Review Article

Medicinal plants: potential for their therapeutic use

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ABSTRACT

The status of medicinal plants' use on global level has been given together with their conservation and sustainability. The Indian system of medicine, indigenous knowledge, cultivation and agro-techniques, and commercial and marketing systems have been discussed in detail. Various aspects of biotechnological application and the need for further research have also been given. **[Medicinal Plants 2009; 1(1) : 1-10]**.

Keywords : Medicinal plants, Indian system of medicine, indigenous knowledge, marketing of medicinal plants, biotechnology.

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INTRODUCTION

The world population is likely to touch 7.5 billion by the year 2020. The World Health Organization (WHO) estimated that 80% of the populations of the developing countries rely on traditional medicines, mostly plant-based drugs, for their primary health care needs. The modern pharmacopoeia still contains at least 25% drugs derived from plants while many others are synthetic analogues built on prototype compounds isolated from plants.

During the last decade, demand for medicinal plants and its products as well as the traditional health system has attracted the world-wide interest due to the growing recognition of the drugs on natural products, food supplements and flavours. Being non-narcotic, having no side effects and easy availability at affordable prices makes these products the only source of health care available to the poor. India, being the botanical garden and treasure house of biodiversity with its diverse ecological conditions, rich ethnic diversity and a strong traditional knowledge base, accounts for 45,000 plant species, out of which more than 8,000 species are used in some 10,000 herbal drug formulations.

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Status of the Natural Resources

Ninety percent of the herbal industry's requirement is taken out from the forests, resulting into their destruction. There is no reliable assessment of the volume or value of the herb related trade in India, but, the conservatives put the quantity of dry raw material collected at 0.5 million tons each year. The global plant based drug is projected between US $ 30 and 60 billion with a 7% annual growth rate, but India has only a 2.5% share in it. Even so, there is a growing realization that the demand in fast outstripping supply is putting an unreasonable pressure on our wild phyto-resources. This has already placed certain species at risk and others will soon follow, if immediate corrective measures are not taken. Besides tribal, who are authorized to collect the minor forest produce for their livelihood, traders illegally collect a large number of plant species. Without replenishment, such overexploitation has resulted into extinction of several species and caused large-scale destruction of habitats. In India, it is estimated that about 1500 plant species are threatened, of which about 124 are endangered, 81 vulnerable and 100 species have been declared as rare (Nayar and Sastry, 1987).

Out of the list of endangered plants, 35 plant species have been enlisted as medicinally important by Gupta and Chadha (1995), however, the Department of Biotechnology, Ministry of Science and Technology, Government of India has given a list of medicinal plants (Table – 1) they are interested in. The need of the hour

Table 1 : Important Medicinal and Aromatic plant species of the Indian subcontinent

Aconitum napellus	*Nardostachys jatamansi*
Acorus calamus	*Panax peudo-ginseng*
Amomum species	*Phyllanthus fraternus*
Andrographis paniculata	*Picrorhiza kurrooa*
Azadirachta indica	*Podophyllum hexandrum*
Cassia augustifolia	*Pogostemon cablin*
Commiphora wightii	*Psoralea corylifolia*
Coptis teeta	*Rouwolfia serpentina*
Crataeva nurvual	*Rheum emodi*
Cymbopogon winteriamus	*Swertia chirata*
Dioscorea deltoidea	*Valeriana wallichii*
Ephedra species	*Vetiveria zizanioides*
Ferula asafoetida	*Withania somnifera*
Mesma ferrea	

Source: Department of Biotechnology, Government of India, New Delhi.

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is to look into the reproductive biology of these plants to assess and apply the effective methods of conservation and multiplication of these individuals.

In an ethno-biological survey conducted by the Ministry of Environment and Forests, Government of India, it has been indicated that our countrymen for their medicinal properties are using about 8,000 plant species. Figures 1 and 2 exhibit the different categories of plants and different plant parts constituting herbal medicines respectively.

Being a treasure house of the phyto-resources, India has an insignificant share in the International Herbal Trade. Besides this, the ancient literatures together with the herbal formulations based on folk medicine and

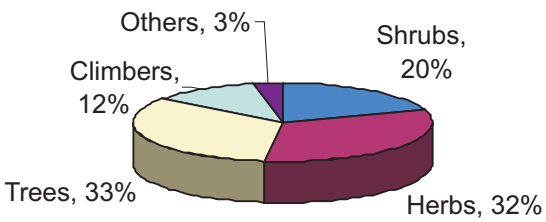


Fig. 1 : Different categories of Medicinal Plants.

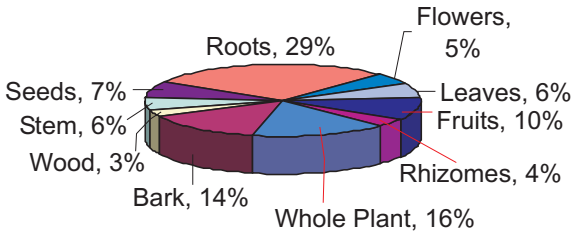


Fig. 2 : Different plant parts used as herbal medicine

indigenous system of curatives emphasize the fact that our country had been the leader since time immemorial in the knowledge of herbal bio-wealth. Such contradictions raise a very genuine question before us – how and why the leaders in herbal sciences are lagging behind now? In our view, to find the right answers is to have broad-spectrum introspection in what we have done in the past. Firstly, we have broken the chain by not doing advanced researches using the latest technologies on existing information on herbal sciences in the past and secondly, we forgot to have a sustainable development of plant resources. Therefore, special attention is required to revitalize it so that the leader (in the field of herbal resources) may regain its proper place.

In the countries of Asia and Africa, the traditional system of medicine is practiced in the rural and tribal areas where modern medicine is generally inaccessible. It is in these areas that plant-based drugs are frequently used, some of which are really effective. As several of the traditionally used plants are not properly investigated phyto-chemically and pharmacologically, much information is not available to the scientific community.

In the mid-sixties, a number of Ayurvedic drugs have been screened for their claimed therapeutic effects. Many new drugs have been developed on the basis of their use in the traditional or folk medicine after a thorough scientific evaluation and the results published so far have been found to support the Ayurvedic claims (Dev, 1999). The establishment of lipid-lowering properties of oleogum-resin of *Commiphora wightii* (Satyavati, 1988), the hypoglycemic effect of *Pterocarpus marsupium* (Ahmed *et al*., 1991; Manickam *et al*., 1997; Grover *et al*., 2002), the memory enhancing effect of bacopasides from *Bacopa monnieri* (Singh *et al*., 1990), the relieving effects of *Adhatoda vasica*, *Ocimum sanctum* and *Solanum trilobatum* in asthma patients (Brindha and Parvathy, 2005), the anticonvulsant activity of *Centella asiatica* and *Bacopa monnieri* (Sudha *et al*., 2005), the anthelmintic activity of

Semecarpus kathalekanensis (Ramana *et al*., 2005), the hepato-protective activity of *Cariaca papaya* (Rasal *et al*., 2005), and the hypoglycaemic, hypolipidemic and antioxidant effect of the fruits of *Withania somnifera* (Udayakumar *et al*., 2005) are some of the examples. Artimisin is without doubt the potent anti-malarial active principle of *Artimisia annua*. The crude extracts of *A. annua* cotain a plethora of other compounds, including a series of flavonoids, some of which enhance the activity of artimisin against *Plasmodium falciparum* in vitro. These findings lend support to the view that there may be some advantages to the medical use of extracts as opposed to isolated single entities. It is interesting to note that in the Indian system of medicine, a crude plant extract or a mixture of plants is administered for any specific disease (Ramavat *et al*., 2004).

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Indian System of Medicine and Pharmaceutical Industry

The Ayurveda **(***ayur*- literally means life and - *veda* means the knowledge or science or way of life), the Indian system of medication, is one of the oldest systems of medication prevailing throughout the globe. Ayurveda (1000 – 500 BC) originated from our ancient literature – ***"Atherva-veda"***, the knowledge of which was documented in *'Charak – Samhita'*(1000 BC) and *'Sushruta Samhita'* and are considered to be the authentic Books (Tirtha, 1998). Ayurveda is considered to be the science of life and this makes it an earlier medical science having a positive concept of health to be achieved through a balanced blend of physical, social, moral, mental and spiritual welfare (Svoboda, 1992; Tiwari, 1995).

The philosophy of 'Ayurveda' is based on the ***"Panch-bhutas"***, of which our body is supposed to be composed of. In a healthy individual, all the various aspects like the physical body and its mental and spiritual counterparts must be in an equilibrium state. Basically, an absence or a disturbed state of such an equilibrium results into the status of disease or the sickness. For promotive and positive aspects of health, Ayurveda has given a detailed daily and seasonal pattern of regular activities. It emphasizes on regulated diet, sleep and sex (Tiwari, 1995).

Generally having a tropical and sub-tropical climatic condition in the developing countries, the pests and insects carry and generate diseases and for many other diseases like those caused by protozoans, viz., Amoebiasis caused by *Entamoeba histolytica*, Malaria by *Plasmodium falciparum* and Filaria by nematodes; a poor hygienic and socio-economic living conditions are responsible. To have an effective control over such diseases plant-based drugs are required. Sometimes these diseases have attained the status of the epidemics. In 1996, 1.5 to 2.7 million deaths has been reported due to malaria and majority of them were children (Phillipson, 2001). The effective medications, Quinine and Artemisin, both are of plant origin. A recent survey has indicated that the number of patients affected by the diseases like diabetes and heart-ailments are gradually rising among Indian inmates at a constant pace due to preferential sedentary life style and poor physical workout and therefore, need immediate attention. So, we require many more effective plant-based drugs to combat with other parasitic diseases, diabetes and heart diseases. Handa (1996) has given the therapeutic potentialities of several plants like *Asparagus racemosus*, *Piper longum*, *Ocimum sanctum*, *Andrographis paniculata*, *Boerhaavia diffusa*, *Berberis aristata*, *Aegle marmelos*, *Bacopa monnieri*, *Phyllanthus emblica*, *Glycyrrhiza glabra*, *Syzygium jambolanum* and *Chlorophytum borivilianum* etc.

There are approximately over 7800 drug manufacturing units in India out of which about 90% industries use plants as the raw material, collected from the forests or from their natural habitats putting an unusual pressure on the natural biodiversity. An estimated 800 species are used in drug production in these industries, but, less than 20% plant species are cultivated commercially. This poses a definite threat to the diversity of medicinal plants' species. During the last forty to fifty years the Indian pharmaceutical units have been bulk producing several plant-based drugs which include morphine, codeine, papaverine, thebaine, emetine, quinine, quinidine, caffeine, hyoscine, psoralen, colchicine, vinchristine, vinblastine, strychnine and ergot alkaloids etc.

Under such circumstances, it is not possible nor is it advisable to exploit the naturally resources of medicinal plants brutally without having thought about their sustainability. It is imperative, therefore, to bring the medicinal plants' species diversity under commercial cultivation for biomass production for the industries. This may be achieved through the conventional as well as the biotechnological approaches.

Indigenous Knowledge

Indians have one of the world's richest medicinal plants' heritage. Around 8,000 species of plants referred to by over 2,00,000 vernacular names, are used by the people of our country in local health care cultures for human,

veterinary and agriculture (bio-fertilizers, seed treatments and bio-pesticides) related applications across country's 10 bio-geographic zones, 25 biotic provinces and 4635 ethnic communities. The knowledge of these plants is undocumented and transmitted through an 'oral' tradition. There are 500 tribal and aboriginal communities in India living in close proximity to forests since time immemorial and have acquired unique knowledge of plants, plant produce and their uses in daily needs and health care and is descended through oral information transmission from one generation to the next.

Bhoxa, the scheduled tribes of tarai belt of Uttarakhand, cure several ailments, disorders and diseases with the use of plants and plant products from the surroundings. Several scientists have documented the valuable ethno-medicinal knowledge of Bhoxas (Kirtikar and Basu, Chopra *et al*., 1956; 1935; Ambasta, 1986 and Singh, 2005). Similarly, documentations have been made on the womenfolk's health care knowledge from other tribal communities (Tarafder, 1983 a, b; 1984; Siddique *et al*., 1988; Singh and Ali, 1996; Balik *et al*., 2000; Shashikumar and Janardhanan, 2002 and Ramana *et al*., 2005). The tribals and aboriginals like Kola, Kharwar, Gonds, Tharu in Uttar Pradesh and Bhoxas, Bhotia and Jaunsari in Uttarakhand have been using plants and plant products for the treatment of rheumatism, gout and arthritis (Anand Prakash and Singh, 2005). Ramana *et al*. (2005) have documented the informations obtained from the Halakki Okkaligas tribes of Uttara Kannada district in Karnataka about the use of plants for pediatric use and also as an antidote to snake bite.

Other documented tribal informations regarding the medicinal plants include the study of lithontriptic plants used by the tribals of Khargone district in Madhya Pradesh (Mahajan and Patel, 2005); birth control practice among rural and tribal women of Chhatarpur district of Madhya Pradesh (Arjariya and Rawat, 2005). Now, as far as possible a scientific documentation of all the practices, for the treatment of diseases using the plant resources, among the tribal communities is required.

Cultivation and Agrotechniques

International trade in medicinal plant material for the production of pharmaceutical and cosmeticeutical preparations is blooming. Sevaral medicinal plants are cultivated and domesticated; cultivation of others that are collected from the wild in a vast amount is desired. However, according to one estimate, of more than 400 plant species used for the production of medicine by Indian herbal industries, less than 35 are currently under cultivation in different parts of the country. In fact, cultivation of medicinal plants is not so easy and is rather a challenging task because very little is known about the seed biology and their method of cultivation. Furthermore, little efforts have been made to search for elite stock and to propagate them. There is an apt need for a scientific approach for propagation of medicinal plants and to collect relevant information regarding agro-technology, genuine planting material, economics of field cultivation and procurement of high yielding varieties etc.

Some ethno-biologists have given the agro-techniques and other related informations about certain important medicinal plants like *Rumex* sp. (Gupta, 1973); *Crotalaria juncea* (Pandey and Sinha, 1977); *Psoralea corylifolia* (Yadav and Kulkarni, 1986); Anthocephalus *chinensis* (Beniwal and Dhawan, 1991); *Calligonum polygonoides* (Kumar *et al*., 1996); *Boerhaavia diffusa* (Bajpai, 1997); *Baliospermum* montanum (Shimpale and Yadav, 2005) and *Stevia rebaudiana* (Singh and Rao, 2005), however, such informations about majority of medicinally important plants is required.

Commercial and Marketing Aspects

As per the survey conducted by FRLHT (a Bangalore based NGO) about 880 plants are traded in India with an estimation of 6,00,000 registered practitioners and crores of local healers who are dependent on medicinal plants grown in wild. It has over 6,000 manufacturing units with a turn over of Rs. 4,200 crores. Eighty percent of world's population is using herbal medicines in their health care systems. During 1990's the International trade of natural product medicines was US $ 50 billion and the annual increase rate was 30% (Sarin, 2003). Our country has a lion share of 75 – 80% of herbal raw materials with respect to export potential (Rawat and Uniyal, 2003).

An annual domestic trade of herbal raw drugs, in India, is accounted to 1,98,000 tonnes with an annual trade value of 4,000 – 4,200 crores (Handa, 1996). The demands for medicinal and aromatic crops (MAC's) in India to meet the domestic and export market is increasing steeply and will be more than 20 – 25% by 2010. The world trade figures suggest that India is next to China by exporting 32,600 tonnes of medicinal raw materials worth US $ 46 million annually (Lange, 1997; Dhar *et al*., 2000; Manjikhola and Dhar, 2002). The mismatch in demand – supply potentials has been attributed to dependence on forest resources for

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medicinal and aromatic plants to an extent of 90% (FAO database, 2003). In meeting the growing demands of herbal products at national and global levels, natural forests solely can not fulfill the needs unless it is supplemented by some other means like commercial cultivation coupled with value addition of the produce (Khanuja *et al*., 2004).

Marketing network has been studied and a flow chart of informations was suggested which include the movement of produce from the collector to the consumers through a series of middlemen (Maikhuri *et al*., 2003). Other scientists have made similar attempts too (Suryanarayana *et al*., 2005; Manjunath *et al*., 2005 and Krishna and Ramana, 2005). However, such updates are regularly required to meet the growing demands and economics of medicinal plants.

Biotechnological Aspects

Although genetic engineering and other biotechnological approaches like micro-propagation have been very widely used for the improvement of crop plants, these methods have least been taken into consideration by the research scientists for the plants of medicinal importance. Constraints such as more importance to secondary metabolites rather than to primary metabolites, seasonal variation in the rate of biosynthesis of active principles; and variable and complex mode of reproduction are some of the bottlenecks in the way of improving the medicinal plants (Ramawat *et al*., 2004). Progress has been made with respect to *in vitro* production of secondary metabolites, micro-propagation of selected materials, endangered species and propagules for domestication through biotechnological methods.

A. Genetic Mapping

DNA fingerprinting of germplasm and the assessment of genetic diversity are of foremost importance in the medicinal plants. In developing countries, the DNA fingerprinting of plant species is just in its infancy, as these sophisticated techniques require sufficient inputs in terms of adequate funds and trained manpower. These techniques would be helpful in conserving the useful germplasm and also establish its centre of origin keeping aside the prevailing controversies. In our country, some medicinal plants are being characterized, viz., *Camellia sinensis* (Paul *et al*., 1997) and *Azadirachta indica* (Singh *et al*., 1999) and the work on several others is under progress.

B. Micro-propagation

Tissue culture techniques are very widely used and its most important application is the micro-propagation (Fig. 3). Micro-propagation protocols have successfully been developed for large number of medicinal plants and it has been used to clone several plant materials like *Coleus forskohlii* (Mahendran and Sampath, 2005) to protect this threatened medicinal plant, *Mentha* sp. for high yield of menthol, *Commiphora wightii* and *Taxus* sp. to multiply a wild plant for propagation at desired rate, *Chlorophytum borivilianum* and *Podophyllum hexandrum* for the development of planting material for domestication. The micro-propagation and mass propagule production of *Stevia rebaudiana* (Mondal and Parathiraj, 2005) has been done to encourage the production of low-calorie sweetener for diabetics.

The micro-propagation technique has been a miraculous tool for the restoration of those flora and fauna, which are threatened and are at the verge of

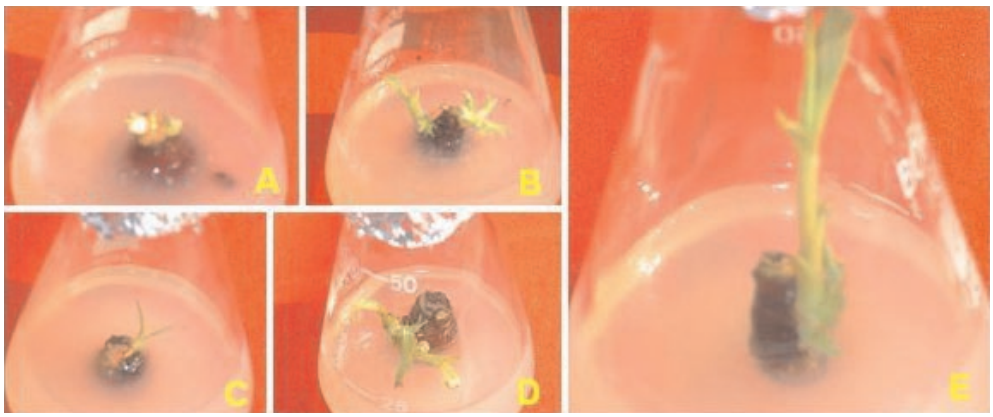


Fig. 3 : Micro-propagation through apical meristem.

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extinction. The pteridophyte – *Ophioglossum* and the angiosperm – *Rouwolfia serpentina* are gradually heading towards extinction and these may only be saved using this technique. Furthermore, several others endangered and threatened plants listed in 'red data book' need to be conserved employing tissue culture techniques.

C. Development of new varieties

The yield of biomass or production of active principles there from has always been the main concern for the scientists particularly the biotechnologists working on the medicinal plants. Hence, to meet the ever-increasing demand of herbal products, one is left with no option, but to continuously improve the yield potential of the particular plant. Therefore, selections through conventional breeding as well as exploitation of somaclonal variation in cultured cells comprise principal methods to improve upon the yield potential (Ramawat *et al*., 2004). Following the proper selection, the plant material gets multiplied using the micro-propagation techniques and the bulk seedling material is made available to the farmers for mass cultivation.

D. Production of biochemicals and active principles

With the growing demands of herbal pharmaceutical industries in India, medicinal plants' scientists have done a lot of work, keeping pace with them, to produce useful biochemicals and active principles from medicinally important plants. Several active biochemicals like an essential oil (Choudhary *et al*., 1951), bicyclic sesquiterpene ketone (Govingachari *et al*., 1958), seychellene and patchoulene (Rucker *et al*., 1976), have been isolated and described from the underground rhizomes of *Nardostachys jatamansi.* Bagchi *et al*. (1988 a, b, c, d, e; 1990; 1991) have carried out exhaustive investigations on the chemistry of the rhizomes of *Nardostachys chinensis* and isolated many active principles from it. Prabhuji *et al*. (2005) have also given the occurrence of various biochemicals and active principles in *Nardostachys jatamansi* and *N. chinensis*.

Some active and very potent active principles like bacoside (Rastogi *et al*., 1994; Rastogi and Kulshreshtha, 1998); bacopasaponins (Garai *et al*., 1996; Mahato *et al*., 2000; Hou *et al*., 2002); bacopaside (Chakravarty *et al*., 2001; Hou *et al*, 2002; and

Chakravarty *et al*., 2003); and bacogenins (Kulshreshtha and Rastigi, 1973a, 1974; Kawai *et al*., 1973; and Garai *et al*., 1996a) have been isolated and identified from the leaves of *Bacopa monnieri*. Prabhuji *et al*. (2005) have also given the occurrence of various active principles in *Bacopa monnieri*.

Safed Musli (*Chlorophytum borivilianum*) has been a very important medicinal plant, the tuberous roots of which yield certain highly effective biochemicals like steroidal saponins (Gupta *et al*., 1979; Tandon *et al*., 1992; Tandon and Shukla, 1992, 1993). Mimaki *et al*. (1996) have isolated three new spirostanol pentaglycosides from the tuberous roots of *Chlorophytum comosum*. Later, Prabhuji *et al*. (2005) have also enlisted the active principles isolated from the tuberous roots of *Chlorophytum borivilianum*, *C. comosum* and *C. malayense*.

The storage roots of *Asparagus racemosus* have been found to exhibit a positive action on female reproductive system and are used as lactogogue and aphrodisiac in traditional systems of medicine and several active biochemicals have been isolated there from (Prabhuji *et al*., 2005). Similarly, Tulsi (different species of *Ocimim*) contains many active principles having anti-microbial properties. There are a number of other plants of medicinal importance, which have been used by the tribal communities in various ailments or are enlisted in ayurvedic system of medicine. Such plants need to be investigated scientifically for their active ingredients and centre of action on the human body.

E. Industrial production of biomass and bioactive compounds

To meet the industrial requirement of bioactive compounds either pure compound is required or mass production of plant tissues is necessitated using plant tissue culture processes. Globally, the plant tissue culture process is used for the production of bioactive compounds by only a few industries like the production of Ginseng by Nitto Denko Company, Osaka, Japan, since 1986; Shikonin production by Mitsui Company, Japan; and Paclitaxel production by Samayang Genex Company, Taejon, Korea since 2001 (Dong and Zhong, 2002).

The secondary bioactive metabolites are mainly obtained from the biomass produced by *in vivo* grown plant materials like ajmalicine from the roots of *Catharanthus roseus*; morphine alkaloids from the latex of opium poppy; quinine from *Cinchona officinalis* and taxol from *Taxus baccata*. The plant cell cultures grown in a bioreactor are being used to generate the biomass of a number of species in order to produce the active principle there from, such as *Taxus*, *Podophyllum* and

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Stizolobium (Suri *et al*., 1999 b; Hibino and Ushiyama, 1999; Rorrer *et al*., 1999). Many industries that were once actively involved in developing commercial plant tissue culture, biomass generation through micro-propagation or directly producing through cell culture, have discontinued their endeavour. The problem lies not only in the difficulties encountered in technological developments, but also in economic factors. So, there is a need to develop mass tissue culture production systems (bioreactors) of large capacities together with its economic viability.

Further Researches Required

Medicinal plants constitute the bio-wealth of our country and as per our ancient literature; they are also deeply involved in our rituals for human welfare. With the population explosion, particularly in the developing countries, there has been an unexpected pressure on our natural resources in general and on medicinal bio-wealth in particular to meet our health care needs. Therefore, we should very seriously think on the following lines keeping in view the overall assessment:

1. Conducting researches to identify the properties of various plants in respect of its medicinal qualities so that the active principles and the biochemicals present there in, may be isolated to study the phyto-chemistry.

2. Proper documentation of our indigenous knowledge, lying with the tribal people, and its recognition together with scientific assessment should be done.

3. Sustainability of our bio-wealth must be maintained to avoid the situation by making the particular species endangered or extinct.

4. For the conservation of medicinal plant germplasm 'herbal gardens' must be maintained in different geographical regions.

5. Development of latest biotechnological approaches, particularly in the field of micro-propagation, reproductive biology, domestication of selected species and agro-technological practices.

6. Enforcement of regulatory acts to protect our natural forest resources.

7. Encouragements for those industries, which implement mass cultivation using the plant tissue culture techniques for the mass production of active principles and biochemicals.

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