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Zinc nanoparticles mediated by *Costus pictus* leaf extract to study GC-MS and FTIR analysis

Bibi Hafsa Azra* and Tarannum Fatima

Department of Botany, Anwarul Uloom College, Hyderabad-Telangana State, India.

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Corresponding Author: **Bibi Hafsa Azra | E-Mail: (hafsaazra55@gmail.com)**

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ABSTRACT

Plants have been used to treat illnesses from the dawn of time, and the term "medicinal plants" has taken on special significance. Because of their pharmacological potency, these plants have continued to be used as a source of medicines and other natural goods worldwide. Costus pictus, Commonly known as flaming costus (Costus igneus Nak), is a South-central American plant recently brought to India. It belongs to the Costaceae family. It is called the "insulin plant" in India because of its alleged anti-diabetic qualities. The methods utilized in this study are GC-MS, FTIR and SEM analysis. The results revealed that GC-MS shows the presence of different compounds: fatty acids, terpenoids, Alkanes, Carboxylic acid and aromatic compounds. The FTIR analysis depicts various functional groups comprising alkanes, alkenes, alkynes, carboxylic acid, aromatic compounds, and halo compounds. SEM analysis depicts the shape and size of nanoparticles, and the size of nanoparticles is 77nm - 113nm. Further research should be done on the characterization of Zn nanoparticles, metabolomics analysis and pharmacological activities.

Keywords: *Zn nanoparticles, SEM, FTIR, GC-MS, Costus pictus*

Introduction

Plants have been used to treat illnesses from the dawn of time, and the term "medicinal plants" has taken on special significance. Because of their pharmacological potency, these plants have continued to be used as a source of medicines and other natural goods worldwide [1] stated that *Costus pictus*, Commonly known as flaming costus *(Costus igneus Nak*), is a South-central American plant recently brought to India. It belongs to the Costaceae family. It is called the "insulin plant" in India because of its alleged anti-diabetic qualities. This Plant's leaves are a natural supplement for treating type 2 diabetes. Systematic evaluation of the Plant is required given its significance for medicine, the environment, society, and the economy on the one hand and India's need for widespread dissemination on the other. Although morphological characterization is crucial for understanding variety, it has well-known limits when identifying genetic or environmental causes of variances [2]. The biological synthesis of Zn Np has gained much importance due to its biocompatible and eco-friendly nature. The green synthesis approach produces maximal and narrow size range nanoparticles between 1and100nm. Due to their numerous uses in electronics, communications, sensors, cosmetics, environmental protection, biology, and medicine, zinc oxide nanoparticles have caught the attention of many researchers [3]. The main Objectives of the study are to synthesize Zinc nanoparticles, To study the GC-MS analysis to know about its different compounds and To explore the characteristics of Zn nanoparticles through FTIR and SEM analysis.

Materials and Methods

10gm of the fresh leaves of *Costus pictus* is cut and carefully cleaned under running water to remove surface impurities and debris. The leaves are cut into small pieces, put in a beaker with 100ml of distilled water, and boiled for around 20 minutes.

After the plant extract has cooled, it is purified through Whatman filter paper No. 1 to create a filtrate. To create zinc nanoparticles, keep the filtrate chilled to 4 degrees Celsius.

Synthesis of Zinc Oxide Nanoparticles

One mM zinc acetate was dissolved in 50 ml Milli-Q water and stirred for 1 hour. After that, 20 mL of NaOH solution was gradually added to the Zinc acetate solution, followed by 25 mL of plant extract. After 1 hour of incubation, the colour of the reaction mixture was changed. The solution was stirred for three hours. The appearance of yellow after the incubation period verified the production of ZnO NPs.

Centrifugation at 8000 rpm at 60 °C for 15 minutes separated the precipitate from the reaction solution, and the pellet was recovered. The pellet was dried in an 80 °C hot air oven for 2 hours and stored in airtight bottles for further investigation [4].

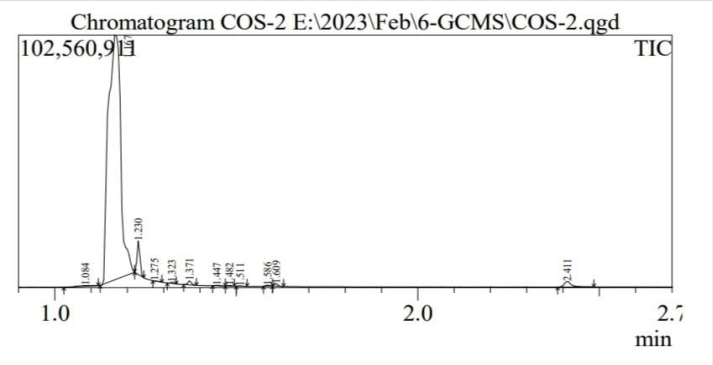
GC-MS Analysis

The Silver nanoparticle leaf extract was analyzed using the conventional GC-MS methodology at the Central Analytical Facility, University College of Technology, Osmania University. The equipment used for the GC-MS analysis is a SHIMADZU type GC-2010, MS-QP2010. The name, molecular weight, and structure of unknown compounds were recognized by comparing the spectra of unknown chemicals to the spectrum of known compounds in their collection.

SEM Analysis

On the Hitachi S-3700N SEM, synthesized ZnNPs were analyzed using scanning electron microscopy (SEM). Before analysis, the ZnNP powder was sonicated for 5 minutes, and a drop of the correctly diluted sample was applied to a copper grid covered with carbon. A magnifying effect caused by this determines the size and shape of the nanoparticles.

Fourier transform infrared spectrophotometer Analysis.
Using a Fourier transform infrared spectrophotometer (FTIR), the functional groups present in the plant extract components are detected. The annotated spectrum provides the wavelength of absorbed light, which indicates the chemical bond. An FTIR spectroscope was then used to analyze the nanoparticle extract from the leaves of the *Costus pictus*. On a Shimadzu FTIR Spectrometer, potential functional groups in biomolecules present in the plant extract were detected using Fourier Transform Infrared Spectroscopy (FTIR) [5].



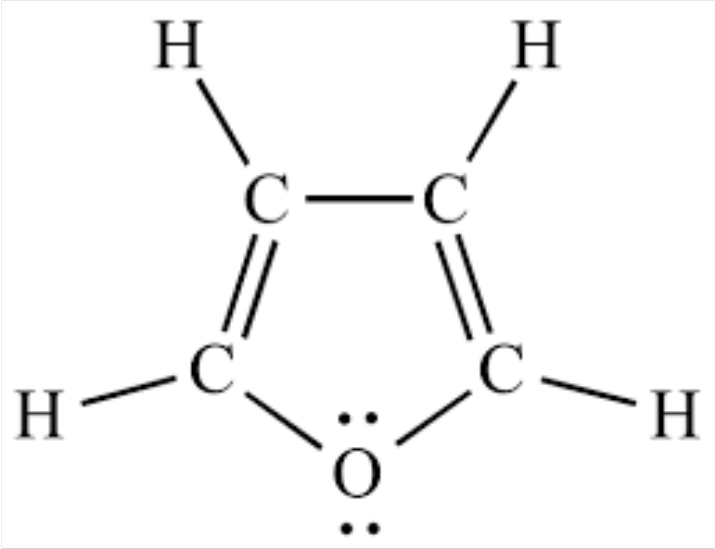
Result and Discussion

GC-MS Analysis
Different metabolic components were identified, and different types of secondary metabolites in an extract were determined using this method.

It shows the presence of different fatty acids, carboxylic acids, alkanes and terpenoids. Some of them are mentioned below.

Name	M.Formula	M.Weight	R.Time	Compound Name
3-Decyn-2-ol	C10H18O	154	1.085	Monoterpenoid
Propane	C5H12O2	104	1.165	Alkane
Butanal	C5H10O	86	1.165	Alcohol
Methylene Chloride	CH2Cl2	84	1.230	organochlorine compound
Oxirane	C4H8O	72	1.165	Ether
2-Methyl butyl isothiocyanate	C6H11NS	129	1.275	Alkyl compound
3,6-Octadecadiynoic acid,	C19H30O2	290	1.275	Fatty acid
Ethanedioic acid	C10H18O4	202	1.325	Dicarboxylic acid
Ethyl Acetate	C4H8O2	88	1.445	Ester
Furan	C4H8O	72	1.510	Heteroarene
Butane	C6H14	86	1.510	Alkane
Ethene	C2H3Cl	62	1.585	Hydrocarbon
Propane	C5H12O2	104	1.610	Alkane gas
Borane	C2H7BO2	74	1.610	Boron
Butanoic acid	C6H12O3	132	1.610	Carboxylic acid
Toluene	C7H8	92	2.410	Aromatic Hydrocarbon
Cycloheptatriene	C7H8	92	2.410	Organic Compound
Cyclobutene	C7H8	92	2.410	cycloalkene

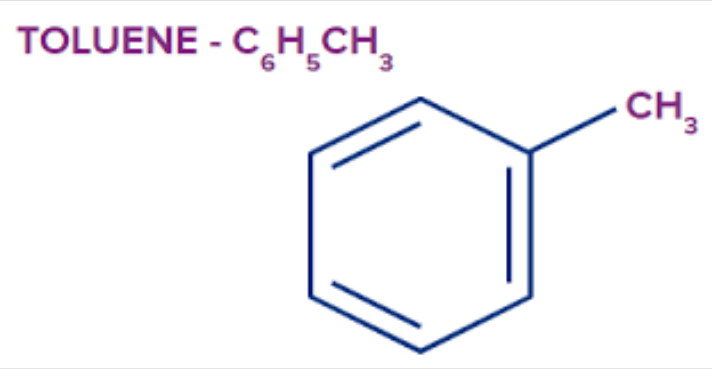
Furan



[6] state that a wide variety of foods that have undergone heat processing include the volatile, heterocyclic, and carcinogenic chemical component furan (C4H4O). Furan has been evidenced to cause cancer in experimental animal models. The furan derivative is an essential heterocyclic chemical with significant biological characteristics. The colon and the lung quickly and extensively absorb furan.

It can infiltrate different organs and cross biological membranes. Many foods naturally include these substances and their derivatives [7]. Many furan derivatives have been discovered recently from natural substances such as plants, fruits, oils, and marine delicacies. Numerous studies have shown that these furan derivatives had positive health impacts on people [8].

Toluene
Toluene is a volatile liquid (i.e., it turns into a vapour at room temperature) that when purposely inhaled in pure form or from a variety of industrial items, including solvents, gasoline, paints, varnishes, paint thinner, adhesives and inks, among other products, causes psychoactive effects. Toluene is an aromatic hydrocarbon with a strong affinity for lipids and is lighter than water in liquid form but three times heavier than air as a vapour. Due to its lipophilic nature, toluene quickly penetrates biological membranes, including the placental barrier. However, exposure to toluene during adolescence affects normal brain development, cognition, and behaviour in adults and constitutes the long-term effects of inhalant usage [9-10].



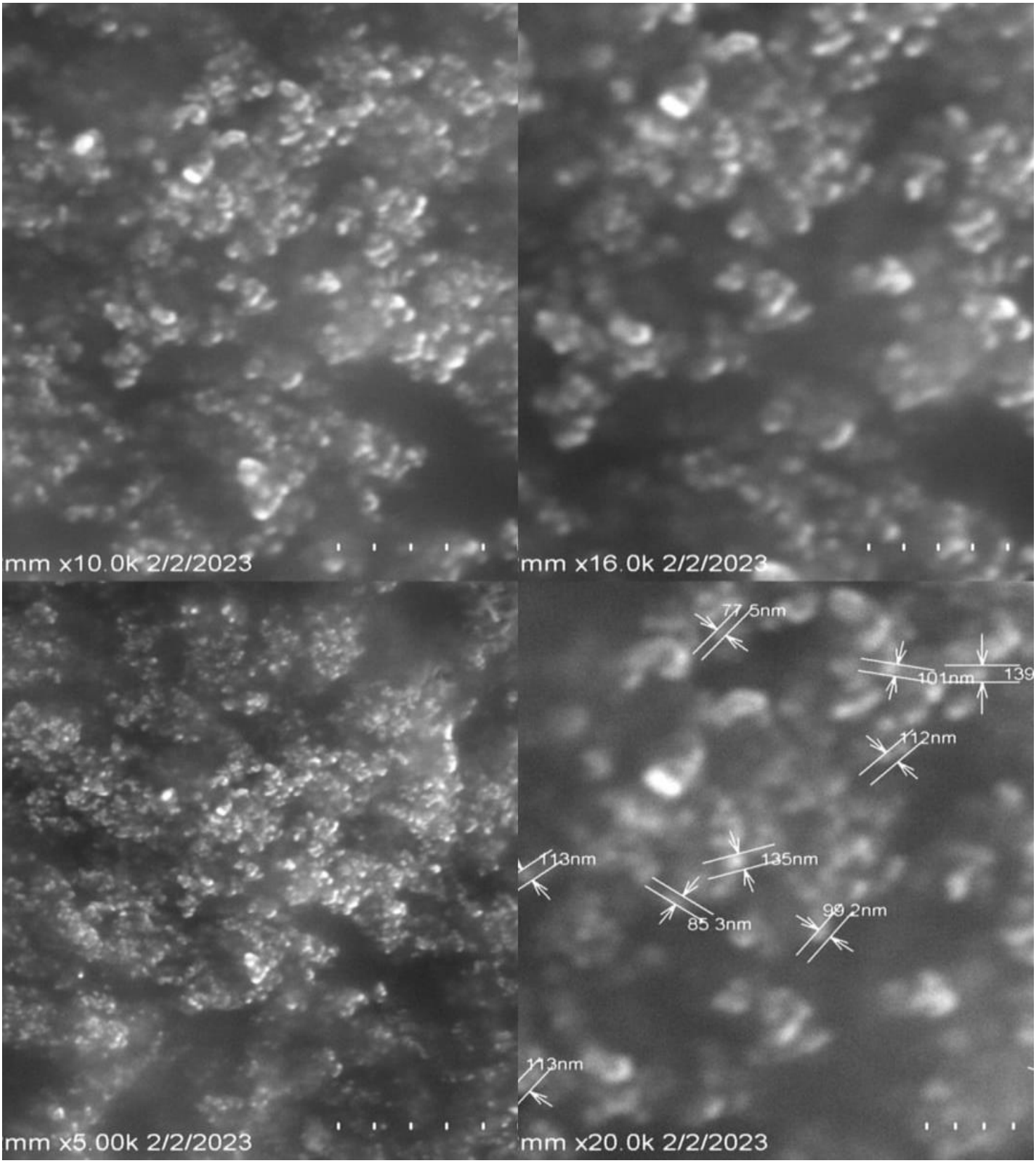
FTIR analysis

Based on the peak values in the I.R. radiation area, the FTIR spectrum is examined to detect the functional groups of the active components found in the extract. Based on their peak ratios, the constituents' functional groups and chemical bonds are categorized as the extract travels through the FTIR.

s.no	Frequency range	Absorption	Compound	Group
1.	4000- 3000 cm	3624.37 - 3604	Alcohol	O-H stretching
2.		3533.71 - 3213.51	Alcohol	O-H stretching
3.		3388.08-3307.06	Primary amine	N-H stretching
4.		3334.07	secondary amine	N-H stretching
5.		3286.81 - 2508.51	carboxylic acid	O-H stretching
6.		3055.35 - 2702.36	alcohol	O-H stretching
7.		2972.4 - 2856.67	amine salt	N-H stretching
8.	3000-2500	3307.06 - 3272.34	alkyne	C-H stretching
9.		3055.35 - 3030.27	alkene	C-H stretching
10.		2972.4 - 2856.67	alkane	C-H stretching
11.		2773.73 - 2702.36	aldehyde	C-H stretching
12.		2588.56 - 2562.52	thiol	S-H stretching
13.	2400- 2000	2196.03	alkyne	CΞC stretching
14.		2094.76 - 1913.45	isothiocyanate	N=C=S stretching
15.		1995.43 - 1913.45	allene	C=C=C stretching
16.	2000-1650 cm	1995.43 - 1792.89	Aromatic compound	C-H bending
17.		1814.11 - 1792.89	acid halide	C=O stretching
18.		1383.97	Aldehyde/ Alkane	C-H bending
19.	1400-1000 cm^{-1}	1419.66 - 1402.3	carboxylic acid	O-H bending
20.		1419.66 - 1333.82	alcohol	O-H bending
21.		1413.87 - 1383.97	sulphate	S=O stretching
22.		1408.08 - 1383.97	sulfonyl chloride	S=O stretching
23.		1383.97 - 1008.8	fluoro compound	C-F stretching
24.		1383.97 - 1327.07	phenol	O-H bending
25.		1344.43	Sulfonate /sulfonamide / sulfonic acid	S=O stretching
26.		1344.43 - 1300.07	sulfone	S=O stretching
27.		1333.82 - 1294.28	aromatic amine	C-N stretching
28.		1300.07 - 1256.67	aromatic ester	C-O stretching
29.		1262.45 - 1216.16	alkyl aryl ether	C-O stretching
30.		1247.02 - 1114.89	amine	C-N stretching
31.		1216.16	vinyl ether	C-O stretching
32.		1128.39	tertiary alcohol	C-O stretching
33.	1000-650 cm^{-1}	717.54 - 708.86	alkene	C=C bending
34.		646.17 - 524.66	halo compound	C-Br stretching
35.		598.92 - 524.66	halo compound	C-I stretching

Primary and secondary amines, alcohol, alkanes, alkenes, alkynes, aromatic compounds, carboxylic acid isothiocyanate, and halo compounds may all be seen in the activated zn nanoparticle extract of the Costus leaf extract. Most functional groups involved are alcohol at different frequency ranges and absorption, i.e., from 3624.37 to 3604 and 1419.66 to 1333.82. The absorption range from 3624.37 to 3604 shows the O-H stretching group; on the contrary, the range from 1419.66 - 1333.82 shows the O-H bending group.

SEM



Scanning electron microscopy was used to research the formed and size characteristics of the created nanoparticles. A glass substrate was used to generate Zn nanoparticles in Figure employing ZnNPs collected from costus leaves. According to the results, ZnNPs were primarily homogenous in size, and their shape could be predicted. Most of the nanoparticles produced were spherical and ranged from 77 to 113 nm. The uniformly distributed Zn nanoparticles on the surface of the cells were observed.

Conclusion

The biosynthesis of Zinc nanoparticles in the leaf extract was carried out in this study, and this study depicts the presence of some secondary metabolites comprised of fatty acids, halo compounds and aromatic compounds. FTIR analysis shows the presence of numerous functional groups with stretching and bending bonds. Further, SEM analysis shows the size of nanoparticles. Further research should be done on the characterization of Zn nanoparticles, metabolomics analysis and pharmacological activities.

References

1. Alizadeh, M., Moludi, J., Khodaei, H., Saber, A., Kheirouri, S., Tabrizi, F. P. F., & Kamari, N. (2020). Recent Updates on Anti-Inflammatory and Antimicrobial Effects of Furan Natural Derivatives, *Journal of Inflammation Research*, *Volume 13*, 451–463. https://doi.org/10.2147/jir.s262132

2. Azra, B. H., & Bhavani, N. L. (2022). Green Synthesis And Phytochemical Characterization Of Silver Nanoparticles From Leaf Extracts Of Chamaecostus Cuspidatus (Nees & Mart). *Journal of Emerging Technologies & Research (JETIR)*, *9*(4), d329–d338. https://www.jetir.org

3. Batool, Z., Xu, D., Zhang, X., Li, X., Li, Y., Chen, Z., ... & Li, L. (2021). A review on furan: Formation, analysis, occurrence, carcinogenicity, genotoxicity and reduction methods. Critical reviews in food science and nutrition, 61(3), 395-406.

4. Cruz, S. L., Rivera-García, M. T., & Woodward, J. J. (2014). Review of toluene action: clinical evidence, animal studies and molecular targets. Journal of drug and alcohol research, 3.

5. *Draw the cyclic five-member ring structure of furan.* (n.d.). Toppr Ask. https://www.toppr.com/ask/question/draw-the-cyclic-five-member-ring-structure-of-furan/

6. Hegde, P. L., Rao, H. R., & Rao, P. K. (2014). A review on Insulin plant (Costus igneus Nak). *Pharmacognosy Reviews*. https://doi.org/10.4103/0973-7847.125536

7. Santhoshkumar, J., Kumar, S. V., & Rajeshkumar, S. (2017). Synthesis of zinc oxide nanoparticles using plant leaf extract against urinary tract infection pathogen. *Resource-Efficient Technologies*, *3*(4), 459-465.

8. Suresh, J., Pradheesh, G., Alexramani, V., Sundrarajan, M., & Hong, S. I. (2018). Green synthesis and characterization of zinc oxide nanoparticle using insulin plant (Costus pictus D. Don) and investigation of its antimicrobial as well as anticancer activities. Advances in Natural Sciences: Nanoscience and Nanotechnology, 9(1), 015008

9. Thomas, S. (2022). Taxonomic, Molecular and Physiological Evaluation of Costus Pictus D. Don Plants Originally Obtained from Different Parts of Kerala, India. *Adbu*. https://www.academia.edu/75198326/

10. Andersen, S. L., Flores, R. G., Madeira, V. S., Jose, H. J., & Moreira, R. F. (2012). Synthesis and characterization of acicular iron oxide particles obtained from acid mine drainage and their catalytic properties in toluene oxidation. Industrial & engineering chemistry research, 51(2), 767-774.