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## Role of ethnomedicinal knowledge in the discovery of modern medicines

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**Abstract-** Ethnomedicine is the sum of traditional knowledge, skills, health, values, beliefs and practices of tribal communities. For centuries tribal healers have been collecting medicinal plants from forests for the formulation of folk medicines. The tribal people till date used their knowledge based ethnobotanical medicines in the treatment of different ailments. Approximately 88 per cent of people in developing countries rely mostly on ethnobotanical medicines for their primary health care needs. Indigenous knowledge has a significant role in the screening and development of modern medicines. A large number of modern medicines such as ephedrine, digitoxin, tubocurarine and reserpine have been derived from the ethnomedicinal knowledge of tribal peoples. About 75 per cent of the 122 ethnomedicinally important plant-derived bioactive compounds have been scientifically validated. Since these compounds were isolated only from 94 species of plants out of an estimated 250,000 flowering plants, one might imagine the abundance of drugs remaining to be identified from plant kingdom. The scientific validation of active constituents of plants ensures its efficacy, safety and further standardization and development of modern medicines. Growing commercial and scientific interest in ethnomedicine systems has led to calls for traditional medical knowledge to be better recognized, preserved and protected. Hence, the World Intellectual Property Organization (WIPO) is primarily concerned with protection of ethnomedicinal knowledge in the Intellectual Property (IP) sense against unauthorized use by third parties. A number of ethnomedicinally important Indian plant species and their traditional uses have been patented by different nations. Scientific community and policy makers have complained on this growing trend of patenting of our medicinal plants and their uses. Some of the well-known plants *Nigella sativa*, *Cassia fistula*, *Curcuma longa*, *Momordica charantia*, *Azadirachta indica* and *Gymnema sylvestre* have been patented. However, a number of the patents have been effectively contested by India. This chapter reviews the ethnomedicinal knowledge and its journey through time, which reveals the importance of this traditional wisdom in the modern scenario. This review paper explores the need to document the indigenous knowledge related to ethnomedicinally important plants and their medicinal and other uses to secure patenting rights as well as to discourage other countries for patenting tribal heritage.

**Key words:** Tribal Medicines, Modern Drug, Intellectual Property, Biopiracy, Patents, Traditional Knowledge Digital Library

### INTRODUCTION

For centuries across the world, people have turned to ethnomedicines and traditional knowledge-based treatments to tackle their health and well-being needs. The modern medicines are derived from traditional knowledge

system of how plant parts are used in the treatment of different diseases.<sup>1</sup> Sometimes the ethnomedicines and its practices were seen as unscientific or the system of ancient period. As a result, the traditional system was replaced by science based, efficient, modern medication system. It is almost unknown by majority of peoples about the role of ethnomedicines in the development of modern medicine.<sup>2</sup>

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However, a long history of traditional practices and medicines into effective treatments are well known. In this modern age, a high consideration has been given to phytochemical, pharmacological and pharmacognostical research and study of ethnomedicinally important plant species.<sup>3</sup> The modern technology of Artificial Intelligence is also being applied in the exploration of vast ethnomedicinal knowledge.<sup>4</sup> According to World Health Organization, more than 40% of pharmaceutical products are being derived from different plant species and associated traditional knowledge. Some of the important lives saving medicines such as artemisinin, aspirin and vinblastine have developed by applying the plant raw materials and traditional knowledge.<sup>5-7</sup> Furthermore, potential of biological activity of ethnomedicines has been examined in various pre-clinical and clinical trials which revealed varied biological effects of a large range of plant derived compounds in different classes of chemicals.<sup>8</sup> Hence, several pharmaceutical companies have transformed their policies in the area of natural product research in order to get potential sources and new chemical constituents for the development of medicines. Therefore, the role of ethnomedicinal knowledge can be useful in the development of highly effective modern medicines in future too. This knowledge is under threat as developed nations are claiming patents on the products originating from conventional medicines.<sup>9</sup> Many corporate and drug manufactures are engaged in the biopiracy to claim their ownership over the intellectual property of the aboriginal communities. Bio-piracy threatens the rights of tribal and local communities as well as sustainability of plant genetic resources.<sup>10</sup> India has taken wise steps to solve this issue by the creation of the Traditional Knowledge Digital Library (TKDL). The concept of TKDL is to document and protect traditional knowledge associated with intellectual property of the native people.<sup>11</sup> The development and discovery of modern medicines from the ethnomedicinal knowledge has been discussed in the present study.

### **Ethnomedicinal Knowledge and Discovery of Modern Medicines**

Ethnomedicinal knowledge associated with plant genetic resources that comes from tribal and local communities provides important information to researchers regarding the particular properties and value of these resources and their potential use for the discovery and development of modern medicines. Many of our modern

medicines have their roots in traditional healing systems.<sup>12</sup> Some of the ethnomedicinally important discoveries are as follows.

**Anti-malarial Medicines:** Malaria has been a big problem in India and poor countries.<sup>13</sup> It is a mosquito borne vector disease caused by some species of *Plasmodium*. *Cinchona officinalis* was an important plant of the ethnic communities generally used as antipyretic, analgesic and antiseptic.<sup>14</sup> The plant was examined by some scientists where they discover natural white crystalline alkaloids quinine and cinchonine having antimalarial, analgesic and anti-inflammatory properties.<sup>15</sup> The phytochemicals contain two most important fused rings system, i.e., aromatic quinoline and bicyclic quinuclidine, the most effective form in treating malaria.<sup>16</sup> The chemical was first used to treat malaria in Rome in 1631.<sup>17</sup> Later it was discovered as an effective anti-malarial drug by Charles Marie de La Condamine in 1737. Quinine is still used as an important medicine against the Malaria. *Artemisia annua* has been used by tribal and aboriginal communities as a traditional medicine of fever and body pain. The Chinese scientist Tu Youyou and her team got a reference to *A. annua* to treat intermittent fevers. They extracted artemisinin, an active phytochemical from the plant that was mostly effective in treating malaria. Artemisinin is now recommended by the World Health Organization in the treatment of malaria. Nobel Prize in medicine was awarded to Tu Youyou for this important discovery in 2015.<sup>18</sup>

**Anti-inflammatory Medicines:** The bark of *Salix* sp. (Willow tree) constitutes an important phytochemical aspirin that is effective in pain and inflammation.<sup>19</sup> It was synthesized by Bayer in 1897. The traditional knowledge of this plant has contributed to modern medicine. The bark of *Salix* tree was used by Sumerians and Egyptians about 3500 years ago as an anti-inflammatory and pain reliever.<sup>20</sup> In ancient Greece the bark powder of the tree was given to ease the pain of childbirth. Aspirin has multiple benefits including improving blood pressure, relieving pain and swelling and preventing heart attack. Multiple alkaloids including papaverine, morphine, codeine and thebaine derived from *Papaver somniferum* is effectively used in pain.<sup>21</sup> The plant was traditionally used in the treatment of cough and pain by the local people of Egypt.<sup>22</sup>

**Anti-cancer Medicines:** The importance of *Catharanthus roseus* (Periwinkle) has been mentioned in Mesopotamian folklore, Indian Ayurveda as well as

traditional medicines of China mostly used in wound healing. The *C. roseus* is now used in childhood cancer. Two important biochemicals vincristine and vinblastine are isolated from the plant.<sup>23</sup>

**Cardiovascular Medicines:** The role of *Crataegus monogyna* and *Digitalis purpurea* in the treatment for cardiovascular disease and hypertension in North America and China dates back to 1800. Currently, evidence has gathered from a range of in vivo and in vitro studies that plants extracts exert of *C. monogyna* and *D. purpurea* have properties to cure heart diseases.<sup>24</sup>

**Anti-hypertensive Medicines:** Traditionally root of *Rauvolfia serpentine* has been used as an important herb in the treatment of snakebite, insomnia, mania, madness and psychological diseases in Ayurveda and Unani systems of medicine.<sup>25</sup> On the basis of traditional uses, scientists have isolated various indole alkaloids from the roots of the plant; these are Reserpine, Serpentine, Ajmalicine and Ajmaline.<sup>26</sup> These phytochemicals are used for the

treatment of circulatory disease, cardiac arrhythm, hypertension and as a sedative medicine.<sup>27</sup>

**Wound and Pain healing Medicines:** Drugs derived from *Datura stramonium* come into use in the modern medicine through the uses of plant material as traditional cure in folklore of medicine.<sup>28</sup> The different plant parts are used in headache, rheumatism, asthma, bronchitis; wound healing, dandruff, insomnia and epilepsy.<sup>29</sup> *Curcuma longa* (Turmeric) is also effectively used in wound healing and respiratory and skin diseases.<sup>30</sup>

**Antibacterial and Antifungal Medicines:** *Azadirachta indica* (Neem) is a popular plant species both in traditional and modern systems of medicines.<sup>31</sup> The various plant parts are used in the treatment of bacterial and fungal diseases. Phytochemicals such as azadirachtin is effective in controlling of bacterial and fungal diseases. *Dioscorea floribunda* is also used as antibacterial and wound healing medicine.<sup>32</sup>

Medicinal Plants	Traditional Uses	Modern Uses	Phytochemicals
<i>Artemisia annua</i>	Fever and body pain	Malaria	Artemisinin
<i>Azadirachta indica</i>	Skin diseases, Wound	Antibacterial, Antifungal	Azadirachtin
<i>Catharanthus roseus</i>	Wound healing	Anti-cancer	Vincristine, Vinblastine
<i>Cinchona officinalis</i>	Antipyretic, Analgesic and Antiseptic	Antimalarial, Analgesic and Anti-inflammatory	Quinine, Cinchonine
<i>Crataegus monogyna</i>	Cardiovascular disease	Cardiovascular disease	Vitexin
<i>Curcuma longa</i>	Wound healing, Skin diseases	Antioxidant, Antibacterial	Curcumin
<i>Datura stramonium</i>	Wound, Asthma, Dandruff	Parkinson's disease, Fistula, Analgesic, Antiasthmatic	Atropine, Hyoscyamine, scopolamine
<i>Digitalis purpurea</i>	Dropsy, Heart congestion	Cardiac problems, Hypertension	Digitoxin, Digoxin, Digitonin
<i>Dioscorea floribunda</i>	Diarrhea, Piles, and chronic liver discomfort	Wound healing, Antimicrobial, Contraceptive	Diosgenin, saponin
<i>Papaver somniferum</i>	Cough, Pain	Joint Pain	Papaverine, Morphine, Codeine, Thebaine
<i>Pilocarpus jaborandi</i>	Eye sights, Glaucoma Diarrhea	Reducing eye pressure	Pilocarpine, Isopilocarpine
<i>Psychotria ipecacuanha</i>	Vomiting, Antiworm	Anthelmintic, antiamebic, Vomiting	Cephaeline, Emetine
<i>Rauvolfia serpentine</i>	Snakebite, Insomnia, Mania, Madness	Circulatory disease, Cardiac problem, Hypertension, Sedative	Reserpine, Serpentine, Ajmalicine, Ajmaline.
<i>Salix alba</i>	Anti-inflammatory, Pain reliever	Highblood pressure, relieving pain, Swelling Preventing heart attack	Aspirin

### Traditional Knowledge and Intellectual Property

Traditional knowledge means the knowledge, practices, and beliefs that have been passed down from one generation to other generation within a particular community, often through oral transmission.<sup>33</sup> This type of knowledge is often associated with indigenous communities and is considered to be an important part of their culture and identity. When community members

innovate within the traditional knowledge framework, they may use the patent system to protect their innovations. However, traditional knowledge as such knowledge that has ancient roots and is often informal and oral is not protected by conventional intellectual property systems.<sup>34</sup> Attempts to exploit traditional knowledge for commercial benefit can lead to its misappropriation and can prejudice

the interests of its rightful custodians. In the face of such risks, there is a need to develop ways and means to protect and nurture traditional knowledge for sustainable development that are in line with the interests of TK holders. The preservation, protection and promotion of the TK-based innovations and practices of local communities are particularly important for developing countries. Their rich endowment of traditional knowledge and biodiversity plays a critical role in their health care, food security, culture, religion, identity, environment, trade and development.<sup>35</sup> Yet, this valuable asset is under threat in many parts of the world. Therefore, United Nation has mentioned in a declaration that Indigenous peoples have the right to maintain, control, protect and develop their cultural heritage, traditional knowledge and traditional cultural expressions, as well as the manifestations of their sciences, technologies and cultures, including human and genetic resources, seeds, medicines, knowledge of the properties of fauna and flora, oral traditions, literatures, designs, sports and traditional games and visual and performing arts. They also have the right to maintain, control, protect and develop their intellectual property over such cultural heritage, traditional knowledge, and traditional cultural expressions.<sup>36</sup>

### **Biopiracy and Patents**

Bio-piracy refers to the use of biological material and associated traditional knowledge without consent and for commercial gain, often without giving credit or compensation to the communities that developed and maintained that knowledge.<sup>37</sup> In India, bio-piracy has become a significant concern in recent years, particularly in the context of the country's rich biodiversity and traditional knowledge systems.<sup>38</sup> The exploitation of traditional knowledge by corporations and individuals for profit is a significant issue in India. This has resulted in the misappropriation of traditional knowledge associated with plant species, medicinal practices, and other natural resources, which have been used for commercial purposes without permission or recognition of the knowledge holders.<sup>39</sup> One notable example is the patenting of the turmeric plant's medicinal properties by foreign corporations, despite the fact that the plant has been used in Ayurvedic medicine in India for thousands of years.<sup>40</sup> Similarly, the use of neem oil and seeds by foreign companies for commercial purposes has raised concerns about the exploitation of India's traditional knowledge systems.<sup>41</sup>

### **Medicinal Plants Useful in Traditional and Modern Medications**



*Artemisia annua*



*Cinchona officinalis*



*Catharanthus roseus*



*Crataegus monogyna*



*Datura stramonium*



*Digitalis purpurea*



*Dioscorea floribunda*



*Papaver somniferum*



*Pilocarpus jaborandi*



*Psychotria ipecacuanha*



*Rauvolfia serpentina*



*Azadirachta indica*



*Curcuma longa*



*Salix alba*

### **Popular cases of Biopiracy of Traditional Knowledge**

**1. *Azadirachta indica*:** The extracts from different parts of *Azadirachta indica* (Neem) are mostly used against bacterial and fungal diseases that attack standing food crops. In 1994, the European Patent Office awarded a patent to the US Company W.R. Grace Company and the US Department of Agriculture for a process to manage plant fungi using hydrophobic extracted Neem oil.<sup>42</sup> In 1995, a group of international NGOs and representatives of Indian farmers filed legal opposition to the patent. They submitted proof that the fungicidal effect of extracts of Neem seeds had been known and used for centuries in Indian agriculture to protect crops and were therefore it cannot be patented. In 1999, the EPO held that all the characteristics of the present dispute had been revealed to the public before the patent application and that the patent was not deemed to require an innovative move. The patent granted on Neem was revoked by the EPO in May 2000. In March 2006, the EPO rejected the request made in 2001 by the USDA and the chemical multinational, W. R..<sup>43</sup>

**2. *Curcuma longa*:** Rhizome of *Curcuma longa* (Turmeric) is used as a flavouring spice as well as an effective ingredient in medicines, cosmetics and dyes. It has historically been used in India as a treatment for the curing of cuts and wound for decades.<sup>44</sup> In 1995, two emigrant Indians at the University of Mississippi Medical Center were granted a US patent on the use of turmeric in wound healing. A re-examination case was filed by the CSIR, India with the USPTO challenging the patent on the rationale of the prior art. CSIR claimed that turmeric had been used for the treatment of wounds and rashes for thousands of years and that its medical usage was not a discovery. They were backed by historical documentation of mainstream expertise, including an ancient Sanskrit text and a paper written in the Bulletin of the Indian Medical Association in 1953. Given an appeal by the patent owner, the USPTO accepted the arguments of the CSIR and revoked the patent. The Turmeric case was a landmark case, as it was the first time that a patent based on the traditional knowledge of a developing country had been successfully challenged. The US Patent Office revoked this patent in 1997, after finding that there was no novelty; the findings of innovators have been known for centuries in India.<sup>45</sup>

**3. *Oryza sativa* (Var. Basmati):** Rice Tec, man. Inc. applied to register the trademark “Texmati” before the

United Kingdom Trade Mark Registry. The Agricultural and Processed Food Export Development Authority (APEDA) successfully opposed it. As a proof, scientists from Indian Agricultural Research Institute, New Delhi, Rice Research Directorate, Hyderabad and Central Food Technological Research Institute provided scientific records.<sup>46</sup>

**4. *Piper methysticum*:** Kava (*P. methysticum*) was first domesticated thousands of years ago as a cash crop in Fiji. It is a high prized crop used in the preparation of beverage. French corporation L’Oreal, a multinational company is using Kava to minimize hair loss and promote hair development.<sup>47</sup>

**5. *Hoodia gordonii*:** *Hoodia cactus* was used as a food by African tribes for thousands of years to quench thirst and starvation. The cactus was copyrighted by South African Council for Science and Industrial Research in 1995 as remedy of obesity and appetite suppressant factor (P57). Later it was purchased by Pfizer in 1998 as a right to produce and sell P57 as a fat treatment and body slimming medicine. The indigenous people began legal action against the pharmaceutical company on the grounds of biopiracy of their traditional knowledge in 2001. A historical agreement was signed in March 2002, in which the San indigenous tribe would receive a share of any future royalties.<sup>48</sup>

**6. *Banisteriopsis caapi*:** The plant has been used by the indigenous people of Amazon basin for centuries as wine known as Ayahuasca. *B. caapi* was patented by Loren Miller in 1986, granting rights to manufacture “Da Vine.” The patent was objected by the tribal community as a result USPTO withdrew this patent on 3 November 1999 at the point of re-examination.

However, the inventor was able to convince the USPTO on 17 April 2001, thereby the original claims being reconfirmed and the patent rights restored to the innovator.<sup>49</sup>

### **Traditional Knowledge Digital Library**

Bio-piracy destabilizes the rights of aboriginal communities as well as sustainable use of biological resources. This issue was addressed by the Indian experts by development of Traditional Knowledge Digital Library (TKDL). The thought to establish a TKDL came to the forefront in the midst of India’s efforts to cancel the patent granted by the United States Patent and Trademark Office (USPTO) on the wound healing properties of turmeric,

and the patent granted by the European Patent Office (EPO) on the antifungal properties of neem. TKDL is a unique tool fighting against biopiracy that is referred as patents. It ensures the protection of all kinds of documents associated with biological diversity, traditional knowledge and recognition of contribution of indigenous people.<sup>50</sup> The TKDL is a unique repository of traditional wisdoms of India. There is a database including 34 million pages of formatted information on some 2,260,000 medicinal formulations in multiple languages such as Arabic, Persian, Sanskrit, Tamil, Urdu and those used by patent examiners of major intellectual properties offices.<sup>51</sup> The TKDL documents are accessible to those patent offices who have signed an agreement for search and examination purpose. TKDL has been a key to success in bringing cancellation of 36 applications from Europe to patent traditionally known medicinal formulations.<sup>52</sup>

## CONCLUSION

Ethnomedicinal knowledge is playing a great role in the treatment of diseases for centuries as well as development of new modern medicines. The phytochemical, pharmacological and pharmacognostical research and evaluation of the plant based ancient medicines recognized their scientific efficacy. A large number of lifesaving pharmaceutical products derived by using of traditional knowledge has approved by the World Health Organization. The ethnomedicinal knowledge is under threat as big pharmaceutical companies of developed nations are claiming patents on the products originating from traditional knowledge. It is a kind of biopiracy that threatens the rights of indigenous communities. Bio-piracy is a most important issue in India because it involves the utilization of traditional knowledge relating to medicinal plants for financial gain without compensating or acknowledging the local communities who created and protected it. India has developed a technique of TKDL to address this problem. Still there is a need to do more to safeguard traditional knowledge and make sure that communities are acknowledged and paid for their contributions.

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