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L'Abbé Rearrangement Enables Access to N-Amino-1,2,3-Triazoles from Pyridotriazole Carbaldehydes with Hydrazine Derivatives

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Abstract: A facile and efficient method for the synthesis of N-amino-1,2,3-triazoles has been established by means of the L'Abbé rearrangement and a “snap-trapping” strategy, with water as the only byproduct. This reaction exhibits prominent advantages including high reactivity, broad functional group tolerance, exceptionally clean reaction profiles and extremely mild conditions, which endows it with promising applications in synthetic and medicinal chemistry.

Keywords: L'Abbé rearrangement,
N-Amino-1,2,3-triazoles,
Pyridotriazole carbaldehydes ,
Hydrazine derivative

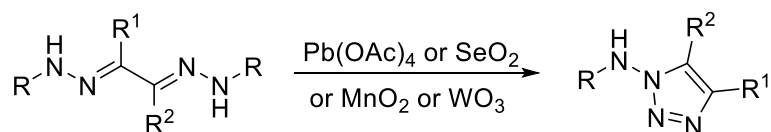
Introduction

Since 1,2,3-triazole was first reported in 1893, it has exhibited broad application prospects and development value in many fields such as medicine¹⁻³, pesticides⁴, materials science⁵⁻⁶ and fine chemical industry⁷⁻⁸ due to its unique molecular structure and chemical and biological properties. The premier work on 1,2,3-triazole synthesis can be dated back to 1960s by Huisgen's 1,3-dipolar cycloaddition of alkynes with organic azides⁹⁻¹¹. Subsequently, the metal-catalyzed azide alkyne cycloaddition from Sharpless, Meldal and Fokin has involved in the concept of "click" chemistry and regiospecific assembly polysubstituted 1,2,3-triazoles¹²⁻¹⁸. Despite the fact that this click reaction is regarded as a versatile strategy for the synthesis of 1-alkyl or aryl-substituted 1,2,3-triazoles, N-amino-1,2,3-triazoles are not accessible through this approach.

N-amino-1,2,3-triazoles have been studied for their application as antibiological agents due to the triazole nucleus is able to bind to a variety of enzymes and receptors in different biological systems¹⁹⁻²⁴. Moreover, N-amino-1,2,3-triazoles have also been applied as energetic materials, assuming a pivotal role in industrial manufacturing and national defense infrastructure²⁵⁻²⁶. Owing to their multifarious and prominent properties, extensive efforts have been devoted to the development of various methods for the synthesis of N-amino-1,2,3-triazoles. The earlier reported method for the synthesis of N-amino-1,2,3-triazoles is the oxidation of bishydrazone using lead(IV) acetate or selenium dioxide following acid hydrolysis (Scheme 1A)²⁷⁻²⁸. However, the cytotoxicity of both lead (a heavy metal) and selenium has caused environmental pollution problems and limited their potential application in life science and pharmaceutical industry. Although the conventional MnO_2/WO_3 -mediated strategy on the synthesis of

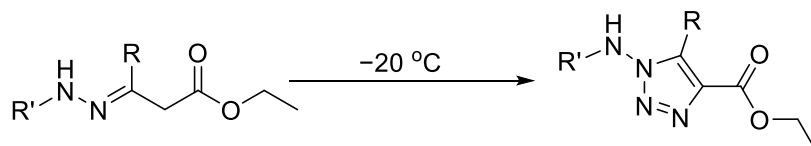
N-amino-1,2,3-triazole involved oxidation of glyoxal derived dihydrazones has been exploited, considerable disadvantage like the poor product selectivity still exists in the process (Scheme 1A)²⁹⁻³⁰. Recently, regitz diazo transfer reaction for the preparation of N-amino-1,2,3-triazoles from β -keto esters derived hydrazones has been developed (Scheme 1B)³¹⁻³³. Nonetheless, the harsh reaction conditions and narrow substrate scopes hinder extensive application of this method. Interestingly, Dimroth rearrangement of 1,2,3-thiadiazolyl-hydrazones has been investigated as an elegant and efficient tool for the synthesis of N-amino-1,2,3-triazoles, which has focused our attention on this transformation (Scheme 1C)^{23,34}. Notably, as a variant of the Dimroth rearrangement, the L'abbé rearrangement features an unusual amine-swapping transformation, in which the triazole ring undergoes opening and reclosure via ring-chain tautomerization, followed by the hydrolysis of the newly formed triazole³⁵⁻³⁶. Representatively, the L'abbé rearrangement has been applied to the labeling of complex biomolecules from pyridotriazole carbaldehydes (PTACs) with primary alkyl amines³⁷⁻³⁸. Inspired by this work, we envisaged that pyridotriazole carbaldehydes (PTACs) could enable labeling of hydrazine derivatives access to N-amino-1,2,3-triazoles by a “snap-trapping” process, thereby realizing a highly efficient L'abbé rearrangement (Scheme 1D).

A. The oxidation of bishydrazones using $\text{Pb}(\text{OAc})_4$ or SeO_2 or MnO_2 or WO_3



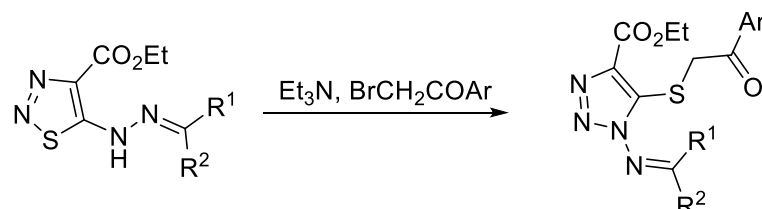
- Environmental pollution
- Poor product selectivity
- Limited application in life science and pharmaceutical industry

B. Regitz diazo transfer reaction for the preparation of N-amino-1,2,3-triazoles

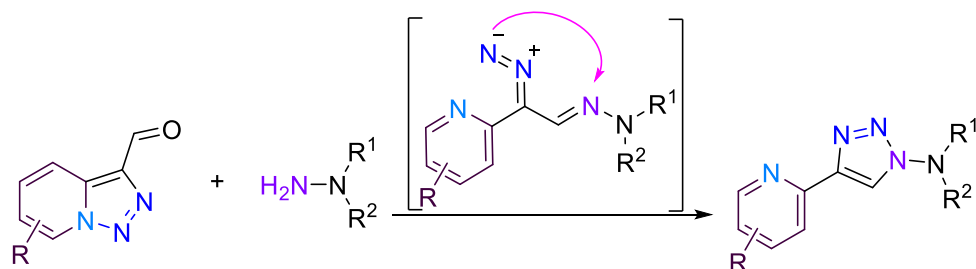


- Harsh reaction conditions
- Narrow substrate scopes

C. Dimroth rearrangement for the synthesis of N-amino-1,2,3-triazoles



D. This work: L'abbé rearrangement for the synthesis of N-amino-1,2,3-triazoles



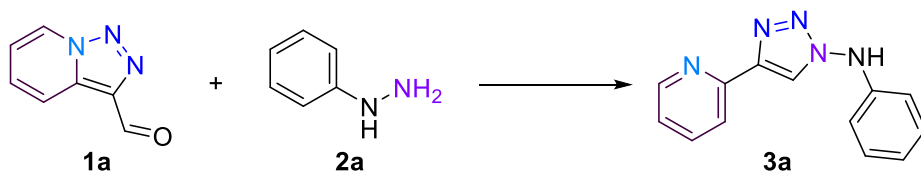
Scheme 1. The synthesis of N-amino-1,2,3-triazoles

Results and Discussion

The hypothesis was confirmed by an initial examination of PTAC **1a** labeling of phenylhydrazine **2a** in THF at room temperature, and the preliminary result was encouraging in that the desired product **3a** was formed efficiently and isolated in 89% yield (Table 1, entry 1). Further optimization of reaction conditions such as solvents and additives, the reaction exhibited excellent robustness (Table 1, entries 2–12). For instance, treatment of the L'abbé rearrangement in DCM furnished the product **3a** in 94% yield, thus DCM was identified as the optimal reaction medium (Table 1, entry 2). Interestingly, the addition of regular acids, bases or Good's buffer had minimal impact on the reaction efficiency in

DCM, with **3a** afforded in nearly identical isolated yields (Table 1, entries 9–13).

Table 1. Optimization of Reaction Conditions^a

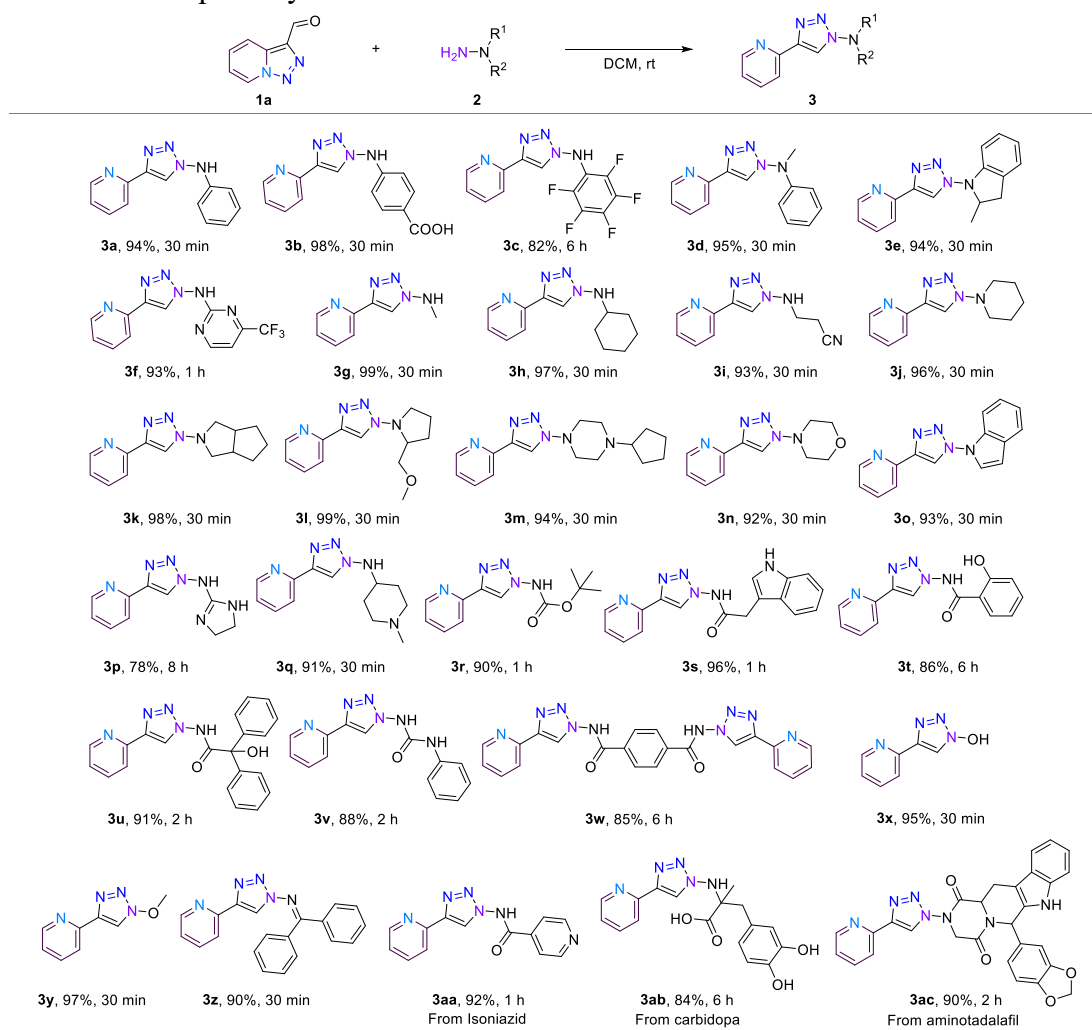
			
entry	additive (0.1 eq)	solvent	yield ^b (%)
1	—	THF	89
2	—	DCM	94
3	—	MeCN	88
4	—	toluene	86
5	—	1,4-dioxane	88
6	—	EtOH	90
7	—	DMF	89
8	—	DMSO	92
9	AcOH	DCM	95
10	TsOH	DCM	96
11	Et ₃ N	DCM	91
12	DBU	DCM	90
13	MOPS	DCM	95

^aReaction conditions: pyridotriazole carbaldehyde **1a** (0.5 mmol), phenylhydrazine **2a** (1.1 equiv, 0.55 mmol) and additive (0.1 equiv, 0.05 mmol) were stirred in 2 mL of solvent at room temperature for 30 min. ^bIsolated yield of **3a** based on **1a**. THF, tetrahydrofuran; DCM, dichloromethane; DMF, *N,N*-dimethylformamide; DMSO, dimethyl sulfoxide; DBU, 1,8-diazabicyclo[5.4.0]undec-7-ene; MOPS, 3-(*N*-morpholino)propanesulfonic acid.

Having established the optimal conditions, we examined the scope and generality of this rearrangement reaction with respect to a range of hydrazine derivatives. As shown in Scheme 2, a variety of hydrazine derivatives were suitable for this rearrangement reaction and the corresponding *N*-amino-1,2,3-triazole derivatives were rendered in

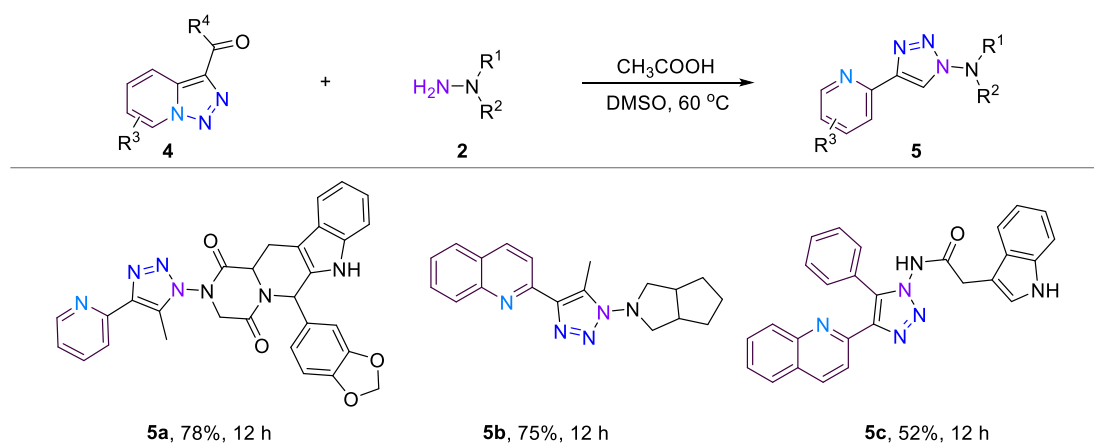
satisfactory yields. Initially, various aromatic hydrazines participated in this rearrangement transformation to deliver structurally diverse N-amino-1,2,3-triazoles in good to excellent yields (**3a–3f**). It is worth noting that electronic effects had negligible impact on this transformation (**3b–3f**), whereas steric hindrance exerted a significant influence on the reaction outcome (**3c**). Focus was placed on alkyl hydrazine derivatives, which were compatible with this transformation, leading to the targeted products with good reactivities (**3g–3l**). Hydrazine derivatives with heterocyclic scaffold were also good candidates for this rearrangement reaction, and the corresponding products were obtained in moderate to excellent yields (**3m–3q**). Utilizing this protocol, the installation of hydrazide and hydrazinecarboxamide moiety proceeded in good to excellent yields (**3r–3w**). Notably, the disubstituted hydrazide moiety was readily incorporated into dual-triazole product **3w** in 85% yield. The transformation was not limited to hydrazine, hydroxylamine and hydrazone were also competent substrates and the corresponding products were afforded in excellent yields (**3x–3z**). Remarkably, the hydrazine derivatives derived from drug molecules could also be modified in satisfactory yields as exemplified by the drug analogues **3aa–3ac**.

Scheme 2. Scope of hydrazine derivatives with PTAC^a



^aReaction conditions: pyridotriazole carbaldehyde **1a** (0.5 mmol) and hydrazine derivatives **2** (1.1 equiv, 0.55 mmol) were stirred in 2 mL of DCM at room temperature for given time. Isolated yields are shown.

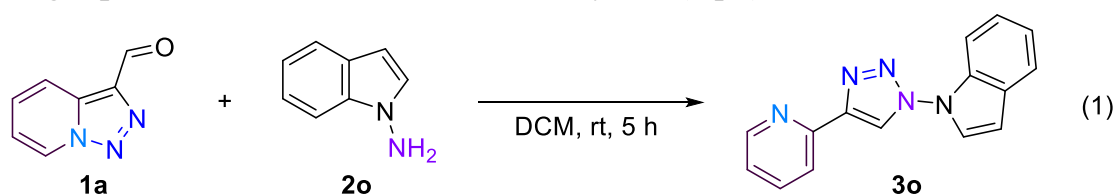
Scheme 3. Scope of hydrazine derivatives with PTACs^a



^aReaction conditions: PTACs **4** (0.5 mmol), hydrazine derivatives **2** (1.1 equiv, 0.55 mmol) and AcOH (0.5 mmol, 1 eq) were stirred in 2 mL of DMSO at $60\text{ }^\circ\text{C}$ for 12 h. Isolated yields are shown.

Moving on to the substrate scope with respect to the pyridotriazole carbaldehydes (PTACs), both acetic acid and elevated temperature were found to be indispensable for promoting the reaction. As shown in Scheme 3, starting from pyridotriazolone incorporating the agent aminotadalafil (for relieving erectile dysfunction) in dimethyl sulfoxide, the target product **5a** could be successfully obtained in 78% yield. Quinolinotriazolone appended with hydrazine derivatives were also compatible with this transformation, leading to the corresponding products **5b** and **5c** in 75% and 52% yield, respectively. Due to the steric hindrance of the benzene ring fragment in the molecule, the compound **5c** exhibited a lower yield in compared with the compounds **5b**.

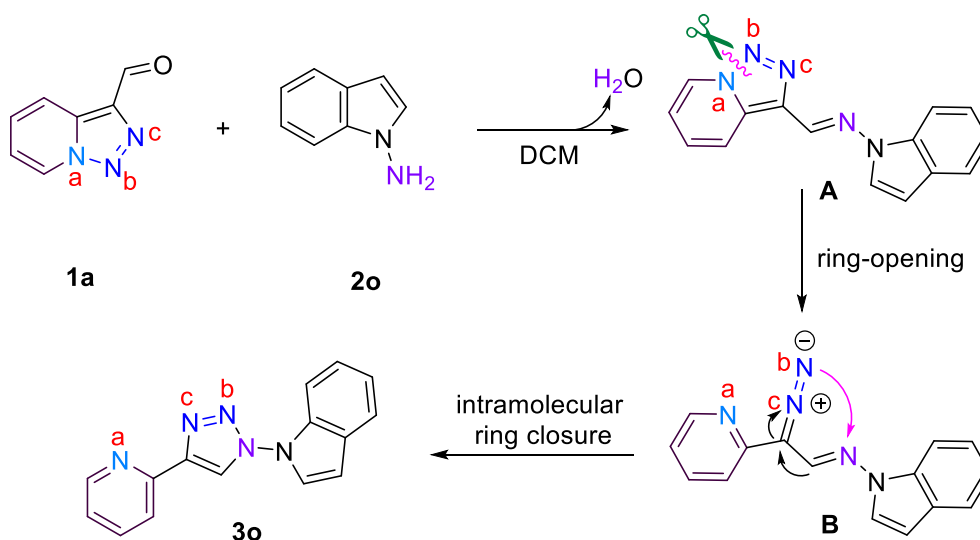
To prove the practicality of this rearrangement reaction, a gram scale synthesis of N-indolyl-1,2,3-triazole **3o** was performed under the standard conditions. When 1.47 g of pyridotriazole carbaldehyde **1a** (10 mmol) and 1.45 g of 1H-indol-1-amine **2o** (11 mmol) were loaded, 2.48 g of the target product **3o** was obtained in 95% yield (eq 1).



Based on the basis of previous reports³⁵⁻³⁸, a plausible reaction

mechanism for the L'Abbé rearrangement of PTACs is depicted in Scheme 4. Initially, iminomethyl pyridotriazole **A** was formed through a sequence of imine condensation of pyridotriazole carbaldehyde **1a** and 1*H*-indol-1-amine **2o**, with water as the sole byproduct. Density functional theory (DFT) calculations reveal that the N_a–N_b bond is weakened owing to reduced orbital overlap between the diazo moiety (N_b = N_c) and the nitrogen atom of the adjacent pyridine ring³⁹. Therefore, pyridyl diazoimine **B** could be generated from **A** via ring-opening of the triazole moiety. Ultimately, intramolecular ring closure of the diazoimine **B** at the newly incorporated imino nitrogen yields the pyridyl triazole **3o**.

Scheme 4. Plausible Reaction Pathways



Conclusions

In summary, we have successfully developed a straightforward and efficient approach for the synthesis of N-amino-1,2,3-triazoles involved with L'abbé rearrangement by a “snap-trapping” process. With advantages such as high reactivity, wide functional group tolerance, exceptionally clean reaction profiles with water as the sole byproduct, and extremely mild conditions, it has the potential to be undoubtedly used in synthetic and medicinal chemistry.

Author contributions

H. L. contributed to synthetic work and data curation, X. J. contributed to chemical characterization and validation, Y. Z. and Y. F. contributed to synthetic work, X. Y. developed the methodology, carried out the formal analysis and contributed to secured funding, X. W. contributed to conceptualization, performed the investigation, wrote the original draft of the manuscript, supervision of the project and revised and edited the manuscript. All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

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.

Data availability

The data that support the findings of this study are available in the supplementary material of this article.

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References

- [1] Palmini A, Gus A, Pinto LF (2026) Epilepsy treatment over time: The chess game analogy for choosing, adjusting, and adding antiseizure medications. *Epilepsia*

67(2): 557–564. <https://doi.org/10.1111/epi.70005>

- [2] Ishizaka Y, Watanabe H, Ono M (2024) Structure-Affinity-Pharmacokinetics Relationships of Novel ^{18}F -Labeled 1, 4-Diazepane Derivatives for Orexin 1 Receptor Imaging. *J Med Chem* 67(21): 18781–18793. <https://doi.org/10.1021/acs.jmedchem.4c01090>
- [3] Butler MS, Capon RJ (2026) Natural product inspired antibiotics approved for human use–1943 to 2025. *Nat Prod Rep* 43(5): 813–896. <https://doi.org/10.1039/d5np00067j>
- [4] Li J, Yu C, Liu T, Dong X, Wang Z, Gao J, Xu, HJ (2026) Research Progress of 1, 2, 3-Triazole Derivatives in Pesticide Discovery. *Agric Food Chem* 74(1): 59–76. <https://doi.org/10.1021/acs.jafc.5c09961>
- [5] Malik P, Yadav M, Bhushan, R (2025) Design, Synthesis and Application of 1, 4-Disubstituted 1, 2, 3-Triazole Based Chemosensors: A Promising Avenue. *Chem Rec* 25(1): e202400195. <https://doi.org/10.1002/tcr.202400195>
- [6] Li ZM, Zhang CQ, Liu C, Zhang HW, Song H, Zhang ZQ, Wei GF, Bao XJ, Yu CZ, Yuan, P (2024) High-efficiency Electroreduction of O_2 into H_2O_2 over ZnCo Bimetallic Triazole Frameworks Promoted by Ligand Activation. *Angew Chem Int Ed* 63(2): e202314266. <https://doi.org/10.1002/anie.202314266>
- [7] Vala DP, Vala RM, Patel HM (2022) Versatile synthetic platform for 1,2,3-triazole chemistry. *ACS Omega* 7(42): 36945–36987. <https://doi.org/10.1021/acsomega.2c04883>
- [8] Sudhakaran R, Sivasubramanian G, Moorthy S, Deivanayagam P (2024) Navigating excellence: a comprehensive review on the versatile potential of high-performance N-heterocyclic triazole as an electrolyte for proton exchange membrane fuel cells. *Ind Eng Chem Res* 63(22): 9661–9677. <https://doi.org/10.1021/acs.iecr.4c00825>
- [9] Huisgen R (1963) 1,3-dipolar cycloadditions. Past and future. *Angew Chem Int Ed* 2(10): 565–598. <https://doi.org/10.1002/anie.196305651>
- [10] Huisgen, R (1963) Kinetics and mechanism of 1,3-dipolar cycloadditions. *Angew Chem Int Ed* 2(11): 633–645. <https://doi.org/10.1002/anie.196306331>
- [11] Huisgen R, Knorr R, Möbius L, Szeimies G (1965) 1,3-Dipolare Cycloadditionen,

XXIII. Einige Beobachtungen zur Addition organischer Azide an CC-Dreifachbindungen. Chem Ber 98(2): 4014–4021. <https://doi.org/10.1002/cber.19650981228>

- [12] Rostovtsev VV, Green LG, Fokin VV, Sharpless KB (2002) A stepwise Huisgen cycloaddition process: copper (I)-catalyzed regioselective "ligation" of azides and terminal alkynes. Angew Chem Int Ed 41(14): 2596–2599. [https://doi.org/10.1002/1521-3773\(20020715\)41:14<2596::AID-ANIE2596>3.0.CO;2-4](https://doi.org/10.1002/1521-3773(20020715)41:14<2596::AID-ANIE2596>3.0.CO;2-4)
- [13] Tornøe CW, Christensen C, Meldal M (2002) Peptidotriazoles on solid phase: [1,2,3]-triazoles by regiospecific copper (I)-catalyzed 1,3-dipolar cycloadditions of terminal alkynes to azides. J Org Chem 67(9): 3057–3064. <https://doi.org/10.1021/jo011148j>
- [14] Spiteri C, Moses JE (2010) Copper-catalyzed azide-alkyne cycloaddition: regioselective synthesis of 1,4,5-trisubstituted 1,2,3-triazoles. Angew Chem Int Ed 49(1) 31–33. <https://doi.org/10.1002/anie.200905322>
- [15] Hein JE, Tripp JC, Krasnova LB, Sharpless KB, Fokin VV (2009) Copper (I)-catalyzed cycloaddition of organic azides and 1-iodoalkynes. Angew Chem Int Ed 48(43): 8018–8021. <https://doi.org/10.1002/anie.200903558>
- [16] Wang Q, Chan TR, Hilgraf R, Fokin VV, Sharpless KB, Finn MG (2003) Bioconjugation by copper (I)-catalyzed azide-alkyne [3+2] cycloaddition. J Am Chem Soc 125(11): 3192–3193. <https://doi.org/10.1021/ja021381e>
- [17] Rodionov VO, Fokin VV, Finn MG (2005) Mechanism of the Ligand-Free Cu^I-Catalyzed Azide–Alkyne Cycloaddition Reaction. Angew Chem Int Ed 44(15): 2210–2215. <https://doi.org/10.1002/anie.200461496>
- [18] Zhou Y, Lecourt T, Micouin L (2010) Direct synthesis of 1,4-disubstituted-5-substituted-1,2,3-triazoles: copper-catalyzed cycloaddition of organic azides and mixed aluminum acetylides. Angew Chem Int Ed 49(14): 2607–2610. <https://doi.org/10.1002/anie.200907016>
- [19] Jordão AK, Afonso PP, Ferreira VF, de Souza MC, Almeida MC, Beltrame CO, Paiva DP, Wardell SM, Wardell JL, Tiekink ER, Damaso CR, Cunha AC (2009) Antiviral evaluation of N-amino-1,2,3-triazoles against Cantagalo virus

replication in cell culture. Eur J Med Chem 44(9): 3777–3783.
<https://doi.org/10.1016/j.ejmech.2009.04.046>

- [20] Zhou CH, Wang Y (2012) Recent Researches in Triazole Compounds as Medicinal Drugs. Curr Med Chem 19(2): 239–280.
<https://doi.org/10.2174/092986712803414213>
- [21] Santos TF, de Jesus JB, Neufeld PM, Jordão AK, Campos VR, Cunha AC, Castro HC, de Souza MC, Ferreira VF, Rodrigues CR, Abreu PA (2017) Exploring 1,2,3-triazole derivatives by using in vitro and in silico assays to target new antifungal agents and treat Candidiasis. Med Chem Res 26(3): 680–689.
<https://doi.org/10.1007/s00044-017-1789-x>
- [22] Lannes AC, Leal B, Novais JS, Lione V, Monteiro GC, Lourenço AL, Sathler PC, Jordão AK, Rodrigues CR, Cabral LM, Cunha AC, Campos V, Ferreira VF, de Souza MC, Santos DO, Castro HC (2014) Exploring N-Acylhydrazone Derivatives Against Clinical Resistant Bacterial Strains. Curr Microbiol 69(3): 357–364. <https://doi.org/10.1007/s00284-014-0591-y>
- [23] Kalinina TA, Bystrykh OA, Pozdina VA, Glukhareva TV, Ulitko MV, Morzherin YY (2015) Synthesis of spiro derivatives of 1,2,3-triazolo[5,1-*b*][1,3,4]thiadiazines and biological activity thereof. Chem Heterocycl Compd 51(6): 589–592. <https://doi.org/10.1007/s10593-015-1742-1>
- [24] Jordão AK, Ferreira VF, Souza TM, de Souza Faria GG, Machado V, Abrantes JL, de Souza MC, Cunha AC (2011) Synthesis and anti-HSV-1 activity of new 1,2,3-triazole derivatives. Bioorg Med Chem 19(6): 1860–1865.
<https://doi.org/10.1016/j.bmc.2011.02.007>
- [25] Li H, Wu JX, Zhang GY, Du NN, Zhan LW, Hou J, Li BD (2025) Thermal Hazard Assessment of the Synthesis of 1,1'-Azobis-1,2,3-Triazole. Org Process Res Dev 29(3) 650–662. <https://doi.org/10.1021/acs.oprd.4c00404>
- [26] Lin QH, Li YC, Li YY, Wang Z, Liu W, Qi C, Pang SP (2012) Energetic salts based on 1-amino-1,2,3-triazole and 3-methyl-1-amino-1,2,3-triazole. J Mater Chem 22(2): 666–674. <https://doi.org/10.1039/c1jm14322k>
- [27] Alexandrou NE, Adamopoulos S (1976) Oxidation of Bis-semicarbazones of α -Dicarbonyl Compounds with Lead (IV) Acetate. A One-step Synthesis of

1-(N-Ureido)-1,2,3-triazoles. *Synthesis* 1976(7): 482–483.
<https://doi.org/10.1055/s-1976-24097>

- [28] Bargamov GG, Bargamova MD (1996) Polyfluoroalkyl-substituted 1-amino-1,2,3-triazoles. *J Fluorine Chem* 79(1): 45–47.
[https://doi.org/10.1016/0022-1139\(96\)03446-X](https://doi.org/10.1016/0022-1139(96)03446-X)
- [29] Kaplan G, Drake G, Tollison K, Hall L, Hawkins T (2005) Synthesis, Characterization, and Structural Investigations of 1-Amino-3-Substituted-1,2,3-Triazolium Salts, and a New Route to 1-Substituted-1,2,3-triazoles. *J Heterocyclic Chem* 42(1): 19–27.
<https://doi.org/10.1002/jhet.5570420104>
- [30] Song L, Ang HT, Senthilperumal J, Kanusu UR, Venugopal S, Rangarajan N, Krishnamoorthy S, Dubbaka SR, O'Neill P, Wu J (2024) 1,2,3-Triazole Synthesis: Development of Safe and Effective Batch and Continuous Manufacturing Processes. *Org Process Res Dev* 28(5): 1998–2005.
<https://doi.org/10.1021/acs.oprd.4c00020>
- [31] Nagarajan R, Emmanuvel L (2019) Unusual Cleavage of N-N Bond of 1-Arylamino-1,2,3-triazole Derivatives: A Simple and Alternate Approach to 4,5-Disubstituted-1H-1,2,3-triazoles. *Asian J Chem* 31(5): 1057–1061.
<https://doi.org/10.14233/ajchem.2019.21857>
- [32] Nagarajana R, Jayashankaran J, Emmanuvel L (2016) Transition metal-free steric controlled one-pot synthesis of highly substituted *N*-amino 1,2,3-triazole derivatives via diazo transfer reaction from β -keto esters. *Tetrahedron Letters* 57(24): 2612–2615. <https://doi.org/10.1016/j.tetlet.2016.04.112>
- [33] Kuruba BK, Emmanuvel L, Sridhar B, Vasanthkumar S (2017) Unprecedented cyclization of α -diazo hydrazones upon N-H functionalization: A Et₃N base promoted one-step synthetic approach for the synthesis of *N*-amino-1,2,3-triazole derivatives from α -diazo hydrazine. *Tetrahedron* 73(18): 2674–2681.
<https://doi.org/10.1016/j.tet.2017.03.061>
- [34] Kalinina TA, Bystrykh OA, Glukhareva TV, Morzherin YY (2017) Transformation of 1,2,3-Thiadiazolyl Hydrazones as Method for Preparation of 1,2,3-Triazolo[5,1-*b*][1,3,4]thiadiazines. *J Heterocyclic Chem* 54(1): 137–146.

<https://doi.org/10.1002/jhet.2554>

- [35] L'abbé G, Bruynseels M, Delbeke P, Toppet S (1990) Molecular rearrangements of 4-iminomethyl-1,2,3-triazoles. Replacement of 1-aryl substituents in 1*H*-1,2,3 - triazole - 4 - carbaldehydes. J Heterocycl Chem 27(7): 2021–2027. <https://doi.org/10.1002/jhet.5570270733>
- [36] L'abbé G, Bruynseels M Replacement of Aryl by Alkyl in 1-Substituted 1*H*-1,2,3-Triazole-4-carbaldehydes. J Chem Soc Perkin Trans 19(5): 1492–1493. <https://doi.org/10.1039/P19900001492>
- [37] Xu HD, Jin P, Chu X, Wei CC, Zhong H, Shen MH, Chen G (2025) Snap-Trapping Strategy for Amine-Specific Bioconjugation with Pyridotriazole Carbaldehydes. J Am Chem Soc 147(46) 42964–42971. <https://doi.org/10.1021/jacs.5c15886>
- [38] Li Y, Wei CC, Tian XJ, Jin P, Song GJ, Xie LC, Chen G, Shen MH, Xu HD (2026) An imine condensation/1,5-electrocyclization cascade enabled permanent aldehyde–amine coupling through a triazole linkage. Org Biomol Chem 24(20): 4312–4319. <https://doi.org/10.1039/d6ob00410e>
- [39] Wang C, Zhou Y, Bao X (2017) Mechanistic Insights into the Rh-Catalyzed Transannulation of Pyridotriazole with Phenylacetylene and Benzonitrile: A DFT Study. J Org Chem 82(7): 3751–3759. <https://doi.org/10.1021/acs.joc.7b00204>

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