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ORIGINAL ARTICLE

Multicomponent Reactions Synthesis of Triaryl-1H Imidazoles Using Reductive-oxidative Reactions by MnO_2-$FeSO_4$ as a Catalyst

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KEYWORDS

Multicomponent Reactions;
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ABSTRACT: The study's chief purpose is to investigate multicomponent reactions synthesis of triaryl-1h imidazoles using reductive-oxidative reactions by MnO_2 - $FeSO_4$ as a catalyst.Some novel substituted imidazoles have been synthesized using MCRs, one-pot synthesis, and MnO_2/$FeSO_4$ as a catalyst; the method involves the reaction of benzil, aromatic aldehyde, and ammonium acetate in the presence of MnO_2/$FeSO_4$ as a reductive-oxidative catalyst under mild conditions. the obtained compounds were nontoxic, excellent yields, and environmentally friendly. The compounds were elucidated using IR and ^{1}H-NMR spectra. To satisfy the aim of the study, Reactions have been performed simply by mixing 1,2-diketone with an aldehyde and ammonium acetate in the presence of the catalytic reagent of MnO_2/$FeSO_4$. The mixture was prepared by ground them together in a mortar with a pestle at room temperature for several minutes; after that, they purified by column chromatography, 2,4,5-triaryl substituted imidazole derivatives were obtained in excellent yields.

INTRODUCTION

In 2020, it was reported the reaction between glyoxal and ammonia, which pioneered a novel synthetic route to imidazole [1]. Over the century, the importance of imidazoles in the biological system has attracted more interest due to their chemical and biochemical features. Compounds with the imidazole ring system have many pharmacological properties and can play an important role in biochemical processes [2]. For example, it is reported that substituted imidazoles can act as glucagon receptor antagonists [3], inhibitors of P38 MAP kinase [4], B-Raf kinase [5], plants growth regulators [6], antibacterial [7], antitumor [8], therapeutic agents [9] and also pesticide [10]. The Chemical Compounds with an imidazole ring system have many pharmacological properties and play important roles in biochemical processes [11]. Many of the substituted imidazoles are known as inhibitors of fungicides and herbicides, plant growth regulators, and therapeutic agents [12]. A recent advance in green chemistry and organometallic chemistry have extended the boundary of imidazoles to the synthesis and application of a large class of imidazoles as ionic liquids and imidazole related to N-heterocyclic carbenes [13]. Multicomponent coupling reactions (MCRs) are attractive for parallel synthesis as large arrays of compounds with diverse substitution patterns can be prepared in one step, mostly in high yields, under mild conditions. MCRs are powerful tools in modern drug discovery and allow fast, automated, and high throughput synthesis of diverse structural scaffolds required in search of novel therapeutic and pharmacological active molecules [14,15].

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MATERIAL AND METHODS

Reactions were carried out simply by mixing 1,2-diketone with an aldehyde and ammonium acetate in the presence of the catalytic reagent of $MnO_2/FeSO_4$. The mixture was prepared by ground them together in a mortar with a pestle at room temperature for several minutes. They get purified by column chromatography, 2,4,5-triaryl substituted imidazole derivatives were obtained in excellent yields.

This catalyst is considered inexpensive and readily available, conveniently handled, and removed from the reaction mixture. Thus, making such a simple and eco-friendly experimental procedure is still strongly desired for the synthesis of these essential heterocyclic compounds As a part of our program, finding at developing new methodologies for the preparation of heterocyclic compounds containing nitrogen [10-13] hither, we wish to describe a new and convenient protocol for the synthesis of 2,4,5-triaryl-1*H*imidazoles via a multicomponent reaction of aldehydes, 1,2-diketone or α-hydroxyketone, and ammonium acetate in the presence of $MnO_2/FeSO_4$.

RESULTS AND DISCUSSION

By obtaining this result, we have extended this protocol to a variety of aldehydes and diketones. This protocol is rapid and efficient for the preparation of several 2,4,5- triaryl substituted imidazoles from both electrons efficient as well as electron-deficient aromatic aldehydes. Electron-dragging groups enhance the rate of the reaction as compared to the electron-donating group. Aliphatic aldehyde and ketones (e.g., acetaldehyde, acetone) were also used as starting carbonyl compounds for the same reaction. There is no product formation that takes place in this reaction by grinding the reagents for more than 30 minutes. Heterocyclic nitrogenous moieties can be considered as a potential building block in a wide variety of biologically and pharmacologically active compounds and as they are important in drug discovery [12].

Azole antifungals are also widely used for the treatment of superficial and invasive fungal infections. They are also classified as imidazoles or triazoles on the basis of whether they have two or three nitrogen in the five-membered azole ring [13]. In the past few decades, a five-membered heterocyclic structure containing two or more than one heteroatoms (O, S, N) is the core structure in the synthesis of anticancer drugs. Such heterocyclic rings are pyrazole, imidazole, oxazole, 1,3,4 thiadiazole, which improved anticancer activities when introduced in the pyrazole skeleton [7,8]. (Figure 1).

Lubricating oils are subjected to deterioration by oxidation at high temperatures. Antioxidants are the main additives that protect the lubricant from oxidative degradation and allow the oil to meet the challenging supplies for industrial applications. Another application of the imidazole derivatives as antioxidants and corrosion inhibitors for base oil improvement [9-14]. (Tables 1, 2).

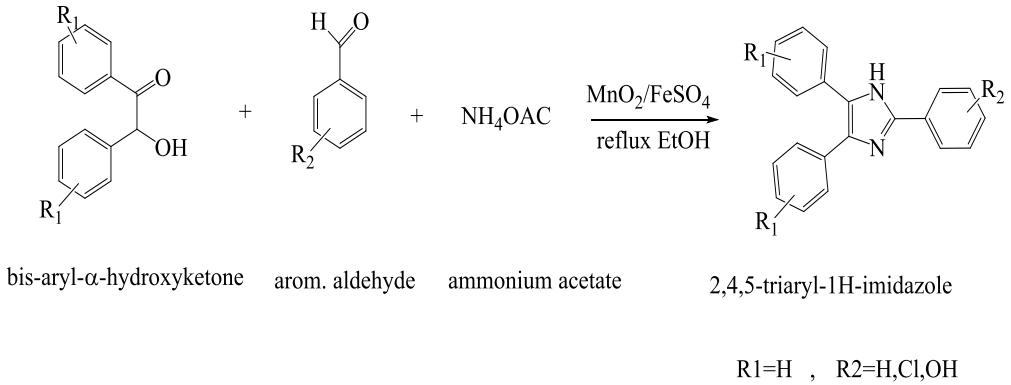

Figure 1. synthesis of substituted 2,4,5-triphenyl-1H-imidazole using $MnO_2/FeSO_4$

Table1. synthesis of 2,4,5-triphenyl-1H-imidazole using $MnO_2/FeSO_4$ in different solvent

Sequence	Solvent	Reaction Time/minute	Yield%
1	Acetone	180	–
2	Water	180	–
3	Chloroform	90	–
4	Ethanol	100	80

Table 2. Physical properties of synthesized substituted 2,4,5-tripheny-1H-limidazoles using $MnO_2/FeSO_4$

Sequence	R1	R2	Colour	M.P.	Yield%
1	H	H	White	269-272	84
2	H	Cl	Grey	205-208	76
3	H	OH	Brown	193-197	69
4	H	MeO	Brown	222-224	٨٠

Experimental Section

The melting point apparatus, Stuart model SMP3, was used for measuring melting points. IR spectra were recorded on a PerkinElmer series II spectrum. 1H NMR spectra were recorded in DMSO-d6 using Bruker DRX-400 spectrometer at 400 and 100 MHz, respectively. All chemicals and solvents were purchased from Aldrich, Merck, and Fluka and were used as received. Melting points and spectral data of all products are fully consistent with those of the reported ones.

Preparation of $MnO_2/FeSO_4$ Mixture

The optimized amounts of MnO_2 and $FeSO_4$, i.e., 5 mmol and 1 mmol, respectively, were ground together in a mortar to obtain a purple powder.

General Procedure for the Synthesis of 2,4,5-Triaryl Imidazoles

a-Hydroxy ketone (1.0 mmol), aromatic aldehyde (1.0 mmol), ammonium acetate (2.5 mmol), and the mixture of MnO_2**/$FeSO_4$**(0.4 mmol) were stirred and refluxed in ethanol. TLC monitored the progress of the reaction. After completing the reaction, the mixture was poured into a cold water (50 mL). The precipitated solid was filtered, washed several times with water, dried, and recrystallized from EtOH or acetone:water (9:1) to get the corresponding 2,4,5-triaryl-1*H*-imidazoles.

Spectral Data of Imidazole Derivatives

1) 2,4,5-triphenyl-1H-imidazole

^{1}H NMR (400 MHz, DMSO-d6)/ppm: (t,1H,7. 2), (t, 2H, 7.3), (t, 2H,7.6) ,7.3-7.5 (m, 6H), (d, 2H,7.9), 8.0 (d, 2H), 12.7

(1H, br). IR (KBr, cm^{-1}): 1558, 1598, 3070, 3200,837,916,1487.

2) 2-(4-Hydroxyphenyl)-4,5-diphenyl-1H-imidazole

IR (KBr, cm ^{1}): 3270 ,3324 ,3020 ,1654, 1593,1506,1489,810.914,763.

3) 2-(4-Nitrophenyl)-4,5-diphenyl-1H-imidazole

^{1}HNMR (400 MHz, DMSO-d6): (t, 1H,7.6), 7.7 (t, 2H), (7.9, d,2H), (d,2H,8.3),13. 1 (br, 1H). IR (KBr, cm^{-1}) :3350,3015,1336,1448,1519,1595,717,852.

CONCLUSIONS

This work is desired to be found a facile, green, and environmentally friendly synthetic method of polysubstitutedimidazoles, via multicomponent one-pot reaction in the presence of $MnO_2/FeSO_4$ as a cheap and eco-friendly catalyst. Products were isolated in good to excellent yields, and also, the catalyst can easily and efficiently recover and reused, Considering this as an economic advantage of this synthesis. This procedure may

give significant applications in the synthesis of more multisubstitutedimidazoles.

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Not applied.

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