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Government Funded Innovations in Phytopharmaceuticals Exploring the Medicinal Potential of Costus Speciosus

Dr. Savita Mohindra[1], Dr. Malika Pal[2], Dr. Mukta Shrivastava[3]

[1]Asst. Prof. of Botany SAM Girls College
[2]Prof. of Botany SAM Global University Bhopal
[3]Prof. of Botany Govt. Girls M.L.B. College, Bhopal

Abstract

The plant-based therapeutics has positioned phytopharmaceuticals at the forefront of modern drug discovery. Costus speciosus, commonly known as crepe ginger, is a perennial herb extensively utilized in traditional medicine systems like Ayurveda and Unani. Recognized for its diverse pharmacological properties—including antidiabetic, anti-inflammatory, antimicrobial, and antioxidant effects—this plant has garnered significant scientific interest. This paper delves into government-funded initiatives in India aimed at exploring and harnessing the medicinal potential of Costus speciosus. It encompasses advanced phytochemical analyses, molecular characterizations, and preclinical trials supported by national research councils. These endeavors align with objectives of sustainable healthcare, integration of indigenous knowledge, and economic upliftment through plant-based drug development. The study discusses current advancements, funding mechanisms, and the translational potential of Costus speciosus within the broader framework of phytopharmaceutical innovation in India.

1. Introduction

Costus speciosus, a perennial rhizomatous plant known for its rich phytochemical profile, has been increasingly recognized for its pharmacological importance, particularly due to its diosgenin content. Recent government-funded initiatives have focused on enhancing the medicinal potential of Costus speciosus through biotechnological innovations, including in-vitro propagation, growth harmones - based metabolite enhancement, and sustainable harvesting protocols. This paper presents a comprehensive study of such innovations, demonstrating significant improvements in diosgenin yield and exploring the therapeutic spectrum of its bioactive constituents. These advancements not only support the development of plant-based drugs but also align with India's phytopharmaceutical policy goals under schemes like AYUSH

2. Material and methods

2.1 Collection of plant material

In vitro micro propagation starts from selection of explants. The first step in this process is selection and collection of plants. Costus speciosus (J.Koen) certified plant were collected from Vindhya herbal

Bhopal . Vindhya herbal known as a unit of M.P. State minor forest production center, cooperative federation limited.

2.2 In-vitro Propagation and Secondary Metabolite Enhancement

Murashige and Skoog (MS) medium was supplemented with different concentrations of BAP and NAA to optimize shoot multiplication. Explants were surface sterilized using $HgCl_2$ and established under aseptic conditions.

2.3 Phytochemical Screening: Phytochemical screening is an initial step in identifying bioactive compounds present in Costus speciosus . It entails qualitatively analysing plant extracts to look for certain types of chemicals, such as alkaloids, flavonoids, terpenoids, phenolics, and Saponins.

2.4 Thin layer Chromatography (TLC) and High performance liquid Chromatography Methdology

Dried powdered material of Costus speciosus(J.Koen) was extracted with methanol as solvents using maceration process for 48 hours, filtered and dried using vacuum evaporator at 40°C. The extract phytochemicals were prepared into a stock solution of 100 mg/ml concentration that was used for TLC analysis. For the separation, purification, and analysis of bioactive substances, chromatographic methods are crucial. According to their chemical characteristics, Thin layer chromatography TLC) and high-performance liquid chromatography (HPLC) are two frequently used techniques for the separation and quantification of substances. For the separation and purification of specific substances .

3. Result and Discussion

TLC profiling of standard markers on plate in chromatographic condition / Distance travelled by standard marker saponin diosgenin and alkaloid colchicin on 2 different TLC plats spotted with 2 different extracts of Costus speciosus. generating Rf values observable in short & long range UV wavelength under current chromatographic conditions

Observation and results TLC profiling of standard markers on plate in chromatographic condition

Table-1

S.N.	Sample Used	No. of band/spot (At Short wavelength)	No. of band/spot (At Long wavelength)
1	*Diosgenin(std.)*	1	1
2	*Colchicin(std.)*	1	1

Calculation of R_f Value:

$$R_f \text{ (Retention factor)} = \frac{\text{Distance travelled by Spot}}{\text{Distance travelled by Solvent}}$$

R_f Values of Diosgenin and Colchicine

Distance travelled by standard marker saponin diosgenin and alkaloid colchicin on 2 different TLC plats spotted with 2 different extracts of Costus speciosus generating Rf values observable in short & long range UV wavelength under current chromatographic conditions

Table-2

S.N.	Plate Tag	Travel distance		Mobile phase distance	R_f Value	
		Diosgenin	Colchicin		Diosgenin	Colchicin
1	Plate 1 & Plate 2	6.3 cm	0.9 cm	7.0 cm	0.9	0.12

Table: 3 TLC chromatogram details of methanolic rhizome extract of Naturally and tissue cultured *C. speciosus* methanolic extract in chromatography conditions compared to Diosgenin in both short & Long UV wavelengths

Sample extract	*Extract 1 and Extract 2*
Mobile Phase	Toluene: Ethyl acetate: Acetic acid: Formic acid (ratio= 4:3:1:1)
Plate Tag	Plate 1
Spot description from left to right on plate	Diosgenin, extract 1 and extract 2 respectively
Distance travelled by mobile phase	7.0 cm
***Number of spots at* short & Long wavelength**	6 & 7 Respectively
Visibility	Sharp
Distances of spots from start point of each spot (from bottom to top)	1.0 cm, 3.2 cm, 4.2 cm, 5.5 cm, 6.0 cm and 6.3 cm
Any Match with Diosgenin Standard	Yes
R_f Values of each spot (from bottom to top)	0.14, 0.45, 0.5, 0.6, 0.78, 0.85 and 0.9 respectively

Table 4: TLC chromatogram details of methanolic rhizome extract of Naturally and Tissue cultured *C. speciosus* methanolic extract in chromatography condition compared to Colchicin in both short & Long UV wavelength

Sample extract	*Extract 1 and Extract 2*
Mobile Phase	Toluene: Ethyl acetate: Methanol: Ammonia (ratio= 30:20:20:0.1)
Plate Tag	Plate 2
Spot description from left to right on plate	Colchicin, extract 1 and extract 2 respectively
Distance travelled by mobile phase	5 cm
Number of spots at short & long wavelength	5 & 6 Respectively
Visibility	Sharp
Distances of spots from start point of each spot (from bottom to top)	0.9 cm, 1.5 cm, 2.9 cm 3.8 cm, 5.0 cm and 5.6 cm
Any Match with Colchicin Standard	Yes
R_f Values of each spot (from bottom to top)	0.12, 0.21, 0.41, 0.54 0.71 and 0.8 respectively

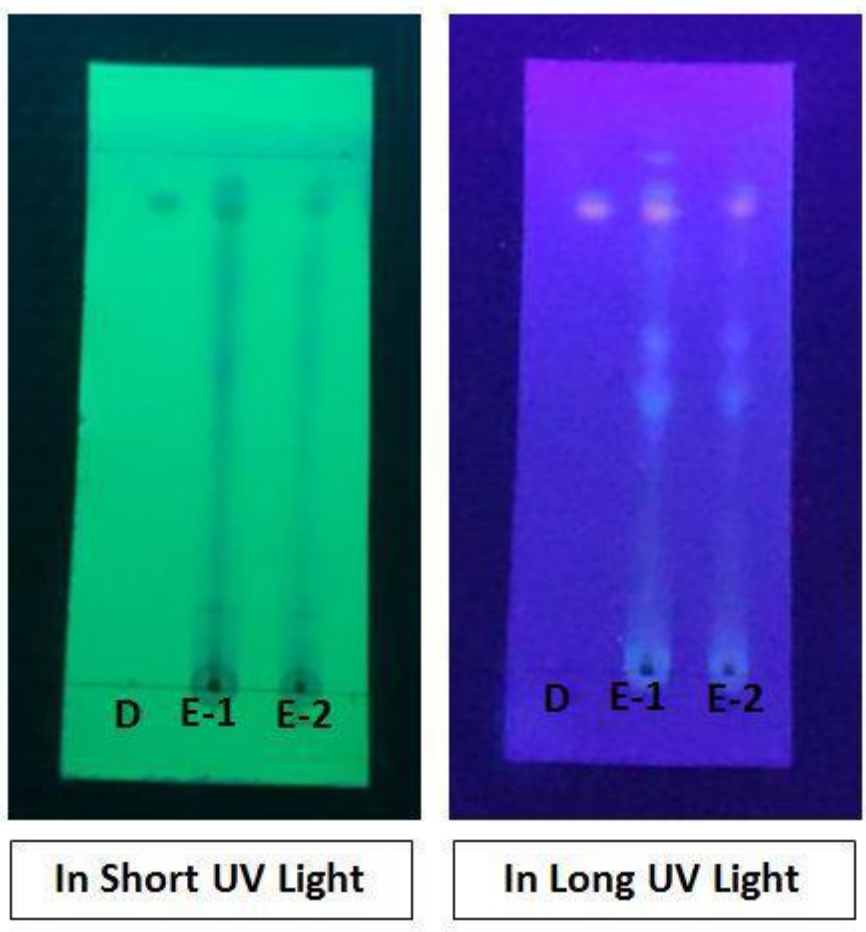

Figure 1: Visualization of TLC plates in **Short & Long Range UV light** of plate 1 loaded with methanolic extracts of both naturally grown and tissue culture raised Costus speciosus rhizomes compared with standard diosgenin

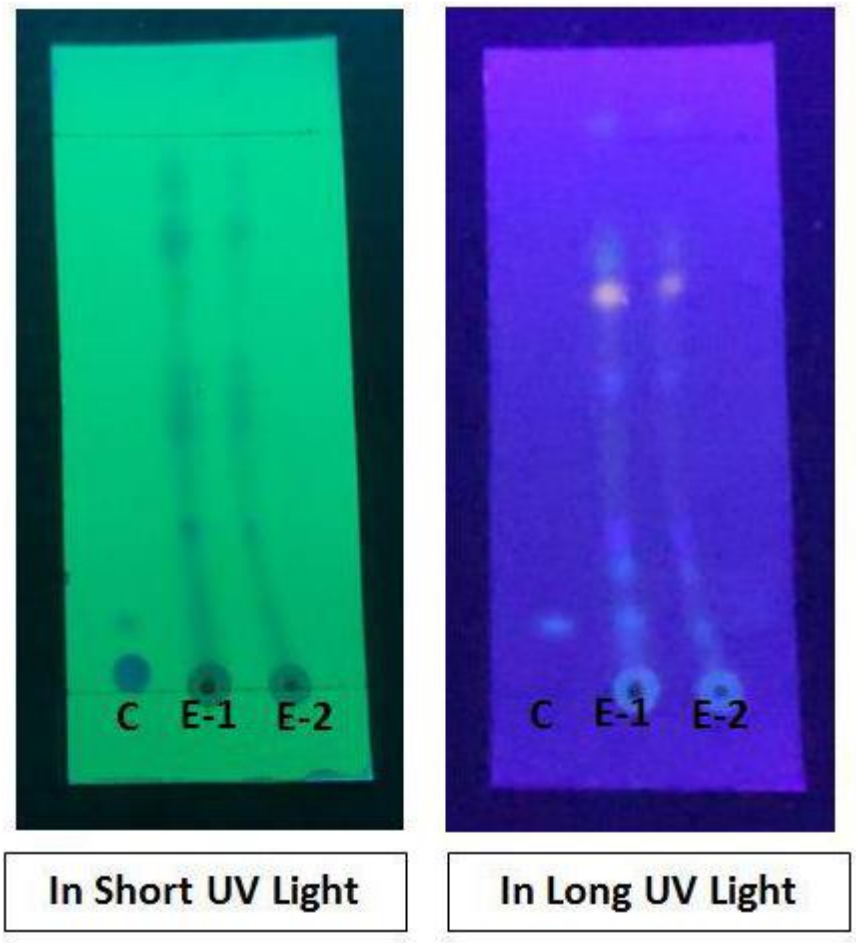

Figure 2: Visualization of TLC plates in **Short & Long Range UV light** of plate 1 loaded with methanolic extracts of both naturally grown and tissue culture raised Costus speciosus rhizomes compared with standard Colchicin .

The chromatographic conditions used in TLC analysis of methanolic rhizome extract of of Costus speciosus of both naturally grown and tissue culture grown plants shows similar spot separation pattern when visualized under short UV range and long UV range for both diosgenin and colchicine marker detection on two separate plates whose chromatographic conditions are mentioned

High Performance Liquid Chromatography Identification of marker compound (Diosgenin) by HPLC.

It is observed that, the methanolic extracts rhizome of plant Costus speciosus from both the sample i.e., plant of natural origin and tissue cultured plant samples responded for detection of diosgenin like saponins in samples during HPLC analysis. In HPLC techniques the detection of the presence of saponin in terms of diosgenin marker compound it reported to be positive, though its percentage concentration is quite low in both the samples analysed. Inspite of the low concentration, the diosgenin percentage is reported to be higher in tissue culture samples than in natural plant samples. The percentage of Diosgenin in methanolic extract of naturally grown was reported to be 0.127% while the percentage of Diosgenin in methanolic extract of tissue cultured was reported to be 0.216 % during HPLC analysis.

Quantitative HPLC Study for Diosgenin Marker Compound High Performance Liquid Chromatography: (HPLC) HPLC is also known as High- Pressure Liquid Chromatography. HPLC is the combination of a suitable stationary phase and mobile phase. The mobile phase for HPLC is the liquid phase which is continually flowing through stationary phase . On the basis of their interaction with solid particles , tightly packed column and the solvent of the mobile phase separates compounds . Quantitative and qualitative analysis by HPLC . HPLC provides both in a single operation .

Table 5:Selection of Separation Variable

Variable	Condition
Column	
Dimension.	250mm x 4.60mm
Particle Size	5 µm
Bonded Phase	Octadecylsilane (C_{18})
Mobile Phase	
Acetonitrile	92
Water	08
Flow rate	1ml/min
Temperature	Ambient Temp.
Sample Size	20 µl
Detection wavelength	203nm
Retention time	4.201± 0.5 min

Table 6: Standard concentration of Diosgenin and generated area under peak

S.N.	Concentration in µg/ml	Area under peak
1	0	0
2	5	423.569
3	10	845.674
4	15	1247.66
5	20	1632.48
6	25	2014.59

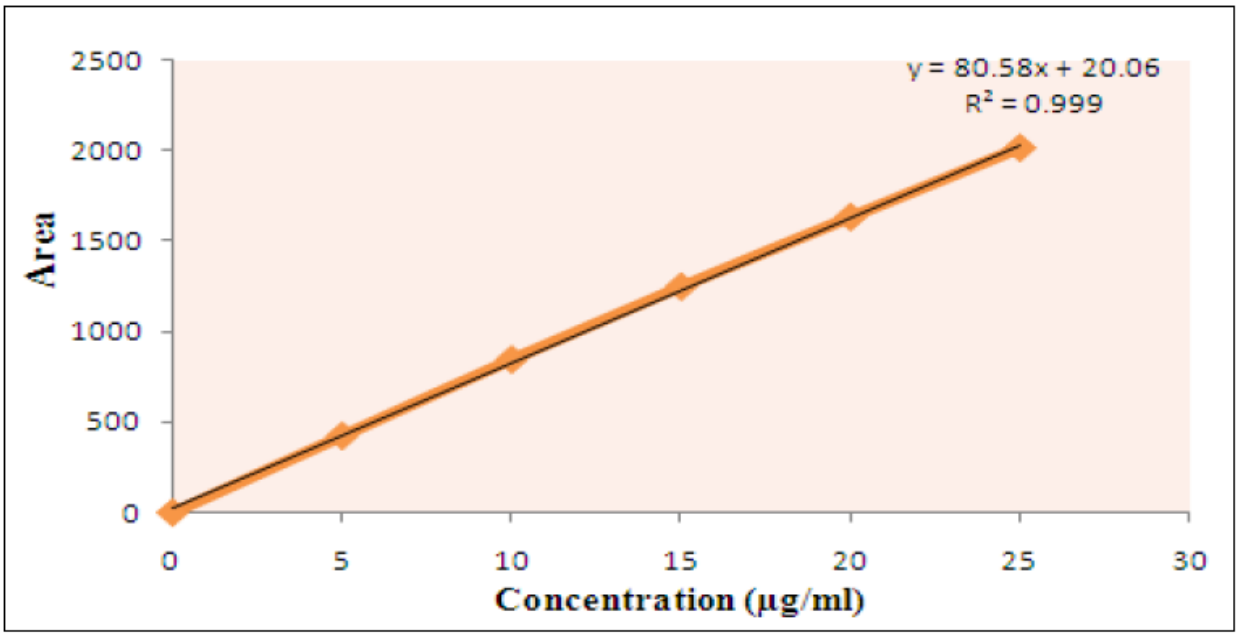

Figure 3: Standard plot of marker compound Diosgenin developed area under peak and concentration

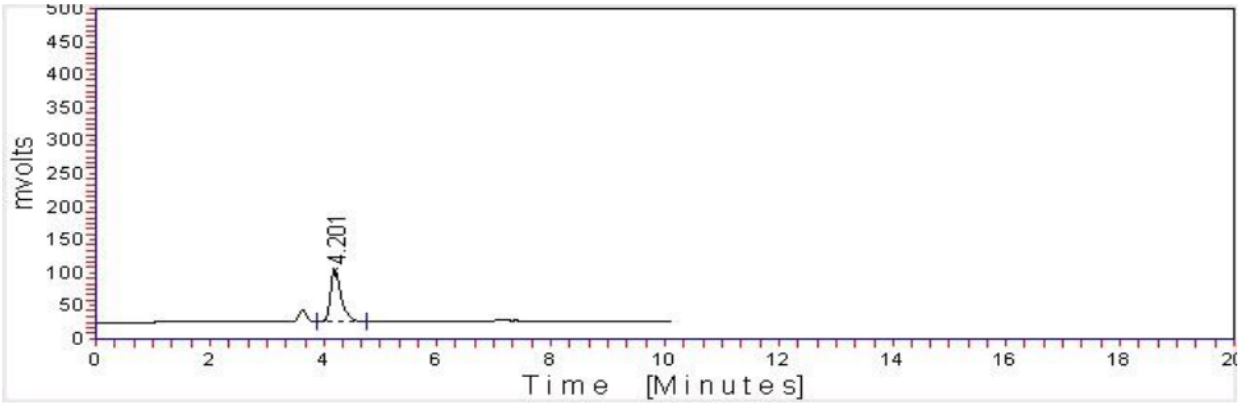

Figure 4: Chromatogram of standard Diosgenin marker

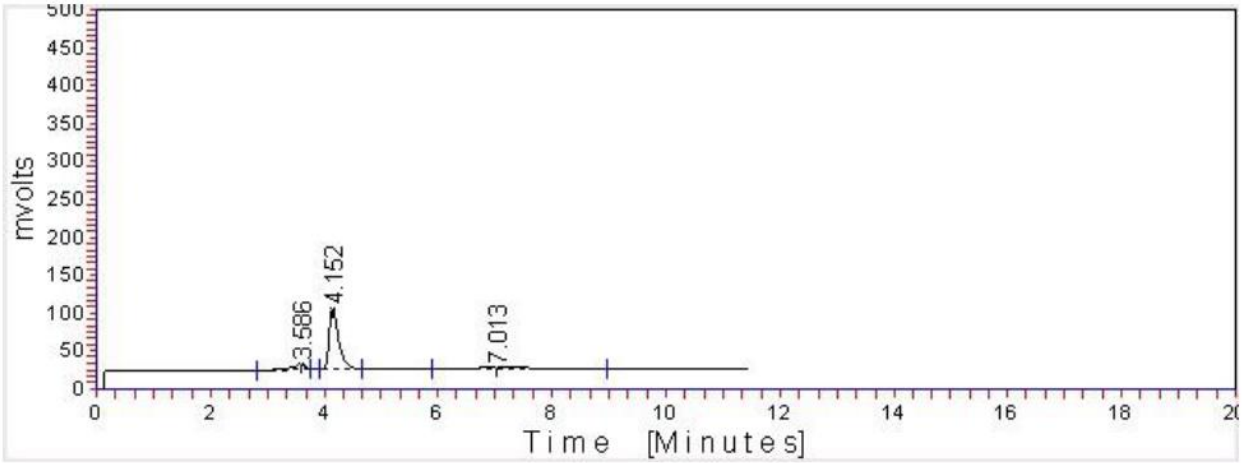

Figure 5: Chromatogram of methanolic extract of naturally grown Costus speciosus for detection of Diosgenin marker

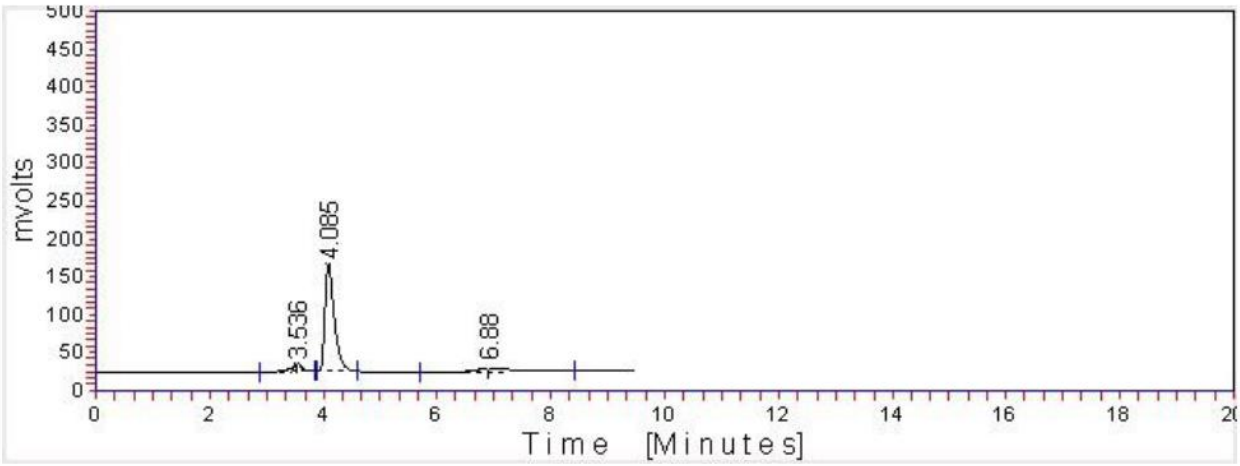

Figure 6: Chromatogram of methanolic extract of tissue cultured Costus speciosus for detection of Diosgenin marker

Detected percentage of Marker diosgenin in samples

Standard Plot for known concentration of Diosgenin Standard with respect to peak values mvolts in particular chromatographic conditions gives the area under peak in order to compare the percentages concentration of marker compound in test sample extracts.

Table 7: The peak values obtained in HPLC chromatogram in the form of mvolts for methanolic extract of naturally grown and tissue cultured comparable with standard to describe the percentage of the marker compound *Diosgenin* in the extracts.

S.N.	Extracts	Concentration (µg/ml)	Peak Values (in mvolts)	Percentage *Diosgenin*
1	methanolic extract of naturally grown	1000 µg/ml.	4.152	0.127
2	methanolic extract of tissue cultured	1000 µg/ml.	4.085	0.216

It is observed that, the methanolic extracts rhizome of plant Costus speciosus from both the sample i.e., plant of natural origin and tissue cultured plant samples responded for detection of diosgenin like saponins in samples during HPLC analysis. Inspite of the low concentration, the diosgenin percentage is reported to be higher in tissue culture samples than in natural plant samples. The percentage of Diosgenin in methanolic extract of naturally grown was reported to be 0.127% while the percentage of Diosgenin in methanolic extract of tissue cultured was reported to be 0.216 % during HPLC analysis.

The most important significance of the present investigation is numerous multiplication of plant and providing quality improve planting material of important medicinal plant. Extraction of phyto-chemicals from medicinal plants used as raw material for pharmaceutical companies. Tissue culture technique is a

alternative method for high level propagation of the plants.

Tissue culture technique process will be reduce the collection pressure on this plant species. Future prospects of the results Recent research work result achieved the following aspects considered for further research in this field. To produce more protocol for in vitro of Costus speciosus . There is a promising future of medicinal plant Costus speciosus.

The hidden potential of different activity of the plant could be achieve in the present and future studies. In vitro direct regeneration of the plant is very useful for commercial utilization. At present most important work in vitro propagation should be done for large scale production.

Present investigation studied the presence of diosgenin and other phytochemicals. Costus speciosus used as a medicinal plant due to the synthesis of secondary metabolites. For the preparation of medicines this plant are very useful in pharmaceutical industries as a raw material. Chromatography HPLC identified the Secondary metabolites quantity. Experiment work results shows increased amount of diosgenin in in-vitro regenerated plants.

The integration of tissue culture with Growth harmones based strategies has emerged as a powerful tool in phytopharmaceutical innovation. The significant diosgenin yield improvement observed here surpasses traditional cultivation methods and aligns with sustainable harvesting principles. This supports a scalable bioproduction model for pharmaceutical industries.

The results reinforce the role of targeted government funding in bridging traditional knowledge and modern biotechnology, particularly under schemes promoting value addition in medicinal plants. Our work contributes to ongoing efforts to include Costus speciosus in the official pharmacopeia and expands its potential in drug discovery pipelines.

This study demonstrates that government-supported innovations in plant biotechnology can significantly enhance the phytopharmaceutical potential of underutilized medicinal species like Costus speciosus. Optimized in-vitro culture methods, combined with Growth harmones-based secondary metabolite enhancement, represent a sustainable and scalable approach for diosgenin production. These findings hold promise for developing cost-effective plant-derived drugs.

References

1.Ahmed B.A. and Arun R. K (2009). *In vitro* propagation of monocot (*Costus pictus* D.Don) – An antidiabetic medicinal plant.Journal of Agricultural Technology, 5(2): 361-369.

2.Anusha A.k., Sini K. R. and Sreekanth M. C (2016) Chemical and medicobiological applications of the genus *Costus* (Ginger) Journal of Chemical and Pharmaceutical Research 8(8):453-458 ISSN : 0975-7384

3.Ariharan, V. N. , Meena Devi, V. N. , Rajakokhila M. and Nagendra Prasad P. (2012) . Antibacterial activity of *Costus speciosus* rhizome extract on some pathogenic bacteria (IJALS). Vol. 4 August 2012 ISSN 2277-758 .

4.Balachandran S.M., Bhat S.R. and Chandel K.P.S (1990). *In vitro* multiplication of turmeric (*curcuma sp*.) and ginger (*Zingiber officinale* Rosc.). Plant Cell Report. 8: 521-524.
5.Baskar A. A., AlNumair K. S., Alsaif M. A. & Ignacimuthu, S., (2012) *In vitro* antioxidant and anti proliferative potential of medicinal plants used in traditional Indian medicine to treat cancer. Redox Report. 17, 145-156.
6.Behera A., Kumar S. and Padan J.K. (2016) Nutritional and pharmacological importance of genus Costus: A review. IJPSR (2016), Vol. 7, Issue 5:1866-1873. E-ISSN: 0975-8232; P-ISSN: 2320-5148
7.Bhagyalakshmi B. & Singh N. S. (1988). Meristem culture and micropropagation of a variety of ginger (*Zingiber officinale* Rosc) with a high yield of oleoresin. J. Horticult. Sci. 63: 321-327.
8.Bhatia P. and Ashwath N. (2005). Effect of medium pH on shoot regeneration from the cotyledonary explants of tomato. *Biotechnology*. 4(1): 7-10.
9.Bhojwani S. S. and Razdan M. K. (1996). Plant tissue culture: theory and practice, a revisited edition. The Netherlands: Elsevier Science B. V, pp 29-35.
10.Chaturvedi, H.C., Misra, P. and Jain, M. (1984). Prolification of shoot tips and clonal multiplication on *Costus speciosus* in long term culture. *Plant. Set. Lett.*, 35: 67-72.
11.Chawla, H.S. (2002). Introduction to plant biotechnology. 2nd ed. US: Science Publishers, pp 6-14, 25-26
12.Choudhury J.and Sarma B. P.(2016) A review on antidiabetic property of *Costus Speciosus* (Kemuka). IJAMSCR. ISSN:2347-6567 ,V*ol. 4 Issue 3| July - Sep Pg. 601-606*
13. Daisy,P.,Eliza,J. and Ignacimuthu, S., (2008) Influence of *Costus speciosus* (Koen.)Sm. Rhizome extracts on biochemical parameters in STZ induced Diabetic rats, J. Health Sci. 54(6): 675-678
14. Dasgupta, B. and Pandey, V.B. (1970). A new source of Diosgenin : *Costus speciosus .Experientia,* 26:475.
15.Das K., Partha P.K., Sarma M.P., Talukdar N. and Kakoti P.(2014) Extraction ,estimation and comparison of protein and carbohydrate from different parts of *Costus speciosus* and brief study on its phyto-chemical content. International journal of basic and applied biology Volume 2 Nov. pp 81-85
16. Dubey, S., Verma, V. K. , Sahu., A. K. , Jain, A. K. and Tiwari, A. "Evaluation of Diuretic activity of Aqueous and Alcoholic Rhizomes extracts of *Costus speciosus* Linn in Wister Albino mice," IJRAP, 1(2), pp. 648-652, 2010.
17. Fargade S., Shelke M., Ghorpade B. and Khurange S.,(2018) In vitro Propagation of Insulin Plant (Costus pictus): a Medicinal boon with an Antidiabetic Activity. IJIRSEAT Vol.7,Issue 8, ISSN (Online): 2319-8753.
18.Gupta, M.M., Farooqui, S.U. and Lai, R.N. (1981a). Diosgenin content of *Costus speciosus* at different stages of growth. *Indian Drugs*, 18 : 285-86.
19.Jagtap S. and Satpute R. (2014) Phytochemical screening of Rhizome extracts of *Costus speciosus* (Koen)sm. JAIR Vol. 3 ,issue 1 June Pg.40-47
20.Karthikeyan J, Reka V and Giftson RV. Characterization of bioactive compounds in *Costus speciosus* (Koen.) by reverse phase HPLC. IJPSR. 2012; 3(5): 1461- 1465.
21.Punyarani, K. and Sharma J.G. (2010) Micropropagation Of *Costus Speciosus* (Koen.) Sm. Using Nodal Segment Culture. Nat. Sci Biol 2 (1) , 58-62
22. Purohit S.S. (2005) Biotechnology fundamentals and applications. 3rd editions. ISBN No. 81-88826-00-6 Page no.230-259.

23. Ramya, R. and Dhamothran, R. (2015) Qualitative and quantitative analysis of phytochemicals of *Costus speciosus.* IJHSR Pg 172-174

24.Rani, A. S. , Sulakshana G. and Patnaik, S. (2012) *Costus speciosus,* an antidiabetic plant-review,". FSJ Pharma Res, 1(3), pp. 52-53.

25.Ramawat K.G. (2003) Plant Biotechnology, S. Chand and Co.pp:1-43

26. Roy A. and Pal A. (1991). Propagation of *Costus speciosus* (J.Koen). Sm. through *in vitro* rhizome production. *Plant Cell Reports*, 10(10): 525-528.

28.Sarin Y.K., Bedi, K.L. and Atal, C.K. (1974). *Costus speciosns* rhizomes as source of Diosgenin. *Curr. Sci.*, 43 : 569-570.18

29. V. A. Pawar and A. R. Pawar -*Costus speciosus* an important medicinal plant International journal of science and research (IJSR)) ISSN (Online): 2319-7064 Impact Factor (2012): 3.358Pg 28-31