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A Review on Seasonal Variations in Phytoconstituents of some Medicinal Plants

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ABSTRACT

Aim: To evaluate the significance of *Kala* (seasonal and temporal factors) in the collection of medicinal plants as described in Ayurvedic literature, and to assess its correlation with modern scientific findings on phytochemical variation.

Background: In Ayurveda, the therapeutic efficacy, safety, and quality of medicinal plants are influenced by several key factors—*Desha* (geographical habitat), *Kala* (time of collection), and *Guna* (inherent properties). Among these, *Kala*, which includes the season, lunar cycle, and time of day, is particularly emphasized in classical texts. Ayurvedic compendia such as *Charaka Samhita*, *Sushruta Samhita*, *Sharangadhara Samhita*, and *Raja Nighantu* provide detailed seasonal guidelines for harvesting different plant parts (roots, bark, leaves, flowers, fruits) to ensure maximum potency.

Results:

A systematic review of classical Ayurvedic references alongside peer-reviewed scientific studies reveals that seasonal variation in phytochemical composition has been examined in 31 medicinal plants. While most modern studies focus on non-Ayurvedic or commercially globalized species, the findings consistently support the Ayurvedic view that the timing of harvest significantly affects the pharmacological properties of crude drugs.

Conclusion:

The Ayurvedic concept of *Kala* is strongly validated by scientific evidence. Seasonal and temporal factors directly impact the phytochemical profile and therapeutic efficacy of medicinal plants, underscoring the need to follow time-specific harvesting protocols.

Clinical Significance:

Integrating the concept of *Kala* into modern pharmacognostic standards and cultivation practices can optimize the quality, safety, and therapeutic value of herbal medicines. This approach also promotes evidence-based validation of traditional Ayurvedic knowledge in contemporary clinical and pharmaceutical contexts

Key Words *Phytochemicals, Seasonal variation, Kala, Ritu, Review*

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INTRODUCTION

Plants have been used for medicinal purposes since time immemorial and these traditional medicines are still popular worldwide due to lower cost and side effects

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compared to conventional medicine[1]. WHO estimated that 60% of the world population and 80% of the population of developing countries rely on traditional medicine, mostly plant drugs, for their primary health care needs[2]. In the present, the demand for herbal products is substantially growing nationally and throughout the globe 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.

The medicinal value of a plant might be dismissed if it lacks activity, yet this judgment often overlooks factors influencing the production of phytochemicals. There is a marked variation in phytoconstituents of medicinal plants due to a number of environmental variables such as temperature, altitude, soil type and change of season/rainfall.

Herbal market needs standardized plant material with ubiquitous active phytochemicals, which ultimately translate to less variation in pharmacological activity[3]. Therefore, to maintain quality, continuous observation of the composition and pharmacological activity in response to environmental conditions affecting the production of phytochemicals is crucial for production of marketable traditional plant material.

Crude drug quality, quoted by *Acharya Charaka* 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. 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.

Right time of collection of plant, storage technique knowledge of crude drug plays a crucial role in quality and safety of finished medicinal plant product. 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 *ritu* (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. This review is a collection of the studies of several groups of researchers on the effect of seasonal variations on secondary metabolites content of medicinally important plants. The results of these studies may help to the researcher those are involved in exploring the plants for the isolation of valuable chemicals from the plants. In this review we aimed to compile the results of researchers those have worked in this field and reported the components of several popular plants.

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AIMS AND OBJECTIVES

The aim of this review is to explore and synthesize existing research data on how seasonal variations influence the content, composition, and bioactivity of phytochemicals in plants, with a focus on identifying trends, mechanisms, and implications for their therapeutic, nutritional, and commercial applications.

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

S.No.	Part used	*Charaka samhita*	*Sushruta samhita*	*Raja nighantu*
1.	*Moola* (root)	*Grishma and Shishira*	*Pravrita*	*Shirisha*
2.	*Pallava* (tender leaves)	*Varsha and Vasanta*		*Grishma*
3.	*Shakha* (twigs/branches)	*Varsha and Vasanta*		
4.	*Pushpa* (flower)	Respecting flowering season		*Vasanta*
5.	*Twak* (bark)	*Sharada*	*Sharada*	
6.	*Kshira* (latex)	*Sharada*	*Hemanta*	
7.	*Sara* (heartwood)	*Hemanta*	*Vasanta*	
8.	*Phala* (fruit)	Respecting fruiting season	*Grishma*	*Vasanta*
9.	*Kanda* (tuber)	*Sharada*	*Hemanta*	
10.	*Patra* (leaves)		*Varsha*	*Shishira*
11.	*Panchanga* (whole plant)			*Sharada*

MATERIALS AND METHODS

A comprehensive literature search was conducted using scientific databases including PubMed, Scopus, Web of Science, ScienceDirect, and Google Scholar. The search included articles published using combinations of keywords such as "phytochemicals," "seasonal variation," "secondary metabolites," "plant bioactive compounds," "seasonal influence," and "plant biochemistry." Boolean operators (AND, OR) were used to refine the search results and improve relevance.

RESULTS AND DISCUSSION

Withania somnifera L.

In this study, *Ashwagandha* (Withania somnifera) roots were collected during *Purnima* (full moon) and *Amavasya* (new moon) phases in both *Shishir* (late winter) and *Grishma* (summer) seasons. The analysis revealed that total phenolic, flavonoid, and carbohydrate contents were higher in the *Purnima* samples compared to the *Amavasya* counterparts. Among the samples, the *Grīṣma Āṣāḍha Paurṇimā* (GAP) sample exhibited the greatest differentiation from the others in parameters such as total carbohydrate alcohols (TCA), total cell wall content (TCW), total fresh weight (TFW), methanolic extract (MEx), water extract (WEX), and pH. Additionally, *Grīṣma Jyeṣṭha Paurṇimā* (GJP) and *Āṣāḍha Paurṇimā* (GAP) samples were found to be superior to the *Amavasya* samples in terms of functional group diversity and withanolide content, as determined by HPTLC analysis[4].

Asparagus racemosus

The seasonal variations in the extractive values, bioactive secondary metabolites and Shatavarin-IV of root tubers of Shatavari are assessed. A large quantity of extractive values, bioactive secondary metabolites, and Shatavarin-IV is observed in *Varsha Ritu* sample and tubers of *A. racemosus*[5].

Senna singueana, Melia azedarach, Moringa oleifera, Lannea discolor

The seasonal variations in total alkaloids content (TAC), total flavonoids content (TFC), total phenolic content (TPC), antioxidant activity (AA) and predominant individual phenolic compounds in methanol extracts of 4 plants was assessed during different seasons. Barks of L. discolour exhibited high levels of TPC, TFC, TAC and AA during hot-dry season (summer) as compared to S. singueana, M. oleifera and M. azedarach leaves which showed significantly ($p< 0.05$) higher levels in hot-wet season (rainy). Levels of TPC, TFC and TAC were signi□cantly ($p< 0.05$) in□uenced by seasonal variations and correlated with levels of AA. Profiles of all phenolic compounds analyzed were not similar in terms of chemical composition and concentration during different seasons. Sinapic acid and 2,4-hydroxybenzoic acid were predominant in S. singueana while sinapic acid and ferulic acid were predominant in M. oleifera. Vanillic acid and 2,4-hydroxybenzoic acid were predominant in L. discolor an M. azedarach respectively[6].

Breonadia salicina

This study involves the investigation of phytochemical composition, antimalarial and antitrypanosomal activities of various plant parts of *Breonadia salicina* (Vahl) Hepper and J.R.I. Wood across multiple consecutive seasons. The dichloromethane leaf extracts in each season had the highest antimalarial activity compared to the methanol leaf, stem bark and root extracts. In addition, the methanol and dichloromethane leaf extracts in autumn, winter, spring and summer displayed the highest antitrypanosomal activity, except for the methanol leaf extracts in winter[7].

Tulbaghia violacea*, *Hypoxis hemerocallidea*, *Drimia robusta* and *Merwilla plumbea

This study was aimed at comparing the phytochemical composition and biological (antibacterial and anticandidal) activities of bulb and leaf extracts of *Tulbaghia violacea, Hypoxis hemerocallidea, Drimia robusta* and *Merwilla plumbea* between spring, summer, autumn and winter seasons. Leaf and bulb extracts exhibited comparable anticandidal activity (MIC < 1 mg/ml) in all the plant species in all seasons. Only ethanol and water extracts of *H. hemerocallidea* corms (autumn and winter) showed correspondingly good fungicidal activity amongst the bulbs tested. Antibacterial activity was fairly comparable between bulbs and leaves with at least one extract of each plant species showing some good MIC values in most of the seasons. The best antimicrobial activities were recorded in winter and autumn seasons, with MIC values as low as 0.2 mg/ml in the DCM bulb extracts of *T. violacea* (winter) against *K. pneumoniae* and *S. aureus*. The amounts of total phenolic compounds in all plant samples were generally higher in spring compared to the other seasons. Condensed tannin, gallotannin and flavonoid levels, depending on the sample, were

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either higher in spring or winter except for *H. hemerocallidea* (corm) which had higher gallotannin levels in autumn. Total saponin levels were higher in winter in all plant samples. Although variation was observed in the phytochemical concentrations between the bulbs and leaves of each plant species, their antimicrobial activities were fairly comparable[8].

Senna italica

The study was aimed at the determination of seasonal variations in the phytochemical content and antioxidant activities of leaves of Senna italica. Total phenolic content was recorded in higher amounts during autumn; total tannin content was in higher amounts during autumn and summer; total flavonoids were higher during autumn and summer and total saponins were higher in summer. High antioxidant activity strength demonstrated through relatively lower IC50 was shown in summer and autumn which, was consistent with the relative phytochemical contents[9].

Barleria dinteri, Grewia flava, Jatropha lagarinthoides

The study was aimed at investigating the effect of seasonal changes on the quantity of phytochemicals in leaves of three medicinal plants. Alkaloids and tannins were in high amounts during colder seasons (autumn and winter) in all plants, whereas flavonoids were in high amounts during warmer seasons (spring and summer). In addition, saponins were in high amounts during warmer seasons in *G. flava* and *J. lagarinthoides*, while no significant seasonal difference was recorded in *B. dinteri*. Furthermore, simple phenols were in high amounts during autumn in G. flava, while in high amounts during summer in *J. lagarinthoides* with no significant difference amongst seasons in *B. dinteri*[10].

Alstonia scholaris

The effect of seasonal variation on the antidiabetic activity of bark of *Alstonia scholaris* L. was assessed. It was observed that, in different seasons there is a change in HPTLC pattern of the antidiabetic constituents i.e. in summer season erythradiol content is more[11].

Azadirachta indica, Eucalyptus globulus

The seasonal variations were studied in the phytoconstituents of leaves and bark of Neem and Eucalyptus. The samples were collected during the four quarters of the year. Results from this study showed a variation in secondary metabolite compositions in response to seasons. In both plants' organs, saponin content peaked and crashed during the second and fourth quarters of the year respectively, while alkaloid had the highest content during the fourth quarter of the year. Highest level of tannin was recorded in the leaf and bark of the plants during the third quarter of the year. Antioxidant activity of both plant extracts showed a regular patterned decrease with increasing concentration, with lowest antioxidant activity for both plants' organs recorded during the third quarter[12].

Carissa macrocarpa

The study aimed to investigate the phytochemical composition and biological activity of the leaf extracts of *C. macrocarpa* in the summer and winter seasons. The phytochemical screening of *C. macrocarpa* leaves showed positive results for a variety of phytochemicals, such as alkaloids, tannins, phenols, naphthoquinones, flavonoids, saponins, steroids, proteins, carbohydrates, mucilage, gum and resin. The results from this study suggest that C. macrocarpa extracts possess antibacterial and antioxidant activity. The winter leaf extracts have potentially higher antibacterial activity and more potent antioxidant activity than the summer leaf extracts, thus inferring that winter is the best season to harvest C. macrocarpa leaves for medicinal use[13].

Rosmarinus officinalis

Estimation of important active compounds was carried out in leaves of Rosemary during summer and winter. The highest amounts of total flavonoids occurred in autumn; while carnosic acid, phenolics, ascorbic acids and soluble sugars were greatest in winter, probably due to regional high precipitation and subtle winters[14].

Aconitum violaceum

The seasonal variation in the aconitine in different parts of the Aconitum violaceum was assessed in this study. The biosynthesis of aconitine in tubers was found to be highest in the month of October (0.99% on dry wt. basis). The maximum aconitine content reported in the leaves was highest in the month of August, which is the pre-flowering season of the plant, however, aconitine content decreases significantly during month of October[15].

Boerhaavia diffusa

This study included the impact of seasonal variation of boeravinone B content in different parts of Boerhavia diffusa. Three-month-old field grown plants of BD were collected for two consecutive years. maximum yield was observed in July and maximum yield was observed in July. Amongst the plant parts, maximum concentration of boeravinone B was obtained in root parts (6.63%) then in leaves (4.28%) and minimal content was ob-tained in shoot parts (3.08%)[16].

Saraca ashoka

The seasonal variation of epicatechin and gallic acid in the bark of Saraca ashoka collected in different seasons was monitored using RP-HPLC. In investigation *Shishira* and *Hemanta Ritu* were responsible for yielding higher content of epicatechin and gallic acid, respectively. Phenolic compounds are maximum during the summer season[17].

Moringa oleifera

The monthly and seasonal variations of the elemental composition and phytochemical analysis of *Moringa oleifera* leaves was investigated. The highest concentrations of Mo, Cr, Fe, Ti, and Si were found during winter, whereas the highest concentrations of Br, Cl, and Cu were found during the summer seasons. The phytochemical analysis revealed that *Moringa oleifera* leaves collected during the spring season resulted in the highest chlorophyll content, phenol content, and the greatest scavenging activity[18].

Phillyrea angustifolia

The study was aimed at determining the seasonal metabolic changes in leaves of Phillyrea angustifolia and the effects of them on its biological activity. Oleuropein and the dialdehydic form of decarboxymethyloleuropein (DHPEA-EDA) were the main metabolites present in the extracts. All the extracts have been tested for their phytotoxicity against Triticum ovatum. T. ovatum plants treated with plants collected during summer were very similar to the control, while the extracts obtained from leaves collected in winter, containing the highest amount of oleuropein, were the most active against the test species[19].

Jatropha curcas

The seasonal variation was analysed in phytochemical of different parts of *Jatropha curcas* L. Leaves collected during summer (May-June) have greater accumulation of total phenols, tannins and free amino acids however, phytic acid was more during rainy season[20].

Camellia sinensis

The seasonal variations in total phenolics, antioxidant activity, and minerals during four harvest seasons (summer, premonsoon, monsoon and winter) in two consecutive years was assessed in South Indian black tea. Summer was the season with the highest total phenolic content and antioxidant activity across all cultivars, followed by premonsoon, winter, and monsoon[21].

Holoptelea integrifolia

The experimental results revealed that the chloroform extracts of leaves and bark of *Holoptelea integrifolia* during winter season were most effective against *S. flexneri* with highest zone of inhibition (ZOI) of 19.5±0.12mm and 22.6 ±0.32mm at 4 mg/40 µµl, respectively. However, MIC of leaf and bark extracts in case of *S. flexneri* were 0.3125 mg/100 µl and 0.0781 mg/100 µl, respectively. Phytochemical analysis of *H. integrifolia* confirmed significant seasonal variation, with phenols, flavonoids and terpenoids highest in the winter season, while alkaloids dominated in autumn season[22].

Taxus wallichiana

The quantitative analysis of UPLC showed that the highest content of taxoids (1.77 ± 0.38 $mg \cdot g^{-1}$) was found in January. On the contrary, the maximum content of total flavonoids obtained in the spectrophotometry (15.82 ± 1.45 $mg \cdot g^{-1}$) was observed in August. The polysaccharide accumulation reached a value of 28.52 ± 0.57 $mg \cdot g^{-1}$ in September[23].

Tinospora cordifolia

The study revealed that 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. Further, antioxidant potential revealed the highest inhibition percentage in winter season as well as in late summer season[24].

Cinnamomum cassia

This study was carried out to evaluate the chemical profiles, as well as the antioxidant and antibacterial activities, of *C. cassia* leaf oil across the four seasons. Spring and autumn leaf oils contained the highest essential oil (2.20% and 1.95%, respectively) and *trans*-cinnamaldehyde (92.59% and 91.10%, respectively). *C. cassia* leaf oil demonstrated the strongest antibacterial activity, with a minimum inhibitory concentration (MIC) of 0.25 mg/mL against *S. aureus* and *L. monocytogenes* for the spring oil. Winter leaf oil exhibited high antioxidant activity, primarily due to the presence of *cis*-cinnamaldehyde, caryophyllene, humulene, alloaromadendrene, γ-muurolene, *cis*-bisabolene, o-methoxycinnamaldehyde, and phenolics[25].

CONCLUSION

Since ancient times, the impact of the *Kala* (time factor) on the properties and therapeutic actions of medicinal plants has been well emphasized in Ayurvedic literature. Modern scientific studies have increasingly validated these classical insights, using contemporary research methodologies to affirm the influence of time on phytochemical potency and efficacy. Therefore, it is imperative to consider the appropriate time of collection to preserve the integrity and effectiveness of crude drugs.

The Ayurvedic concept of *Kala* is not merely philosophical but is grounded in scientific reasoning, significantly affecting the pharmacological profile and safety of medicinal plants. Each part of a plant—root, bark, leaf, flower, or fruit—exhibits its peak therapeutic potential when harvested in the right season and growth stage, as outlined in classical treatises. Recognizing this, the integration of *Kala* into the framework of Good Collection Practices (GCP) in Ayurveda is essential. It not only upholds traditional knowledge but also contributes to standardization, sustainability, and quality assurance in the production of herbal medicines. Further in-depth research on this concept can bridge the gap between traditional wisdom and modern pharmacognosy, thereby enhancing the global acceptance of Ayurvedic medicine.

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REFERENCES

1. Sofowora, A., Ogunbodede, E., Onayade, A. The role and place of medicinal plants in the strategies for disease prevention. Afr. J. Tradit. Complement. Altern. Med, 2013;10:210–229.

2. Kosalge SB, Fursule RA. Investigation of Ethno medicinal claims of some plants used by tribals of Satpuda Hills in India. Journal of Ethno Pharmacology, 2009;121: 456-461

3. A. Falasca, D. Melck, D. Paris, G. Saviano, A. Motta, M. Iorizzi. Seasonal changes in the metabolic fingerprint of *Juniperus communis* L. berry extracts by H-NMR-based metabolomics. Metabolomics, 2014:165-174

4. Swagata Dilip Tavhare, Karra Nishteswar, Vijay J Shukla. Effect of seasonal variations on the phytoconstituents of Aśvagandhā w.r. to lunar cycles. Anc Sci Life, 2016 Jan-Mar;35(3):150–158

5. Venkata Narasimhaji, Anupam Mangal, Rekha Prabhu, Gokul Marimuthu . Seasonal Evaluation of Shatavarin-IV by HPLC for the Best Procurement Time of *Asparagus racemosus* Willd. tubers and pharmacognostical Studies. Journal of Drug Research in Ayurvedic Sciences, 2022;7(3):200-208

6. Bonface Mwamatope, David Tembo, Elizabeth Kampira, Cecilia Maliwichi-Nyirenda. Seasonal variations of Phytochemicals in Four Selected Medicinal Plants. Pharmacognosy Research, 2021;13(4):218-226

7. Dorca Tlhapi, Isaiah Ramaite, Chinedu Anokwuru, Teunis van Ree, Ntakadzeni Madala, Heinrich Hoppe. Effect of seasonal variation on phytochemicals contributing antimalaria and antitrypanosonal activities of *Breonadia salicia* using a metabolomic approach. ScienceDirect, 2024;10(2)

8. B.Nacube, J.F. Finnie, J. Van Staden. Seasonal variation in antimicrobial and phytochemical properties of frequently used medicinal bulbous plants from South Africa. South African Journal of Botany, 2011;77(2):387-396

9. Sibusiso C. Mncube, Sechene S. Gololo, Motetelo A. Mogale. Seasonal variations of phytochemical content and antioxidant activity of Senna italica leaves. Asian Journal of Chemistry, 2020;32(9):2371-2374

10. Stanley Sechene Gololo, Leshweni or Leshwene Jeremia or Jeremia Shai, Nana Agyei, Motetelo Alfred Mogale. Effect of seasonal changes on the quantity of phytochemicals in the leaves of three medicinal plants from Limbo Province, South Africa. Journal of Pharmacognosy and Phytotherapy, 2016;8(9):168-172

11. Gautam Palshikar, P. Shanmuga Pandiyan. Impact of Seasonal Variations on Antidiabetic Phytochemicals in Alstonia Scholaris. CIBTech Journal of Pharmaceutical Sciences, 2021;10:1-9

12. Olaunbosum Akiode, Adewale Elijah Fadeyi, Anna Ibi, Muhammad Bashir Hassan. Effect of seasonal changes on the quantity of secondary metabolites from Neem and Eucalyptus plants in North Central Nigeria.

World Journal Biology Pharmacy and Health Science, 202;7(2):43-52

13. Reshika Ramasar,Yougasphree Naidoo,Yaser Hassan Dewir, Antar Nasr El-Banna. Seasonal change in phytochemical composition and biological activities of Carissa macrocarpa (Eckl) A. DC. Leaf extract. Horticulture, 2022;8:780

14. Mojtaba Hadi Soltanabad, Mohammad B. Bagherieh-Najjar, Manijeh Mianabadi. Seasonal variations in Carnosic Acid content of Rosemary Correlates with Anthocyanins and Soluble Sugars. Journal of Medical Plants and By-products, 2018;2:163-171

15. Janhvi Mishra Rawat, Balwant Rawat, Susmita Mishra, Ranjana K. Negi. Altitudinal and Seasonal Variation in Bioactive Compound Aconitine in Aconitum violaceum, a Threatened Medicinal Plant of Indian Himalayan Region. International Journal of Advance Research, 2014;2(10):981-988

16. Savita Sharma, Jyotsna Sharma, Deepika Singh, Sharada Mallubhotla. Seasonal variation of boeravinone B content in plant parts of Boerhavia diffusa L. Israel Journal of Plant Science, 2023;70(3-4):1-6

17. Pushkar M. Ketkar, Shraddha U. Nayak, Sandeep R. Pai, Rajesh K. Joshi. Monitoring seasonal variation of epicatechin and gallic acid in the bark of Saraca asoca using reverse phase high performance liquid chromatography (RP-HPTLC) method. Journal of Ayurveda and Integrative Medicine, 2015;6(1):29-34

18. Abdallah A. Shaltout, Fahmy A. S. Hassan. Seasonal Variability of Elemental Composition and Phytochemical Analysis of Moringa oleifera Leaves Using Energy-Dispersive X-ray Fluorescence and Other Related Methods. Biology Trace Element Research, 2021;199:4319-4329

19. Monica Scognamiglio, Brigida D'Abrosca, Vittoria Fiumano, Mimmo Golino. Seasonal phytochemical changes in Phillyrea angustifolia L. Metabolomic analysis and phytotoxicity assessment. Phytochemistry Letters, 2014

20. Nisha Singh Tomar, Malini Sharma, R M Agarwal . Phytochemical analysis of Jatropha curcas L. during different seasons and developmental stages and seedling growth of wheat (Triticum aestivum L) as affected by extracts/leachates of Jatropha curcas L. Physiol Mol Biol Plants, 2015;21(1):83-92

21. Kottur Govindasamy, Daisylin Anbu Sujitha Sugumar, N Mani Kandan, N Nagaprasad, Krishnaraj Ramaswamy. Seasonal variations in the phenolic profile, antioxidant activity, and mineral content of south Indian black tea (*Camellia sinensis* (L.) O. Kuntze). Scientific Reports, 2023

22. Deeksha Kumari, Mamta Devi, Kalpana Thakur, Sunil Jaswal. Effect of seasonal variations on phytoconstituents and antimicrobial properties of Holoptelea integrifolia, an important medicinal plant from Kangra District in Himachal Pradesh, India: A case study. South Asian Journal of Experimental Biology, 2024;14(2)

23. Li Yang, Zan-Sheng Zheng. Seasonal Dynamics of Metabolites in Needles of *Taxus wallichiana* var. *mairei.* Molecules, 2016;21(10):1403

24. Namrta Choudhry, Shweta Singh, Mohammad Badruzzaman Siddiqui, Sayyada Khatoon. Impact of Seasons and Dioecy on Therapeutic Phytoconstituents of *Tinospora cordifolia*, a Rasayana Drug. Biochemistry Research International, 2014

25. Yanrong Cheng, Ying Fu, Dingze Gu, Yan Huang. Seasonal Variation in Chemical Composition and Antioxidant and Antibacterial Activity of Essential Oil from *Cinnamomum cassia* Leaves. Plants, 2024 Dec 30;14(1):81