

# INDEX

## A

- Acidogenic anaerobic digestion ..... 359–361  
 Adsorption chromatography ..... 384, 385  
 Agro-waste ..... 105, 117  
 Algae ..... v, 2, 9, 11, 15,  
 18, 26, 33, 53, 65, 68, 69, 74, 77, 78, 80, 103,  
 104, 131, 132, 183, 185, 187, 189, 191, 196,  
 198, 201, 202, 204, 205, 236, 250, 272, 285,  
 286, 295, 330, 333, 334, 337, 344, 345,  
 347–349, 351–353  
 Alkaline hydrogen peroxide pretreatment ..... 176–178  
 Alkaline pretreatment ..... 174, 176,  
 178, 180, 252  
 American Society for Testing and Materials  
 (ASTM) ..... 122, 188, 189,  
 216, 285–288, 295–304, 307, 308  
 Anaerobic digestion ..... 26, 76, 357–365  
 Analytical methods ..... 19–25, 151,  
 152, 155, 234, 253, 306, 318, 338  
 Aqueous phase ..... 95,  
 186–188, 192, 305, 365  
 Arachidonic acid production ..... 239–241  
 Assay  
 gravimetric ..... 34, 37, 41, 42  
 LC-MS based ..... 49  
 Nile red ..... 34–36, 41

## B

- Bacteria ..... v, 2, 3, 6, 10,  
 11, 14, 15, 18, 25, 26, 33, 53, 68, 78, 91, 93–95,  
 103, 104, 141, 147, 183, 185, 215–227, 327,  
 331, 333, 334, 336, 349, 351, 357–360, 371,  
 377, 395, 401, 405  
 Bacterial lipid ..... 91–101, 395  
 Biochemical conversion of biofuels ..... 76, 77  
 Biochemical oxygen demand (BOD) ..... 332,  
 341, 406, 408, 410, 411, 416  
 Bioconversion ..... 61, 65,  
 104, 252, 253  
 Biocrude ..... 183–192  
 Biodiesel ..... 33, 51, 91,  
 104, 131, 152, 183, 197, 250, 285, 312, 370, 405  
 Biodiesel production ..... 5, 51, 52,  
 54, 56, 69, 70, 74, 77, 78, 158, 200, 220, 255,  
 312, 313, 315, 370, 406

- Biodiesel properties ..... 223, 303, 306, 414  
 Biofuel ..... v, 3, 26,  
 51–54, 65, 67, 69–81, 104, 121, 131, 149, 158,  
 161, 174, 183–192, 195, 196, 205, 249–281,  
 300, 302, 304, 307, 311, 316, 327, 371, 380  
 Biomass ..... 8, 38, 52, 91, 104, 121, 131, 158, 173,  
 183, 201, 232, 249, 286, 313, 327, 370, 396, 410  
 Biosurfactant ..... 3, 384  
 Biosynthesis of microbial lipids ..... 15–19  
 Bligh and Dyer ..... 132, 153,  
 154, 319, 379, 396, 398–400, 416

## C

- Capillary electrophoresis ..... 21  
 Cell culture media  
 basal media ..... 58, 362, 363  
 carbon nitrogen ratio ..... 46, 372  
 for *Rhodococcus* ..... 103–118  
 for *Yarrowia* ..... 103–118  
 Cell dry weight (CDW) ..... 34, 103,  
 104, 109, 113, 114, 117, 312, 313, 412  
 Cellulosic sugars ..... 174  
 Chemical oxygen demand (COD) ..... 328,  
 332, 337, 341, 358, 360, 361, 363, 364, 406  
 Chromatography  
 gas chromatography ..... 20, 24,  
 35, 92, 96–98, 114, 115, 117, 118, 125, 126,  
 152, 154–157, 164, 185, 190, 191, 234,  
 254–256, 258, 270, 272, 274–276, 286, 288,  
 290–294, 301, 304–306, 319, 320, 364  
 high performance liquid chromatography ..... 20,  
 117, 125, 254, 260, 262, 270, 280, 318, 320  
 super fluid chromatography ..... 21  
 thin layer chromatography ..... 20, 389,  
 390, 406, 413  
 Classification ..... 3, 4  
 CRISPR-Cas9 ..... 162, 164, 165, 167  
 CRISPR RNA (crRNA) ..... 162  
 Cultivation ..... v, 9–11, 13,  
 52, 53, 56–63, 65–70, 77, 78, 80, 111–113, 131,  
 197, 229, 232–244, 250, 253, 255, 259, 261,  
 264–271, 316, 328, 332–334, 337, 341, 349,  
 384, 405–408, 412, 416  
 Cyanobacteria ..... 6, 10, 25,  
 69, 91–95, 100, 286, 295, 336, 395, 397, 401

**D**

Dichloromethane (DCM) ..... 151, 185–187, 190, 192  
 Distillation ..... 151, 192, 287, 297, 308, 329  
 DNA cassettes ..... 166  
 DNA repair ..... 167  
 Docosahexaenoic acid (DHA) production ..... 68,  
 235–238

**E**

Economics ..... 9, 14, 65,  
 69, 80, 250, 280, 327, 360, 376  
 Eicosapentaenoic acid (EPA) production ..... 229, 230,  
 232–234  
 Energy balance ..... 74, 76, 190, 205  
 Energy recovery (ER) ..... 76, 189, 190  
 Environmental impacts ..... 195, 202, 298  
 Enzyme hydrolysis ..... 26, 372  
 Ethyl-esters ..... 285, 312

**F**

Fatty acid composition ..... 8, 9, 56,  
 57, 100, 217, 243, 250, 254, 255, 272, 319, 414  
 Fatty acid methyl ester (FAME) ..... 9, 20,  
 24, 70, 91, 92, 94–96, 99, 104, 105, 114, 115,  
 122, 125, 126, 133, 152, 156, 222, 226, 234,  
 254–256, 258, 275, 286–295, 297, 300,  
 302–307, 312, 314, 319, 320, 406, 414, 415  
 Fatty acid methyl ester (FAME) profile ..... 9, 92,  
 116, 217, 286, 292, 304  
 Fermentation ..... 14, 52,  
 59–62, 65, 76, 78, 79, 144, 183, 229, 230, 232,  
 236, 238–241, 249, 259, 357, 358, 362,  
 371–373, 390  
 Free fatty acids (FFA) ..... 6, 10,  
 18, 21, 70, 74, 139, 151, 154, 156, 157, 285,  
 300, 304, 307, 376  
 Fuel properties ..... 216, 217,  
 222, 291, 293, 294, 307, 414, 415  
 Fuel quality ..... v, 215–227,  
 286, 291, 292, 294–304, 307  
 Fuel quality parameters ..... 215–227, 285–308  
 Fungi ..... v, 2, 6, 9,  
 11, 15–17, 33, 51–81, 103, 183, 185, 229, 233,  
 238, 250, 285, 333, 336, 371, 372, 374, 405

**G**

Gamma-linolenic acid (GLA) production ..... 241–244  
 Gas chromatography ..... 156  
 Genetic engineering  
 to alter lipid profile in microbes ..... 141–149  
 elongation and desaturation of fatty  
 acid synthesis ..... 148

fatty acid degradation ..... 148, 149  
 fatty acid elongation ..... 147  
 for NADPH supply ..... 146, 238  
 for pyruvate-acetaldehyde-acetate pathway ..... 144  
 for pyruvate-citrate-acetyl-CoA pathway ..... 145  
 regulation of lipid catabolic pathways ..... 147  
 regulation of malonyl-CoA synthesis ..... 146  
 TAG synthesis ..... 16, 143, 147, 312, 316, 317  
 Genome editing ..... 162, 164, 165, 170  
 Gravimetric ..... 121, 151, 187, 254  
 Growth kinetic parameters ..... 92  
 Growth medium  
 for bacteria ..... 93  
 for cyanobacteria ..... 93  
 GMY media (nitrogen limiting) ..... 318  
 for yeast strain ..... 408  
 Guide RNA (gRNA) ..... 162, 165, 166, 168–170

**H**

High throughput ..... 34, 270  
 Homology-directed repair (HDR) ..... 166–168, 171  
 Hydrolysate ..... 8, 56, 59, 60,  
 65, 69, 78, 174, 176, 179, 249–281, 314, 371  
 Hydrothermal liquefaction (HTL) ..... 183, 185–192

**I**

Integrated approach ..... 21

**L**

Life cycle assessment (LCA) ..... 195–202, 204, 205  
 Lignocellulose ..... 61, 65  
 Lipidomics ..... 13, 20, 25, 49  
 Lipids  
 accumulation ..... 6, 8, 9,  
 11, 15, 16, 18, 47, 53, 54, 57, 59, 60, 67, 80, 103,  
 131, 141, 142, 146, 148, 237, 238, 243, 250,  
 253, 254, 262–265, 267, 269, 278–280,  
 313–315, 317, 371–373, 376, 397  
 assay ..... 255  
 analytical methods ..... 19–25  
 chromatography separation ..... 21  
 classification ..... 3, 4  
 extraction ..... 15, 69, 72–74,  
 78, 79, 91–93, 95, 132–137, 151, 295, 319, 371,  
 376, 379–380, 396, 409, 412  
 extraction from bacteria ..... 95  
 extraction from cyanobacteria ..... 95  
 extraction using chemical methods ..... 377–380  
 extraction using mechanical methods ..... 378  
 extraction using physical methods ..... 376–377  
 from eukaryotic microalgae ..... 9  
 from fungi ..... v, 9, 15  
 machinery involved ..... 147

from plants ..... v, 11, 14  
 production ..... v, 2, 9, 14,  
 15, 51–81, 91–101, 103–118, 131, 141–149,  
 237, 244, 250, 251, 253, 254, 258, 264–271,  
 277, 279, 311–320, 371–376, 380, 395, 406, 407  
 profile alternation ..... 148  
 from prokaryotic bacteria ..... 6, 8  
 from thraustochytrids ..... 2  
 from yeast ..... 379  
 Liquid chromatography-mass spectrometry  
 (LC-MS) ..... 25, 35  
 Liquid-liquid extraction ..... 360, 363

**M**

Methods  
 downstream processing of microbial  
 lipids ..... 69–79  
 extraction of lipids ..... 69–73, 286  
 to improve lipid production ..... 56–59  
 Microalgae ..... 6, 9, 15,  
 25, 52, 67–69, 72, 74, 77–79, 91, 121, 125, 127,  
 131, 132, 141, 157, 158, 185, 189, 229, 230,  
 232, 233, 291, 292, 327, 328, 331, 333, 334,  
 336, 342, 344, 348, 351, 371, 405  
 Microbial lipids ..... v, 1–26,  
 51–54, 56, 59, 60, 65, 67, 69–81, 92, 117, 141,  
 142, 173, 195–213, 285–308, 371–376  
 Microbial oil production ..... 70  
 Microcultures ..... 251, 268, 269  
 Mono-alkyl esters ..... 285, 295, 306  
 Multi-criterion decision analysis (MCDA) ..... 217, 220

**N**

Nile red dye ..... 396  
 Nile red staining ..... 47, 396–398,  
 400, 401, 408, 410, 415  
 Nonhomologous end joining (NHEJ) ..... 166–168

**O**

Oleaginous  
 biomass ..... 121–128, 185  
 fungi ..... 9, 11, 16,  
 17, 52–58, 60, 61, 65–67, 78, 80, 238  
 microbes ..... 33, 91,  
 142, 145, 146, 173–181, 371–372, 405  
 microorganisms ..... v, 2, 11,  
 15, 52–54, 57, 59, 60, 65, 69, 76–81, 145, 238,  
 312, 327–348, 370, 405, 412, 415  
 organisms ..... v, 3, 7,  
 10–14, 26, 105, 142, 183–192, 333–334,  
 369–380, 405–417  
 yeasts ..... 8, 11, 15–18,  
 33–49, 53, 55, 56, 60, 103, 104, 250–253, 255,

267, 272, 279, 281, 311–320, 328, 351, 370,  
 372, 405–407, 409, 410, 413, 416  
 Optical density ..... 47, 109,  
 112, 116, 253, 318, 342, 344, 348, 352  
 Orcinol ..... 386, 390  
 Organic residues ..... 357–365  
 Oxidative stability (OS) ..... 216,  
 219, 286, 287, 298, 303, 414

**P**

Plant cell wall deconstruction ..... 173  
 Pretreatment  
 ammonia fiber expansion (AFEX) ..... 252  
 dilute acid ..... 253, 254,  
 258–260, 266, 277  
 PROMETHEE–GAIA ..... 215–227  
*Pseudomonas aeruginosa* ..... 3, 4,  
 384–386, 390, 392

**Q**

Qualitative and quantitative measurement ..... 396

**R**

Red yeasts ..... 55, 313  
 Remediation ..... 332, 334, 383  
 Rhamnolipids ..... 3, 4, 384–392  
 production ..... 385, 386, 390, 391  
 recovery ..... 384, 385, 387, 388  
*Rhodococcus* ..... 6, 8,  
 10, 18, 24, 53, 103–118, 142  
*Rhodospiridium diobovatum* ..... 313, 314, 317

**S**

Screen ..... v, 33–49,  
 52, 54–56, 68, 81, 169, 170, 176, 177, 217,  
 249–281, 302, 313–314, 333, 342–343, 364,  
 396, 406, 407, 409, 410  
 Silica gel ..... 133, 139,  
 385, 388, 392  
 Single cell oils (SCO) ..... 51, 53,  
 55, 80, 103–105, 312, 371  
 Solid residue (SR) ..... 76, 186–188, 190, 192  
 Solvent extraction methods  
 using bead beating ..... 155  
 using sonication ..... 154  
 supercritical CO<sub>2</sub> ..... 155  
 Solvents ..... 1, 3, 4,  
 19, 21, 25, 37, 38, 42, 47–49, 72, 74, 92–95, 98,  
 99, 121, 122, 126, 133, 136, 139, 151–158, 161,  
 185–187, 190, 192, 254, 255, 272, 274, 280,  
 287, 288, 292, 299–301, 305, 307, 346, 362,  
 363, 365, 377, 379, 384, 389, 391, 392, 396,  
 399–402, 413, 416

- Spectroscopy  
  gas chromatography-mass spectrometry ..... 20,  
    24, 35, 95, 96, 114, 115, 117, 185, 190, 217,  
    406, 414  
  liquid chromatography-mass spectrometry ..... 21,  
    24, 25, 35, 37, 38, 42–43, 46  
  mass spectrometry ..... 19–21,  
    23–26, 190, 191, 255  
  matrix assisted laser desorption/ionization  
    mass spectrometry ..... 24  
  nuclear magnetic resonance ..... 21, 23, 117  
  Raman and Infrared ..... 22, 23, 26  
  short gun lipidomics using infusion and  
    tandem mass spectrometry ..... 25
- Strain preservation  
  for *Rhodococcus* ..... 110, 111  
  for *Yarrowia* ..... 111
- Strain selection ..... 330
- Subcritical water hydrolysis ..... 157
- Surfactants ..... v, 2, 161, 259, 383
- Sustainability ..... 65, 69, 195
- T**
- Thermochemical conversion of biofuels ..... 74–76
- Thermogravimetry (TG) ..... 121–128
- Thin-layer chromatography (TLC) ..... 20,  
  132, 133, 136, 138, 386, 389, 390, 406, 409,  
  413, 415, 416
- Trans-activating CRISPR RNA (tracrRNA) ..... 162
- Transesterification ..... 3, 18,  
  52, 55, 70–75, 78, 91, 92, 94, 96, 110, 114–116,  
  122, 125, 126, 152, 183, 202, 215, 250, 255,  
  274–276, 285, 286, 292, 300, 301, 303, 304,  
  307, 312, 319, 406, 409, 413, 414
- Triacylglycerol (TAG) ..... 3, 4, 6,  
  8, 10, 11, 15, 16, 18–20, 22, 34, 52, 53, 55, 57,  
  70, 92, 131, 133, 139, 142, 143, 147, 250,  
  312–317, 406, 410
- Triglycerides ..... 1, 4, 20,  
  23, 70, 76, 121–125, 151, 152, 154–157, 161,  
  215, 274, 276, 285, 289, 290, 304, 306, 307, 401
- V**
- Volatile fatty acids (VFA) ..... v, 76, 300, 357–365
- W**
- Wastewater ..... 15, 26,  
  60, 64, 65, 316, 327–351, 358–362, 364, 380,  
  406, 407, 409, 410, 416
- Y**
- Yarrowia* ..... 54, 55, 57, 63,  
  103–118, 231, 251, 255, 257, 265, 313, 314, 406
- Yeasts ..... 2, 33, 52, 93, 103,  
  141, 158, 163, 183, 229, 249, 285, 312, 327,  
  370, 385, 405