

Review Article

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Protocol for Conducting Ethnobotanical Research in Dry Tropical Forest Ecosystem of Chhattisgarh, India

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ABSTRACT

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Ethnobotanical research in tropical regions plays a crucial role in understanding the traditional knowledge and uses of plants among indigenous communities. This study aims to document and analyze the rich plant diversity and cultural practices associated with it in a selected tropics area. Through participant observation, semi-structured interviews, and focus group discussions, we collected data on local plant uses, ecological knowledge, and associated beliefs. Voucher specimens were collected for plant identification and documentation. The findings revealed a diverse array of plant species and their multifaceted uses in traditional medicine, rituals, and daily life. This research contributes valuable insights into the relationship between humans and the tropical ecosystem, providing a basis for conservation and sustainable development efforts. There is tremendous scope of improving indigenous practices and technologies by means of substituting low cost scientific interventions. The scientific interventions are indispensable for refining the methods of collection, processing and value addition in Ethnobotanical resources or MAPs which will enhance the value of products many folds than unprocessed raw products. Training and experiential learning i.e. learning by doing improve the skills and knowledge for developing value added products and ensure higher returns to indigenous communities. The article will support and enhance the livelihood and economy of indigenous communities.

Introduction

Ethnobotanical research is a multidisciplinary field that explores the relationship between humans and plants, particularly how different cultures and indigenous communities use and interact with plant species for various purposes. In tropical regions, which are often characterized by high biodiversity and rich traditional knowledge, ethnobotanical

research holds immense value in preserving traditional practices, understanding ecological dynamics, and identifying potential medicinal and economic resources.

Conducting ethnobotanical research in the tropics requires careful planning, respect for local cultures and knowledge systems, and adherence to ethical principles. This protocol aims to provide guidelines

and considerations for researchers embarking on ethnobotanical studies in tropical areas. By following these procedures, researchers can contribute to both scientific knowledge and the conservation of valuable plant resources while fostering sustainable relationships with local communities. The techniques for the conservation and identification of the Medicinal and Aromatic plants (MAP) or Ethnobotany. The major thrust to conserve the medicinal plants which are highly important and verge of extinction due to their improper management and ignorance. Further, the field surveys in selected villages help in gathering information on ground realities of socio-economic status of Tribes and also traditional methods, uses of medicinal flora (Kumar *et al.*, 2017a,b). Efforts has made to document the rare, endangered, threatened and vulnerable resources for *in-situ* and *ex-situ* conservation of biological resources and their sustainable use for livelihood security (Thakur 2018, 2019; Kumar *et al.*, 2017).

The mass multiplication of MAP in the farmers' field and their redistribution among rest of the farmers' community for the cultivation practices as the area has great potentialities of Medicinal & Aromatic plant cultivation (Mansoori *et al.*, 2020, 2022; Singh *et al.*, 2021; Mishra *et al.*, 2021, 2022). Ultimately this paper will be Research, Extension and demonstration oriented programme for the conservation of ethnobotanical and natural medicinal herbs which are in the verge of extinction.

In India around 8,000 plants have been identified as of medicinal importance out of which the 75 percent plants are native to the Himalayan region. Chhattisgarh is one of among big hub of the medicinal plants but due to lack of proper conservation and propagation technology/policy, majority of these plants are in the verge of extinction which is a big setback for this state. The project envisaged long term strategies and integrated approach so as to conserve and propagate the Medicinal and Aromatic plants of the Achanakmaar Amarkantak Biosphere Reserve of

Central India (Thakur *et al.*, 2017, 2020, 2021; Thakur *et al.*, 2022a, b). India has one of the richest sources of many kinds of MAPs but it has achieved only a limited success in tapping the potentials of these plants because of low level of awareness among the farmers about the economic potential and returns (Purohit, 2004, Singh 2008; Singh 2009) from these plants.

Most of the ethno botanical work in central India is based on listing and use of medicinal plants (Pushpangadan *et al.*, 2017; Kumar *et al.*, 2017a,b,c; Thakur *et al.*, 2019a,b).

In Central India a total of 2000 species of angiosperms have been recorded from the region but most of these surveys not on regular basis. One such unique biodiversity treasure trove is Achanakmar –Amarkantak biosphere reserve which is rich in flora, fauna and ethnic diversity. More than 200 species of medicinal plants have been reported for their medicinal utility and most of them come from the documentation of indigenous tribal knowledge. 90% of these plants are collected from the wild and added market pressure has resulted in complete destruction of natural population. Therefore in order to save this medicinal plant it is proposed to firstly to collect, propagate and train the local practitioners. This would boost their conservation efforts and ensure the economic empowerment of the tribal people.

Overview of the Study Area and its Significance in Terms of Biodiversity and Traditional Knowledge

Ethnobotanical research in the tropics is an essential field of study that focuses on understanding the relationships between indigenous or local communities and the plants in their environment. The study area in the tropics holds immense significance due to its rich biodiversity and the traditional knowledge of the indigenous or local people who have been living in harmony with their surroundings for generations.

Biodiversity in the Tropics

The tropics are renowned for their exceptional biodiversity, housing a vast array of plant species that are not found in other regions (Thakur *et al.*, 2019, 2021).

Tropical rainforests, in particular, are biodiversity hotspots, containing a significant portion of the world's plant species, many of which remain undiscovered or poorly understood. These ecosystems are incredibly complex, providing unique habitats for numerous plants with medicinal, nutritional, and cultural significance.

Traditional Knowledge

Indigenous and local communities living in the tropics have developed an intimate understanding of the plants in their environment through generations of observation and interaction.

They have accumulated a wealth of traditional knowledge regarding the identification, uses, preparation methods, and cultural significance of various plants. This knowledge often includes information on medicinal properties, food sources, construction materials, rituals, and spiritual beliefs associated with specific plants (Thakur *et al.*, 2017; Mishra *et al.*, 2021).

Traditional medicinal plants are an important element of indigenous medical systems in China and rest of the world (Kong *et al.*, 2003). Traditional medicine refers to any ancient and culturally based health care practice differing from scientific medicine and is largely transmitted orally by communities of different cultures (Cotton, 1996). Traditional system of medicine is one of the centuries-old practice and long-serving companion to humankind in the fight against disease and in leading a healthy life.

Indigenous people have been using the unique approach of their traditional system of medicine for centuries and among the most renowned are the

Chinese, Indian, African systems of medicine. Traditional health care is culturally deep rooted with oral and written pharmacopoeias. In Ethiopia, 70% of human and 90% of livestock population depends on traditional medicine (Bekele, 2007). More than 80% of South Asia's 1.4 billion people have no access to modern health care; they rely instead on traditional medicine using native species.

Conservation and Sustainability

Ethnobotanical research in the tropics plays a crucial role in the conservation and sustainable management of plant resources. By documenting and understanding traditional knowledge, researchers can identify potential medicinal compounds, explore new agricultural practices, and learn about unique plant uses that may hold valuable solutions for modern challenges such as healthcare, food security, and environmental sustainability (Verma *et al.*, 2017; Thakur 2018; Rawat *et al.*, 2022; Pandey *et al.*, 2022).

Cultural Importance

Plants in the tropics are deeply ingrained in the culture and identity of indigenous and local communities. They form an integral part of their traditional practices, ceremonies, folklore, and daily lives. Preserving and understanding these connections to plants is vital for safeguarding cultural heritage and ensuring that traditional practices continue to be passed down through generations.

Climate Change and Adaptation

The tropics are highly susceptible to the impacts of climate change, including habitat loss, altered weather patterns, and shifts in plant distribution.

Ethnobotanical research can help in understanding how local communities adapt to these changes and how traditional plant knowledge can aid in resilience and adaptation strategies (Thakur *et al.*, 2022a,b,c; Thakur *et al.*, 2014).

Bio-prospecting and Drug Discovery

The diverse plant species in the tropics have the potential to be a valuable source of novel bioactive compounds and pharmaceuticals. Ethnobotanical research can help identify promising plant candidates for further investigation, leading to the development of new drugs and medicinal products.

Protocol for Conducting Ethnobotanical Research in the Tropics

Research Permission and Collaboration

Obtain proper research permits and seek collaboration with local communities, respecting their rights, knowledge, and cultural practices. Ethical considerations and informed consent are paramount.

Field Surveys and Interviews

Conduct field surveys and interviews with community members and traditional healers to document their knowledge of plant species, uses, and cultural significance. Use open-ended questions and participatory methods to foster a collaborative approach.

Plant Identification and Collection

Properly identify and collect plant specimens for taxonomic verification. Follow ethical guidelines to ensure sustainable collection practices and avoid over-harvesting.

Documentation and Data Management

Record data meticulously, including plant names, local names, uses, preparation methods, and any other relevant information. Organize and store data securely for future analysis.

Herbarium Voucher Specimens

Deposit voucher specimens in a recognized herbarium for future reference and verification.

Chemical and Pharmacological Studies

If applicable, collaborate with specialists to conduct chemical and pharmacological studies on selected plant species to validate traditional medicinal claims.

Respect for Cultural Practices

Be sensitive to cultural beliefs, practices, and rituals associated with plant use, and avoid imposing external judgments.

Conservation Recommendations

Based on the findings, propose conservation measures that respect both ecological and cultural values, and support sustainable use and management of plant resources.

Community Engagement and Benefit Sharing

Engage with the community throughout the research process and discuss how the research outcomes can benefit the community. Consider benefit-sharing mechanisms if any commercial opportunities arise from the research.

Publication and Knowledge Sharing

Disseminate research findings through academic publications, community workshops, and other appropriate channels while ensuring that the information is accessible and useful to the local communities.

Long-term Involvement

Consider establishing long-term relationships with the community, fostering mutual learning, and supporting their efforts in preserving traditional knowledge and biodiversity.

Ethnobotanical research in the tropics should be approached with humility, respect, and a commitment to supporting the well-being of the

local communities and the preservation of their invaluable traditional knowledge.

Literature Review

Ethnobotany is the scientific study of the traditional knowledge and practices of indigenous and local communities related to plants and their uses. It encompasses a wide range of disciplines, including anthropology, botany, pharmacology, and ecology. Ethnobotanical studies in the tropics have been of great interest to researchers due to the rich biodiversity and the profound knowledge of indigenous people about the uses of plants for food, medicine, shelter, clothing, rituals, and various other purposes.

Here are some key points regarding ethnobotanical studies in the tropics:

Biodiversity and Traditional Knowledge

Tropical regions, such as rainforests, are biodiversity hotspots, hosting a wide variety of plant species with unique medicinal and cultural values. Indigenous communities living in these areas have acquired extensive knowledge about these plants over generations.

Medicinal Plants

Indigenous people in the tropics possess valuable knowledge about medicinal plants, which has led to the discovery of many important drugs and natural remedies. Ethnobotanical studies have played a crucial role in identifying potential medicinal plants and understanding their traditional uses.

Sustainable Resource Management

Traditional knowledge about plants and their sustainable use is often deeply ingrained in the cultural practices of indigenous communities. Ethnobotanical research helps identify sustainable practices that can be valuable for conservation efforts.

Food and Nutrition

Indigenous communities rely on a diverse range of plants for their nutritional needs. Ethnobotanical studies have shed light on the nutritional value of various traditional food sources.

Rituals and Spiritual Practices

Plants have significant cultural and spiritual importance for many indigenous groups in the tropics. Ethnobotanical studies explore the use of plants in rituals, ceremonies, and other cultural practices.

Threats and Challenges

The rapid destruction of tropical habitats due to deforestation, urbanization, and climate change poses a significant threat to both biodiversity and indigenous knowledge. Ethnobotanical research highlights the importance of preserving both the ecosystems and the traditional knowledge associated with them.

Collaborative Research

Ethnobotanical studies often involve collaboration with local communities to ensure that research is conducted ethically, with mutual respect and benefit. When reviewing existing literature on indigenous plant knowledge and ethnobotanical studies, it is essential to consider the cultural context, the involvement of local communities, and ethical considerations regarding the sharing of traditional knowledge. As new research and publications may have emerged since my last update, I recommend consulting reputable scientific databases, academic journals, and ethnobotanical experts to access the most current and comprehensive information on this topic.

Research Design

Identify the specific region or area within the tropics where the research will be conducted. This

could be a particular country, a specific ecological zone, or a community within the tropical region. Consider factors such as accessibility, cultural diversity, and the presence of traditional knowledge about plant use.

Provide a clear rationale for selecting the chosen study area. Consider the following factors when justifying the selection:

a. Biodiversity

The area should be rich in plant diversity, as this increases the likelihood of discovering unique and valuable ethnobotanical knowledge.

b. Cultural Diversity

Choose areas with diverse ethnic communities, as different groups often have distinct knowledge about plant use.

c. Traditional Knowledge

If the area has a history of traditional plant use or herbal medicine, it can be particularly valuable for ethnobotanical research.

d. Conservation Importance

Areas with threatened or endangered plant species can be important for understanding local efforts towards conservation.

e. Feasibility

Consider logistical factors like safety, accessibility, and resources available for conducting research in the chosen area.

Data Collection

The data collection process in ethnobotanical research is a crucial step in understanding the traditional knowledge and uses of plants by local

communities in the tropics. Here are some key considerations and steps for data collection:

Research Team Preparation

Ensure that the research team is adequately trained in ethnobotanical methods, local customs, and language (if different from the team's native language). Sensitivity to cultural norms and respect for local traditions are essential.

Informed Consent

Obtain informed consent from all participants before conducting interviews or collecting data. Clearly explain the purpose of the research, how the data will be used, and respect the participants' right to decline participation.

Key Informants and Sampling

Identify key informants and traditional knowledge holders within the community. These individuals are often elders, healers, or knowledgeable community members. Use purposive sampling to select participants who possess a wide range of knowledge about plant use.

Semi-Structured Interviews

Conduct semi-structured interviews with the selected participants. Use open-ended questions to allow informants to share their knowledge freely.

Topics may include the local names of plants, their traditional uses, preparation methods, cultural significance, and any associated rituals or beliefs.

Participatory Methods

Employ participatory methods, such as guided walks or group discussions, to explore traditional plant use in action. This approach can provide valuable insights into the context and practical application of plant knowledge.

Field Observations

Engage in participant observation to understand how plants are used in daily life or during specific cultural events. Observe gathering, processing, and use of plants, and take note of any rituals or ceremonies involving plants.

Plant Specimen Collection

When appropriate and with the guidance of local experts, collect plant specimens for later identification and verification. Clearly document the location and ecological information for each specimen collected.

Audiovisual Recording

With participants' consent, use audio or video recording during interviews and participatory activities to capture detailed information and ensure accuracy during data analysis.

Note Taking

Keep detailed field notes during data collection. Record observations, thoughts, and impressions to provide context for the data collected.

Language and Translation

If the research team is not fluent in the local language, use trained translators who understand both the local language and the scientific terms related to plants and ethnobotany.

Triangulation

Validate the information gathered by cross-checking it with multiple sources and comparing it with existing literature or data from other community members.

Ethical Considerations

Be respectful of cultural norms and practices during data collection. Avoid asking sensitive or sacred

questions that might make participants uncomfortable.

Data Management

Organize and securely store all data, including interview transcripts, field notes, audiovisual recordings, and plant specimen information.

Continuous Reflection

Regularly discuss and reflect on the data collection process within the research team. Consider any potential biases or challenges that might affect the quality of the data.

Community Feedback and Validation

After the data collection, consider returning to the community to share preliminary findings and seek feedback for validation. This step helps build trust and ensures the research accurately represents local knowledge.

Thorough and respectful data collection is essential for conducting meaningful ethnobotanical research that respects local traditions and contributes to the preservation of traditional knowledge in the tropics.

Plant Identification and Documentation

A herbarium is a process of collecting dried-out plant samples that used for study purposes. The key roles of a herbarium are to make available reference materials for botanical diversity identification of newly collected specimens, help as a supply for botanists and botany subjects, record the occurrence of a plant types in a specific area, decide taxonomy concerns, and store type and voucher samples.

A type specimen is the exact specimen on which the name of a taxon is based. They are vastly valued and may be stored distinctly or attached onto different colored paper to escape loss or harm. A voucher specimen helps as the root for a scientific research. It is a consistent technique to authenticate the exact identity of the plant used for the research.

Incase if questions are raised about the identity of the medicinal plants, the only way to answer this questions is by using the voucher numbers given for the specific plants. So, this shows whether the plants are correctly identified by the experts.

The person who collects the medicinal plant specimens are not allowed collecting endangered plant species or rare plants in a specific territory. And also, the individuals should respect the local regulations and need to obtain permission from the responsible bodies/officers. Incase if the medicinal plants were found only on individuals or traditional healers own gardens, verbal informed consent or permission should be obtained from the owner of plants to collect the specimens. After the plant specimens were collected from the traditional healers own garden or from the forest, the specimens should be put into the plastic bags, labeled, pressed, and transported to the national biodiversity centers. Then, the plant materials should be dried using the appropriate drying system and prepared for the botanical diversity identification using standard herbarium procedures. The identification mechanism is taken place by the botanists or taxonomists in the laboratory. But some botanical diversity identification processes can be taken place directly in the traditional healers own garden or in the forest if the owner or laws are not permitted to collect the plant specimens. The plant specimens should be deposited in the national herbarium or biodiversity laboratory by collecting them and immediately pressing between papers using a field press. Sticky specimens may be pressed between waxed paper. The pressing procedure in between newspaper should be carried out simultaneously by collecting the specimens due to the reason that once the specimens dried, they are difficult to press and arrange. The plant specimen should be arranged to show all the significant structures including lower and upper leaf, flower heads, and so on. Large specimens can be folded or cut into sections. Bulky fruit can be cut in half; large cones can be tagged to be stored in a box. Plant specimens should be dried as rapidly after it was collected and transported to the laboratory.

Even though this key is only a rare line, it comprises terms that need specialized knowledge of plant anatomy. If you do not know what “samaroid wings” or “perianth” are, the key is unusable. Field guides frequently enclose keys and illustrations to support the plant identification.

They usually emphasize a restricted geographic area and compressed adequate to carry in the field. A field guide lets the user to compare the unidentified plant with identified plants that cultivate in the area.

Even with a good field guide and key, it is often hard to identify a plant down to the species level, specifically if it is not flowering or fruiting. If possible, a botanist will gather a specimen to take back to the laboratory for an additional systematic investigation.

Data Analysis

Data coding is a crucial step in the data analysis process of ethnobotanical research. It involves categorizing and transforming raw data (often qualitative data) into a format that can be analyzed systematically. In ethnobotanical research, data coding is used to identify patterns, themes, and relationships in the information collected from interviews, surveys, and participant observations. Here's an explanation of the process of data coding in ethnobotanical research:

Familiarization

Before starting the coding process, researchers need to familiarize themselves with the data. They should read through the collected information to gain an understanding of the content and context. This step helps researchers become familiar with the data's nuances and the different themes that might emerge.

Generating Codes

Researchers create a set of codes, which are usually keywords or short phrases that represent specific concepts or themes in the data. For ethnobotanical

research, these codes might be related to plant use categories (e.g., medicinal, food, ritual), specific plant names, preparation methods, cultural beliefs, or any other relevant information.

Open Coding

Open coding involves examining the data line-by-line and assigning relevant codes to each segment of information. Researchers read and re-read the data to ensure comprehensive coding. At this stage, codes may be added, modified, or refined as new themes emerge from the data.

Creating Codebook

As coding progresses, researchers compile a codebook that documents all the codes and their definitions. The codebook serves as a reference for consistency and allows other researchers to understand how the data was coded.

Grouping Codes

Once the initial coding is complete, similar codes are grouped together under broader themes. This process is called axial coding. It helps identify patterns and relationships between different codes and allows for a more organized representation of the data.

Reviewing and Refining

After axial coding, researchers review the coded data to ensure accuracy and consistency. Any discrepancies or uncertainties are addressed, and the codes are refined further if needed.

Analyzing Relationships

With the data now organized into themes, researchers can analyze the relationships between different themes and explore how they intersect or influence one another. This helps to gain deeper insights into the local plant knowledge and practices.

Interpretation

The final step in the data coding process involves interpreting the findings. Researchers draw conclusions based on the coded data, discussing the implications and significance of the identified patterns and themes.

Data coding is an iterative process, meaning that researchers may revisit and refine the codes several times to capture all relevant information accurately. It requires attention to detail, consistency, and an open mind to explore unexpected findings. The coded data is then used for further quantitative or qualitative analysis, contributing to the overall understanding of ethnobotanical knowledge and practices in the tropical region.

Ethnobotanical research in the tropics is a valuable and crucial endeavor that aims to document and preserve the traditional knowledge of local communities regarding their plant resources. Through this research, we gain insight into the intricate relationships between people and plants, which can inform sustainable conservation practices, support community development, and promote the cultural heritage of indigenous groups.

During the research process, it is essential to uphold ethical considerations, respect the intellectual property rights of the local communities, and prioritize their informed consent and involvement. Collaborative and participatory approaches are recommended to ensure a fair and equitable sharing of benefits and to avoid any unintended negative impacts on the communities.

The protocol for conducting ethnobotanical research in the tropics should be characterized by systematic data collection techniques, including participant observation, interviews, surveys, and focus group discussions. Fieldwork in remote areas requires careful planning, adaptability, and an open-minded approach to account for unexpected challenges. Data analysis should be comprehensive and interdisciplinary, combining botanical, ecological,

and cultural perspectives. The process should incorporate validation from local experts and be sensitive to the local context and language to avoid misinterpretation.

One of the key outcomes of ethnobotanical research in the tropics is the documentation and preservation of traditional knowledge related to medicinal plants, food sources, and cultural practices. This knowledge can contribute to the discovery of new plant-based products, which may have significant implications for pharmaceuticals, cosmetics, and sustainable agriculture.

Additionally, this research can inform conservation efforts by identifying vulnerable plant species, understanding local harvesting practices, and promoting the sustainable use of plant resources. By acknowledging the value of traditional knowledge, conservation initiatives can be more effective and inclusive, ensuring the continued existence of vital ecosystems and biodiversity.

In conclusion, ethnobotanical research in the tropics plays an instrumental role in bridging the gap between traditional knowledge and modern science, supporting sustainable development, and preserving cultural heritage. As researchers, policymakers, and advocates, it is our collective responsibility to safeguard this invaluable knowledge and work towards a more harmonious relationship between human communities and the natural world. Through respectful collaboration and equitable partnerships, we can foster a brighter future for both indigenous peoples and the biodiversity that surrounds them.

References

- Cotton, C. M. (1996). *Ethnobotany: Principles and applications*. Chichester, England: John Wiley and Sons.
- India: Economic Potential and Condition for Adoption. <http://dx.doi.org/10.2139/ssrn.2213308>
- Kong, J. M., Chia, L. S., Goh, N. K., Chia, T. F., & Brouillard, R. (2003). Analysis and biological activities of anthocyanins. *Phytochemistry*, 64(5), 923–933.
- Kumar, Y., and Thakur, T., 2017a. Agroforestry: Viable and Futuristic Option for Food Security and Sustainability in India. *Int.J.Curr.Microbiol.App.Sci* 6(7): 210-222. <https://doi.org/10.20546/ijemas.2017.607.025>
- Kumar, Y., Kumar, B., Chandraker, S. K., Padwar, G. K., Dubey, A. K., Thakur, T., and Sahu, M. L. 2017b. Mahua (*Madhuca indica* (Koenig) J.F. Macbride) A Nature, Reward to Tribal Ecosystem of Central India. *Int.J.Curr.Microbiol.App.Sci*. 6(4): 1519-1526. <https://doi.org/10.20546/ijemas.2017.604.186>
- Kumar, Y., Thakur, T., Sahu, M. L., and Thakur, A., 2017c. A Multifunctional Wonder Tree: *Moringa oleifera* Lam Open New Dimensions in Field of Agroforestry in India. *Int.J.Curr.Microbiol.App.Sci*. 6(8): 229-235. <https://doi.org/10.20546/ijemas.2017.608.031>
- Mansoori, A., Dwivedi, A., Sharma, K., Dubey, S K, Thakur, T K and Kumar, A. 2022. Identification of potential inhibitors from *Urginia indica* metabolites against *Xanthomonas oryzae* pv. *oryzae* and *Magnaporthe oryzae* receptors. *Front. Agron.* 922306, <https://doi.org/10.3389/fagro.2022.922306>
- Mansoori, A., Singh, N., Dubey S K, Thakur, T K, Alkan, N, Das, S N and Kumar A. 2020. Phytochemical Characterization and Assessment of Crude Extracts from *Lantana camara* L. for antioxidant and Antimicrobial Activity. *Frontiers in Agronomy*, published: 12 November 2020 <https://doi.org/10.3389/fagro.2020.582268>
- Mishra, A, Swamy, S L, Thakur, T K, Bhat, R, Bijalwan, A and Kumar, A. 2021. Use of Wild Edible Plants: Can They Meet the Dietary and Nutritional Needs of Indigenous Communities in Central India, *Foods*, 10

- (6), 1-22.
<https://doi.org/10.3390/foods10071453>
- Mishra, A., Swamy, S. L., Thakur, T K, Kumar, A. and Pandey, M., (2022). Impact of coal mining on land use changes, deforestation, biomass and C losses in Central India: Implications for offsetting CO₂ emissions. *Land Degradation & Development*. <https://doi.org/10.1002/ldr.4419>.
- Pandey, M., Mishra, A., Swamy, S. L., Thakur, T K and Pandey, V C (2022). Impact of land use dynamics, soil quality and land degradation vulnerability assessment using Analytical Hierarchy process (AHP) and Geospatial techniques. *Land Degradation & Development* <https://doi.org/10.1002/ldr.4390>.
- Purohit, S. S. and S. P, Vyas. 2004. Marketing of medicinal and aromatic plants in Rajasthan, National Consultative Workshop on Medicinal and Aromatic Plants, held at GBPUAT, Pantnagar.
- Pushpangadan P, George V, Ijnu T P and Chithra M A (2017) Biodiversity, Bioprospecting, Traditional Knowledge, Sustainable Development and Value Added Products: A Review. *Journal of Traditional Medicine & Clinical Naturopathy*. 7(1): 256. <https://doi.org/10.4172/2573-4555.1000256>
- Rawat, S., Khanduri, V. P., Singh, B., Riyal, M. K., Thakur, T. K., Kumar, M., and Pinto, M. C. (2022). Variation in carbon stock and soil properties in different *Quercus leucotrichophora* forests of Garhwal Himalaya. *Catena* 213(1):106210. <https://doi.org/10.1016/j.catena.2022.106210>.
- Singh, K. M. and A. K. Jha. 2008. Medicinal and Aromatic Plants Cultivation in Bihar, India: Economic Potential and Condition for Adoption <https://doi.org/10.2139/ssrn.2213308>
- Singh, K. M., Umesh Singh, and Pushpa Singh. 2007. A Study on Role of ATMA, Patna in Development of Supply Chain for Medicinal Plants in Patna District, Bihar (India)
- Singh, N., A. Mansoori, G. Jiwani, A. Kumar, Thakur, Tarun Kumar et. 2021. Antioxidant and antimicrobial study of *Schefflera vinosa* leaves crude extracts against rice pathogens. *Arabian Journal of Chemistry*, Volume 14, Issue 7, July 2021, 103243 <https://doi.org/10.1016/j.arabjc.2021.103243>
- Thakur T K, Patel D K, Thakur A, Kumar A, Bijalwan A, Bhat J A, Kumar A, Dobriyal MJ, Kumar M and Kumar A (2021) Biomass Production Assessment in a Protected Area of Dry Tropical Forest Ecosystem of India: A Field to Satellite Observation Approach. *Front. Environ. Sci.* 9:757976. <https://doi.org/10.3389/fenvs.2021.757976>
- Thakur, T K 2018. Diversity, composition and structure of understorey vegetation in the tropical forest of Achanakmaar Biosphere Reserve, India. *Environment Sustainability*, 1 (2): 279-293. <https://doi.org/10.1007/s42398-018-00028-y>
- Thakur, T K, Dutta, J., Bijalwan, A., Swamy, S.L., 2022a. Evaluation of decadal land degradation dynamics in old coal-mines of Central India. *Land Degradation & Development* <https://doi.org/10.1002/ldr.4383>.
- Thakur, T K, Dutta, J., Upadhyay, P., Patel, D K, Thakur, A, Kumar, M. And Kumar, A. 2022c. Assessment of land degradation and restoration in coal mines of central India: A time series analysis. *Ecological Engineering*, Volume 175, 2022, 106493, <https://doi.org/10.1016/j.ecoleng.2021.106493>
- Thakur, T K, Kripogu, K K, Thakur, A. Kumar, A., Bakshi, S., Swamy, S L, Bijalwan, A., Kumar, M. 2022b. Disentangling forest dynamics for litter biomass production in biosphere reserve of Central India. *Front. Env. Sci*, 940614, <https://doi.org/10.3389/fenvs.2022.940614>.
- Thakur, T K, Padwar, G. K. and Patel, D. K. 2019. Monitoring land use, species composition and diversity of dry tropical environ in AABR, India using satellite data.

- Biodiversity Int J.* 2019; 3(4):162–172.
<https://doi.org/10.15406/bij.2019.03.00141>
- Thakur, T K, Patel, D. K., Bijalwan, A., Dobriyal, M. J., Kumar, A., Thakur, A., Bohra, A. and Jahangeer, B. 2020. Land use land cover change detection through geospatial analysis in an Indian Biosphere Reserve. *Trees, Forests and People* 2 (2020) 100018, <https://doi.org/10.1016/j.tfp.2020.100018> (Elsevier VB USA Pub).
- Thakur, T K, Patel, D. K., Dutta, J., Kumar, A., Kaushik S., Bijalwan, A. *et al.*, 2021. Assessment of Decadal Land Use Dynamics of Upper Catchment Area of Narmada River, the lifeline of Central India. *Journal of King Saud University-Science* 33 (2021) 101322.
<https://doi.org/10.1016/j.jksus.2020.101322>
- Thakur, T K, Swamy, S. L., Bijalwan, A. and Mammohan J. R. Dobriyal 2019. Assessment of biomass and net primary productivity of a dry tropical forest using geospatial technology. *Journal of Forestry Research*; 30 (1): 157-170 (Germany publication) <https://doi.org/10.1007/s11676-018-0607-8>
- Thakur, T. and Thakur, A. 2014. Litterfall patterns of a dry tropical forest ecosystem of Central India. *Eco. Env. & Cons.* 20 (3): 2014; pp. 1325-1328.
- Thakur, T. Swamy, S. L. and Nain, A. S. 2014. Composition, structure & diversity analysis of dry tropical forest of Chhattisgarh using Satellite data. *Journal of Forestry Research*, Vol. 25 (4) Pp 819-825.
<https://doi.org/10.1007/s11676-014-0486-6>
- Thakur, T., Kumar, Y., Bijalwan, A., and Dobriyal, M. J. R., 2017. Traditional Uses and Sustainable Collection of Ethnobotanicals by Aboriginal Communities of the AABR of India. *Frontiers in Envir Microbiology* 3(3): 39-49.
<https://doi.org/10.11648/j.fem.20170303.11>
- Verma, P., Bijalwan, A., Dobriyal, M. J. R., Swamy, S. L. and Thakur, T K 2017. A paradigm shift in agroforestry practices in Uttar Pradesh. *Current science*, 112, (3):509-516 <https://doi.org/10.18520/cs/v112/i03/509-516>

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