.
EN: European Standard for testing method.

Table S3. Chemical and physical properties of some oils used in this study.

Properties	Unit	Oils		
		Canola	Waste cooking	Cat fish
Density	g cm^{-3}	0.915	0.918	0.916
Acid value	mg KOH/g oil	0.80	1.07	4.23
Oleic acid (C18:1)*	wt.%	61.42	47.2	48.00
Linoleic acid (C18:2)*	wt.%	22.34	31.42	12.00
Linolenic acid (C18:3)*	wt.%	11.47	10.21	–
Stearic acid (C18:0)*	wt.%	1.15	2.77	7.10
Palmitic acid (C16:0)*	wt.%	2.51	7.42	27.40
Myristic acid (C14:0)*	wt.%	–	–	3.50
Other fatty acids	wt.%	1.11	1.15	2.00