

**PLANT GROWTH PROMOTING AND DISEASE PREVENTION PROPERTIES OF ENDOPHYTIC AND RHIZOPLANE BACTERIA ISOLATED FROM *HEMIDESMUS INDICUS*- A RARE ENDANGERED MEDICINAL PLANT**

*Research article*

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**ABSTRACT**

Endophytic and rhizoplane are beneficial bacteria that colonize plant and enhance the growth and disease resistance ability through various mechanisms. The application of growth promoting endophyte and rhizoplane is steadily increasing as an alternative to chemical fertilizers and pesticides. These organisms have greater role to play in the ecological adaptation of plants which are considered to be on the verge of becoming rare and endangered. Also microorganisms from medicinal plant are of great importance as these organisms are reported to produce metabolites which are of medicinal value. The objective of this study is to isolate the endophytic and rhizoplane bacterial strain which have growth promoting characteristic as well as phytopathogen suppressing ability from *Hemidesmus indicus*, a medicinal plant which is considered as rare and endangered as a reason of overexploitation because of its medicinal value. In the current study we have been able to isolate 11 endophytic and 6 rhizoplane bacteria. Among them 8 endophytes and 3 rhizoplane isolates are showing significant antifungal activity. This suggests the role these organisms play in disease resistance and can be used as potential bio control agents.

**Introduction:**

Endophytic and Rhizoplane bacteria are the organisms which dwell inside and on the surface of plant body without causing any harmful effect to plants. They exhibit strong interaction and have symbiotic association with their host (Misaghi et al, 1990). These microorganisms have i) Growth promoting abilities ii) enhance disease resistance against phytopathogens and iii) increase mineral absorption capacity of plants. (Sturz et al., 1999; Nejad et al., 2000). These beneficial effects of endophytic and rhizoplane bacteria occur through various mechanisms including; i) nitrogen fixation ii) solubilization of phosphate ii) siderophore production iv) synthesis of growth hormones like indole acetic acid and cytokinin v)

hydrogen cyanide production and vi) release of antimicrobial compounds (Ngoma et al., 2013).

Nitrogen fixation is achieved due to the presence of nifH gene in *paenibacillus polymyxa* (Pp) bacteria. In addition to this, bacteria is capable of producing growth hormone cytokinin. The growth promotion ability of cytokinin hormone released by Pp bacteria has been demonstrated in *Arabidopsis thaliana* (Ryu et al., 2005; Timmusk et al., 1999). Phosphorous is one of the important plant nutrient required for physiological activities like cell division, photosynthesis and development of root system. Major portion of phosphate present in soil is immobilized because of insoluble organic and inorganic matter. Endophytic and rhizoplane bacteria possess the ability to solubilize the

immobilized mineral phosphate by releasing organic acids and phosphate enzyme (Paul *et al.*, 2013; Sharma *et al.*, 2011). Siderophore, an iron chelating compound which is released from fluorescent pseudomonas, extracts iron from rhizosphere and makes it available to plants. Iron is one of the important element required by plants for various biochemical activities such as electron transport system, formation of heme, as a cofactor for enzymes and synthesis of chlorophyll (Deshwal *et al.*, 2013). Indirect way through which endophytes can promote growth is by protecting the plants from pathogens. These endophytic and rhizoplane bacteria produce certain antifungal compounds which gives these plants disease resistance ability. For instance introduction of growth promoting bacteria into rhizosphere enhanced the growth rate of capsicum annum and also increased its disease resistance ability (Kokalis *et al.*, 2006).

*Hemidesmus (H). indicus* is a slender, laticiferous and twining shrub, sometimes prostrate other times semi-erect with slender stem thickened at the nodes. The leaves are opposite, short-petiole, very variable, elliptic-oblong to linear lanceolate. It is widely recognized in folk medicine and as ingredient in Ayurvedic and Unani preparations against diseases of biliousness, blood diseases, diarrhoea, skin diseases, respiratory diseases, fever, bronchitis, eye diseases, burning sensation, rheumatism and gastric disorders (Austin, 2008; Ravishankara *et al.*, 2004 and Mary *et al.*, 1987). Extract of this plant is reported to possess anti-inflammatory, antipyretic, antioxidant and antiulcerogenic properties (Mary *et al.*, 1987; Alam, Gomes, 1998; Anoop, Jegadeesan, 2003). *H. indicus* extract is also found to inhibit lipid peroxidation and scavenge hydroxide radicals (Amirghofran, 2000). Endophytes from medicinal plants have become a hot topic for metabolite discovery because of their high biodiversity, predicted potential to produce novel compounds, involvement in growth promotion and enhancement of disease resistance ability in plants. (Ryu *et al.*, 2005). There exist many medicinal plants being unexplored for the endophyte and rhizoplane communities. *H. indicus* is one among them. The aim of current study is to isolate and examine the plant growth promoting properties and disease prevention properties of endophytic and rhizoplane bacteria from the medicinal plant *H. indicus*.

### Methods:

*H. indicus* plant samples were collected from Art of Living International Centre, Bengaluru. Roots were cut in to 1 cm long section and sterilized as follows: washed initially with running tap water for 10 minutes to remove soil, dirt & debris adhering to it then it was treated with 5% sodium hypochlorite solution for 10min; with 70% ethanol for 2 min; washed in sterile double distilled water for three times. The efficacy of sterilization was confirmed by spreading 0.1 mL of final washed solution on the surface of Tryptone soy agar medium (TSA). There was no growth witnessed after 24 hours of incubation indicating the sterility of final solution. Root samples were cut into smaller pieces and inoculated on TSA, Nutrient agar media, Kings B media, Soil extract media and Rovira medium. These plates were incubated at 28°C for 48-72 hours. Pure cultures were obtained with streaking method. (Misaghi, 1990; Zinniel, *et al.*, 2002; Anjum *et al.*, 2015). 10cm long root surface was rinsed in sterile petridish containing 10 mL of sterile saline phosphate buffer (pH 7.4) by gently rubbing with sterile painting brush to harvest adhered bacterial community before surface sterilization. The washed saline phosphate buffer was considered as source of rhizoplane bacteria and 0.1 mL of source was inoculated on TSA, Nutrient agar media, Kings B media, Soil extract media and Rovira media. (Kokalis *et al.*, 2006). Some of the biochemical tests conducted to determine the growth promotion and antifungal property of endophytic and rhizoplane bacteria are as follows.

### Siderophore production test: (Gamit *et al.*, 2014)

Succinic acid is the media used for siderophore production test. Composition of Succinic acid media are as follows: K<sub>2</sub>HP0<sub>4</sub>, 6.0; KH<sub>2</sub>P0<sub>4</sub>, 3.0; (NH<sub>4</sub>)<sub>2</sub>S0<sub>4</sub>, 1.0; MgS0<sub>4</sub>.7H<sub>2</sub>0, 0.2; succinic acid, 4.0. Above chemicals were dissolved in 1000ml of distilled water. The pH was adjusted to 7.0 by addition of 1N NaOH prior to sterilization. Enriched endophytic and rhizoplane cultures were inoculated into above media and incubated at 37° C with constant shaking for 24 to 48 hours. Appearance of green color indicates the presence of siderophore.

### Phosphate solubilization test: (Goldstein, 1986)

The test is conducted by growing the cultures on the solid media which has phosphate as one of the ingredient. Bacterial plates were kept for incubation at 30° C for 2-3 days. The colonies forming halo zone of clearance around them were counted as Phosphate

solubilizers. Media include following components: Glucose–10, NH<sub>4</sub>Cl–1, MgSO<sub>4</sub>.7H<sub>2</sub>O–1, Agar–20. 50 mL of 10% K<sub>2</sub>HPO<sub>4</sub> and 100 mL of 10% CaCl<sub>2</sub> were autoclaved separately and added later.

**Indole Acetic acid (IAA) test: Tryptone media: (Deshwal *et al.*, 2013)**

Qualitative indole production was determined using kovav’s reagent (HCL + Dimethylaminobenzaldehyde in amyl alcohol). Formation of cherry red color indicates the presence of indole. Loop full of inoculum was added to tryptophan media and incubated for 24 hours and culture was used for the test.

**Voges proskeur test: (Hemraj *et al.*, 2013)**

Bacterial isolates were inoculated into MR–VP media and incubated at 35° C for 24–48 hours. 1ml of the culture was aseptically transferred into clean, sterile test tubes. 15 drops of VP reagent A was added followed by 5 drops of VP reagent B. Red color within 20 minutes indicates the positive result.

**Methyl red Test: (Hemraj *et al.*, 2013)**

24–48 hours old bacterial cultures were taken in clean, sterile test tubes and added with 5 drops of Methyl red indicator. Color change to bright red indicates the positive result.

**Hydrogen cyanide (HCN) production test: (Ngoma *et al.*, 2013)**

Bacterial isolates were grown in 10% Tryptone Soya Agar media containing 4.4g/l of glycine. A Whatman filter paper No.1 was soaked in 2% sodium carbonate and 0.5% picric acid solution was placed on the

underside of petridish lids. Plates were sealed with parafilm to avoid escape of gases. Plates were kept for incubation at room temperature for 5 days. Color change of filter paper from Yellow to reddish brown indicates the production of HCN.

**Antifungal activity (Dual Culture Method): (Patel *et al.*, 2012)**

Fungal pathogen *Phytophthera* grown on Potato Dextrose Agar (PDA) media was taken and inoculated at the centre on PDA plates containing 10% TSA. Bacterial culture was streaked on both sides of the fungal pathogen. This was sealed and incubated at room temperature for 4–5 days and examined for zone of inhibition.

**Catalase test: (Guptha *et al.*, 2015)**

24 hour old bacterial culture was taken on a glass slide and a drop of H<sub>2</sub>O<sub>2</sub> was added. Rapid evolution of oxygen as evidenced by bubbling within 5-10 sec is considered as positive catalase test.

**Results:**

Total number of endophytic bacteria isolated were 11 which are named as follows ENBHI1, ENBHI2, ENBHI3, ENBHI4, ENBHI5, ENBHI6, ENBHI7, ENBHI8, ENBHI9, ENBHI10 and ENBHI11 and the number of rhizoplane bacteria isolated were 6 which are named as RPBHI1, RPBHI2, RPBHI3, RPBHI4, RPBHI5 and RPBHI6. List of Biochemical tests conducted and their results are shown in **Tables 1 and 2.**

**Tables 1: Biochemical test results for Endophytic bacteria isolated from *H. indicus***

Endophytic Bacterial strain	Indole test	Siderophore production test	Phosphate solubilization test	Methyl red test	Voges-proskauer test	Catalase test	Dual culture	HCN production test
ENBHI1	-	-	-	-	-	-	+	-
ENBHI2	+	-	-	-	-	-	-	-
ENBHI3	-	+	-	-	-	+	+	+
ENBHI4	-	-	+	+	+	+	+	+
ENBHI5	-	-	+	-	+	+	+	-
ENBHI 6	-	-	-	+	-	-	-	-
ENBHI7	-	-	-	-	+	-	+	-
ENBHI8	-	-	-	-	-	+	+	-
ENBHI9	-	+	-	-	-	-	+	-

ENBHI10	-	-	+	+	+	+	+	+
ENBHI11	-	-	-	-	-	+	-	-

**Table 2: Biochemical test results for Rhizoplane bacteria isolated from *H. indicus***

Rhizoplane bacterial strain	Indole test	Siderophore production test	Phosphate solubilization test	Methyl red test	Vogesproskauer test	Catalase test	Dual culture	HCN production test
RPBHI1	-	-	+	-	+	+	-	+
RPBHI2	-	-	-	-	-	+	-	-
RPBHI3	-	-	-	+	+	+	+	+
RPBHI4	-	-	+	-	+	+	-	-
RPBHI5	-	-	-	+	-	-	+	-
RPBHI6	-	-	+	-	+	+	+	-

In the current study 72.72% of endophytic and 50% of rhizoplane cultures showed significant antifungal activity against phytophthora. Isolates ENBHI1, ENBHI3, ENBHI4, ENBHI5, ENBHI7, ENBHI8, ENBHI9, ENBHI10, RPBHI1, RPBHI3, RPBHI4 and RPBHI5 are very efficient in suppressing the growth of Phytophthora pathogens. Phytophthora species are considered to be soil borne pathogens responsible for many plant diseases. These pathogens were used to test the antifungal activity of isolates with dual culture method (**Image 1 and 2**).

Image 1 shows the control plate of phytophthora and Image 2 shows how its growth has been inhibited by one of the endophytic isolate ENBHI9. 53% of endophytic and 83.3% of rhizoplane cultures are catalase positive. 27.27% of endophytic and 33.33% of rhizoplane bacteria are HCN positive. Tests conducted to check for growth promoting characteristics were IAA test, siderophore production test and phosphate solubilisation test. One endophytic isolate has shown positive indole production test and none of rhizoplane bacteria were positive for IAA test. 3 strains of endophytic and 3 strains of rhizoplane bacteria are positive for phosphate solubilisation. 2 of endophytic isolates are showing positive result for qualitative siderophore production test which was determined through chrome azurol test.



### Discussion:

Endophytic bacteria have been reported to be isolated from various medicinal plants like Capparis indica (Bhagat *et al.*, 2014), Oscunum sanctum (Tiwari *et al.*, 2010), catharanthus roseus, Mentha arvensis, Stevia rebaudiana (Anjum *et al.*, 2015), and Achyranthus aspera (Khaidem, 2017). To our knowledge this current study is the first to isolate bacteria from *H. indicus*. The role of endophytic bacteria in growth, development and fighting phytopathogens are well documented (Jasim *et al.*, 2014; Reiter *et al.*, 2002).

In the current study, different growth media like Tryptone soya agar, Kings B, and Rovira media were used to isolate endophytic and rhizoplane bacteria from plant root. Different medias were used to get isolates which are non culturable on single media. Total numbers of endophytic bacteria isolated were 11 and rhizoplane bacteria were 6. The role of these organisms in growth, development and suppressing phytopathogens are well documented. In the current study we conducted biochemical tests like siderophore production test, Indole acetic acid test, and phosphate solubilization test in order to determine the growth promoting ability of these organisms and antifungal activity test, Hydrogen cyanide test and catalase test to check the antimicrobial activity of bacterial isolates. We found that the 3 of endophytic and 1 of rhizoplane bacteria are positive for all 3 tests (HCN, catalase and antifungal activity) indicating the significant pathogen suppressing activity. In addition 8 of endophytic and 3 of rhizoplane bacterial isolates are showing antifungal activity. This was determined by dual culture method in which phytophthora fungal pathogen was used. Phytophthora species are considered to be soil borne pathogens which cause plant diseases (Shouan zhang, 2010). Compared to control, plate of phytophthora, the plates with bacterial isolates streaked on either side of fungal pathogen showed significant reduction in the growth of pathogen. This is shown in the **image 1 and 2**. Potential of these organisms to suppress soil borne pathogen has been earlier examined in potato tubers and cocoa plant and results by other authors have been promising. (Melnick *et al.*, 2008; Sturz *et al.*, 1999).

These organisms produce other antimicrobial compounds like Hydrogen cyanide and enzyme like catalase which are toxic to bacterial and fungal pathogens (Deshwal *et al.*, 2013). Considering the results of above tests significant pathogen suppressing

ability of endophytic and rhizoplane bacteria isolated from *H. indicus* can be concluded.

Indole acetic acid (IAA) is one of the main naturally occurring auxin (a plant growth hormone). IAA controls cell elongation, division, and tissue differentiation resulting in plant growth and development (Jasim *et al.*, 2014). One endophytic isolate has shown positive indole production test. Plants are often unable to utilize the insoluble phosphate which is present in soil. Certain bacteria are capable of solubilizing the immobile phosphate through the production of organic acids and phosphatase enzyme and thus make it available for plant. Appearance of halo zone around the bacterial colonies grown on the media containing tri calcium phosphate indicates the phosphate solubilizing ability of bacteria. Three strains of endophytic and three strains of rhizoplane bacteria are positive for phosphate solubilization.

Two endophytic isolates are showing positive result for qualitative siderophore production test. Siderophore, an iron chelating molecule aids plant in iron uptake from soil and thus making it unavailable to pathogens (Khaidem *et al.*, 2017).

*H. indicus* is a medicinal plant which is being over exploited for its medicinal values and is now considered as rare and endangered plant (Subbaiyan *et al.*, 2014). Endophytes associated with the plant could be one of the ways to increase the plant population. Our current study has shown the growth promoting properties as well as its ability to enhance disease resistance in the plant. It is suggested that endophytes have symbiotic relationship with their host and acts as natural biocontrol agents to protect plants from phytopathogens. As a next step to this study, we wish to apply endophytic and rhizoplane bacteria isolated from *H. indicus* directly to host plant to see if it is actually enhancing the growth of the plant and to study if the organisms act as bio control agents.

### Conclusion:

From the foregoing, it can be concluded that *H. Indicus* – a rare and endangered plant, has the ability to produce endophytic and rhizoplane bacteria. Total of 11 endophytes and 6 rhizoplane bacteria were isolated. Eight among 11 endophytes and 3 among 6 rhizoplane cultures showed antibacterial property. In addition, 3 of 11 endophytes and 3 of 6 rhizoplane cultures showed significant plant growth promoting properties. This

indicates the potential use of these organisms as bio control agents.

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### References:

- Alam M and Gomes A, (1998), *Viper venom-induced inflammation and inhibition of free radical formation by pure compound (2-hydroxy-4-methoxy benzoic acid) isolated and purified from anantmul (Hemidesmus indicus R.Br.) root extract*, *Toxicol*, 36: 207-215.
- Amirghofran Z, Azadbakht M and Karimi MH, (2000), *Evaluation of immunomodulatory effects of five herbal plants*. *J. Ethnopharmacol*, 72: 167-172.
- Anjum N, Chandra R, (2015), *Endophytic bacteria: Optimization of isolation procedure from various medicinal plants and their preliminary characterization*, *Asian Journal of Pharmaceutical and clinical research*, 8: 0974-2441.
- Anoop A and Jegadeesan M, (2003), *Biochemical studies on the antiulcerogenic potential of Hemidesmus indicus R. Br. var indicus*. *J Ethnopharmacol*, 84: 149-156.
- Austin A, (2008), *A Review on Indian Sasaparilla, Hemidesmus indicus (L.) R. Br.*, *Journal of Biological Sciences*, 8(1): 1-12.
- Bhagat M M, El Bous M M, Kawashty S A, Mohammed El N A, (2014), *Characterization of Endophytic bacteria isolated from the medicinal plant Capparis indica Veill. And analyze its Bioactive Flavonoid*, *Indian Journal of Applied research*, 4.
- Deshwal V K., Punkaj K., (2013), *Production of plant growth substance by pseudomonas*, *Journal of academia and industrial research*, 2: 2278-5213.
- Gamit Dhara. A., Tank A.K., (2014), *Effect of siderophore producing microorganisms on plant growth of cajanus cajan (Pigeon pea)*, *International Journal of*
- Research in Pure and Applied Microbiology, 2277–3843.
- Goldstein, A. H., (1986), *Bacterial solubilization of mineral phosphates: historical perspective and future prospects*, *Am. J. Altern. Agric*, 1: 51–57.
- Guptha R M, Kale P S, Rathi M L, Jadhav N N, (2015), *Isolation, characterization and identification of endophytic bacteria by 16S rRNA partial sequencing technique from roots and leaves of Prosopis cineraria plant*, *Asian journal of plant science and research*, 5: 36-43.
- Hemraj V, Sharma diksha, Gupta Avneet, (2013), *A review on commonly used biochemical test for bacteria*, *Innovare Journal of Life Science*, 1(1),
- Jasim B, Joseph A. A, Jimtha john C, Mathew J, Radhakrishnan E. K, (2014), *Isolation and characterization of plant growth promoting endophytic bacteria from the rhizome of Zingiber officinale*, *Springerlink*, 4: 197-204.
- Khaidem A.D, Pandey P, Sharma G. D, (2017), *Plant growth promoting endophyte serratia marcescens AL2-16 enhances the growth of Achyranthes aspera L., a Medicinal plant*, *HAYATI journal of biosciences*, 1-8.
- Kokalis–Burelle N., Kloepper J. W., Reddy M.S., (2006), *Plant growth promoting Rhizobacteria as transplant amendments and their effects on indigenous rhizosphere microorganisms*, *Applied soil ecology*, 31: 91–10.
- Mary N, Achuthan C, Babu B and Padikkala J, (1987), *In vitro antioxidant and antithrombotic activity of Hemidesmus indicus (L) R.Br.*, *J Ethnopharmacol*, 87: 187-191.
- Melnick R. L., Zidack N. K., Bailey B A., Maximova S. N., Guiltinan M, Backman P. A, (2008), *Bacterial endophytes: Bacillus spp. From annual crops as potential biological control agents of black pod rot of cacao*, *Biological control*, 46: 46-56.
- Misaghi, I. J., and Donndelinger, C. R., (1990), *Endophytic bacteria in symptom-free cotton plants*, *Phytopathology*, 80: 808-811.

Nejad P., Johnson P A., (2000), *Endophytic bacteria induce growth promotion and wilt disease suppression in oilseed rape and tomato*, Biological control, 18: 208-215.

Ngoma L., Esau B., Babalola O O., (2013), *Isolation and characterization of beneficial indigenous endophytic bacteria for plant growth promoting activity in molelwane farm, Mafikeng, South Africa*, African Journal of Biotechnology, 12: 4105-4114.

Patel H A., Patel R K., Khristi S M., Parikh K., Rajendran G, (2012), *Isolation and characterization of bacterial endophytes from Lycopersicon esculentum plant and their plant growth promoting Characteristics*, Nepal Journal of Biotechnology, 2(1): 37-52.

Paul D., Sinha S N., (2013), *Phosphate solubilising activity of some bacterial strains isolated from jute mill effluent exposed water of river ganga*, Indian journal of fundamental and applied life sciences, 3: 39-45.

Ravishankara M, Shrivastava N, Padh H and Rajani M, (2004), *Evaluation of antioxidant properties of root bark of Hemidesmus indicus R.Br. (Anantmul)*, Phytomed, 9:153-160.

Reiter B, Pfeifer U, Schwab H and Sessirsch A, (2002), *Response of Endophytic Bacterial Communities in Potato Plants to infection with Erwinia carotovora subsp. Atroseptica*, Applied and Environmental Microbiology, 68: 2261-2268.

Ryu, Choong Min, Jinwoo Kim, Okhee choi, soo young park, Seung hwan park, chang seuk park, (2005), *Nature of root associated Paenibacillus polymyxa from field grown winter barley in korea*, Journal of microbiology and biotechnology, 15: 984-991.

Sharma S., Vijay K., Tripathi R. B., (2011), *Isolation of phosphate solubilising microorganism (PSMs) from*

*soil*, Journal of Microbiology and Biotechnology Research, 1: 90-95.

Shouan Zang, White Thomas L, Martinez Miriam C, McInroy John A, Kloepper Joseph W, (2010), *Evaluation of plant growth-promoting rhizobacteria for control of phytophthora blight on squash under greenhouse conditions*, Biological Control, 53: 129-135.

Sturz A.V., Christie B.R., Matheson B.G., Arsenault W.J., Buchanan N.A., (1999), *Endophytic bacterial communities in the periderm of potato tubers and there to improve disease resistance to soil borne plant pathogens*, Plant pathology, 48: 360-369.

Subbaiyan B, Samydurai P, Karthik Prabu M, Ramakrishnan R and Thangapandian V, (2014), *Inventory of Rare, Endangered and Threatened (RET) Plant Species in Maruthamalai Hills, Western Ghats of Tamilnadu, South India*, our nature, 12: 37-43.

Timmusk S, Nicander B, Granhall U, Tillberg E, (1999), *Cytokinin production by Paenibacillus polymyxa*, Soil biology and Biochemistry, 31: 1847-1852.

Tiwari R, Kalra A, darokar M.P, Chandra M, Aggarwal N, Singh A.K, Khanuja S.P.S, (2010), *Endophytic bacteria from Ocimum sanctum and their yield enhancing capabilities*, Curr Microbiol, 60: 167-171.

Zinniel D K., Lambrecht P., Harris N B., Feng Z., KUczmarski D., Higley P., Ishimaru C A., Arunkumari A., Barletta R G., Vidaver A K., (2002), *Isolation and characterization of endophytic colonizing bacteria from Agromonic crops and prairie plants*, Applied and environmental microbiology, 68: 2198-2208.

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