Journal of Pharmaceutical and Scientific Innovation

www.jpsionline.com

Review Article

INFLUENCE OF TIME FACTOR ON PHYTOCONSTITUENTS IN CERTAIN AYURVEDIC MEDICINAL PLANTS: A COMPREHENSIVE REVIEW

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DOI: 10.7897/2277-4572.04553

Received on: 23/08/15 Revised on: 28/09/15 Accepted on: 18/10/15

ABSTRACT

In Ayurveda, the safety and quality of crude medicinal plants has been quoted to base upon major factors like Desha (habitat), Kala (Time), Guna (properties), etc. Among them, Kala i.e. the time factor (season, lunar period and day) plays a significant role in influencing the pharmacotherapeutic properties. Accordingly, protocol for crude drug collection in six rutus (seasons) according to the parts used has been denoted in Charaka, Sushruta, Sharangdhara samhita and Raja nighantu. In modern pharmaceutics, extensive research has been carried out to assess the role of seasons, diurnal variation, maturing stages on phytoconstituents of different plants parts. Extensive data is available on non- Ayurvedic plants. In this paper, a thorough review was made pertaining to the concept of Kala, in relation to medicinal plants, from available classical literature. Scientific reports have been compiled from the available online scientific journals. On critical analysis, data on seasonal variation was found reported in 36 medicinal plants used in Ayurveda whereas data on diurnal variation was found in 8 medicinal plants. Thus, the concept of Kala in Ayurveda truly holds a scientific stand and plays an essential role in deciding the quality of the crude drug.

Keywords: Kala, seasonal variation, diurnal variation, phytoconstituents, etc.

INTRODUCTION

There has been a substantial increase in the global and national demands of medicinal plants, since last two decades. As a consequence, the safety and quality of herbal medicines have become increasingly major concerns both in the health as well as pharmaceutical sector. Crude drug quality, quoted by Acharya Charaka[1] depends upon major factors like Desha (habitat), Kala (Time), Guna (properties) and Bhajana sampat (cultivation area). Kala (time) is one of the major factors that influence the potency of medicinal plants. Kala is often classified to be nityaga (diurnal) and avasthika (rutu wise i.e. seasonal). Avastha (phenological growth) can also be related to the immature stage to maturing stage of medicinal plants as stated by Charaka[2] and also has a great impact on the qualitative and quantitative aspects of drug. As regards to time, it can be seasonal variation, lunar influence (fortnight variation) and diurnal variation. Further, the time of collection and harvesting also plays an important role in deciding the quality of drugs. Illustrations[3] of collection time of some drugs like Madanphala (*Randia dumetorum*) to be collected in between Vasanta and Grishma rutu, Ikshwaku (*Lageneria siceraria*) to be procured before its flowering stage and Trivrut (*Operculina turpethum*) to be procured in waxing moon phase i.e. shuklapaksham has been described in the classical texts.

The basic points of consideration like the suitable time of collection of plants, knowledge of storage techniques of crude plant material play an inevitable role in quality and safety of the finished medicinal plant products. A sincere practice of GACP (Good Agriculture and Collection Practices) designed by WHO (World Health Organisation) can help to improve the quality check.

Ayurveda has focussed this necessity and has mentioned a protocol namely 'Dravya samgraha kala' wherein the collection of crude plant drug has been classified according to parts used and rutu (season). (Table 1)

In the recent past, many research works have been undertaken to explore the role of time factor on the phytopharmacological properties of medicinal plants. Research data on seasonal, lunar and diurnal variations on phyto constituents along with therapeutic efficacy of medicinal plants of Ayurveda has been reported. In his paper, an attempt has been made to compile the research data and present in a comprehensive manner.

Table 1: Time of collection of parts used of medicinal plants according to different *Acharyas*

Sr.no.	Part used	*Charaka Samhita*	*Sushruta Samhita*	*Raja Nighantu*
1.	*Moola* (Root)	*Grishma* (summer) or *Shishira* (winter)	*Pravrita* (period in between summer and rainy season)	*Shishira*
2.	*Pallava* (Tender leaves)	*Varsha* (rainy season) & *Vasanta* (spring)		*Grishma* (summer)
3.	*Shakha* (Twigs/branches)	*Varsha* (rainy season) & *Vasanta* (spring)		
4.	*Pushpa* (Flowers)	Respective flowering season	-	*Vasanta* (spring)
5.	*Twak* (Bark)	*Sharada* (autumn)	*Sharada* (autumn)	-
6.	*Kshira* (latex)	*Sharada* (autumn)	*Hemanta* (early winter)	-
7.	Sara (heartwood/sap)	*Hemanta* (early winter)	*Vasanta* (spring)	
8.	Phala (Fruits)	Respective flowering seasons	*Grishma* (summer)	*Vasanta* (spring)
9.	*Kanda* (Tuber)	*Sharada* (autumn)	*Hemanta* (early winter)	-
10.	*Patra* (leaves)	-	*Varsha* (rainy season)	*Shishira* (winter)
11.	*Panchanga* (whole plant)	-	-	*Sharada* (autumn)

DISCUSSION

***Achyranthes aspera* L.[Apamarga]**

This study included impact of seasonal variation on the antibacterial activity of *Achyranthes aspera* L against various strains of bacteria. The aqueous, Hexane, Ethyl acetate, Methanol and Ethanol extracts of root, stem, leaf and seeds of *Achyranthes* were used for the study. Among them, the highest activity was observed for hexane extracts in the month of January against all bacteria at 100 µg/ml disc concentration. [7]

***Adhatoda vasica* Nees [Vasa]**

The seasonal variation in the vasicine content of five parts of *Adhatoda vasica* was assessed with the help of TLC-UV densitometric estimation technique. Highest amount of vasicine was found to be present in the inflorescence and in the months of July-Sept. in most parts of the plant.[8]

In other study, seasonal variation of the vasicine and deoxyvasicinone in roots and leaves of *Adhatoda vasica* was investigated. Maximum amount of vasicine was found in the month of August in both leaves and roots whereas Deoxyvasicinone was found to be maximum in month of December- January in roots and in November for leaves.[9]

***Alstonia scholaris* R.Br. [Saptaparna]**

The effect of seasonal variation on the antineoplastic activity of *Alstonia scholaris* R. Br. in HeLa cells was assessed. The study demonstrated that the extract of bark prepared from the summer collection, and the fractions containing the alkaloids were highly effective in cell killing.[10]

***Andrographis paniculata* (Burm.f.) Wall.ex. Nees [Kalmegh]**

The seasonal dynamics of *A. paniculata* was carried out on Kharif and Rabi seasons in two successive years. The andrographolide accumulation and its assessed in two calendar months i.e. June and November. The results revealed that last week of October ideal for obtaining maximum dry herbage and total andrographolide yield, respectively.[11]

***Anogeissus latifolia* (Roxb.) [Dhava]**

Changes in the phytoconstituents if any during winter and summer in the apical bark, middle bark and mature inner bark of *Anogeissus latifolia* was studied. It was observed that, highest content of reducing sugars, amylopectin, amylose, starch crude fibre, etc and phytochemicals like polyphenols, tannin, alkaloids, etc. in the apical bark, were greater in amount in summer season whereas the quantity of starch, amylopectin, crude fibre and amylase was more in winter season.[12]

***Bacopa monnierri* L. Wettst [Brahmi]**

In this present study, the saponin content was assessed in different parts of Brahmi during three different seasons in different stages of its growth. The results showed that total saponin contents in Brahmi were highest in rainy season while the weight yield of Brahmi was the highest in summer. Ages of Brahmi (1-4 months) slightly affected total saponin content. High level of total saponins (1.91±0.48% w/w) was detected at the shoot. These findings indicate that the saponin quantity is affected by seasons and the distribution of the saponins is different in each part of the plant.[13]

***Barleria prionitis* Linn. [Sahachara]**

The seasonal variation (winter, rainy and summer) in the total alkaloid and total phenol contents of mature leaves were assessed in a study in *Barleria prionitis*. Maximum amount of alkaloids and phenols were found in summer season.[14]

***Boerhaavia diffusa* Linn. [Punarnava]**

The seasonal variation (winter, rainy and summer) in the total alkaloid and total phenol contents was assessed in a study in *Boerhaavia diffusa*. Fully mature leaves exposed to sunlight were collected randomly during rainy (July-September), winter (December-February) and summer (April-June) seasons which were dried and used for analysis. Maximum amount of alkaloids and phenols were found in summer season.[15]

***Butea monosperma* Lam. [Palasha]**

Estimation of lipid and alkaloid content was carried out in different parts like leaves, bark and wood of *Palasha* during summer, monsoon and winter for two consecutive years. The lipid concentration was observed to be highest in summer in leaves. The alkaloid content was highest in summer season in bark and wood respectively.[16]

***Calotropis gigantea* R.Br. [Alarka]**

The seasonal variation was studied in the physicochemical parameters of Arka kshara. The plant was collected in three rutus namely Grishma, Sharada and Shishira. The yield of kshara was found to be more in Sharad rutu. The moisture content was high in plants collected in Grishma rutu. Acid insoluble ash was found more in Shishira rutu.[17]

***Calotropis procera* Ait. [Arka]**

The seasonal variations (winter, summer and monsoon) in different parts of the plant namely apical bud, mature leaves, stem, whole plant and flower. The test used were protein, tannin, carbohydrate, phenol, fixed oil and essential oil content. It was observed that all the plant parts except apical bud showed higher protein and carbohydrate content in summer season. Tannin was high in amounts in monsoon in apical buds while in summer in the stem.[18]

***Citrullus colocynthis* Linn Schrad [Indravaruni]**
The seasonal variation in three different seasons i.e. winter, rainy and summer in total alkaloid and total phenol contents of mature leaves were assessed in a study in *Citrullus colocynthis.* Maximum amount of alkaloids and phenols were found in summer season.[19]

***Dalbergia sissoo* Roxb [Shimshapa]**
The roots of leguminous plant *Dalbergia sissoo* Roxb. and the soil samples were screened for their Arbuscular mycorrhizal fungal association that have symbiotic association during the year. Percentage of root colonization and spore number of the plant were co-related to each other. Higher spore number was recorded in *Dalbergia sissoo* Roxb. in months of December and April whereas percent root colonization significantly increased during April. The result revealed that both root colonization and sporulation decline from September to April.[20]

***Datura metel* L. [Dhatura]**
In Datura, maximum chlorophyll content in fresh leaves was observed in rainy season in flowering stage. Proline content was observed to be maximum at maturity stage in summer. Protein content was maximum in summer. Highest alkaloid content was seen in rainy season.[21]

***Desmodium gangeticum* (L.) DC. [Shalaparni]**
In this study, observations regarding the seasonal variation in anatomical, physiological and phytochemical profiles of Shalaparni [*Desmodiumgangeticum*(L.)] were done. The percentage of lupeol was very low in young plants and was found to be increased with growth and maximum % of lupeol was observed in the flowering stage. Plant showed variation in content of lupeol, quantitatively from season to season. Pharmacognostical variation was also observed in the quantity of cell inclusions, amount of phloem fibers, xylem fibers and in the wall thickness of vessel elements.[22]

***Fagonia cretica* L. [Dhanvayasa]**
The seasonal variation in macronutrient and micronutrient mineral composition in four different parts (root, stem, leaf and fruit) were studied in *Fagonia cretica* L. The iron and zinc content was found higher in summer whereas the Ca, Mn, Na, Cu and Mg levels were high in winter season.[23]

***Glycyrrhiza glabra* L. [Yashtimadhu]**
The seasonal variation of the glycyrrhizin and isoliquiritigenin glycoside contents in the thickening roots of Glycyrrhiza glabra L. were determined. The glycyrrhizin content in 1-year-old roots rapidly increased from October to November, whereas the isoliquiritigenin glycoside content increased up to October. In 3-year-old plants, although the isoliquiritigenin glycoside content rapidly increased from June to July, the glycyrrhizin content did not show any significant increase from May to August. The glycyrrhizin content increased during the senescence of the aerial parts as well as during the early stage of shoot elongation.[24]

***Grewia tenax* Forsk. [Gangeruki]**
Seasonal variation (winter, rainy and summer) in the total alkaloid and total phenol contents of mature leaves were assessed in a study in *Grewia tenax.* Maximum amount of alkaloids and phenols were found in present in summer season.[25]

***Momordia charantia L.* [Karvellaka]**
Anti-diabetic and hypolipidemic activities of *Momordica charantia* fruits harvested at different seasons of the year, namely spring, summer, autumn and winter were assessed in Twenty –four rats divided into four groups. The highest activity was observed with spring sample, followed by the summer sample in a dose dependent manner.[26]

***Leptadenia reticulata* (Retz) Wight. [Jivanti]**
In this study, the variations if any, in the chemical constituents of *Jivanti* (whole plant powder) collected during three seasons (winter, summer and rainy) were ruled out using HPTLC with *p*-coumaric acid as a reference standard. All the three extracts showed similar bands at Rf 0.14, 0.18, 0.37, 0.48 and 0.52. However the monsoon sample showed the presence of an additional band at Rf 0.72, which was specific only to that season. Extracts of the plants collected during the summer and the winter seasons showed an extra band at Rf 0.32. Samples collected during all the three seasons showed hardly any variation in constituents when compared to peaks of reference standards. But minor changes were observed.[27]

***Madhuca indica* Gmel [Madhuka]**
The lipid and alkaloid concentration was observed in three seasons in the bark, wood and leaves of *Madhuca indica.* It was reported to be highest in summer in leaves (lipids: 12.55 to15.8 mg/gm) and (alkaloids: 1.85 mg/gm) followed by bark and wood.[28]

***Mentha longifolia* L. Huds. [Putiha]**
The maximum dry weight, total fibres and minerals shoots of *M.longifolia* were recorded during the summer season, while moisture contents were higher than in the autumn season. The least dry matter was produced in autumn, total fibers and minerals in winter and moisture contents in summer season.[29]

***Mimusops elengi* L [Bakula]**
A study conducted on the estimation of lipid and alkaloid concentration in leaves, bark and wood of *Mimusops elengi* was carried out in three seasons namely summer, winter and monsoon. The highest concentration of both was found in summer in leaves followed by bark and wood.[30]

***Peganum harmala* L. [Harmala]**
The seasonal variation in macronutrient and micronutrient mineral composition in four different parts (root, stem, leaf and fruit) were studied in *Peganum harmala.* An increase in Ca, Mg, Na, Al, Fe, Moand Zn was observed in winter season as compared to summer.[31]

***Plumbago zeylanica* L. [Chitraka]**
The plumbagin content was measured in winter (Dec- Feb) and in summer (May- June). Roots harvested during the winter months i.e. during December to February yielded high plumbagin content and during summer month i.e. in June, its yield became very low. It was also observed that if it is harvested just before the sprouting of leaves in February, the roots yield highest amount of plumbagin (1.8%).[32]

***Ricinus communis* L. [Eranda]**
The seasonal variation in macronutrient and micronutrient mineral composition in four different parts (root, stem, leaf and fruit) were studied in *Ricinuscommunis*. An increase in Ca, Mg and Fe was observed in summer whereas high amounts of Na, Mnand Zn were observed in winter.[33]

***Sesbania grandiflora* Pers.[Agastya]**
The seasonal variation in total ash, water soluble ash and water insoluble ash was investigated in leaves, wood and bark of *Sesbania grandiflora* in summer, monsoon and winter. The total ash content of leaves of *S.grandiflora* was higher in summer whereas of bark and wood was highest in winter. The water soluble ash for leaves was high in monsoon, that for wood in summer, that for bark in winter. The water insoluble ash was highest in quantity in bark and wood in winter.[34]

***Sesbania cannabina* and *Sesbania bispinosa* [Jayanti]**
Evaluation of total ash, water soluble ash and water insoluble ash was carried out leaves, wood and bark of *Sesbania cannabina* and

Sesbania bispinosa in three different seasons (summer, winter, monsoon). The total ash content of leaves of *S. cannabina* was higher in monsoon while it was found to be high in bark and wood in winter. The water insoluble ash was highest in bark and wood in winter while it was more in leaves in summer. The water insoluble ash was high in case of leaves and bark in winter.[35]
The leaves and wood of *S.bispinosa* exhibited higher amount of total ash content in winter. The water soluble ash was found high in wood and bark in winter whereas the water insoluble ash was highest among the three parts in bark in monsoon season.

***Sizygium cumini* Linn. [Jambu]**
Estimation of lipid and alkaloid concentration in the bark, wood and leaves was carried out in three seasons. It was observed to be highest in summer in leaves (lipid: 27.475 mg/gm) and (1.85mg/gm) followed by bark and wood.[36]

***Tamarindus indicus* L. [Amlika]**
The roots of leguminous plant *Tamarindus indicus* L and the soil samples were screened for their Arbuscular mycorrhizal fungal association that have symbiotic association during the year. Percentage of root colonization and spore number of the plant were co-related to each other. Higher spore number was recorded in *Tamarindus indicus* L in months of December and April whereas percent root colonization significantly increased during April. The result revealed that both root colonization sporulation decline from September to April.[37]

***Terminalia arjuna* L. [Arjuna]**
Variation in tannin and oxalic acid content of bark was screened in climatic conditions like (rainfall, humidity and mean temperature). Barks collected in the March contained higher amount of tannins (14.82%) followed by the bark collected in November.[38]

***Terminalia bellerica* (Gaertn) Roxb. [Bibhitaki]**
The bark and leaf of *Bibhitaki* were screened for their cytotoxic and anti-oxidant activity in four different seasons namely spring (February), summer (May), Rainy season (July) and autumn (October) under similar experimental conditions. The cytotoxic activity of leaf was found to be pronounced in polar extracts in summer season. In case of bark, the activity of hexane, DCM and chloroform extracts was maximum in May sample whereas that of chloroform and methane extracts was maximum in July sample. In case of anti-oxidant activity, results were positive in months of May and July samples. As the activities were more in the summer months, the ideal collection time could be probably taken in from May to July.[39]

***Tinospora cordifolia* Thunb. [Guduchi]**
The effect of seasonal variation on phytoconstituents in male and female stem samples of *Tinospora cordifolia* Thunb. was seen in a study. It revealed total phenolics and total sugar concentration obtained highest values in summer season while starch and tannin content were found maximum in winter season in both the genders. However, biomarkers, tinosporaside and berberine, reached to their highest concentration in monsoon season. The antioxidant potential revealed the highest inhibition percentage in winter season as well as in late summer season.[40]

***Tribulus terrestris* L. [Gokshura]**
The seasonal variation in macronutrient and micronutrient mineral composition in four different parts (root, stem, leaf and fruit) were studied in *Tribulus terrestris*. An increase in Ca, Mg and Zn was observed in summer whereas increase in Na and Al in winter.[41]

***Trichosanthes cucumerina* L. [Patola]**
The total cucurbitacin content produced in the different parts of *T. cucumerina* L. var. *Cucumerina* viz., fruit, stem and leaves with time and temperature was studied during the year 2007-08. The highest amount of cucurbitacins was produced in the month of February, i.e., 0.8, 1.7 and 3.7 w/w % and lowest was in the month of July i.e. 1.9, 0.5 and 0.17 w/w % in fruit, stem and leaves respectively.[42]

***Withania somnifera* Dunal. [Ashwagandha]**
Plant material from *Withania* was collected from natural habitat in different seasons and at different physiological stages and evaluated for variation in total chlorophylls and polyphenols present in leaves. The chlorophylls and polyphenols were maximum in winter and in vegetative stage in particular.[43]

Table 2: Plants that are reported to possess seasonal variation according to part used.

Sr.no.	Part used	Plants
1)	Leaf	Palasha, Maduka, Jambu , Bakula, Vasa, Apamarga, Patola, Dhanvayasa, Gokshura, Eranda, Harmala, Sahachara, Indravaruni, Punarnava, Nagabala, Brahmi, Dhatura, Ashwagandha, Shankhapushpi, Bibhitaki, Agastya, Jayanti, Kalmegha, Arka
2)	Stem bark	Arjuna, Bibhitaki, Dhava, Palash, Madhuka, Jambu, Bakula, Saptaparna, Agastya ,Jayanti
3)	Roots	Apamarga, Dhanvayasa, Harmala, Gokshura, Eranda, Brahmi, Shalaparni, Chitraka, Vasa, Chincha, Dalbergia, Yastimadhu
4)	Shoots	Brahmi, Putiha
5)	Flower	Arka
6)	Fruit	Dhanvayasa, Gokshura, Harmala, Eranda, Patola, Karvellaka
7)	Stem	Dhanvayasa, Gokshura, Harmala, Eranda, Patola, Apamarga, Guduchi
8)	Seed	Apamarga
9)	Wood	Palash, Madhuka, Jambu, Bakula, Agastya, Jayanti
10)	Apical bud	Arka
11)	Whole plant	Arka, Alarka

Effect of lunar cycle

The influences of moon on the phytochemicals of the plants are claimed in the classical texts of *Ayurveda*. So far very scarce data is available on lunar influence in medicinal plants. A study on effect of phases of moon on growth and active principles of *Acorus calamus* has been reported.[44]

There are 4 phases of moon and plantation is closely related to these phases. **In a waxing moon**, when light increases towards a full moon, sap flow is drawn up. This is the most suitable time for sowing and transplanting flowering annuals, biennials, grains and melons. **With waning moon**, when the light is decreasing as the moon changes from a full to a new moon, the sap flow is drawn down. This focuses the energy towards the roots, which is more suited to root crops and perennials, plants that live longer than two years.[45]

Plants like lettuce, spinach, cabbage and celery which are named leafy annuals should be sowed in the new moon phase. The full moon phase is a good time for taking cuttings and planting apples, potatoes, asparagus and rhubarb.

Diurnal variation in phytoconstituents of plants

Apart from seasonal variations, daily changes have also been reported in some plants.

***Brassica oleracea Var.acephala cv Galega* : [Gobi]**
Changes in the total and individual glucosinolate concentrations of Portuguese leaf type cabbage *(Brassica oleracea* var acephala cv Galega) were monitored throughout the day. A significant decrease in total glucosinolate concentration was noted between 6.00h and 10.00 h.[46]

***Brassica oleracea* var *capitata cv Predena*. [Gobi]**
White cabbage was monitored throughout the day for evaluating diurnal variation in total and individual glucosinolate concentrations. Significant decrease in total glucosinolate concentration was noted between 6.00h and 10.00 h.[46]

***Coriandrum sativa* L. [Dhanyaka]**
Assessment of essential oil content of *Coriandrum sativum* green shoots, fruits and leaves, on four hourly basis, shows that the content of essential oil varied according to the hour of day and night, highest being at 12h.[47]

***Crocus sativus* L. [Kumkum]**
The variation in stigma composition of saffron on harvesting the flowers at four different hours of the day after flower blossom. The highest content of crocin (18.20%) and picrocrocin (7.66%) was obtained at the last time of harvest and second time of harvest respectively. Safranal content however was found to be decreased with delay of harvest, being highest (1.36%) in first harvest time.[48]

***Nicotiana tabacum L.(cv.Wisconsin 38)*. [Tamraparna]**
Cytokinins, auxin, and Abscissic acid levels undergo significant variations in leaves of tobacco plant during the day and night.[49]

***Ocimum gratissimum* L. [Ram tulasi]**
Daily fluctuation was seen in the essential oil of *Ocimum gratissimum* (Lamiaceae), where levels of eugenol in the essential oil were observed to drop from 98% at 12 a.m. to 11% at 5 p.m.[50]

***Papaver somiferum* L. [Ahiphena]**
Diurnal fluctuations of the alkaloid concentration in latex of poppy *Papaver somniferum* were assessed. It was concluded that diurnal fluctuations in the concentration of the major alkaloids namely morphine, codeine and noscapine are not reflections of enzymatic processes but the result of water transport between the laticifers and the surrounding vascular tissue.[51]

***Rosa damascene* Mill. [Taruni]**
The highest essential oil content (0.043%, v/w) was obtained from the rose flowers which were harvested at 04:00 am and the lowest (0.017%, v/w) from the flowers harvested at 02:00 pm. The percentage of citronellol + nerol, main components of rose oil, increased with delay in harvesting. Geraniol content (26.3%) was maximum when the flowers were harvested at 10:00 am, but after that there was significant reduction in its concentration upto 06:00 pm.[52]

It is seen that studies of seasonal variation has been carried out in nine parts of plants. The works reported in seasonal variation in leaves is maximum i.e. twenty plants followed by 13 in roots, 9 in stem bark, 7 in stem, 6 in fruit, 5 in wood, 3 in shoots, and 1 each in flower stigma and seed.(Table 2) All the studies related to seasonal variation in plants are found to focus on the variation in phytochemicals and their therapeutic activities. Significant differences are observed in the amount of phytochemical contents as well as therapeutic activity of the plants. A total of 36 Ayurvedic medicinal plants have been found to possess seasonal variation in medicinal plants of Ayurveda till date.

Table 3: Comparative analysis of collection period in classics and its similar action reported in the similar period

Sr no.	Medicinal plants	Part used	Reported for highest quality/activity	Month /season of study	Classical reference
1)	Apamarga	Root	Anti bacterial activity	January (Shishira)	Charaka samhita
		Stem	Anti bacterial activity	January (Hemanta)	Sushruta samhita
2)	Vasa	Leaves	Vasicine content	August (Varsha)	Charaka samhita, Sushruta samhita
		Roots	Deoxyvasicinone content	December (Shishira)	Charaka samhita, Raja nighantu
3)	Brahmi	Shoots (pallava)	Saponin content	Monsoon (Varsha)	Charaka samhita, Raja nighantu
4)	Arka	Pallava	Tannin content	Monsoon (Varsha)	Charaka Samhita
5)	Shimshapa	Roots	Root colonization and spore formation	Dec-April (Shishira and Grishma Rutu)	Charaka samhita
6)	Dhatura	Fresh leaves	Alkaloid content	Rainy Season (Varsha)	Sushruta samhita
7)	Dhanvayasa	Root	Ca, Mn, Na,Mg composition	Winter (Shishira)	Charaka samhita, Raja nighantu
		Stem		Winter (Hemanta)	Sushruta samhita
8)	Karavellaka	Fruit	Anti-diabetic and hypolipidemic activity	Spring (Vasanta)	Raja nighantu
9)	Harmala	Root	Ca, Mg, Fe, Na, Zn composition	Winter (Shishira)	Charak samhita, Raja nighantu
		Stem		Winter (Shishira)	Sushruta samhita
10)	Chitraka	Root	Plumbagin content	Winter (Shishira)	Charaka samhita, Raja nighantu
11)	Eranda	Root	Ca, Mg, Fe composition	Winter (Shishira)	Charaka samhita, Raja nighantu
		Stem		Winter (Shishira)	Sushruta samhita
12)	Jayanti	Leaves	Total ash content	Monsoon (Varsha)	Sushruta samhita
13)	Amlika	Roots	Root colonization and spore formation	Dec-April (Shishira And Grishma Rutu)	Charaka samhita
14)	Guduchi	Stem	Starch and tannin content; anti-oxident potential	Winter (Hemanta)	Sushruta samhita
15)	Patola	Fruit	Total cucurbitacin content	February (Vasanta)	Raja nighantu

Among them, 15 plants show similarities in enhancement of activity or phytoconstituent content in the partwise and rutuwise protocol described in Charak samhita, Sushruta samhita and Raja nighantu. Major reports coincide with time periods of Charak and Sushruta. (Table 3) Some reports on seasonal variation in tea leaves extract are also available.[53]

Apart from seasonal variation, diurnal variation is also observed in medicinal plants. But, meagre studies have been reported in case of medicinal plants used in Ayurveda. Only eight studies have been found in these lines. The studies of variations as per the lunar influences are deficient. The data on lunar influences is available in relation to the agricultural cultivation practices which are prevalent in some countries since long. Thus, all the compiled data throws light on the concept of the effect of time factor in medicinal plants from various perspectives.

The role of Kala in Ayurveda in relation to plants is pertaining to the seasonal differences, diurnal differences and the lunar influences that occur in plants. A subtle difference has been reported in amounts of principle constituents, their physic chemical changes, general growth of plants as per their diverse parts used in formulations.

CONCLUSION

Since ancient period, influence of time factor on properties and actions of the medicinal plants have been highlighted. In the recent past, many researches were carried out with modern parameters confirm the verse of ancient texts. Hence, it is necessary to give importance on time factor during collection of the crude drugs. Thus, the concept of Kala in Ayurveda truly holds a scientific stand and plays an essential role in deciding the original and crude drug quality. Further, works on the concept of Kala (Time) in Ayurveda can find a place in development of Good collection practices in Ayurveda that follow classical path.

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Source of support: Nil, Conflict of interest: None Declared

QUICK RESPONSE CODE	ISSN (Online) : 2277 –4572
	Website http://www.jpsionline.com

How to cite this article:
Anagha Vishwas Ranade, Rabinarayan Acharya. Influence of time factor on phytoconstituents in certain Ayurvedic medicinal plants: A comprehensive review. J Pharm Sci Innov. 2015;4(5):235-241 http://dx.doi.org/10.7897/2277-4572.044553