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Review on the Synthesis of Benzimidazole Derivatives Utilizing Several Nanoparticles as a Catalyst

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Abstract:*Because they constitute a component of the structure of numerous biological components, heterocyclic compounds are used and put to use more frequently in medical chemistry. Due to the structural similarity of one of the heterocyclic chemicals, benzimidazole, to naturally occurring nucleotides like the adenine base of DNA and a component of vitamin B12, it has been widely used in drug synthesis and medicinal chemistry. The synthesis of benzimidazole derivatives employing transition metal nanoparticles as a catalyst is summarised in this paper. Some of the keywords include benzimidazole, nanoparticles, medicinal chemistry, and o-phenylenediamine.*

I. INTRODUCTION

Benzoimidazoles are significant heterocyclic substances that are both natural and manufactured. Some of these chemicals are sold as psychiatric, anthelmintic, and antifungal drugs [1, 2]. It has been discovered that several derivatives have some intriguing bioactivities [4], [5]. Many techniques for the synthesis of benzimidazole and its derivatives have been documented in the literature due to the wide variety of pharmacological actions as well as industrial and synthetic applications' some processes, cyclo condensation can occur between Ophenylenediamines and carboxylic acids or their derivatives [6], [7]. While many of the listed methods are quite efficient, some of them have considerable disadvantages, such as prolonged reaction times, intense reaction conditions, high reaction temperatures, reduced yields, severe side reactions, and the need for costly ingredients and hazardous solvents. So, developing safe and useful methods to produce benzimidazole derivatives still interests scientists.

Due to their large surface area to volume ratio and coordination sites, which are primarily responsible for their catalytic activity, transition metal nanoparticles have recently been employed as efficient catalysts in several synthetic organic transformations [8]. Also, researchers are continually looking for ways to use solvent free processes including those that use water media, green catalysts, ionic liquids, or microwave irradiation in place of hazardous, poisonous, volatile, and inorganic and organic reagents. Heterogeneous transition metal (TM) catalysts are typically found to be more effective and permit the streamlining of chemical processes due to their accessibility, robustness, and simplicity of recycling.

The primary development in this area to make the process ecologically benign is the introduction of nano-catalysts. Also, because of the active sites' dispersion on an amorphous surface and their larger surface area, these catalysts' reactions go along swiftly. In order to avoid the creation of any dangerous by products, it is crucial to use catalysts that can only be activated by O2, air, H2O2, or other hydroperoxides [9]. Due to their fascinating size dependent optical, electrical, magnetic, and catalytic capabilities in compared to their bulk counterparts, metal and metal oxide nanomaterials have attracted a lot of attention.

The production of nanomaterials with the goals of size and shape selectivity, elimination of hazardous compounds in the synthesis protocols with scalability, and straightforward workup approaches has attracted a lot of interest over the past ten years [10]. We have described many procedures in this research for synthesising various benzimidazole derivatives employing catalysts made of transition metal nanoparticles.

Nano-Transition Metal catalyzed oxidative coupling of o-phenylenediamine

Scheme 1 -

AlinezhadHeshmatollah et al. produced substituted benzimidazole derivatives with excellent yield by condensation of substituted ophenylenediamine with formic acid in the presence of a catalytic amount of mechanochemically synthesised zinc oxide nanoparticles (2 mol%) under the solvent-free condition at 70oC [11].

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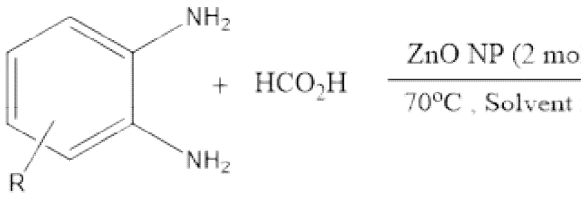
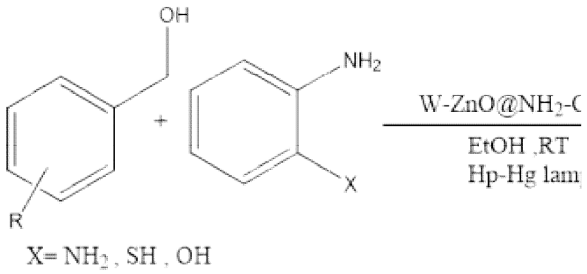


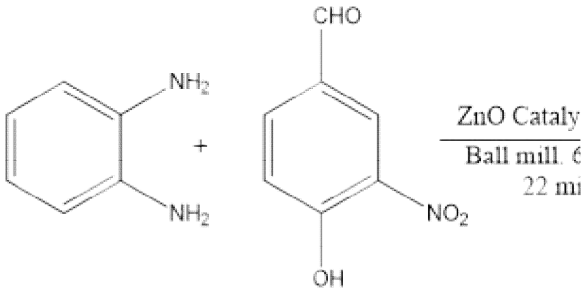
Scheme 2-

Ruijuan Chen et al. generated benzimidazoles and 2 substituted benzimidazoles from the reaction of ophenylenediamine and benzylic alcohols in ethanol at room temperature [12] in the presence of coomassie brilliant blue-coated W ZnO@NH2 nanoparticles as a catalyst.



Scheme 3-

By adopting a ball milling approach, Hemant Sharma and colleagues effectively created 1,2-disubstituted benzimidazoles by reacting o-phenylenediamine with 4-hydroxy-3-nitrobenzaldehyde in the presence of ZnO nanoparticles (0.2 mol%) at room temperature for 22 minutes [13].



Scheme 4-

Under the catalysis of ZnO (0.3 eq.) nanoparticles, Vipin Kumar et al. produced luminous b-carboline C-1 tethered benzimidazole derivatives. The process began with the reaction of 1-formyl b-carboline and substituted o-phenylenediamine at room temperature for 16–28 hours in the presence of dry chloroform, which produces a Schiff base. Next, an intramolecular cyclization reaction was carried out to produce b-carboline-linked benzimidazole in good yields [14].

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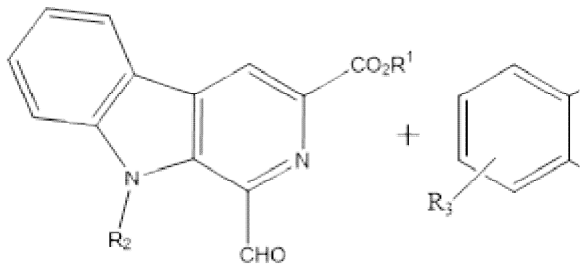
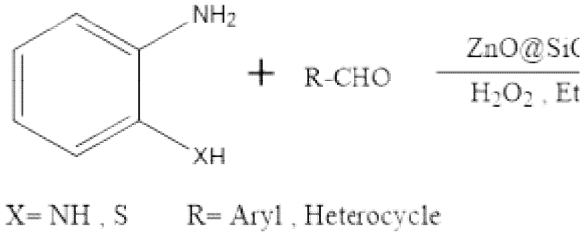


Scheme 5-

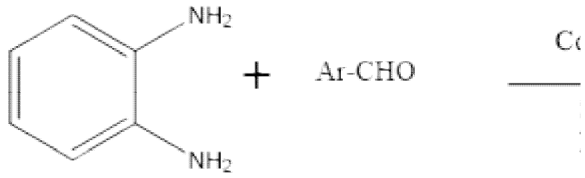
By using ZnO@SiO2-TTIP composite nanoparticles as an efficient catalyst in the presence of ethyl alcohol and hydrogen peroxide at 25°C to condense o-phenylenediamine and various aromatic aldehydes, KiumarsBahrami and colleagues successfully prepared 2-substituted benzimidazoles with a high yield [15].



X= NH , S R= Aryl , Heterocycle

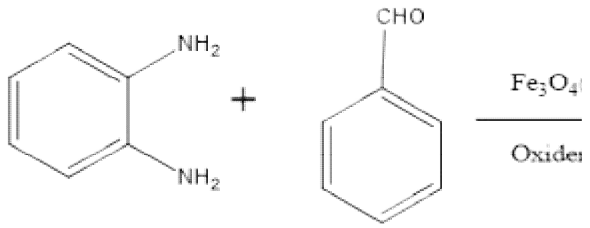
Scheme 6-

Kunde et al. produced 2-arylbenzimidazole by microwave irradiation (Raga Scientific MW, 750W) at 450-W power for the requisite period under solvent-free circumstances using a combination of o-phenylenediamine (1 mmol), aldehyde (1 mmol), and Cd0.03Zn0.97O nanoflakes (10 mol%) as catalyst [16].



Scheme 7-

By reacting o-phenylenediamine and an aromatic aldehyde at room temperature with ethanol and using Fe3O4@CS@ZnO as a catalyst, Tian et al. were able to produce 2-phenyl benzimidazole [17].



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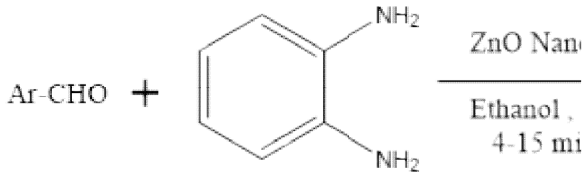
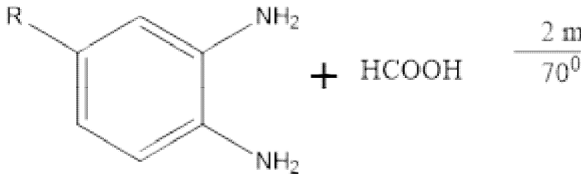
Scheme 8-

ZnO nanoparticles were used as a reusable catalyst in the production of 2-aryl benzimidazoles by Shyam Banjare et al. O-phenylenediamine and an aromatic aldehyde were condensed for 4 to 15 minutes at room temperature in the presence of ethanol to provide an excellent yield [18].

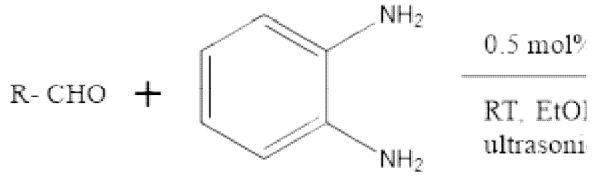


Scheme 9-

Bubun Banerjee et al. produced bioactive heterocycles, such as different benzimidazole and 2-arylbenzimidazole derivatives, with outstanding yields by using zinc oxide nanoparticles as a catalyst [19]. The reaction of a mixture of substituted o-phenylenediamines (1 mmol) and formic acid (2 mmol) at 70 °C with no solvent results in a high yield. The catalyst is nano-ZnO (2 mol%).[19]

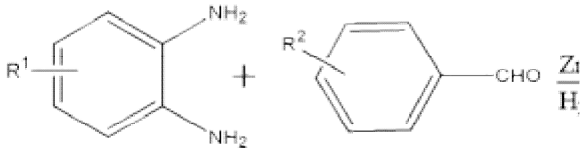


They produced a variety of 2-substituted-benzimidazoles from the reaction of o-phenylenediamine with various aldehydes under ultrasonic irradiation in ethanol at room temperature for 10 min. using ZnO nanoparticles (0.5 mol%) as the catalyst.



Scheme 10-

Chen and colleagues reported the synthesis of 2-arylbenzimidazoles derivatives from various substituted aromatic aldehydes and substituted o-phenylenediamines in the presence of hydrogen peroxide, methanol, and ZnO/SiO2-NC-600 as a catalyst. yields a large amount of fruit [20].



Scheme 11-

Derivatives of the benzimidazole were created by Leila Dinparast and colleagues. In this reaction, nano-ZnO/MgO in [bmim]Cl functions as a catalyst as substituted o-phenylenediamines react with a substituted aromatic aldehyde. A greater yield is produced by the reaction at 60o C [21-23].

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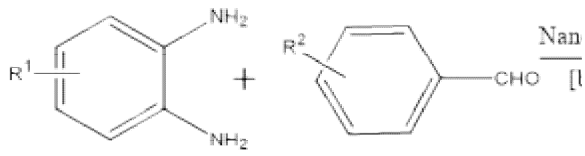

II. CONCLUSION

In this Review we have described the simple synthesis of the Benzimidazole Derivatives using the various nanoparticles specially the Zinc oxide nanoparticles.

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REFERENCES

[1]. Middleton, R.W.; Wimberley D. G. J. Het. Chem. 1980, 17, 1757.
[2]. Kumar R, Joshi YC E-journal of chemistry, 2007, 4(4):606-610.
[3]. Sukalovic V., Andric D., Roglic G., Sladjana K.R., Schratteholz A. and Soskis V., Eur. J. Med. Chem., 2005, 40, 481.
[4]. Hashem Sharghietal Journal of Heterocyclic Chemistry Volume 45, Issue 5 September/October 2008 Pages 1293–1298.
[5]. J S Yadav, etal Canadian Journal of Chemistry, 2008, 86, 124-128.
[6]. Elder field, R. C.; Kreysa, F. J. J. Am. Chem. Soc. 1948, 70, 44.
[7]. B. S. Praveen, Reddy, P.; Sondhi, S. M.; Lown, J. W. Pharmacol. Ther.1999, 84, (1) 1-111.
[8]. Sluka, J.; Novak, J.; Budesinsky, Z. Collect. Czech. Chem. Commun. 1976, 41, 3628.
[9]. Nitin A. Mirgane, Vitthal S. Shivankar, Sandip B. Kotwal, Gurumeet C. Wadhawa, Maryappa C. Sonawale, Degradation of dyes using biologically synthesized zinc oxide nanoparticles, Materials Today: Proceedings, Volume 37, Part 2021, 849-853, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.06.037.
[10]. Nitin A. Mirgane, Vitthal S. Shivankar, Sandip B. Kotwal, Gurumeet C. Wadhawa, Maryappa C. Sonawale, the Waste pericarp of ananas comosus in green synthesis zinc oxide nanoparticles and their application in wastewater treatment, Materials Today: Proceedings, Volume 37, Part 2, 2021, 886-889, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.06.045.
[11]. Shubhada S. Nayak, Nitin A. Mirgane, Vitthal S. Shivankar, Kisan B. Pathade, Gurumeet C. Wadhawa, Adsorption of methylene blue dye over activated charcoal from the fruit peel of plant hydnocarpuspentandra, Materials Today: Proceedings, Volume 37, Part 2, 2021, 2302-2305, ISSN 2214-7853, https://doi.org/10.1016/j.matpr.2020.07.728.

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[12]. Patil, D.D.; Mhaske, K.D.; Wadhawa, C.G., Antibacterial and Antioxidant study of Ocimumbasilicum Labiatae (sweet basil), Journal of Advanced Pharmacy Education & Research (2011) 2, 104-112.

[13]. Dinanath PD, Gurumeet WC, 2013. Antibacterial, antioxidant and antiinflammatory studies of leaves and roots of Solanum xanthocarpum. Unique J Ayurvedic Herb Med (2013) ;(3):59-63.

[14]. Dynashwar K. Mhaske, Dinanth D. Patil, Gurumeet C. wadhawa. Antimicrobial activity of methanolic extract from rhizome and roots of Valerianawallichii. International Journal on Pharmaceutical and Biomedical Research, 2011; 2(4):107- 111

[15]. G. C. Wadhawa, V. S. S. Hivankar, Y. A. Gaikwad, B. L. Ingale, B. R. Sharma, S. S. Hande, C. H. Gill and L. V. Gavali, Eur. J. Pharm. Med. Res., 3, 556 (2016).

[16]. Patil DD, Mhaske DK, Patare MA and Wadhawa GC: Antibacterial and antioxidant, anti-inflammatory study of leaves and root Delonix regia. International Journal of chemical and pharmaceutical sciences 2014; 3: 131-5

[17]. Patil DD, Mhaske DK, Patare MA and Wadhawa GC: Antibacterial and antioxidant, anti-inflammatory study of leaves and root Delonix regia. International Journal of chemical and pharmaceutical sciences 2014; 3: 131-5

[18]. Arun K. Valvi, Shubhada S. Nayak, Vitthal S. Shivankar, Gurumeet C. Wadhawa, Nano catalyst derived from plant PolyzygusTuberosus: A suitable for efficient and green synthesis of benzimidazole derivatives, Materials Today: Proceedings, Volume 50, Part 5, 2022, Pages 1522-1526, ISSN 2214-7853, https://doi.org/10.1016 /j.matpr.2021.09.102.

[19]. Patil, D.D., Deshmukh, A.K., and Wadhava, G.C., Diuretic activity of root and bark of erythrina indica lam.. International Journal of Pharmaceutical Sciences and Research. 2011; 2 (7), 1811-1813

[20]. S. S. Nayak, N. A. Mirgane, K. B. Pathade, V. S. Shivankar and G. C. Wadhawa. "Phytochemical analysis, antioxidant and anti-inflammatory activity of leaves and bark of Ceropegiarollae Hemadri," Plant Sci. Today, 8(3), 2021, 425–428. https://doi.org/10.14719/pst.2021.8.3.906

[21]. Algul, O.; Karabulut, A.; Canacankatan, N.; Gorur, A.; Sucu, N.; Vezir, O. Apoptotic and anti-angiogenic effects of benzimidazole compounds: Relationship with oxidative stress mediated ischemia/reperfusion injury in rat hind limb. Antiinflamm. Antiallergy Agents Med. Chem. 2012, 11, 267–275. [CrossRef]

[22]. Thakuria, H.; Das, G. An expeditious one-pot solvent-free synthesis of benzimidazole derivatives. Arkivoc 2008, 15, 321–328. [CrossRef]

[23]. Rithe, S.R.; Jagtap, R.S.; Ubarhande, S.S. One Pot Synthesis of Substituted Benzimidazole Derivatives and Their Characterization. RASAYAN J. Chem. 2015, 8, 213–217. [CrossRef]