CHAPTER I

INTRODUCTION
Medicinal and aromatic plants (MAPs) have a long history of their use for various purposes. These plants play an important role in the healthcare of people around the world, especially in the developing countries. Until the advent of modern medicines, man was dependent on plants for treating human and livestock diseases. The use of traditional medicine has increased in developed countries also, mainly due to the failure of modern medicine to provide effective treatment for chronic diseases and emergence of multi-drug resistant bacteria and parasites. The adverse effects of chemical drugs, questioning of the approaches and assumptions of allopathic medicine, their increasing costs and greater public access to information on traditional medicine has also led to an increase of interest in alternative treatments according to the World Health Organization (WHO, 2002). Plants have been attracting medical attention for their effective and amazing cures for thousands of years and are the most widely used medicines in the world today (Sarwar et al., 2011).

Medicinal plants have curative properties due to presence of various complex chemical substances of different compositions, which are found as secondary plant metabolites in one or more parts of these plants. These plant metabolites, according to their composition, are broadly grouped as terpenoids, alkaloids, carbohydrates, glycoside, steroids, tannins and phenolic compounds, flavonoids, phenyl propanoids, etc. Convention on Biological Diversity and Global Strategy for plant conservation supports the active use of plants by society. The medicinal plants contribute to cater 80% of raw materials used in the preparation of drugs. Besides this, there is also an increasing demand for natural products including items of medicinal value, pharmaceuticals, food supplements and cosmetics in both domestic and international market. According to WHO the international market of herbal products is estimated to be US$ 62 billion which is poised to grow to US$ 5 trillion by the year 2050 (Nagpal and Karki, 2004; Subrat, 2005). Medicinal plants are looked upon not only as a source of affordable health care products but also as a source of income. There is a growing demand for plant based medicines, health products, essential oils, fragrances, cosmetics and natural aroma chemicals in the national and international markets. Several reports highlighted the global importance of MAPs due to huge volume of trade at national and international levels (Kuipers, 1997; ICMAP, 2003). The Task Force on medicinal plants in India reported that international market for medicinal plants is over US$ 60 billion per year and herbal drug market continues to grow at the rate of 7-30% annually (Anon., 2000).
The herbal medicine is earning huge currency and acceptability. The documentation of valuable indigenous knowledge about medicinal plant species is receiving urgent priority, due to the recent controversies of biopyracy. The precious indigenous knowledge, when supplemented and validated by the latest scientific findings, can offer new holistic models of sustainable development that are economically viable, environmentally friendly, and socially acceptable. The herbs have been priced for their medicinal, flavouring, and aromatic qualities for centuries. WHO has estimated that up to 80% of the people still rely on traditional remedies such as herbs for their medicine (Sood and Chauhan, 2009). In developing countries, 3.4 billion people have been estimated to use plants as medicine (Banamar et al., 2010). Most of prescribed drugs are synthesized from natural products. In this context, attempts have been made by the WHO to identify all the medicinal plants used globally and listed more than 20,000 species (Pandey et al., 2008).

Many pharmaceutical companies are showing interest in the production and marketing of herbal medicines. The sales of herbal medicine products have plateaued to such an extent that these products have become available to consumers as positive health care. Herbal medicines are in great demand in developed as well as developing countries for primary health care because of wide biological activities, higher safety margins, and lesser costs. Plant-based molecules are continuously gaining widespread acceptance due to their effective therapeutic properties (Dubey et al., 2004).

Phyto-chemical studies of the medicinal plant preparations are necessary for standardization, which helps in understanding the significance of phytoconstituents in terms of their observed activities. Phyto-chemistry also helps in standardizing the herbal preparations so as to get the optimal concentrations of known active constituents, and in preserving their activities. Standardization can be carried out by obtaining a chemical fingerprint/profile or through bioactivity guided fractionation. Chemical fingerprints through chromatographic techniques are more commonly used for standardization and are obtained in terms of one or more marker compounds. It would be ideal to use the active constituent in the plant as the marker compound; however, in cases where active constituents are not known, the marker compound can be independent of the therapeutic activity (Roman, 2001).

According to European Medicines Agency guidelines (EMEA, 2005), quantification of substances with known therapeutic activity or markers is obligatory. As per the European Pharmacopoeia, marker compounds should be characteristic or
unique for the herbal material or herbal preparation, have an established chemical structure, should be present in the starting material as well as the finished product in sufficient amounts, be accessible to quantification with common analytical methods such as high-performance liquid chromatography (HPLC) or high performance thin layer chromatography (HPTLC), be sufficiently stable, and be commercially available or able to be isolated by the company in its own laboratory. Thin layer chromatography (TLC) and HPLC are the most commonly used methods for obtaining chemical fingerprints and identification of the crude plant extracts. However, there are several possibilities that may arise while using these techniques for standardizing the crude extracts. It is possible that the plant material collected from the same plant in two different seasons can show different phyto-chemical fingerprints and therefore different biological activities or two plants with identical taxonomy collected under same environmental condition can show different phyto-chemical fingerprints but similar biological activities. In such situation comparison of the phyto-chemical profiles as an indicator of important constituents can act as a shortcut for identifying biologically active constituents. Medicinal plant production is largely dependent on genetic background and environmental conditions, and contents of the major bioactive compounds varied according to different environments due to the response to different physical, chemical and biotic elicitors (He et al., 2010).

Over exploitation of bio resources, without ensuring the sustainability, can lead to extinction. The main causes of threats to medicinal plants are anthropogenic activities and environmental factors. Poverty, lack of education and awareness, lack of alternate sources of income, declining interest and faith in the traditional medicine and knowledge, and lucrative prices attract the local people towards collecting and trading of these medicinal plants. Some of the potential causes in the rarity and quality of the medicinal plant species include habitat specificity, narrow range of distribution, land-use disturbances and introduction of exotics, habit alteration, climatic changes, heavy livestock grazing and exploration, growth of human population, fragmentation and degradation of population, population bottleneck, genetic drift, adulterations and contaminations (Kala and Sajwan, 2007). Realizing the threat of extinction of such endangered medicinal plant species, attention has already been focused towards developing production alternatives of whole plant parts-derived phytomolecules in order to meet the growing demand of pharmaceutical industries (Kumar et al., 2004).
Non Timber Forest Products (NTFPs) including MAPs are increasingly becoming popular in national markets as they are important ingredients of several herbal cosmetics, herbal tea, food, medicines, etc. The value of NTFPs has been recognized widely with its increasing contribution to the Nepalese economy (Edwards, 1996). The collection and marketing of NTFPs is a major source of rural income and an important source of revenue to the Government of Nepal. The Department of Forest (DoF) collected about Rs 2.1 crore as revenue from the sale of more than 2170 tonnes of NTFPs in the fiscal year 2008/09 (GoN/MOFSC/DoF, 2010). Most of them were exported to India in crude form or semi-processed form. But in the last few years, semi-processed or processed NTFPs are being exported not only to India but also to the other third world countries. Essential oils are the major exported commodity among processed herbs. Essential oils are extracted from more than 18 plants and the oil worth Rs 8.2 crore was exported to third countries in 2010/2011 (TEPC, 2011).

The trade in MAPs from Nepal to India is roughly estimated at 10,000-15,000 tonnes per year. The annual sales value of these NTFPs is pegged at 8.6 million dollars (Subedi, 2006). Annually, exports of about 42 thousands tonnes of over 100 NTFPs from Nepal, generates over US$ 30 million (Gurung, 2009). In 2009, Nepal exported US$ 9.8 million of MAPs and US$ 6 million in 2010 (GoN, Trade and Export Promotion Centre, in German Development Cooperation, GIZ, 2011). Each year, about 20,000 metric tonnes of MAPs worth USD 18-20 million are traded (ICIMOD, 2007); In 2008/09 about NRs 760 million (USD 10.6 million) of MAPs (including seeds and fruits used in perfumery, pharmacy, or for insecticides) were exported. In 2008/09, NRs 813 million (USD 11.3 million) of medicinal herbs and essential oils were exported from Nepal.

It is estimated that 7000 species of higher value plants exist in Nepal making it the twenty-fifth most species-rich country in the world (Bhuju et al., 2007; MoFSC, 2009). Nepal hosts nearly 2000 species of potentially useful plants, including medicinal and food plants (Ghimire, 2008). These plants are identified and used as traditional medicine (Bhattrai and Karki 2006; Shrestha et al., 2000; Hasan et al., 2013). Majority of such valuable plants grow in wild condition as natural component of vegetation in different regions from tropical to alpine climate in Nepal altitude from 100m to 6000m (DPR, 2007). Various plant parts of these wild medicinal species are collected and sold by rural poor especially in the mid-hills and mountains since ancient times (Rawal et al., 2009).
Nepal remains predominantly a rural society with 83 per cent of its 26.6 million populations living in rural areas (Census, 2011a; 2011b). Over six million people live with high levels of poverty in the remote, mid-hills and mountainous areas in the west from where most high value MAPs are collected. According to GIZ, 2011), 85 percent of Nepal’s MAPs are collected from the Far Western and Mid-West Development Regions—the two regions with highest levels of poverty. Local collectors and harvestors are usually impoverished children, women, the elderly and Parsons from disadvantage groups. The two species such as *Nardostachys grandiflora* and *Picrorhiza kurrooa*, out of five high value species, have estimated the export value $17.5 million from Nepal which has over 50% of volume and value in trade involving 161 species (Olsen, 2005a). The Master Plan for Forestry Sector (MPFS, 1988), the Tenth Five-Year Periodic Plan (2002-2007) (NPC, 2003) and the three-year Interim Plan of Nepal (2007/08-2009/10) (NPC, 2007) have strongly focused promoting the management of NTFPs, especially the medicinal and aromatic plants, as a program for poverty reduction. The Government of Nepal current Three Year Plan (2010-2013) states: Program for production and processing of MAPs is encouraged with public-private partnership, and a policy of development for special zones for production and management of MAPs (NPC, 2010). The government promotes the trade in NTFPs, including MAPs with international commitments.

The medicinal plants in Nepal are now threatened due to over and unsustainable harvesting for trade, habitat destruction and encroachment for agriculture, deforestation, fires, grazing etc. 53 medicinal plants have entered into different threat categories such as rare, endangered, vulnerable and commercially threatened (Shrestha and Joshi, 1996; Bhattarai et al., 2001). These plants are continuously harvested without a long-lasting plan to regenerate them (Sharma et al., 2004). This has resulted into the supply of counterfeit and adulterated raw material and products, and ultimately threat to their efficacy.

Conservation and domestication of such high valued medicinal plant species in Nepal acquires significant importance for saving them from extinction and also getting the benefits of biological, pharmaceutical, scientific, socio-economic and ecological values associated with them. One of the recommended practices/strategies for addressing such issues is to screen the natural populations (Dhar et al., 2000) and identify the chemically superior genotypes in terms of their bioactive marker constituents for mass multiplication. Mass multiplication of such genotypes would
make quality planting material available for cultivation leading thereby the
domestication of these plant species for sustained supply of the quality raw material.

In view of the above, screening of *P. kurrooa*, a threatened medicinal plant
species, occurring across its distribution range in Nepal, and identification of
chemically superior genotypes containing enhanced bioactive marker constituents for its
conservation and domestication acquires significant relevance from scientific and field
applicability point of view.
References:


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