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SEASONAL VARIATION OF PHYTOCHEMICALS

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ABSTRACT

Plant kingdom is a potential source of pharmaceutically active substances. Medicinal plants depict a tremendous variation in active constituents during different seasons; which have been widely attributed to variations in environmental variables such as temperature and rainfall. Aspects of synergistic effects due to UV radiation, humidity and hot temperatures can explain seasonal trends of plant secondary metabolite accumulation. Since active principles of some plants vary quantitatively in different seasons of the year so therapeutic efficacy of medicinal plants is also likely to vary during different seasons of the year and the majority of plant materials are usually best collected during season when the herbs are at peak maturity and concentration.

KEY WORDS

Active constituents, Medicinal plants, Seasons, Therapeutic efficacy, UV radiation

INTRODUCTION

The plant kingdom is a treasure house of potential drugs and in the recent years there has been an increasing awareness about the importance of medicinal plants. Medicinal plants are of great local significance and also global importance. In Ayurveda about 2000 plant species are labeled as a source of medicinal value, while, in Chinese Pharmacopoeia 5700 traditional medicines are listed (Chopra *et al*., 1956), most of which are still used in conventional medical practice though the whole plants are rarely used (Todarwal *et al*., 2011). Medicinal plants have been used in traditional treatments for numerous human diseases for thousands of years and they continue to be an important therapeutic aid for alleviating the ailments of human kind (Momin and Kadam, 2011). Among the 120 active compounds currently isolated from the higher plants and widely used in modern medicine, today 80% show a positive correlation between their modern therapeutic use and the traditional use of the plants from which they are derived (Fabricant and Famsworth, 2001; Pandith, 2012).

Drugs from the plants are easily available, less expensive, safe, and efficient and rarely have side effects (Yadav and Agarwala, 2011). Traditional knowledge of medicine has long been used since ages for curing various human ailments. About 60-80% of world populations still rely on plant-based medicines (Santhi *et al*., 2011). Though the traditional Indian system of medicine has a long history of use, yet they lack adequate scientific documentation, particularly in light of modern scientific knowledge (Shrivastava and Leelavathi, 2010).

The medicinal value of plant lies in the bioactive phytochemical constituents of the plant showing various physiological effects on human body. So, through phytochemical screening one could detect the various important compounds which could be used as the base of modern drugs for curing various diseases (Sheikh *et al*., 2013). Phytochemical screening of various plants has been reported by many workers (Mojab *et al*.,

2003; Parekh and Chanda, 2008). These studies have revealed the presence of numerous chemicals including alkaloids, flavonoids, steroids, phenols, glycosides and saponins.

Plants being valuable source of a wide range of secondary metabolites are used as pharmaceuticals, agrochemicals, flavors, fragrances, colors, biopesticides and food additives. Over 80% of the approximately 30,000 known natural products are of plant origin (Fowler and Scragg, 1988). Secondary metabolites perform no direct metabolic function but fulfill specific ecological functions such as maintaining aesthetics of the plant, attracting insects for pollen transfer and animals for consumption of fruits, as defense mechanism in conditions of stress, wounding or pathogen attack and as natural pesticides (Heldt, 2005). Despite advancements in synthetic chemistry, biological sources are usually preferred for a number of secondary metabolites including pharmaceuticals due to lesser side effects and better biodegradability (Pezzuto, 1995; Vimala *et al*., 2014). Previously the crude drugs/extracts prepared from plants were identified by comparison only with the standard descriptions available in the literature, but recently due to advancement in the field of pharmacognosy, various techniques have been followed for the standardization of crude drugs. Phytochemical screening is one of the techniques to identify new sources of therapeutically and industrially important compounds like alkaloids, flavonoids, phenolics, steroids, tannins, saponins etc. present in the plant extracts. These compounds can be derived from any part of the plants like bark, leaves, flowers, seeds, etc.

Knowledge of the chemical constituents of plants is desirable because such information will be of value for the synthesis of new bioactive compound/s for treating the specific disease (Geetha and Geetha, 2014).

IMPACT OF SEASONS ON PHYTOCHEMICALS

Season has impact on availability of active principles in medicinal plants. According to principles of western herbal medicine, therapeutic efficacy varies during different times or seasons of the year. The constituents and active principles vary quantitatively at different seasons of the year and the majority of plant materials are usually best collected during season when the herbs are at peak maturity and concentration (Singh, 2008; Jayanthy *et al*., 2013).

Biosynthesis of these secondary metabolites is not only controlled genetically, but is also strongly affected by different biotic and abiotic stresses (Naghdi *et al*., 2004). Number of factors such as climate, altitude, rainfall and other conditions may affect growth of plants which in turn affect the quality of herbal ingredients present in a particular species even when it is produced in the same country. These conditions may produce major variations in the bioactive compounds present in the plants (Kokate *et al*., 2004; Geetha and Geetha 2014).

Many studies on medicinal plants indicated that chemical content composition of these plants may vary substantially with the developmental stage of the plants. For this reason, investigations on ontogenetic variation of secondary metabolites from different classes have received considerable interest from plant scientists over several decades (Cirak *et al.,* 2007). The analytical determination of taxanes in extracts from the bark of *T. baccata* indicates that the taxane content depends significantly on the season of the year. It appears likely that the choice of the right season for harvesting plant material, along with optimization of other parameters (e.g. improved isolation techniques) can lead to the availability of taxanes in higher yields (Vesela,1999).

Secondary metabolites are only produced in large quantities when they are needed, at a particular stage in lifecycle, at certain seasons or in those tissues that require most protection (Salminen *et al.,* 2001). Climatic conditions, such as time of day, precipitation and outside temperature, have a significant influence on the physical qualities, chemical composition of the medicinal plants. Sunshine duration, the average height of rainfall, average temperature and thermal amplitude between day and night also influence the physiological and biochemical activity of plants. It is important to predetermine all of these factors (Endrias, 2006). Studies have shown that in Brassicaceae concentrations and profiles of GLS show considerable variation within species and that they vary with environmental conditions and developmental stage (Poelman *et al.,* 2008; Hanson *et al.,* 2009).

Alkaloid content changes constantly in a plant throughout the growth period, the maximum stocks of alkaloids in leaves are accumulated before flowering (Maknickiene *et al*., 2013). The average contents of vitamin C, glucosinolate, total phenol, and total flavonoid and antioxidant activities were significantly

higher in florets in the spring than in the fall in broccoli (Bhandari and Kwak, 2014).

The concentration of a particular phenolic compound within a plant tissue is dependent on season and may also vary at different stages of growth and development (Ozyigit *et al*., 2007). Stefkov *et al*. (2009) reported in *Teucrium polium* that the content of total flavonids are the highest in the period from May to July, which could be recommended as the most convenient period in the season for its collection. Contents of phenolics and flavonoids as well as anti-oxidant activity of daisy flowers vary to a relatively small extent during the year (Siatka and Kasparova, 2010).

According to Generalic *et al*. (2012), *Salvia officinalis* (extract) collected in the month of the May is richest in total flavonoids and showed the best ant-ioxidant properties and the highest anti-microbial activity. Thus, collection of these plants during May seems the best choice for further use in the pharmaceutical industry. In *Melilotus indicus*, total flavonoid and phenolic content increases from colder to hotter seasons when plants receive stronger sunlight for a longer duration. Antioxidant activities and lipid peroxidation inhibitory activities of methanolic extracts and their fractions also showed variation with the seasonal change (Ahmed *et al*., 2012). The active components in *Momordica charantia* fruit which are responsible for its anti-diabetic and hypolipidemic activity vary quantitatively and/or qualitatively during different seasons of the year and reach the peak during spring (Kolawole and Ayankunle, 2012).

Essential oils extracted from *Inga laurina* in the rainy season showed a better inhibition of the bacterial growth when compared to the oils of the dry season, particularly with respect to aerobic microorganisms (Furtado *et al*., 2014). In *Microtus oeconomus* concentration of flavonoids, condensed tannins and total phenols being lowest in the month of June and gradually increasing from July to August/September (Dai *et al*., 2014). Firdusi *et al*. (2015) observed that total alkaloids, flavonoids and phenolic compounds showed increasing value in monsoon than pre-monsoon in *Lasia spinosa*.

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