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RESUME
AYELET FISHMAN

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Technion – Israel Institute of Technology
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ACADEMIC DEGREES

2002 Ph.D., Dept. of Biotechnology and Food Engineering, Technion, Haifa, Israel.
1992 M.Sc., Dept. of Biotechnology and Food Engineering, Technion, Haifa, Israel.
1989 B.Sc. (summa cum laude), Dept. of Biotechnology and Food Engineering, Technion, Haifa, Israel.

ACADEMIC APPOINTMENTS

2011- Associate Professor, Dept. of Biotechnology and Food Engineering, Technion, Haifa, Israel.
2005-2011 Assistant Professor, Dept. of Biotechnology and Food Engineering, Technion, Haifa, Israel.
2002-2004 Post-doctoral fellow with Prof. Thomas K. Wood. Dept. of Chemical Engineering, University of Connecticut, Storrs, CT, USA.
2001-2002 Adjunct lecturer, Dept. of Biotechnology and Food Engineering, Technion, Haifa, Israel.

PROFESSIONAL EXPERIENCE

1993-2005 Research scientist and project leader, TAMI-IMI Institute for R&D, Member of Israel Chemicals Ltd., Haifa Bay, Israel. Specializing in the use of enzymes in organic chemistry, enzyme modification and immobilization. Working on syntheses of complex chemical molecules *via* biocatalysis.

RESEARCH INTERESTS

- Molecular biocatalysis: using protein engineering techniques such as directed evolution, saturation mutagenesis, site specific mutagenesis as well as statistical modeling to tailor enzymes for use with unnatural substrates.
- Applied biocatalysis: using enzymes and whole cells to obtain chemicals with high added value, with special focus on chiral drug intermediates and food ingredients.
- Structure-function correlations of enzymes: using protein engineering tools and crystallography to study how enzyme structure influences activity and selectivity. Special focus is placed on oxidizing enzymes and lipases.
- Enzymes in non-aqueous media: using organic solvents and ionic liquids to tailor enzyme properties and allow synthesis of commercially attractive chemicals.

TEACHING EXPERIENCE

2001-present	Applied Biocatalysis	Graduate and undergraduate level (2 credit points). A new course which I designed and initiated as an adjunct lecturer.
2005-present	Food Analysis	Undergraduate level (3 credit points).
2005-present	Laboratory in analysis of food and biological compounds	Undergraduate level (2 credit points).
2006-present	Food Chemistry	Undergraduate level (3 credit points).
2008	Food Engineering 3 (Unit operations)	Undergraduate level (3 credit points).

TECHNION ACTIVITIES

2005-2009 Department representative in the computation committee at the Technion
2012-2014 Technion committee for undergraduate and graduate studies

DEPARTMENT ACTIVITES

2010-2011 Department seminar coordinator
2009-present Department coordinator of undergraduate studies
2008-present Responsibility for Open Day activities
2006-2009 Supervision of the department library
2005-2007 Secretary of the Department of Biotechnology and Food Engineering council

HONORS AND AWARDS

2012 The Technion award for excellence in teaching – top 4%
2011 The Moshe Yanai prize for excellence in teaching
The Henri Gutwirth Prize for the Promotion of Research
The Technion award for excellence in teaching – top 4%
2010 The Technion award for excellence in teaching – top 4%
2009 The Technion award for excellence in teaching – top 4%
2008 The Technion award for excellence in teaching – top 4%
The Alfred & Yehuda Wiessman award for excellence in teaching
2007 The Technion award for excellence in teaching - top 4%
2005-6 The Abraham and Jennie Fialkow Academic Lectureship

GRADUATE STUDENTS

Completed Theses

PhD students

1. Moran Brouk, 2005-2010, currently at Protalix.
2. Vered Shuster Ben-Yosef, 2005-2011, currently at Protalix.
3. Janna Shainsky, 2007-2012, currently the lab manager of Dr. Avi Schroeder, Chemical Engineering Dept., Technion.

MSc students

1. Roi Feingersch, 2005-2007, currently a lab manager and researcher at the Faculty of Medicine, Zfat.
2. Netta Nir, 2006-2008, currently at Duet Medical Consulting.
3. Netta-Lee Derry, 2007-2009, currently at Protalix.

Theses in progress

PhD students

1. Mor (Sendovski) Goldfeder, 2008-2013 (Co-supervisor: Prof. Noam Adir, Dept. of Chemistry).
2. Yigal Achmon, 2008-2013
3. Adi Dror, 2009-2014
4. Almog Bregman, 2012-2016

MSc Students

1. Sivan Isaschar, 2011-2013
2. Bernadeth Sudach Abu-Atta, 2012-2014
3. Nataliya Kuplennik, 2012-2014 (co-supervisor with Prof. Moshe Narkis)

UNDERGRADUATE STUDENTS

2005: Netta Nir
2006: Janna Shainsky, Nadav Eshkol, Alex Golberg
2007: Itay Palmor, Mor Sendovski, Shay Cohen, Keren Dabush, Arij Kbishi
2008: Shiri Shushan, Osnat Kaufman, Shirley Rosenberg, Alice Moscowich
2009: Eyal Briller, Rotem Vaknin
2010: Ravit Piterman, Idan Shafrir, Mor Egozi, Tanya Birman
2011: Sivan Isaschar, Nurit Ben-Brit, Einav Shemesh, Liron Sigawi, Yotam Lahav
2012: Elian Dror, Natali Dayan, Moran Eliashvili
2013: Shalev Gichaz, Irit Cogan, Batel Deri

POST-DOCTORATE FELLOWS

2009-2012 Dr. Kalia Bernath-Levin. Completed her PhD studies in the Weizmann Institute, Rehovot, Israel. *Recipient of the Fein Scholarship.*

2011-2013 Dr. Margarita Kanteev. Completed her PhD studies in the Chemistry Department at the Technion, Israel.

PUBLICATIONS

Refereed papers in professional journals

1. **Fishman, A.**, Berk Z. and Shoham Y. (1995) Large scale purification of xylanase T-6. *Appl. Microbiol. Biotechnol*, 44:88-93.
2. **Fishman, A.** and Zviely, M. (1998) Chemo-enzymatic synthesis of (S)-α-cyano-3-phenoxybenzyl alcohol. *Tetrahedron:Asymmetry* 9:107-118.
3. **Fishman, A.**, Basheer, S., Shatzmiller, S. and Cogan, U. (1998) Fatty-acid-modified enzymes as effective enantioselective catalysts in microaqueous organic media. *Biotechnol. Lett*. 20:535-538.
4. **Fishman, A.**, Kellner, D., Ioffe, D., Shapiro, E. (2000) A practical chemo-enzymatic process for the preparation of (1R,cis)-2-(2,2-dihaloethenyl)-3,3-dimethylcyclopropane carboxylic acids. *Org. Proc. Res. Develop.* 4:77-87.
5. Shapira-Levinger, M. and **Fishman, A.** (2000) Kinetic resolution of a Diltiazem intermediate by lipase-catalyzed enantioselective alcoholysis. *J. Mol. Catal. B: Enzymatic* 9:251-257.
6. **Fishman, A.**, Eroshov, M., Sheffer Dee-Noor, S., van Mil, J., Cogan, U. and Effenberger, R. (2001) A two step enzymatic resolution process for large-scale production of (S)- and (R)-ethyl-3-hydroxybutyrate. *Biotechnol. Bioeng*. 74:256-263.
7. **Fishman, A.**, Levy, I., Cogan, U., Shoseyov, O. (2002) Stabilization of horseradish peroxidase in aqueous-organic media by immobilization onto cellulose using a cellulose-binding-domain. *J. Mol. Catal. B:Enzymatic*, 18:115-125.
8. **Fishman, A.** and Cogan, U. (2003) Bio-imprinting of lipases with fatty acids. *J. Mol. Catal. B:Enzymatic*, 22:193-202.
9. Tao, Y., **Fishman, A.**, Bentley, W.E., and Wood, T.K. (2004) Oxidation of benzene to phenol, catechol and 1,2,3,-trihydroxybenzene by toluene-4-monooxygenase of *Pseudomonas mendocina* KR1 and toluene-3-monooxygenase of *Ralstonia pickettii* PKO1. *Appl. Environ. Microbiol.* 70: 3814-3820.
10. Tao, Y., **Fishman, A.**, Bentley, W.E., and Wood, T.K. (2004) Altering toluene 4-monooxygenase from *Pseudomonas mendocina* KR1 by active site engineering for the synthesis of 3-methoxycatechol, methoxyhydroquinone, and methylhydroquinone. *J. Bacteriol.* 186:4705-4713.
11. **Fishman, A.**, Tao, Y., and Wood, T.K. (2004) Toluene 3-monooxygenase of *Ralstonia pickettii* PKO1 is a *para*-hydroxylating enzyme. *J. Bacteriol*. 186:3117-3123.
12. Rui, L., Kwon, Y., **Fishman, A.**, Reardon, K.F., and Wood, T.K. (2004) Saturation mutagenesis of toluene *ortho*-monooxygenase of *Burkholderia cepacia* G4 for enhanced 1-naphthol synthesis and chloroform degradation. *Appl. Environ. Microbiol.*70:3246-3252.
13. **Fishman, A.**, Tao, Y., Bentley, W.E., and Wood, T.K. (2004) Protein engineering of toluene 4-monooxygenase of *Pseudomonas mendocina* KR1 for synthesizing 4-nitrocatechol from nitrobenzene. *Biotechnol. Bioeng.* 87:779-790.
14. **Fishman, A.**, Tao, Y., and Wood, T.K. (2004) Physiological relevance of successive hydroxylations of toluene by toluene *para*-monooxygenase of *Ralstonia pickettii* PKO1. *Biocatal. Biotrans*. 22:283-289.
15. **Fishman, A.**, Tao, Y., Rui, L., and Wood, T.K. (2005) Controlling the regiospecific oxidation of aromatics via active site engineering of toluene *para*-monooxygenase of *Ralstonia pickettii* PKO1. *J. Biol. Chem*. 280:506-514.
16. Feingersch, R., Shainsky, J., Wood, T.K., and **Fishman, A.** (2008) Protein engineering of toluene monooxygenases for synthesizing chiral sulfoxides. *Appl. Environ. Microbiol*. 74:1555-1566.

17. Nir, N., Bahalul, M., Feingersch, R., Katz-Ezov, T., Kashi, Y., and **Fishman, A.** (2008) Improvement of natural isolates of *Saccharomyces cerevisiae* strains for synthesis of (S)-4-chloro-3-hydroxybutanoic acid ethyl ester by classic genetics. *Appl. Micrbiol. Biotechnol.* 78:659-667.
18. Eshkol, N., Sendovski, M., Bahalul, M., Katz-Ezov, T., Kashi, Y., and **Fishman, A.** (2009) Production of 2-phenylethanol from L-phenylalanine by a stress tolerant *Saccharomyces cerevisiae* strain. *J. Appl. Microbiol.* 106:534-542.
19. Brouk, M., and **Fishman, A.** (2009) Protein engineering of toluene monooxygenases for synthesis of hydroxytyrosol. *Food Chem.* 116:114-121.
20. Shuster, V., and **Fishman, A.** (2009) Isolation, cloning and characterization of a tyrosinase with improved activity in organic solvents from *Bacillus megaterium*. *J. Mol. Microbiol. Biotechnol.* 17:188-200.
21. Shainsky, J., Derry, N-L., Leichtmann, Y., Wood, T.K., and **Fishman, A.** (2009) Rapid methods for high throughput detection of sulfoxides. *Appl. Environ. Microbiol.* 75:4711-4719.
22. Sendovski, M., Nir, N., and **Fishman, A.** (2010) Bioproduction of 2-phenylethanol in a biphasic ionic liquid-aqueous system. *J. Agric. Food Chem.* 58:2260-2265.
23. Brouk, M., Derry, N-L., Shainsky, J., Ben-Barak Zelas, Z., Boyko, Y., Dabush, K., and **Fishman, A.** (2010) The influence of key residues in the tunnel entrance and the active site on activity and selectivity of toluene-4-monooxygenase. *J. Mol. Catal. B:Enzymatic.* 66:72-80.
24. Brouk, M., Nov, Y., and **Fishman, A.** (2010) Improving biocatalyst performance by integrating protein engineering and statistical methods. *Appl. Environ. Microbiol.* 76:6397-6403.
25. Sendovski, M., Kanteev, M., Shuster Ben-Yosef, V., Adir, N. and **Fishman, A.** (2010) Crystallization and preliminary X-ray crystallographic analysis of a bacterial tyrosinase from *Bacillus megaterium*. *Acta Crystallography F*. 66 (9):1101-1103.
26. Shuster Ben-Yosef, V., Sendovski, M., and **Fishman, A.** (2010) Directed evolution of tyrosinase from *Bacillus megaterium* for enhanced diphenolase activity. *Enzyme Microb. Technol.*47:372-376.
27. Brouk, M., Nov, Y., and **Fishman, A.** (2010) Toward biosynthesis of a potent olive antioxidant: Integrating protein engineering and statistical methods for improved enzyme performance. *J. Biotechnol.* 150:S513 - S513.
28. Sendovski, M., Kanteev, R., Shuster Ben-Yosef, V., Adir, N., and **Fishman, A.** (2011) First structures of *Bacillus megaterium* tyrosinase reveal plasticity in copper binding. *J. Mol. Biol.* 405:227-237.
29. Achmon, Y., Goldshtein, J., Margel, S., and **Fishman, A.** (2011) Hydrophobic microspheres for *in situ* removal of 2-phenylethanol from yeast fermentation. *J. Microencapsulation.* 28:628-638.
30. Brouk M., and **Fishman, A.** (2012) Improving process conditions for hydroxytyrosol synthesis by toluene 4-monooxygenase. *J. Mol. Catal. B:Enzymatic* 84:121-127.
31. Dror, A., and **Fishman, A.** (2012) Engineering non-heme mono- and dioxygenases for biocatalysis. *Comput. Structur. Biotechnol. J.* 2 (3): e201209011. doi: http://dx.doi.org/10.5936/csbj.201209011.
32. Goldfeder, M., Egozi, M., Shuster Ben-Yosef, V., Adir, N. and **Fishman, A.** (2013) Changes in tyrosinase specificity by ionic liquids and SDS. *Appl. Microbiol. Biotechnol*. 97:1953-1961.
33. Goldfeder, M., Kanteev, M., Adir, N. and **Fishman, A.** (2013) Influencing the monophenolase/diphenolase activity ratio in tyrosinase. *BBA-Proteins and Proteomics*. 1834:629-633.
34. Shainsky, J., Bernath-Levin, K., Isaschar-Ovdat, S., Glaser, F., and **Fishman, A.** (2013) Protein engineering of nitrobenzene dioxygenase for enantioselective synthesis of chiral sulfoxides. *Prot. Eng. Des. Select.* doi:10.1093/protein/gzt005. Chosen for the cover of the May volume.

Book chapters

1. **Fishman, A.**, Tao, Y., Vardar, G., Rui, L., and Wood, T.K. (2006) Controlling regiospecific oxidation of aromatics and the degradation of chlorinated aliphatics via active site engineering of toluene monooxygenases. In: Pseudomonas: molecular biology of emerging issues, Ramos, J-L. and Levesque, R.C. Eds., Springer, Netherlands. pp. 237-286.

2. **Fishman, A.** Orange juice processing (2010) In: Food Processing. Kristbergsson, K., and Ötles, S. Eds., Springer, Netherlands.
3. Brouk M. and **Fishman, A.** Functional properties of date seeds. (2013) In: Functional Properties of Traditional Food. Kristbergsson, K., and Ötles, S. Eds., Springer, Netherlands.

Patents

1. **Fishman, A.**, Kellner, D., Ioffe, D., Shapiro, E. and Shatzmiller, S. (1996) Process for the preparation of optically active cis-3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropane carboxylic acid. Application for Israeli Patent IL 118728.
2. **Fishman, A.**, Eroshov, M., Sheffer Dee-Noor, S. and Van Mil, J. (2000) An enzymatic method for the preparation of (S)-and (R)-α-hydroxy esters. Application for an Israeli Patent, IL 134500.
3. Shapiro, E., **Fishman, A.**, Effenberger, R., Maymon, A., Schwartz, A. (2003) Selective enzymatic esterification and solvolysis of epimeric vitamin D analog and separation of the epimers. PCT Int. Appl. WO 2003060094. TEVA Pharmaceutical Industries Ltd.
4. Effenberger, R., **Fishman, A.** (2006) Enzymatic transformation of a prostaglandin (Bimatoprost) intermediate. PCT Int. Appl. WO 2006094294.
5. Hedvati, L., **Fishman, A.** (2007) Preparation of (S)-pregabalin nitrile via optical resolution of its racemate prepared from a 2-alkoxycarbonyl-3-cyano-5-methylhexanoic acid ester and its use as intermediate in the synthesis of (S)-pregabalin via optical resolution. PCT Int. Appl. WO 2007143152.
6. Hedvati, L., **Fishman, A.** (2007) Enzymatic resolution for the preparation of intermediates of pregabalin. PCT Int. Appl. WO 2007143113.
7. Perlman, N., **Fishman, A.** (2008) Reduction process for the preparation of ezetimibe. PCT Int. Appl. WO 2008151324.

CONFERENCES

Invited talks

1. Using biocatalysis to synthesize chemicals identical to natural bioactives. Fourth International Conference on Mechanisms of Action of Nutraceuticals (ICMAN4), October 21-24, 2007, Tel-Aviv, Israel.
2. Use of natural isolates of *Saccharomyces cerevisiae* strains for green chemistry. FISEB – Federation of Israel Societies for Experimental Biology, January 28-31, 2008, Eilat, Israel.
3. Directed evolution of biocatalysts for food ingredients. Food in the New Era 2008. The International Conference of the Israeli Food Industry, June 23-24, 2008, Airport City, Israel.
4. Bioproduction of 2-phenylethanol in a biphasic ionic liquid/aqueous system. The Israel Society for Microbiology Annual Meeting, March 23-24, 2009, Bar Ilan, Israel.
5. Production of a flavor and fragrance compound from yeast using a biphasic system. Food in the New Era 2009. The International Conference of the Israeli Food Industry, June 28, 2009, Airport City, Israel.
6. Evolving biocatalysts for the synthesis of phenolic antioxidants. Enzymes & Biocatalysis, April 20-22, 2010, Shanghai, China.
7. *In-situ* removal of a flavor and fragrance compound from yeast fermentation using various strategies. The 46th meeting of the Israel Institute of Chemical Engineers, IIChE2010, June 10, 2010, Haifa, Israel.
8. Trans fatty acids in health and food. Plenary talk. The Annual Meeting of the Israel Chemistry Teachers, December 27, Weizmann Institute Rehovot, Israel.

Contributed talks

1. Chemo-enzymatic synthesis of (S)-α-cyano-3-phenoxybenzyl alcohol. The 63rd meeting of the Israel Chemical Society, 1998, Tel-Aviv, Israel.
2. Enzymatic resolution of β-hydroxy esters: from conception to pilot plant realization. Enzymillennium: From enzyme evolution to industrial biocatalysis, February 2000, Tel-Aviv, Israel.

3. Enzymatic resolution of β-hydroxy esters. ChiraSource 2000, 5th Annual Conference and Exhibition, 2-4, October 2000, Lisbon, Portugal.
4. Enzymatic resolution of β-hydroxy esters: from conception to pilot plant realization. The 37th meeting of the Israel Institute of Chemical Engineers, IIChE2001, April 12, 2001, Haifa, Israel.
5. Controlling the regiospecificity of toluene oxidation *via* active site engineering of toluene para-monooxygenase of *Ralstonia pickettii* PKO1. The 41st meeting of the Israel Institute of Chemical Engineers, June 9, 2005, Tel-Aviv, Israel.
6. Directed evolution of toluene monooxygenases for controlling regiospecificity and enantioselectivity. The Israel Society for Microbiology Annual Meeting, February 21-22, 2006, Beer Sheva, Israel.
7. Protein engineering of toluene monooxygenases for controlling regiospecificity and enantioselectivity. International Congress on Bioprocessing in Food Industries, ICBF 2006, June 18-21, 2006, Patras, Greece.
8. Protein engineering of toluene monooxygenases for synthesis of chiral sulfoxides. BioTrans2007, The 8th conference on Biocatalysis and Biotransformation, July 8-13, 2007, Oviedo, Spain.
9. Protein engineering of toluene monooxygenases for synthesis of chiral sulfoxides. The American Institute of Chemical Engineers, AIChE Annual Meeting, November 4-9, 2007, Salt Lake City, Utah, USA.
10. Crystal structures of *Bacillus megaterium* tyrosinase reveal plasticity in copper binding. Biocat2010, August 29-September 2, 2010, Hamburg, Germany.
11. Combining protein engineering with statistical modeling for the novel synthesis of hydroxytyrosol by toluene 4-monooxygenase, BioTrans2011, October 2-6, 2011, Sicily, Italy.