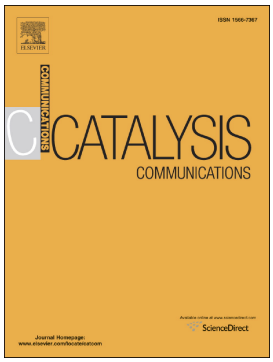

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The amine as carbonyl precursor in the chemoenzymatic synthesis of Passerini adducts in aqueous medium

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Abstract

A new simple environmentally friendly protocol based on sequential chemoenzymatic synthesis of α-acyloxy carboxyamides from amines as a carbonyl precursor is presented. For the synthesis of the desired products, biocatalytic process combining laccase/TEMPO oxidation of amine followed by Passerini reaction was developed. After a careful optimization of the reaction conditions only one of desired Passerini reaction products was obtained despite of the presence of two different carboxylic acids in reaction medium. The developed protocol offers a chemoselective and environmentally friendly procedure for the synthesis of various α-acyloxy amides with good to excellent yields.

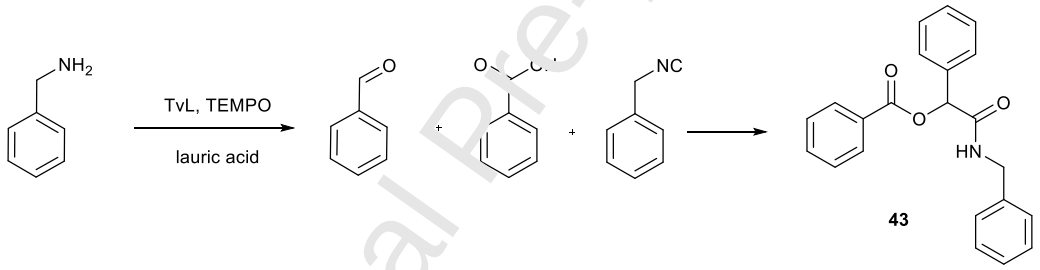
Keywords: chemoenzymatic, Passerini, laccase, enzyme, oxidation, amine

1. Introduction

The amines are important nitrogen-containing building blocks for the synthesis of valuable compounds applied in medicinal chemistry,[1] drug discovery programs,[2] combinational chemistry,[3] natural product synthesis,[4] agrochemistry[5] and polymer chemistry[6]. Moreover, naturally occurring amines such as adrenaline, histamine, serotonine, thiamine chloride, tyramine are essential for living organisms.[7] Therefore, chemists inspired by natural metabolic processes of amines try to develop new catalytic processes engaging amines as the substrates. Thus, the biomimetic oxidation reaction seems to be very attractive approach which resembles biological processes. Among all metabolites of biogenic amines, α-keto acids, aldehydes or other oxidized forms of amine-containing products are of particular significance.[8] The natural degradation of amines *via* their transformation into aldehydes is important process for organic chemistry. Currently, the selective generation of aldehydes is fundamental reaction [9] as they are important synthons and intermediates.[10] They are high-value components for the perfume or food industry as well.[11] Common procedures for the synthesis of aldehydes are based on the oxidation of alcohols or reduction of carboxylic acids.[12] However, many oxidation systems require harsh reaction conditions and produce metal-containing wastes which are intolerable for pharmaceutical or cosmetic industry.[13] Therefore, the development of new methods of generation of aldehydes *in situ* using metal-free methodologies is still desired. Interesting alternatives for the synthesis of aldehydes under mild and sustainable conditions are biocatalytic processes.[14] For example, primary amines can be oxidized to aldehydes by copper amine oxidases (CAOs) through redox cofactor and molecular oxygen. [15] Yoshida et al. reported enzymatic oxidation of vanillylamine by amine oxidase from *Aspergillus niger* as the one of the method for the synthesis of vanillin (4-hydroxy-3-methoxy benzaldehyde), an important flavor component of vanilla.[16-17] The amine dehydrogenases (AmDH) were applied for the oxidation of amines to carbonyl compounds in the presence of cofactors e.g. tryptophan tryptophyquinone (TTQ) or NAD(P).[18-19] However, these methods are limited by high cost of enzymes and cofactors.

In recent years, the selective enzymatic oxidation of wide range of electron-rich compounds in aqueous medium has been extensively studied. In this context the group of multi-copper oxidases such as laccase (EC 1.10.3.2) plays the important role.[20] Giacomini's group reported the selective oxidation of amines to aldehydes or imines *via* laccase using TEMPO as mediator and oxygen as an

electron acceptor.[21] Due to a great interest of metabolic processes, the application of aqueous liposomes solution in organic synthesis is of great importance. The usage of liposomes allows to replace an organic solvent by an aqueous surfactant system resembling the protocells model.[22-23] Interesting example of the use of liposomes as a protocells model is the synthesis of peptidomimetics.[24] The convenient method of peptidomimetics synthesis is based on Passerini reaction, an advanced tool used in medicinal chemistry and drug discovery.[25] According to the literature data, Passerini reaction can be successfully performed in the presence of liposomes.[26] However, due to the instability of aldehydes, the development of alternative sequential process combining an oxidation reaction with Passerini reaction is highly important.[27] There are several literature-known protocols for the one-pot oxidation followed by Passerini reaction. In recent years, our group has presented the important role of laccase from *Trametes versicolor* (TvL) in chemoenzymatic sequential oxidation of benzyl alcohol followed by Passerini reaction.[28] However, these methods are limited for oxidation of alcohols. The only example of the oxidative coupling of primary amines and its application for Ugi reaction involves the usage of harsh oxidant such as IBX.[29] To the best of our knowledge, oxidation of amine has yet not been attempted to obtain products of Passerini reaction under environmentally friendly conditions. Herein, we report the first synthesis of α-acyloxy carboxyamides using amines as a carbonyl precursor (Scheme 1). For this purpose the chemoenzymatic sequential reaction based on bioremediation of benzyl amines *via* TvL/TEMPO system followed by Passerini reaction was studied. The studied reaction was carried out in the aqueous medium under air atmosphere.

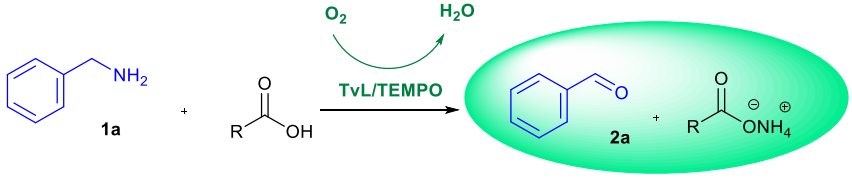


Scheme 1. The synthesis of α-acyloxy carboxyamides from amines as a carbonyl precursor.

2. Results and Discussion

Initial studies were focused on bioremediation of benzyl amine into benzaldehyde under Passerini reaction conditions in the vesicular medium. According to the literature data, the benzyl amine (**1a**) can be oxidized by laccase from *Trametes versicolor* (TvL) to the corresponding aldehyde (**2a**) in the acetic buffer pH 5.2 [21]. Moreover, Giacomini's group showed the significant influence of acetic acid on the oxidative deamination of amine in distilled water. [21] To the best of our knowledge, the acetic buffer is not an efficient solvent for Passerini reaction. As we previously reported, the phosphate buffer pH 5.2 is optimal for TvL/TEMPO oxidation of benzyl alcohol and followed Passerini reaction. [28] Therefore, the optimal conditions of oxidative deamination of benzyl amine such as the amount of TEMPO, laccase from *Trametes versicolor* and acetic acid in phosphate buffer were studied (see Supporting Information). The full conversion of amine **1a** into aldehyde **2a** was detected on GC when the reaction was conducted in phosphate buffer with addition of 1 eq of acetic acid.

Table 1. The influence of carboxylic acids on the oxidative deamination of benzyl amine.



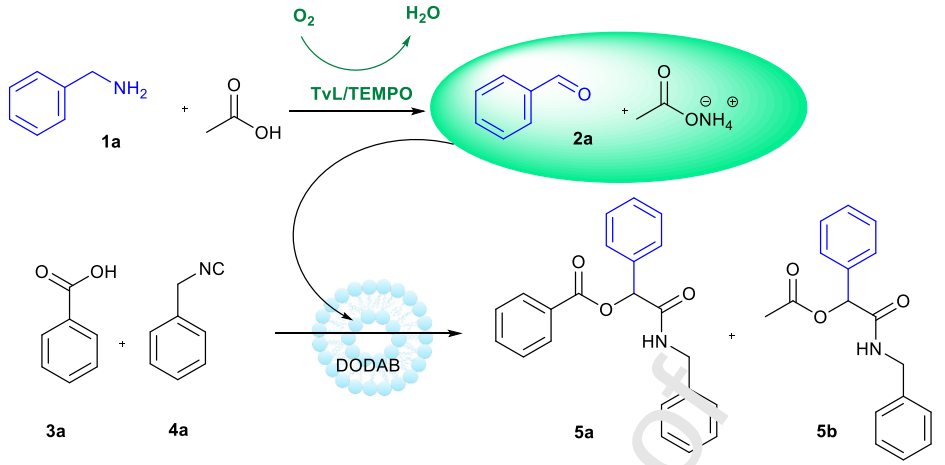
	Carboxylic acid	Yield of **2a** (%)[a,b]
1.	-	56
2.	Acetic	99
3.	Propionic	99
4.	Benzoic	67
5.	Phenylacetic	62
6.	Oleic	72
7.	Stearic	53
8.	Caprylic	65
9.	Lauric	84

[a] Reaction conditions: benzylamine (**1a**, 0.25 mmol); carboxylic acid (0.25 mmol); TEMPO (0.05 mmol); laccase from *Trametes versicolor* (25U) in 2.5 mL of phosphate buffer (100 mM, 5.2 pH) were mixed for 24 h at 30°C. [b] The reaction yield was determined on GC area

In the next set of experiments, we investigated the influence of various carboxylic acids on oxidative deamination of amine in aqueous medium (Table 1). The enzymatic oxidation performed in water without the addition of any carboxylic acids resulted in the formation of aldehyde in 56% of yield. The best results were obtained in the presence of acetic and propionic acids giving product **2a** quantitatively (Table 1, entries 2 and 3, respectively). The addition of aromatic acids such as benzyl or phenylacetic acids led to the formation of the product **2a** with 62-67% of yield (Table 1, entries 4 and 5). Moreover, we were also interested if carboxylic acids can promote oxidation of amine as well as the multicomponent reaction. According to our previous research [30], the application of micelle- or vesicle-forming fatty acids as substrates for Passerini reaction promote this reaction in water only (without the addition of surfactant). For this purpose different fatty acids (such as caprylic, lauric, stearic, oleic acids) which are also known to form micelles and/or vesicles were tested (Table 1, entries 6-9). The reaction carried out with lipophilic, high-melting stearic acid provided product **2a** with lower yield than in water (56% *vs* 53%; Table 1, entries 1 and 7). The application of caprylic, oleic or lauric acids slightly improved the reaction course (Table 1, entries 6-9). As the best result was obtained in the presence of acetic acid, this compound was selected for further studies.

In the next step, the influence of surfactants on the oxidation process was studied. We tested series of surfactants including non-ionic, cationic, anionic and zwiterrionic surfactants. However, for all performed experiments, the addition of surfactant gave aldehyde **2a** with lower yield than in water only (see Supporting information). When cationic surfactants such as DDAB (didodecyldimethylammonium bromide) or DODAB(dimethyldioctadecylammonium bromide) were used, the desired aldehyde was obtained with 80 and 87% yield, respectively. With this data in hand, the one-pot chemoenzymatic sequential oxidation-Passerini reaction was performed. For the model reaction benzyl amine (**1a**), benzoic acid (**3a**) and benzyl isocyanide (**4a**) were selected as substrates. For the first 24 hours, an enzymatic oxidative deamination of **1a** with acetic acid and lacccase/TEMPO system took place and then benzoic acid and benzyl isocyanide were added. The proposed protocol may lead to the formation of two products of Passerini reaction: 2-(benzylamino)-2-oxo-1-phenylethyl benzoate (**5a**) and 2-(benzylamino)-2-oxo-1-phenylethyl acetate (**5b**). First, the studies on the combination of the oxidative deamination of benzyl amine with subsequent Passerini reaction in aqueous solvents were performed (Table 2).

Table 2. The studies on chemoenzymatic sequential oxidation-Passerini reaction



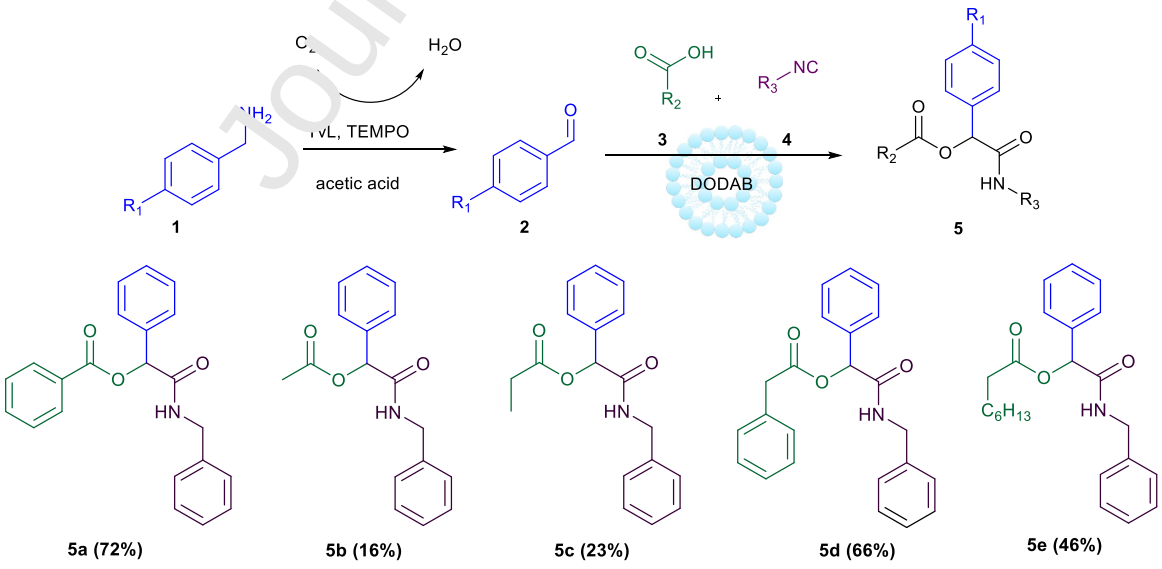
	Solvent	Surfactant	Yield of **5a** (%)[a,d]	Yield of **5b** (%)[a]
1.	Water	-	40	-
2.	Water	DODAB[b]	64	-
3.	Water	DODAB[c]	59	-
4.	PBS 5.2pH	-	45	-
5.	PBS 5.2 pH	DODAB[b]	72	-
6.	PBS 5.2 pH	DODAB[c]	51	-

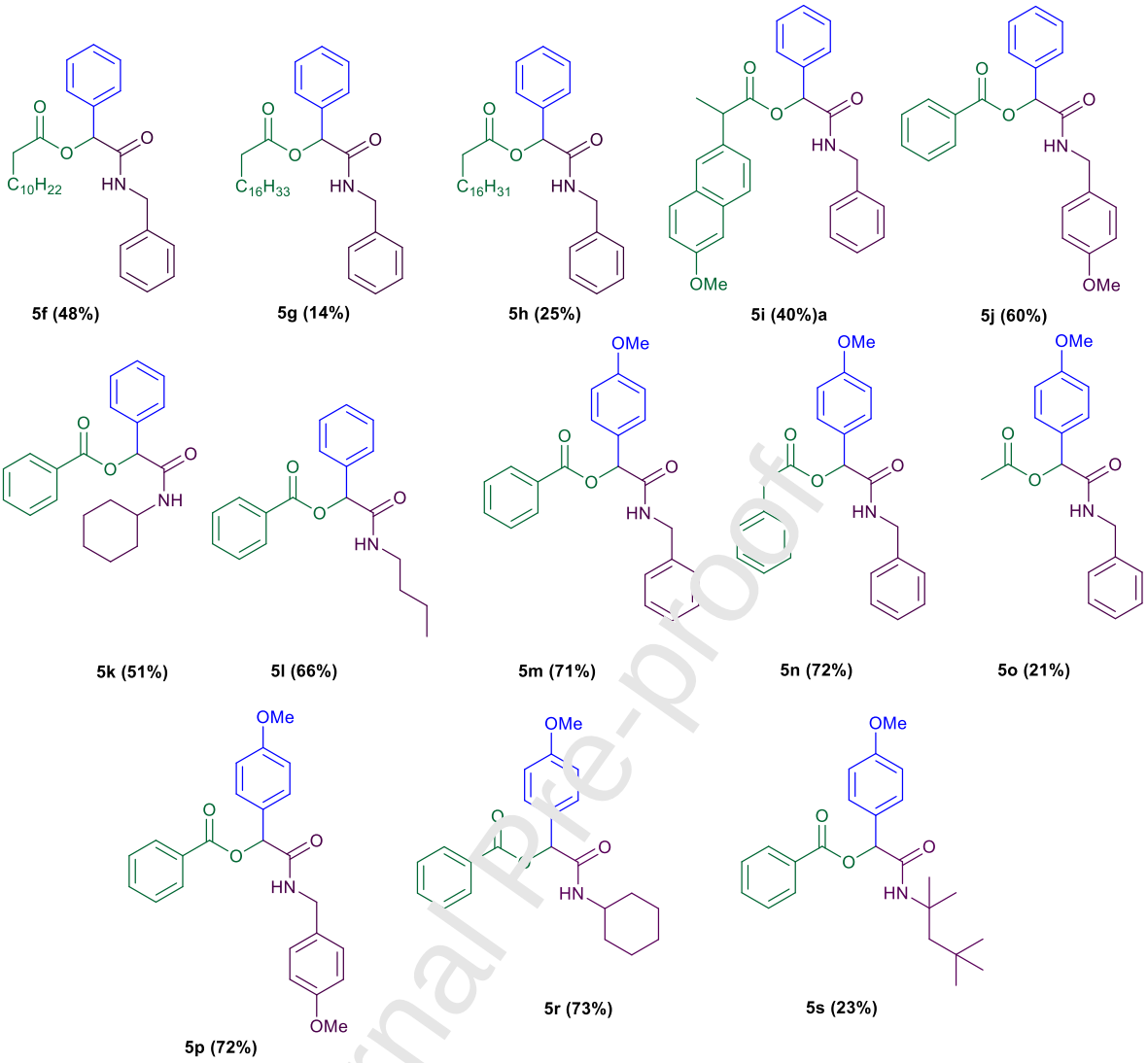
[a] Reaction conditions: benzylamine (**1a**, 0.25 mmol); acetic acid (0.25 mmol); TEMPO (0.05 mmol); laccase from *Trametes versicolor* (25U) were mixed in 2.5 mL of solvent for 24 h at 30°C. Then, benzoic acid (**3a**, 0.25 mmol) and benzyl isocyanide (**4a**, 0.25 mmol) were added and the reaction was stirred for additional 24 h. [b] DODAB (20 mol%) was added after oxidation step. [c] The oxidation was carried out in the presence of DODAB (20 mol%). [d] The yield of isolated product.

During our studies, we performed proposed reactions in distilled water or in phosphate buffer (5.2 pH), a common solvent used for oxidation reaction *via* laccase from *Trametes versicolor*.[28] Moreover, we were interested whether the chemoenzymatic sequential oxidative deamination of amine **1** to aldehyde **2** followed by Passerini reaction can be achieved in the presence of liposomes. Therefore, the chemoenzymatic sequential one-pot oxidation-Passerini reaction in distilled water in the presence of 1 eq of acetic acid were performed. Among all expected products, compound **5a** was obtained as the only product with 40% yield (Table 2, entry 1). Although the oxidation of amine in the presence of acetic acid in water proceeded quantitative, the yield of **5a** was not satisfying for the whole process. Based on our previous work, the reaction efficiency could be improved by the addition of protocells (aggregates of surfactants). [26,28] Thus, in the next step we have studied the impact of DODAB on chemoenzymatic sequential reaction efficiency. Two various cases were tested - when both reaction steps were carried out in the presence of DODAB (Table 2, entry 3) or when the surfactant was added after the oxidation step (Table 2, entry 2). In both cases the product of **5a** was obtained with good yield, however the slightly better results was observed when DODAB was applied only for second reaction step (Table 2, entry 2). Moreover, we have also performed similar experiments used phosphate buffer pH 5.2 as medium (Table 2, entries 4-6). Comparing the chemoenzymatic sequential reaction performed in distilled water with reaction in PBS (5.2 pH), product **5a** was obtained with better yield when PBS was used as reaction medium (Table 2, entry 5). As the stability and activity of laccase from *Trametes versicolor* strictly depend on reaction conditions such as e.g. pH, concentration of surfactant, temperature, [31-34] we have also performed the studies on the optimization of reaction conditions such as time, type and concentration of surfactant, pH value (Supporting Information). The obtained results showed that the best efficiency was

observed when the chemoenzymatic sequential reaction was conducted in PBS pH 5.2 in the presence of 20 mol% of DODAB during 48 hours, providing product of **5a** with 72% yield.

With the optimized reaction conditions in hand, the generality and scope of this new procedure were performed providing to α-acyloxycarboxamides **5a**-**5s** (Scheme 2). The series of experiments with various aromatic amines **1**, carboxylic acids **3** and isocyanides **4** were carried out in the presence of surfactants. The amine **1** was mixed with laccase, TEMPO and acetic acid in phosphate buffer at 30 °C. Then, after 24hours DODAB as well as **3** and **4** were added and resulted mixture was stirred for 24 hours at 30°C. When benzyl amine **1a**, various acids **3** and benzyl isocyanide **4a** were used as substrates, Passerini reaction products **5a**-**5i** were isolated with yields up to 72%. The application of acetic acid and propionic acid as substrates resulted in the formation of products **5b** and **5c** with 16% and 23% yield, respectively. The reaction with phenylacetic acid gave product **5d** with 66% yield. Then, the application of sustainable acids was verified. The chemoenzymatic sequential reactions with caprylic, lauric, stearic, oleic acids gave products **5e**-**5h** up to 48%. The best results were obtained when the caprylic (46%) or lauric acids (48%) were used. Additionally, the influence of DODAB protocells on the diastereoselectivity of Passerini reaction was studied. For this purpose, the reaction with benzyl amine **1a**, (*S*)-naproxen **3i** and benzyl isocyanide **4a** was performed. The product **5i** was obtained with 40% yield as a mixture of diastereomers (dr: 1:1). Next, the influence of different isocyanides on chemoenzymatic sequential reaction course was investigated. The model reraction with *p*-methoxybenzyl isocyanide gave product **5j** with 60% yield. The reaction with *n*-butyl and cyclohexyl isocyanide **4k** resulted in the formation of products **5k** and **5l** (51% and 46% of yield, respectively). The change of benzyl amine **2a** το π–μετηοξψβενζψλ αμινε **2μ** ρ συλτεδ in the formation of product **5m** with 71% yield. The Passerini reaction with phenylacetic acid gave products **5n** and **5o** (71% and 21%, respectively). Reaction with *p*-methoxybenzyl isocyanide and cyclohexyl isocyanide resulted in product **5p** and **5r** with yield about 72%. The use of 1,1,3,3-tetramethylbutyl isocyanide gave low yield of **5s** (23%). In any of cases, the formation of the Passerini reaction products form acetic acids were not observed. This indicates that proposed methodology is chemoselective in the presence of protocells model.

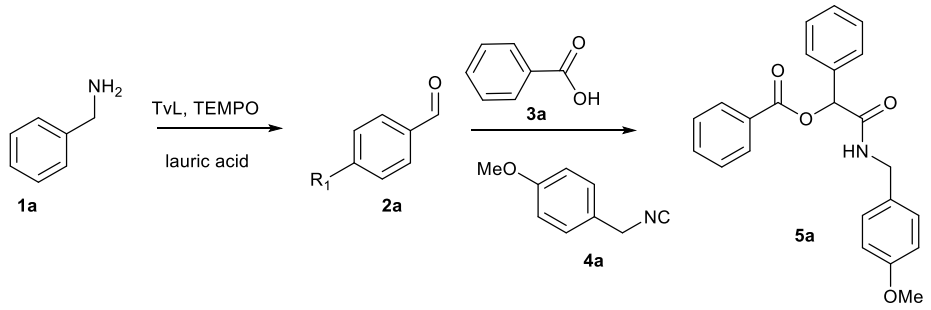




Reaction conditions: benzylamine (**1a**, 0.25 mmol); acetic acid (0.25 mmol); TEMPO (0.05 mmol), laccase from *Trametes versicolor* (2.5U) were mixed in 2.5 mL of phosphate buffer (100 mM, pH 5.2) for 24 h at 30°C. Then, DODAB (20 mol%), carboxylic acid (**3**, 0.25 mmol) and isocyanide (**4**, 0.25 mmol) were added. Then, the reaction was stirred for additional 24h. Isolated yield. [a] Mixture of diastereoisomers, dr = 1 : 1

Scheme 2. Scope and limitation of the TvL/TEMPO oxidation P-3CR system.

Next, we were interested whether carboxylic acid can promote oxidation of amine as well as be used as a substrate in subsequent Passerini reaction. On this purpose four carboxylic acids such as acetic acid, propionic acid, benzoic acid and phenylacetic acid were selected. They were initially used to promote oxidative deamination of **1a** to **2a**. Additionally, the experiments in which second equivalent of the same carboxylic acid is added after oxidation step were performed. However, among all selected acid only the reaction with acetic acid gave satisfying results (see Supporting Information). As the addition of lauric acid promotes successfully the oxidation of benzylamine (Table 1, entry 9), we have also tested if this acid can be used as a surfactant in Passerini reaction (instead of DODAB)[29] thus all steps of proposed reaction could be conducted in the presence of lauric acid (Scheme 3).



Scheme 3. Chemoenzymatic sequential Passerini reaction in the presence of lauric acid.

To gain this goal, the chemoenzymatic sequential reaction in the presence of lauric acid was performed (Scheme 3). The reaction with benzyl amine (**1a**), laccase/TEMPO system and lauric acid was carried out for the first 24hrs and then benzoic acid (**3a**) and benzyl isocyanide (**4a**) were added. The addition of lauric acid has beneficial influence on all steps of sequential reaction leading to the formation of product **5a** with 50% yield. The by-product of Passerini reaction with lauric acid was observed only on TLC and was not isolated.

3. Conclusions

We have developed a new environmentally friendly chemoselective one-pot chemoenzymatic oxidation-Passerini reaction in the presence of protocells model. For the first time the amines were used as precursors of carbonyl compounds to the synthesis of α-acyloxy carboxyamides. The methodology based on the TvL/TEMPO oxidation of amines followed by Passerini reaction in the presence of protocells of DODAB was established. To improve efficiency of oxidative deamination of amines, the addition of acetic acid was needed. To make the procedure more sustainable, fatty acids were also used as substrates for Passerini reaction or to promote the oxidative deamination of amine. After detailed optimization of reaction conditions, the scope of substrates was investigated. In all cases only one product of Passerini reaction was received with good to excellent yield what indicates the chemoselective course of Passerini reaction in the aqueous medium. Aditionally the developed methodology is free from transition metal, harsh oxidants or organic solvents what is desirable from an environmental point of view.

4. Expermental section

Experimental details and characterization of products are given in Supporting Information.

Acknowledgements

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References

[1] S. Kłossowski, A. Muchowicz, M. Firczuk, M. Świech, A. Redzej, J. Golab, R. Ostaszewski, Studies toward Novel Peptidomimetic Inhibitors of Thioredoxin–Thioredoxin Reductase System, J. Med. Chem. 55 (2012) 55-67. https://doi.org/10.1021/jm201359d.

[2] E. Ruijter, R. V. A. Orru, Multicomponent reactions – opportunities for the pharmaceutical industry. Drug Discovery Today Technol. 10 (2013) e15-20. https://doi.org/10.1016/j.ddtec.2012.10.012.

[3] W. H. Moos, C. R. Hurt, Morales, G. A. Combinatorial chemistry: oh what a decade or two can do. Mol. Diversity. 13 (2009) 241-245. https://doi.org/10.1007/s11030-009-9127-y
[4] B. B. Tour, D. G. Hall, Chem. Rev. 109 (2009) 4439-4486. https://doi.org/ 10.1021/cr800296p.
[5] C. Lamberth. Multicomponent reactions in crop protection chemistry. Bioorg. Med. Chem. 28 (2020) 115471. https://doi.org/10.1016/j.bmc.2020.115471.
[6] R. Kakuchi, Multicomponent Reactions in Polymer Synthesis. Angew. Chem. Int. Ed. 53 (2014) 46-48. https://doi.org/ 10.1002/anie.201305538.
[7] M. B. A. Gloria, Encyclopedia of Food Sciences and nutrion. Second Edition. 2003, 173.
[8] D. E Edmondson, A Mattevi, C Binda, M Li, F. Hubálek, Structure and mechanism of monoamine oxidase. Curr Med Chem. 11 (2004) 1983-1993. https://doi.org/ 10.2174/0929867043364784.
[9] M. Pagliaro, S. Campestrini, R. Ciriminna, Ru-based oxidation catalysis. Chem. Soc. Rev. 34 (2005) 837-845. https://doi.org/10.1039/B507094P.
[10] J. H. Teles, I. Hermans, G. Franz, R. A. Sheldon, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2015, DOI: 10.1002/14356007.a18_261.pub.
[11] U. R. Pillai, E. Sahle-Demessie, Oxidation of alcohols over Fe3+/montmorillonite-K10 using hydrogen peroxide Appl. Catal. Gen. 245 (2003) 103-109. https://doi.org/10.1016/S0926-860X(02)00617-8.
[12] I. E. Marko, P. R. Giles, M. Tsukazaki, I. Che´lle-Regnaut, A. Gautier, M. S. Brown, C. J. Urch, Efficient, Ecologically Benign, Aerobic Oxidation of Alcohols. J. Org. Chem. 64 (1999) 2433-2439. https://doi.org/10.1021/jo982239s.
[13] M.; Gupta, Paul, S.; Gupta, R. General aspects of 12 basic principles of green chemistry with applications. Curr. Sci. 99 (2010) 1341-1360. https://www.jstor.org/stable/i24069032.
[14] J. Dong, E. Fernández-Fueyo, F. Hollmann, C. E. Paul, M. Pesic, S. Schmidt, Y. Wang, S Younes, W. Zhang, Biocatalytic Oxidation Reactions: A Chemist's Perspective. Angew. Chem. Int. Ed. 57 (2018) 9238-9261. https://doi.org/10.1002/anie.201800343.
[15] M. Largeron, Aerobic catalytic systems inspired by copper amine oxidases: recent developments and synthetic applications. Org. Biomol. Chem. 15 (2017) 4722-4730. https://doi.org/10.1039/C7OB00507E.
[16] A. Yoshida, Y. Takenaka, H. Tamaki, I. Frefibort, O. Adachi, H. J. Kumagai, Vanillin formation by microbial amine oxidases from vanillylamine. J. Ferment. Bioeng. 84 (1997) 603-605. https://doi.org/10.1016/S0922-338X(97)81920-4.
[17] H. Priefert, J. Rabenhorst, Steinbüchel, Appl Microbiol Biotechnol. 56 (2001) 296-314. https://doi.org/10.1007/s002530100687.
[18] V. L. Davidson, Electron transfer in quinoproteins. Arch. Biochem. Biophys. 428 (2004) 32-40. https://doi.org/ 10.1016/j.abb.2004.03.022.
[19] G. Golime, G. Bogonda, , H. Y. Kim, K. Oh, Biomimetic Oxidative Deamination Catalysis via ortho-Naphthoquinone-Catalyzed Aerobic Oxidation Strategy. ACS Catal. 8 (2018) 4986-4990. https://doi.org/ 10.1021/acscatal.8b00992.
[20] R. Hilger, J.-P. Vincken, H. Gruppen, M. A. Kabel, Laccase/Mediator Systems: Their Reactivity toward Phenolic Lignin Structures. ACS Sustainable Chem. Eng. 6 (2018) 2037-2046. https://doi.org/ 10.1021/acssuschemeng.7b03451.
[21] P. Galletti, F. Funiciello, R. Soldati, D. Giacominia, Selective Oxidation of Amines to Aldehydes or Imines using Laccase-Mediated Bio-Oxidation. Adv. Synth. Catal. 357 (2015) 1840-1848. https://doi.org/10.1002/adsc.201500165.
[22] M. Ghandi, M. T. Nazeri, M. Kubicki, An efficient one-pot, regio- and stereoselective synthesis of novel pentacyclic-fused pyrano[3,2,c]chromenone or quinolinone benzosultone derivatives in water. Tetrahedron. 69 (2013) 4979-4989. https://doi.org/ 10.1016/j.tet.2013.04.018.
[23] P. Klumphu, B.H. Lipshutz, “Nok”: A Phytosterol-Based Amphiphile Enabling Transition-Metal-Catalyzed Couplings in Water at Room Temperature. J. Org. Chem. 79 (2014) 888-900. https://doi.org/ 10.1021/jo401744b.

[24] J. Gante, Peptidomimetics-Tailored Enzyme Inhibitors. Angew. Chem. Int.Ed. 33 (1994) 17, 1699-1720. https://doi.org/10.1002/anie.199416991.
[25] A. Domling, W. Wang, K. Wang, Chemistry and Biology Of Multicomponent Reactions. Chem. Rev. 112 (2012) 3083-3135. https://doi.org/ 10.1021/cr100233r.
[26] D. Paprocki, D. Koszelewski, P. Walde, R.Ostaszewski, Efficient Passerini reactions in an aqueous vesicle system. RSC Adv. 5 (2015) 102828-102835. https://doi.org/ 10.1039/C5RA22258C.
[27] T. Ngouansavanh, J. Zhu, Alcohols in Isonitrile-Based Multicomponent Reaction: Passerini Reaction of Alcohols in the Presence of O-Iodoxybenzoic Acid. Angew. Chem. Int. Ed, 45 (2006) 3495-3497. https://doi.org/ 10.1002/anie.200600588.
[28] D. Paprocki, D. Koszelewski, A. Żądło, P. Walde, R. Ostaszewski, Environmentally friendly approach to α-acyloxy carboxamides via a chemoenzymatic cascade. RSC Adv. 2016, 6, 68231-68237. https://doi.org/10.1039/C6RA13078J.
[29] K. Singh, A. Kaur, V. S. Mithu, S. Sharma, Metal-Free Organocatalytic Oxidative Ugi Reaction Promoted by Hypervalent Iodine. J Org Chem. 82 (2017) 5285-5293. https://doi.org/ 10.1021/acs.joc.7b00594.
[30] D. Paprocki, M. Wilk, A. Madej, P. Walde, R. Ostaszewski, Catalyst-free synthesis of α-acyloxycarboxamides in aqueous media. Environ Chem Lett. 17 (2019) https://doi.org/10.1007/s10311-018-0797-5.
[31] M. J. Han, H. T. Choi, H. G. J. Song, Purification and characterization of laccase from the white rot fungus Trametes versicolor. Microbiol. 43 (2005) 555-560.
[32] L. A. Beaudette, O. P. Ward, M. A. Pickard, P. M. Fedorak, Low surfactant concentration increases fungal mineralization of a polychlorinated biphenyl congener but has no effect on overall metabolism. Lett. Appl. Microbial, 30 (2000) 155-160. https://doi.org/ 10.1046/j.1472-765x.2000.00700.x.
[33] J. Michizoe, H. Ichinose, N. Kamiya, T. Maruyama, M. Goto, Biodegradation of phenolic environmental pollutants by a surfactant-laccase complex in organic media. J. Biosci. Bioeng., 99 (2005) 642-647. https://doi.org/ 10.1263/jbb.99.642.
[34] P.-P. Champagne, M. E. Nesheim, J. A. Ramsay, Effect of a non-ionic surfactant, Merpol, on dye decolorization of Reactive blue 19 by laccase. Enzyme and Microbial Technology, 2010, 46, 147-152. https://doi.org/ 10.1016/j.enzmictec.2009.10.006.

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Dear Sir/Madam,

We are submitting CRediT author statement for manuscript entitled „ *The amine as carbonyl precursor in the chemoenzymatic synthesis of Passerini adducts in aqueous medium*" CATCOM-D-20-00271R2.
Arleta Madej: Investigation, Chemical experiments, Enzymatic experiments, Writing- Original draft preparation, Visualization,
Dominik Koszelewski; Investigation, Data curation
Daniel Paprocki: Investigation,
Anna Brodzka: Language corrections, editing
Ryszard Ostaszewski: Corresponding author, Supervision. Conceptualization, editing, submission of manuscript.
Yours sincerely,

Ryszard Ostaszewski

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Ryszard Ostaszewski for manuscript entitled „*The amine as carbonyl precursor in the chemoenzymatic synthesis of Passerini adducts in aqueous medium*"
Ref. No.: CATCOM-D-20-00271R2.

Highlights

A new environmentally friendly method for the synthesis of α-acyloxy carboxyamides was evaluated.

It consists sequential enzymatic oxidation of amines into aldehydes followed by Passerini reaction.

A tandem one pot - two step protocol was elaborated.

For the first time chemoselective Passerini reaction was achieved.