MEDICO BIOWEALTH OF INDIA

VOL- VII

Ambika Prasad Research Foundation | Odisha

MEDICO BIOWEALTH OF INDIA

VOL- VII

B L Manjula
Bhagwati Prashad Sharma
Manish Kumar
Sohan Lal
Sanjeet Kumar

Ambika Prasad Research Foundation | Odisha

MEDICO-BIOWEALTH OF INDIA VII

BL Manjula ● Bhagwati P Sharma ● Manish Kumar ● Sohan Lal ● Sanjeet Kumar

Editors

MEDICO-BIOWEALTH OF INDIA VII

APRF PUBLISHERS

Editors

BL Manjula
Department of Botany, Sri Jagadguru Renukacharya College of Science, Arts & Commerce, Karnataka, India
Bhagwati P Sharma
Department of Botany, Sidharth Government College, Nadaun, Himachal Pradesh
Manish Kumar
SD College, Barnala, Punjab
Sohan Lal
Department of Botany, School of Science, ISBM University, Navapara Kosmi Block Chhura, Gariyaband, Chhattisgarh, India
Sanjeet Kumar
Ambika Prasad Research Foundation, Odisha, India

Title: Medico-Biowealth of India VII
ISBN: 978-81-955847-7-2
DOI: 10.5281/zenodo.7368926
Published by:
APRF Publishers
Ambika Prasad Research Foundation, India

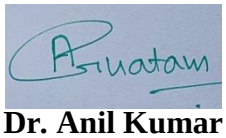
Medico-Biowealth of India: 2022

Cover Page: Fruits of *Micromelum minutum*
Back Page: Logo and address of APRF
Price: Rs. 1200/-

Sidharth Govt. College Nadaun Distt Hamirpur, Himachal Pradesh

MESSAGE

India is a rich repository of plant biowealth and traditional knowledge of use of plants for various purposes including treatment of various types of illness. Compilation and documentation of plant biowealth and traditional knowledge is a matter of the utmost importance nowadays. Besides traditional medicinal knowledge is a treasure for providing solution for pandemics and diseases in present time. In this scenario the book "Medico-biowealth of India, Volume-VII" is an exceptional work on biowealth of India and its various aspects. I congratulate the editors and authors of the book, and Dr. S. Kumar CEO, APRF, Odisha for their sincere efforts to bring out this treasure trove.



Dr. Anil Kumar Gautam
PhD (HPU)
Principal
Sidharth Govt. College
Nadaun Distt, Hamirpur (HP)
Pin Code - 177033

PREFACE

The Indian subcontinent is recognised for its cultural richness and flora diversity. The indigenous people of this region have access to the wealth of untapped ethnomedical and ethnopharmacological knowledge about the flora in their immediate surroundings, which might be particularly advantageous in rural communities. The World Health Organization estimates that 4.3 billion people, or more than 80% of the world's population, rely on such conventional plant-based medical systems for their primary healthcare. Numerous health issues, including hypertension, cancer, diabetes mellitus, wound healing, asthma, pharyngitis, and tuberculosis, can be treated naturally using herbal plants. Because of their pharmacological qualities, plants with high concentrations of bioactive phytomedicine substances including alkaloids, flavonoids, tannins, and polyphenols have been utilised to treat health problems. This book focuses on presenting the ethnomedicinal importance, ecology and bioactive properties of various medicinal plants. The first chapter of the book by Kaur and Kumar, evaluated *in vitro* tissue cultures of *Gossypium arboreum* and *G. hirusutum* cultivars for the production of various flavonoids compounds. Hindlekar et al. have explained about the herbaceous flora and soil properties of the Eastern coast of Odisha state, India, in the second chapter. They have listed 25 species from the sand dunes, 12 of which have culinary and medicinal uses. In chapter 3, Tarun Raut and coworkers have made an effort to describe the medicinal and commercial value of *Oecophylla smaragdina* as well as its link to other medicinal plants. In Chapter 5, Kumar and researchers studied *Parthenium hysterophorus* and *Cannabis sativa* for their phytotoxic, antioxidant, and anticancer properties as well as their phytochemical analysis. Singh has described the ethnomedical plants of Mandal Tehsil in Bhilwara, Rajasthan, India, in chapter 6. The antidiabetic properties of *Syzgium palghatense,* an indigenous medicinal plant of Western Ghats of India, is discussed in the following chapter by Snehalatha and Rasmi. The climber *Gymnema sylvestre* is explained in Chapter 8 by Thakur for its ethnobotanical, bioactive phytochemical, and pharmaceutical uses. Singh in Chapter 9 describes many varieties of wild edible mushrooms found in Ranchi, Jharkhand, India. The value of plants growing along the National Highway from Parwanoo to Shimla is discussed in the last chapter by the author Kumari.

It should be noted that any scientific inquiries or questions should be directed at the authors of the individual chapters. We are really grateful to the experts who donated their work and made this book a distinctive collection of study in the area. The book can be used by researchers working on a variety of plants as a handbook.

(Editors)

CONTENTS

Chapter 1	Effect of phenylalanine on the production of flavonoids in three cotton cultivars *Gossypium arboreum* (RG-8), *G. hirsutum* (GA and Pusa 8-6) grown *in-vitro*	Amardeep Kaur and Manish Kumar	1-6
Chapter 2	Medicinal sand dune flora & their ecology	Sheelpa Hindlekar, Vinayaka KS, Laxminarayan Hegde, Meenu Elizabath Benny, Goutam Basak, T Srinivas Rao and Sanjeet Kumar	7-14
Chapter 3	*Oecophylla smaragdina*: source of tribal bioentrepreneurship & its ecological aspects with medicinal plants	Smita Tarun Raut, Debasmita Mahanta, Ilarani Pradhan, Soumi Sardar and Sanjeet Kumar	15-19
Chapter 4	Natural Farming: a sustainable way of cultivation	Bhagwati Prashad Sharma, Arti Sharma, Sagar K Jadav, Anjali Arya & Sanjeet Kumar	20-24
Chapter 5	Evaluation of phytotoxic, antioxidant and anticancer activities of *Parthenium hysterophorus* L. and *Cannabis sativa* L.	Manish Kumar, Amardeep Kaur, Aashita Garg, Khusboo, Jashanpreet Kaur and Anu Rani	25-35
Chapter 6	Ethnomedicinal plants of Mandal Tehsil, Bhilwara, Rajasthan, India	Jyoti Singh	36-49
Chapter 7	Scientific validation of antidiabetic properties of Syzygium palghatense Gamble, an endemic medicinal plant of Western Ghats, India	Snehalatha VR and Rasmi AR	50-55
Chapter 8	*Gymnema sylvestre* R. Br. (Apocynaceae): a medicinal climber of India	Shikha Thakur	56-61
Chapter 9	Documentation of wild edible mushrooms available in the local markets of Ranchi, Jharkhand, India	Anuranjita Singh	62-65
Chapter 10	Anti-diabetic woody plant resources of Himachal Pradesh, India	Priya Kumari	66-70

CONTRIBUTORS

Aashita Garg, SD College, Barnala, Punjab, India

Amardeep Kaur, SD College, Barnala, Punjab, India

Anjali Arya, Department of Biosciences (SLAS), Mody University of Science and Technology, Rajasthan, India

Anu Rani, SD College, Barnala, Punjab, India

Anuranjita Singh, B/808, Sector 2, Dhurwa, Ranchi, Jharkhand

Arti Sharma, Department of Botany, Government College Jawalaji, Himachal Pradesh, India

Bhagwati Prashad Sharma, Department of Botany, Sidharth Government College, Nadaun, Himachal Pradesh, India

BL Manjula, Department of Botany, Sri Jagadguru Renukacharya College of Science, Arts & Commerce, Karnataka, India

Debasmita Mahanta, Tassar silk park, Bhagamunda, Ministry of handloom, textiles and handicrafts dept. Govt. Of Odisha, Odisha, India

Goutam Basak, Department of Zoology, Raiganj University, Raiganj, West Bengal, India

Ilarani Pradhan, Department of Botany, GIET University, Gunupur, Rayagada, Odisha, India

Jashanpreet Kaur, SD College, Barnala, Punjab, India

Jyoti Singh, Department of Botany, SPC Government College, Ajmer, Rajasthan, India

Khusboo, SD College, Barnala, Punjab, India

Laxminarayan Hegde, College of HORTL. ENGG. and Food Technology, Devihosur, Karnataka, India

Manish Kumar, SD College, Barnala, Punjab, India

Meenu Elizabath Benny, Department of Botany, Mar Athanasius College, Kothamangalaam, Kerala, India

Priya Kumari, Haryana State Biodiversity Board, Panchkula

Rasmi AR, PG and Research Department of Botany, Govt. Victoria College, Palakkad, Kerala, India

Chapter 1
Effect of phenylalanine on the production of flavonoids in three cotton cultivars *Gossypium arboreum* (RG-8), *G. hirsutum* (GA and Pusa 8-6) grown *in-vitro*

Amardeep Kaur and Manish Kumar

Abstract: Plant tissue culture technique is of great interest as it serves as an important tool for geneticists, plant breeders, morphologists, pathologists and physiologists in understanding and solving various problems. Many plant species are grown *in vitro* which provide many advantages over the intact plant parts grown *in vivo* for biosynthetic studies. Secondary metabolites are naturally occurring compounds in plants. *In-vitro* plant materials are good source of secondary metabolites and by using precursors, these metabolites production can be enhanced. So in the present study, effect of various concentrations of phenylalanine (PA) on the production of flavonoids in tissue cultures of three cotton varieties has been studied. Results demonstrated enhanced production of flavonoids. The current work will be of great value/interest in biotechnological and pharmaceutical research.

Keywords: Plant tissue culture, Phenylalanine, Flavonoids, *Gossypium*

A Kaur (✉), ORCID: https://orcid.org/my-orcid?orcid=0000-0003-2634-1068
SD College, Barnala, Punjab, India
e-mail: amar.bot03@gmail.com

M. Kumar, ORCID: https://orcid.org/my-orcid?orcid=0000-0001-7402-2665
SD College, Barnala, Punjab, India
e-mail: kumarmanish639@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7003486

Introduction: Organic synthesis of many plants secondary metabolites is in great progress although most of these compounds are difficult to synthesize chemically. Food consumers also prefer natural compounds than synthetic ones in general. These facts lead to the development of procedures for growing plant tissues *in vitro*. Plant

tissue culture technique has been tried for large scale production of secondary metabolites in various plant species (Filova 2014). Flavonoids have been detected in callus cultures of *Camellia chinensis, Momordica charantia, Crataegus sinaica* (Nikolaeva et al., 2009; Agarwal and Kamal, 2007; Maharik et al. 2009), in hairy root cultures of *Fagopyrum esculentum* (Trotin et al. 1993; Lee et al. 2007) *Sentellaria bicalensis* (Zhou et al. 1997) and suspension culture of *polygonum hydropiper* (Nakao et al. 1999) and *Trifolium pretense* (Kasprova et al. 2009). A number of medicinal plants are worked out for *in vitro* production of various secondary metabolites (Cardoso et al. 2019). Effect of plant elicitors on the production of flavonoids has been studied in callus culture of *Ononis arvensis* L (Tumova et al. 2011). All the tested elicitors markedly increased the production of flavonoids in comparison to control. The accumulation of secondary metabolites in plants is part of the defense response against pathogenic attack, which is triggered and activated by elicitors (Zhao et al. 2005). Production of flavonoids in cotton plants have been detected by a number of physiologists (Ismailov et al. 1994; Wu et al. 2008; Corradini et al. 2011). It is analyzed that cotton fiber cell development was retarded by flavonoid Naringenin (Tan et al. 2013). Reddening of leaves in *Gossypium hirsutum* L. is reported due to polyphenol complex (Edreva et al. 2006). So in the present study, effect of precursor phenylalanine on the production of flavonoids is studied in the tissue cultures of three cotton cultivars (RG-8, GA and Pusa 8-6).

Methodology: Callus cultures initiated on MS medium then shifted to LS medium were maintained by frequent subculturing (Murashige and Skoog 1962; Linsmaier and Skoog 1965). These static cultures were shifted to LS medium fed with various concentrations of Phenylalanine (25,50,75 and 100 mg PA/100 ml medium). Tissues were harvested at 6 weeks age for estimation of flavonoid production. Different tissue samples were dried weighed and were Soxhlet extracted with 80% hot ethanol for 24 hours on water bath (Subramanian and Nagarajan 1969). The concentrated extract was re-extracted with petroleum ether (40- 60^0 c Fraction I), ethyl ether (Fraction II) and ethyl acetate (Fraction III) in succession. Fraction III was hydrolyzed with 7% H_2SO_4 for 2 hours after drying it in vacuo. The filtrate was washed and dried. Fraction I was removed due to rich in fatty substance.TLC plates were developed using solvent mixture of n-butanol, Acetic acid and water (4:1:5 upper layer). The developed plates were visualized under UV light. The florescent spots coinciding with those of standard reference compounds of quercetin and kaempferol were marked scrapped and collected separately along with silica gel. There elutes were prepared with ethanol and then crystallized with chloroform. Thus, isolated compounds were estimated quantitatively.

Quantitative estimation: For quantitative estimation the identified compounds were subjected to colorimetery method of Kariyone et al (1953) for quercetin and Mabry et al. (1970) was followed. Stock solution of both quercetin and kaempferol were prepared separately by dissolving the authentic samples in methanol. Six concentrations of each of the standard samples (25 mg/ml to 150 mg/ml) were used to develop the chromatograms. Solvent system used same as that used for

identification of compounds (n-butanol: acetic acid: water 4; 1:5 upper layer). After visualizing the developed chromatogram under UV light, the fluorescent spots were collected with adsorbent in separate test tubes and shaken vigorously with ethanol, centrifuged and supernatants were collected separately. The volume of elutes was made up to 10 ml by adding spectroscopic methanol. To each of these test tubes 3 ml of 0.1 M Aluminum chloride was added and shaken vigorously. For each sample five such replicates were prepared and optical density (OD) was measured using spectronic 20 colorimeter (Bausch and Lomb) set at 440 nm for quercetin and 423 nm for kaempferol against a blank (10 ml Spectro methanol + 3 ml of 0.1ml $AlCl_3$). Regression curves for quercetin and kaempferol were separately plotted between their respective concentration and optical density which followed Beers law. Each of the ethyl ether and ethyl acetate extract was dissolved in spectroscopic methanol and applied on chromatographic plate along with standard quercetin and kaempferol. Fluorescent spots coinciding with those of reference compounds were eluted with methanol and subjected to colorimetric analysis as above. The amount of quercetin and kaempferol was determined (mg/gdw) by comparing with respective standard regressive curves. Mean values of five replicates of each sample was calculated (S.E. < 0.05%).

Results and discussion: Total flavonoid content (quercetin and kaempferol) showed a marked increase in the tissue fed with phenylalanine; higher amount of flavonoids was observed in tissues grown on LS medium supplemented with 75 mg PA/100 ml medium as compared to other concentrations of phenylalanine in tissues of each variety. The amount of flavonoid contents however, decreased in each variety when the tissues were grown on the medium fed with 100mg of phenylalanine /100ml of medium but the amount was still higher when compared with the amount obtained from tissues grown on control medium (Kaur 2018; Table1). The amount of kaempferol is higher than that of quercetin in all the varieties and at all the concentrations of phenylalanine. Maximum amount of kaempferol (2.63mg / gdw) and quercetin (0.7mg /gdw) was found in RG-8 variety. In tissues of Pusa 8-6 total amount of flavonoid was less but amount of quercetin was higher than that in GA variety at all the concentrations of phenylalanine. The minimum amount of flavonoid content was found in Pusa 8-6 tissues fed with 25 mg PA/100 ml medium (Table 1). Phenylalanine is reported to be the precursor of flavonoids (Harborne, 1965). More precise information has been obtained with pulse labelling experiments. Degradation experiment with kaempferol in pursley cell cultures by pulse feeding C14 dl-β-Phenylalanine and exogenous Kaempferol indicated that flavonoid synthesis and turnover are growth associated in their degradation experiments of kaempferol glycoside (C^{14} labeled) with peroxides (POD) indicated para-hydroxy benzoic acid as the resultant in different plant cell cultures (Hosel et al. 1977). Turnover of flavonoids and their glycosides have been determined by using $^{14}CO_2$ (Dittrich and Kandler 1971) or C^{14}*phenylalanine* (Grisebach and Bopp 1959) in *Picea abies* and *Buck-wheat* seedlings respectively. As in the current studies with callus cultures of cotton cultivars, the presence of kaempferol and effect of various

concentrations of dl-β-phenylalanine in tissues of *Agave wightii* (Saluja 1981) and *Cheiranthus cheiri* (Agarwal 1982) was reported.

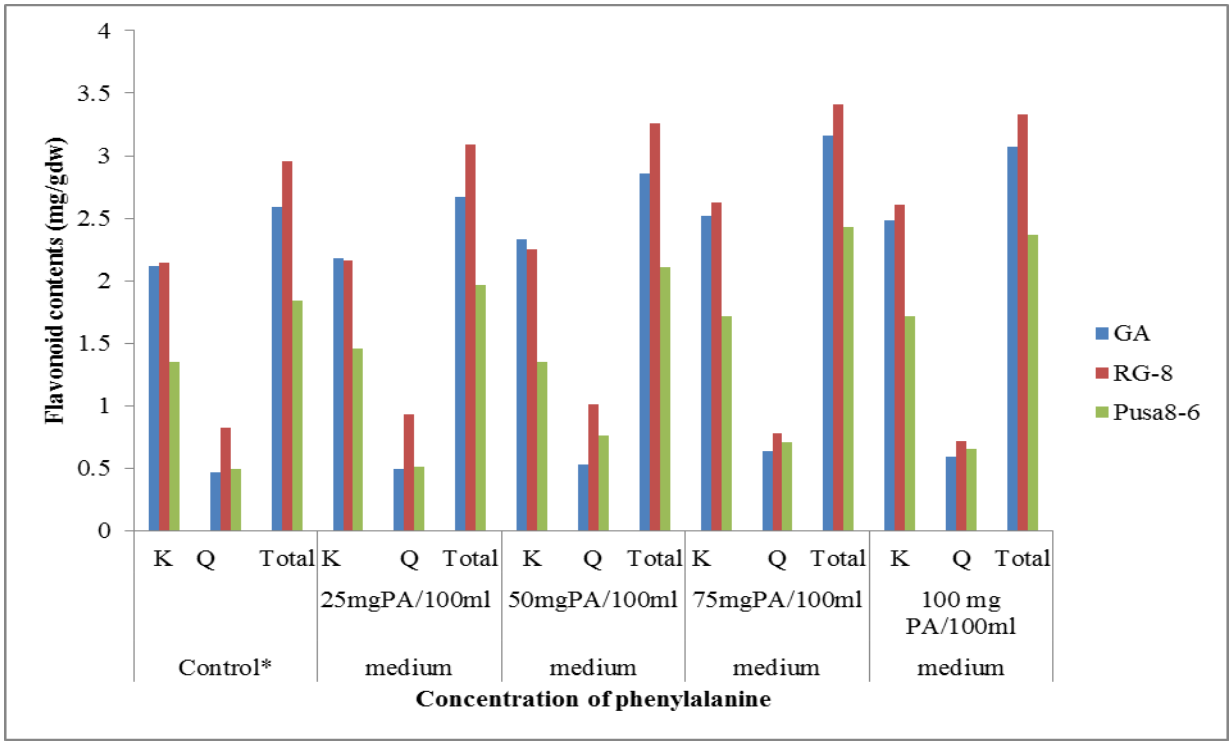


Figure 1: Effect of concentration of phenylalanine on the production of flavonoids in calli of cotton cultivars

Table 1: Effect of phenylalanine on the production of flavonoids in calli of cotton cultivars (GA, RG-8 and Pusa8-6) (Kaur 2018)

Variety	Control*			25mgPA/100ml medium			50mg PA/100ml medium			75mgPA/100ml Medium			100 mg PA/100ml Medium		
	K	Q	Total	K	Q	Total	K	Q	Total	K	Q	Total	K	Q	Total
GA	2.12	0.47	2.59	2.18	0.49	2.67	2.33	0.53	2.86	2.52	0.64	3.16	2.48	0.59	3.07
RG-8	2.14	0.82	2.96	2.16	0.93	3.09	2.25	1.01	3.26	2.63	0.78	3.41	2.61	0.72	3.33
Pusa8-6	1.35	0.49	1.84	1.46	0.51	1.97	1.35	0.76	2.11	1.72	0.71	2.43	1.72	0.65	2.37

(Q =Quercetin, K= Kaempferol, PA =Phenylalanine)

Amount of kaempferol increased significantly in the tissues of A.*wightii* , fed with 50 mg PA/ 100 ml medium when compared with the control. In tissues of *C. cheiri* the amount of kaempferol considerably increased at the concentration level of 75 mg PA / 100 ml of medium (control 0.30 %, fed 1.00 % in 4 weeks) (Saluja 1981; Agarwal 1982). Similarly amount of kaempferol enhanced in phenylalanine fed cultures of *Tribulus alatus* (Jit 1985) and *Lycium barbarum* (Shekhawat 1985). Maximum amount of flavonoids is observed in callus tissues of *Abutilon pannosum* raised with 75 mg PA / 100 ml medium (Singh 1989). Incorporation of different concentration of dl-β-

phenylalanine in the medium for growing the tissues augment the flavonoidal contents significantly. This indicated the possible role of this amino acid in flavonol biosynthesis which is supported by the view of (Barz 1977) that phenylalanine is a precursor of flavonoids. Increased production of flavonoids is reported by using elicitors methyl jasmonate and salicylic acid in suspension cultures of *Hypericum perforatum* (Wang et al. 2015). Increased production of flavonoids as well as biomass has been observed in callus tissues of *Hydrocotyl bovariensis* raised on the medium supplemented with precursors (Masoumian et al. 2011). Although increase in precursor phenylalanine concentration increases flavonoids considerably, very high concentration of phenylalanine decreases the production of flavonoids.

Conclusion: It is concluded that the production of flavonoids can be enhanced to a considerable extent in the tissues raised *in vitro* by using the precursor but after finding the appropriate concentration of precursor to be added in the culture medium.

Conflict of interest: Authors declare no conflict of interest.

References

Agarwal M, Kamal R. (2007). Studies on flavonoid production using in vitro cultures of *Momordica charantia* L. Indian Journal of Biotechnology. 6:277-279.

Agarwal R. (1982). Productionof primary and secondary metabolites from *in vivo* and *in vitro* tissue cultures.Ph.D. Thesis, University of Rajasthan Jaipur, India.

Barz W. (1977). Catabolism of endogenous and exogenous compounds by plant cell cultures, In: Plant tissue culture and its biotechnological applications (Eds. Barz W,Reinherd E and Zenk M H). Springer-Verlag,New York, pp. 153-171.

Cardoso JC, Oliveira ME, Cardoso FDC. (2019). Advances and challenges on the *invitro* production of secondary metabolites from medicinal plants**.** Horticultura Brasileira. 37(2): 124-132.

Corradini E., Foglia P, Ginnisanthi Pet al. (2011) Flavonoids: Chemicalproperties and analytical methodologies of identification and quantization in food and plants. Natural Product Research. 25:469-495.

Dittrich P, Kandler O, (1971). Einfluß der Jahreszeit auf Bildung und Umsatz von Phenolkörpern in der Fichte (*Picea abies* [L.] Karst.). Berichte der Deutschen Botanischen Gesellschaft, 84; 465-473.

Edreva A, Dagnon S, Gurel A, et al. (2006). Reddeningof cotton (*G.hirsutum*) leaves. Analysis of the polyphenol complex. Agrochemica 50, 54-61.

Filova A. (2014). Production of secondary metabolites in plant tissue cultures. Res J Agric Sci *46*(1).

Grisebach H, Bopp M. (1959). Studies on the biogenetic relation between quercetin and cynadine in buck wheat with the help of ^{14}C labeledcompound. Zeitschrift für Naturforschung. 14:485-490.

Harborne JB. (1965). Flavonoid Pigments.In: Plant Biochemistry (Esd'Borner J. and J.E. Varner), Academic Press, New York, pp.633.

Hösel W, Burmeister G, Kreysing P et al. (1977). Enzymological aspects of flavonoid catabolism in plant cell cultures**.** In Plant Tissue Culture and Its Bio-technological Application,Springer, pp. 172-177,

Ismailov AI, Karimdzhanov AK, Islambekov SY, Rakhinikhanov ZB. (1994). Flavonoid of cotton plant and plant close to it**.** Chemistry of Natural Compounds. 30, 1-14.

Jit Surinder. (1985). Production of primary and secondary products from *in vivo* and *in vitro* tissue cultures of some arid zone plants.Ph.D.Thesis,University of Rajasthan, Jaipur, India,.

Kariyone T, Hashimoto Y, Kimura M. (1953). Microbial studies on plant components. IX. Distribution of flavonoids in plants by paper chromatography. Journal of the Pharmaceutical Society of. Japan. 73:253-256.

Kasprova M., Siatka T, Dusek J. (2009). Production of isoflavonoids in the *Trifolium pretense* L. suspension culture. Ceska a Slovenska Farmacie. 58(2):67-70.

Kaur A. (2018). Flavonoid contents from seeds and callus culture of *Gossypium* varieties. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 9(4): 977-980.

Lee S Y, Cho S J, Park M H,et al. (2007). Growth and rutin production in hairy root culture of buck weed *(Fagopyruum esculentum*). Preparative Biochemistry & Biotechnology. 37:239-246.

Linsmaier EM, Skoog F. (1965). Organic growth factor requirements of tobacco tissue cultures. Physiologia plantarum. 18(1): 100-127.

Mabry TJ, Markhan KR, Thomas MB. (Eds). (1970). In; The Systematic Identification of Flavonoids**.** Springer-Verlag, Berlin, pp.119.

Maharik N, Elgengaihi S, Taha H. (2009). Anthocyanin production in callus cultures of *Crataegus sinaica*Bioss. International Journal of Academic Research**.** 1:30-34

Masoumian M., Arbakariya A., Syahida A, Maziah M. (2011). Effect of precursors on flavonoid production by *Hydrocotyl bovariensis* callus tissues. African Journal Biotechnology. 10(32): 6021-6029.

Murashige T, Skoog F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue cultures. Physiologia Plantarum. 15:473-97.

Nakao K, OnoK, Takio S. (1999). The effect of calcium on flavonol production in cell suspension culture of *Polygonum hydropiper*. Plant Cell Reports. 18:759-763.

Nikolaeva TN, Zagoskina NV, Zaprometov MN. (2009). Production of phenolic compounds in callus cultures of tea plant under the effect of 2,4-D and NAA. Russian Journal of Plant Physiology**.** 56:45-49.

Saluja M. (1981). Production of primary and secondary products from *in vivo* and *in vitro* tissue cultures of medicinal plants. Ph.D. Thesis, University of Rajasthan, Jaipur, India.

Shekhawat SS. (1985). Phytochemical investigation of some arid zone plants of Rajasthan*in vivo* and *in vitro*.Ph. D. Thesis, University of Rajasthan, Jaipur, India.

Singh V. (1989). Primary and secondary metabolites from some arid zone plants of Rajasthan, Ph.D. Thesis, University of Rajasthan, Jaipur, India, 1989.

Subramanian S.S.and Nagarajan S. (1969). Flavonoids of the seeds of *Crotolaria retusa* and *C. striata***.** Current Science. 38:65.

Tan JF, Tu LL, Deng FL,et al. (2013). A genetic andmetabolic analysis revealed that cotton fiber cell development was retarded by flavonoid Naringenis**.** Plant Physiology. 162: 86-95.

Trotin F, Moumou Y and Vasseur J. (1993). Flavonoid production by *Fagopyrum escullentum* hairy and normal root cultures. Phytochemistry; 32:929-931.

Tumova L, Tuma J, Dolezal M. (2011). Pyrazinecarboxamides as potential elicitors of flavonolignan and flavonoid production in *Silybum marianum* and *Ononis arvensis* cultures *in vitro***.** Molecules. *16*(11): 9142-9152

Wang J, Qian J, Yao L, Lu Y. (2015). Enhanced production of flavonoids by methyl jasmonate in cell suspension culture of *Hypericum perforatum*. Bioresources and Bioprocessing. 2:5.

Wu T, Abdullah R, Yang Y et al. (2008). Flavonoids from *Gossypium hirsutum* flowers. Chemistry of Natural Compounds. 44: 370-371.

Zhao J, Davis L C, Verpoorte R. (2005). Elicitor signal transduction leading to production of plant secondary metabolites. Biotechnology Advances. 23:283-333

Zhou Y, Hirotani M, Yoshikava T, Furuya T. (1997). Flavonoid and phenylethanoids from hairy root cultures of *Scutellaria bicalensis*. Phytochemistry 42:69-72.

Chapter 2
Medicinal sand dune flora & their ecology

Sheelpa Hindlekar, Vinayaka KS, Laxminarayan Hegde, Meenu Elizabath Benny, Goutam Basak, T Srinivas Rao and Sanjeet Kumar

Abstract: Soil nutrients in natural ecosystems are spatially discrete at the macro, meso and micro aspects but in coastal dunes, the distribution of nutrients are gibbous and create a patchy environment with specific plants. Sand dune plants indicate the changes in climate and help to understand the ecology. Keeping this in view, an attempt has been made to document the medicinal sand dune flora of eastern coastal areas of India and their association with soil. The Field Data Book was filled of each collected species and Passport Data Form (PDF) was used to gather the soil characters & uses. The results revealed that 25 plants were common in all selected sites along with 12 medicinal and 2 carnivorous plants. The present study highlights the importance of soil characters in balancing of the sand dune ecosystem and conservation of medicinal sand dune flora.

Keywords: soil characters, sand dune ecology, conservation aspects

S Hindlekar (✉), ORCID: https://orcid.org/0000-0003-4334-9096
Department of Botany, Government College of Arts, Science and Commerce, Quepem, Goa, India
e-mail: phadtegaurisha@gmail.com
KS Vinayaka, ORCID: https://orcid.org/0000-0003-0088-5630
Department of Botany, Sri Venkataramana Swamy College, Vidyagiri, Bantwal, Karnataka, India
e-mail: ks.vinayaka@gmail.com
L Hegde (✉), ORCID: https://orcid.org/0000-0003-1048-7011
College of HORTL. ENGG. and Food Technology, Devihosur, Karnataka, India
e-mail: hegdelax@gmail.com
ME Benny, ORCID: https://orcid.org/0000-0002-8138-8283
Department of Botany, Mar Athanasius College, Kothamangalaam, Kerala, India
e-mail: meenuelizabathbenny1@gmail.com
G Basak, ORCID: https://orcid.org/0000-0003-3773-2267
Department of Zoology, Raiganj University, Raiganj, West Bengal, India
e-mail: basakgoutam197@gmail.com
TS Rao, ORCID: https://orcid.org/0000-0001-8500-5940
Department of Agriculture, Andman & Nicobar Islands, India
e-mail: srinivasbabu.sr@gmail.com
S Kumar, ORCID: https://orcid.org/0000-0001-9538-397X
Biodiversity and Conservation Lab., Ambika Prasad Research Foundation, Odisha, India
e-mail: sanjeetaprf@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7003985

Introduction: In coastal areas, the sand dune vegetation is very unique and ecologically important. The distinct features of coastal sand are alkalinity (high carbonate content) and stabilization by plant growth with adequate rainfall. Sand dune also show the increase organic matter with age and corresponding decrease in pH. Sand dune sands are highly permeable with good drainage. The presence of calcium carbonate may induce deficiencies in some elements, but at the same time it reduces the toxicity of sodium. Factors that perturb the processes leading to soil formation include the development of blowouts, the movement of slip faces over vegetation, and erosion due to waves and fires (Jones et al. 2008). All these above characters provide platform for unique type of vegetation which help to balance the sand dune ecosystem from microbes to higher taxa. The stress of this environment allows to grow unique plants with specific secondary metabolites. Therefore, they could be potent therapeutic agents. Very less reports are available on medicinal sand dune flora and their relationship with the soil. Keeping this in view, an attempt has been made to study the herbaceous flora along with their soil characters from seven sites of eastern coast of Odisha state, India.

Methodology: Seven sites of Eastern Coastal areas of Odisha state, India (Chandrabhaga, Jahania, Marine drive road, Ramachandi, Konark-Chandrabhaga Road, Nolia sahi and Udayakani) were selected for the study of medicinally important flora of sand dune (Figure 1). The plants were enumerated and identified by the authors. The information on uses was collected through the Passport Data Form (PDF) and Field Data Book was maintained.

Results: The survey results revealed about 25 species belonging to 23 genus and 21 families. It was observed that *Aristolochia indica, Hydrophylax maritima, Ipomoea pes-caprae*, *Launaea sarmentosa* and *Spinifex littoreus* are growing on sand dune with pH 7.0 and no organic matter. The soil character was sandy. *Bergia ammannioides, Ceratopteris thalictroides, Crinum asiaticum, Limnophila indica, Pedalium murex, Sesamum indicum* and *Tribulus terrestris* were growing on salty & loamy soil having pH more than 7.0. It was noticed that *Drosera burmannii, D. indica, Eriocaulon quinquangulare, Epaltes divaricata, Murdannia nudiflora, Osbeckia stellata, Polycarpaea corymbosa, Schoenoplectus articulatus, Utricularia polygaloides, U. bifida, Xyris difformis* and *Zornia gibbosa* were growing on clay loamy soil with pH lower than 7. It was also noticed that these species were growing near natural salt lick and high evidences of herbivores. Details are listed in the Table 1.

Among the enumerated 25 species from sand dune, 12 plants are identified having food and medicinal values by the local communities. Details are listed in Table 2. NIL mentioned in Table 2 indicates that we are losing the traditional knowledge on those locally available plants and there is a need for exploration & documentation works on those sand dune flora.

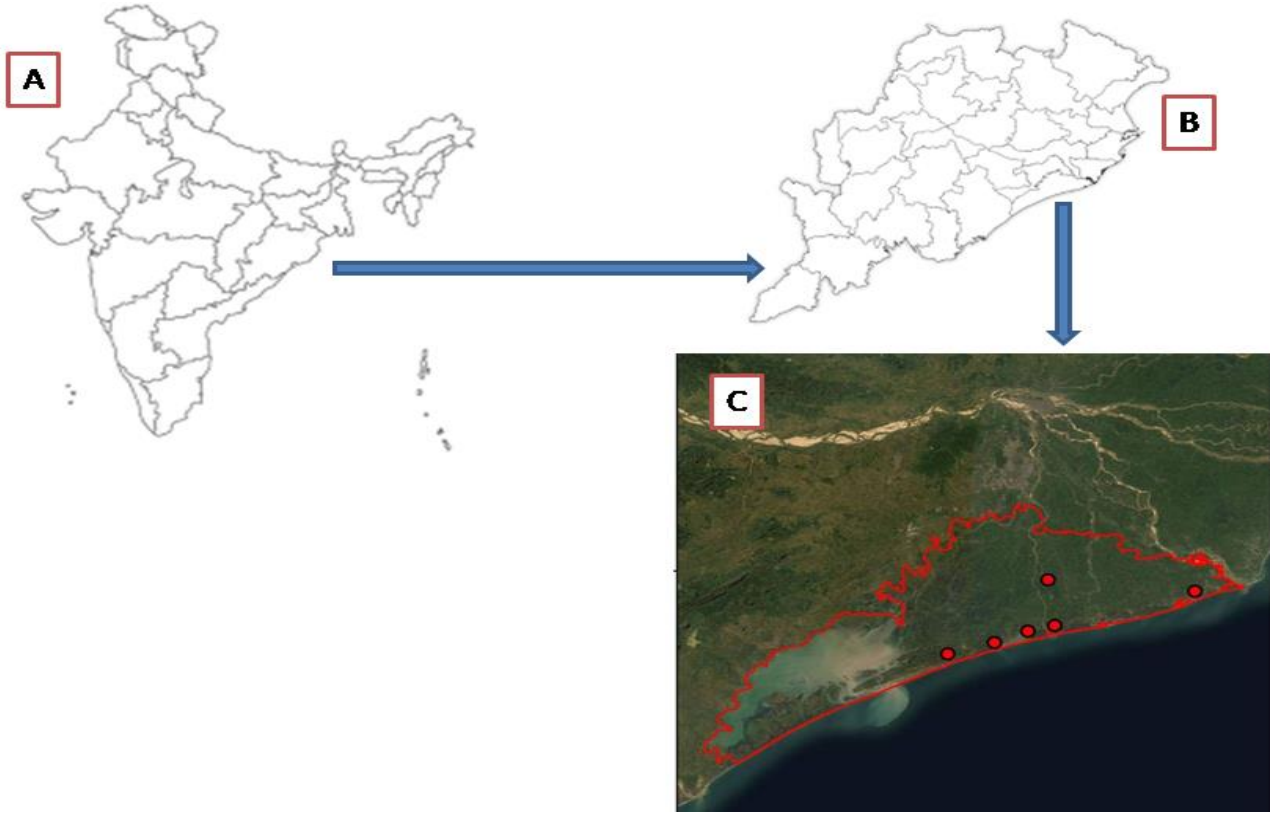


Figure 1: Geographical location of study areas, A) India; B) Odisha state, C) Study areas

Table 1: Herbaceous sand dune flora and their soil characters

Plant Name	Family	Habitat	Soil characters	Organic matter	pH
Aristolochia indica	Aristolochiaceae	Sand dune	Sandy	Zero	7.0
Bergia ammannioides	Elatinaceae	Brackish water	Silt & sandy	Moderate	8.1
Centranthera tranquebarica	Orobanchaceae	Dried areas of Brackish water	Silt & sandy	High	7.5
Ceratopteris thalictroides	Pteridaceae	Brackish water	Silt & sandy	Moderate	7.6
Crinum asiaticum	Amaryllidaceae	Brackish water	Silt & sandy	Moderate	7.3
Drosera burmannii	Droseraceae	Dried areas of Brackish water	Clay loamy	High	6.2

Drosera indica	Droseraceae	Dried areas of Brackish water	Clay loamy	High	6.5
Epaltes divaricata	Asteraceae	Dried areas of Brackish water	Clay loamy	High	6.5
Eriocaulon quinquangulare	Eriocaulaceae	Dried areas of Brackish water	Clay loamy	High	6.5
Hydrophylax maritima	Rubiaceae	Sand dune	Sandy	Zero	7.0
Ipomoea pes-caprae	Convolvulaceae	Sand dune	Sandy	Zero	7.0
Launaea sarmentosa	Asteraceae	Sand dune	Sandy	Zero	7.0
Limnophila indica	Plantaginaceae	Dried areas of Brackish water	Clay loamy	High	7.5
Murdannia nudiflora	Commelinaceae	Dried areas of Brackish water	Clay loamy	High	6.5
Osbeckia stellata	Melastomataceae	Dried areas of Brackish water	Clay loamy	High	6.5
Pedalium murex	Pedaliaceae	Dried areas of Brackish water	Clay loamy	High	7.3
Polycarpaea corymbosa	Caryophyllaceae	Dried areas of Brackish water	Clay loamy	High	6.5
Schoenoplectus articulatus	Cyperaceae	Dried areas of Brackish water	Clay loamy	High	6.5
Sesamum indicum	Pedaliaceae	Dried areas of Brackish water	Clay loamy	High	7.5
Spinifex littoreus	Poaceae	Sand dune	Sandy	Zero	7.0
Tribulus terrestris	Zygophyllaceae	Dried areas of Brackish water	Clay loamy	High	7.5
Utricularia bifida	Lentibulariaceae	Dried areas of Brackish water	Clay loamy	High	6.5
Utricularia polygaloides	Lentibulariaceae	Dried areas of Brackish water	Clay loamy	High	6.5
Xyris difformis	Xyridaceae	Dried areas of Brackish water	Clay loamy	High	6.5
Zornia gibbosa	Fabaceae	Dried areas of Brackish water	Clay loamy	High	6.5

Table 2: Medicinal values of enumerated sand dune flora

Plant Name	Habit	Uses
Aristolochia indica	Climber	Leaves paste is used in eczema
Bergia ammannioides	Herb	Leaves infusion is used to cure scabies.
Centranthera tranquebarica	Herb	NIL
Ceratopteris thalictroides (Figure 2)	Herb	Leaves are consumed as a leafy vegetable.
Crinum asiaticum	Under shrub	Tuber paste is used to cure muscular pain.
Drosera burmannii	Herb	Plant powder is used in asthma
Drosera indica	Herb	Plant powder is used in asthma
Epaltes divaricata	Herb	NIL
Eriocaulon quinquangulare	Herb	NIL
Hydrophylax maritima	Succulent prostrate creeping herb	NIL
Ipomoea pes-caprae	Creeping climber	Root paste is used to cure piles.
Launaea sarmentosa	Herb	The plant parts are crushed with Karanja seed oil and paste is applied to cure skin infections.
Limnophila indica	Herb	NIL
Murdannia nudiflora	Herb	NIL
Osbeckia stellata	Herb	NIL
Pedalium murex	Herb	Whole plant decoction is used to cure kidney stone.
Polycarpaea corymbosa	Herb	NIL
Schoenoplectus articulatus	Sedge	The leaf decoction is taken to cure eye problems.
Sesamum indicum (Figure 3)	Herb	Seed oil is used to cure fungal infections.
Spinifex littoreus	Grass	NIL
Tribulus terrestris	Herb	The whole plant decoction is used in urinary problems.
Utricularia bifida	Herb	NIL
Utricularia polygaloides	Herb	NIL
Xyris difformis	Herb	NIL
Zornia gibbosa	Herb	NIL

Figure 2: The vegetative parts of *Ceratopteris thalictroides*

Figure 3: Flowers of *Sesamum indicum*

Discussion: Many researchers have documented the floral species of coastal areas. Rodrigues et al. (2011) have reported 267 species from coastal areas of India. Sahu et al. (2011) have reported 46 plant species having medicinal values from the coastal districts of Odisha. Chakraborty et al. (2012) have reported about 12 species of plants along with their habitat and soil quality from the coastal areas of Odisha and West Bengal. Sahoo et al. (2014) have reported 352 species of angiosperms belonging to the sandy coast of Balasore, Odisha. Tripathy et al. (2016) reported 37 coastal floras from Arribada beach, Odisha. Sahu et al. (2019) have reported 31 common species from the coastal areas of Odisha state. Nayak et al. (2019) have reported microbial diversity of coastal sand dunes of Odisha. The literature survey indicates that less work has done on the association between flora and soil characters as well as local medicinal practices.

Recommendations: The present study and the literature survey indicate that there is a lack of data on association between medicinal sand dune flora and soil characters. Globally due to climate change and anthropogenic activities, we are observing the biodiversity loss. Therefore, it is necessary to take further steps to do more exploration and restore the coastal flora to maintain the coastal ecology and to minimize the biodiversity loss from microbial diversity to higher taxa. The results of present study

highlight the importance of soil characters in maintaining the specific medicinal herbaceous flora.

References

Chakraborty T, Mondal AK, Parui SM. (2012). Studies on the prospects and some problems of sand dune vegetation at the fragile coastal zones of West Bengal and Odisha, in Eastern India. African Journal of Plant Science. 6(2):48-56.

Jones MLM, Sowerby A, Williams DL and Jones RE. (2008). Factors controlling soil development in sand dunes: evidence from a coastal dune soil chronosequence. Plant Soil. DOI: 10.1007/s11104-008-9601-9.

Nayak S, Behera S and Dash PK. (2019). Potential of microbial diversity of coastal sand dunes: need for exploration in Odisha coast of India. The Scientific World Journal. doi.org/10.1155/2019/2758501.

Sahoo RC, Sahu D and Misra MK. (2014). Angiosperm diversity of sandy coast of Balasore district, Odisha, India. Nelumbo. 56: 89-123.

Sahu L, Devi RS and Kumar S. (2019). Coastal sand dune flora of Odisha: source for drug formulations against antimicrobial resistance. Journal of Biodiversity and Conservation. 3(1): 217-228.

Sahu SC, Pattnaik SK, Sahoo SL, Lenka SS and Dhal NK. (2011). Ethnobotanical study of medicinal plants in the coastal districts of Odisha. Current Botany. 2: 1-4.

Tripathy B, Behera SR, Rajasekhar PS and Mishra AK. (2016). Coastal dune flora and fauna of Arribada beach, Rushikulya in Ganjam district, Odisha, India. 14(1): 28-32.

Chapter 3
Oecophylla smaragdina: source of tribal bio-entrepreneurship & its ecological aspects with medicinal plants

Smita Tarun Raut, Debasmita Mahanta, Ilarani Pradhan, Soumi Sardar and Sanjeet Kumar

Abstract: *Oecophylla smaragdina* are being used for various medicinal and nutritive purposes by local tribes in Odisha, India and worldwide. It is locally known as Kurkuti. The study attempts to document medicinal and economic values along with relationship with medicinal plants. Findings revealed that *O. smaragdina* has sound food & medicinal values. About 24 host medicinal plant species are noted down. The chapter highlights the importance of medicinal plants in the existence of *O. smaragdina*.

Keywords: Red Weaver Ants, Medicinal plants, Host plants, Conservation

---

ST Raut, ORCID: https://orcid.org/0000-0002-5576-3596
Department of Botany, Rashtrapita Mahatama Gandhi, Arts, Commerce and Science College, Saoli, Chandrapur, Maharashtra, India
e-mail: smitaraut23@gmail.com

D Mahanta, ORCID: https://orcid.org/0000-0002-9572-2326
Tassar Silk Park, Bhagamunda, Odisha, India
e-mail: mdebasmita1994@gmail.com

I Pradhan (✉), ORCID: https://orcid.org/0000-0002-3964-8440
Department of Botany, GIET University, Gunupur, Rayagada, Odisha, India
e-mail: pradhanilarani94@gmail.com

S Sardar, ORCID: https://orcid.org/0000-0002-2641-3298
Department of Zoology, University of Kalyani, Nadia, West Bengal, India
e-mail: soumisardar6@gmail.com

S Kumar, ORCID: https://orcid.org/0000-0001-9538-397X
Biodiversity and Conservation Lab., Ambika Prasad Research Foundation, Odisha, India
e-mail: sanjeetaprf@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7012781

Introduction: The term "entomophagy" is derived from the Greek word 'entomon'," insect" and 'phagen', "to eat" (Gahukar 2018). Anthropo-entomophagy, is no novel phenomenon, because obviously it has been practised since the very early development of human beings (Elorduy 2009). Since ancient times, human beings have developed the skills in selection of food from animal diversity. Despite the growth in modern medicine, many communities continue to make use of traditional foods from faunal taxa available in wild. These are important nutraceutical foods, which fulfil their daily nutritional and medicinal needs. Among the wide diversity of wild animal foods, insects play a vital role. Edible insects are used as a source of natural medicines, which can provide avenues for income generation through their marketing. Considering these, the science that deals with all forms of insect-human interaction in traditional society is known as Ethnoentomology (Rajagopal et al. 2018). In most part of India, local communities, particularly tribes, consume different types of insects. Odisha state is home for about 62 different tribal communities. Among them, almost every community consume *Oecophylla smaragdina* (Red Weaver Ants) as a traditional food and for medicinal purposes. The local communities sell them with the name of Kurkuti/Kai. *O. smaragdina* is a natural pest controller in forest. *O. smaragdina* has specific host plants and most of them come under medicinal plants group. Due to over extraction of medicinal plants from wild, the population of associated species of *O. smaragdina* have declined leading to ecological imbalance. Therefore, an attempt has been made to enumerate the medicinal host plants of *O. smaragdina* and their uses from Odisha state, India.

Methodology: The present study employed a mixed approach, comprising both quantitative and qualitative data analysis (Kumar and Jena 2017). The field work was carried out in the different areas of Sundargarh district in Odisha state, India during 2021-2022.

Survey for the collection of information and RWAs: The survey was carried out along with the floral survey in different areas of Sundargarh district in Odisha state and collected information was analyzed through Passport Data Form (Kumar et al. 2013).

Results and discussion: The tribal and rural areas of Odisha are rich in traditional food system. They consume diverse food stuffs collected from nearby forest areas. For the present study, authors have visited several villages and local markets of Odisha and interacted with local tribes for collecting information on *O. smaragdina*. Hillocks and small hills of Sundargarh district are selected for the observation. From the information collected from local communities, it was found that *O. smaragdina* is consumed in the form of pickle or ground to chutney. It is consumed mainly with rice and country liquor.

Figure 1: Habitat of *O. smaragdina* in study areas

Figure 2: Local communities are used to sell the *O. smaragdina* in local markets

The previous research in ethnoentomology has revealed that apart from consumptive value these ants are also remarkable for their medicinal value. Ethnic tribes in the district use both adults and eggs of *O. smaragdina*, as a local medicine It was noted that *O. smaragdina* is commonly used to treat cough, asthma and to improve eyesight.

Economic values: It was observed that in many weekly markets of Sundargarh district, the *O. smaragdina* is sold by the local communities for their livelihood The average cost is Rs. 10-15 per leaf pocket.

Association with plants: From enumerated host plant species, about 24 plant species are recorded having food and medicinal values. The most commonly observed medicinal host plants are *Annona reticulata, Diospyros melanoxylon, Shorea robusta, Syzygium cumini, Schleichera oleosa* etc. Details are listed in Table 1.

Table 1: The medicinal host plants of *O. smaragdina*

Scientific name	Local name (s)	Family	Food	Medicinal
Annona reticulata	Ramphal	Annonaceae	√	√
Annona squamosa	Sitaphal	Annonaceae	√	√
Azadirachta indica	Nimba	Meliaceae	√	√
Bauhinia purpurea	Kundhali	Fabaceae	√	√
Butea monosperma	Palasha	Fabaceae	NIL	√
Capsicum annuum	Lonka	Solanaceae	√	√
Cascabela thevetia	Kaner	Apocynaceae	NIL	√
Cassia fistula	Sonari	Fabaceae	NIL	√
Cassine glauca	Chauli	Celastraceae	NIL	√
Citrus limon	Nembu	Rutaceae	√	√
Combretum roxburghii	Atundi	Combretaceae	NIL	√
Diospyros melanoxylon	Kendu	Ebenaceae	√	√
Ficus benghalensis	Bara	Moraceae	NIL	√
Holoptelea integrifolia	Charala	Ulmaceae	NIL	√
Madhuca longifolia	Mahula	Sapotaceae	√	√
Mangifera indica	Ambo	Anacardiaceae	√	√
Polyalthia longifolia	Debadaru	Annonaceae	NIL	√
Pongamia pinnata	Karanja	Fabaceae	NIL	√
Psidium guajava	Pijudi	Myrtaceae	√	√
Schleichera oleosa	Kusuma	Sapindaceae	√	√
Shorea robusta	Sal	Dipterocarpaceae	NIL	√
Syzygium cumini	Jamun	Myrtaceae	√	√
Tamarindus indica	Tentuli	Fabaceae	√	√
Terminalia catappa	Desi badam	Combretaceae	NIL	√

Conclusion: The present study brings out the importance of entomotherapy therapeutic system. These ants (*Oecophylla smaragdina*) are being used for various medicinal and food purposes by tribal communities of Odisha. It is concluded that *Oecophylla smaragdina* is used as a nutraceutical and have economic values. *Oecophylla smaragdina* is closely associated with medicinal plants for their existence. Therefore, there is a need of more documentation on their host plants and conservation strategy.

References

Elorduy RA. 2009. Anthro-entomophagy: cultures, evolution and sustainability. Entomological Research 39: 271-288.

Gahukar RT. 2018. Entomophagy in traditional healthcare practiced by indigenous communities: potential, implications and constraints. International Journal of Basic and Applied Sciences 7(4): 55-61.

Kumar S, Behera SP, Jena PK. 2013. Validation of tribal claims on *Dioscorea pentaphylla* L. through phytochemical screening and evaluation of antibacterial activity. Plant Science Research 35: 55-61.

Kumar S, Jena PK. 2017. Tools from biodiversity: wild nutraceutical plants, Ed: Furze JN. Mathematical advances towards sustainable environment systems. DOI 10.1007/978-3-319-43901-3_9.

Rajagopal T, Singam P, Kulandaivel S, Selvarani S, Sevarkodiyone S, Ponmanickam P. 2018. Survey of red weaver ants (*Oecophylla smaragdina*) and their host plants in urban and rural habitats of Madurai District, Tamil Nadu, India. Journal of Entomology and Zoology studies 7(1):938-943.

Chapter 4
Natural Farming: a sustainable way of cultivation

Bhagwati Prashad Sharma, Arti Sharma, Sagar K Jadav, Anjali Arya & Sanjeet Kumar

Abstract: When health evanesces, wisdom cannot reveal itself, art cannot manifest, strength cannot fight, wealth becomes useless, and intelligence cannot be applied. Keeping this in view, an attempt has been made to gather the information available on Natural Farming. Here the authors are presenting the importance of Natural Farming and how it can be a sound tool for bio-entrepreneurship.

Keywords: Organic, Toxic free, Sustainable, Bio-entrepreneurship

---

BP Sharma, ORCID: https://orcid.org/0000-0002-8134-9807
Department of Botany, Sidharth Government College, Nadaun, Himachal Pradesh, India
e-mail: bp76sharma@gmail.com
A Sharma, ORCID: https://orcid.org/0000-0002-9151-2225
Department of Botany, Government College Jawalaji, Himachal Pradesh, India
e-mail: artigndu@gmail.com
SK Jadav (✉), ORCID: https://orcid.org/0000-0002-3273-7264
Department of Genetics and Plant Breeding, College of Agriculture, Navsari Agricultural University, Waghai, Gujrat, India
e-mail: jadavsagar27@gmail.com
A Arya, ORCID: https://orcid.org/0000-0002-5334-8196
Department of Biosciences (SLAS), Mody University of Science and Technology, Rajasthan, India
e-mail: anjaliarya386@gmail.com
S Kumar, ORCID: https://orcid.org/0000-0001-9538-397X
Biodiversity and Conservation Lab., Ambika Prasad Research Foundation, Odisha, India
e-mail: sanjeetaprf@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7047247

Introduction: Natural farming or the natural way of farming is also known as do-nothing farming. It is an ecological approach referring to organic farming, sustainable agriculture, agroecology, agroforestry, eco-agriculture, permaculture and fertility farming. The

natural farming works along with local biodiversity, interaction of plant-animal and as per the climatic conditions. The objective of natural farming is producing food and medicinal stuff with aesthetic or spiritual values which lead to the cultivation and perfection of human beings. The ideology of natural farming is to promote the quality of nutrients and minimizing the use of chemicals. It is also a royal approach to prevent water pollution, biodiversity loss and soil erosion along with the production of ample amounts of food or nutraceuticals (Anderson 2005).

Principles of Natural Farming: The farmers or practitioners of natural farming always keep in mind that they are part of nature and using classical methods, have to get food and nutraceuticals. The practice is depending on culture, landscapes and communities of the areas. It has five important principles. They are 1) No tillage, 2) No fertilizers, 3) No pesticides, 4) No weeding and 5) No pruning.

Using the above mentioned practices and principles, one can minimize the labour cost, and can get easily food stuffs from nature like rice, barely, citrus, medicinal herbs etc. Without plowing, seeds germinate well and all other faunal-floral species help them and also provide key to understand the performance and mood of climate which provide a sound sustainability (Hanley 1990). In the natural farming, periodically the ground and herbaceous plants are cut and left on the surface to get more nutrients in the soil. It also facilitates the sowing of seeds in the same location providing a dense ground layer which hides the seeds from faunal species like birds (Toyoda 2008). Japanese farmer & philosopher Masanobu Fukuoka introduced the word Natural farming in his book, 'The One-Straw Revolution' in 1975. Yoshikazu Kawaguchi is the instigator of Natural Farming in modern era and he re states the core values of natural farming. As per his ideology, Natural Farming means 1) Do not plough the fields; 2) Weeds and insects are not our enemies; 3) There is no need to add fertilizers; 4) Focus on the foods you grow based on your local climate and conditions. His work is recognized outside his country and became a main character of the documentary film entitled "Final Straw: Food, Earth, Happiness" (Toyoda 2008). Natural Farming recognizes soils as a basic asset and is capable to generate the life. In Natural farming, tilling is not practiced due to following reasons:

1. It destroys the soil characters like water suction, soil horizons. No tillage preserves the crop residues which is helpful to increase the total organic matter, nitrogen level, population of aerobic, facultative anaerobic and anaerobic bacteria.

2. In tilling, the roots of plants are uprooted which create loss of oxygen in soil. The living roots drill millions of tiny holes in the soil for oxygen, space for insects and worms. Certain types of roots also fix the nitrogen (Sylvia et al. 1999).

Characteristic features of Natural Farming: The Natural farming has characteristic features like a) Natural Farming is environment friendly; b) It respects the life and opposes human exploitation; c) Natural Farming products have quality, good taste, and

better yield; d) Natural Farming does not use pesticides; e) Natural Farming does not use herbicides; f) Natural Farming uses the native weeds rather than killing them; g) Natural Farming doesn't use chemical fertilizers; h) Natural Farming does not emit any waste water; i) Natural Farming cares nutritive cycle theory; j) Natural farming maintains the growth of native soil microorganisms.

Components of Natural Farming: The major components of Natural Farming are: 1) Organic pesticides & herbicides; 2) Organic compost & foliar fertilizers; 3) Biological pest control through beneficial bacteria, fungus, insect parasites and predators; 4) Uses of Biochar & very close to 100 % natural environment.

Zero Budget Natural Farming (ZBNF): ZBNF is a low input, climate resilient farming that inspires farmers to use natural materials, eliminating the use of chemical fertilizers & pesticides. ZBNF is able to reduce high labour wages, environmental problems, unpredicted monsoon problems and food problems. ZBNF is started by Subhash Palekar and introduced ZBNF as Krishi ka Rishi. The uniqueness of ZBNF are: 1) An approach towards sustainability; 2) Expense free farming; 3) Farming with minimum electricity and water consumption; 4) Producing quality and poison free food stuff; 5) Reducing external labour requirement; 6) Techniques of multi cultivation for higher net income under bio-entrepreneurship.

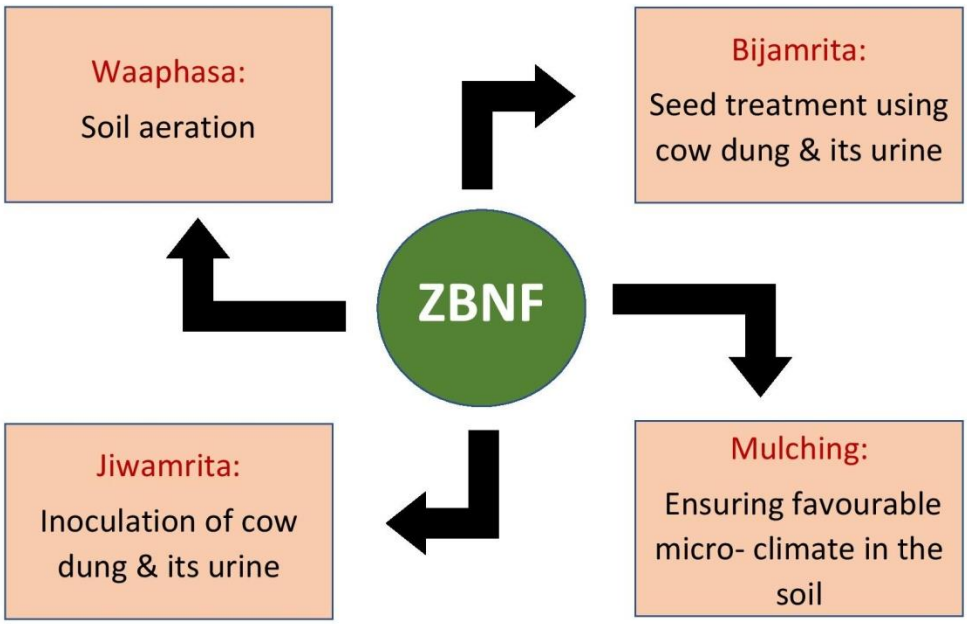


Figure 1: Components of Zero Budget Natural Farming

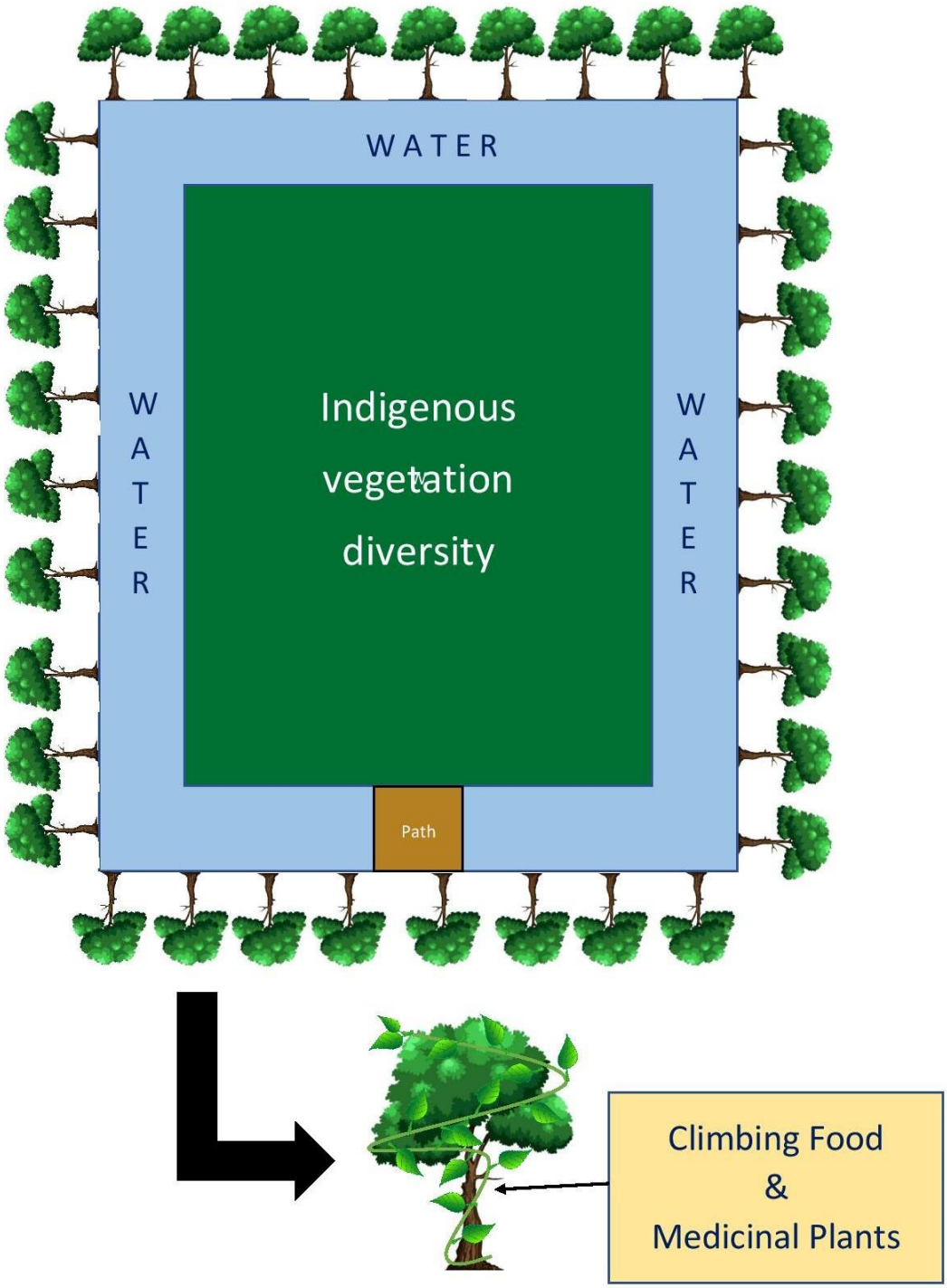


Figure 2: A proposed model for Natural Farming (Food plants, Medicinal plants, Fish farming)

ZBNF will be an important tool for bio-entrepreneurship because 70 % of land area is under dry land agriculture with marginal resource required for poor farmers and the average pesticide usage of country is 0.6 kg/ha < China (13kg/ha) <Korea (16.56 kg/ha), So ZBNF can be easily employed. Eighty percent conventional yield can be achieved with

ZBNF. Farmer gets premium price of 22-35% for conventional produce. Due to diversified cropping, farmers get year round income and insurance against crop failures. The income obtained from the farm is high with low input. ZBNF has four pillars (Bijamrita, Jiwamrita, Mulching and Waaphasa). Details are illustrated in Figure 1.

Conclusion: Climate & environment is changing at alarming rate due to anthropogenic activities. Within a few years we will be in the edges of extinction if we do not go back to the nature. To reduce the negative impacts and to improve the health of human beings, Natural farming is essential in modern ways. The techniques discussed in the present paper could also provide ample opportunity in livelihood sectors under bio-entrepreneurship (Figure 2). Hence, for the sustainability of environment, ecology and human activities, the implementation of Natural farming is needed globally.

References

Anderson MK. (2005). Native American Knowledge and the Management of California's Natural Resources". *Tending the Wild: Native American Knowledge and the Management of California's Natural Resources*. University of California Press, Oakland. pp. 1-555.

Hanley P. (1990). Agriculture: A Fundamental Principle. *Journal of Bahá'í Studies*. 3(1): 1-10.

Sylvia DM, Fuhrmann JJ, Hartel PG and Zuberer DA. (1999). *Principles and Applications of Soil Microbiology*. New Jersey, Prentice Hall. pp. 39–41.

Toyoda N. (2008). Humans must strive to know the unknown? What does Natural farming mean? *Japan Spotlight*. 48-49.

Chapter 5
Evaluation of phytotoxic, antioxidant and anticancer activities of *Parthenium hysterophorus* L. and *Cannabis sativa* L.

Manish Kumar, Amardeep Kaur, Aashita Garg, Khusboo, Jashanpreet Kaur and Anu Rani

Abstract: Medicinal plants contain a variety of phytochemicals, including lignans, terpenoids, alkaloids, flavonoids, phenolic acids, etc. with a variety of biological functions. In the present study, *Cannabis sativa* and *Parthenium hysterophorus* are investigated for phytotoxic, antioxidant and anticancer activity along with their phytochemical analysis. Results demonstrated that aqueous extracts of selected plants leaves had significant phytotoxic effect on the growth of *Vigna radiata* L (Mung bean) and *Zea mays* L. (Maize) seedlings as evident from various parameters studied (shoot length, root length, fresh weight and dry weight). Results of antioxidant activity revealed that both aqueous extracts of *C. sativa* & *P. hysterophorus* leaves showed good scavenging activities. The IC_{50} value were found to be 348.21 µg/ml and 610.50 µg/ml respectively. Further, both extracts also showed antiproliferative effects against human non-small cell lung carcinoma (NSCLC) A549 in MTT assay. The GI_{50} for aqueous extracts of *C. sativa* & *P. hysterophorus* leaves were found to be 47.75 µg/ml and 53.78 µg/ml respectively. Activities obtained in the present studies are may be due to various phenolic phytochemicals present in the extracts. Conclusively, results of the present study highlights the bioactive efficacy of both selected plants.

Keywords: *Cannabis sativa, Parthenium hysterophorus,* Phytotoxic, Antioxidant, Antiproliferative

---

M Kumar (✉), ORCID: https://orcid.org/my-orcid?orcid=0000-0001-7402-2665
SD College, Barnala, Punjab, India
e-mail: kumarmanish639@gmail.com
A Kaur, ORCID: https://orcid.org/my-orcid?orcid=0000-0003-2634-1068
SD College, Barnala, Punjab, India
e-mail: amar.bot03@gmail.com
A Garg, ORCID: https://orcid.org/0000-0001-8964-3376
SD College, Barnala, Punjab, India
e-mail: aashitabnl@gmail.com
Khusboo, ORCID: https://orcid.org/0000-0002-5250-4476
SD College, Barnala, Punjab, India
e-mail: gkhushboo152@gmail.com

J Kaur, ORCID: https://orcid.org/0000-0001-9857-8211
SD College, Barnala, Punjab, India
e-mail: jashan41964@gmail.com
A Rani, ORCID: https://orcid.org/0000-0003-0303-0080
SD College, Barnala, Punjab, India
e-mail: bhagrathanu@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7134143

Introduction: Over the course of human history, plant resources have remained a crucial component of civilization. Mankind has looked for an appropriate medicine among plants to treat a variety of ailments (WHO 2002; Mouele et al. 2022). Since the dawn of human civilization, medicinal plants have served as a source of healing in local communities throughout the world. Nevertheless, it continues to be crucial in today's world as a primary healthcare method for over 85% of the world's population (Pesic 2015) and as a source for drug discovery, since 80% of all synthetic pharmaceuticals come from plant (Bauer and Bronstrup 2014). The annual market value for medicinal plant products surpasses $100 billion worldwide (Sofowora et al. 2013). Various wild plant products are a regular source of income for millions of people in under developed nations (Maroyi 2017). Traditional medicinal systems have made considerable use of ethnomedicinal plants to treat a variety of diseases (El-Seedi et al. 2013). This connection dates back to the Neanderthal man, who treated illnesses using plants. The world society has acknowledged that many indigenous groups rely on biological resources, particularly medicinal plants, despite the fact that they are very old (Akerele 1993). Due to their widespread availability, cultural acceptance, and challenging economic circumstances, traditional medicinal plant cures the majority of the world's population (Hamilton 2004). 25% of prescription pharmaceuticals come from higher plants, whereas 75% of herbal medications were generated via study on traditional medicinal plants (Wang et el. 2002). The vast majority of bioactive chemicals with a variety of therapeutic qualities are found in medicinal plants. Anti-inflammatory, antiviral, anticancer, antimalarial, and analgesic qualities are only a few of the numerous therapeutic benefits linked to the medicinal plants (Negi et al. 2011; Aye et al. 2019). Western Ghats and the Himalayas are two of India's most biodiverse areas, making it one of the world's wealthiest countries in terms of plant species. Out of the 43,000 plant species that exist in the nation, over 7500 are included in different medicines, and 1700 species are recognized in the Ayurvedic literature. Phytochemicals are utilised in India for a variety of purposes besides medicine, including cosmetics, health and hygiene, scent, and dietary supplements (Singh et al. 2020). Among various medicinal plants, *Cannabis sativa* and *Parthenium hysterophorus* are important medicinal plant with immense therapeutic properties. Both are regarded as weeds in India. In the present study, *Cannabis sativa* and *Parthenium hysterophorus* are investigated

for phytotoxic, cytotoxic and antioxidant activity along with their phytochemical analysis.

Methodology: Leaves of *C. sativa* and *P. hysterophorus* were collected from the campus of SD College Barnala, Punjab (India) in the month of April. After the collection, material was washed 4-5 times in running water followed by grinding in distilled water with the help of pestle and mortar. Extract was filtered in a conical flask with Whatman filter paper. The filtered extracts (Liquid) were used for phytotoxic studies. For the antioxidant and anticancer activity, this filtered extract so obtained was concentrated using Rotary Vacuum Evaporator and dried. The extracts were named as follows: Aqueous extract of *C. sativa* as WCS and aqueous extract of *P. hysterophorus* as WPH.

Phytochemical Screening (Harborne 1998**)**

Phenolics: Few drops of ferric chloride were added to the extract solution**.** The formation of dark green colour indicated the presence of phenolic acids.

Flavonoids: NaOH (1N) was added to the extract solution. Mixture turns yellow in colour, followed by addition of dil. HCl., solution turns colourless indicating presence of flavonoids.

Phytotoxic Studies: Liquid extract of leaves of *C. sativa* (WCS) and *P. hysterophorus* (WPH) were evaluated for their phytotoxic activity by measuring growth parameters of *Vigna radiata* L (Mung bean) and *Zea mays* L. (Maize) seedlings respectively**.** Seed viability of both *V. radiata* (Mung bean) and *Z. mays* (Maize) was tested employing 2,3,5 triphenyl tetrazolium chloride test.

2,3,5- Triphenyl Tetrazolium Chloride Dye Test: In this experiment about 100 seeds of selected plants were soaked overnight in water and then their seed coats were removed to expose seeds. The seeds were cut into halves in such a way that the seeds were cut exactly into half along with an embryo. Then these cut seeds were treated with 0.5 % of 2,3,5- triphenyl tetrazolium chloride dye for about half an hour in dark. The seed turns red if they are viable while non viable seeds remain colourless.

Treatment of *V. radiata* (Mung bean) seeds with liquid extract of WCS: Seeds of *V. radiata* were soaked overnight and then placed on the glass petriplates containing wet cotton. After one day, seeds were treated with liquid extract of WCS and allowed to grow for seven days. After seven days, growth parameters such as shoot length, root length, fresh weight and dry weight were measured.

Treatment of *Z. mays* (Maize) seeds with liquid extract of WPH

Seeds of *Z. mays* were soaked overnight and then placed on the glass petriplates containing wet cotton. After one day, seeds were treated with liquid extract of WPH and allowed to grow for seven days. After seven days, growth parameters such as shoot length, root length, fresh weight and dry weight were measured.

Antioxidant Activity: Little modifications were made to the procedure given by Blois (1958) for the DPPH radical scavenging test. Extracts of varying concentrations (300 µl) were added to a clean test tube followed by the addition of 2 ml of 0.1 mM methanolic DPPH solution. The solution was mixed by shaking and incubated in dark place for next 30 minutes for the completion of

scavenging reaction. The final absorbance was read at 517 nm. Rutin was used as a standard antioxidant.

DPPH radical scavenging potential of extracts was calculated using formula:

DPPH radical scavenging activity (%) = $Z_0 - Z_1/Z_0 \times 100$

where,

Z_0 *is the absorbance of control solution*

Z_1 *is the absorbance of reaction mixture containing test sample*

Anticancer Activity: Cytotoxic activity of both extracts was assessed against Human lung cancer (A549) cells. Cell line was purchased from the National Centre for Cell Science (NCCS), Pune, India. In DMEM media containing 10% foetal bovine serum and an antibiotic/antimycotic solution, A549 lung cancer cells were grown and cultured. Trypan blue dye was added to the cells to check their viability. Only the cells that were still unstained by the dye were considered to be viable. For cytotoxicity investigations, the cell population with viability of more than 95% was employed.

MTT assay: The cytotoxic potential of extracts of selected plants was assessed using MTT assay (Mosmann 1983) with slight modifications. For the experiment, cells were seeded into 96 well plate at the density of 8000 cells per well and allowed to adhere. After complete adherence of cells, cells were treated with various concentrations of extracts for next 24 h. After treatment, cells were treated with MTT for next 3 hrs. After that media was carefully removed from wells of 96 well plates and 100 µl DMSO was added to each well to dissolve formazan crystals. The final absorbance of solution was taken at 570 nm using ELISA plate reader (Synergy HT BIOTEK).

Cytotoxicity of extracts was calculated using formula:

Cytotoxic activity (%) = $Z_0 - Z_1/Z_0 \times 100$

where,

Z_0 *is the absorbance of control cells*

Z_1 *is the absorbance of cells treated with extracts*

Statistical Analysis: The results were showed as average ± standard error. Regression analysis was done using best fit method. GI_{50}/IC_{50} values (50% inhibitory concentrations) were calculated with help of regression equations. One-Way ANOVA analysis was also done followed by determination of honestly significant difference (HSD) among means using Tukey's test. The significance of results was checked at $p \leq 0.05$ or 0.001.

Results and Discussion: Qualitative phytochemical analysis showed presence of phenolics in WCS and WPH extract while flavonoids were detected in WCS only. In the current study, both extracts *viz*. WCS and WPH were evaluated for their phytotoxic effect on the *V. radiata* (Mung bean) and *Z. mays* (Maize) seedlings growth respectively. The seeds of *V. radiata* (Mung bean) and *Z. mays* (Maize) showed 100% seed viability in Tetrazolium seed viability test. WCS extract significantly inhibited the growth of shoot and root length of 7- days old Mung seedlings. Extract showed shoot length of 2.66±0.088 cm at highest tested concentration of 10% (Figure 1**)**. Control showed shoot length of 16.2±1.665 cm. WCS also inhibited the root length (0.83±0.233) at highest tested concentration

as compared to the control seedlings (3.46±0.481 cm). WPH extract significantly reduced the growth of shoot and root length of 7- days old maize seedlings. The shoot length was found to be 5.50±1.041 cm at 5% concentration as compared to the control (13.23±1.468 cm) (Figure 2). Extract also significantly decreased the root growth (8.1±1.973 cm) as compared to the control (2.83±0.667 cm). The treatment with extracts *viz.* WCS and WPH significantly reduced the parameters such as fresh and dry weight (Figure 3 & 4). As the concentrations of WCS extract increased, there was significant reduction in the fresh weight of Mung seedlings from 0.407±0.052 g (control) to 0.057±.003 g at highest tested dose. There was reduction of 0.027±0.003 g (highest tested concentration of 10 %) from 0.057±0.003 g (control) in dry weight (Figure 3 & 4). On the other hand, WPH reduced the fresh weight of maize seedlings from 0.417±0.011 g (control) to 0.248±0.020 g (highest tested concentration of 5%). Seedlings also showed dry weight of 0.150±0.025 g at highest tested concentration of 5% as compared to control (0.020±0.012 g) (Figure 3 & 4). Similar results were found in the studies of Khan et al. (2021), they reported phytotoxic effects of medicinal plant, *Justicia adhatoda* L. on germination and growth of cauliflower, broccoli, tomato, foxtail millet and barnyard grass under laboratory and in pot conditions. Results revealed that high extract concentrations decreased germination and growth (shoot length, root length, and biomass weight) of seedlings as compared to control. Effects of aqueous extracts of Eucalyptus (*Eucalyptus camaldulensis*) and sugar beet (*Beta vulgaris*) on the germination and growth of purslane (*Portulaca oleracea*) was studied by Dadkhah et al. (2013). The results demonstrated that the concentration of water extract from the examined plants did not affect the germination percentage of purslane seeds. However, aqueous extracts of the investigated plants profoundly impacted seed vigour index and seedling growth.

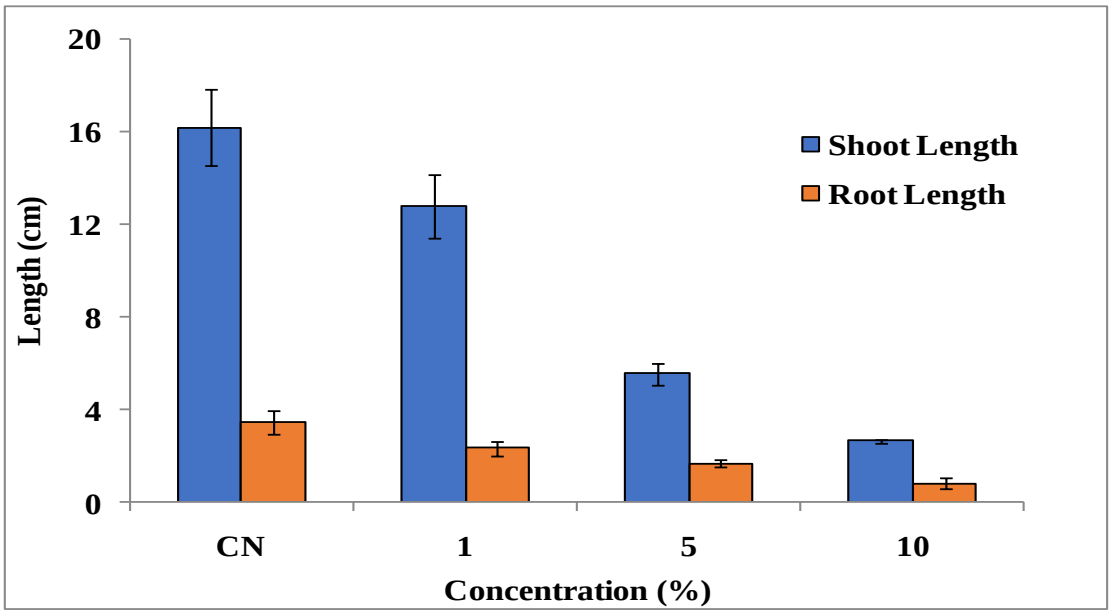


Figure 1: Effect of WCS extract on the shoot and root length of *V. radiata* (Mung bean)

[One way Anova analysis: F-ratio (3, 8): 32.105*; HSD: 5.00 (shoot length); F-ratio (3, 8): 11.79*;HSD: 1.46(root length) (*p≤0.05)]

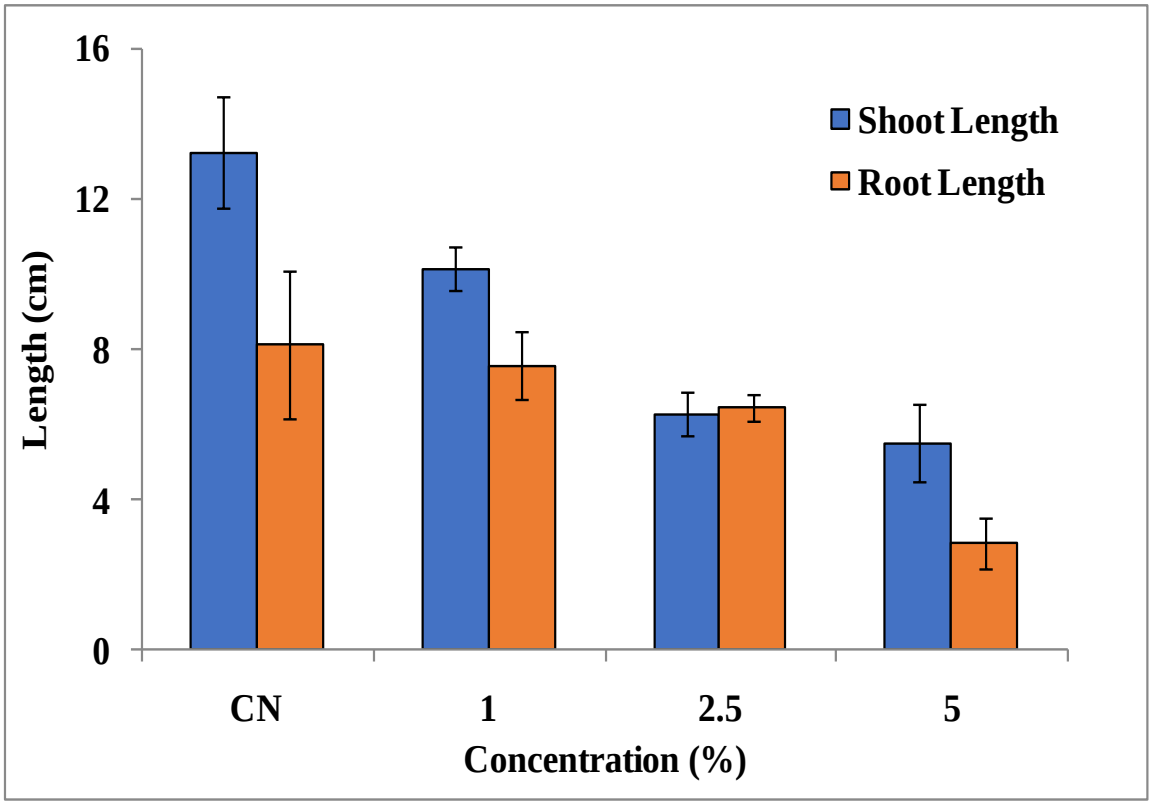


Figure 2: Effect of WPH extract on the shoot and root length of *Z. mays* (Maize)
[One-way Anova analysis: F-ratio (3, 8): 13.15*; HSD: 4.48 (shoot length); F-ratio (3, 8): 4.23*; HSD: 5.21 (root length) (*p≤0.05)]

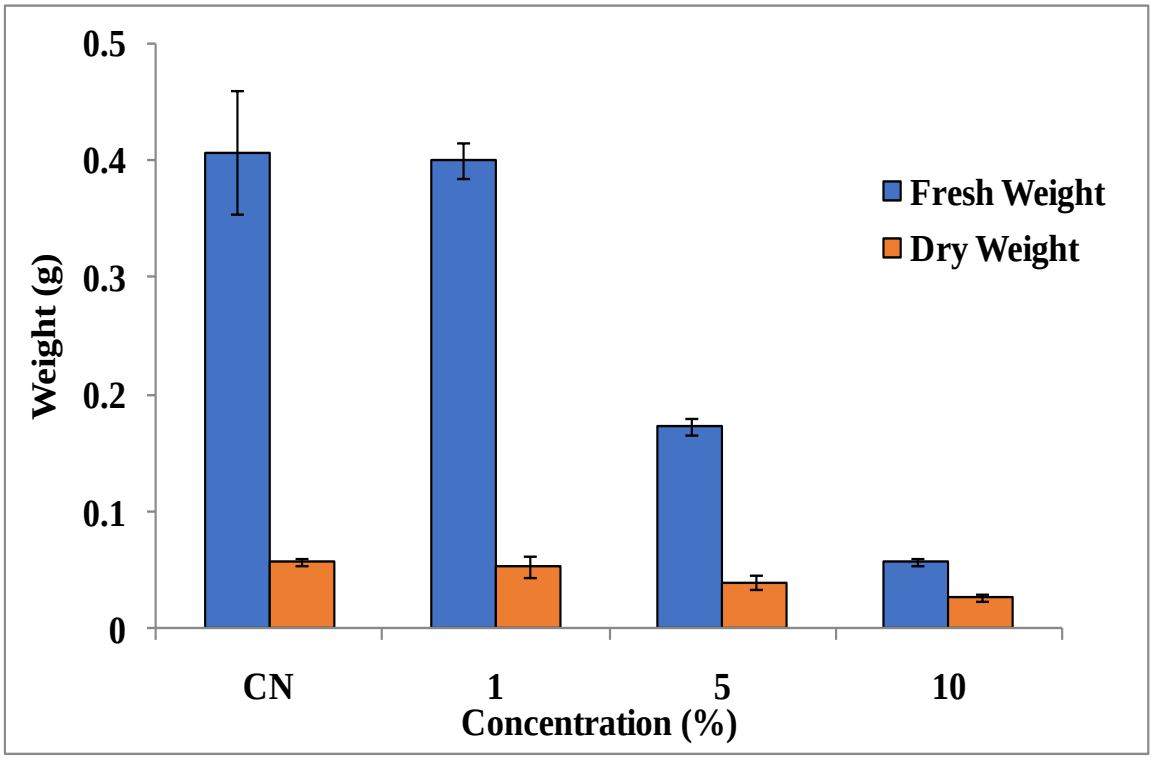


Figure 3: Effect of WCS extract on the fresh and dry weight of *V. radiata* (Mung bean)
[One-way Anova analysis: F-ratio (3, 8): 22.63*; HSD: 0.16 (fresh weight); F-ratio (3, 8): 5.61*; HSD: 0.02 (Dry weight) (*p≤0.05)]

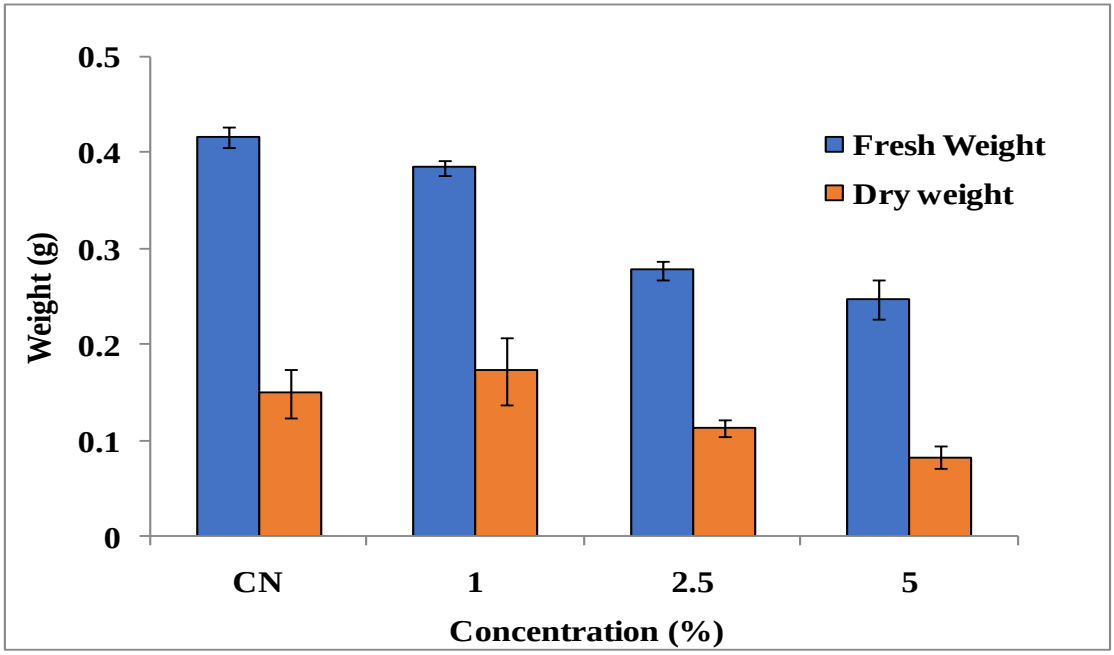


Figure 4: Effect of WPH extract on the fresh and dry weight of *Z. mays* (Maize)
[One-way Anova analysis: F-ratio (3, 8): 37.55*; HSD: 0.06 (fresh weight); F-ratio (3, 8): 3.00; HSD: 0.10 (Dry weight) (*p≤0.05)]

Ramalakshmi et al. (2015) investigated the phytotoxicity of several organic extracts from the leaves of the medicinal plant *Tabebuia rosea* (TR) on radish seeds. At 10,000 ppm, all TR extracts dramatically reduced root growth. However, the petroleum ether and ethanol fractions had greater germination rates for radish seeds.

Antioxidant studies: WCS extract significantly scavenged the DPPH free radicals in the DPPH assay. As evident from the results, the extract showed inhibition of 76.72 % at highest tested dose of 1000 µg/ml. The lowest tested concentration *i.e* 50 µg/ml exhibited inhibition of 11.98%. The IC_{50} was found to be 348.21 µg/ml. Results were compared with standard antioxidant rutin (IC_{50} 43.39 µg/ml) (Figure 5). WPH extract demonstrated inhibition of 64.60 % at highest tested concentration of 1000 µg/ml. The lowest tested concentration *i.e* 50 µg/ml showed inhibition of 4.54 %. The IC_{50} was found to be 610.50 µg/ml (Figure 6). Antioxidant efficacy of extracts is may be due to the presence of various phenolic compounds as detected in phytochemical analysis. Results were compared with standard antioxidant rutin (IC_{50} 43.39 µg/ml). Similar results were reported by various workers on different medicinal plants, Kumar et al. (2011) reported the antioxidant activity of chloroform and ethyl acetate fractions of *Koelreuteria paniculata* using DPPH assay along with other experiments. Results demonstrated that extract possessed high antioxidant efficacy as compared to control. Authors correlated the activities with phenolic and flavonoid compounds in the extracts. In another study, Tailor et al. (2014) reported DPPH (1, 1diphenyl-2-picryl hydrazyl) radical scavenging activity of different extracts of aerial parts like leaves and flowers of *Ageratum conyzoides* Linn. Plant extracts showed high antioxidant activity with an IC_{50} value of 9.3 and 24.8 µg/ml for ascorbic acid and alcoholic leaves extract respectively. High

antioxidant potency of extracts could be because of its phenolic and flavonoid contents.

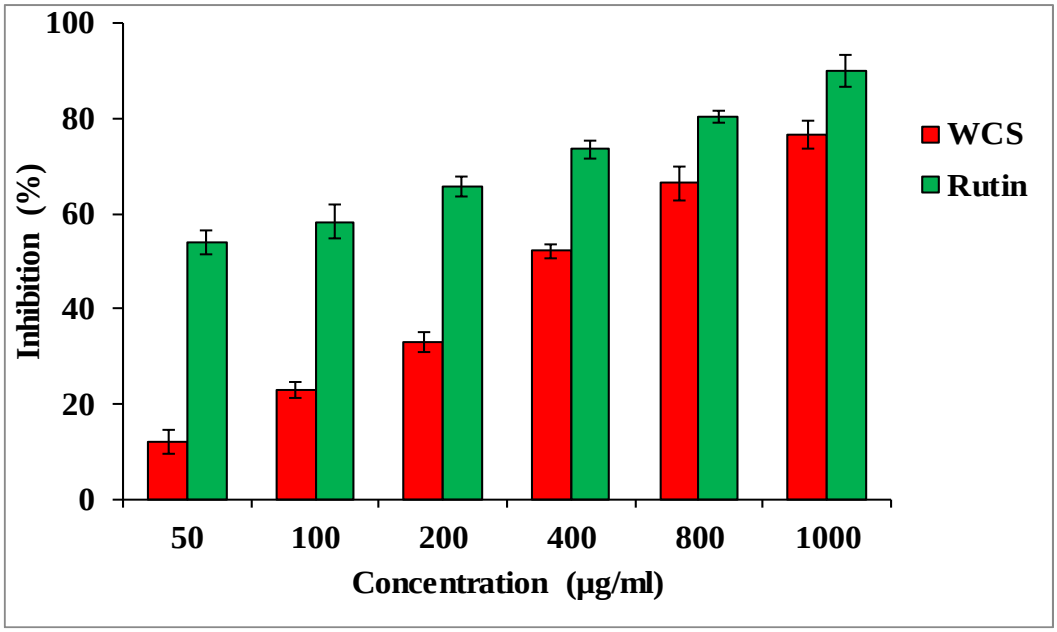


Figure 5: Antioxidant activity of WCS and standard rutin in DPPH radical scavenging assay
[One-way Anova analysis: F-ratio (5, 12): 98.77; HSD: 12.13 (*p≤0.001)]

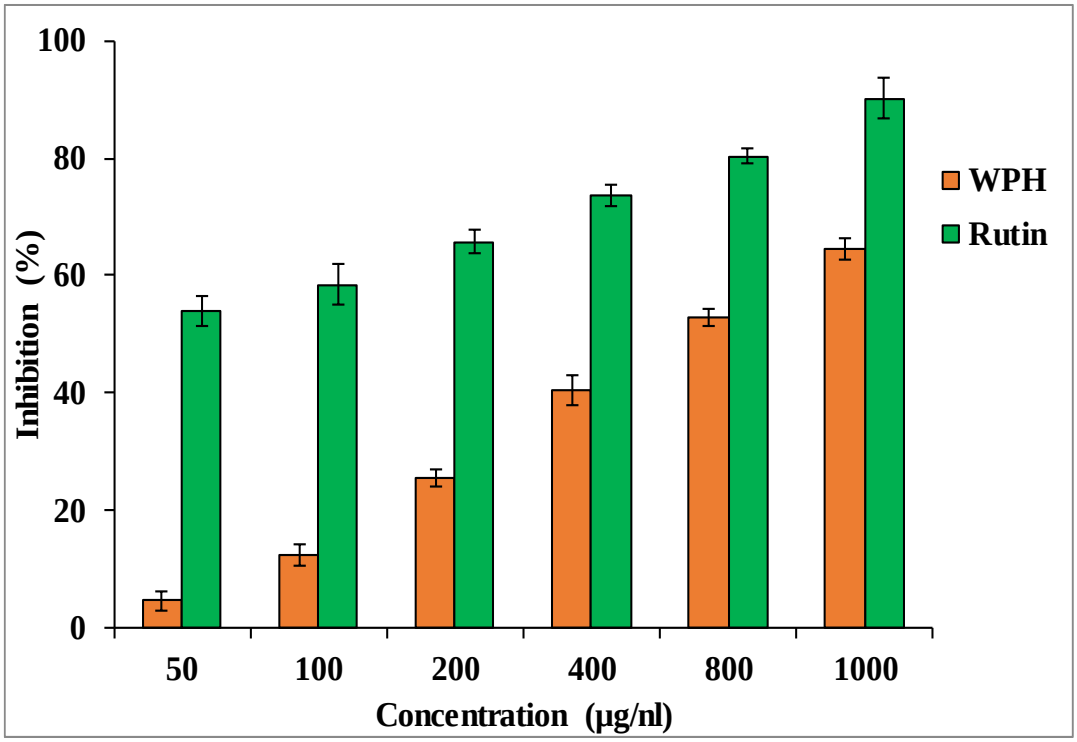


Figure 6: Antioxidant activity of WPH and standard rutin in DPPH radical scavenging assay
[One-way Anova analysis: F-ratio (5, 12): 163.67; HSD: 8.69 (*p≤0.001)]

Anticancer studies: The anticancer effects of both extracts *viz.* WCS and WPH were evaluated against human non small cell lung carcinoma (NSCLC) A549 in MTT assay. Results showed cytotoxicity of 16.84 % and 10.88 % for WCS and

WPH extracts respectively at lowest tested concentration of 50 µg/ml. The highest tested concentration of 1000 µg/ml showed cytotoxicity of 92.67 and 88.60 % respectively (Figure 7). The GI_{50} for WCS and WPH was found to be 47.75 µg/ml and 53.78 µg/ml respectively. Extracts activity was due to presence of phytoconstituents as detected in phytochemical analysis. Similar results were reported by various workers. The cytotoxic activity of *Tecoma stans* extracts was compared with that of the drug vincristine against a lung cancer cell line (Robinson et al. 2017). Results indicated that there was a significant increase in cell death with an increase in extract concentration. The SRB test was used to assess the anticancer activity of leaf extracts from 10 *Ipomoe*a species on the A549 cell line and the HepG2 cells (Rane and Patel 2015). The crude aqueous extracts *Ipomoea* species showed significant antiproliferative activity against HEPG2 and A549 cells. For the HEPG2 cell line, *I. cairica* was the most effective growth inhibitor (GI_{50} at 30.6 µg/ml), followed by *I. hederifolia* (GI_{50} at 38.1 µg/ml) and *I. carnea* (GI_{50} at 40.0 µg/ml). Out of different species, only *I. aquatic* showed significant results with a GI_{50} at 75.6 µg/ml against A549 cell line.

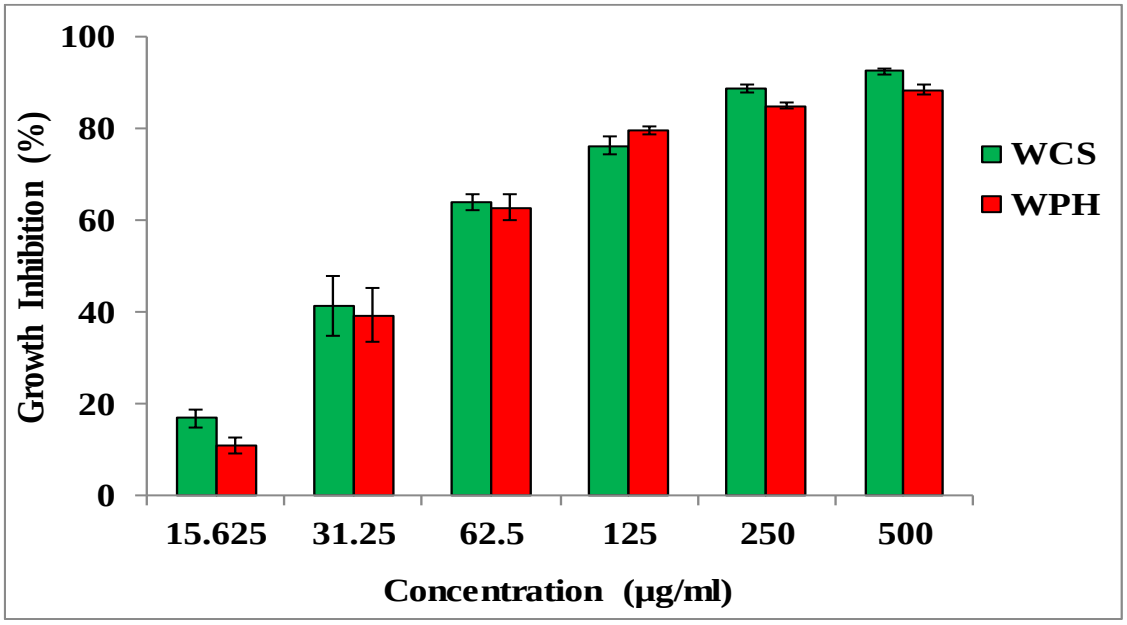


Figure 7: Growth inhibitory effects of various concentrations of WCS and WPH on A549 Lung cancer cells in MTT Assay
[One-way Anova analysis: F-ratio (5, 12): 91.41; HSD:14.61 (WCS); F-ratio (5,12): 113.90; HSD:13.60 (WPH) (*p≤0.001)]

Conclusion: Results of the present study demonstrated that extracts of both plants *viz*. *C. sativa* and *P. hysterophorus* possess phytotoxic, antioxidant and antiproliferative activity. Further studies are needed to isolate and identify various phytochemicals and their mode of action.

Conflict of authors: The authors have no conflicts of interest regarding this investigation

Acknowledgements: This work was carried out under DBT Star College Scheme (Strengthening Component), Department of Biotechnology (DBT), Government of India. Financial support provided by Department of

Biotechnology; Government of India is duly acknowledged. Authors are also thankful to the worthy Management and Dr. Rama Sharma (Principal), S.D. College Barnala, Punjab (India) for providing necessary facilities to carry out this work. Authors are also thankful to the Department of Botanical and Environmental Sciences, Guru Nanak Dev University, Amritsar-143005, Punjab, India for testing samples for anticancer activity.

References

Akerele O. (1993). Nature's medicinal bounty: don't throw it away. World Health Forum. 14(4):390-395.

Aye MM, Aung HT, Sein MM, Armijos C. (2019). A Review on the Phytochemistry, Medicinal Properties and Pharmacological Activities of 15 Selected Myanmar Medicinal Plants. Molecules. 24(2):293

Bauer A, Brönstrup, M. (2014). Industrial natural product chemistry for drug discovery and development. Natural Product Reports. 31 (1), 35–60.

Blois MS. (1958). Antioxidant determinations by the use of a stable free radical. Nature.;29:1199-1200.

Dadkhah A. (2013). Phytotoxic potential of sugar beet (Beta vulgaris) and eucalyptus (*Eucalyptus camaldulensis*) to control purslane (*Portulaca oleracea*) weed, Acta Agriculturae Scandinavica, Section B — Soil. Plant Science. 63: 46-51,

El-Seedi HR, Burman R, Mansour A, Turki Z, Boulos L, Gullbo J. (2013). The traditional medical uses and cytotoxic activities of sixty-one Egyptian plants: discovery of an active cardiac glycoside from *Urginea maritima*. Journal of Ethnopharmacology. 145:746–57.

Hamilton AC. (2004). Medicinal plants, conservation and livelihoods. Biodivers Conserv. 13:1477–517.

Harborne JB. (1998). Phytochemical Methods: A guide to modern techniques of plant analysis. Edition: 3, Springer. Germany

Khan MSI, Kaium MA, Sarkar BK, Begum R, Begum N, Islam MA, Chowdhury MTI, Habib M, Hakim MA. (2021). Potencies of *Justicia adhatoda* L. for its possible phytotoxic activity. Plant Science Today. 8(2):289-292.

Kumar M, Kumar S, Kaur SJ. (2011). Investigations on DNA protective and antioxidant potential of chloroform and ethyl acetate fractions *of Koelreuteria paniculata* Laxm. African Journal of Pharmacy and Pharmacology. 5(3): 421-427.

Maroyi A. (2017). Diversity of use and local knowledge of wild and cultivated plants in the Eastern Cape province. South African Journal of Ethnobiology and Ethnomedicine.13:43.

Mosmann T. (1983). Rapid colorimetric assay for cellular growth and survival: application to proliferation and cytotoxicity assays. Journal of Immunological Methods. 65(1-2):55-63.

Mouele, UGM, Nkoulembene CA, Kokolo B, Sevidzem SL, Ibrahim. (2022). Ethnobotanical and ethno-pharmacological approach to ichthyotoxic plants of Gabon. Journal of Medicinal Plants Research, 16(5): 154-164.

Negi JS, Singh P, Rawat B. (2011). Chemical constituents and biological importance of swertia: A review. Current Research in Chemistry. 3: 1-15.

Ouelbani R, Bensari S, Mouas TN, Khelifi D. (2016). Ethnobotanical investigations on plants used in folk medicine in the regions of Constantine and Mila (north-east of Algeria). Journal of Ethnopharmacology. 194:196–218.

Pesic M. (2015). Development of natural product drugs in a sustainable manner. Brief for United Nations Global Sustainable Development Report.

Ramalakshmi S, Muthuchelian K. (2015). Phytotoxicity studies on leaf fractions of *Tabebuia rosea* (Bertol.) DC. Indian Journal of Science, 15(48), 189-201

Rane VA, Patel BB. (2015). In-vitro cytotoxic activity of leaf extracts of *Ipomoea* Jacq. species against A549 and HEP-G2 cell Lines. International Journal of Pharmaceutical Sciences and Research. 6(1): 294-99.

Robinson JP, Suriya K, Subbaiya R, Ponmurugan P. (2017). Antioxidant and cytotoxic activity of *Tecoma stans* against lung cancer cell line (A549). Brazilian Journal of Pharmaceutical Sciences. 53 (03): e00204

Singh MK, Singh SK, Singh AV, Verma H, Singh PP, Kumar A. (2020). Phytochemicals: Intellectual property rights. In Bhanu Prakash's. Functional and Preservative Properties of Phytochemicals, Academic Press, pp.363-375

Sofowora A, Ogunbodede E, Onayade A. (2013). The role and place of medicinal plants in the strategies for disease prevention. African Journal of Traditional, Complementary, and Alternative Medicines. 10(5):210-29.

Tailor CS, Goyal A. (2014). Antioxidant Activity by DPPH Radical Scavenging Method of *Ageratum conyzoides* Linn. Leaves. American Journal of Ethnomedicine. 1(4): 244-249.

Wang M-Y, West BJ, Jensen CJ, Nowicki D, Su C, Palu AK. (2002). *Morinda citrifolia* (Noni): a literature review and recent advances in noni research. Acta Pharmaceutica Sinica B. 23:1127–141.

WHO. (2002). Traditional Medicine: Growing Needs and Potentials.

Chapter 6
Ethnomedicinal plants of Mandal Tehsil, Bhilwara, Rajasthan, India

Jyoti Singh

Abstract: The World Health Organization (WHO) has been promoting traditional medicines as a source of less expensive, comprehensive medical care especially in developing countries. Indigenous communities living in biodiversity rich areas possess a wealth of knowledge on the utilization and consideration of various types of plants. This traditional knowledge developed over years of observation, trial and error, inference and inheritance has largely remained with the indigenous people. The Aravalli hills of Rajasthan harbour vast diversity of vegetation. These vegetation rich areas are inhabited by the major tribes of the state viz. Bhils, Garasias, Damors and Kathodias. A survey work is carried out during 2016-2019 in Mandal Tehsil of Bhilwara district, Rajasthan, India. Results revealed that about 91 common plants are used by the local communities to cure many diseases and disorders. The chapter highlights the importance of ethnomedicinal plants.

Keywords: Traditional medicines, indigenous communities, Aravalli hills, tribes, Mandal

---

J Singh (✉), ORCID: https://orcid.org/ 0000-0003-0755-8341
Department of Botany, SPC Government College, Ajmer, Rajasthan, India
e-mail: jyotisingh1972@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7137125

Introduction: The Indian subcontinent, with the history of one of the oldest civilizations, harbours many traditional health care systems. One of the ancient classics, "*Charak Samhita*" is the oldest text available on the complete treatment of diseases which specifies the use of hundreds of herbs in the complete treatment of diseases. The Ayurveda, is one of the ancient health care systems, which is a potential source of indigenous drugs. Herbs are staging a comeback and herbal renaissance is happening all over the globe. The herbal products today symbolise safety in contrast to the synthetics that are regarded as unsafe to human and environment. Medicinal plants need more attention due to their important role in primary healthcare delivery

system for improvement of people health. It is an essential component of human healthcare especially for the rural communities who solely rely on forest plants for food, shelter, energy and medicine. The Flora of Rajasthan has been attended by several workers. Bhandari (1978) and Sharma and Tiagi (1979) have worked out the flora of Western and North Eastern part of Rajasthan respectively. Shetty and Singh (1987-1993) edited the three volumes of flora of Rajasthan. Sharma (2002) presented the flora of Rajasthan which covers mainly the Eastern part of the state. Tiagi and Aery (2007) published the flora of Rajasthan (South and South East region). Flora of Banswara is prepared by Singh (1983) and flora of Tonk district is by Shetty and Pandey (1983). Yadav and Meena (2011) pioneered the work in South Central Rajasthan. The ethnobotanical works in organized way were started by Botanical Survey of India in 1960 in the country. Since then, the uses of plants by tribals are being recorded for variety of purposes (Jain 1981a, 1981b, 1991, 1991a, 1995). Joshi (1995) made a floristic survey of ethnomedicinal plants in Southern Rajasthan and reported various aspects of medicinal plants useful for man and animals. Meena (2011) provided ethnobotanical knowledge in particular of Garasia tribes of Sirohi district of Rajasthan. India is one of the 17 Mega biodiversity centres of the world, in which Rajasthan is the largest state of India, having an area of 3,42,239 sq. km. forming Eastern extremity of great arid and semiarid belt of the World. The study area of the present work is Mandal tehsil of district Bhilwara. It lies between 25º10' to 25º43' N latitudes and 74º10' to 74º60' E longitudes. The tehsil spreads in the Western part of the district. It is the biggest tehsil of Bhilwara district. In Mandal tehsil, Bhil and Meena are the main tribes. These tribes are the custodians of local indigenous knowledge. The surrounding plants for these people form an integral part of their culture and the information about plants get passed on from generation to generation only through oral folklore, although many times kept secret. Deforestation, semi-modernization, transmigration, colonization, industrialization and other developmental activities have threatened not only the biological resources but also the traditional culture and ethnobotanical knowledge. Therefore, an urgent need is felt to undertake ethnobotanical studies before extinction of the traditional knowledge through aggressive modern civilization.

Materials and Methods: Before embarking on trips the localities were carefully selected on the basis of the available information of the area to be visited and the people to be studied, taking aid of maps, divisional forest working plans, floras, icons, literature on the tribes and obviously, discussions with relevant person. Before the ethnobotanical survey, it is essential to establish the rapport with one or two persons preferably the chief, guidance sought and contact was then established with other tribals of the locality. The linguistic fluency, personality and social standing are crucial in establishment of rapport between the participants involved. On reaching camp, rapport was established with the village headmen through whom using different

ways, which altered with situations and places, the men folk, womenfolk, young children and the medicine men were contacted and befriended. Prejudices against outsiders resulting from harassment and exploitation at the hands of non tribals was a formidable barrier which had to be overcome. Almost everywhere for authenticity of utility of plants, the information collected during fieldwork was verified at different places by different informants and in different seasons. The collected herbs were identified up to species level. Herbarium sheets and photographs were prepared and deposited in the Herbarium, Department of Botany, MLV Government College, Bhilwara. The survey was carried out during 2016-2019.

Results and discussion: In the present study a brief account of ethnomedicinal uses of plant species that are used by tribals of Mandal tehsil is prepared after thorough field visits and interviews. Tribal communities have strong belief in their traditional healing practices. A large number of plants or plant parts are being used in the treatment of various diseases by them. This traditional knowledge is being transferred from generation to generation only through oral folklore Therefore, an attempt has been made to document various plants and plant parts used as medicine. The observations recorded 91 common ethnomedicinal plants which are presented in the Table 1.

Conclusion: The present study shows that indigenous knowledge of medicinal plants is very helpful in traditional treatments. The plant based traditional knowledge is the base for new sources of drugs. It manifests the importance of documentation of traditional ethnomedicinal knowledge before it is lost. The cultivation of ethnomedicinal plants should be promoted. They can be grown in botanical gardens, agroforestry systems and also in home gardens. There is also a need to involve tribal people and their indigenous practices for sustainable utilization of natural resources.

Table 1: Plants used in ethnomedicinal practises by the tribal communities of study areas

Name of Plant	L.N.	Family	Parts Used	Mode of uses
Abrus precatorius L.	Chirmi, Ratti	Fabaceae	Leaves, seeds	The fresh leaves are chewed in case of mouth ulcer. These are also chewed by the professional singer to keep their throat fit.
Abutilon indicum (L.) Sweet.	Dabi Dablya, Tara Kanchi	Malvaceae	Root, bark, leaves, seeds	The roots, leaves and bark are mucilaginous and are used to smoothen and to protect the mucous membrane

				of the respiratory and urinary system. A decoction of the root is given in bronchitis. The mucilaginous nature of these acts as a tonic for the skin.
Acacia catechu (L.f.) Willd.	Khair, kattha	Fabaceae	Gum Kattha	The gum is used in the form of laddu especially by tribal males (because they are prohibited to use gum of *Anogeissus latifolia*) during winter season for 15 days to treat weakness.
Acacia nilotica (L.) Willd. ex Del	Boriyo	Fabaceae	Bark, leaves	The bark paste is applied for healing wounds. The paste of leaf is applied on cuts and wounds. Fruits are given to cattle to cure weakness and to increase lactation in female.
Acanthospermum hispidum DC.	Dokanta	Asteraceae	Leaves	The fresh leaves are given to goat to increase milk production.
Achyranthes aspera L.	Andhijara	Amaranthaceae	Ripe seeds	Ripe seeds are collected and mixed with latex of *Calotropis procera* and mixture is put in an earthen pot to dry. After drying, the seeds are removed from the dried latex of *C. procera* and powdered. The powder is taken with betel leaves to cure cough.
Adhatoda zeylanica Medic.	Aduso	Acanthaceae	Leaves	The leaves extract is used in case of cough, bronchitis and asthma.
Aegle marmelos (L.) Corr.	Bel	Rutaceae	Fruit	The pulp of ripe fruit is taken in constipation. The unripe fruit is taken in case of chronic diarrhoea and dysentery.
Aerva persica (Burm. f.)	Bui	Amaranthaceae	Flowers and leaves	The decoction of flowers and leaves is given to animals in digestive disorders and to promote urination.

Ailanthus excelsa Roxb.	Ardu, Aduso	Simaroubaceae	Bark	1 tsp bark powder is taken daily in abdominal pain.
Annona squamosa L.	Sitaphal	Annonaceae	Leaves, stem bark	(i) Decoction of the leaves is used as a remedy for cold and urinary problems. (ii) Bark decoction is used in diarrhoea.
Arachis hypogaea L.	Mumfali	Papaveraceae	Fruit coat and seed husk	The fruit coat and seed husk that remains after extraction of oil from seeds are given to cattle for recovery after delivery and improving milk production.
Argemone mexicana L.	Pili Kanteli	Papaveraceae	Yellow latex and seed	The yellow latex and powder of seed is mixed and applied externally on the affected area of skin to cure eczema.
Asparagus racemosus Willd.	Satavari	Liliaceae	Tuberous root	1 tsp fresh juice from tuberous roots is dried and cooked with butter, it is given orally to increase lactation after delivery. Medicated oil prepared using tuberous root is beneficial for nervous and rheumatic complaints.
Bacopa monnieri L. Pennel	Brahmi	Scrophuariaceae	Whole plant	Decoction of whole plant is used as brain tonic.
Balanites aegyptiaca (L.) Delile. (Plate 1)	Hing- oriya	Balanitaceae	Fruits	About 150 g. of dried fruits of *Balanites aegyptiaca*, 100 g. stem bark of *Corallocarpus epigaeus* are ground with water to make a paste which is applied locally twice a day for 4-5 days to cure skin eruption.
Barleria prionitis L. (Plate 1)	Danteli, kala Bans	Acanthaceae	Root, leaves	1 tsp decoction of leaves juice is given twice a day for the treatment of cough. The leaves are chewed to relieve body ache and toothache.
Blepharis maderaspatensis	Kanti	Acanthaceae	Leaves	Handful of leaves, mixed with onion bulb, made into a paste and

(L.) Heyne ex Roth.				applied externally on cuts and wounds.
Boerhavia diffusa L.	Punarnava	Nyctaginaceae	Roots, leaves	Leaves: The paste of leaves is given 4-5 times daily orally. Root: 1 tsp powder of roots is taken 2 times a day for jaundice and liver disorders.
Bombax ceiba L.	Hemro	Bombacaceae	Roots	The young roots are dried in shade and cooked as vegetable. The vegetable increases the number of sperms in semen.
Boswellia serrata Roxb. ex. Colebr.	Saler	Burseraceae	Gum	Bark decoction is given to treat arthritis and indigestion.
Butea monosperma (Lam.) Taub.	Khankra, Sura	Fabaceae	Gum, flower, Seed	The gum is known as Kamarkas, it is used in in the form of laddu. It is an essential tonic after delivery. The flower keeps waist in shape, juice is given to children in fever and cold. Dried seeds are crushed on stones and given to newly born child as cure of diarrhoea.
Calotropis procera (Ait.) Ait. f. subsp. *hamiltonii* (Weights) Ali	Akra, Madar	Asclepiadaceae	Stem, root, leaves	The dried stem of *Calotropis procera* is used as a pipe and the smoke of *Xanthium* achenes inhaled through this pipe to relieve headache. The leaf is curled to make pipe for smoking purposes. Smoke of stem is produced to cure Khurpaka disease.
Capparis decidua (Forsk.) Edgew.	Kair	Capparidaceae	Flower bud root, stem	1-2 tsp powdered coal of stem with 1 cup of water is taken for the treatment of bone fracture.
Cassia fistula L.	Amaltas	Caesalpiniaceae	Fruit pulp	The mature fruit pulp is dissolved with 1/4 glass of water and is taken by children as well as adult to cure constipation.

Celosia argentea L.	Surli	Amaranathaceae	Root	100 g of root mixed with 4 garlic pieces and few pepper seeds, ground into a fine paste and taken orally to treat fits.
Chenopodium murale L.	Badi chil	Chenopodiaceae	Leaves	At morning 1-2 tsp of fresh leaf paste taken with jaggery (Gur) and dissolved in 1 glass of cow milk. It is taken on an empty stomach for 3 days to remove piles.
Citrullus colocynthis (L.) Schrad.	Tumba	Cucurbitaceae	Fruit	Decoction of fruits and roots is given to treat constipation, digestive disorders and flatulence.
Cleome viscosa L.	Bagro, Pili hulhul	Cleomaceae	Whole plant	The paste of whole plant is applied externally for healing ulcer and wounds.
Commelina benghalensis L.	Bokano	Commelinaceae	Leaves	The leaves of *Commelina benghalensis* and *Jasminum angustifolium* are crushed to make juice. 1 glass of juice is taken for 3 days to treat animal bite.
Commiphora wightii (Arn.) Bhandari	Gugal	Burseraceae	Gum resin	Decoction of plant or gum resin in warm water is used for gargling against pyorrhea and spongy gums. Gugal is also used in Dhoop and to cure bronchitis, nasal catarrh and laryngitis.
Cordia dichotoma Forst. f.	Gonda	Ehretiaceae	Fruit	The mature fruits are used in indigestion, constipation and gastric troubles.
Croton bonplan-dianum Baill	Kala- Bhangra	Euphorbiaceae	Latex	Latex is applied externally on wounds.
Crotalaria burhia Buch. - Ham.	Sinio	Fabaceae	Roots	Roots are boiled, filtered and given to cattle orally to expel retained placenta.
Dalbergia sissoo Roxb.	Shisham	Fabaceae	Stem	A cavity of about 1 glass volume capacity is made in dried stem which is filled with water for overnight, after this water is taken

				in morning to cure diabetes.
Dendrophthoe falcata (L. f.) Etting	Dudhi	Loranthaceae	Leaves	Leaves along with stem strips of *Bambusa* sp. are tide on fractured bones.
Dichrostachys cinerea (L.) Wight & Arn.	Goya- Khair kolai	Fabaceae	Root	Root bark extract is mixed with extract of stem bark of *Butea monosperma* and *Ziziphus mauritiana* equally and 1/4 cup juice + 3/4 cup of water is used, only one dose is sufficient for diarrhoea.
Echinops echinatus Roxb.	Oont kantilo	Asteraceae	Roots	Pieces of 2-inch size of fresh root kept at the back of head touching scalpel or coiled fresh root kept in the naval before parturition time or during delivery pain for easy delivery in human beings.
Elytraria acaulis (L.f.) Lindau.	Rukhri	Acanthaceae	Gum	The fried gum, mixed with wheat flour and sugar to prepare ladoos, used after delivery for early healing of damaged tissues and as tonic.
Enicostema hyssopifolium (Lam.) Roynal	Nami, nava	Gentianaceae	Whole plant	1/4th cup extract of whole plant is taken once a day for 3 days for fever. 1 tsp plant juice is taken for seven days, it relieves body pain.
Euphorbia caducifolia Haines	Danda thore	Euphorbiaceae	Stem	The dried stem is burnt to produce smoke. The affected painful part of the body is exposed to smoke, it relieves pain.
Euphorbia hirta L.	Dudhi	Euphorbiaceae	Whole plant	Decoction of whole plants is taken to cure cough.
Evolvulus alsinoides (L.) L.	Phooli	Convolvulaceae	Whole plant	1-2 tsp fresh juice of leaves is taken orally for fever.
Ficus benghalensis L.	Bar, Bargad	Moraceae	Latex	Patashas are filled with latex and 1 patasha is given daily for seven days to treat weakness in children.
Ficus racemosa L.	Gular	Moraceae	Bark	Bark paste is mixed with stem sap of banana plant; filtered and given

				to the animal orally to cure diarrhoea during rainy season.
Helicteres isora L.	Anteri, Maror phali	Sterculiaceae	Fruit	2 tsp powder of fruit is taken with water twice a day, for 3 days.
Holoptelea integrifolia (Roxb.) Planch.	Sil, Kanjeri	Ulmaceae	Seed	Fresh leaf paste applied to cure ringworm.
Hygrophila auriculata (Schumach.) Heine.	Kantela	Acanthaceae	Leaves	Handful of leaves mixed with seeds of *Cuminum cyminum* L. and made in the form of juice. 1 glass juice is taken for 3 days to relieve cough.
Indigofera linnaei Ali.	Bakario	Fabaceae	Roots	The root is dug out to make a paste, 1 tsp paste + 1 glass of water is given to children 1-2 times a day to treat diarrhoea.
Jatropha curcas L.	Ratan Jot	Euphorbiaceae	Root	Latex is used in the treatment of itching of genital organs.
Launaea procumbens (Roxb.) Ramayya & Rajagopal	Kankargobi	Asteraceae	Leaves	The latex of fresh leaves is applied locally to cure piles.
Lepidagathis trinervis Wall. ex Nees	Pathar- phor	Acanthaceae	Leaves	The paste of leaves is applied on cuts and wounds as antiseptic.
Leucas aspera (Willd.) Link	Gotta	Lamiaceae	Whole plant	5 ml of flower extract is taken for curing fever and headache. Whole plant pastes mixed with little lime juice and water; mixture applied locally twice a day till recovery for piles.
Lycium barbarum L.	Morali, Jari	Solanaceae	Stem bark, leaves	Powder of leaves is mixed with butter and applied on abscesses. Powder of stem bark is introduced into nostrils to cure bronchitis in cattle.
Madhuca indica J.F. Gmelin	Mori	Sapotaceae	Leaf, Corolla, Seed	A cup of *Mohri* (local liquor known as Mohri) mixed with small quantity of *Curcuma* powder is taken at night. It is useful in cold, cough and

				bronchitis. Flowers are eaten by tribal women to increase lactation. Leaves are applied as a poultice to eczema and bandage on the swelling or affected muscles. The leaf ash is mixed with butter to make a dressing for wounds and burns. The oil extract from seeds is laxative and is taken to relieve constipation, to loosen the stool in haemorrhoid sufferers. Oil is applied to itchy skin.
Maytenus emarginata (Willd.) Ding Hou	Kankero	Celastraceae	Leaf, fruit	An ointment prepared by mixing of ash of burnt leaves and butter and applied on wounds.
Medicago sativa L.	Rizka	Fabaceae	Leaves	1/2 cup of fresh plant extract is taken as tea at night for 3 days for night blindness.
Melia azedarach L.	Bakain	Meliaceae	Leaves	Decoction of ½ kg fresh leaves is given to buffalo once a day for dewormification.
Momordica dioica Roxb. ex Willd.	Kinkora	Cucurbitaceae	Fruits	The fruits are used as chutney or vegetable to regularize menstrual disorders and in diabetic problems.
Mukia madera-spatana (L.) M. Roem	Phori- Kachri	Cucurbitaceae	Roots	The root is dug out and crushed on stones to make paste and ½ - 1 tsp paste is taken orally to cure dysentery.
Nicotiana tabacum L.	Tambakhu	Solanaceae	Leaf	The tambakhu is smoked with chilum keeping a wet cloth (saphie). The tobacco extract on the saphie is applied to eyes to relieve eye irritation.
Nyctanthes arbortristis L.	Harsingar	Oleaceae	Root	The root powder along with milk is taken in morning to cure leucorrhoea.
Pedalium murex L.	Bada- gokhru	Pedaliaceae	Fruits	(i) The powder of mature fruits is taken

				orally to cure diarrhoea and dysentery. (ii) Pills made by mixing the fruit powder with wheat flour and butter are taken thrice a day for 10 days to cure dropsy.
Pergularia daemia (Forsk.) Chiov.	Dudhi- Bel	Asclepiadaceae	Leaves	Handful of leaves mixed with salt and made into paste, taken orally to relieve stomach ache.
Peristrophe paniculata (Forsk.) Brum.	Bhamwara, Kaker	Acanthaceae	Leaves	1/4th cup of leaf paste is mixed with sugar and taken twice a day for 3 days to cure alternate day fever
Phoenix sylvestris (L.) Roxb.	Khajoor	Arecaceae	Leaves	The paste and juice of fresh leaves is used as first aid on cuts and wounds.
Plumbago zeylanica L.	Chitrak	Plumbaginaceae	Leaves, root	The paste of the leaves and root is applied to painful rheumatic areas or in chronic and itchy skin problems.
Pongamia pinnata (L.) Pierre	Kanjio	Fabaceae	Seed	The seeds are crushed and paste is applied to hair to kill lices.
Rhus mysorensis G. Don	Dansara	Anacardiaceae	Fruits	Fruits are eaten to increase lactation as well as to improve digestion.
Ricinus communis L.	Arandi	Euphorbiaceae	Leaves	In case of muscular injury without bleeding, the leaves of plant along with mustard oil are applied on the affected area. The leaf is applied to head to relieve headache. The leaf is boiled with maize grain and used as a rat killer.
Saccharum officinarum L.	Hanta, Ganna	Poaceae	Leaves	The leaves of *Saccharum officinarum* are given to cattle after delivery for removing the placenta.
Salvia aegyptiaca L.	Boti	Lamiaceae	Leaves	The dried leaves are smoked for asthmatic problems. The fresh leaves are rubbed on stings and

				bites as a first aid remedy.
Sorghum halepense (L.) *Pers.*	Baru	Poaceae	Inflorescence or caryopsis	The fresh or dried inflorescence or caryopsis is given to animal to cure diarrhoea.
Sonchus asper (L.) Hill	Kalijibi	Asteraceae	Latex	Latex is applied on cuts and gums.
Sphaeranthus indicus L.	Gorakhmundi	Asteraceae	Leaves	1 gm of leaves crushed and decoction is taken with 1 glass of water once for three days to retain pregnancy.
Sterculia urens (Roxb.)	Kadaya	Sterculiaceae	Leaves, rhizome	The "Ladoos" prepared from dried tuber powder are given to women after delivery as tonic.
Striga gesnerioides (Willd.) Vatke	Gwaria mendi	Scrophulariaceae	Whole plant	The paste is applied for healing wounds during rainy season. The whole plant is crushed and applied as well as whole plants are kept in shoes for early healing.
Tamarindus indica L.	Aamli	Caesalpiniaceae	Fruits	The immature fruits are eaten as vegetables to cure fever.
Tecomella undulata (Sm.) Seem.	Rohera	Bignoniaceae	Leaves	Herbal tea prepared from leaves is taken to cure stress.
Terminalia bellirica (Gaertn.) Roxb.	Bahera	Combretaceae	Fruits	The powder of seeds taken as health tonic.
Tinospora cordifolia (Willd.) Miers	Giloy, Neemgiloy	Menispermaceae	Stem	The stem juice is kept overnight and then used in fever, jaundice, diabetes and general disability.
Trianthema portulacastrum L.	Buti, Kola- Satta	Aizoaceae	Whole plant	½ cup decoction of whole plant is used once a day for seven days to cure jaundice.
Tribulus terrestris L.	Gokhru Ki Kanti	Zygophyllaceae	Fruit powder, plant extract	1tsp fruit powder is used 3 times daily for cough, asthma and backache, fruit powder and root extract is taken orally to cure stones. Plant extract is applied on wounds.
Tridex procumbens L.	Tal muriyo	Asteraceae	Leaves	Fresh leaves juice is applied on cuts and wounds.

Typha angustata Bory & Chaub.	Pater	Typhaceae	Inflorescence	The inflorescence is tied as dressing over wound for healing.
Urginea indica (Roxb.) Kunth.	Mar Kando	Asparagaceae	Bulb, Leaves	(i) Dried powdered bulbs yield "Indian Squill" used as an expectorant, stimulant and cardiotonic in small doses. (ii) Poultice of bulb is used to reduce the pain and swelling of gout/ rheumatism. (iii) Paste of leaves is externally applied on cracked skin. (iv) The bulbs are used as a remedy for bronchial troubles.
Vitex negundo L.	Nirgundi	Verbenaceae		(i) Decoction of leaves used to relieve body pain. (ii) Dried leaves taken as a tonic and vermifuge, also smoked for relief of headache. (iii) Leaf Juice is used to clean infected ulcers. (iv) Roots are febrifuge, tonic, expectorant, anodyne and diuretic. (v) Flowers used in fever, diarrhoea and liver complaints. (vi) Seeds are used to treat skin diseases.
Withania somnifera (L.) Dunal	Ashwagandha	Solanaceae	Root and Leaves	½ tsp leaf powder with water once a day is useful in anemia. ½ tsp root powder with 1 glass of water or milk is taken daily in stress.
Wrightia tinctoria (Roxb.) R.Br.	Dudhi, Karu	Apocynaceae	Leaves	The leaf paste mixed with oil of *Azadirachta indica* and applied externally for treating eczema.
Xanthium strumarium L.	Adhasisi	Asteraceae	Fruit	Dry fruits of *Xanthium strumarium* are kept on dried stem of *Calotropis procera* and then lit the fruit. The smoke is inhaled 3 times to relieve headache.

Ziziphus nummularia (Burm.f.) Wight & Arn.	Jhari, Bordi	Rhamnaceae	Root, leaves, fruit	Fruits boiled in water and water is used to take bath for curing sun stroke.

Plate 1: Common ethnomedicinal plants of Study areas (*Balanites aegyptiaca & Barleria prionitis)*

References

Bhandari MM. (1978). Flora of the Indian desert. Scientific publishers, Jodhpur.

Jain SK. (1981a). Adivasi Bhil and Meena. Sadhana Books, Jaipur.

Jain SK. (1991). Contribution to Indian Ethnobotany, Scientific Publishers, Jodhpur.

Jain SK. (1991a). Dictionary of Indian Folk Medicine and Ethnobotany, Deep publication, New Delhi.

Jain SK. (1995). A manual of Ethnobotany, Scientific Publishers, Jodhpur.

Jain SK. (1981b). Glimpses of the Indian Ethnobotany. Oxford and IBH Publishing Co. New Delhi.

Joshi P. (1995). Ethnobotany of the primitive tribes in Rajasthan, Printwell Publishers, Jaipur.

Meena KL. (2011). Ethnobotany of Garasia Tribe: Rajasthan, Publishers, Jodhpur, India.

Sharma NK. (2002). Ethno-Medic-Religious plants of Hadoti Plateau SE Rajasthan- (S.E. Rajasthan) a Preliminary Survey. In: Ethnobotany, Trivedi, P.C. (Ed.). Aaviskar Publishers, Jaipur, India

Sharma S and Tiagi B. (1979). Flora of North East Rajasthan, Kalyani Publishers, New Delhi.

Shetty BV and Pandey RP. (1983). Flora of Tonk district, Botanical Survey of India, Howrah, West Bengal, India

Shetty BV and Singh V Edits. (1987). Flora of Rajasthan Vol **1**. Botanical Survey of India, Howrah, West Bengal, India

Shetty BV and Singh V Edits. (1991). Flora of Rajasthan Vol **2**. Botanical Survey of India, Howrah, West Bengal, India

Shetty BV and Singh V Edits. (1993). Flora of Rajasthan Vol **3**. Botanical Survey of India, Howrah, West Bengal, India

Singh V. (1983). Flora of Banswara District, Botanical Survey of India, Howrah, West Bengal, India

Tiagi B and Aery NC. (2007). Flora of Rajasthan: South and South-East Region, Himanshu Pub, New Delhi.

Yadav BL and Meena KL. (2011). Flora of South-Central Rajasthan, Scientific Publisher, Jodhpur, India

Scientific validation of antidiabetic properties of *Syzygium palghatense* Gamble, an endemic medicinal plant of Western Ghats, India

Snehalatha VR and Rasmi AR

Abstract: One of the most important metabolic illnesses, diabetes, which is characterized by hyperglycemia, has alarming pandemic proportions. Defects in insulin action, secretion, or both may be to contribute. The use of contemporary medications for glycemic control has resulted in several negative side effects, which has increased the demand for safe and affordable solutions. Phytoconstituents found in medicinal plants can have mild to strong antihyperglycemic effects. As a result, throughout the past few decades, a wide variety of medicinal plants have had their antidiabetic potential extensively studied. The plants coming under the family, Myrtaceae have significant antidiabetic potential. The present study involves the first-time report of the antidiabetic potential of *Syzygium palghatense* leaves. The methanol extracts of *S. palghatense* leaves revealed the presence of alkaloids, phenolics, tannins, glycosides, carbohydrates, reducing sugars, essential oils, and saponins. The presence of these secondary metabolites may be the reason for the biological properties of the test plant. A significant result in alpha-amylase and alpha-glucosidase enzyme activity was reported. Thus, *S. palghatense* could be a better substitute for diabetic problems.

Keywords: *Syzygium palghatense*, traditional medicine, endemic, phytochemical, qualitative, quantitative, antidiabetic, alpha-amylase, alpha-glucosidase

VR Snehalatha(✉), ORCID: https://orcid.org/0000-0003-4068-960X
PG and Research Department of Botany, Govt. Victoria College, Palakkad, Kerala, India
e-mail: snehagvc@gmail.com

AR Rasmi, ORCID: https://orcid.org/0000-0002-8079-9005
PG and Research Department of Botany, Govt. Victoria College, Palakkad, Kerala, India
e-mail: rasmibotany@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7140322

Introduction: Tropical and subtropical areas are home to a variety of *Syzygium* species which are members of the Myrtaceae family. According to scientific studies, extracts

from different *Syzygium* species have a variety of pharmacological properties, including antioxidant, anti-inflammatory, antimicrobial, antidiarrheal, antidiuretic, antihyperlipidemic, antiscorbutic, antiulcerogenic, astringent, cardioprotective, hepatoprotective, and stomachic. Diabetes mellitus is a chronic condition brought on by restrictions in insulin action or release. Hyperglycemia, which is the first step towards more severe illness consequences, coexists with this impairment. There are several forms of diabetes, including type I diabetes, type II diabetes, and gestational diabetes. By 2040, it is predicted that 642 million adults between the ages of 20 and 79 will have diabetes worldwide. Additionally, diabetes was the cause of 6.8% of fatalities worldwide in the same age group in 2010 (Krishnasamy et al. 2015; Rashied et al. 2022). Drugs, obesity, hereditary conditions and pregnancy related complications can all contribute to diabetes. Polydipsia, poor wound healing, polyuria, and polyphagia are all signs of diabetes. In addition, diabetes can cause a variety of side effects, including nephropathy, glaucoma, ischemic heart disease, neuropathy, and ketoacidosis (Zulcafli et al.2020). Injections of insulin, oral medications that lower blood sugar and nutritional therapy are all common diabetic therapies. Biguanide, thiazolidinedione, and sulfonylurea administration result in several unfavorable side effects, including higher levels of low density lipoprotein cholesterol, lethargy, and weight gain. Furthermore, oral medication use frequently results in hypoglycemia (Singh et al. 2016). The use of contemporary medications for glycemic control has resulted in several negative side effects, which has increased the demand for safe and affordable solutions (Widyawati et al. 2019). By enhancing beta cell function, encouraging glucose absorption, lowering insulin resistance, or controlling glucagon-like peptide-1 homeostasis, bioactive chemicals extracted from plants may lower blood glucose levels. One of the key factors contributing to the widespread use of herbal medications in the treatment of diabetes, particularly in rural areas, is accessibility. As a result, throughout the past few decades, a wide variety of medicinal plants have had their antidiabetic potential extensively studied. Currently, certain powerful biomolecules from plants have been identified that may have antidiabetic benefits (Zulcafli et al. 2020). Several members of the Myrtaceae family have demonstrated potential antidiabetic properties. The majority of the 1200–1800 species of *Syzygium* are shrubs and evergreen trees. Northeastern Australia and Malaysia have the greatest variety of these species. *S. cumini*, *S. polyanthum*, *S. samarangense*, *S. calophyllifolium*, *S. aqueum*, *S. aromaticum*, *S. malaccense*, and *S. alternifolium* are some antidiabetic potential plants (Arya et al. 2011, Ahmad et al. 2016). The presence of bioactive chemicals in the plants is thought to be the cause of their antidiabetic properties. Evidence from the recent research demonstrates the ability of seed, leaf, and fruit extracts from several *Syzygium* species to enhance insulin production and maintain blood glucose homeostasis. A potential role in clinical therapy for type 1 or type 2 diabetes is highlighted by this promising antidiabetic activity (Sharma et al. 2011). *S. palghatense*, an endemic of the Western Ghats, India has not yet been the subject of providing any reports. The goal of the current experiment was to determine the effects of leaf of *S. palghatense* to treat diabetes.

Methodology: Qualitative phytochemical analysis for secondary metabolites were carried out in different solvent extracts including chloroform, ethyl acetate, methanol,

and distilled water. Quantitative estimation was also documented (Morsy 2014). To determine the antidiabetic potential of the plant, alpha glucosidase and the alpha-amylase inhibitory assay was carried out (Hansawasdi et al. 2000; Yin et al. 2014).

Results and discussion: Aminoacids, proteins, alkaloids, phenolics, tannins, flavonoids, glycosides, saponins, reducing sugars, starch, carbohydrates, anthraquinones, fats and oils, essential oils, steroids, and coumarin were observed from the leaves of *S. palghatense* (Table 1). It was observed that methanol and aqueous extracts of leaves contained more phytoconstituents as compared to chloroform and ethyl acetate. Quantitative estimation was carried out in both methanol and aqueous extracts. Methanol extract of leaves showed higher values for all tests. Methanol extract of leaves of *S. palghatense* contain 128.8 µg/mg alkaloid, 180 µg/mg flavonoids, 318.5 µg/mg glycosides, and 237.4 µg/mg tannin (Table 2).

Table 1: Phytochemicals in the different solvent extracts of *Syzygium palghatense* leaf

Qualitative analysis	Solvent extracts			
	Chloroform	Ethyl acetate	Methanol	Distilled water
Alkaloids	-	-	+	+
Flavonoids	-	-	-	-
Glycoside	-	-	+	-
Saponins	-	-	-	+
Carbohydrate	-	-	+	+
Tannin	-	-	+	+
Reducing sugar	-	-	+	+
Starch	-	-	-	-
Phenolics	-	-	+	+
Anthraquinone	-	-	-	-
Fatty oil	-	-	-	-
Essential oil	+	+	+	+
Proteins	-	-	-	-
Amino acids	-	-	-	-
Steroids	-	-	-	-
Coumarin	-	-	-	-

(+: Presence; -: Absence)

Table 2: Quantitative amount of phytochemicals in the leaves of *Syzygium palghatense*

Parameters	Leaves (µg/mg gallic acid equivalent)	
	Methanol	Distilled water
Alkaloids	128.8 µg/mg	88.8 µg/mg
Flavonoids	180 µg/mg	146.25µg/mg
Glycosides	318.5 µg/mg	234.5 µg/mg
Saponin		145.5 µg/mg
Total carbohydrate	81.25 mg/g	
Tannin	237.4 µg/mg	250 µg/mg
Reducing sugar	2.8 mg/g	
Phenol	100.3 µg/mg	100.5 µg/mg

The plants with high antidiabetic potential have an increased amount of polyphenols (Guidsy et al. 2019). The present study was in accordance with the studies carried out on other species of *Syzygium* (Baliga and Manjeshwar 2013). Alpha amylase and alpha-glucosidase inhibitory assay were done in methanol extracts of leaves of *S. palghatense* and significant results were obtained (Tables 3-4). According to the solvent concentrations employed, the percentage of inhibition rose. This demonstrates the potent antidiabetic properties of plant. In the alpha-amylase inhibitory experiment, methanolic extract of leaves demonstrated 91.27 ± 0.58 percentage of inhibition. In the alpha-glucosidase inhibitory experiment, *S. palghatense* leaf samples showed an inhibition percentage of 87.47 ± 0.40. There have been reports of enzymatic inhibitory activity in the *Syzygium* species *S. cumini*, *S. polyanthum*, *S. aqueum*, *S. aromaticum*, and *S. malaccense*. Maltase and glucosidase were discovered to be inhibited by *S. cumini* extract (Shinde 2008). Numerous investigations also demonstrated the effectiveness of *S. aromaticum* extracts as α-amylase inhibitors (Tahir et al. 2015).

Table 3: α-amylase activity of *Syzygium palghatense* leaves

Concentration (µg/µl)	Percentage of inhibition (%)
20	38.46±1.02
40	49.15±0.81
60	61.44±0.75
80	82.03±0.69
100	91.27±0.58

Table 4: α- Glucosidase inhibition assay of *Syzygium palghatense* leaves

Concentration (µg/µl)	Percentage of inhibition (%)
20	37.50±0.74
40	45.36±0.67
60	54.84±0.51
80	68.62±0.48
100	87.47±0.40

It was discovered that the active ingredient in *S. malaccense*, myricitrin, inhibits both glucosidase and amylase (Arumugam et al. 2016). Sharma et al. (2012) reported that *S. cumini* exhibited antidiabetic activities through reduction of insulin resistance.

Conclusion: In conclusion, our present works show the antidiabetic effect of methanolic extracts of leaves of *S. palghatense* for the first time. The findings of the present investigation demonstrated that *S. palghatense* has strong antidiabetic properties. The possible sources of bioactive chemicals were revealed by qualitative and quantitative analysis. Alkaloids, phenolics, tannins, glycosides, carbohydrates, reducing sugars, essential oils, and saponins were present in the methanol extracts of *S. palghatense* leaves. These secondary metabolites might be the cause of the test plant's biological characteristics. Alpha-amylase and alpha-glucosidase enzyme activity showed a considerable activity. Therefore, *S. palghatense* may therefore be a superior alternative for diabetic issues.

References

Ahmad B, Baider C, Bernardini B, Biffin E, Brambach F, Burslem D, et al. (2016). *Syzygium* (Myrtaceae): Monographing a taxonomic giant via 22 coordinated regional revisions. PeerJ Preprints. 4:e1930v1 https://doi.org/10.7287/peerj.preprints.1930v1.

Arumugam B, Palanisamy UD, Chua KH, Kuppusamy UR (2016). Potential antihyperglycaemic effect of myricetin derivatives from *Syzygium malaccense*. Journal of Functional Foods. 22:325-336.

Arya V, Gupta V and Ranjeet KA. (2011). Review on fruits having anti-diabetic potential. Journal of Chemical and Pharmaceutical Research. 3:204-212.

Baliga, Manjeshwar S. et al. (2013). Scientific Validation of the Antidiabetic Effects of *Syzygium jambolanum* DC (Black Plum), a Traditional Medicinal Plant of India. The Journal of Alternative and Complementary Medicine. 19(3): 191-97.

Gudise V, Chowdhury B and Manjappa AS. (2019). In vitro free radical scavenging and antidiabetic activity of aqueous and ethanolic leaf extracts: a comparative evaluation of *Argyreia pierreana* and *Matelea denticulata*. Future Journal of Pharmaceutical Sciences. 5(1):1–1.

Hansawasdi C, Kawabata J and Kasai T. (2000). α-Amylase inhibitors from roselle (*Hibiscus sabdariffa* Linn.) tea. Bioscience, Biotechnology, and Biochemistry. 64(5):1041-1043.

Krishnasamy, Gopinath and Karthikeyan Muthusamy. (2015). *In Vitro* evaluation of antioxidant and antidiabetic activities of *Syzygium densiflorum* Fruits. Asian Pacific Journal of Tropical Disease. 5(11): 912-17.

Morsy N. (2014). Phytochemical analysis of biologically active constituents of medicinal plants. Main Group Chemistry 13(1):7–21.

Rashied, Rasha MH. et al. (2022). *Syzygium samarangense* leaf extract exhibits distinct antidiabetic activities: evidences from in silico and *in vivo* studies. Arabian Journal of Chemistry. 15(6): 1-4.

Sharma AK, Bharti S, Kumar R, Krishnamurthy B, Bhatia J, Kumari S, et al. (2012). *Syzygium cumini* ameliorates insulin resistance and β-cell dysfunction via modulation of PPAR, dyslipidemia, oxidative stress, and TNF-α in type 2 diabetic rats. Journal of Pharmacological Sciences. 119(3):205-13.

Sharma SB, Rajpoot R, Nasir A, Prabhu KM and Murthy PS. (2011). Ameliorative effect of active principle isolated from seeds of *Eugenia jambolana* on carbohydrate metabolism in experimental diabetes. Evidence-Based Complementary and Alternative Medicine. 789-871.

Shinde J, Taldone T, Barletta M, Kunaparaju N, Hu B, Kumar S, et al. (2008). α-glucosidase inhibitory activity of *Syzygium cumini* (Linn.) Skeels seed kernel *in vitro* and Goto-Kakizaki (GK) rats. Carbohydrate Research. 343(7):1278-81.

Singh S, Kumar R, Pal R, Kumar N, Dixit RK and Nath R. (2016). Switch over to alternative therapy for diabetes mellitus. Current Research in Diabetes and Obesity Journal. 1(2):555-557.

Tahir HU, Sarfraz RA, Ashraf A and Adil S. (2015). Chemical composition and antidiabetic activity of essential oils obtained from two spices (*Syzygium aromaticum* and *Cuminum cyminum*). International Journal of Food Properties. 19(10):215-664.

Widyawati T, Pane YS and Yusoff NA. (2019). Effect of *Lawsonia inermis* Linn. Extracts on blood glucose level in normal and streptozotocin-induced diabetic rats. Pakistan Journal of Nutrition. 18(7):671-676.

Yin Z, Zhang W, Feng F, Zhang Y and Kang W. (2014). α-Glucosidase inhibitors isolated from medicinal plants. Food Science and Human Wellness. 3(3-4):136–174.

Zulcafli, Azrin S et al. (2020). Antidiabetic Potential of *Syzygium* Sp.: An Overview. Yale Journal of Biology and Medicine. 93: 307-32.

Chapter 8
Gymnema sylvestre R. Br. (Apocynaceae): a medicinal climber of India

Shikha Thakur

Abstract: *Gymnema sylvestre* (Apocynaceae) also known as 'Gurmar' or 'Sugar destroyer' is a woody, climbing traditional medicinal herb which has many therapeutic applications in Ayurvedic system of medicines. It is used for lowering serum cholesterol, triglycerides and blood glucose level (hypoglycemic or antihyperglycemic) and helps in supporting healthy pancreatic functions. By working directly on the level of the blood, it helps to balance the blood sugar levels. The chapter highlights the common uses of this important medicinal climber of India.

Keywords: Diabetes, Morphology, Ethnobotany, Pharmacology

S Thakur, ORCID: https://orcid.org/0000-0003-3636-4415
Thakur College of Science and Commerce, Department of Biotechnology, Mumbai, India
email-Id: patho.shikha@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7177382

Introduction: *Gymnema sylvestre* has a long history of use in India's Ayurvedic medicine. It is a valuable herb belonging to the family Apocynaceae, and widely distributed in India, Malaysia, Srilanka, Australia, Indonesia, Japan, Vietnam, tropical Africa and the Southwestern region of the People's Republic of China. The plant is commonly known as Periploca of the woods (English), Gurmar (Hindi), Meshashringi, Madhunashini (Sanskrit), Kavali, Kalikardori (Marathi), Dhuleti, Mardashingi (Gujrathi), Adigam, cherukurinja (Tamil), Podapatri (Telgu) and Sannagerasehambu (Kannada) (Kanetkar et al. 2007; Paliwal et al. 2009; Rachh et al. 2010). The word "Gymnema" is derived from a Hindi word "Gurmar" meaning "destroyer of sugar". It is believed that *G. sylvestre* might neutralize the excess of sugar present in the body in Diabetes mellitus (Keshavamurthy et al. 1990; Kritikar and Basu 1998; Saneja et al. 2010; Thakur et al. 2012; Ramasubramania et al. 2017).

Morphological and anatomical characters: It is a gregarious woody climber, much branched, running over the tops of tall trees. Leaves are 3–5 cm long and up to 3 cm broad, ovate-elliptic, acute or shortly acuminate, pubescent on both sides; base

rounded or heart shaped with 6–13 mm long petioles. Flowers are small, yellow, in axillary and lateral umbel in cymes; Follicles are terete and lanceolate up to 3 inches in length. The Calyx lobes are long, ovate, obtuse and pubescent. Corolla is pale yellow campanulate, valvate, corona single, with 5 fleshy scales. Scales adnate to throat of corolla tube between lobes; Anther connective produced into a membranous tip, pollinia 2, erect, carpels 2, unilocular, locules many ovuled (Potawale et al. 2008; Kritikar and Basu 1998; Gurav et al. 2007). The leaf odour is characteristic and taste is slightly bitter and astringent. It also possesses remarkable property of paralyzing the sense of the taste for sweet substances for few hours (Agnihotri et al. 2004; Madhurima et al. 2009). Transverse section of petiole is horse shoe shaped. The epidermis is single layered with barrel shaped thick walled cells covered with uniseriate, multicellular, non-glandular trichomes. The cortex is collenchymatous and vascular bundles are amphicribal and three in number. Well developed phloem consists of sieve tubes, companion cells and phloem parenchyma. The xylem consists of vessels, tracheids and tracheidal fibres. The starch grains are polygonal, simple or compound in two or many groups. The rosette crystals of calcium oxalate are present more towards the center (Agnihotri et al. 2004; Anonymous 2003). The epidermal cells of lamina are square shaped with outer convex wall and thin cuticle. When viewed transversally, epidermal cell surface is interrupted with trichomes, which are uniseriate, multicellular with 2 to 5 celled, present in abundance on both the surfaces. Single layered closely arranged palisade cells are present just below the adaxial epidermis. Vascular bundles are amphicribal and the mesophyll is 3-5 celled thick (Agnihotri et al. 2004; Anonymous 2003). The transverse section of stem is circular in outline. The epidermis is made up of barrel shaped thick walled cells. Trichomes are multicellular, uniseriate and 185-485 µ long and 9-25 µ broad. The cork is 3 to 5 layered thick, and cortical cells are elongated and collenchymous. The phloem is well developed consisting of large sieve plates, companion cells and phloem parenchyma. The xylem is in the form of a continuous cylinder transversed by narrow medullary rays. The endodermis is conspicuous and the pericycle is broad (Agnihotri et al. 2004; Madhurima et al. 2009).

Medicinal values: Susruta describes *G.sylvester*, as a destroyer of madhumeha (glycosuria). It is a potent antidiabetic plant and used in folk, ayurvedic and homeopathic systems of medicine. It is also used in the treatment of asthma, eye complaints, snakebite, urinary complaints, stomach problems, piles, chronic cough, breathing troubles, colic pain, constipation, dyspepsia and hemorrhoids, hepatosplenomegally. It is also reported to be bitter, astringent, acrid, thermogenic, antinflammatory, anodyne, digestive, liver tonic, diuretic, stomachic, stimulant, antihelmenthics, laxative, cardiotonic, expectorant, antipyretic and uterine tonic. It is useful in dyspepsia, constipation and jaundice, haemorrhoids, renal and vesicle calculi, cardiopathy, asthma, bronchitis, amenorrhoea, conjunctivitis and leucoderma (Mahasker et al. 1930; Vaidyaratnam 1995; Chopra et al. 1992). The drug is also used in the composition of ayurvedic preparations like Ayaskri, Varunadi kasaya, Varunadighrtam, Mahakalyanakaghrtam (Joy and Thomas 1998). In addition, it also possesses antimicrobial, antihypercholesterolemic, antinflammatory and sweet suppressing activities.

Chemical constituents and bioactive components: The antidiabetic array of molecules has been identified as a group of closely related gymnemic acids after it was successfully isolated and purified from the leaves of *G. sylvestre* (Liu 1992; Sinsheimer and Manni 1965). The main constituent of *Gymnema* is believed to be gymnemic acid, a mixture of at least 17 different saponins. Gymnemic acid formulations have been found useful against obesity, according to recent reports (Yoshikawa et al. 1993). The atomic arrangement of gymnemic acid molecules is similar to that of glucose molecules. These molecules fill the receptor locations on the taste buds thereby preventing its activation by sugar molecules present in the food, thereby curbing the sugar craving. Similarly, Gymnemic acid molecules fill the receptor location in the absorptive external layers of the intestine thereby preventing the sugar molecules absorption by the intestine, which results in low blood sugar level (Sahu et al. 1996). There are some possible mechanisms by which the leaves and especially Gymnemic acids from *G. sylvestre* exert its hypoglycemic effects. They are:

1. It increases secretion of insulin
2. It promotes regeneration of islet cells
3. It increases utilization of glucose: It is shown to increase the activities of enzymes responsible for utilization of glucose by insulin-dependent pathways, an increase in phosphorylase activity, decrease in gluconeogenic enzymes and sorbitol dehydrogenase.
4. It causes inhibition of glucose absorption from intestine, the exact action being unknown. It could involve one or more mechanisms (Nakamura et al. 1999).

Ethnobotanical uses There are more than four hundred different tribal and other ethnic groups in India. Each tribal group is having their own tradition, folk language, beliefs and knowledge about the use of natural resources as medicines. The plant is reported to be useful in ethnobotanical surveys conducted by ethnobotanists. In Madras, 'Vaids' are known to recommend the leaves in the treatment of furunculosis and madhumeha. The juice obtained from root is used to treat vomiting and in dysentery and plant paste is applied with mother milk to treat mouth ulcer (Kirtikar and Basu1998; Agnihotri et al. 2004; Ekka and Dixit 2007). According to the Ayurvedic Pharmacopoeia of India, both the dried leaf and root of gymnema, depending on dosage form and formulation, are also used in the treatment of svasa (bronchial asthma), kasa (cough), kustha (leprosy and other skin diseases), and vrana (wounds), among other conditions. According to Charaka Samhita, it removes bad odor from breast milk. It is aperitive. This plant is useful as purgative, in eye troubles. The leaf extract and flower are beneficial for eyes. Bark is given in the diseases caused by vitiated kapha (phlegm) (Pragada et al. 2012).

Pharmacological properties of *Gymnema sylvestre*

Antiobesity activity: *G. sylvestre* helps in weight loss possibly due to its ability to control blood sugar levels. It has been reported that the constituent gurmarin peptide blocks the ability to taste sweet or bitter flavors and thus reduces sweet cravings (Pierce 1999; Ninomiya and Imoto 1995). A standardized *G. sylvestre* extract in combination with

niacin bound chromium and hydroxycitric acid has been evaluated for antiobesity activity by monitoring changes in body weight, body mass index (BMI), appetite, serum leptin, lipid profiles and excretion of urinary fat metabolites.

Hypolipidaemic activity: *G. sylvestre* possess hypolipidemic activity. Adequate doses of leaf extract of *G. sylvestre* was given to hypolipidemic rats for two weeks. It has been found that leaf extract help in the reduction in serum triglyceride (TG), total cholesterol (TC), very low density lipoprotein (VLDL) and low-density lipoprotein (LDL). The efficiency of this drug was almost similar to that of a standard lipid lowering agent (Rachh et al. 2010, Malik et al. 2008).

Antiarthritic activity: The antiarthritic activity of *G. sylvestre* leaves was studied in Freund's adjuvant induced arthritic rat. Diclofenac sodium was used as a standard drug. The study revealed that the aqueous extract and petroleum ether extract possessed antiarthritic activity. This antiarthritic activity of *G. sylvestre* leaves may be due to the presence of saponins, triterpenoids and steroids (David and Sudarsanam 2013).

Antibiotic and Antimicrobial activity: The antibiotic and antimicrobial activity of different extracts of *G. sylvestre* was determined against a number of pathogens, namely, *S. aureus*, *E. coli*, and *B. subtilis* while no activity was observed against gram-negative bacteria. *G. sylvestre* leaf showed good prospects as an antibiotic herbal remedy was also effective as herbal formulation for the treatment of microbe's related infections (Saumend et al. 2010). The antibacterial activity of *G. sylvestre* and gymnemic acid was also studied against *E. coli* and *B. cereus* and the antimicrobial effect was significant against the microbes (Yogisha and Raveesha 2009). Bhuvaneswari et al. (2011) demonstrated that the methanolic extracts of *G. sylvestre* were assessed for antimicrobial activity of aerial and root parts separately. The result exhibited that the methanol extracts in acidic range have good activity towards all the pathogens showing its broadspectrum nature. In a similar study, the antimicrobial effect of ethanolic extract of *G. sylvestre* against *Bacillus pumilus*, *B. subtilis*, *P. aeruginosa* and *S. aureus* showed promising antimicrobial effect (Satdive et al. 2004). The ethanolic extract of *G. sylvestre* leaves showed good antimicrobial activity against *Bacillus pumilis*, *B. subtilis*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* and no activity was found against *Proteus vulgaris* and *Escherichia coli* (Satdive et al. 2003). The aqueous and methanolic extract of *G.sylvestre* leaves also showed moderate activity against the three pathogenic *Salmonella* species (*Salmonella typhi*, *S. typhimurium* and *S. paratyphi*).

Conclusion: Gudmur leaves have been used by natural clinics in India for centuries to support healthy blood sugar levels. The taste of its leaves suppresses the ability to detect sweet tastes. It has an important place among such antidiabetic medicinal herbs. As, diabetes is now becoming a common disease throughout the world, a lot of new drugs are being synthesized for the same. Many Indian herbs are being used in traditional practices to cure diabetes. *G. sylvestre*, has an important place among such antidiabetic medicinal plants. It can also be used in treating dyspepsia, constipation and jaundice, haemorrhoids, renal and vesicle calculi, cardiopathy, asthma,

bronchitis, amenorrhoea, conjunctivitis and leukoderma. Realising the medicinal and economic importance of *G.sylvestre* extensive research needs to be done on those areas which are still unexplored. At the same time, an extensive research should be undertaken on this herb and its products including standardization of various parts and subparts and drug development program using *G.sylvestre* compounds for their better economic and therapeutic utilization.

References

Agnihotri AK, Khatoon S, Agarwal M, Rawat AS, Mehrotra S, and Pushpangadan P. (2004). Nat Prod Sci. 10 (4): 168-172.

Anonymous. (2003). Quality standards of Indian medicinal plants. Indian Council of Medical Research, New Delhi.

Bhuvaneswari CH, Rao K and Giri A. (2011). Evaluation of *Gymnema sylvestre* antimicrobial activity in methanol. Recent Res. Sci. Technol. 73–75.

Chopra RN, Nayar SL and Chopra IC. (1992). Glossary of Indian Medicinal Plants. Council of Scientific and Industrial Research, New Delhi. 319-22.

David Beverly C and Sudarsanam G. (2013). Antimicrobial activity of *Gymnema sylvestre* (Asclepiadaceae). J. Acute Disease. 222-225

Ekka NR and Dixit VK. (2007). Ethnopharmacognostical studies of medicinal plants of Jashpur district (Chhattisgarh). Int J Green Pharmacy. 1-4.

Gurav S, Gulkari V, Durgkar N and Patil A. (2007). Systematic review: Pharmacognosy, Phytochemistry and clinical application of *Gymnema sylvestre* R.Br. Pharmacog Rev. 338-343,

Joy PP and Thomas J. (1998). Medicinal plants. Kerala Agriculture University, Aromatic and Medicinal Plants Research Station.1-16.

Kanetkar P, Singhal R and Kamat M. (2007). *Gymnema sylvestre*: A Memoir. J. Clin. Biochem. Nutr. 77–81.

Keshavamurthy K.R. and Yoganarasimhan S.N. (1990). Flora of Coorg - Karnataka, Vimsat publishers, Banglore. 1-282.

Kritikar K, Basu B. (1998) Indian Medicinal Plants. International Book Distributors, Dehradun. 1-1625.

Liu HM, Kiuchi F, Tsuds Y. (1992). Isolation and structure elucidation of Gymnemic acids, antisweet principles of *Gymnema sylvestre*. Chem Pharm Bull. 1366-1375.

Madhurima SH, Ansari P, Alam S, Ahmad MD and Akhtar S. (2009). Pharmacognostic and phytochemical analysis of *Gymnema sylvestre* R. Br. Leaves. J Herb Med Toxicology. 73-80.

Malik JK, Manvi FV, Aagawadi KR and Noolvi M. (2008). Evaluation of anti-inflammatory activity of *Gymnema sylvestre* leaves extract in rats. International Journal of Green Pharm. 114-15.

Mhasker K S and Caius J F. (1930). A study of Indian medicinal plants. II. *Gymnema sylvestre.* R.Br. Ind. J. Med. Res. Memoirs. 2-75.

Nakamura Y, Tsumura Y, Tonogai Y and Shibata T. (1999). Fecal steroid excretion is increased in rats by oral administration of gymnemic acids contained in *Gymnema sylvestre* leaves. J Nutr. 129 pp.1214-1222.

Ninomiya Y and Imoto T. (1995). Gurmarin inhibition of sweet taste responses in mice. Am J Physiology. 268(4): 1019-1025.

Paliwal R, Kathori, S and Upadhyay B. (2009). Ethno-Med. 3(2): 133-135.

Pierce A. (1999). *Gymnema* Monograph: Practical guide to natural medicine, Stonesong Press Book, New York. 324-26.

Potawale SE, Shinde VM, Anandi L, Borade S, Dhalawat H and Deshmukh RS. (2008). Gymnema sylvestre, a comprehensive review. Pharmacologyonline. 144-157.

Pragada PM, Rao DS and Venkaiah M. (2012). Study of some ethnomedicinal plants for treatment of dysentery of North Coastal Andhra Pradesh, India. Int J Biosci. 2(1): 18-24.

Rachh PR, Rachh MR, Ghadiya NR, Modi DC, Modi KP, Patel NM and Rupareliya MT. (2010). Antihyperlipidemic activity of *Gymnema sylvestre* R. Br. leaf extract on rats fed with high cholesterol diet. Int J Pharmacol. 138-141.

Ramasubramania R, Raja, M. Sekar, J.V., Pallavi, K, Pramoda P, Poojitha and Lakshmi Sai. (2017). World Journal of Pharmacy. 6(10): 191-195.

Sahu N, Mahato SB, Sarkar SK and Poddar G. (1996). Triterpenoid saponins from *Gymnema Sylvestre*. Phytochem. 41: 1181-1185.

Saneja Ankit, Sharma Chetan, Aneja KR, Pahwa, Rakesh. (2010). *Gymnema Sylvestre* (Gurmar): A Review. Scholars Research Library, Der Pharmacia Lettre. 2(1) 275-284.

Satdive RK, Abhilash P, Devanand PF. (2003). Antimicrobial activity of *Gymnema sylvestre* leaf extract. Fitoterapia. 74: 699:701.

Satdive RK, Satdive P, Abhilash and Fulzele DP. (2004). Antimicrobial activity of *Gymnema sylvestre* leaf extract. Fitoterapia. 74: 699–701.

Saumendu DR, Sarkar K, Dipankar S, Singh T and Prabha B. (2010). *In vitro* antibiotic activity of various extracts of *Gymnema sylvestre*. Int. J. Pharmacet. Res. Develop. 2.

Sinsheimer JE and Manni PE. (1965). Constituents from *Gymnema sylvestre* leaves. J Pharm Sci. 54: 1541-1544.

Thakur Gulab, Sharma S, Sanodiya Rohit, Bhagwan S, Pandey Mukeshwar, Prasad GBKS and Bisen. (2012). Prakash S. Journal of Applied Pharmaceutical Science. 2 (12): 001-006.

Vaidyaratnam P. (1995). Indian Medicinal Plants. Orient Longman Publisher, Madras. 107-9.

Yogisha S and Raveesha KA. (2009). In vitro antibacterial effect of selected medicinal plant extracts. J. Nat. Products. 64–69,

Yoshikawa K, Kondo Y, Arihara S, and Matsuura K. (1993). Antisweet natural products IX structures of gymnemic acids XV-XVIII from *Gymnema sylvestre*. R. Br. Chem Pharm Bull. 40: 730-1732

Chapter 9
Documentation of wild edible mushrooms available in the local markets of Ranchi, Jharkhand, India

Anuranjita Singh

Abstract: State Jharkhand is known for its rich biodiversity and Sal-dominated forests in India. During monsoons when there is a shortage of vegetables in the local markets, wild mushrooms are a prime food source and earnings of the local tribal communities in this state. Wild mushrooms have medicinal values too. There is a lack of documentation on the importance of wild edible mushrooms in Jharkhand state. Keeping this in view, an attempt has been made to document the wild edible mushrooms having economic values available in different local & weekly markets of Ranchi district of Jharkhand state during May 2022 to August 2022. The results revealed that about 11 species of wild edible mushrooms are commonly sold in different markets of study areas. It was found that indigenous and tribal people come from a distance of 80-90 km to get a high value per kg. The present study highlights the importance of wild edible mushrooms in providing food and livelihood.

Keywords: Biodiversity, Nutraceutical, Ethnomycological, Wild edible mushroom, Indigenous people

---

A Singh, ORCID: https://orcid.org/0000-0002-9628-9464
B/808, Sector 2, Dhurwa, Ranchi, Jharkhand
e-mail Id: anu246ranjita@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7190222

Introduction: Wild edible mushrooms are the source of seasonal ethnomycological food (Adhikari and Devkota 2005), because of their high nutritional and medicinal values, have high economical demand (Khulakpam and Sharma 2018; Pandey et al. 2018;

Upadhyay et al. 2020; Rout et al. 2020). They are macrofungal and have saprophytes, parasites, or symbiotic habitats (Chang and Miles 1992). Mushrooms are also a rich source of vitamin B and D along with protein (Rathee et al. 2012). They are also a source of antioxidant, antinflammatory, antimicrobial, immunomodulating and anticancer agents. A number of wild mushrooms are identified (Veera et al. 2016) but need documentation of their uses. Some mushrooms are growing in the upper layer of soil like Rugra mushrooms. It is native to Jharkhand, and is very helpful for patients suffering from anaemia and diabetes (Heleno et al. 2015). Wild edible mushrooms are very important food from the forest (Rout et al. 2020). The local communities collect them and consume them by making different delicacies. They also sell them in near local or weekly markets to as livelihood. Very less reports are available from Jharkhand state. Therefore, an attempt has been made to document them through a survey of weekly and daily markets of Ranchi, Jharkhand. The chapter brings attention towards the importance of wild edible mushrooms in Jharkhand and their future aspects.

Methodology: The survey was carried out during May 2022 to August 2022 in selected areas and markets of Ranchi. Ranchi is known for its moderate climate and forests receive maximum rainfall from the Southwest monsoon. Ranchi is located at 23.35N latitude and 85.33E longitude. High rainfall and Sal forests are responsible for the growth of different indigenous varieties of mushrooms. Fresh samples were manually collected by visiting the local market, Haat of Doranda, Shalimar, Kanke, Namkum, Morabadi, Hatia, Dhurwa in the month of May 2022 to August 2022. The detail information about mushrooms are collected after regular discussions and questionnaires from the ethnic seller through regular field visits. Different varieties of mushrooms are identified through their morphology, colour, shape, size, arrangement of gills, smells, brushing, by applying potassium hydroxide, and by their local names.

Figure 1: Locals are selling Rugra mushroom in the market of Ranchi

Results and discussion: The dominant tree of Jharkhand is *Shorea robusta*. The sal forests ecosystem is most suitable for the growth of wild edible mushrooms. The indigenous peoples are very much aware about which one is poisonous and which one is edible and they pass this information from generation to generation. The locals denominate the mushrooms by various names according to their morphology and place of origin like - Jamun Khukhri, Chirko Khukri, Balu Khukri and Rugra (Figure 1). A total of 11 edible are recorded in local markets of Ranchi. The price of mushroom varies and depend on season and availability. The price also varies from market to market. It was noticed that, the price of *T. hemii* in Doranda market is Rs 1000/Kg but Rs 2000/Kg in Morabadi market. In the village market, its price is Rs 500/Kg. The dominant genus was *Astraeus* and *Termitomyces*. It was analyzed that 90% of mushroom collectors belong to tribal community, mostly females. Peoples also consume more mushrooms for their taste during the holy month of SHRAVAN as an alternative of non-vegetarian foods. The enumerated mushrooms are *Amanita caesarea* (Figure 2L), *Amanita egregia* (Figure 2R), *Astraeus hygrometricus* (Rugra), *Boletus edulis* (Jamun), *Russula rosea* (Patra), *Termitomyces heimii* (Tecknus), *Russula brevipes, Termitomyces medius, Termitomyces microcarpus* (Balu), *Cantharellus cibarius* and *Russula vesca*. Other researchers also have published their works on wild mushrooms of Jharkhand. Kumari and Shrivastava (2019) reported 10 species of wild mushrooms from Ranchi. Khan and Chandra (2021) reported the bioprospecting of 9 wild mushroom species.

Figure 2: Common *Amanita* species (left to right, *Amanita caesarea, Amanita egregia*)

Conclusion: The diversity of wild mushrooms shows the rich forest wealth of the landscapes. They also play an important role in ecological balance and provide food to the local communities. The local communities collect them and sell them to get a seasonal livelihood. In this aspect, the present study indicates that the forest around Ranchi is

good, and locals get plenty of mushrooms as food. The enumerated 11 species of mushrooms have economic values. Among the enumerated, *Astraeus hygrometricus* & *Termitomyces heimii* have high demand and economic values. Further, there is a need of work on their documentation and value addition.

Acknowledgment: The author is highly grateful to the ethnic female seller of the local market and Haat for providing their invaluable support, knowledge, and experience. I am also thankful to Dr. Sanjeet Kumar, CEO, Ambika Prasad Research Foundation, Odisha Dr. Arun Kumar, Department of Botany, Gauhati University, Assam.

References

Adhikari MK and Devkota S. (2005). Ethnomycological Knowledge on Uses of Wild Mushrooms in Western and Central Nepal. Our Nature. 3:13- 19.

Chang T and Miles PG. (1992). Mushroom biology - a new discipline mycologist. 6: 64-65.

Heleno A, Barros L, Anabela M, Patricia M, Virginia FR, Jasmina G. (2015). Nutrotional value, bioactive compounds, antimicrobial activity and bio accessibility studies with wild edible mushrooms. Food Science and Technology. 63:799-806.

Khan F and Chandra R. (2021). Bioprospecting of selected wild mushrooms from Jharkhand, India. Plant Science Today. 9(3): 752–759.

Khulakpam A and Sharma AK. (2018). Wild edible mushrooms traded by ethnic communities of Senapati and Kangpokpi district of Manipur, India. Journal of Pharmacognosy and phytochemistry. 7(1): 2303-2306.

Kumari N and Srivastava AK. (2019). Collection and Documentation of the Wild Edible Mushrooms from Different Forest of Ranchi District. Journal of Emerging Technologies and Innovative Research. 6(6): 981-990.

Pandey VV, Kumari A, Kumar M, Saxena J, Kainthola C and Pandey A. (2018). Mushroom cultivation: Substantial key to food security. Journal of Applied and Natural Science. 10(4): 1325-1331.

Rathee D, Kumar V and Rathee P. (2012). Mushrooms as therapeutic agents, Revista Brasileira de Farmacognosia. 22(2): 459-474.

Rout Y, Behera F, Kumar S, Sahoo MP and Devi RK. (2020). Mushroom diversity of Dhenkanal District, Odisha, India: Source of Alternate Foods and Medicine. European Journal of Medicinal Plants. 31(7):33-41.

Upadhyay RC, Debnath S, Saha K, Majumdar P, Das AK and Saha A. (2020). Checklist of macrofungi (mushroom) diversity and distribution in the forest of Tripura. Journal of Threatened Taxa. 12(10):16314-16346.

Veera T, Jari M, Mikko K and Kauko S. (2016). Modelling the yields of marketed mushrooms in picea abies stands in eastern Finland. Forest ecology and management. 362:79-88.

Chapter 10
Anti-diabetic woody plant resources of Himachal Pradesh, India

Priya Kumari

Abstract: Himachal Pradesh is situated in the Northern part of India**.** It is spread across valleys with many perennial rivers flowing through them. Due to its geographical condition, the state is rich in plant resources having medicinal values. The present study is related to some antidiabetic woody plants of Solan and Shimla districts. Diabetes mellitus is a lifestyle disorder that is rapidly becoming a major threat to populations all over the globe. Diabetes prevalence has been rising more rapidly in middle income and low-income countries and is a major cause of blindness, kidney failure, heart attacks, stroke etc. Total 18 species belonging to 16 genera and 11 families have been recorded and identified with their scientific name, family and parts used. The aim of this chapter is to share the knowledge about antidiabetic plant resources which are very useful in pharmaceutical industry, herbal medicines and to protect these plant resources for the utilization of future generation *i.e.* sustainable use through the conservation strategies.

Keywords: Antidiabetic, Woody plants resources, Himachal Pradesh

P Kumari, ORCID:
Haryana State Biodiversity Board, Panchkula
e-mail: kpriya703@gmail.com

B. L. Manjula et al. (eds.), Medico Biowealth of India, ISBN: 978-81-955847-7-2
DOI: https://doi.org/10.5281/zenodo.7190426

Introduction: Himachal Pradesh is known for its natural environment, hill stations and is one of the richest reservoirs of biological diversity due to diverse climatic conditions and altitude. Solan and Shimla, two districts of Himachal Pradesh having varied altitudinal variation from lower (Parwanoo) to higher (Shimla). The present study is related to some antidiabetic woody plants of Solan and Shimla district. Diabetes mellitus commonly known as diabetes, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time (WHO 2014). Pancreas is not producing enough insulin or the cells of the body is not responding properly to the insulin produced (Shoback and Gardner 2011). Diabetes is one of the largest global health emergencies of the century, ranked among the 10 leading causes of mortality together with

cardiovascular diseases (CVD), respiratory diseases and cancer (IDF 2019; WHO 2021). Diabetes is becoming more prevalent in India, based on the data obtained from cross-sectional surveys conducted in various parts of the country (Anjana et al. 2011). Keeping the importance of plants in treatment of diabetes, enlisting of antidiabetic woody plant resources along the National Highway from Parwanoo to Shimla for the chapter was carried out.

Methodology: Field surveys was carried out for the collection of plant samples (Parwanoo to Shimla) in the year 2018. Photographs, herbarium mounts, interviews and secondary sources were used for the compilation of the chapter. Plants were identified from different floras namely: Flora Simlensis by Collet (1902, 1921), Flora of Lahaul & Spiti by Aswal and Mehrotra (2009), Flora of Kullu by Dhaliwal and Sharma (1999), Flora of Sirmaur by Kaur and Sharma (2004), Flora of Bushar Himalayas by Nair (1977), Flora of Himachal Pradesh by Chowdhury and Wadhwa (1984) and Flora of Chamba district by Singh and Sharma (2006).

Results: Total 18 species belonging to 16 genera and 11 families have been recorded and indentified with their scientific name, family name, Vernacular name and part used. (Table 1; Figure 1-18).

Table 1: List of Antidiabetic woody plants Resources

Scientific Name	Family	Local Name	Part Used
Acacia catechu (L.f.) Willd. syn. *Acacia wallichiana* DC.	Fabaceae	Khair	Whole plant
Bougainvillea spectabilis Willd. syn. *Bougainvillea bracteata* Pers.	Nyctaginaceae	Booganbel	Leaves
Butea monosperma (Lam.) Taub. syn. *Butea frondosa* Roxb. ex Wild.	Fabaceae	Palash	Root bark
Campsis grandiflora (Thunb.) K. Schum. syn. *Tecoma grandiflora* (Thunb.) Loisel.	Bignoniaceae	NIL	Flowers
Catharanthus roseus (L.) G. Don syn. *Vinca rosea* L.	Apocynaceae	Sadabahar	Whole plant
Cissampelos pareira L. syn. *Cissampelos auriculata* Miers	Menispermaceae	Patha	Whole plant
Ficus benghalensis L. syn. *Ficus banyana* Oken	Moraceae	Bar, Bargad	Bark, Latex
Ficus racemosa L. syn. *Ficus glomerata* Roxb.	Moraceae	Umrai	Fruit, Root
Ficus religiosa L. syn. *Ficus caudata* Stokes	Moraceae	Pipal	Bark, Fruit
Helicteres isora L. syn. *Helicteres grewiaefolia* DC.	Malvaceae	Marorphali	Root
Holoptelea integrifolia Planch. syn. *Ulmus integrifolia* Roxb.	Ulmaceae	Dhamna	Bark, Leaves
Petrea volubilis L. syn. *Petrea arborea* Kunth	Verbenaceae	Nilmani lata	Leaves
Pongamia pinnata (L.) Pierre syn. *Derris indica* (Lamk.) Benn.	Fabaceae	Kiramal	Flowers
Rubus paniculatus Sm.	Rosaceae	-	Aerial parts
Senna sophera (L.) Roxb. syn. *Cassia sophera* L.	Fabaceae	Kasundi	Root
Syzygium cumini (L.) Skeels syn. *Syzygium obovatum* (Poir.) DC.	Myrtaceae	Jamun	Fruit

Tecoma stans (L.) Juss. ex Kunth	Bignoniaceae	Piliya	Leaves
Tinospora sinensis (Lour.) Merr. syn. *Tinospora cordifolia* (Willd.) Miers.	Menispermaceae	Giloe	Stem

Conclusion: Diabetes is a disorder of carbohydrate, fat and protein metabolism caused by insufficient production of insulin or due to its inhibitory action which can be considered as a major cause of high economic loss which can in turn impede the development of nations (Patel et al. 2011). According to statistics, 2.8% of the world's population suffer from this disease and it is expected to increase to more than 5.4% by 2025 (Mukesh et al. 2013). There are plenty of plants with strong antidiabetic properties. The purpose of this paper is to prepare a list of antidiabetic woody plants used in the treatment of diabetes and many other secondary complications related with diabetes. These plants have been a good source of medicine for the treatment of various type of diseases, still many plants and their chemicals or compounds have not been well described/identified. More exploration and experiments must be carried out to evaluate the exact mechanism of action of medicinal plants with antidiabetic properties. Habitat fragmentation, invasive species, pollution, overpopulation and climate change are the major factors for the biodiversity loss including plants, so there is an urgent need to conserve the plant species and plant related knowledge for the future generation & sustainable use.

References

Anjana RM, Ali MK, Pradeepa R, Deepa M, Datta M and Unnikrishnan R. (2011). The need for obtaining accurate nationwide estimates of diabetes prevalence in India-Rationale for a national study on diabetes. Indian J Med Res. 133:369–80.

Chowdhary HJ and Wadhwa BM. (1984). Flora of Himachal Pradesh: An analysis. Department of Environment, Government of India, Botanical Survey of India, Howrah, India. 860.

Collett H. (1902, 1921). Flora Simlensis, A handbook of flowering plants of Simla & the neighborhood. 1st edition by Thacker, Spink and Co., London, 2nd edition by Thacker, Spink and Co., Calcutta and Shimla. 1-652.

Dhaliwal DS and Sharma, M. (1999). Flora of Kullu District (Himachal Pradesh). Bishen Singh Mehendra Pal Singh, Dehradun, India. 1-744.

International Diabetes Federation. (2019). IDF Diabetes Atlas. 9th ed. Brussels, Belgium: International Diabetes Federation.

Kaur H and Sharma M. (2004). Flora of Sirmaur (Himachal Pradesh). Bisen Singh Mehendra Pal Singh, Dehradun, India. 1-770.

Mukesh R and Namita P. (2013). Medicinal Plants with Antidiabetic Potential-A Review. American-Eurasian J Agric Environ Sci. 13(1):81-94.

Patel DK, Kumar R, Laloo D and Hemalatha S (2011). Evaluation of phytochemical and antioxidant activities of the different fractions of *Hybanthus enneaspermus* (Linn.) F. Muell. (Violaceae). Asian Pac J Trop Med. 4(5):391–396.

Shoback DG and Gardner D. (2011). Greenspan's basic & clinical endocrinology (9th ed.). New York: McGraw-Hill Medical.

Singh H and Sharma M. (2006). Flora of Chamba district (Himachal Pradesh). Bishen Singh Pal Singh, Dehradun, India. 1-881.

World Health Organization. (2014). Archieved from the original on 31 March 2014. Retrieved 4 April 2014.

World Health Organization. (2021). The top 10 causes of death. Last accessed on 2021 Jun 04.

Fig. 1: *Acacia catechu*

Fig. 2: *Bougainvillea spectabilis*

Fig. 3: *Butea monosperma*

Fig. 4: *Campsis grandiflora*

Fig. 5: *Catharanthus roseus*

Fig. 6: *Cissampelos pareira*

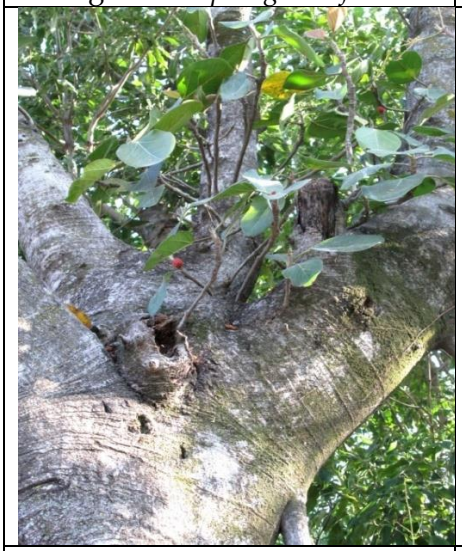


Fig. 7: *Ficus bengalensis*

Fig. 8: *Ficus racemosa*

Fig. 9: *Ficus religiosa*

Fig. 10: *Helicteres isora*

Fig. 11: *Holoptelea integrifolia*

Fig. 12: *Petrea volubilis*

Fig. 13: *Pongamia pinnata*

Fig. 14: *Rubus paniculatus*

Fig. 15: *Senna sophera*

Fig. 16: *Syzygium cumini*

Fig. 17: *Tecoma stans*

Fig. 18: *Tinospora sinensis*

Figure 1-18: Antidiabetic woody plants resources

Ambika Prasad Research Foundation
Cuttack, Odisha-753014
Phone: +91 9937045614
Email: aprf.bbsr@gmail.com
www.aprf.co.in