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COSMO-RS based prediction for alpha-linolenic acid (ALA) extraction from microalgae biomass using room temperature ionic liquids (RTILS) (Article)

(Open Access)

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Abstract

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One of the essential fatty acids with therapeutic impacts on human health is known to be omega-3 polyunsaturated fatty acids (PUFA). More lately, ionic liquids (ILs) have received significant attention among scientists in overcoming the disadvantages of traditional solvents in biomass lipid extraction. However, the large pool of cations and anions possibly accessible will lead to a growing number of innovatively synthesized ILs. Nevertheless, the exhaustive measurement of all these systems is economically impractical. The conductive screening model for real solvents (COSMO-RS) is considered a precious approach with the availability of a few models to predict the characteristics of ILs. This work introduces the estimate of capacity values at infinite dilution for a range of ILs using COSMO-RS software as part of solid-liquid extraction. This favorable outcome presented that the capacity values of the IL molecules are extremely dependent on both anions and cations. Among the 352 combinations of cation/anion tested, short alkyl chain cations coupled with inorganic anions were found to be most efficient and therefore superior in the extraction method. Sulphate-, chloride-, and bromide-based ILs were found to have higher extraction capacities in contrast with the remainders, while propanoate revealed an extraordinary capacity when combined with ethyl-based cations. Eventually, the predicted results from COSMO-RS were validated through the experimentally calculated extraction yield of alpha-linolenic acid (ALA) compound from Nannochloropsis sp. microalgae. Three selected ILs namely [EMIM][Cl], [TMAm][Cl], and [EMPyrro][Br] were selected from COSMO-RS for empirical extraction purpose and the validation results pinpointed the good prediction capability of COSMO-RS. © 2020 by the authors.

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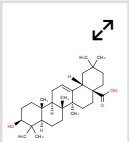
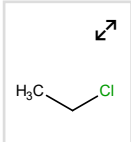

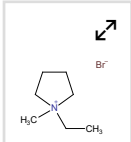

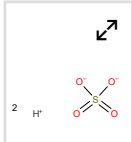

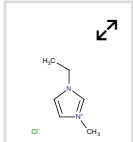

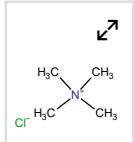

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(2019) Molecules

Ionic liquid-based extraction of fatty acids from blue-green algal cells enhanced by direct transesterification and determination using GC × GC-TOFMS

Kilulya, K.F. , Msagati, T.A.M. , Mamba, B.B.
(2014) Chromatographia

Ionic liquids for the fractionation of microalgae biomass

Orr, V.C.A. , Rehmann, L.
(2016) Current Opinion in Green and Sustainable Chemistry

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ALA extraction | Capacity at infinite dilution | COSMO-RS | Ionic liquids | Omega-3 PUFAs | Solid-liquid extraction | Tetramethyl ammonium

Indexed keywords

EMTREE drug terms: bromide | chloride | ionic liquid | linolenic acid | sulfate | anion | cation | ion | ionic liquid | linolenic acid

EMTREE medical terms: Article | biomass | dilution | extraction | microalga | nonhuman | prediction | room temperature | software | validation process | chemical structure | chemistry | molecular model | temperature | thermodynamics

MeSH: alpha-Linolenic Acid | Anions | Cations | Computational Chemistry | Ionic Liquids | Ions | Microalgae | Models, Molecular | Molecular Structure | Temperature | Thermodynamics

Chemicals and CAS Registry Numbers:

bromide, 24959-67-9; chloride, 16887-00-6; linolenic acid, 1955-33-5, 463-40-1; sulfate, 14808-79-8;

alpha-Linolenic Acid; Anions; Cations; Ionic Liquids; Ions

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Funding text #2

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References (60)

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1 Duc, D., Vigne, S., Pot, C.
Oxysterols in autoimmunity (Open Access)

(2019) *International Journal of Molecular Sciences*, 20 (18), art. no. 4522. Cited 3 times.
https://www.mdpi.com/1422-0067/20/18/4522/pdf
doi: 10.3390/ijms20184522

View at Publisher

2 Lauritano, C., Ianora, A.

Marine organisms with anti-diabetes properties (Open Access)

(2016) *Marine Drugs*, 14 (12), art. no. 220. Cited 28 times.
http://www.mdpi.com/1660-3397/14/12/220/pdf
doi: 10.3390/md14120220

View at Publisher

3 Ryckebosch, E., Bruneel, C., Muylaert, K., Foubert, I.

Microalgae as an alternative source of omega-3 long chain polyunsaturated fatty acids

(2012) *Lipid Technology*, 24 (6), pp. 128-130. Cited 84 times.
doi: 10.1002/lite.201200197

View at Publisher

4 Sinn, N., Milte, C.M., Street, S.J., Buckley, J.D., Coates, A.M., Petkov, J., Howe, P.R.C.

Effects of n-3 fatty acids, EPA v. DHA, on depressive symptoms, quality of life, memory and executive function in older adults with mild cognitive impairment: A 6-month randomised controlled trial (Open Access)

(2012) *British Journal of Nutrition*, 107 (11), pp. 1682-1693. Cited 169 times.
http://journals.cambridge.org/BJN
doi: 10.1017/S0007114511004788

View at Publisher

5 Domenichiello, A.F., Kitson, A.P., Bazinet, R.P.

Is docosahexaenoic acid synthesis from α-linolenic acid sufficient to supply the adult brain? (Open Access)

(2015) *Progress in Lipid Research*, 59, pp. 54-66. Cited 97 times.
www.elsevier.com/locate/plipres
doi: 10.1016/j.plipres.2015.04.002

View at Publisher

6 Lemahieu, C., Bruneel, C., Ryckebosch, E., Muylaert, K., Buyse, J., Foubert, I.

Impact of different omega-3 polyunsaturated fatty acid (n-3 PUFA) sources (flaxseed, Isochrysis galbana, fish oil and DHA Gold) on n-3 LC-PUFA enrichment (efficiency) in the egg yolk

(2015) *Journal of Functional Foods*, Part B 19, pp. 821-827. Cited 40 times.
http://www.elsevier.com/wps/find/journaldescription.cws_home/717426/description#description
doi: 10.1016/j.jff.2015.04.021

View at Publisher

7 Gibson, R.A., Muhlhausler, B., Makrides, M.

Conversion of linoleic acid and alpha-linolenic acid to long-chain polyunsaturated fatty acids (LCPUFAs), with a focus on pregnancy, lactation and the first 2 years of life

(2011) *Maternal and Child Nutrition*, 7 (SUPPL. 2), pp. 17-26. Cited 138 times.
doi: 10.1111/j.1740-8709.2011.00299.x

View at Publisher

8 Kartikasari, L.R., Hughes, R.J., Geier, M.S., Makrides, M., Gibson, R.A.

Dietary alpha-linolenic acid enhances omega-3 long chain polyunsaturated fatty acid levels in chicken tissues

(2012) *Prostaglandins Leukotrienes and Essential Fatty Acids*, 87 (4-5), pp. 103-109. Cited 44 times.
doi: 10.1016/j.plefa.2012.07.005

View at Publisher

9 Liu, J., Sun, Z., Gerken, H.
Recent advances in microalgal biotechnology omega-3 polyunsaturated fatty acids from algae
(2015) *Biotechnol. Adv.*, 8, pp. 709-727.

10 Handayania, N.A., Ariyantib, D.
Potential production of polyunsaturated fatty acids from microalgae
(2012) *Int. J. Sci. Eng.*, 1, pp. 13-16. Cited 9 times.

11 Abedi, E., Sahari, M.A.
Long-chain polyunsaturated fatty acid sources and evaluation of their nutritional and functional properties (Open Access)

(2014) *Food Science and Nutrition*, 2 (5), pp. 443-463. Cited 192 times.
onlinelibrary.wiley.com/journal/10.1002/%28ISSN%292048-7177
doi: 10.1002/fsn3.121

View at Publisher

12 Shahidi, F., Ambigaipalan, P.
Omega-3 Polyunsaturated Fatty Acids and Their Health Benefits

(2018) *Annual Review of Food Science and Technology*, 9, pp. 345-381. Cited 88 times.
http://www.annualreviews.org/journal/food
doi: 10.1146/annurev-food-111317-095850

View at Publisher

13 Lee, J.-Y., Yoo, C., Jun, S.-Y., Ahn, C.-Y., Oh, H.-M.
Comparison of several methods for effective lipid extraction from microalgae

(2010) *Bioresource Technology*, 101 (1 SUPPL.), pp. S75-S77. Cited 790 times.
http://www.journals.elsevier.com/bioresource-technology/
doi: 10.1016/j.biortech.2009.03.058

View at Publisher

14 Patel, A., Arora, N., Sartaj, K., Pruthi, V., Pruthi, P.A.
Sustainable biodiesel production from oleaginous yeasts utilizing hydrolysates of various non-edible lignocellulosic biomasses

(2016) *Renewable and Sustainable Energy Reviews*, 62, pp. 836-855. Cited 74 times.
doi: 10.1016/j.rser.2016.05.014

View at Publisher

15 Xu, D.-P., Li, Y., Meng, X., Zhou, T., Zhou, Y., Zheng, J., Zhang, J.-J., (...), Li, H.-B.
Natural antioxidants in foods and medicinal plants: Extraction, assessment and resources (Open Access)

(2017) *International Journal of Molecular Sciences*, 18 (1), art. no. 96. Cited 179 times.
http://www.mdpi.com/1422-0067/18/1/96/pdf
doi: 10.3390/ijms18010096

View at Publisher

16 Mercer, P., Armenta, R.E.
Developments in oil extraction from microalgae

(2011) *European Journal of Lipid Science and Technology*, 113 (5), pp. 539-547. Cited 283 times.
doi: 10.1002/ejlt.201000455

View at Publisher

17 Ahn, D.-G., Cho, C.-G., Jeong, S.-H., Lee, D.-G.
Design of photobioreactor for mass production of microalgae
(2011) *J. Korean Soc. Precis. Eng.*, 28, pp. 140-153. Cited 2 times.

18 Schneider, W.F., Brennecke, J.F., Maginn, E.J., Mindrup, E., Gurkan, B., Price, E., Goodrich, B.
(2019) *Ionic Liquids Comprising Heteraromatic Anions*. Cited 2 times.
Patent

19 Lei, Z., Chen, B., Koo, Y.-M., MacFarlane, D.R.
(2017) *Introduction: Ionic Liquids*. Cited 5 times.
ACS Publications: Washington, DC, USA

20 Dai, Y., Van Spronsen, J., Witkamp, G.-J., Verpoorte, R., Choi, Y.H.
Ionic liquids and deep eutectic solvents in natural products research: Mixtures of solids as extraction solvents

(2013) *Journal of Natural Products*, 76 (11), pp. 2162-2173. Cited 198 times.
doi: 10.1021/np400051w

View at Publisher

21 Saki, K., Bahmani, M., Rafieian-Kopaei, M.
The effect of most important medicinal plants on two importnt psychiatric disorders (anxiety and depression)-a review (Open Access)

(2014) *Asian Pacific Journal of Tropical Medicine*, 7 (S1), pp. S34-S42. Cited 138 times.
http://www.elsevier.com/wps/find/journaldescription.authors/722894/description#description
doi: 10.1016/S1995-7645(14)60201-7

View at Publisher

22 Kim, Y.-H., Park, S., Kim, M.H., Choi, Y.-K., Yang, Y.-H., Kim, H.J., Kim, H., (...), Lee, S.H.
Ultrasound-assisted extraction of lipids from Chlorella vulgaris using [Bmim][$MeSO_4$]

(2013) *Biomass and Bioenergy*, 56, pp. 99-103. Cited 51 times.
doi: 10.1016/j.biombioe.2013.04.022

View at Publisher

23 Motlagh, S.R., Harun, M.R., Biak, D.R.A., Hussain, S.A., Wilfreda, C.D., Krishnan, S.
Screening of long chain imidazolium base ionic liquids for EPA and DHA extraction from microalgae using COSMO-RS model

(2019) *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 58 (1), pp. 23-29.
http://www.akademiabaru.com/doc/ARFMTSV58_N1_P23_29.pdf

24 Kim, Y.-H., Choi, Y.-K., Park, J., Lee, S., Yang, Y.-H., Kim, H.J., Park, T.-J., (...), Lee, S.H.
Ionic liquid-mediated extraction of lipids from algal biomass

(2012) *Bioresource Technology*, 109, pp. 312-315. Cited 126 times.
doi: 10.1016/j.biortech.2011.04.064

View at Publisher

25 Choi, S.-A., Oh, Y.-K., Jeong, M.-J., Kim, S.W., Lee, J.-S., Park, J.-Y.
Effects of ionic liquid mixtures on lipid extraction from Chlorella vulgaris

(2014) *Renewable Energy*, 65, pp. 169-174. Cited 71 times.
doi: 10.1016/j.renene.2013.08.015

View at Publisher

26 Durga, G., Mishra, A.
Ionic liquids: Industrial applications
(2011) *Encycl. Inorg. Bioinorg. Chem.*, pp. 1-13. Cited 341 times.
https://doi.org/10.1002/9781119951438.eibc2434

27 Gonfa, G., Azmi Bustam, M., Murugesan, T., Man, Z., Abdul Mutalib, M.I.
Thiocyanate based task-specific ionic liquids for separation of benzene and cyclohexane

(2013) *Chemical Engineering Transactions*, 32, pp. 1939-1944. Cited 14 times.
http://www.aidic.it/cet/13/32/324.pdf
doi: 10.3303/CET1332324

View at Publisher

28 Scheffczyk, J., Fleitmann, L., Schwarz, A., Lampe, M., Bardow, A., Leonhard, K.
COSMO-CAMD: A framework for optimization-based computer-aided molecular design using COSMO-RS

(2017) *Chemical Engineering Science*, 159, pp. 84-92. Cited 33 times.
http://www.journals.elsevier.com/chemical-engineering-science/
doi: 10.1016/j.ces.2016.05.038

View at Publisher

29 Weis, D.C., MacFarlane, D.R.
Computer-aided molecular design of ionic liquids: An overview

(2012) *Australian Journal of Chemistry*, 65 (11), pp. 1478-1486. Cited 20 times.
doi: 10.1071/CH12344

View at Publisher

30 Xue, Z., Mu, T., Gmehling, J.
Comparison of the a Priori COSMO-RS models and group contribution methods: Original UNIFAC, modified UNIFAC(Do), and modified UNIFAC(Do) consortium

(2012) *Industrial and Engineering Chemistry Research*, 51 (36), pp. 11809-11817. Cited 25 times.
http://pubs.acs.org/journal/iecred
doi: 10.1021/ie301611w

View at Publisher

31 Klamt, A.
The COSMO and COSMO-RS solvation models

(2011) *Wiley Interdisciplinary Reviews: Computational Molecular Science*, 1 (5), pp. 699-709. Cited 371 times.
http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1759-0884
doi: 10.1002/wcms.56

View at Publisher

32 Pereiro, A.B., Deive, F.J., Esperança, J.M.S.S., Rodríguez, A.
Alkylsulfate-based ionic liquids to separate azeotropic mixtures

(2010) *Fluid Phase Equilibria*, 291 (1), pp. 13-17. Cited 31 times.
doi: 10.1016/j.fluid.2009.12.016

View at Publisher

33 Kumar, L., Banerjee, T., Mohanty, K.
Prediction of selective extraction of cresols from aqueous solutions by ionic liquids using theoretical approach

(2011) *Separation Science and Technology*, 46 (13), pp. 2075-2087. Cited 9 times.
doi: 10.1080/01496395.2011.589421

View at Publisher

34 Meindersma, G.W., De Haan, A.B.
Cyano-containing ionic liquids for the extraction of aromatic hydrocarbons from an aromatic/aliphatic mixture

(2012) *Science China Chemistry*, 55 (8), pp. 1488-1499. Cited 58 times.
doi: 10.1007/s11426-012-4630-x

View at Publisher

35 Paduszyński, K.
An overview of the performance of the COSMO-RS approach in predicting the activity coefficients of molecular solutes in ionic liquids and derived properties at infinite dilution

(2017) *Physical Chemistry Chemical Physics*, 19 (19), pp. 11835-11850. Cited 34 times.
http://www.rsc.org/Publishing/Journals/CP/index.asp
doi: 10.1039/c7cp00226b

View at Publisher

36 Domańska, U., Marciniak, A.
Activity coefficients at infinite dilution measurements for organic solutes and water in the ionic liquid 4-methyl-N-butyl-pyridinium bis(trifluoromethylsulfonyl)-imide

(2009) *Journal of Chemical Thermodynamics*, 41 (12), pp. 1350-1355. Cited 83 times.
doi: 10.1016/j.jct.2009.06.011

View at Publisher

37 Motlagh, S.R., Harun, R., Biak, D.R.A., Hussain, S.A., Ghani, W.A.W.A.K., Khezri, R., Wilfred, C.D., (...), Elgharbawy, A.A.M.
Screening of suitable ionic liquids as green solvents for extraction of eicosapentaenoic acid (EPA) from microalgae biomass using COSMO-RS model (Open Access)

(2019) *Molecules*, 24 (4), art. no. 713. Cited 9 times.
https://www.mdpi.com/1420-3049/24/4/713/pdf
doi: 10.3390/molecules24040713

View at Publisher

38 Mohanty, S., Banerjee, T., Mohanty, K.
Quantum chemical based screening of ionic liquids for the extraction of phenol from aqueous solution

(2010) *Industrial and Engineering Chemistry Research*, 49 (6), pp. 2916-2925. Cited 28 times.
doi: 10.1021/ie901684q

View at Publisher

39 Zhang, Y., Zhou, Z., Zou, L., Chi, R.
Imidazolium-based ionic liquids with inorganic anions in the extraction of salidroside and tyrosol from Rhodiola: The role of cations and anions on the extraction mechanism

(2019) *Journal of Molecular Liquids*, 275, pp. 136-145. Cited 9 times.
doi: 10.1016/j.molliq.2018.11.009

View at Publisher

40 Hawker, R.R., Haines, R.S., Harper, J.B.

Variation of the cation of ionic liquids: The effects on their physicochemical properties and reaction outcome

(2014) *Targets in Heterocyclic Systems*, 18, pp. 141-213. Cited 15 times.
https://www.soc.chim.it/sites/default/files/ths/18/chapter_6.pdf

41 Du, F.-Y., Xiao, X.-H., Luo, X.-J., Li, G.-K.

Application of ionic liquids in the microwave-assisted extraction of polyphenolic compounds from medicinal plants

(2009) *Talanta*, 78 (3), pp. 1177-1184. Cited 193 times.
doi: 10.1016/j.talanta.2009.01.040

View at Publisher

42 Xu, W., Chu, K., Li, H., Zhang, Y., Zheng, H., Chen, R., Chen, L.

Ionic liquid-based microwave-Assisted extraction of flavonoids from bauhinia championii (Benth.) benth. (Open Access)

(2012) *Molecules*, 17 (12), pp. 14323-14335. Cited 45 times.
http://www.mdpi.com/1420-3049/17/12/14323/pdf
doi: 10.3390/molecules171214323

View at Publisher

43 Kilulya, K.F., Msagati, T.A.M., Mamba, B.B.

Ionic liquid-based extraction of fatty acids from blue-green algal cells enhanced by direct transesterification and determination using GC × GC-TOFMS

(2014) *Chromatographia*, 77 (5-6), pp. 479-486. Cited 7 times.
http://www.chromatographia.de/
doi: 10.1007/s10337-014-2632-x

View at Publisher

44 Severa, G., Kumar, G., Troung, M., Young, G., Cooney, M.J.

Simultaneous extraction and separation of phorbol esters and bio-oil from Jatropha biomass using ionic liquid-methanol co-solvents

(2013) *Separation and Purification Technology*, 116, pp. 265-270. Cited 23 times.
doi: 10.1016/j.seppur.2013.06.001

View at Publisher

45 Kim, Y.-H., Park, S., Kim, M.H., Choi, Y.-K., Yang, Y.-H., Kim, H.J., Kim, H., (...), Lee, S.H.

Ultrasound-assisted extraction of lipids from Chlorella vulgaris using [Bmim][$MeSO_4$]

(2013) *Biomass and Bioenergy*, 56, pp. 99-103. Cited 51 times.
doi: 10.1016/j.biombioe.2013.04.022

View at Publisher

46 Praveenkumar, R., Lee, K., Lee, J., Oh, Y.-K.

Breaking dormancy: An energy-efficient means of recovering astaxanthin from microalgae

(2015) *Green Chemistry*, 17 (2), pp. 1226-1234. Cited 49 times.
http://pubs.rsc.org/en/journals/journal/gc
doi: 10.1039/c4gc01413h

View at Publisher

47 Cheong, L.-Z., Guo, Z., Yang, Z., Chua, S.-C., Xu, X.
Extraction and enrichment of n-3 polyunsaturated fatty acids and ethyl esters through reversible π-π Complexation with aromatic rings containing ionic liquids

(2011) *Journal of Agricultural and Food Chemistry*, 59 (16), pp. 8961-8967. Cited 21 times.
doi: 10.1021/jf202043w

View at Publisher

48 Zhang, Q.-G., Wang, N.-N., Yu, Z.-W.
The hydrogen bonding interactions between the ionic liquid 1-Ethyl-3-methylimidazolium ethyl sulfate and water

(2010) *Journal of Physical Chemistry B*, 114 (14), pp. 4747-4754. Cited 182 times.
http://pubs.acs.org/journal/jpcbfk
doi: 10.1021/jp1009498

View at Publisher

49 Mu, X., Jiang, N., Liu, C., Zhang, D.
New Insight into the Formation Mechanism of Imidazolium-Based Ionic Liquids from N-Alkyl Imidazoles and Halogenated Hydrocarbons: A Polar Microenvironment Induced and Autopromoted Process

(2017) *Journal of Physical Chemistry A*, 121 (5), pp. 1133-1139. Cited 8 times.
http://pubs.acs.org/jpca
doi: 10.1021/acs.jpca.6b11610

View at Publisher

50 Kim, Y.-H., Choi, Y.-K., Park, J., Lee, S., Yang, Y.-H., Kim, H.J., Park, T.-J., (...), Lee, S.H.
Ionic liquid-mediated extraction of lipids from algal biomass

(2012) *Bioresource Technology*, 109, pp. 312-315. Cited 126 times.
doi: 10.1016/j.biortech.2011.04.064

View at Publisher

51 Olkiewicz, M., Plechkova, N.V., Earle, M.J., Fabregat, A., Stüber, F., Fortuny, A., Font, J., (...), Bengoa, C.
Biodiesel production from sewage sludge lipids catalysed by Brønsted acidic ionic liquids

(2016) *Applied Catalysis B: Environmental*, 181, pp. 738-746. Cited 52 times.
www.elsevier.com/inca/publications/store/5/2/3/0/6/6/index.htt
doi: 10.1016/j.apcatb.2015.08.039

View at Publisher

52 Miazek, K., Kratky, L., Sulc, R., Jirout, T., Aguedo, M., Richel, A., Goffin, D.
Effect of organic solvents on microalgae growth, metabolism and industrial bioproduct extraction: A review (Open Access)

(2017) *International Journal of Molecular Sciences*, 18 (7), art. no. 1429. Cited 26 times.
http://www.mdpi.com/1422-0067/18/7/1429/pdf
doi: 10.3390/ijms18071429

View at Publisher

53 Zhou, W., Wang, Z., Alam, M.A., Xu, J., Zhu, S., Yuan, Z., Huo, S., (...), Ma, L.
Repeated utilization of ionic liquid to extract lipid from algal biomass (Open Access)

(2019) *International Journal of Polymer Science*, 2019, art. no. 9209210. Cited 7 times.
http://www.hindawi.com/journals/ijps/
doi: 10.1155/2019/9209210

View at Publisher

54 Ullah, H., Wilfred, C.D., Shaharun, M.S.
Comparative assessment of various extraction approaches for the isolation of essential oil from polygonum minus using ionic liquids (Open Access)

(2019) *Journal of King Saud University - Science*, 31 (2), pp. 230-239. Cited 7 times.
http://www.sciencedirect.com/science/journal/10183647
doi: 10.1016/j.jksus.2017.05.014

View at Publisher

55 Klamt, A.
Conductor-like screening model for real solvents: A new approach to the quantitative calculation of solvation phenomena

(1995) *Journal of Physical Chemistry*, 99 (7), pp. 2224-2235. Cited 2358 times.
doi: 10.1021/j100007a062

View at Publisher

56 Dreizler, R.M., Gross, E.K.U.
(2012) *Density Functional Theory: An Approach to the Quantum Many-Body Problem*. Cited 3096 times.
Springer Science & Business Media

57 Grimme, S.
Supramolecular binding thermodynamics by dispersion-corrected density functional theory

(2012) *Chemistry - A European Journal*, 18 (32), pp. 9955-9964. Cited 641 times.
doi: 10.1002/chem.201200497

View at Publisher

58 Pan, J., Muppaneni, T., Sun, Y., Reddy, H.K., Fu, J., Lu, X., Deng, S.
Microwave-assisted extraction of lipids from microalgae using an ionic liquid solvent [BMIM][HSO_4]

(2016) *Fuel*, 178, pp. 49-55. Cited 54 times.
http://www.journals.elsevier.com/fuel/
doi: 10.1016/j.fuel.2016.03.037

View at Publisher

59 Lewis, T., Nichols, P.D., McMeekin, T.A.
Evaluation of extraction methods for recovery of fatty acids from lipid-producing microheterotrophs

(2000) *Journal of Microbiological Methods*, 43 (2), pp. 107-116. Cited 270 times.
doi: 10.1016/S0167-7012(00)00217-7

View at Publisher

60 Burja, A.M., Armenta, R.E., Radianingtyas, H., Barrow, C.J.
Evaluation of fatty acid extraction methods for Thraustochytrium sp. ONC-T18

(2007) *Journal of Agricultural and Food Chemistry*, 55 (12), pp. 4795-4801. Cited 57 times.
doi: 10.1021/jf070412s

View at Publisher

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