

[Add to Marked List](#)

◀ 1 of 1 ▶

Shedding Light on Lipase Stability in Natural Deep Eutectic Solvents

By: [Elgharbawy, AA](#) (Elgharbawy, A. A.)^[1]; [Hayyan, A](#) (Hayyan, A.)^[2,3]; [Hayyan, M](#) (Hayyan, M.)^[3,4]; [Rashid, SN](#) (Rashid, S. N.)^[3]; [Nor, MRM](#) (Nor, M. R. M.)^[5]; [Zulkifli, MY](#) (Zulkifli, M. Y.)^[5]; [Alias, Y](#) (Alias, Y.)^[3,6]; [Mirghani, MES](#) (Mirghani, M. E. S.)^[1,7]

[View Web of Science ResearcherID and ORCID](#)

CHEMICAL AND BIOCHEMICAL ENGINEERING QUARTERLY

Volume: 32 Issue: 3 Pages: 359-370

DOI: 10.15255/CABEQ.2018.1335

Published: 2018

Document Type: Article

[View Journal Impact](#)

Abstract

This study presents the potential role of natural deep eutectic solvents (NADESs) in a lipase catalyzed hydrolysis reaction as both a co-solvent in an aqueous solution and as a main solvent. Ammonium salts such as choline chloride (ChCl) were paired with different hydrogen bond donors such as glycerol and malonic acid and sugars (glucose, fructose and sucrose). The hydrolysis of p-nitrophenyl palmitate by six different lipases: lipase from porcine pancreas (PR), lipase from *Candida rugosa* (CR), Amano lipase PS, from *Burkholderia cepacia* (AM), lipase from *Rhizopus niveus* (RN), lipase acrylic resin from *Candida antarctica* (ARC), lipase B *Candida antarctica* immobilized on Immobead 150, recombinant from *Aspergillus oryzae* (CALB), were tested in live NADESs. The results showed that NADES3 prepared from ChCl/sucrose was the most promising solvent as it enhanced the activities of both CALB and lipase from porcine pancreas to 355 % and 345 %. The kinetics investigation confirmed the higher catalytic efficiency (k(cat)/K-m) of lipases in the 40 % of (NADES3) and compared with the aqueous form. The trend achieved by NADES may be a promising approach for applications and further perspectives as genuinely green industrial solvents.

Keywords

Author Keywords: [biotransformation](#); [biotechnology](#); [ionic liquids](#); [choline chloride](#); [p-nitrophenyl palmitate](#); [lipase B](#) [Candida antarctica](#)

KeyWords Plus: [IONIC LIQUID](#); [HYDROLYSIS](#); [ACTIVATION](#); [PROTEINS](#); [MEDIA](#); [OIL](#)

Author Information

Reprint Address:

Universiti Malaya Univ Malaya, Nanotechnol & Catalysis Res Ctr NANOCAT, Kuala Lumpur 50603, Malaysia.

Universiti Malaya Univ Malaya, UMCiL, Kuala Lumpur 50603, Malaysia.

Sohar University Sohar Univ, Fac Engn, Dept Chem Engn, POB 44, Sohar 311, Oman.

Corresponding Address: Hayyan, A (corresponding author)

+ Univ Malaya, Nanotechnol & Catalysis Res Ctr NANOCAT, Kuala Lumpur 50603, Malaysia.

Corresponding Address: Hayyan, A; Hayyan, M (corresponding author)

+ Univ Malaya, UMCiL, Kuala Lumpur 50603, Malaysia.

Corresponding Address: Hayyan, M (corresponding author)

+ Sohar Univ, Fac Engn, Dept Chem Engn, POB 44, Sohar 311, Oman.

Addresses:

+ [1] Int Islamic Univ Malaysia, Int Inst Halal Res & Training INHART, Kuala Lumpur 50728, Malaysia

+ [2] Univ Malaya, Nanotechnol & Catalysis Res Ctr NANOCAT, Kuala Lumpur 50603, Malaysia

+ [3] Univ Malaya, UMCiL, Kuala Lumpur 50603, Malaysia

+ [4] Sohar Univ, Fac Engn, Dept Chem Engn, POB 44, Sohar 311, Oman

+ [5] Univ Malaya, Acad Islamic Studies, Halal Res Grp, Kuala Lumpur 50603, Malaysia

+ [6] Univ Malaya, Dept Chem, Fac Sci, Kuala Lumpur 50603, Malaysia

+ [7] Int Islamic Univ Malaysia, Kulliyah Engn, Dept Biotechnol Engn, Kuala Lumpur 50728, Malaysia

E-mail Addresses: adeeb.hayyan@yahoo.com; maan_hayyan@yahoo.com

Funding

Funding Agency	Grant Number
Bantuan Kecil Penyelidikan (BKP) grant	BK0332017

Citation Network

In Web of Science Core Collection

6

Times Cited

[Create Citation Alert](#)

All Times Cited Counts

6 in All Databases

[See more counts](#)

33

Cited References

[View Related Records](#)

Most recently cited by:

[Elgharbawy, Amal A. M.](#); [Hayyan, Maan](#); [Hayyan, Adeeb](#); et al.

[A grand avenue to integrate deep eutectic solvents into biomass processing.](#)
BIOMASS & BIOENERGY (2020)

[Hollenbach, Rebecca](#); [Bindereif, Benjamin](#); [van der Schaaf, Ulrike S.](#); et al.

[Optimization of Glycolipid Synthesis in Hydrophilic Deep Eutectic Solvents.](#)
FRONTIERS IN BIOENGINEERING AND BIOTECHNOLOGY (2020)

[View All](#)

Use in Web of Science

Web of Science Usage Count

2

Last 180 Days

11

Since 2013

[Learn more](#)

This record is from:

Web of Science Core Collection
- Science Citation Index Expanded

Suggest a correction

If you would like to improve the quality of the data in this record, please [suggest a correction](#).

UMRG

RP037B-15AET

[View funding text](#)**Publisher**

CROATIAN SOC CHEMICAL ENGINEERING TECHNOLOGY, BERISLAVICEVA 6, PO BOX 123, HR-10000 ZAGREB, CROATIA

Categories / Classification

Research Areas: Biotechnology & Applied Microbiology; Engineering

Web of Science Categories: Biotechnology & Applied Microbiology; Engineering, Chemical

See more data fields

◀ 1 of 1 ▶

Cited References: 33Showing 30 of 33 [View All in Cited References page](#)*(from Web of Science Core Collection)*

1. **Case Study: Recombinant bromelain downstream processing BT** Times Cited: 1
By: Amid, A; Arshad, Z.I.M; Othman, M.E.F.
Recombinant Enzymes-From Basic Science to Commercialization Pages: 175-185 Published: 2015
Publisher: Springer International Publishing, Switzerland
URL: https://doi-org.ezaccess.library.uitm.edu.my/10.1007/978-3-319-12397-4_12
2. **The use of lipases as biocatalysts for the epoxidation of fatty acids and phenolic compounds** Times Cited: 60
By: Aouf, Chahinez; Durand, Erwann; Lecomte, Jerome; et al.
GREEN CHEMISTRY Volume: 16 Issue: 4 Pages: 1740-1754 Published: 2014
3. **Cholinium-based deep eutectic solvents and ionic liquids for lipase-catalyzed synthesis of butyl acetate** Times Cited: 31
By: Bubalo, Marina Cvjetko; Tusek, Ana Jurinjak; Vinkovic, Marijana; et al.
JOURNAL OF MOLECULAR CATALYSIS B-ENZYMATIC Volume: 122 Pages: 188-198 Published: DEC 2015
4. **Natural deep eutectic solvents as new potential media for green technology** Times Cited: 720
By: Dai, Yuntao; van Spronsen, Jaap; Witkamp, Geert-Jan; et al.
ANALYTICA CHIMICA ACTA Volume: 766 Pages: 61-68 Published: MAR 5 2013
5. **Deep Eutectic Solvents in Polymerizations: A Greener Alternative to Conventional Syntheses** Times Cited: 135
By: del Monte, Francisco; Carriazo, Daniel; Serrano, Maria C.; et al.
CHEMUSUSCHEM Volume: 7 Issue: 4 Pages: 999-1009 Published: APR 2014
6. **Deep eutectic solvents: Synthesis, application, and focus on lipase-catalyzed reactions** Times Cited: 134
By: Durand, E.; Lecomte, J.; Villeneuve, P.
EUROPEAN JOURNAL OF LIPID SCIENCE AND TECHNOLOGY Volume: 115 Issue: 4 Pages: 379-385 Published: APR 2013
7. **Evaluation of deep eutectic solvents as new media for Candida antarctica B lipase catalyzed reactions** Times Cited: 110
By: Durand, E.; Lecomte, J.; Barea, B.; et al.
PROCESS BIOCHEMISTRY Volume: 47 Issue: 12 Pages: 2081-2089 Published: DEC 2012
8. **Are emerging deep eutectic solvents (DES) relevant for lipase-catalyzed lipophilizations?** Times Cited: 4
By: Durand, Erwann; Lecomte, Jerome; Villeneuve, Pierre
OCL-OILSEEDS AND FATS CROPS AND LIPIDS Volume: 22 Issue: 4 Article Number: D408 Published: JUL-AUG 2015
9. **In situ coating - An approach for particle modification and encapsulation of proteins during spray-drying** Times Cited: 48
By: Elversson, Jessica; Millqvist-Fureby, Anna
INTERNATIONAL JOURNAL OF PHARMACEUTICS Volume: 323 Issue: 1-2 Pages: 52-63 Published: OCT 12 2006
10. **Natural designer solvents for greening analytical chemistry** Times Cited: 115
By: Espino, Magdalena; de los Angeles Fernandez, Maria; Gomez, Federico J. V.; et al.
TRAC-TRENDS IN ANALYTICAL CHEMISTRY Volume: 76 Pages: 126-136 Published: FEB 2016
11. **Water Dynamics in Protein Hydration Shells: The Molecular Origins of the Dynamical Perturbation** Times Cited: 133
By: Fogarty, Aoife C.; Laage, Damien
JOURNAL OF PHYSICAL CHEMISTRY B Volume: 118 Issue: 28 Pages: 7715-7729 Published: JUL 17 2014
12. **Hydrolase-catalyzed biotransformations in deep eutectic solvents** Times Cited: 266
By: Gorke, Johnathan T.; Srien, Friedrich; Kazlauskas, Romas J.
CHEMICAL COMMUNICATIONS Issue: 10 Pages: 1235-1237 Published: MAR 14 2008

13. **Fruit sugar-based deep eutectic solvents and their physical properties** Times Cited: **118**
By: Hayyan, Adeeb; Mjalli, Farouq S.; AlNashef, Inas M.; et al.
THERMOCHIMICA ACTA Volume: 541 Pages: 70-75 Published: AUG 10 2012
14. **Pure and aqueous deep eutectic solvents for a lipase-catalysed hydrolysis reaction** Times Cited: **28**
By: Juneidi, Ibrahim; Hayyan, Maan; Hashim, Mohd Ali; et al.
BIOCHEMICAL ENGINEERING JOURNAL Volume: 117 Pages: 129-138 Part: A Published: JAN 15 2017
15. **Effect of deep eutectic solvent mixtures on lipase activity and stability** Times Cited: **33**
By: Kim, Sung Hee; Park, Saerom; Yu, Hyejeong; et al.
JOURNAL OF MOLECULAR CATALYSIS B-ENZYMATIC Volume: 128 Pages: 65-72 Published: JUN 2016
16. **Selected issues related to the toxicity of ionic liquids and deep eutectic solvents-a review** Times Cited: **74**
By: Kudlak, Blazej; Owczarek, Katarzyna; Namiesnik, Jacek
ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH Volume: 22 Issue: 16 Pages: 11975-11992 Published: AUG 2015
17. **Distribution, enrichment, and potential toxicity of trace metals in the surface sediments of Sundarban mangrove ecosystem, Bangladesh: a baseline study before Sundarban oil spill of December, 2014** Times Cited: **147**
By: Kumar, Alok; Ramanathan, A. L.; Prasad, M. B. K.; et al.
ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH Volume: 23 Issue: 9 Pages: 8985-8999 Published: MAY 2016
18. **Deep eutectic solvents (DESS) are viable cosolvents for enzyme-catalyzed epoxide hydrolysis** Times Cited: **152**
By: Lindberg, Diana; de la Fuente Revenga, Mario; Widersten, Mikael
JOURNAL OF BIOTECHNOLOGY Volume: 147 Issue: 3-4 Pages: 169-171 Published: JUN 2010
19. **Effectiveness of using deep eutectic solvents as an alternative to conventional solvents in enzymatic biodiesel production from waste oils** Times Cited: **16**
By: Merza, Fatima; Fawzy, Aya; AlNashef, Inas; et al.
ENERGY REPORTS Volume: 4 Pages: 77-83 Published: NOV 2018
20. **Effect of ionic liquid on activity, stability, and structure of enzymes: A review** Times Cited: **169**
By: Naushad, Mu; AlOthman, Zied Abdullah; Khan, Abbul Bashar; et al.
INTERNATIONAL JOURNAL OF BIOLOGICAL MACROMOLECULES Volume: 51 Issue: 4 Pages: 555-560 Published: NOV 2012
21. **Microwave assisted enzymatic saccharification of oil palm empty fruit bunch fiber for enhanced fermentable sugar yield** Times Cited: **46**
By: Nomanbhay, S.M.; Hussain, R.; Palanisamy, K.
J. Sustain. Bioenergy Syst. Volume: 3 Pages: 7-17 Published: 2013
22. **Natural Deep Eutectic Solvents - Solvents for the 21st Century** Times Cited: **583**
By: Paiva, Alexandre; Craveiro, Rita; Aroso, Ivo; et al.
ACS SUSTAINABLE CHEMISTRY & ENGINEERING Volume: 2 Issue: 5 Pages: 1063-1071 Published: MAY 2014
23. **Green solvents for green technologies** Times Cited: **2**
By: Panic, Manuela; Radosevic, Kristina; Bubalo, Marina Cvjetko; et al.
JOURNAL OF BIOTECHNOLOGY Volume: 256 Supplement: S Pages: S11-S12 Published: AUG 30 2017
24. **Spray drying technique of fruit juice powder: some factors influencing the properties of product.** Times Cited: **97**
By: Phisut, N.
International Food Research Journal Volume: 19 Issue: 4 Pages: 1297-1306 Published: 2012
25. **Stability and activity of enzymes in ionic liquids BT** Times Cited: **2**
By: Sanghamitra, N.J.M; Ueno, T.
Green Solvents II: Properties and Applications of Ionic Liquids Pages: 235-273 Published: 2012
Publisher: Springer Netherlands, Dordrecht
URL: https://doi-org.ezaccess.library.uitm.edu.my/10.1007/978-94-007-2891-2_10
26. **Deep Eutectic Solvents (DESS) and Their Applications** Times Cited: **1,515**
By: Smith, Emma L.; Abbott, Andrew P.; Ryder, Karl S.
CHEMICAL REVIEWS Volume: 114 Issue: 21 Pages: 11060-11082 Published: NOV 12 2014
27. **Steering the enzymatic activity of proteins by ionic liquids. A case study of the enzyme kinetics of yeast alcohol dehydrogenase** Times Cited: **17**
By: Weibels, Sebastian; Syguda, Adrian; Herrmann, Christian; et al.
PHYSICAL CHEMISTRY CHEMICAL PHYSICS Volume: 14 Issue: 13 Pages: 4635-4639 Published: 2012
28. **Hydration of enzyme in nonaqueous media is consistent with solvent dependence of its activity** Times Cited: **165**
By: Yang, L; Dordick, JS; Garde, S
BIOPHYSICAL JOURNAL Volume: 87 Issue: 2 Pages: 812-821 Published: AUG 2004

29. [Both hydrolytic and transesterification activities of *Penicillium expansum* lipase are significantly enhanced in ionic liquid \[BMim\]\[PF6\]](#) Times Cited: 51
By: Yang, Zhen; Zhang, Kai-Pei; Huang, Ying; et al.
JOURNAL OF MOLECULAR CATALYSIS B-ENZYMATIC Volume: 63 Issue: 1-2 Pages: 23-30 Published: APR 2010
30. [Choline-based deep eutectic solvents for enzymatic preparation of biodiesel from soybean oil](#)
-