Uttar Pradesh Journal of Zoology

Volume 44, Issue 18, Page 35-41, 2023; Article no.UPJOZ.2775
ISSN: 0256-971X (P)

Zoochemical-mediated Nanoparticle Synthesis Using Marine Sponge *Hyattella intestinalis* (Lamarck, 1814) as a Reducing Agents

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2023/v44i183603

Editor(s):
(1) Prof. Juan Carlos Troiano, University of Buenos Aires, Argentina.
Reviewers:
(1) Khalida Ali Thejeel, Al-Karkh university of science , Iraq.
(2) P. Aji Udhaya, Holy Cross College , India.

Original Research Article

Received: 07/06/2023
Accepted: 11/08/2023
Published: 16/08/2023

ABSTRACT

The aim of the study is to explore zoochemical-mediated nanoparticle synthesis using marine sponge *Hyattella intestinalis* as a reducing agents**.** In this term, zoochemical-mediated nanoparticle synthesis using the zoo-chemicals from zoo-extract, which contains zoo-chemicals, is involved as reducing agents. The first time authors introduced the term "zoochemical-mediated nanoparticle synthesized" using zoo-chemicals from marine sponge *Hyattella intestinalis* as a reducing agent, which were involved in reducing metal ions to form nanoparticle. Zoo-chemicals are naturally occurring animal secondary metabolites like alkaloids, terpenoids, etc., produced by *Hyattella intestinalis* marine sponges, which are equivalent to plant secondary metabolites. Marine sponge

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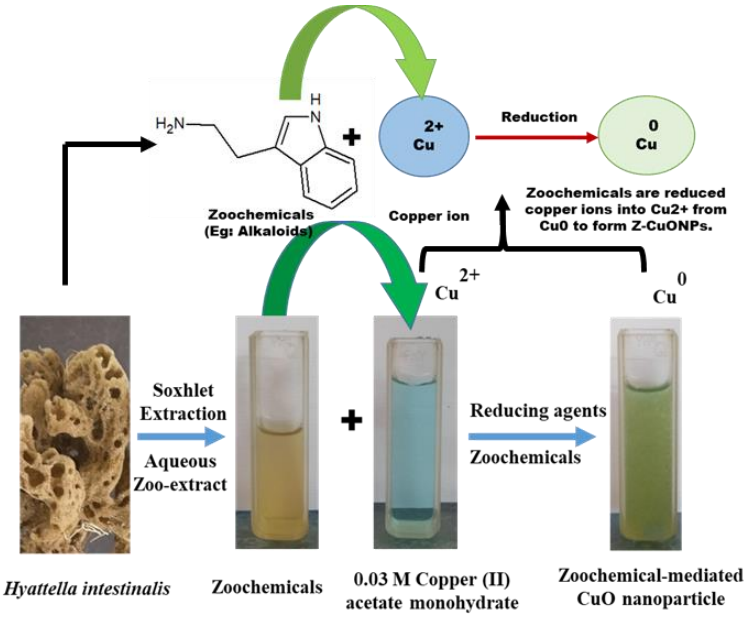
Hyattella intestinalis provided several zoo-chemicals involved in reducing copper ions into Cu^{2+} from Cu^{0}, which is a response to zoochemical-mediated CuO nanoparticle synthesis as recording zoo-chemicals as reducing agents. The finding of the results, zoo-chemicals are evidence of reducing agents that use nanoparticle synthesis, which results in effective nanobased, eco-friendly drugs. The author scientifically first time coined the term "zoochemical-mediated nanoparticle synthesis" using zoo-chemicals from *Hyattella intestinalis*.



Graphical abstract of zoochemical-mediated nanoparticle synthesis using marine sponge *Hyattella intestinalis* (Lamarck, 1814) as a reducing agents

Keywords: Zoochemical-mediated; marine sponge; Hyattella intestinalis; nanoparticles; reducing agents.

1. INTRODUCTION

In this term, zoochemical-mediated nanoparticle synthesis using the zoo-chemicals from zoo-extract, which contains zoo-chemicals, is involved as reducing agents in this mechanism to be coined "zoochemical-mediated nanoparticle." zoochemical-mediated nanoparticle synthesis as similar to phytochemicals-mediated nanoparticle synthesis, which secondary metabolites compounds are involved in reducing agents. Zoo-chemicals are naturally occurring animal secondary metabolites like alkaloids, terpenoids, etc., produced by animals, including marine sponges, as recorded by Karnan et al. [1] and involving reducing agents. The main chemical constituents of triterpene saponins are a source of natural bioactive compounds in marine invertebrate animals [2]. Zoo-chemicals are present in animals that are equivalent to phytochemicals in plants [3,1]. Marine-derived natural products have potential medicinal uses; the majority of the invertebrate phyla have been produced in zoo-chemicals, including sea stars, which are provided by secondary metabolites such as alkaloids, triterpenoids, flavonoids, saponins, and cardiac glycosides [4]. Marine alkaloids are a class of secondary metabolic compounds that can be used as effective drugs [5]. Some animals are able to biosynthesize alkaloids, including a huge number of alkaloids from marine animals [6]. The marine environment naturally provides valuable secondary metabolites, including marine sponges and biological properties with potential applications in new drug development and reducing agents. Roopan and Elango [7] reported that several reducing agents play a role in the formation of metal salts into metal nanoparticles. Metal nanoparticle synthesis technically involves the reduction of metal ions into nanoparticles and reducing agents obtained from phytoconstituents and microorganisms metabolic extract [8] using green synthesis methods. The aim of the present study, zoochemical-mediated nanoparticle synthesis and recording of zoo-chemicals as

reducing agents using *Hyattella intestinalis*. Previously, Karnan et al. [1] recorded more than 50 zoo-chemicals in *Hyattella intestinalis* and a succession of nanoparticle synthesises.

2. MATERIALS AND METHODS

The marine sponge was collected from the east coast of Mallipattinam village, Thanjavur district, Tamil Nadu, India, using the hand-picking method. The collected marine sponge was identified by a literature of Sivaleela, [9] and the molecular taxonomic identification using the 28S rRNA genome, gene was submitted to the GenBank (Accession No: OQ196103).

2.1 Zoochemical-mediated Nanoparticle Synthesis Using Zoo-chemicals from *Hyattella intestinalis*

Hyattella intestinalis zoo-chemicals were extracted with deionized water using the Soxhlet apparatus, as reported by Karnan et al. [1]. The present study recorded the term of zoochemical-mediated nanoparticle synthesis as similarly phytochemical-mediated nanoparticle synthesis, and the present study's methodology is supported by the method of Ghidan et al. [10]. The concentrated zoo-chemicals (20 gram of *Hyattella intestinalis* marine sponge extract with 200 ml of deionized water, using Soxhlet apparatus, a duration of 3 h, and a temperature of 50 to 60°C produced a brownish-colored extract that was concentrated to 20 ml) from *Hyattella intestinalis* were added dropwise with 0.03 M copper ions (Cu^{2+}) to change the colour from blue to green, which resulted in the reducing property of zoo-chemicals being recorded (Cu^{2+} from Cu^{0}). After 1 hour, the formation of green-coloured zoochemical-mediated CuONPs. In this reducing mechanism, zoochemical-mediated nanoparticles are synthesised from zoo-chemicals, as first-hand reports of zoochemical-mediated nanoparticles using *Hyattella intestinalis* zoo-chemicals indicate.

2.2 HPLC and FTIR Analysis of 70% hydroalcoholic Zoo-chemicals Extract of *Hyattella intestinalis*

Hyattella intestinalis was separately cut into pieces and extracted with 70% hydroalcoholic extract using Soxhlet extraction (3hr and 50 to 60°C) to obtained extract subjected to HPLC using a 254 nm detector in alkaloids analysis [11-14].

3. RESULTS

The *Hyattella intestinalis* molecular taxonomic identification using the 28S rRNA genome, gene was submitted to GenBank (Accession No: OQ196103). The present study recorded zoo-chemicals from *Hyattella intestinalis* aqueous extract as being involved in reducing the properties of copper ions into Cu^{2+} from Cu^{0} to form zoochemical-mediated nanoparticle, with reducing mechanisms of zoo-chemicals are displayed in Figs. 1 and 2. The tryptamine alkaloids were identified from the marine sponge *Hyattella intestinalis* using HPLC techniques, and the FTIR spectrum provided information that was used to identify the functional groups that were responsible for the reduction and capping processes of zoo-chemicals from zoochemical-mediated nanoparticle synthesis.

3.1 Zoochemical-mediated Nanoparticle Synthesis Mechanism

In this term, zoochemical-mediated nanoparticle synthesis using the zoo-chemicals from zoo-extract, which contains zoo-chemicals, is involved as reducing agents in this mechanism to be coined "zoochemical-mediated nanoparticle" (Fig. 1).

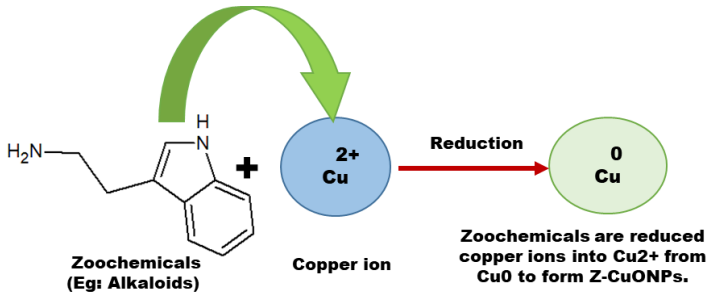


Fig. 1. Zoo-chemicals are reduced copper ions into Cu^{2+} from Cu^{0} to form zoochemical-mediated CuONPs synthesis mechanism

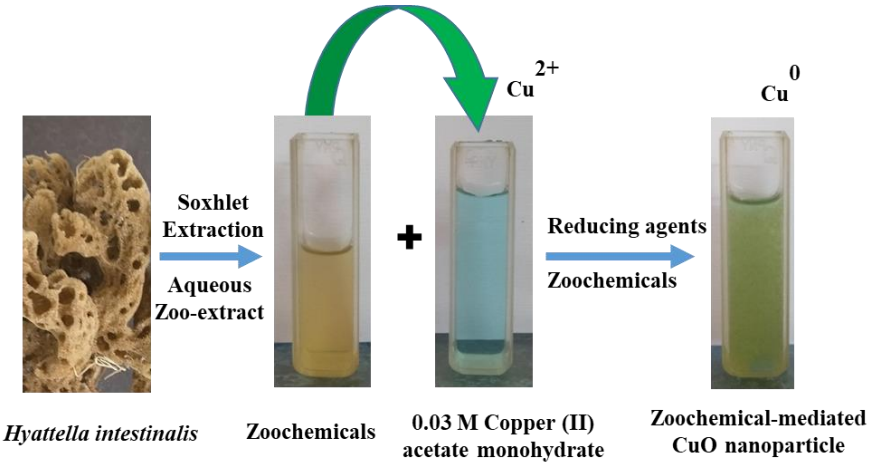


Fig. 2. Zoo-chemicals-mediated copper oxide nanoparticle synthesis using *Hyattella intestinalis* zoo-chemicals to reduce copper ions into Cu^{2+} from Cu^{0} to form zoochemical-mediated CuONPs

The first reported recording of marine sponge *Hyattella intestinalis* used zoochemicals-mediated copper oxide nanoparticle synthesis as a reducing agent of zoo-chemicals (Alkaloids and terpenoids were qualitative identified and also involved in metal ions reducing). The zoo-chemicals of *Hyattella intestinalis* reduced copper ions into 0.03M Cu^{2+} from Cu^{0}, which resulted in zoochemical-mediated nanoparticle synthesis (Fig. 2).

Fig. 2 shows concentrated zoo-chemicals from *Hyattella intestinalis* were added dropwise with 0.03 M copper ions (Cu^{2+}) to change the colour from blue to green, which resulted in the reducing property of zoo-chemicals being recorded (Cu^{2+} from Cu^{0}). After 1 hour, the formation of green-colored Zoo-chemicals-mediated CuONPs. In this reducing mechanism, zoochemical-mediated nanoparticles synthesised from zoo-chemicals are recorded.

3.2 Reducing Agents Identified from Zoochemical Extract Using Spectroscopy Technique

Previously, Karnan et al. [1] recorded 60 zoo-chemicals, including notable amine compounds such as 1,2,2-Trimethylcyclopropan-1-amine and N-(1,1-Dimethyl-2-propynyl)-N,N-dimethylamine in a 70% hydroalcoholic zoochemical extract of *Hyattella intestinalis* using GC-MS techniques. The tryptamine alkaloids was identified from marine sponge *Hyattella intestinalis* using HPLC technique with a 254nm detector (Table 1 and Fig. 3) and alkaloids was qualitatively identified. To obtain the 70% ethanolic zooextract, it was subjected to FTIR analysis showed the presence of alcohols, phenols, amines, and aromatics. The FTIR spectrum peak values of 3449.06 cm^{-1} presence of alcohols and phenols, 2923.49 and 2852.26 cm^{-1} presence of alkanes, 1637.42 cm^{-1} presence of 1° amines, 1453.02 cm^{-1} presence of aromatics, 1069.22 cm^{-1} presence of aliphatic amines and 620.58 cm^{-1} presence of alkynes functional groups were also involved in reducing agents. The zoo-chemicals of *Hyattella intestinalis* provided information which was used to identify the functional groups that were responsible for the reduction and capping processes of zoo-chemicals from *Hyattella intestinalis*, represent in Fig. 4. The present study concludes that strong conformations of functional groups such as phenols, alcohols, amines, and aromatics are present in *Hyattella intestinalis* and used for eco-friendly approaches to zoochemical-mediated nanoparticle synthesis.

Table 1. HPLC analysis of marine sponge *Hyattella intestinalis* alkaloids derivatives using 254nm detector

Peak #	Ret. Time	Identified compound	References
1	3.13	Tryptamine	Hisiger and Jolicoeur, [11]
2	3.70		

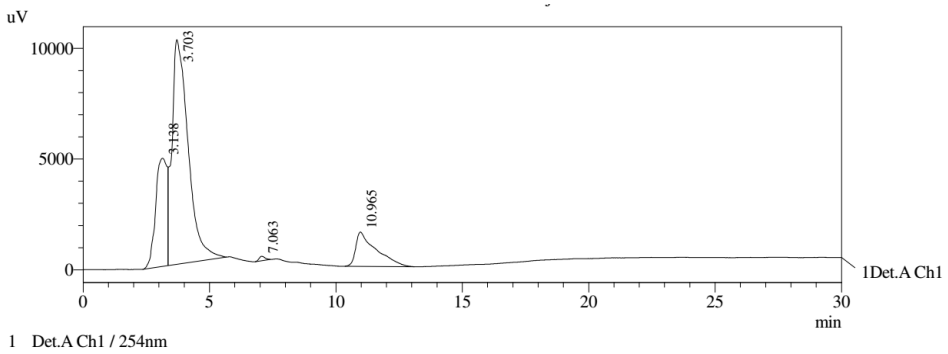


Fig. 3. HPLC chromatogram of zoo-chemicals extract of *Hyattella intestinalis*

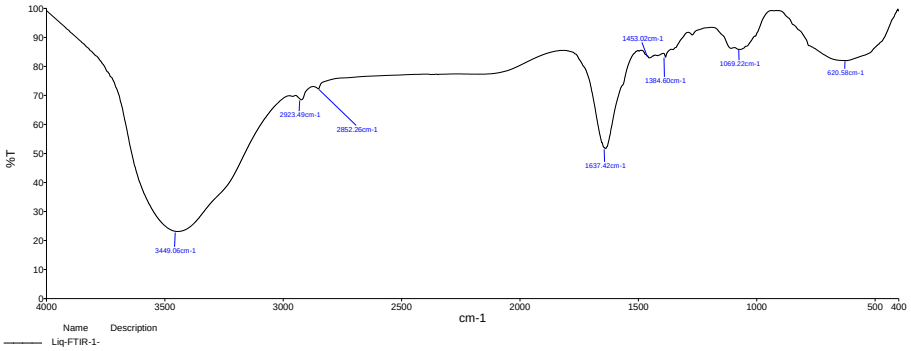


Fig. 4. FTIR spectrum of zoo-chemicals extract of *Hyattella intestinalis*

4. DISCUSSION

In the present study, tryptamine alkaloids was identified from marine sponge *Hyattella intestinalis* using HPLC technique with a 254nm detector and alkaloids was qualitatively identified. The marine alkaloids are a kind of compound that can be separated from marine organisms, as reported by Zhou and Huang [15]. HPLC can be 254nm detectors was previously observed as tryptamine at a retention time of 3.5 minutes by Hisiger and Jolicoeur, [11,12] and Tikhomiroff and Jolicoeur [14] reported a retention time of 3.5 minutes in tryptamine alkaloids. *Hyattella intestinalis* retention time peaks were observed at 3.13 and 3.70 minutes using a detector at 254nm. Similarly, Dagnino et al. [16] used UV detection by HPLC to identify tryptamine alkaloids. Marine alkaloids are mainly involved in biological activity, such as anticancer, antimicrobial and anti-inflammatory properties [15]. Campos et al. [17] report on tryptamine derivatives identified from the marine sponge *Fascaplysinopsis reticulata* and three new tryptophan-derived alkaloids, including. Bian et al. [18] recently reported a succession of marine alkaloids from sponges' extensive pharmacological activities, and marine alkaloids synthesised from sponges continued to play a leading role in drug discovery by Singh and Majik, [19]. Almadiy and Nenaah, [20] reported silver nanoparticle synthesis from potato alkaloids. Similarly, the present study recorded nanoparticle synthesis using zoo-chemicals as reducing agents from *Hyattella intestinalis,* and the present study agreed that tryptamine alkaloids found in *Hyattella intestinalis* are involved in reducing copper ions to form zoochemical-mediated copper oxide nanoparticle synthesis, and supported zoochemical functional groups such as phenols, alcohols, amines, and aromatics are present in *Hyattella intestinalis*.

Nanoparticle synthesis using phytochemicals that play an important role in reducing metal ions into M^+ from M^0 [21]. Plant-mediated synthesis approaches for metal nanoparticles are more reliable [22] and economic. Similarly, in the present study, metal nanoparticles were synthesised using zoo-chemicals from *Hyattella intestinalis* and zoo-chemicals are involved in the reduction of metal ions to form metallic nanoparticles. Physically, zoo-chemicals are involved in the reducing mechanism observed into copper ions (Cu^{2+}) blue colour from (Cu^0) green colour observed to confirm zoochemical-

mediated nanoparticle synthesis from *Hyattella intestinalis.* The present study supports the evident reduction of secondary metabolites by reduced metal ions, as agreed by Ghidan et al. [10], who studied plant species of *Punica granatum* peels to extract reduced copper ions to form copper oxide nanoparticles. The results provided strong scientific evidence of zoo-chemicals from the marine sponge *Hyattella intestinalis* that reduced metal ions to form nanoparticles and involved secondary metabolic zoo-chemicals. The first recording of the term was zoochemical-mediated nanoparticle synthesis using zoo-chemicals from the marine sponge *Hyattella intestinalis* as a reducing agent of zoo-chemicals.

5. CONCLUSION

The first time introduced the term “zoochemical-mediated nanoparticle synthesized” using zoo-chemicals from marine sponge *Hyattella intestinalis* as a reducing agent, which were involved in reducing Cu^{2+} from Cu^{0} to form zoo-chemicals-mediated CuO nanoparticle. Tryptamine alkaloids produced by *Hyattella intestinalis* marine sponges, which are equivalent to plant secondary metabolites. The finding of the results, zoo-chemicals are evidence of reducing agents that use nanoparticle synthesis, which results in effective nanobased, eco-friendly drugs. The author scientifically first time coined the term "zoochemical-mediated nanoparticle synthesis" using zoo-chemicals from *Hyattella intestinalis*.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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