Electronic Supplementary Material (ESI) for Green Chemistry.

Efficient algal lipid extraction via green bioelectro-Fenton process and its conversion into biofuel and bioelectricity with concurrent wastewater treatment in photosynthetic microbial fuel cell

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Supplementary file:

Table S1: Configuration of all BEF-PMFCs fabricated during experimentation

PMFC designation	Catalyst coating
BEF-PMFC-T1	Cathode surface coated with Ni-Pd/C catalyst
BEF-PMFC-T2	Cathode surface coated with CoFe-AC catalyst
BEF-PMFC-T3	Cathode surface coated with AC-Fe catalyst
PMFC-C	Bare carbon felt; Without having any catalyst

Table S2: A comparative results of different advanced oxidation process-assisted algal cell disruption with yield

Advanced oxidation	Optimal condition	Microalgal strain	Algal lipid recovery	Reference
Fenton	$FeSO_4$ conc.: 0.025 mol/L; RT: 4 min; H_2O_2 conc.: 0.29 mol/L	*Chlorella vulgaris*	Highest lipid yield of 17.4% w/w; 95 % of lipid extraction efficiency	[1]
Fenton	0.79% of H_2O_2; pH 3.4; Molar ratio of H_2O_2 to $FeCl_3$ =170:1; RT: 20 min	*C. vulgaris*	Maximum extraction efficiency for lipids was 77.4%	[2]
Fenton and Lewis acid reaction	$FeCl_3$ concentration: 2 mM; RT: 90 min; Reaction temperature: 87 °C	*Nannochloropsis salina*	Maximum lipid extraction yield of 213 mg/g biomass; highest extraction yield of 19.3%	[3]
Electro-Fenton	H_2O_2 concentration: 0.03 mol/L; RT: 40 min; Current density: 0.32 mA/cm^2	*Chlorella homosphaera*	Maximum lipid yield of 18.29%; highest lipid extraction efficiency of 90.66%	[4]
Electro Fenton	OH• generation: 1.27 mM; $FeSO_4$ conc.: 9.1 mM; Current density:16.4 mA/cm^2; RT: 37 min	*Nannochloropsis oceanica* IMET1	Maximum lipid extraction yield of 155 mg; lipid extraction efficiency increased from 40% to 87.5%	[5]
Photocatalytic reaction	Photoanode: N-doped TiO_2; Cathode: palladium; Reaction time: 4 h; H_2O_2 conc.: 3% v/v	*C. vulgaris*	96% of lipid-extraction efficiency; FAME yield of 55%	[6]
Pulsed electric field	Electric field strength: 2.7 kV/cm; Electrode: stainless steel; Electrode distance: 15 mm	*C. vulgaris*	Highest lipid extraction yield of 22% w/w of biomass	[7]
Anodic oxidation	H_2O_2 conc.: 8 ± 2 µM; Applied current: 500 mA Reaction time: 2 h	*Scenedesmus dimorphus*	Highest extraction yield 23.4 g-lipid/g-of biomass	[8]
Bio-electro Fenton	H_2O_2 conc.: 125 mg/L, pH 3; RT: 6 h; BEF-Catalyst: Ni-Pd/C	Mixed algal consortium	Highest 39.2 % w/w of lipid yield, 95% of lipid extraction efficiency; maximum power density of 74.5 mW/m^2	Present investigation

Note: FAME: fatty acid methyl ester; Conc.: concentration, RT: retention time; BEF: bioelectro-Fenton

Table S3: Performance efficiency of all three bioelectro-Fenton assisted PMFC setups

Parameter	BEF-PMFC-T1	BEF-PMFC-T2	BEF-PMFC-T3	PMFC-C
OCV (mV)	658.5 ± 52.3	620± 44.2	595± 41.5	550.8 ± 35.6
OV (mV)	162.8 ± 10.6	132 ± 10.1	122 ± 10.2	81.6 ± 9.6
COD removal (%)	89.2 ± 6.5	85.5 ± 6.8	81.2 ± 6.2	72.3 ± 6.1
CE (%)	24.7 ± 1.3	22.3 ± 1.2	20.5 ± 1.2	14.0 ± 1.0
Power density (mW/m^2)	74.5	56.8	48.6	25.8
Current density (mA/m^2)	625.2	468.7	360.5	292.4
Internal resistance (Ω)	66.5	78.3	90.4	140.0

Note: OCV: open circuit voltage; OV: operating voltage; COD: chemical oxygen demand; CE: coulombic efficiency; BEF: Bio-electro Fenton; PMFC: photosynthetic microbial fuel cell; BEF-PMFC-T1: cathode coated with Ni-Pd/C; BEF-PMFC-T2: cathode coated with CoFe-AC; BEF-PMFC- T3: cathode coated with AC-Fe; PMFC-C: control reactor

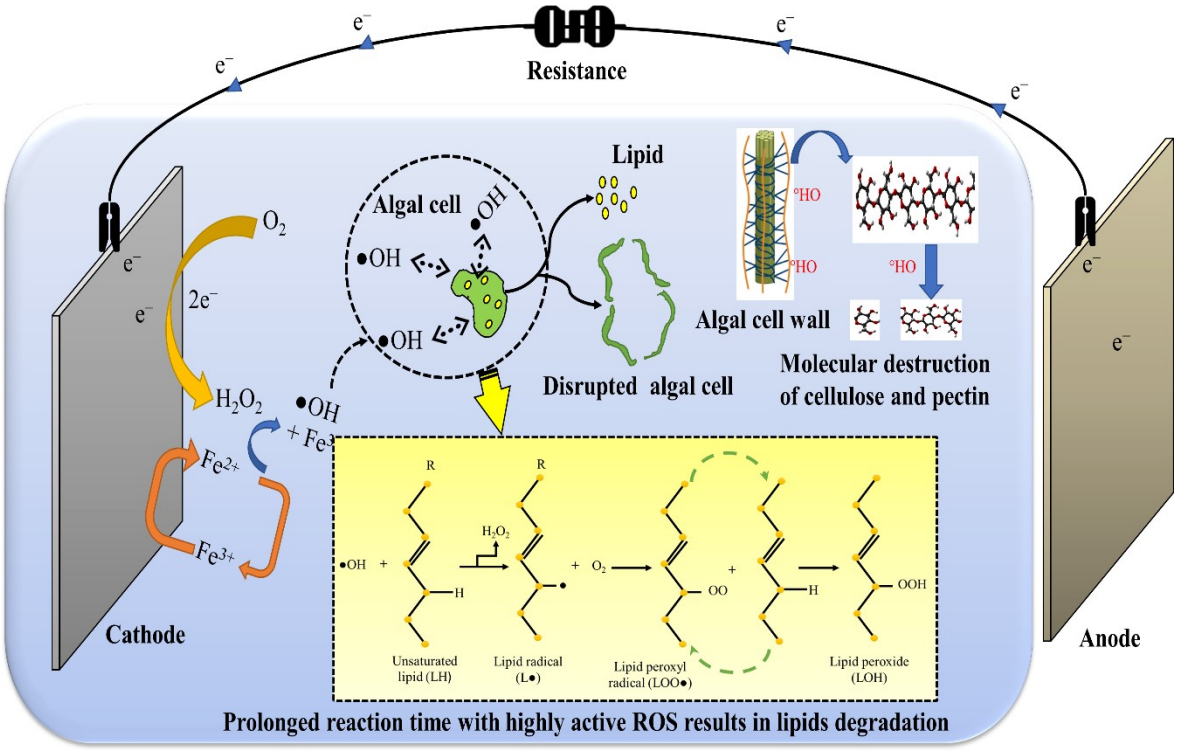

Fig. S1: Reaction in the cathodic chamber of BEF-PMFC along with algal cell disruption mechanism in the presence of highly reactive oxygen species

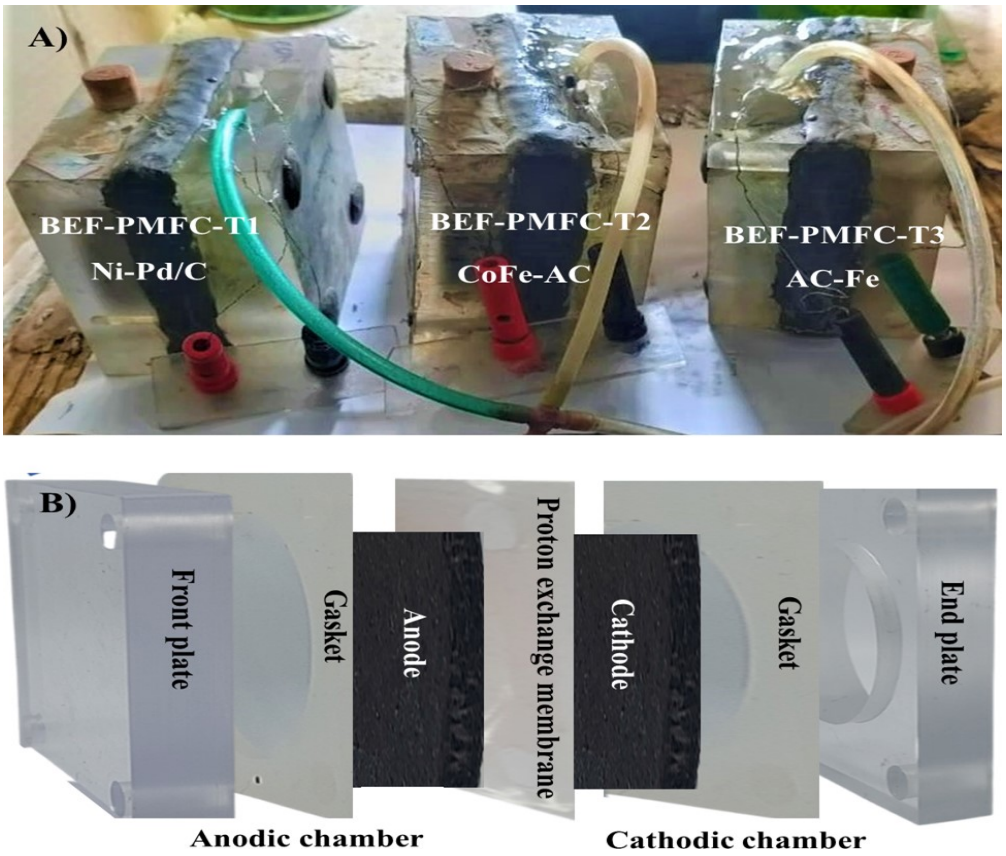

Fig. S2: (A) Three double chamber Fenton-assisted PMFC named as BEF-PMFC-T1 (cathode coated with Ni-Pd/C catalyst, BEF-PMFC-T2 (cathode coated with CoFe-AC catalyst) and BEF-PMFC-T3 (cathode coated with AC-Fe catalyst); (B) Schematic diagram of bioelectro-Fenton-assisted PMFC fabricated with acryl sheet

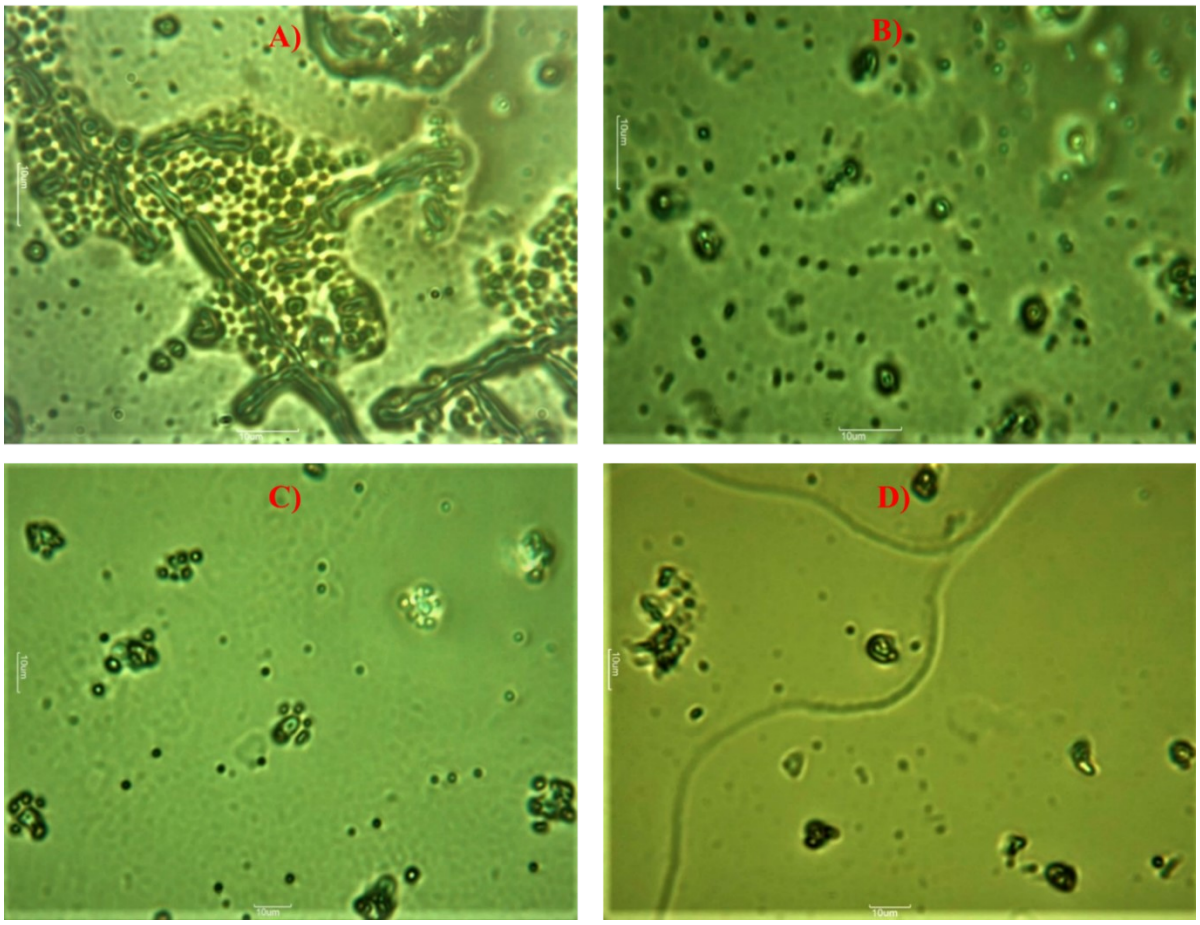

Fig. S3: Microscopic image of algal cell disruption under a magnification of 100X resolution: (A) Intact algal cell; (B) AC-Fe; (C) CoFe-AC; (D) Ni-Pd/C catalyst-assisted disrupted algal cell

Reference

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