ISSN: 2157-7439
Journal of
Nanomedicine & Nanotechnology
OPEN ACCESS Freely available online
Mini Review

Catalytic Performance of a Phosphate-Benzimidazole-Based on Hybrid Nanocomposite: Review

Sibous Serrar*

Department of Chemistry, Ibn Tofail University, South Africa

ABSTRACT

Using the condensation of aromatic aldehydes substituted with active methylene compounds in the presence of hybrid nanocomposites (dibenzimidazolyl butane dichlorhydrates), under ecological settings, we have established a straightforward and very effective experimental technique in this work. The Knoevenagel condensation in ethanol as an environmentally friendly solvent has shown a strong catalytic activity for the Phosphate-Benzimidazole hybrid nanocomposite as heterogeneous catalysts. It has many benefits, including quick reaction times and an easy, environmentally friendly operating process. While this is going on, xMCl2-yNaPO3 may be recovered using straightforward filtration, and the catalytic system has an unusual lifetime of five cycles without any activity degradation.

INTRODUCTION

More than half of the world's phosphate reserves are in Morocco, which is also primarily the top exporter. Indeed, phosphate from Morocco is shipped to all regions, including Asia, Europe, and Latin America. Hybrid phosphate materials have attracted a lot of attention recently. Phosphate hybrids, broadly speaking, combine various phosphate characteristics with those of organic compounds like polymers and organic salts. In many contemporary technologies and nanotechnologies today, such as photocatalysis, biomedicine, corrosion inhibition, photovoltaics, and particularly in catalysis, hybrid materials are being employed more and more. The Knoevenagel condensation reaction, which frequently occurs in the creation of fine chemicals and active methylene compounds with two electron-withdrawing groups, is a crucial organic process [1]. Carbonyl molecules (aldehydes or ketones) and active methylene compounds heterocyclic substances with biological importance. It has been a topic of attention for the creation of highly processed compounds, such as UV filters in cosmetics and coumarin derivatives in fragrances. Additionally, the creation of an important intermediary by Knoevenagel condensation occurs along the synthetic routes of too many medicines and therapeutic compounds.

Aldehyde and malononitrile have been reported to react using a variety of catalysts, including chitosan hydrogel, acrylic resin immobilized lipase, mesoporous zirconia, Mg-Al mixed oxide on hexagonal silica, biguanide-functionalized meso-porous silica, acid-based bifunctional mesoporous MCM-41 silica, and amine-functionalized super par This study looked at hybrid nanocomposite as potential heterogeneous catalysts for the Knoevenagel condensation, which occurs when various aldehydes combine with active methylene in ethanol at ambient temperature [2].

METHOD

The Merck or Fluka Chemical Companies provided all of the chemicals for the catalytic reaction. By comparing the melting points and spectral data of the known products to those published in the literature, they were located. The development of the reactions was tracked using thin-layer chromatography (TLC) on silica gel SIL G/UV 254 plates. The uncorrected melting points were measured using a KOFLER hot stage setup. On a Brucker 300-MHz spectrometer, 1H NMR and 13C NMR spectra were captured in DMSO-d6. Soft chemistry was used to create the hybrid xMCl2-yNaPO3 nanocomposites at ambient circumstances. The sodium metaphosphates anions and the Benzimidazole derivative cations were exchanged during the synthesis. Five molar ratios have been created by varying the phosphate concentration in order to examine the morphological and structural characteristics of hybrid materials. YNaPO3 hybrid nanocomposites catalysts. Different investigations, including X-ray diffraction, Fourier transform infrared (FTIR), Raman, UV-visible, transmission electron microscope (TEM), and energy dispersive X-ray spectroscopy (EDX), are used to analyse the generated hybrid nanocomposites catalysts. We examined all of these catalysts in accordance with the five molar ratios of the synthesised hybrid nanocomposites (xMCl2-

*Correspondence to: Sibous Serrar, Department of Chemistry, Ibn Tofail University, South Africa, E-mail:- serrar.34@gmail.com

Received: 3-Jul -2022, Manuscript No: jnmnt-22-17540, **Editor assigned:** 6-Jul-2022, Pre QC No: jnmnt-22-17540 (PQ), **Reviewed:** 20-Jul-2022, QC No: jnmnt-22-17540, **Revised:** 23-Jul-2022, Manuscript No: jnmnt-22-17540(R); **Published:** 30-Jul-2022, DOI: 10.35248/2157-7439.22.13.630.

Citation: Serrar S (2022) Catalytic Performance of a Phosphate-Benzimidazole-Based on Hybrid Nanocomposite: Review. J Nanomed Nanotech. 13: 630.

y-NaPO3), and we selected the best catalyst R2 to investigate the ideal circumstances for the Knoevenagel condensation. After that, we generalized the ideal circumstances for the other catalysts (R1, R3, R4 and R5) [3]. The extra information contains the hybrid catalyst characterization data Ion exchanges between MCl2 cations and NaPO3 anions are used to create hybrid materials. xMCl2's molecular composition. It was combined with active methylene, R2 heterogeneous catalyst (6 mg), ethanol (3 mL), and the carbonyl compound. The reaction mixture was agitated for the requisite amount of time at room temperature. Thin-layer chromatography (TLC) was used to check that the reaction had finished using n-hexane-EtOAc as the eluent. The reaction mixture was then thinned out with 5 mL of hot ethanol before the catalyst was simply filtered out and the filtrate was evaporated. From ethanol, the products (3a–j) were recrystallized. By comparing the 1H and 13C NMR data with genuine samples that were reported in the literature, it was determined that the products generated 3 are recognised chemicals. A model reaction between p-chlorobenzaldehyde 1a and malonitrile 2a was carried out in 3mL of ethanol at room temperature to measure the catalytic efficacy of the catalyst R2 (1MCl2- 2NaPO3). Initial xMCl2-yNaPO3 nanocomposite hybrid catalysts with varying phosphate molar ratios were used to catalyse the model reaction: MCl2, R1, R2, R3, R4, and R5. The outcomes are listed in [4]. After 180 minutes, the reaction produced only a 54 percent yield of the desired product in the absence of a catalyst. The product 2 (4chlorobenzylidene) malononitrile 3a was produced in 90 percent yields within 4 minutes, making R2 the best catalyst. In order to accelerate the Knoevenagel condensation reaction, the R2 (1MCl2-2NaPO3) was chosen as the catalyst. Subsequent research was then conducted employing R2 as a heterogeneous catalyst.

The heterogeneous catalyst R2 (1MCl2-2NaPO3), the carbonyl compound (1 mmol), active methylene (1 mmol), ethanol (3 mL), and other components were combined [5]. The reaction mixture was agitated for the requisite amount of time at room temperature. Thin-layer chromatography (TLC) was used to check the reaction's progress while employing n-hexane-EtOAc (5:1) as the eluent. The reaction mixture was then thinned out with 5 mL of hot ethanol before the catalyst was simply filtered out and the filtrate was evaporated. From ethanol, the products (3a–j) were recrystallized. By comparing the 1H and 13C NMR data with genuine samples that were reported in the literature, it was determined that the products generated 3 are recognised chemicals. A model reaction between p-chlorobenzaldehyde 1a and malonitrile 2a was carried out in 3mL of ethanol at room temperature to measure the catalytic efficacy of the catalyst R2 (1MCl2- 2NaPO3). Initial xMCl2-yNaPO3 nanocomposite hybrid catalysts with varying phosphate molar ratios were used to catalyse the model reaction: MCl2, R1, R2, R3, R4, and R5. The outcomes are outlined. After 180 minutes, the reaction produced only a 54 percent yield of the desired product in the absence of a catalyst [6-7]. The product 2-(4-chlorobenzylidene) malononitrile 3a was produced in 90 percent yields within 4 minutes, making R2 the optimal catalyst. As a result, R2 was chosen as the catalyst for the Knoevenagel condensation reaction, and subsequent research was carried out utilising R2 as a heterogeneous catalyst. The 4-chlorobenzaldehyde and malononitrile condensation reaction [8-10].

RESULT

Second, 0.01 g of catalyst R2 was used to assess the role of the solvent in the process. In protic solvent, ethanol, and methanol, the reaction moved quite swiftly [11-12]. An average conversion was produced by the reaction in an aprotic solvent like THF and CH3CN. Indeed, the optimum solvent for this reaction was shown to be ethanol. The reaction between p-chlorobenzaldehyde 1a and malonitrile 2a in the presence of the catalyst R2 was taken into consideration to analyse the impact of the catalyst quantity. The next step in the study was to carry out the reaction while adjusting the molar ratios of the catalysts in the nanocomposite hybrids. According to the findings, we chose 0.006 g of R2 as the catalyst quantity for the Knoevenagel reaction in relation to the substrates. The catalytic activity is the last by running the Knoevenagel reaction on a variety of substrates; it is possible to thoroughly generalize the catalyst's catalytic activity. Melting point measurements and 1H and 13C NMR spectroscopy were used to characterise each product [13]. These findings allow us to endorse R2 as a suitable heterogeneous catalyst for the Knoevenagel reaction because it produced well to excellent conversion for all sets of substrates under investigation in a short (3–30 min) reaction period. We noticed that R2 (1MCl2-2NaPO3) is filtration to demonstrate the effectiveness and capabilities of the current protocol of our catalyst with certain known catalysts for the Knoevenagel reactions. It was carefully cleaned and dried. By running the model reaction five times with recycled catalyst present, it was possible to examine the reuse of the R2 (1MCl2-2NaPO3) as a heterogeneous catalyst for the Knoevenagel reaction [4].

CONCLUSION

It is obvious that the catalyst can be reused for additional reactions without significantly losing its catalytic activity. After the reaction was finished, the catalyst kept its shape and properties. It also possesses all the benefits of solid phase catalysts, including their ease of use, filterability, and capacity for regeneration and re-use [15]. There was no significant decrease in activity. We have shown that the hybrid MCl2-NaPO3 nanocomposite is a new heterogeneous catalyst for the Knoevenagel condensation that is very effective and reusable. Green chemistry, sustainability, and environmental security would all benefit greatly from it. This process has a number of benefits, including great yields in a short amount of time and the ability to recycle the catalyst five times without significantly losing any of its catalytic activity.

Acknowledgement

None

Conflict of Interest

None

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