Environmental Technology and Innovation • Volume 30 • May 2023 • Article number 103123

Document type
Article

Source type
Journal

ISSN
23521864

DOI
10.1016/j.eti.2023.103123

Publisher
Elsevier B.V.

Original language
English

View less

The production of microbial biodiesel from cellulose-derived fungal lipid via consolidated bioprocessing

Hasni, Mohd Haffizi[a]; Ahmad, Farah Binti[a, b] ; Athoillah, Ahdyat Zain[a, c]

Save all to author list

[a] Department of Chemical Engineering & Sustainability, Faculty of Engineering, International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia

[b] Department of Mechanical Engineering, University of Malaya, Kuala Lumpur, 50603, Malaysia

[c] Department of Transdisciplinary Science and Engineering, School of Environment and Society, Tokyo Institute of Technology, Japan

Abstract

Lignocellulosic biomass from agro-industrial residues can potentially be used as carbon-rich carbohydrate feedstock for the conversion via oleaginous microorganisms into lipids, and subsequently microbial biodiesel. As multiple processes are required to conventionally convert lignocellulosic

biomass into lipids, from the hydrolysis of carbohydrate into simple sugars for the fermentation, it is not economically favourable. Consolidated bioprocessing (CBP) combines the saccharification and fermentation of lignocellulosic biomass into a single processing step. As such, this study aims to screen multiple oleaginous fungi to identify the most effective lipid producers in CBP systems, followed by optimization study. Three different fungi (Aspergillus niger, Aspergillus oryzae, and Rhizopus sp.) were screened by the co-cultivation of monosaccharides. Rhizopus sp. yielded the highest lipid content. The response surface methodology (RSM) was used to optimize lipid production by Rhizopus sp. from cellulose in CBP systems. The CBP system with carbon concentration of 0.8% (w/v), temperature of 32 °C, and carbon to nitrogen ratio (C/N) of 99.5, yielded the optimum lipid content (51.8%). The lipid from Rhizopus sp. was then converted into biodiesel, that comprised 56.0% of saturated fatty acids. Fuel properties analysis indicated that microbial biodiesel from lipids of Rhizopus sp. is a promising alternative to diesel fuel. © 2023 The Authors

Author keywords

Biodiesel; Biofuel; Consolidated bioprocess; Lignocellulosic biomass; Lipid; Oleaginous fungi

Indexed keywords

SciVal Topics

Funding details

References (44)

View in search results format >

All

Export Print E-mail Save to PDF Create bibliography

1 Ahmad, F.B., Zhang, Z., Doherty, W.O.S., O'Hara, I.M.

A multi-criteria analysis approach for ranking and selection of microorganisms for the production of oils for biodiesel production (Open Access)

(2015) *Bioresource Technology*, 190, pp. 264-273. Cited 45 times.
www.elsevier.com/locate/biortech
doi: 10.1016/j.biortech.2015.04.083

View at Publisher

2 Ahmad, F.B., Zhang, Z., Doherty, W.O.S., O'Hara, I.M.

Evaluation of oil production from oil palm empty fruit bunch by oleaginous micro-organisms (Open Access)

(2016) *Biofuels, Bioproducts and Biorefining*, 10 (4), pp. 378-392. Cited 27 times.
http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1932-1031
doi: 10.1002/bbb.1645

View at Publisher

3 Ahmad, F.B., Zhang, Z., Doherty, W., O'Hara, I.M.

Microbial oil production from sugarcane bagasse hydrolysates by oleaginous yeast and filamentous fungi

(2016) *38th Annual Conference Australian Society of Sugar Cane Technologists, ASSCT 2016*, pp. 251-259. Cited 9 times.

4 Ahmad, F.B., Zhang, Z., Doherty, W.O.S., O'Hara, I.M.

Optimising extraction of microalgal oil using accelerated solvent extraction by response surface methodology

(2018) *Journal of Engineering Science and Technology*, 13 (4), pp. 964-976. Cited 4 times.
http://jestec.taylors.edu.my/Vol%2013%20issue%204%20April%202018/13_4_9.pdf

5 Ahmad, F.B., Zhang, Z., Doherty, W.O.S., O'Hara, I.M.

The outlook of the production of advanced fuels and chemicals from integrated oil palm biomass biorefinery (Open Access)

(2019) *Renewable and Sustainable Energy Reviews*, 109, pp. 386-411. Cited 107 times.
https://www.journals.elsevier.com/renewable-and-sustainable-energy-reviews
doi: 10.1016/j.rser.2019.04.009

View at Publisher

6 Ahmad, F.B., Zhang, Z., Doherty, W.O.S., O'Hara, I.M.

The prospect of microbial oil production and applications from oil palm biomass (Open Access)

(2019) *Biochemical Engineering Journal*, 143, pp. 9-23. Cited 29 times.
www.elsevier.com/locate/bej
doi: 10.1016/j.bej.2018.12.003

View at Publisher

7 Ahmad, F.B., Zhang, Z., Doherty, W.O.S., Te'o, V.S.J., O'Hara, I.M.

Improved microbial oil production from oil palm empty fruit bunch by Mucor plumbeus (Open Access)

(2017) *Fuel*, 194, pp. 180-187. Cited 19 times.
http://www.journals.elsevier.com/fuel/
doi: 10.1016/j.fuel.2017.01.013

View at Publisher

8 Altaie, M.A.H., Janius, R.B., Rashid, U., Taufiq Yap, Y.H., Yunus, R., Zakaria, R.

Cold flow and fuel properties of methyl oleate and palm-oil methyl ester blends (Open Access)

(2015) *Fuel*, 160, pp. 238-244. Cited 36 times.
http://www.journals.elsevier.com/fuel/
doi: 10.1016/j.fuel.2015.07.084

View at Publisher

9 Asghar, A., Raman, A.A.A., Daud, W.M.A.W.

A Comparison of Central Composite Design and Taguchi Method for Optimizing Fenton Process (Open Access)

(2014) *Scientific World Journal*, 2014, art. no. 869120. Cited 137 times.
http://www.hindawi.com/journals/tswj/
doi: 10.1155/2014/869120

View at Publisher

10 Assawah, S.M., El Gadidy, M.S., Saad-Allah, K.M., El-Badry, A.S.
Evaluation of the oleaginous Rhizopus stolonifer capability for lipid production using agricultural wastes as cheap nutritional sources for biodiesel production
(2020) *Egypt. J. Exp. Biol. (Bot.)*, 16 (1), pp. 35-48. Cited 2 times.

11 Athoillah, A.Z., Ahmad, F.B.
Biodiesel Production from Bioremediation of Palm Oil Mill Effluent via Oleaginous Fungi (Open Access)

(2022) *Clean - Soil, Air, Water*, 50 (4), art. no. 2200025.
http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1863-0669
doi: 10.1002/clen.202200025

View at Publisher

12 Bordignon, S.E., da Silva Delabona, P., Lima, D., Perrone, O., da Silva Souza, M.G., Santos, A.S., da Cruz Pradella, J.G., (...), da Silva, R.
Induction of fungal cellulolytic enzymes using sugarcane bagasse and xylose-rich liquor as substrates

(2020) *Brazilian Journal of Chemical Engineering*, 37 (3), pp. 443-450. Cited 2 times.
https://link.springer.com/journal/43153
doi: 10.1007/s43153-020-00055-5

View at Publisher

13 Breil, C., Abert Vian, M., Zemb, T., Kunz, W., Chemat, F.
"Bligh and Dyer" and Folch methods for solid–liquid–liquid extraction of lipids from microorganisms. Comprehension of solvatation mechanisms and towards substitution with alternative solvents (Open Access)

(2017) *International Journal of Molecular Sciences*, 18 (4), art. no. 708. Cited 136 times.
http://www.mdpi.com/1422-0067/18/4/708/pdf
doi: 10.3390/ijms18040708

View at Publisher

14 Chandra, M.S., Viswanath, B., Reddy, B.R.
Optimization of extraction of β-endoglucanase from the fermented bran of Aspergillus niger (Open Access)

(2010) *Indian Journal of Microbiology*, 50 (1 SUPPL.), pp. S122-S126. Cited 13 times.
doi: 10.1007/s12088-010-0020-2

View at Publisher

15 Chen, H., Hao, G., Wang, L., Wang, H., Gu, Z., Liu, L., Zhang, H., (...), Chen, Y.Q.
Identification of a critical determinant that enables efficient fatty acid synthesis in oleaginous fungi (Open Access)

(2015) *Scientific Reports*, 5, art. no. 11247. Cited 78 times.
www.nature.com/srep/index.html
doi: 10.1038/srep11247

View at Publisher

16 Chuengcharoenphanich, N., Watsuntorn, W., Qi, W., Wang, Z., Hu, Y., Chulalaksananukul, W.

The potential of biodiesel production from grasses in Thailand through consolidated bioprocessing using a cellulolytic oleaginous yeast, Cyberlindnera rhodanensis CU-CV7

(2023) *Energy*, Part B 263, art. no. 125759. Cited 3 times.
https://www.journals.elsevier.com/energy
doi: 10.1016/j.energy.2022.125759

View at Publisher

17 Cohen, J.

A power primer

(1992) *Psychological Bulletin*, 112 (1), pp. 155-159. Cited 28887 times.
www.apa.org/journals/bul.html
doi: 10.1037/0033-2909.112.1.155

View at Publisher

18 Demirbas, A.

Characterization of biodiesel fuels

(2009) *Energy Sources, Part A: Recovery, Utilization and Environmental Effects*, 31 (11), pp. 889-896. Cited 34 times.
doi: 10.1080/15567030801904202

View at Publisher

19 Giakoumis, E.G., Sarakatsanis, C.K.

A comparative assessment of biodiesel cetane number predictive correlations based on fatty acid composition (Open Access)

(2019) *Energies*, 12 (3), art. no. 422. Cited 56 times.
https://www.mdpi.com/1996-1073/12/3
doi: 10.3390/en12030422

View at Publisher

20 Hasunuma, T., Kondo, A.

Consolidated bioprocessing and simultaneous saccharification and fermentation of lignocellulose to ethanol with thermotolerant yeast strains

(2012) *Process Biochemistry*, 47 (9), pp. 1287-1294. Cited 132 times.
doi: 10.1016/j.procbio.2012.05.004

View at Publisher

21 Hazmi, A.T., Ahmad, F.B., Athoillah, A.Z., Jameel, A.T.

Comparison of ex-situ and in-situ transesterification for the production of microbial biodiesel (Open Access)

(2021) *Bulletin of Chemical Reaction Engineering & Catalysis*, 16 (4), pp. 733-743. Cited 3 times.
https://ejournal2.undip.ac.id/index.php/bcrec/article/view/11044/6198
doi: 10.9767/bcrec.16.4.11044.733-743

View at Publisher

22 Intasit, R., Cheirsilp, B., Louhasakul, Y., Boonsawang, P.
Consolidated bioprocesses for efficient bioconversion of palm biomass wastes into biodiesel feedstocks by oleaginous fungi and yeasts

(2020) *Bioresource Technology*, 315, art. no. 123893. Cited 18 times.
www.elsevier.com/locate/biortech
doi: 10.1016/j.biortech.2020.123893

View at Publisher

23 Jin, M., Slininger, P.J., Dien, B.S., Waghmode, S., Moser, B.R., Orjuela, A., Sousa, L.D.C., (...), Balan, V.
Microbial lipid-based lignocellulosic biorefinery: Feasibility and challenges

(2015) *Trends in Biotechnology*, 33 (1), pp. 43-54. Cited 222 times.
www.elsevier.com/locate/tibtech
doi: 10.1016/j.tibtech.2014.11.005

View at Publisher

24 Kamariah, L., Azmi, A., Rosmawati, A., Ching, M.W., Azlina, M., Sivapragasam, A., Tan, C., (...), Lai, O.
Physico-chemical and quality characteristics of virgin coconut oil–a Malaysian survey
(2008) *J. Trop. Agric. Fd. Sc.*, 36 (2). Cited 17 times.

25 Linger, J.G., Darzins, A.
Consolidated bioprocessing

(2013) *Advanced Biofuels and Bioproducts*, 9781461433484, pp. 267-280. Cited 9 times.
http://dx.doi.org/10.1007/978-1-4614-3348-4
ISBN: 978-146143348-4; 1461433479; 978-146143347-7
doi: 10.1007/978-1-4614-3348-4_16

View at Publisher

26 Mofijur, M., Rasul, M.G., Hassan, N.M.S., Masjuki, H.H., Kalam, M.A., Mahmudul, H.M.
Assessment of physical, chemical, and tribological properties of different biodiesel fuels

(2017) *Clean Energy for Sustainable Development: Comparisons and Contrasts of New Approaches*, pp. 441-463. Cited 24 times.
http://www.sciencedirect.com/science/book/9780128054239
ISBN: 978-012805424-6; 978-012805423-9
doi: 10.1016/B978-0-12-805423-9.00014-4

View at Publisher

27 Nair, S.G., Sindhu, R., Shashidhar, S.
Enzymatic bleaching of kraft pulp by xylanase from Aspergillus sydowii SBS 45 (Open Access)

(2010) *Indian Journal of Microbiology*, 50 (3), pp. 332-338. Cited 21 times.
doi: 10.1007/s12088-010-0049-2

View at Publisher

28 Mohammad Padzil, F.N., Lee, S.H., Ainun, Z.M.A., Lee, C.H., Abdullah, L.C.
Potential of oil palm empty fruit bunch resources in nanocellulose hydrogel production for versatile applications: A review (Open Access)

(2020) *Materials*, 13 (5), art. no. 1245. Cited 43 times.
https://res.mdpi.com/d_attachment/materials/materials-13-01245/article_deploy/materials-13-01245.pdf
doi: 10.3390/ma13051245

View at Publisher

29 Papanikolaou, S., Aggelis, G.
Lipids of oleaginous yeasts. Part II: Technology and potential applications

(2011) *European Journal of Lipid Science and Technology*, 113 (8), pp. 1052-1073. Cited 308 times.
doi: 10.1002/ejlt.201100015

View at Publisher

30 Pontoh, J.
Gas chromatographic analysis of medium chain fatty acids in coconut oil
(2016) *J. Pure Appl. Chem. Res.*, 5 (3), p. 157. Cited 8 times.

31 Qin, Y., Fu, Y., Li, Q., Luo, F., He, H.
Purification and Enzymatic Properties of a Difunctional Glycoside Hydrolase from Aspergillus oryzae HML366 (Open Access)

(2020) *Indian Journal of Microbiology*, 60 (4), pp. 475-484. Cited 5 times.
http://www.springerlink.com/content/0046-8991/
doi: 10.1007/s12088-020-00892-5

View at Publisher

32 Ramírez-Verduzco, L.F., Rodríguez-Rodríguez, J.E., Jaramillo-Jacob, A.D.R.
Predicting cetane number, kinematic viscosity, density and higher heating value of biodiesel from its fatty acid methyl ester composition

(2012) *Fuel*, 91 (1), pp. 102-111. Cited 494 times.
doi: 10.1016/j.fuel.2011.06.070

View at Publisher

33 Ramos, M.J., Fernández, C.M., Casas, A., Rodríguez, L., Pérez, A.
Influence of fatty acid composition of raw materials on biodiesel properties

(2009) *Bioresource Technology*, 100 (1), pp. 261-268. Cited 1480 times.
www.elsevier.com/locate/biortech
doi: 10.1016/j.biortech.2008.06.039

View at Publisher

34 Ratledge, C.

Fatty acid biosynthesis in microorganisms being used for Single Cell Oil production

(2004) *Biochimie*, 86 (11), pp. 807-815. Cited 882 times.
www.elsevier.com/locate/biochimie
doi: 10.1016/j.biochi.2004.09.017

View at Publisher

35 Roth, J.C.G., Hoeltz, M., Benitez, L.B.

Current approaches and trends in the production of microbial cellulases using residual lignocellulosic biomass: a bibliometric analysis of the last 10 years

(2020) *Archives of Microbiology*, 202 (5), pp. 935-951. Cited 18 times.
link.springer.de/link/service/journals/00203/index.htm
doi: 10.1007/s00203-019-01796-9

View at Publisher

36 Singh, A.

Lipid production by a cellulolytic strain of Aspergillus niger

(1991) *Letters in Applied Microbiology*, 12 (5), pp. 200-202. Cited 7 times.
doi: 10.1111/j.1472-765X.1991.tb00539.x

View at Publisher

37 Singh, S.P., Singh, D.

Biodiesel production through the use of different sources and characterization of oils and their esters as the substitute of diesel: A review

(2010) *Renewable and Sustainable Energy Reviews*, 14 (1), pp. 200-216. Cited 1029 times.
doi: 10.1016/j.rser.2009.07.017

View at Publisher

38 Spier, F., Buffon, J.G., Burkert, C.A.V.

Bioconversion of Raw Glycerol Generated from the Synthesis of Biodiesel by Different Oleaginous Yeasts: Lipid Content and Fatty Acid Profile of Biomass (Open Access)

(2015) *Indian Journal of Microbiology*, 55 (4), pp. 415-422. Cited 34 times.
http://www.springerlink.com/content/0046-8991/
doi: 10.1007/s12088-015-0533-9

View at Publisher

39 Weeraphan, T., Tanasupawat, S., Savarajara, A.

Naganishia cerealis IN1S2.5 Oil Production from the Hydrolysate of NaOH-Impregnated & Catalyst Steam Explosion Pretreated Oil Palm Empty Fruit Bunch (Open Access)

(2021) *BioResources*, 16 (2), pp. 2987-3004. Cited 2 times.
https://bioresources.cnr.ncsu.edu/wp-content/uploads/2021/03/BioRes_16_2_2987_Wphan_TS_Naganishia_Oil_Prodn_Hydrolysate_NaOH_Steam_Expl_OPEFB_18511-1.pdf
doi: 10.15376/biores.16.2.2987-3004

View at Publisher

40 Xu, Q., Singh, A., Himmel, M.E.

Perspectives and new directions for the production of bioethanol using consolidated bioprocessing of lignocellulose

(2009) *Current Opinion in Biotechnology*, 20 (3), pp. 364-371. Cited 238 times.
doi: 10.1016/j.copbio.2009.05.006

View at Publisher

41 Zhang, J., Wang, Y., Gou, Q., Zhou, W., Liu, Y., Xu, J., Liu, Y., (...), Gong, Z.

Consolidated bioprocessing of cassava starch into microbial lipid for biodiesel production by the amylolytic yeast Lipomyces starkeyi

(2022) *Industrial Crops and Products*, 177, art. no. 114534. Cited 6 times.
www.elsevier.com/inca/publications/store/5/2/2/8/2/5
doi: 10.1016/j.indcrop.2022.114534

View at Publisher

42 Zhao, M., Zhou, W., Wang, Y., Wang, J., Zhang, J., Gong, Z.

Combination of simultaneous saccharification and fermentation of corn stover with consolidated bioprocessing of cassava starch enhances lipid production by the amylolytic oleaginous yeast Lipomyces starkeyi

(2022) *Bioresource Technology*, 364, art. no. 128096. Cited 2 times.
www.elsevier.com/locate/biortech
doi: 10.1016/j.biortech.2022.128096

View at Publisher

43 Zheng, Y., Yu, X., Zeng, J., Chen, S.

Feasibility of filamentous fungi for biofuel production using hydrolysate from dilute sulfuric acid pretreatment of wheat straw (Open Access)

(2012) *Biotechnology for Biofuels*, 5, art. no. 50. Cited 104 times.
doi: 10.1186/1754-6834-5-50

View at Publisher

44 Zicker, M.C., Craig, A.P., de Oliveira Ramiro, D., Franca, A.S., Labanca, R.A., Ferreira, A.V.M.

Quantitative analysis of acidity level in virgin coconut oils by Fourier transform infrared spectroscopy and chemometrics

(2016) *European Journal of Lipid Science and Technology*, 118 (9), pp. 1350-1357. Cited 5 times.
http://www3.interscience.wiley.com/journal/69502350/home
doi: 10.1002/ejlt.201500407

View at Publisher

Ahmad, F.B.; Department of Chemical Engineering & Sustainability, Faculty of Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia; email:farahahmad@iium.edu.my

About Scopus

What is Scopus

Content coverage

Scopus blog

Scopus API

Privacy matters

Language

日本語版を表示する

查看简体中文版本

查看繁體中文版本

Просмотр версии на русском языке

Customer Service

Help

Tutorials

Contact us