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Review article

All India coordinated research project on ethnobiology and genesis of ethnopharmacology research in India including benefit sharing

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Abstract

Man has been using medicinal plants to alleviate diseases and discomfort from the very dawn of evolution of human beings. People living in different parts from time immemorial, had selected their food and medicine by a process of trial and error or even by experimentation from the biological resources, particularly from the plants, found around them and this became known as the ethnic food/ traditional food and ethnic medicine/ traditional medicine. India has one of the oldest, richest and most diverse cultural traditions, associated with the use of medicinal plants. The country has a great heritage of medicinal plant use, dating back to the early *Vedic* period. Like in many other indigenous cultures or civilizations across the world, the Indian indigenous communities have possessed/accumulated vast knowledge on multifarious uses of plants and other natural resources found around them. Living close to nature and by trial, error, empirical reasoning and experimentation, the primitive indigenous societies have developed their own unique wealth of knowledge pertaining to conservation and sustainable use of plants, animals and other natural resources. During the 1980s, Ministry of Environment and Forests and Climate Change (MoEF&CC), Govt. of India launched an All India Co-ordinated Research Project on Ethnobiology (AICRPE). JNTBGRI has developed a benefit sharing model through AICRPE with Kani tribe on the plant *Trichopus zeylanicus* Gaertn. ssp. *travancoricus* (Bedd Burkill *ex* Narayanan). This model is perhaps a unique experiment ever done, wherein the benefits accrued from the development of a product based on an ethnobotanical lead were shared with the holders of that traditional knowledge. Considering the significant outcome of this model in community empowerment, income generation and poverty eradication of a tribal community, Pushpangadan was awarded with the UN-Equator Initiative Prize (under individual category) at the World Summit on Sustainable Development held in Johannesburg in August 2002. Now with the CBD and WIPO guidelines and our national legislation on biodiversity in position, the JNTBGRI or Kani case study could be taken as an ideal model of equitable benefit sharing involving genetic resources and associated traditional knowledge.

Key words: All India Coordinated Research Project on ethnobiology, ethnobotany, ethnopharmacology, biodiversity, benefit sharing, *Trichopus zeylanicus* Gaertn.

1. Introduction

All India Coordinated Research Project on Ethnobiology (AICRPE) was a multidisciplinary, multi-institutional, and action oriented research project, launched by Government of India from 1982 to 1998. Dr. C. K. Atal, the then Director, Regional Research Laboratory (RRL), Jammu (now known as CSIR-Indian Institute of Integrative Medicine), selected Dr. P. Pushpangadan, a Senior Scientist of RRL, as the Chief Coordinator of AICRPE from about 25 candidates from all over India. Dr. T. N. Khoshoo then the Secretary of Ministry of Environment and Forest, Govt. of India appointed Dr. Pushpangadan as the Chief Coordinator of AIRCPE and provided him a room in the Ministry of Environment and Forest, New Delhi for 15 days in a month. The project was aimed at inventorying and documenting the multidimensional perspectives of the life, culture and traditions of the tribes as well as their knowledge system associated with the utilization of the local biological resources. The project further intended to develop strategies for conservation/preservation of traditional life, knowledge system and resource utilization pattern by tribes (Pushpangadan,

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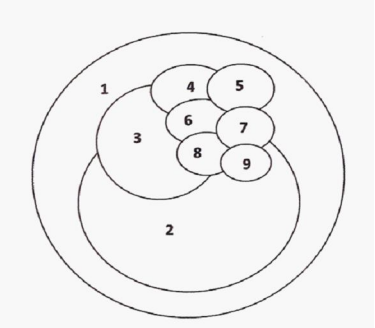
2002; Pushpangadan and Nair, 2005; Pushpangadan and Pradeep, 2008; Pushpangadan *et al.*, 2008; Pushpangadan, 2010; Pushpangadan, 2014; Pushpangadan *et al.*, 2014; Pushpangadan *et al.*, 2015a, b; Pushpangadan *et al.*, 2016a, b; Pushpangadan and Ijinu, 2017; Pushpangadan *et al.*, 2017a, b). "Modern system of medicine is based on experimental data, toxicity studies, preclinical and clinical studies. But, Pharmacopoeial standards on raw material/ finished products are not available. Standardization of herbal drugs is decisive to evaluate the quality of drugs, based on their bioactivity, phytochemical, chemical *in vitro* and *in vivo* parameters. The quality assessment of herbal formulations is of paramount to justify their acceptability in modern system of medicine"(Sachan *et al*., 2016, Rais -ur- Rahman, 2017).

AICRPE coordination unit was established at Regional Research Laboratory, Jammu from 1983-1990 and later at Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Thiruvananthapuram from 1990-1998 and had carried out the co-ordination, overall supervision, synthesis of data, promotion and smooth functioning of the 27 constituent AICRPE units in the country. The coordination unit also carried out field studies (ethnopharmacology) to collect base line information pertaining to socio-techno-economic conditions of the tribes with the aim of identifying and recommending suitable location oriented production technologies for the economic upliftment of the tribes. The pharmacology unit was later named as Ethnopahrmacology. This unit was taking chemical and biological screening of the promising tribal medicinal plants, collected from the different project areas in the country (Pushpangadan and Pradeep, 2008).

With the survey team required to reach highly inaccessible terrains spread across the country and most of these with limited communication coordination was an arduous task. The Chief Coordinator and his staff made frequent visits to the different AICRPE units and held discussions on various problems associated with the project work. The Coordinator was instrumental in bringing close contact and collaboration among different scientists of the constituent units of AICRPE, drawn from multidisciplinary backgrounds on account of the frequent interactions with a large number of scientists belonging to various disciplines in the country, the Chief Coordinator was able to bring out effective monitoring and coordination of this multidisciplinary and multi-institutional project programme. Exchange of new ideas and useful suggestions given by the Coordinator from time-to-time have helped many AICRPE units to adopt a comprehensive and action oriented approach towards the project programme, and to undertake the work in a transdiciplinary manner using system approach rather than a sectoral approach to understand and evaluate the tribal situation in their ecosystem context. Many AICRPE units were thus able to study and diagnose clearly and identify the critical constraints of the multidimensional perspective of the complex fabric of the life, culture, traditions, knowledge system, resources utilization pattern, technological capabilities and the peculiar socio-economic problems of the tribes and then suggest suitable scientific measures to deal with it (Pushpangadan and Pradeep, 2008).

1.1 All India Coordinated Research Project on Ethnobiology (AICRPE), 1982-1998

The multi-institutional and multidisciplinary project was operated in about 27 centres by over 500 scientific personnel located in the different institutions, spread over the length and breadth of the country. AICRPE during the course of its operation (1982-1998) recorded information on the multidimensional perspectives of the life, culture, tradition and knowledge system associated with biotic and abiotic resources of the 550 tribal communities comprising over 83.3 million people belonging to the diverse ethnic group. In India, there are 550 communities of 227 ethnic groups. There are 116 different dialect of 227 subsidiary dialects spoken by tribals of India. The knowledge of these communities on the use of wild plants for food, medicine and for meeting many other material requirements are now considered to be potential information for appropriate S&T intervention for developing value added commercially marketable products. The traditional knowledge (TK) is oral in tradition and not qualified for the formal IPR system. The vast information collected by the AICPPE team is locked up as unattended reports for want of proper resources. Traditional knowledge on about 10,000 plants (Figure 1) have been collected during the course of the project. It may be mentioned here that the classical systems of medicine (*Ayurveda, Siddha, Unani, Amchi, etc*.) makes use of only 2,500 plants whereas we have a database on 10,000 plants which requires further scientific validation. Out of this 8000 wild plant species used by the tribals for medicinal purposes, about 950 are found to be new claims and worthy of scientific scrutiny. Out of 3900 or more wild plant species used as edible as subsidiary food/vegetable by tribes, about 8000 are new informations and atleast 250 of them are worthy of investigation. Out of 400 plant species used as fodder, 100 are worth recommending for wider use and out of 300 wild species used by tribals as piscides or pesticides, atleast 175 are quite promising to be developed as safe pesticides (Pushpangadan, 2002; Pushpangadan and Nair, 2005; Pushpangadan and Pradeep, 2008; Pushpangadan *et al.*, 2008; Pushpangadan, 2010; Pushpangadan, 2014; Pushpangadan *et al.*, 2014; Pushpangadan *et al.*, 2015a, b; Pushpangadan *et al.*, 2016a, b; Pushpangadan and Ijinu, 2017; Pushpangadan *et al.*, 2017a).



1. Total (10000)
2. Medicinal (8000)
3. Edible Use (4000)
4. Other Material and Cultural Requirements (750)
5. Fibre and Cordage (600)
6. Fodder (500)
7. Pesticides, Piscicides etc. (325)
8. Gum, Resin and Dye (300)
9. Incence and perfumes (100)

Figure 1: Utilization pattern of wild plants by tribals of India

The tribal communities of our country generally also use wide varieties of medicine derived from both invertebrate and vertebrate animals. As regards to use of animal drugs, there is a remarkable similarity in practices among the tribes at many places depending on the availability of specific animals around their habitats. Thus, it indicates indirectly the authenticity of such drugs in their medicinal practice running through ages. About 76 species of animals have proved to be the vital source of tribal medicine. Of these, 16 species are invertebrates like insects, crustaceans, arachnids, molluscs, *etc*., and 60 are vertebrates. The latter includes six species of pisces, one species of amphibia, nine species of reptilia, 16 spp. of aves and 29 spp. of mammalia including human beings. The invertebrates are generally used as a whole, while in case of vertebrates; the body parts, tissues, exoskeletons, flesh, blood, bite, fat, bones, gastrointestinal tracts, *etc*., are used. Likewise, animal products such as honey, egg, milk, spider net, urine, faeces, *etc*., are of vital value in curing many fatal diseases. The diseases known to be cured with the help of animal drugs are too many such as tuberculosis, rheumatic and joint pain, asthma, piles, pneumonia, night blindness, impotency, paralysis, weakness, cholera, body ache, *etc*. In other words, to get diseases cured, the dependable source of medicine was either plants or animals since the modem medicines were completely unknown to them. However, the overall development in recent times in the country is bringing rapid change in their disease treatment preferences through modern medicine (Pushpangadan and Pradeep, 2008).

Table 1: Number of invertebrate and vertebrate animals used by tribes of India

Invertebrates (16 species)	Vertebrates (60 species)
Includes insects, crustaceans, arachnids, molluscs etc.	6 species of Pisces 1 species of amphibia 9 species of reptilia 16 species of aves 29 species of mammalia including human beings
Total	76 species

1.2 Traditional knowledge

All over the world, the tribes possess a vast wealth of indigenous knowledge system (IKS) which has been unique to a given culture or a society. TK is a result of co-evolution and co-existence of indigenous cultures and their traditional resource use. It can also be termed as 'Natural Capitalism' or a 'Green Economy'. Further, TK is a community based functional knowledge developed, preserved and maintained over many generations by local and indigenous people through continuous interactions, observations and experimentations with their surrounding environment. TK serves as a powerful tool for bio-prospecting of plant wealth and also for converting into value added products ensuring health security to masses in a most befitting and sustainable manner. Indigenous communities are responsible for discovery of a range of health giving herbal formulations including nutraceuticals and medicinal plants which can generate considerable economic value for our nation and alleviate the poverty as well. It plays a very important role in the development of the economy at national and global levels (Pushpangadan *et al.*, 2010; Pushpangadan *et al.*, 2012; Pushpangadan and Ijinu, 2017, Pushpangadan *et al.*, 2018a, b). About 4.8 billion people (80% of world's population) rely on plants for their primary source of medicine (Hanman, 1991; Inglis, 1994; Marshall, 1998; Ijinu *et al.*, 2011).

The traditional communities, thus became a treasure trove of accumulated knowledge and wisdom about the management and utilization of various plants and other materials around him. Due to modernization, the precious knowledge system have been eroding and corroding fast and at times getting totally disappearing during the last many years. It was the realization of this fact that researchers from many countries around the world were motivated to undertake ethnobotanical investigations to document the traditional knowledge and wisdom of the people. It is now well recognized that the traditional wisdom and knowledge on utilization of the biological resources is of immense value to biodiversity planners and scientists in developing strategies in conservation, utilization and generation of wealth from the bioresources. Bioscientists consider that ethnobiological/ethnobotanical knowledge system as a first effective means for identifying as well as locating alternative food sources and leads for drugs and pharmaceuticals, natural dyes, colours, gums, resins, *etc*.

1.3 Genesis of the subject ethnopharmacology

Ethnopharmacology as a scientific term, was first introduced at an international symposium held at San Francisco in 1967 (Efron *et al.*, 1967). This was used while discussing the theme 'Traditional Psychoactive drugs' in this symposium. But, later Rivier and Bruhn (1979) made an attempt to define Ethnopharmacology as "a multidisciplinary area of research concerned with observation, description and experimental investigation of indigenous drugs and their biological activities". It was later redefined by Bruhn and Holmstedt (1981) as "The interdisciplinary scientific exploration of biologically active agents traditionally employed or observed by man". In its entirety, pharmacology embraces the knowledge of the history, source, chemical and physical properties, compounding, biochemical and physiological effects, mechanism of action, absorption, distribution, biotransformation, excretion and therapeutic and other uses of drugs. A drug is broadly defined as any substance (chemical agent) that affects life processes. Therefore, briefly, the main component of ethnopharmacology may be defined as pharmacology of drugs used in ethnomedicine. However, none of the above said definitions captures the true spirit of this interdisciplinary subject. Ethno- (*Gr.*, culture or people) pharmacology (*Gr.*, drug) is about the intersection of medical ethnography and the biology of therapeutic action, *i.e.*, a transdisciplinary exploration that spans the biological and social sciences. This suggests that ethnopharmacologists are professionally cross-trained, for example, in pharmacology and anthropology- or that ethnopharmacological research is the product of collaborations among individuals whose formal training includes two or more traditional disciplines. In fact, very little of what is published as ethnopharmacology meets these criteria. Hansen *et al.* (1995) has suggested that the objectives of Ethnopharmacology should focus on i. the basic research aiming at giving rational explanation to how a traditional medicine works, and ii. the applied research aiming at developing a traditional medicine into a modern medicine (pharmacotherapy) or to develop its original usage by modern methods (phytotherapy).

The scientific evaluation and standardization of traditional remedies using exclusively the parameters of the modern medicine is both conceptually wrong and unethical. Evaluation of traditional remedies particularly those of the classical traditions has to be based on the theoretical and conceptual foundation of these classical systems of medicine, but may utilize the advancements made in modern scientific knowledge, tools and technology. In fact, it is important to combine the best of elements of concept and practice from traditional medicines and modern medicines with the objective to improve the healthcare system of humankind. Such an integrated approach to study and develop holistic healthcare system is termed as the Ethnopharmacological approach. The concept of Ethnopharmacology research in India evolved in 1980s independently of this international initiative.

Ethnopharmacology research in India was initiated at Regional Research Laboratory (RRL), Jammu in 1985 by the then Director Dr. C.K. Atal along with his student Dr. P. Pushpangadan, the then Chief Coordinator of All India Coordinated Research Project on Ethnobiology (AICRPE) and the senior author of this communication. Dr. Atal, however left RRL in mid 80s. But Dr. Pushpangadan and his students, colleagues and a few other enthusiasts, notably Dr. A.K. Sharma, Dr. S. Rajasekharan, Dr. V. George, Dr. P.G. Latha, Dr. K. Narayanan Nair, Dr. B.G. Naqavi, Shri. P.R. Krishna Kumar, *etc*., continued their effort to develop ethnopharmacology research. They observed that subjecting the traditional herbal remedies including the remedies of the classical systems like *Ayurveda*, *Siddha* and *Unani* to the parameters of modern medicine is not only foolish, but suicidal. Both these systems are conceptually quite different. The concept of disease, its etiology, manifestation and approach to treatment, *etc*., are all viewed on a holistic basis contrary to the reductionistic approach of modern medicine. Only, an integrated approach that combines the best of theory, concepts and methods of the classical systems of medicine such as *Ayurveda*, *Siddha* and *Unani* with the modern scientific knowledge (phytochemistry and pharmacology), tools and technology can bring in the desired results (Pushpangadan, 2002; Pushpangadan and Nair, 2005; Pushpangadan and Pradeep, 2008; Pushpangadan *et al*., 2008; Pushpangadan, 2010; Pushpangadan, 2014; Pushpangadan *et al.*, 2014; Pushpangadan *et al.*, 2015a, b; Pushpangadan *et al.*, 2016a, b; Pushpangadan and Ijinu, 2017; Pushpangadan *et al*., 2017a).

The concept and methods of ethnopharmacology research thus developed by the authors contain experts from diverse disciplines like *Ayurveda*, *Siddha*, scholars of Sanskrit and Tamil languages (who can correctly interpret the classical texts of *Ayurveda* and also its theoretical basis like 'Sankhya' and 'Vaiseshika' philosophy), ethnobotany/ethnomedicine, chemistry, pharmacognosy, pharmacology, biochemistry, molecular biology, pharmacy, *etc*. The main objective of this approach was to develop appropriate techniques to evaluate the traditional remedies in line with the classical concepts of Ayurvedic pharmacy and pharmacology such as the 'Rasa', 'Guna', 'Veerya', 'Vipaka' and 'Prabhava', in other words 'Samagrah Guna' of the 'Draya Guna' concept of *Ayurveda*.

The senior author was successful in convincing the late Prof. M.G.K. Menon way back in 1985 who then agreed to be the Chief Patron of the newly formed the National Society of Ethnopharmacology, India (NSE). This society was formally registered in 1986 with the senior author as its Founder President. The first ethnopharmacology laboratory started functioning at Regional Research Laboratory, Jammu under the All India Coordinated Research Project on Ethnobiology (AICRPE), funded by the Ministry of Environment and Forest, Govt. of India. However, the first full fledged ethnopharmacology division was started in 1992 at Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) where the senior author joined in 1990 as its Director. At JNTBGRI the team could successfully demonstrate the integrated approach and could develop novel scientifically verified standardized herbal drugs. Some herbal drugs developed at JNTBGRI after filing patents were released for commercial production. The National Society for Ethnopharmacology in association with JNTBGRI and with the financial assistance of DANIDA organized the first 'National Conference on Ethnopharmacology' in Thiruvananthapuram, Kerala from 24th to 26th May 1993. Selected papers in this conference were compiled and published as 'Glimpses of Indian Ethnopharmacology' in 1995. The 2nd 'National Conference of Ethnopharmacology' was organized at J.S.S College of Pharmacy, Mysore in 1997 and the 3rd at Pankaj Kasthuri Ayurveda College, Thiruvananthapuram in 2004 and the 4th at Amala Cancer Research Institute, Thrissur in 2006. In 1999 Feb., the senior author moved from JNTBGRI, Thiruvananthapuram to National Botanical Research Institute (NBRI) Lucknow, a pioneer plant research institute under the umbrella of Council of Scientific and Industrial Research (CSIR). International Society of Ethnopharmacology in association with the National Society of Ethnopharmacology, India and National Botanical Research Institute (NBRI) have organized the Vth International Congress on Ethnopharmacology in November, 1999 at NBRI, Lucknow. At NBRI, the senior author has established a state of the art ethnopharmacology laboratory and herbal product development division where the latest analytical techniques such as HPLC, HPTLC, MS, high-through put analysis, activity guided isolation techniques and similar other innovative new techniques in validating, formulating and standardizing the herbal products, *etc*., were introduced.

1.4 First workshop on ethnobiology and tribal welfare

The First 'National Workshop on Ethnobiology and Tribal Welfare' of the National Society of Ethnopharmacology, India was organized on behalf of the Ministry of Environment and Forest, Govt. of India in association with the International Institute of Ayurveda (IAA), Coimbatore by the AICRPE Coordination Unit. The workshop was held from 1st to 3rd November, 1985 at Patanjilipuri Campus of the IAA, Coimbatore. The aim of this workshop was to bring together the senior administrators, planners, scientists, voluntary agencies associated with tribal welfare programmes as well as the tribal representatives in order to interact and evolve ways and means by which the information generated from AICRPE could immediately be translated into action. The workshop was attended by 185 participants consisting of 30 administrators at the level of Secretary, Directors and Forest Conservators, 35 Scientists, 60 representatives from leading voluntary organizations and 60 tribal representatives. The three days deliberation emerged in the context of the fact that destruction of the material resource base due to deforestation caused great hardship and economic misery to tribes. The workshop after discussion on the various issues and problems of the tribes and also keeping in view of the AICRPE project findings made specific recommendation for improving the socio economic status and quality of life of the tribal people. The

conference made some recommendations and submitted to the Ministry of Environment and Forests, Govt. of India.

1.5 National conference on India's traditional knowledge

The fifth National Conference of the National Society of Ethnopharmacology, India on India's Traditional Knowledge "Dhishana-Towards formulating a *Sui-generis* Regime" was conducted from May 23-25, 2008 at Thiruvananthapuram and adopted a declaration, namely; 'Thiruvananthapuram Declaration' on Traditional Knowledge. This was the outcome of the deliberations conducted during the three days by eminent Scientists, Scholars, Tribal leaders, Legal Experts, Administrators, Researchers, *etc*. The copies of the declaration have been circulated to all concerned. A book entitled "A Glimpse at Tribal India: An Ethnobiological Enquiry" was published and released during the conference. Professor M.S. Swaminathan, Chairman, M.S. Swaminathan Research Foundation has kindly contributed a foreword to this book. This book gives an overview of the studies conducted under the All India Co-ordinated Research Project on Ethnobiology (AICRPE), a study conducted by the Ministry of Environment and Forests, Govt. of India from 1982 to 1998 with Dr. P. Pushpangadan as the Chief Coordinator.

1.6 Sixth and seventh meeting of NSE, India

The sixth national symposium on "Recent Advances in Natural Products" was conducted from November 15-17, 2012 at Amity University, Noida in association with 7th International Symposium of the International Society for the Development of Natural Products (ISDNP) and 1st International Symposium of Phytochemical Society of Asia (PSA). This was the outcome of the deliberations conducted during the three days by eminent Scientists, Scholars, Tribal leaders, Legal Experts, Administrators, Researchers, *etc*. A book entitled "Natural Products: Recent Advances" was published. The seventh annual meet of the National Society of Ethnopharmacology, India was conducted in association with an international conference on "Herbal and Natural Components as the Future of Pharmacology" held at Avinashilingam University, Coimbatore from 27th February- 1st March, 2017.

1.7 International regime on access and benefit sharing

Developing the international law and policies to put this idea into practice is, however, far from simple. In addition, the role of traditional knowledge in bioprospecting further complicates matters. On many occasions, it is traditional knowledge held by indigenous peoples and local communities that provides clues as to the potentially useful properties of a genetic resource. ABS was conceived as a tool to promote fairness and equity at the inter-state level, however, and traditional knowledge demands regulatory action at the intra-state level. Indigenous peoples and local communities reside within State boundaries, and their rights, subject to international human rights norms, are regulated by national law. Furthermore, abuse of the intellectual property rights system has resulted in a series of famous biopiracy cases involving the misappropriation of traditional knowledge, including those related to turmeric, neem, ayahuasca and hoodia. International law on ABS, thus needs both to address the practical aspects of ABS transactions and to serve broader aims related to fairness, equity and justice (Tsioumani, 2015). In addition, International law needs to guide the development of domestic legislation on ABS, and ensure fairness in transnational ABS transactions in order to reduce asymmetries both among parties in each individual transaction, and among developed and developing States (Morgera *et al.*, 2014).

Growing concern over monopolization of benefits led genetic resource providing countries to restrict access to genetic resources and associated traditional knowledge. The ratification of Convention on Biological Diversity (CBD) in 1993, by the members of the UN brought forward the agenda of Access and Benefit Sharing (ABS) from the use of genetic resources. CBD, ITPGR (2001) and the Bonn Guidelines (2002) provide a broad frame work for ABS procedures. In light of the asymmetries between States providing and using genetic resources, as well as growing expectations concerning the commercial value of biodiversity, ABS was conceived as a tool for equity and as an opportunity for sustainable development. The idea behind it was, developing countries host most of the world's biodiversity and, thus genetic resources; commercial products developed on the basis of these genetic resources benefit mostly companies and consumers in developed countries; part of these benefits should flow back to the countries of origin of genetic resources.

Many countries from the South felt that while the Bonn Guidelines elaborated on access, they had left the benefit-sharing aspect relatively unspecific. The voluntary nature of the Guidelines has been judged as insufficient for implementing the ABS provisions of the CBD. In order to further implement the third objective of the Convention and its ABS related provisions, the World Summit on Sustainable Development, held in Johannesburg, called for action (WSSD 2002, 44o) to negotiate within the framework of the Convention on Biological Diversity, an International regime to promote and safeguard the fair and equitable sharing of benefits arising out of the utilization of genetic resources. In 2004, in response to this call for action the COP mandated the Ad Hoc Open-ended Working Group on ABS (COP 5 decision V/26) with the collaboration of the Working Group on Article 8(j) and related provisions (COP 4 decision IV/9), to elaborate and negotiate an International Regime on Access to Genetic Resources and Benefit sharing with the aim of adopting instrument(s) to effectively implement the provisions in Article 15 and 8(j) of the Convention and the three objectives of the Convention and at its ninth meeting, in 2008, in Bonn, Germany, the COP agreed on a schedule of meetings to complete negotiations before its tenth meeting, in 2010 at Nagoya, Japan. The objective of the Nagoya Protocol is the fair and equitable sharing of benefits arising from the utilization of genetic resources, with a view to contributing to the conservation of biodiversity and the sustainable use of its components. Benefit-sharing is envisaged through appropriate access to genetic resources, the transfer of relevant technologies, and funding. Benefit-sharing obligations also arise from the use of traditional knowledge associated with such genetic resources and genetic resources held by indigenous and local communities. In this regard, the Nagoya Protocol is particularly innovative: it is the first time that such obligations are triggered by the use of traditional knowledge for research and development purposes in an international legally binding instrument. The Protocol is also innovative in detailing measures to ensure compliance with ABS-related obligations - an aspect that was neglected under the CBD (Tsioumani, 2015).

COP 10 adopts the Nagoya Protocol (decision UNEP/CBD/COP/10/L.43/Rev.1) on Access to Genetic Resources and Fair and

Equitable sharing of Benefits Arising from their Utilization, which will be open for signature at UN Headquarters in New York from 2 February 2011 to 1 February 2012, and calls upon CBD Parties to sign and ratify it. The Nagoya Protocol entered in to force on 12th October 2014 having been ratified by 54 coutries at that time. The first meeting of its Parties (COP/MOP 1) was held from 13-17 October 2014, during the second week of the twelfth meeting of the Conference of the Parties (COP 12) to the CBD. The major achievement of the first meeting of the Parties to the Protocol was the establishment of a compliance committee and agreement on procedures and mechanisms to promote compliance and address cases of non-compliance. The second meeting of the Conference of the Parties serving as the meeting of the Parties to the Nagoya Protocol, will be held in Los Cabos, Mexico, in November 2016 (COP 12 Decision).

There are three key remaining areas to address to help make the ABS regime more functional: contractual mechanisms for access and for benefit-sharing; domestic legislative, policy, and administrative measures in both user countries and provider countries; and clarifying questions at the international level including the possibility of unregulated genetic resources in certain arenas (Tvedt and Schei, 2014). It is, therefore, increasingly urgent for the CBD to make ABS work as was intended. The entry into force of the Nagoya Protocol represents a step in this direction. The new instrument, however, cannot reach these goals alone and so much will rely on functional implementation moving forward.

1.8 Indian scenario

India is one of the identified megadiverse countries rich in biodiversity. With only 2.4 per cent of the earth's land area, India accounts for 7-8 per cent of the recorded species of the world. India is also rich in associated traditional knowledge, which is both coded as in ancient texts of Indian systems of medicines such as Ayurveda, Unani and Sidha, and also non-coded, as it exists in oral undocumented traditions. India lead group of nations for over two decades in UN negotiation to get the other developed countries signed the Nagoya Protocol in 2011 and the Union Cabinet ratified it in 2012. India is one of the megadiverse countries rich in biodiversity and traditional knowledge is expected to get maximum benefits as Nagoya protocol gets implemented. It has also been seen that our country has been a regular victim of misappropriation of our genetic resources and associated traditional knowledge, which have been patented in other countries (well known examples include haldi and neem). It is expected that the Access Sharing and Benefit (ABS) Protocol which is a key missing pillar of the CBD, would rectify this problem (Mehta, 2014).

As the genetic resources and traditional knowledge are transferred from provider country to the user (industry), property rights including intellectual property rights (IPR), are the most relevant critical factors in the access and benefit sharing of genetic resources (ABS) concept. There are two possibilities that exist for strengthening the property rights of resource managers. On the one hand, national governments can ensure that the local level participates in the property rights over biodiversity and the benefits that arise from their use. On the other hand, International and National patent law requires the disclosure of the origin of genetic resources when IPRs are granted (Mehta, 2014). It is hoped that the Nagoya Protocol would address the imbalance arising from property rights distribution. The Protocol has strengthened the local level by asking the parties to take legislative, administrative or policy measures to ensure that benefits arising from the utilization of genetic resources that are held by indigenous and local communities are shared in a fair and equitable way with the communities concerned.

1.9 Kani model of benefit sharing

India has the distinction of being the first country in the world in experimenting a benefit-sharing model that implemented the Article 8(j) of CBD, in letter and spirit. It was the Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI) in Kerala (where Dr. P. Pushpangadan was Director) that demonstrated indigenous knowledge system merits support, recognition and fair and equitable compensation. The model, which later on came to be known as "Kani Model" or "TBGRI Model" or "Pushpangadan Model", relates to the sharing of benefits with a tribal community in Kerala, the Kanis, from whom a vital lead for developing a scientifically validated herbal drug (Jeevani) was obtained by scientists of JNTBGRI. The JNTBGRI model has got wider acclaims, acceptance and popularity the world over, because it was the first of its kind that recognized the resource rights and IPR of a traditional community by way of sharing equitably the benefits derived out of the use of a knowledge that has been developed, preserved and maintained by that community for many generations (Anand, 1998; Anuradha, 1998; Bagla, 1999; Gupta, 2002; Mashelkar, 2001; George *et al.*, 2016). Further, it demonstrates the vast and as yet under - explored or untapped potentials of the Indian traditional knowledge systems, particularly the traditional healthcare practices of the local and indigenous people in India. It would, therefore, be interesting to give brief background information regarding the traditional medicine system of India and the genesis and operation of an ambitious programme - "All India Coordinated Research Project on Ethnobiology (AICRPE 1992-1998), which led to the TBGRI benefit-sharing model (Pushpangadan, 2002; Pushpangadan and Nair, 2005; Pushpangadan and Pradeep, 2008; Pushpangadan *et al.*, 2008; Pushpangadan, 2010; Pushpangadan, 2014; Pushpangadan *et al.*, 2014; Pushpangadan *et al.*, 2015a, b; Pushpangadan *et al.*, 2016a, b; Pushpangadan and Ijinu, 2017; Pushpangadan *et al.*, 2017a, b).

1.10 Tribal scenario in India

After independence, the government inherited a tribal scenario evolved out of conflicting policies of development. There was hardly any useful data to comprehend the "felt needs' or the real needs of the varied tribal groups numbering well over 250, spreading over a large spectrum, ranging from the pre literate *Andamanese* and the *Abujhmadias* to the acculturated *Bhilalas* and the *Khasis*. They followed varied vocations, depending upon their level of cultural development, from hunting and food-gathering to slash and burn cultivation, settled agriculture or even iron smelting. Rich in cultural heritages, they spoke various dialects and practiced different customs and rituals in marriage, during child birth and death ceremonies. From animism to monotheism, they followed an array of religious beliefs, rituals and practices. Land tenure systems were different and so were the personal laws.

On the basis of historical, ethnic and socio-cultural affinities the tribal communities living in different regions can be divided as follows;

- Northeast India comprising the states of Assam, Arunachal Pradesh, Nagaland, Manipur , Tripura, Mizoram, Meghalaya and Sikkim.
- Sub-Himalayan Region of the North and North-west India comprising northern sub-mountainous districts of Uttar Pradesh and Himachal Pradesh.
- Central and Eastern India Constituting West Bengal, Bihar, Orissa, Madhya Pradesh, Andhra Pradesh and Andaman and Nicobar Islands.
- Southern India covering TamilNadu, Karnataka, Kerala, Pondicherry and Lakshadweep.
- Western India including Rajasthan, Maharashtra, Gujarat, Damon, Diu and Dadra Nagar Haveli.

Fundamental issues of the Indian polity like the present modalities in signing the international protocols and treaties were addressed as also the basic problems of the tribal areas and conservation of biodiversity. Professor M.S. Swaminathan in one of his address said that the path towards sustainable food security is "ever-green revolution" which will help increase productivity in perpetuity without the associated ecological harm. He stressed the need for blending traditional knowledge with modern science. He added that it is only such a blend that would empower us in the area of meeting the challenges posed by climate change and transboundary pests, as well as shrinking per capita land and water availability and expanding biotic and abiotic stresses (Pushpangadan and Pradeep, 2008).

2. Conclusion

Ethnobotanical research can provide a wealth of information regarding both past and present relationships between plants and the traditional societies. Investigations into traditional use and management of local flora have demonstrated the existence of extensive local knowledge of not only about the physical and chemical properties of many plant species, but also of the phenological and ecological features in the case of domesticated species. In addition to its traditional roles in economic botany and exploration of human cognition, ethno-botanical research has been applied to current areas of study such as biodiversity prospecting and vegetation management. The new thinking centered on the concept of 'knowledge engineering' for building up future 'knowledge assistance' and 'knowledge industries' is now gaining attention and acceptance both nationally and internationally. Knowledge based development of value added products from bio-resources and its commercialization has become one of the fastest developing economic activities in the world. Generation of such technology and its commercialization requires to be properly safeguarded for measures of protecting the IPR of the holders of TK so that they could achieve economic prosperity and help in sustainable development.

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Conflict of interest

We declare that we have no conflict of interest.

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