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REVIEW

Bis[(L)prolinate-N,O]Zn: A water-soluble and recycle catalyst for various organic transformations

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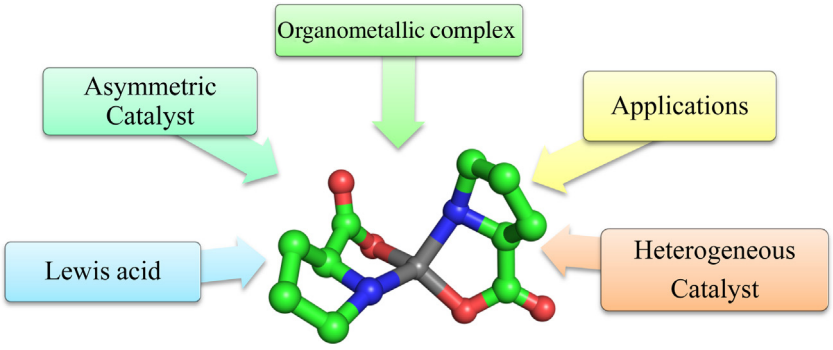
GRAPHICAL ABSTRACT



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ABSTRACT

Under the green chemistry perspective, bis[(L)prolinate-N,O]Zn (also called zinc–proline or Zn [(L)-pro]$_2$) has proven its competence as a promising alternative in a plethora of applications such as catalyst or promoter. Owing to its biodegradable and non-toxic nature of bis[(L)prolinate-N,O]Zn, it is being actively investigated as a water soluble green catalyst for synthetic chemistry. Bis[(L)prolinate-N,O]Zn are readily utilized under mild conditions and have high selectivity and reactivity with broad range of substrate acceptance to make it better reaction

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medium for a wide variety of organic transformations. This Review summarizes the till date literature on its synthesis, characterization, and its catalytic role in various organic reactions.

Roona Poddar is an Assistant Professor of Chemistry and teaches post graduate student in Department of Chemistry, University of Delhi, Delhi, India. She has a Master Degree in Chemistry from Indian Institute of Technology (IIT) Delhi, and a Ph.D. in Chemistry from the University of Delhi (DU). She has worked as Post Doctorate Fellow for three years before joining as faculty in Department of Chemistry, University of Delhi, Delhi, India She has published numerous research papers in peer reviewed journals.

Arti Jain obtained her PhD (Organic Chemistry) from University of Delhi, India, in 2013. She is currently an Assistant Professor in Department of Chemistry, Daulat Ram College, University of Delhi, India. Her research area is based on the exploration of newer environmental benign protocol for various traditional reactions, use of agricultural waste material to apply cradle to cradle approach etc. She has 4 years of teaching experience to the undergraduate students. She is still doing research in the college.

M. Kidwai is working as Professor at the Department of Chemistry, Delhi University, delhi, India. He has 30 years of teaching experience at the university level. Currently he has 260 papers in the Journal of National and International repute and supervised 40 Ph.D. students and 31 M. Phil students. Pioneer in the field of Green Chemistry, who has started first research work in this field in India in 1990. From Asia among 5 members is inclusive of himself in the international Advisory board make Globally figure in the exclusive field of Green chemistry.

Introduction

The recent past scientific and technological advances have provided a great insight regarding the catalytic properties and mechanism of metal-amino acid complexes. Metal salts with chiral amino acid have been used as promising materials for biological as well as chemical advancement as they tend to exhibit the advantage of the metal salts and the asymmetrical organic amino acids [1,2]. α–Amino acids could act as chelating ligands and form five member ring because they have two types of coordination atoms [3–7] due to the presence of proton acceptor amino group (NH_2) and the donor carboxylic acid group (COOH) in them.

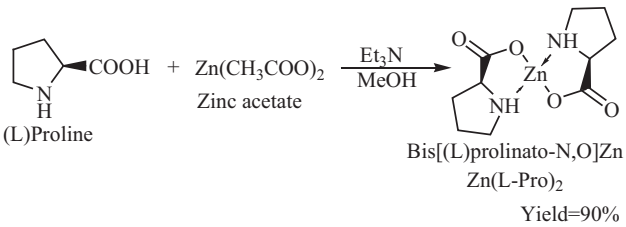
Zinc catches eyes of several researchers due to several reasons, as it can show various coordination geometries, is abundant in nature, is redox-inactive [8], and forms stable complexes with nitrogen. Zinc is an essential micronutrient, which is involved in various biological processes such as transcription, cell signaling catalysis, hormone synthesis, and structural integrity of cell membrane [9,10]. From the biological point of view, more than 300 zinc metallo-enzymes covering all six classes of enzymes have been discovered [11,12]. In most cases, the zinc ion is an essential cofactor for the observed biological function of these metalloenzymes. By the virtue of biological activity, thousands of synthetic zinc complexes have been formed either to mimic natural structure or to completely diverge from the natural platform [13–18]. Moreover zinc is present in active site of class II aldolases (an enzyme) witnessing the bis[(L)prolinate-N,O]Zn as a valid candidate for aldolase mimics.

Deprotonated amino acid coordination chemistry is dominated by the formation of the nitrogen and oxygen chelating motif producing the geometrically (and energetically) favoured five membered metallocyclic compounds [19].

Stability of the zinc complexes varies with different amino acids [20–23]. Metal ion-ligand affinity increases as the polarizability of the donor atom is increased (O < N < S) [24]. So there is an increase in selectivity for the amino acid having (N, S) linkage followed by (N, O). It has been shown that cysteine and its derivatives are more selective for metal ion-ligand binding as compared to other amino acid having (N, O) linkage [25]. The cumulative energy required for the acid dissociation of carboxylic acid to carboxylate ion and ammonium ion to secondary amine for proline with Zinc (II) is lower than other amino acid which has primary amine group and acid group. In secondary amine, there is more inductive effect which makes it more labile for acid dissociation constant [26,27].

Complex synthesis

Originally Darbre and Machuquiero have synthesized this bis[(L)prolinate-N,O]Zn complex. They have synthesized bis[(L)prolinate-N,O]Zn complex by adding small quantity of Et_3N



Scheme 1