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Classical approach to collect medicinal plants - A prudent view in optimizing pharmacological affluence

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ABSTRACT

Medicinal value of the plants mainly depends upon the season in which they are grown and place in which they are collected. The place (*Desha*) denotes the richness of inherent quality of drugs (*Dravya*-plants), whereas the time (*Kaala*) denotes the potentiating factors of such inherited qualities. The state of drug and method of its collection are specified again to conserve those potentiated inherent qualities of the plants otherwise called active principles. The research works done on plant physiology and applied botany render scientific explanation for the classical approach. This review paper is an endeavor to put light on four classical perspectives in collection of medicinal plants; place, time, state and method.

Key words: Medicinal plants, Active principles, Plant physiology, Applied botany.

INTRODUCTION

Collection of specific drugs play utmost role in Ayurveda. Ayurveda has considered that all the drugs are made up of *Pancha Mahabhoota* (five elements). Substances of any use, medicinal or dietary are intimately related to the type of land in which they are produced. Therefore, due consideration should be given to the type of land, i.e. soil, which ultimately determines the *Guna - Karma* (properties-action) of *Dravyas* (plants), produced in it. The herbs should also have some characters, not affected by smoke, rain, air or water and also collected in respective season. Drugs must have single predominant *Rasa* (taste), well developed, such drug may be collected and preserved

for therapeutic utility. Soil and water are responsible for the formation of *Rasa* (taste) in plants and trees. The predominance *Panchamahabhoota* (five elements) in the soil, water and environmental factors attribute for the same. As all the medicinal *Dravyas* (plants) from various sources are related to soil and season, its study for fertility and usefulness becomes essential. The main aim of different perspective in collection of the drug i.e., place, time, state and method is to maintain its potency by conserving its properties and action.

A. Place of drug collection (*Dravya Sangraha Desha*)

Plants, being *Panchabhoutika* in nature, are solely dependent on soil for their abode and nutrients

Qualities of an ideal land to collect drugs,

- The land surface should be even, covered by grass, climbers and big trees
- The soil should be unctuous (*Snigdha*), soft (*Mrudu*), fertile and black (*Krishna*) / red (*Lohita*) / yellowish white (*Goura*) in colour.^[1]

The land covered with grass and climbers benefit soil in many ways;

- Erosion control - Grasses produce masses of tangled roots that spread out in different

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directions, holding soil together and making it more resistant to erosion caused by wind and water

- Grass blades capture rain drops, channels water to the soil and there by reduces run off.
- Soil organic matter - Grasses are usually plentiful and their thin, fibrous roots are easily decomposed; the remains of plants and animals in various stages of decomposition increases fertility, improves soil structure and helps rebuild top soil.

The prime component to inspect at the place of collection is soil. Soil, the top layer of Earth's crust, provides structural stability for plants and retains and relinquishes water and the nutrients necessary for plant growth.

Soil is a necessary mixture of following elements^[2]

Inorganic /mineral materials - Consists of typically weathered rock of varying sizes;

- Sand (largest particle - 2.0 to 0.05 mm)
- silt (much smaller - 0.05 to 0.002 mm)
- clay (the smallest - less than 0.002 mm)

The relative proportions of sand, silt, and clay determine a soil's textural class i.e., *Mruduta* and *Snigdhatta*. A soil that is composed of 12% sand, 55% clay and 33% silt is considered to be fine class of texture. The same proportion of these three elements also determines the pore space of land.

Organic matter - Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus, Sulphur, Potassium, Calcium and Magnesium within organic residues.

For plant growth, most soil scientists agree that 50% pore space, 45% mineral matter and 5% organic matter make up an ideal ratio.

pH - 6.5 to 7.0 is considered as "ideal" for most plants, exceptions: Blueberries (ph-5), Asparagus (pH-8)

Cation Exchange Capacity (CEC) - Soils high in clay, silt and organic matter will have a good CEC value . Soils with high CEC not only hold more nutrients, they are

better able to buffer or avoid rapid changes in the soil nutrients level.

These qualities of soil are equally applicable to both wild and cultivated in concern of collecting medicinal plants.

The colour of the soil is formed by minerals, organic constituents, moisture content and their abundance. The colour alone do not predict the quality of soil but does provide clue on certain conditions. Examples:

- Light or pale colors in grainy topsoil are frequently associated with low organic content, high sand content, and excessive leaching.
- Dark colour soil may result from high organic content with poor drainage
- Shades of red indicate an Iron rich clay soil which is well-aerated
- Shades of gray indicate less minerals with inadequate drainage

Table 1: Depicts the various colour of soil with prominent constituents and soil fertility.

Colour of the soil	Prominent Constituents	Fertility
Black (Black soil) [<i>Krishna</i>]	Humus , Iron, Manganese	Most Fertile
Off white (Alluvial soil) [<i>Goura</i>]	Iron forms a yellow oxide (presence of Oxygen and moisture)	Fertile
Bluish	Iron in reduced state (Water logged soil and Oxygen)	Less fertile
Red –Brown (Laterite soil) [<i>Lohita</i>]	Red oxides of Iron and Al compound (presence of Oxygen and moisture)	Fertile
White	Silicates and salts	infertile

Qualities of land from where a drug should not be collected^[3]

- The land should not be uneven, should not have big pits, burrows, rocks and ant hills.
- The plants which grow near burial grounds, temples and slaughter houses should not be gathered.
- Soil should not be sandy and it should not be too alkaline or acidic.

Research plant physiologist Darren Haver has found that;

- If the land is more with rocks or gravel, the soil will have a reduced water and nutrient holding capacity, and will be unfit for growing plants.
- Low soil pH (i.e. pH between 1 and 4) which is a highly acidic and alkaline soil (pH > 8) condition tightly holds soil nutrients which are unavailable for plant uptake.

Classics have explained three specific places from where a plant should not be collected for medicinal purpose - near burial grounds, slaughter houses and temples. Few of recent research works provide clue on these;

Mineral contamination from Soils near Burial grounds^[4]

Twenty three soil samples were collected from various sites on and off site of cemetery (Zandfontein) and analyzed for 31 minerals using ICP-AES. It was found that mineral and heavy metals concentrations of soils within and around the Cemetery were considerably higher than those off site. These excess metals are probably of anthropogenic origin associated with burial practices and could pose an environmental, groundwater and human health hazard. Strict monitoring of water quality in boreholes in the vicinity of the cemetery is recommended.

Hence plants grown in such places with influence of contaminated ground water has been considered unfit to be used as medicines.

Poultry production and the environment – A review^[5]

Flesh, food, carcasses, feathers, bedding, litter and discharge of waste water are the most significant elements harming the environment.

- Poultry by-products and waste may contain up to 100 different species of micro-organisms (including pathogens), contaminated feathers, feet and intestinal contents (Arvanitoyannis and Ladas, 2007).
- Unprocessed waste water generated during poultry activities typically has high biochemical Oxygen demand and chemical oxygen demand (BOD and COD) due to the presence of organic materials such as blood, fat, flesh and excreta. In addition, unprocessed waste water (used for washing and disinfection) may contain high levels of nitrogen, phosphorus and residues of chemicals such as chlorine as well as various pathogens including *Salmonella* and *Campylobacter*
- These elements thus form the source to contaminate top soil and ground water there by causing harm to plants.

Analysis of soil quality for environmental impact assessment - A model study^[6]

Four soil samples were collected within available radial distance of the study area and were analysed for the soil quality,

- Sample one (S1) - collected near temple at project site.
- Sample two (S2) - collected at a distance of 1.6km from the plant in the North
- Sample three (S3) - collected at distance of 1.5km from the plant in the East
- Sample Four (S4) - collected at a distance of 1.7km from the plant in the South

Parameters analysed for the soil samples - porosity, texture, silt content, clay content, electrical conductivity, organic matter%, Organic carbon%, Na, Ca, Zn, Mg, Mn, Hg, Se, B, Al, Cr, Cu, Fe, Pb.

RESULTS

- The Texture of S1 is silty clay (sand is 17.8%)
- pH - more acidic in S1
- Organic matter comparatively more in S1 (2.716), Manganese and Sodium content was low (Decrease cation exchange), Iron and Cu - high, calcium and Lead content was high.

This work explains about the quality of the soil near temple as more acidic with decreased CEC value, etc. which are the factors that does not promote well growth of plants. But there is no attribute of any reason for the same.

B. Time of drug collection (*Dravya Sangaraha Kaala*)

Time for collection denotes here two aspects - Season and time of the day. *Matsya Purana* has a whole chapter dedicated only to the month of spring, *Samba Purana* gives a reference to the different colours of the sun in the Six *Ritu's*: *Kapila* (tawny or yellowish brown) in *Vasantha Rtu*, *Tapta Kanchana* (furnace gold) in *Greeshma*, *Sweta* (white) in *Varsha Rtu*, *Pandu* (pale) in *Sharad Rtu*, *Pingala* (coppery or reddish brown) in *Hemanta Rtu*, and *Raktha* (reddish) in *Sishira Rtu*.^[7] These colours influences the complete flora and fauna on Earth. This could be the ancient approach of complying the wavelength of sunlight.^[8]

Table 2: Depicts the *Samhita Kaala* reference of collection of specific parts in different seasons.

Parts to be collected	<i>Charaka Samhita</i> ^[9]	<i>Sushruta Samhita</i> ^[10]	<i>Bhavaprakasha</i> ^[11]	<i>Bhaishajya Ratnavali</i> ^[12]	Examples
<i>Mula</i>	<i>Grishma shishira</i>	<i>Pravrit</i>	<i>Shishira</i>	<i>Grishma, Shishira</i>	<i>Ashvaghanda, Punarnava</i>
<i>Patra</i>	<i>Varsha, Vasanta</i>	<i>Varsha</i>	<i>Grishma</i>	<i>Varsha, Vasanta</i>	<i>Talisa, Tamala</i>

<i>Shakha</i>	<i>Varsha, Vasanta</i>	-	-	<i>Varsha, Vasanta</i>	<i>Guduchi</i>
<i>Pushpa</i>	<i>Yatha Rtu</i>	-	<i>Vasanta</i>	<i>Yatha Rtu</i>	<i>Dhataki</i>
<i>Phala</i>	<i>Yatha Rtu</i>	<i>Grishma</i>	-	<i>Yatha Rtu</i>	<i>Haritaki</i>
<i>Sara</i>	<i>Hemanta</i>	<i>Vasanta</i>	-	<i>Hemanta</i>	<i>Asana, Khadira</i>
<i>Tvak</i>	<i>Sharad</i>	<i>Sharad</i>	-	<i>Sharad</i>	<i>Nimba, Dalchini</i>
<i>Kanda</i>	<i>Sharad</i>	-	-	<i>Sharad</i>	<i>Varahi, Surana</i>
<i>Kshira</i>	<i>Sharad</i>	<i>Hemanta</i>	-	<i>Sharad</i>	<i>Snuhi, Arka</i>
<i>Panchanga</i>	-	-	<i>Sharad</i>	-	<i>Bhrungaraja</i>

Plants determine the time of year by the length of daylight, known as the Photo Period. The famous botanist BJ Atwell says, 'Plants have a temperature memory, they measure the product of time and temperature and can work out how cold it's been and for how long'. They do this, by keeping track of the interactions between certain proteins, which sign that it's time to activate a key gene to break or to begin the dormancy.^[13]

Dormancy is a period in plant life cycle when growth and development are temporarily stopped. This minimizes metabolic activity and therefore helps a plant to conserve energy. Dormancy tends to be closely associated with environmental conditions. It could apply for whole plant or only specific parts in certain seasons/conditions.^[14]

SEASONAL COLLECTION OF SPECIFIC PARTS

Sharad Ritu/Post monsoon (Sept-Nov)

Sharad Ritu is the beautiful post monsoon season. *Acharya Sharangdhara* says *Sharad* is the right time to collect medicinal plants for all purpose. But still different classical texts mentioned in table no. 1 have specified to collect Tubers (*Kanda*), Latex (*Ksheera*)

and Bark (*Twak*) in this season. The changes in plant physiology gives reasons for this;

Kanda - Plants with root tubers are propagated in late summer to late winter. Ideal temperature for tuber growth is 5 - 30°C. The dormancy of tubers happens by end of summer season, develops by rainy season and acquires optimum potency with matured/fully formed metabolites following rainy season. Hence *Sharad* and *Hemanta* would have been recommended for collection of tubers (*Kanda*).^[15]

Ksheera - Before autumn, the latex vessels form a continuous network throughout the bark of root and shoot, with the youngest vessels nearest the cambium (inner portion) and the oldest towards the exterior, yielding more latex at this period. Hence *Ksheera* would have been told to collect in *Sharad* and *Hemanta* i.e., before autumn).^[16]

Twak - To be collected prior to spring season or after spring for the following reason, Bark can be separated easily from stem.^[17]

Hemanta Ritu/Winter (Nov- Jan)

As the vertical rays of Sun move towards the southern part of equator, marks the beginning of cold weather. Different classical texts mentioned in table no. 1 have specified to collect *Saara* (Heart wood), *Kanda* (tubers) and *Ksheera* (latex) in this season.

Saara - As winter approaches, leaves lose chlorophyll and the tree salvages its constituents mainly nitrogen, magnesium and phosphates for recycling. The nutrients are carried back from the leaves and bark into the branches and stem. Thus the potentiated *Saara* is said to be collected. The reason to collect Tubers and Bark are discussed earlier.^[18]

Adding a point from plant physiology about autumn; Traditional thinking believes that leaves fall as temperatures drop during the autumn, allowing the plant to enter a resting phase and save energy. Professor Brian Ford, a scientist, writer and broadcaster, adds that, leaf drop occurs in order to excrete waste products from the tree, leaf is not only an organ of photosynthesis, homeostasis and transpiration but also an excretory. He has found

that, shortly before they are shed, levels of potentially harmful components such as tannins and oxalates in leaves increase. The levels of heavy metals in abscised leaves are also raised, and they are clearly excreted rather than stored. This gives an idea that the parts that are specified in classics are only to be collected and the one not said are not to be collected in specified seasons.^[19]

Vasanta Ritu /Spring (Mar-May)

Vasanta is the rejuvenating season on Earth for complete flora. Classics specify to collect *Patra* (leaves), *Shaka* (twigs), *Saara* (heart wood) and *Pushpa* (flowers) in this period.

Patra - During the spring and summer the leaves serve as factories where most of the foods necessary for the tree's growth are manufactured.^[20]

Shaka, Saara - Trees in the temperate zones (like India) develop a new layer of wood by growing the cambium between the inner bark and the previous growth ring (both in stem and branches) contributing for Sapwood and heart wood; performs two functions: transportation of the nutrients and adding support to the tree. Hence *Vasanta* could have been recognized as appropriate time to collect *Shaka* and *Saara*.^[21]

Pushpa - Flower induction is the physiological process during spring, the shoot apical meristem of most of the plants (meristematic cells) becomes competent to develop flowers.

From Society for Experimental Biology, Dr. Steve Jackson and fellow scientists have uncovered a new piece in the Puzzle about why some plants flower in spring, some in autumn and some in summer. They have isolated a gene responsible for regulating the expression of *CONSTANS*, an important inducer of flowering, in plant called *Arabidopsis*.

In winter or early spring, *Arabidopsis* plants without an active *DNF* gene are already flowering. Those with active *DNF* gene will delay flowering until later in the year when days are longer and conditions are more favorable for survival of their seedlings.^[22]

Greeshma Ritu/Summer (May-July)

Mula (Roots) and *Patra* (Leaves) are the parts to be collected in this season.

Patra - High temperatures speed up the normal living process of plants to a maximum rate. During the spring and summer the leaves serve as factories where most of the foods necessary for the tree's growth are manufactured.^[23]

Mula - To combat natural moisture evaporation from leaves in summer, roots attain more ability to pierce down to get water and required nutrients, hence *Mulas* might be suggested to collect in summer.^[24]

Varsha Ritu /Rainy (July-Sept)

By month of July the south western monsoons become dominate and prevail all over, bringing rain. Different classical texts mentioned in table no. 1 have specified to collect *Patra* (leaves) and *Shaka* (twigs) in this period.

Patra, Shaka - Rain water brings lots of Nitrogen to soil, the most essential component required for growth of more branches production of Chlorophyll and thus Chlorophyll accumulate in most higher concentration during rainy season.^[25] Hence the rainy season is the prime time to collect leaves (*Patra*) and *Shaka*.

A study on 'Wet and Dry Season Effects on Selected Soil'^[26] conveys that soil nutrients are more readily available during the wet season than during the dry season, probably because there is more soil moisture available in the wet season that facilitates soil nutrient release. The study concludes that soil moisture has to be available in order for nutrients to be released for plant uptake.

Research works on seasonal variation of drug components - Seasonal variations in physicochemical profiles of *Guduci Satva*.^[27]

- Maximum yeild in *Shishira Ritu* (3.78%) minimum in *Grishma* (2.23%).
- Total alkaloid content found to be bit higher in *Varsha* and *Vasanta* (0.34%)

Time of the day to collect medicinal plants^[28]

Praatah Kaala, the early hours in the morning time is considered to be best to collect medicinal plants as they contain highest % of active principles. The more deeper probe in plant physiology reveals that, the light received at 6° angle from below and above horizon is specially received by phytochrome photo receptor of all plants initiating all sorts of physiological process.^[29]

When comes to factor of *Kaala*, as sun influence flora during day, so the moon influence plants during night. Pull of moon is stronger than sun as it is nearer to earth. Strongest effect is felt when moon and sun pull from opposite side of the earth at full moon day. These forces effect the water content of the soil, creating more moisture in soil at full moon days. The increase in moisture proportionately increases plant energy, encourages the roots to grow and seed to sprout

There is evidence that composition of number of secondary plant metabolites varied throughout day and night Eg: amount of glucoside in leaves of *Digitalis* is highest during day and breaks down in night.^[30]

Daily circadian fluctuations in constituents of essential oils distilled from leaves, shows levels of monoterpenes dropped by 50% from 6am to noon and increased by 9pm.

Circadian rhythm are also known to control stomatal opening, gene expression and transcription.

Research works on lunar plantations.^[31]

- Full moon day influences the growth of *Ashwagandha* compared to new moon days.
- The % of oil of *Acorus calamus* within rhizome vary with lunar phase. Total constituents, osmotic pressure in root and plant growth were high during full moon than new moon.
- Garlic cloves had high % of oil during full moon day.

Thus moon rays have a profound effect on the cell sap within the plants which in turn affect the transpiration, root pressure and active principles.

Thus therapeutic efficacy is presumed to depend on the quality and quantity of secondary metabolites which in turn are influenced by the time of collection.

C. State of drug collection (*Dravya Sangrahana Avastha*)

Fresh form of drugs is more preferred for all the preparations except for *Vidanga*, *Pippali*, *Guda*, *Dhanya*, *Ajya* and *Makshika*.^[32] Post harvest maturation of secondary metabolites could be the reason here. Few classical examples telling about state of drug are;

Fruits - Except *Bilwa* (*Aegle marmelous*) all other fruits must be collected and used when they are matured/ripen.

Leaves - Leaves are to be in fresh state and fully grown.

Tubers - fresh and matured , seasonal and non infected.

Food grains - Should neither be very new nor too old, grown in clean place acc to season is collected

Flowers - Few of them to be collected after blooming as *Dhataki Pushpa* (*Woodfordia fruticosa*) and few before blooming as Clove (to preserve their fragrance and volatile principles).

D. Method of drug collection (*Dravya Sangraha Vidhi*)

The method of collecting is yet another note worthy aspect. Every segment of a plant has its own role in plant survival, in many ways. Classics mention drug collection in a methodical and ritual way.

*Gruhnuyattani Sumanaha Shuchihi Prartah Suvasare
Aditya Sammukho Mouni Namaskrutya Shivam Hrudi
Sadharana Dravyam Gruhniyad Uttarashritam ||*^[33]

The ritual practices always bounds a person to do a work with at most care and concentration. This helps to pick the required segment of the plant in required quantity in a right way and also without causing any damage to other parts. Few instances to quote - harvesting flowers and fruits has a significant impact on species regeneration and on population viability

and survival.^[34] On the other hand, harvesting bark or root is more damaging in terms of tree survival.^[35] Thus with the good intention of conserving plants and supporting fast recover of the parts used for medicinal purpose, many studies have been taken in the recent years with respect to method of collection. One of them is depicted below.

Depending on the diameter of the tree, to affect 20%, 50%, 75% and 100% removal of bark was sampled for study with 12 different species of plants.^[36] Bark here is considered as all tissues outside the vascular cambium regardless of their composition.^[37]

The complexity of the bark tissues derives from the combined presence of dead and living tissues. The rhytidome is the dead outer part of the bark. The latter protects the tree against insect attacks and also against fire and fungi. The living tissue, usually called phloem, constitutes the inner bark. It is easy to understand that a simple wound in the bark can easily disrupt the physiological functioning of the tree. Continuous development of new vascular tissues however, allows to regenerate wounded tree parts thus maintaining all metabolic processes.^[38]

Results of the study - In partial bark harvesting sheet group (20% and 50%), growth was more successful in completing wound closure, compared to 75% and 100% group.

GACP guidelines

Good Agriculture and Collection Practice guidelines^[39] in section 2 and 3 explains in detail about site selection and collection of medicinal plants which very much simulates the classical quotes of *Dravya Sangraha Desha*, *Kaala*, *Avastha* and *Vidhi*. The technical points include optimal soil condition, field temperature, soil type, drainage, moisture retention, fertility and pH w.r.t. medicinal plant species and/or target medicinal plant part.

Harvest/Collection - Medicinal plants should be harvested during the optimal season or time period to ensure the production of medicinal plant materials and finished herbal products of the best possible quality. The time of harvest depends on the plant part

to be used. The best time for harvest (quality peak season/time of day) should be determined according to the quality and quantity of biologically active constituents

Recommendations by WHO for cultivated medicinal plants^[40] Incorporation of crop residues in the soil should be encouraged so that soil carbon and soil nitrogen could be increased.

Supplemental crop irrigation should be encouraged in order to avert drought impacts on crop production.

Planting Considerations

Root crops where edible portions come into direct contact with soil have highest contamination risk; Shoot and leaf crops will have less of a contamination risk; Fruit crops will have the least amount of contamination risk. Hence documentation w.r.t. soil constituents and composition Environmental factors of site, fertilizers used are to be seen in detail.

CONCLUSION

Soil provides structural stability for plants and retains and relinquishes water and the nutrients necessary for plant growth. Thus a proper proportion of sand, silt and clay with pore space, Organic matter, pH and CEC value are to be determined at the site of collection. Plants go through seasonal changes after detecting differences in day length. The time of harvest depends on the plant part to be used. The best time for harvest (peak season and time of day) should be determined according to the quality and quantity of biologically active constituents, this ensures the production of medicinal plant materials and finished herbal products of the best possible quality.

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