

Think locally act globally: With reference to ethnomedicinal knowledge of India

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India has a large number of ethnomedicinal plants growing under different geographical conditions. The article emphasizes on think locally and act globally scenario of the hidden Indian medicinal knowledge and its worldwide implementation as life saving novel herbal formulations. The article also emphasizes possible role of novel herbal formulations based on ethnomedicinal knowledge in uplifting of Indian economy. Looking into the current situation of biopiracy and gene robbing, the country should take immediate steps to bioprospect its ethnomedicinal knowledge and to commercialize novel herbal formulations at global level.

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Human beings were familiar with plants and used them in different ways from very beginning. India's traditional medicinal system is one of the world's oldest traditional knowledge systems. Ancient Indian ethnic people were having amazing knowledge of the medicinally important plants. People from ancient traditional societies learnt from animals about the medicinal value of different plants. This field is known as Zoopharmacognosy and comprises investigating the self-medication behaviors of animals. Such relationship between plants and man continued from ages and several plants were used as medicines to cure different diseases¹. The ancient Indian generally observed how animals used different plants in their self-medication. This approach provided knowledge on ethnomedicinal plants and also offered a novel approach to drug discovery that is beneficial in treating different human diseases. Discovery of reserpine and other valuable alkaloids from the traditionally used medicinal plant 'Sarpagandha' (*Rauwolfia serpentina*) is highly fascinating. *Rauwolfia serpentina* is known as, 'Chota Chand' and is used by the local people at foothills of Himalayan Mountains against snake bite. A local legend claims that in ancient days mongooses were observed to feed on the roots of "Sarpagandha" before engaging in combat with snake. Based on this

observation local people found that the Sarpagandha plant could serve as an antidote to snakebite². This plant is also used to treat epilepsy, insanity, sleeplessness and insomnia³. Later on, Reserpine isolated from *Rauwolfia serpentina* was also recognized as one of the highly potent drugs for hypertension⁴. The plant has excellent tranquilizer potency as mentioned in the autobiography of Mahatma Gandhi⁵. Interestingly, there is a similar legend about discovery of first anti-malarial plant. In 17th century, an old man suffering from high malarial fever was lost in an Andean forest. He drank the stagnant water of a pond which was bitter in taste to quench the thirst. Surprisingly, the fever soon abated and he shared this information to fellow villagers, who successfully used extract from the bark of quina-quina (*Cinchona*) tree growing near pond to treat malarial fever^{6,7}. Similarly, potent anti-malarial compounds were also isolated from the leaves of Eveve Bakweri (*Trichilia rubescens*) based on a behavioral observation related to health benefits of chimpanzee from Kibale National Park, Uganda⁸.

Scenario of ethnobotanically significant therapeutic and nutraceutical herbal formulations from Indian biodiversity

Ancient Indian literature suggested that earlier the people used different kinds of medicinal plants for

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combating diseases. Such knowledge of ancient Indian medicine and medicinal herbs has been passed down through generations and has survived among the ethnic communities of the country. Most of the indigenous and local communities that are blessed with knowledge on ethnomedicinal plants are mostly confined in areas that are enriched with vast world's plant genetic resources. There are an estimated 461 tribal communities in India⁹. Different ethnic communities such as Gond, Bhil, Baiga, Bediya, Pardhi, Bhilala, Korcu and Bhariya inhabited in the Indian sub-continent, live in the forest fringe areas¹⁰. Cross cultural ethnomedicinal information from different ethnic tribes would be of great help in selecting highly important ethnomedicinal plants leading to effective drug formulation.

Although, India has a very rich ancient knowledge on phytomedicines that are effective in prevention and cure of human diseases, only some of the Indian knowledge on medicinal plants has been mentioned in the Hindu scriptures viz., Rigveda (4500-1600 BC), Charak Samhita (6th-2nd century BC) and Atharvaveda (200-1000 BC). However, most of the ethnomedicinal knowledge is still undocumented and scientifically non-validated. Indian Materia Medica provides a vast knowledge on the folk practices and traditional aspects of therapeutically used phytomedicines. Time to time, ethnobotanists of the country have reported wonderful therapeutic and nutraceutical herbal formulations which have international recognition. JEEVNI, an anti-aging and anti-depressive drug developed from the Arogyapacha plant (*Trichopus zeylanicus*) is an outcome of the traditional knowledge of the Kani tribes of Kerala¹¹. The drug was formulated based on the information provided by Kani tribes and the earnings of the drug were shared with the tribal people for their educational and socio-economic development. Similarly, *Bergenia ciliata* or Pasanabheda, widely used by tribal community of Chhota Bhangal, Western Himalaya to treat their urinary related problems, is presently recognized for the major constituent of cysteine used in kidney stone treatment¹². Another miraculous synergistic herbal formulation known as URO-05 was also prepared combining five therapeutic herbs i.e., *Bergenia*, *Tinospora cordifolia*, *Berberis*, *Tribulus terrestris* and *Phyllanthus* sp. to treat nephrolithiasis and urolithiasis¹³.

Ethnobotanical knowledge employed in Western system of medicine

Novel drug discovery in the light of ethno pharmacological knowledge played a crucial role in

development of modern medical sector. The majority of the plant-based products which are currently employed in Western system of medicines, have an ethnomedicinal use. It is reported that nearly 25% of all drugs prescribed in current time are botanicals based, thereby, strongly strengthening that botanical based drugs contributed tremendous role in drug development¹⁴. Artemisinin, an anti-malarial drug effective against *Plasmodium falciparum*, the common malaria causing mosquito in India and China, was isolated from *Artemisia annua* (sweet wormwood) by Chinese scientists in 1972. The plant was known as Qinghao to the Chinese herbalists for more than 2000 years¹⁵. *Taxus brevifolia* (the Pacific yew trees) was earlier used ethnomedicinally in the Pacific Northwest region of United States and now reported to contain taxol, the anticancerous compound which kills cancer cells through a novel mode of action¹⁶. Similarly, Lutein which helps to prevent cataracts, has been isolated from marigold and different green vegetables and fruits¹⁷. Lycopene from tomatoes is also effective to prevent prostate, lung and breast cancers¹⁸. Patentiflorin 'A', phytoproduct of *Justicia gendarussa*, is comparatively more effective against HIV virus than synthetic azidothymidine drug¹⁹. In addition, active principles i.e., vinblastine, vinorelbine, vindesine and vincristine of *Catharanthus roseus* are globally used as anticancerous drugs. Aspirin, the anti-inflammatory medicine, is a synthesized analogue of salicin, found in the bark of *Salix alba*. Salicin is metabolized in human body into salicylic acid, a precursor to aspirin. The herbal extract of bark of *Salix alba* has been used since antiquity as indigenous and folk medicine to get rid of health problems viz., pain, fever and inflammation. *Echinacea purpurea* is also one of the most prominent examples of traditionally used medicinal plant²⁰ which is used to treat cold, upper respiratory tract infection as well as to boost immunity.

Global demand of herbal medicine

In recent period, medicinal plants are getting immense importance all around the world as safer alternatives of allopathic drugs. In the United States of America approximately 100,000 people died every year due to side effects of allopathic medicines activities²¹. Rofecoxib, selective non-steroidal, anti-inflammatory drugs (NSAID), was approved by the US Food and Drug Administration (FDA) in 1999 for the treatment of rheumatoid arthritis, dysmenorrhoea,

osteoarthritis, juvenile rheumatoid arthritis, and migraine. In 2004, Merck voluntarily withdrew Rofecoxib from the market due to reports on increased risk of heart attack and stroke associated with this drug²². Favorable safety profiles of herbal formulations make them preferable in intervention or prevention of several health disorders²³. Recently, when there is lack of suitable medicine for dengue fever in allopathic system, the tablets and capsules of *Carica papaya* are reported to be highly effective against it due to presence of major bioactive components *i.e.*, papain and chymopapain²⁴. This is the great example strengthening the use of ethnomedicinal knowledge during times of crisis management. Similarly, galantamine, an alkaloid obtained from *Galanthus nivalis*, apomorphine a semi-synthetic compound derived from morphine of *Papaver somniferum*, bacosides from *Bacopa monnieri* (Brahmi) are some nootropic agents used to treat neurodegenerative diseases such as Parkinson's and Alzheimer's diseases all over the world. A large number of traditional medicinal plants such as *Ocimum sanctum*, *Terminalia arjuna*, *Tinospora cordifolia*, *Withania somnifera* and active principles such as withanolide, curcumin and berberine are well known immunomodulators frequently used as immune boosting formulation during degenerative phase of life²⁵. Based on our traditional knowledge we can develop many wonder drugs similar to taxol, brahmi, jeevni and reserpine.

World Health Organization (WHO) estimated that 80% people of the developing countries rely on the phytomedicines to treat their primary health problems²⁶. The global medicinal plants industry is rapidly expanding and valued at approximately 165.66 billion USD in 2022 and USD 347.50 billion in 2030. India and China are the leading exporters of medicinal plants with India demonstrating a remarkable 6.14% CAGR in exports from 2017 to 2021, in contrast to China's negative growth. Thus, the Indian medicinal plants industry offers great potential, however, it needs to boost sustainable cultivation, conservation, and ethical trade in order to meet international standards²⁷.

Ethnomedicinal knowledge in boosting economy of the country

Ethnomedicinal plants of India may be revenue generating resources and may help in uplifting of economy of marginalized and indigenous people. Discovery of 'Jeevni', the world's first non-steroid

stamina boosting miracle drug, is a significant example where patent fund is shared between government and the Kani tribes. The formulation not only uplifted living conditions of Kani tribes but also boosted economy of the country through its large-scale marketing in different foreign countries²⁸. Although, there are about 25,000 plant-based formulations used in Indian folk and traditional medicine, only few are scientifically documented²⁹. Properly standardized ethnobotanical formulations have enormous scope for India leading the country a major player in global herbal market. Reverse pharmacology is a smart strategy, combining traditional or folk medicinal knowledge and the modern technology to facilitate development of novel botanical formulations based on ethnomedicinal knowledge. Reverse pharmacology may expedite the drug development process. Guggulipid from *Commiphora mukul* as hypolipidemic agent and *Mucuna pruriens* based drug for Parkinson's disease are some key examples of reverse pharmacology. Currently, there is also huge demand for natural bioenhancers to enhance drug efficacy through improving their bioavailability. Natural bioenhancers have been used in Indian traditional medicinal system from ancient time. Trikatu, a combination of black pepper (*Piper nigrum* Linn.), ginger (*Zingiber officinale* Rosc) and long pepper (*Piper longum* Linn.) enhances metabolic activities of the body causing rapid absorption of nutrients³⁰. Currently, several plant-based bio-enhancers *viz.*, piperine, quercetin, glycyrrhizin, genistein are practically used to enhance even the bio-efficacy of allopathic medicines³¹. *Piper nigrum* extract is reported to enhance analgesic activity of diclofenac sodium and pentazocine drugs³².

Ethnomedicine in achieving SDGs set by the United Nations General Assembly

Among seventeen sustainable development goals (SDGs) set by the United Nation General Assembly in 2015 goal-3 (Good Health and Well-being) aims to provide safe, affordable, effective medicine in order to promote healthy life and well being to all. Looking towards the side effects of many allopathic medicines and high demand of herbal formulations for old age diseases, the scientifically documented and validated ethnomedicinal formulations of the country will be on high demand throughout the world to ensure healthy lives and promoting well-being at all ages. Because of vast repository of ethnobotanical biodiversity, India has an immense scope to achieve global leadership in

the field of herbal medicine. Most of the world biogeographical zones and biomes are found in India, favoring the existence of wonderful diverse endemic plant species. The medicinal plants of the country not only constitute a major resource for drug development but also provide livelihood and health security to a large section of Indian population.

Need to reclaim Indian identity and boost ethnomedicinal knowledge globally

Scottish town planner Patrick Geddes (1915)³³ coined the slogan “Think globally, act locally”, which, express to make use of the learning about issues, cultures and events around the world to improve local area, hometown or country. However, for our country which is very rich in indigenous herbal knowledge, the appropriate slogan will be “Think locally, act globally”. Discovery of wonder drugs like, Jeevani, Trikatu and Piperine and several others strongly favor implementation of “Think locally, act globally” scenario. Looking into the current situation of biopiracy, India needs to bioprospect its ethnomedicinal knowledge where indigenous people and local communities should be the main component. Traditional medicine based bioprospecting would offer unmatched novel green chemicals and their promising new leads for improvement of human health. It’s time to be vocal for our local ethnomedicinal formulations and to commercialize novel herbal formulations at global level. Cross-cultural knowledge on medicinal plants and their therapeutic uses may also intensify the development of cheaper, safer and effective drugs³⁴. We are in competition with other countries which are also rich in ethnomedicinal knowledge. Hence, with the help of incorporating modern technologies, the country should urgently expedite to bring some of our ethnomedicinal products at global level.

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Conflict of Interest

Authors declare that there is no any conflict of interest.

Author Contributions

Original draft writing, conceptualization and data collection was done by S T. Formal analysis, writing

and conceptualization was performed by V K. Further, review, writing, editing, rechecking data and literature was done by N K D. Final manuscript was approved by all the authors.

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