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A CONCISE BOTANICAL CONSIDERATION ON VARIOUS PLANT PARTS (PRAYOJYANGA) STATED IN AYURVEDA

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ABSTRACT

The plants are the backbone of many traditional health care practices, and they are always said as best friends of human beings. In *Ayurveda*, The *Panchavidha Kashaya Kalpana* has been quoted as the fundamental therapeutic preparations mostly as herbal preparations. Among them, *Swarasa* (Fresh juice) & Kalka (paste) are made generally by fresh plant parts like leaves and tuberous roots. While dried *Panchanga* (whole plant) are mostly used in the preparation of *Kwatha* (decoction), *Hima* (cold infusion) and *Phanta* (hot infusion). The term *Panchanga* indicates *Tvaka* (bark), *Pushpa* (flower), *Patra* (leaves), *Phala* (fruit), and *Mula* (root). Apart from this, *Saara* (pith), *Ksheera* (latex), *Niryasa* (exudate/ oleoresin/gum) and *Kanda* (bulb) has been also cited in the *Ayurveda* text. With the help of modern plant science, information can be obtained for an upgraded, précised and easily understanding of the individual plant part. Thus, this article provides ample information on the terminologies of plant parts in the classical text and their description in line with botanical science.

Keywords: *Panchanga, Ayurveda,* Plant, Parts, *Kashaya*

INTRODUCTION

Since time immemorial plants and human beings are having a symbiotic relationship and they have always remained the backbone of various traditional health care systems of India. Among them, *Ayurveda* is a popularised traditional system across the globe having a holistic approach to the prevention of health and cure of diseases. *Ayurveda* stands on the three pillars known as *Trisutra* i.e. *Hetu* (cause), *Linga* (symptoms), and *Aushada* (medicine)[1]. The *Aushadha* component broadly covers every substance in the world but gives more emphasis on plants and plant products. The fresh plant material mostly leaves are considered as most suitable for the preparation of *Swarasa* which is the first and foremost formulation prepared by grinding them and extracting juice. Similarly, *Kalka* is a simple paste of fresh plant material. Moreover, dried parts of the plant are generally used in the preparation of *Kwatha* (decoction), *Hima* (cold infusion), and *Phanta* (*hot infusion*). The *Panchanga*[2] have been mostly utilized at a very early stage of the drug development called *Panchavidya Kashya Kalpana*[3].

As per the *Charaka Samhita*, the human body has roughly categorized into *Shadanga* (six parts) and the plant has divided into *Panchanga* i.e. *Tvaka* (bark), *Pushpa* (flower) *Patra* (leaves), *Phala* (fruit), and *Mula* (root)[4]. The *Susharutacharya* has mentioned the different parts of *Audbhida* (herbal drugs) used in medicine that includes *Mula, Tvak, Saara, Niryasa, Nala, Svarasa, Pallava, Patra, Kshara, Kshira, Phala, Pushpa, Bhasma, Taila, Kantaka, Kaanda* and *Praroha*. Further in the context of *Sthavara Visha Adhishtan* (sites of poison in plants), he has also mentioned few more plant components like viz. *Saara* (Pith), *Ksheera* (latex), *Niryasa* (exudates/oleoresin/gum), and *Kanda* (bulb)[5]. Apart from that *Kaiyadeva Nighantu*[6] has quoted the *Dashanga* (ten parts) which includes *Panchanga* and *Saara, Niryas, Shakha* (branches), *Shringa* (buds) and *Paya/Ksheera* (latex) and he further mentioned that in place of *Shakha* one can also consider *Vrinta* (petiole) and *Kantaka* (prickles)[5]. Similarly, *Raja Nighantu* has defined many other plant components [6]. Whereas, *Sharangdhara Samhita* gives more information on the use of specific plant parts with examples like viz. bark of *Nyagrodha* (*Ficus benghalensis* L.), *Saara* of *Bijaka* (*Pterocarpus marsupium* Roxb), *Patra* of *Talisa* (*Abies webbiana*), *Phala* of *Amalaki* (*Phyllanthus Emblica* L.), *Bibhitaki* (*Terminalia bellerica* Roxb.*)* and *Haritaki* (*Terminalia chebula* Retz.), *Pushpa* of *Dhataki* (*Woodfordia fruiticosa* Kurz*), Ksheera* of *Snuhi* (*Euphorbia neriifolia* Linn), *Shakha* of *Guduchi* (*Tinospora cordifolia* (Willd.) Hook. F. & Thoms.), and *Niryasa* of *Hingu* (*Ferula asafoetida* Linn)[7]. Certainly, any part of plants can be always capsulated under the broad umbrella of *Panchanga*, but with help of modern plant science, it can provide more insight on the subject. Hence an attempt has been made to find out the classical and botanical information on plant parts.

MATERIAL AND METHOD

The systemic review of *Ayurveda* classical literature like *Samhita* and *Nighantu* along with lexicons and research articles was carried out through a web search on the use of varied plant parts in *Ayurveda* drug preparation. Similarly, the appendix of the Ayurvedic Formulary of India (AFI)[8] was scrutinized for the updated information on plant parts that are mentioned for the preparation of different formulations. Then, a study of the botanical description of plant's fundamental components was also carried out for the most probable correlation between the *Ayurveda* and botany terms and further presented in tabular form along with examples of plants (Table No.1). The concise description of plant parts as per the botanical science is as follows.

- **Root:** An underground part of a plant that absorbs the water and dissolved minerals and transports them to the stem and also acts as a food storage reservoir. A typical tap root system is observed in gymnosperms and dicotyledons, where primary root further divides into smaller roots and the smallest end roots are called rootless. Whereas grasses and other monocotyledons are having a fibrous root system where roots are in mass and with about equal diameter, and the root

network does not ascend as a branch of primary root but it emerged from the stem base. Apart from that, instead of arising from roots other roots that are arising from organ-like stems or leaves are called adventitious roots which are considered rhizomes, corms, and tubers. Some of them are known as aerial roots which are primarily unattached to soil or attached to non-soil surfaces like rocks or other plants. A rhizome grows perpendicular and contains a node from which roots and shoots originate and each node is capable to produce a new plant. The corms are a short, thick underground storage shoot with the prevalence of stem tissues. Similarly, tubers are enlarged structures considered as nutrients storage organs.

- **Stem**: A plant axis that bears buds and shoots with leaves and transports water, minerals, and food to other parts of the plant. Sometimes, green stems can also produce food and may act as storage of food. The nodes, internodes, terminal, or apical bud, lateral or axillary bud petiole, pedicel, and organs like leaves and flowers are distinct parts of a typical plant stem. The buds, leaves, aerial roots, and branches get originated from the nodes and it can hold leaves and buds together in a stem. The space between two successive nodes is called as 'inter nodal' zone. The bud located at the apex of the plant and always have in a state of division is called terminal or apical bud. A small bud, which gives rise to a new stem and is located between the stem and leaf is called an axial or lateral bud. Whereas a stalk connecting the leaf with the node of the stem is a petiole. The leaf with a petiole is called that petiolate leaf and without it is called a sessile leaf. Similarly, a stalk that connects an individual flower to an inflorescence (cluster of flowers) is called a pedicel. The main lateral appendage of the stem arises from the nodes are leaves. The annual plant completes its life cycles in one growing season and then the entire plant, as well as the stem, dies. Whereas, in biennial plant stem's lower portion generally modifies towards food storage and even also remains after the first growing season and in the second growing season from its buds arises an erect stem again. However, in the perennial plant, the short stem may produce new shoots for many years. Thus, plants that produce a woody stem are called a tree and shrub. The tree is having a noticeable trunk and the shrubs are having branches from or near the ground. It is a slender stem that grows horizontally along the ground, giving rise to roots and aerial (vertical) branches at specialized points called nodes. Overall, the stem is an erect or ascending structure of a plant, but in some plants, it remains horizontal on the ground. Though few plants stem also climbs on plants or rocks with supporting structures like tendrils. In few other plants, a stem curves toward the ground, and when it reaches a moist spot, it produces a root and again forms an upright stem and this kind of stem is called a stolon. The underground stems are also the rhizome, corm, and tuber. In some other plants during their early development, their stems instead of getting elongation form a short conical structure from which a crown of leaves arises and may form a bulb (as in the onion and lily), ahead (cabbage, lettuce), or a rosette (dandelion, plantain). The thickened, bulblike stems that store both water and nutrients are pseudobulbs. The flattened stem that serves the photosynthetic function of a leaf is termed cladophyll. Whereas thorns are shortened stems modified to form sharp, protective spikes however spines can be extensions of the periderm or even modified leaves. The stem wood is generally categorized under sapwood and heartwood. The sapwood is the outermost living portion of a woody stem or branch, and the heartwood is the older, non-living central wood of a tree or woody plant, usually darker and harder than the younger sapwood.
- **Bark:** Generally, the external covering of the woody stems, branches, and roots of plants means all the tissues outside the vascular cambium that overlaps the wood and consists of the inner bark and the outer bark. The inner soft bark,

or bast, is produced by the vascular cambium whereas the outer bark, which is the product of the cork cambium (phellogen) is mostly dead tissue, layered outer bark, containing cork and old, dead phloem, is also known as rhytidome.

- **Leaves:** The leaves are usually flattened green outgrowth from the stem of a vascular plant that works as the primary site of photosynthesis and produces food for plants. Botanically, they are an integral part of the stem system. A typical leaf is having a broad expanded blade/lamina attached with stalk/petiole with plant stem, and with the vascular system. However, leaves are diverse in their shape, size, and other characteristics which include blade margin and the arrangement of veins. Sometimes, whole leaves or its part generally get modified to perform special functions like climbing and substrate attachment, storage, protection, or even trapping and digesting insect prey. The spines are also modified leaves that protect the plant from herbivores and radiate heat from the stem during the day. Whereas, for water storage other desert plants have succulent leaves. Tendrils and hooks are the most common modifications for climbing and support.
- **Flower:** It is the organs of a plant that performs sexual reproduction and finally develops into a seed. It is a complex structure developed from the flower axis and usually transforms into the receptacle and the perianth. The perianth consists of calyx and corolla. The calyx is made up of the sepals, the corolla by the petals. When the calyx and corolla are unknowable or the calyx is absent, it is termed as an incomplete flower. The male reproductive organ in totality is called the androecium that comprises the stamens. Where each stamen consists of a filament and an anther. Similarly, the female reproductive organ is the gynoecium that includes the carpel. The carpel is made up of an ovary and a stigma and contains one or more ovules. Sometimes, one or more carpels get combined to form a pistil (ovary, style, and stigma) that is gynoecium. When a flower contains both androecium and gynoecium then it is called an androgynous or hermaphroditic flower. Whereas in a monoecious plant, both male and female flowers live on a single plant, and in dioecious plants, male and female flowers are borne on separate plants. Whereas the arrangement of flowers on the floral axis is known as inflorescence.
- **Fruit:** It is a mature ovary, and its associated parts usually contain seeds, which have developed from the enclosed ovule after fertilization. The principal purpose of the fruit is the protection and dissemination of the seed. It is of two types; a true fruit develops only from the ovary and a false or pseudocarp is that develops from other modified parts of the flower, like the thalamus, inflorescence, calyx (Apple, Strawberry, etc.). The fruits can be further classified based on the carpels present in gynoecium are free or in a fused state and the involvement of one or more flowers in the formation of fruit. Thus, it is further categorized as simple, aggregate, multiple, and accessory fruits. a) Simple fruit: The fruit that develops from a single ovary of a single flower is called simple fruit and it may be fleshy or dry. In the majority of fleshy fruit entire pericarp is soft and pulpy (e.g., the grape, tomato, banana, pepo, hesperidium, and blueberry) whereas the drupe may have a pulpy, fibrous, or leathery outer layer and its endocarp hardens into a pit or stone enclosing one or more seeds (e.g., the peach, cherry, olive, coconut, and walnut). Moreover, dry fruits are divided into dehiscent fruits that hard or papery shells split open to release the mature seed and indehiscent fruits that do not split. Legumes come under dehiscent fruits and a few of them splits at both edges (e.g., the pod of the pea and bean), and the others split on only one side (e.g., milkweed and larkspur) b) Aggregate fruit: The fruit which consists of a mass of small drupelets and every drupelet is developed from a separate ovary of a single flower (e.g., blackberry and raspberry). c) Multiple fruits: It is developed from the ovaries of many flowers growing in a cluster (e.g., pineapple and

mulberry). Thus, the pericarp is an ovarian wall that gets ripened, and fruit to fruit varied in nature. The pericarp has three layers, epicarp is outer; mesocarp is the middle and the endocarp is the innermost layer.

- **Seed:** After fertilization ovules, develops into a seed and it is made up of a seed coat and an embryo. It is primarily of two type's viz. monocotyledonous seed and dicotyledonous seed. A Monocotyledonous seed has a single cotyledon and outer layer of the seed coat. The seed coat called Hull is membranous and generally fused with the fruit wall. Whereas the endosperm is bulky and stores food. Its outer covering separates the embryo by a protein layer called the aleurone layer. The embryo is small and situated in a groove at one end of the endosperm. The scutellum is one large and shield-shaped cotyledon. The embryonal axis is having plumule and radicles are the two ends. Moreover, the plumule and radicle are enclosed in sheaths. They are coleoptile and coleorhiza. On the other hand, a dicotyledonous seed has two cotyledons. Its seed coat has two layers, the outer testa, and the inner tegmen. The hilum is a scar on the seed coat through which the developing seed was attached to the fruit. The micropyle is a small pore present above the hilum. The embryo consists of an embryonal axis and two cotyledons that are often fleshy and full of reserve food materials. And radicle and plumule are present at the two ends of the embryonal axis. In some seeds, the endosperm formed because of double fertilization is a food storing tissue. However, in other plants, the endosperm is absent in the matured seed known as non-endospermic.
- **Latex:** It is a fluid, usually milky white, which consists of tiny droplets of organic matter suspended or dispersed in an aqueous medium. It is usually obtained by cutting the plant to make it bleed.
- **Oleo Gums:** They are produced by exudation that is usually considered as a pathological response to injury to the plant, either accidental or caused by insect borers, or by deliberate injury i.e., tapping. It is mostly from the stem of a tree but in a few cases from the root also. However, seed gums are also isolated from the endosperm portion of some seeds.
- **Resins:** Resins are very widely distributed in the plant kingdom that can occur in almost any organ or tissue of the plant; a few (such as lac) are produced from insects. It is a solid or semi-solid material, usually, a complex mixture of organic compounds called terpenes, which is insoluble in water but soluble in certain organic solvents.

DISCUSSION

When a seed germinates the first organ which appears is called primary root or radical. The sprout is having synonyms like *Ankura*, *Udabhrida*, and *Praroha*. The synonyms like *Mula*, *Charana*, *Netra*, *Pada* and *Aghri* has been mentioned in the classical text[9]. In *Charaka Samhita*, *Adraka* is mentioned as the best *Kanda* for consumption and *Aluka* (potato)[10]as very bad moreover, *Kanda* is included under *Shakavarga*[11] that indicate its consumption as *Ahara* (diet). There are classical examples of roots are *Brihata Panchamula*, *Laghu Panchamula*, *Dashamula*, *Madhyama Pamchamula* etc.[12] and it has been also stated in classical text of *Ayurveda* that if a specific part of the plant has not been mentioned then that plants root (*Jata*) should be considered for therapeutic preparation[13]. Thus, in context with classical text *Mula* and *Kanda* can be differentiated as *Mula* is root and *Kanda* is tuberous or rhizomatous or corm root, mostly used as *Ahara Dravya*. While the *Trina Panchamula* indicates creeping roots whereas *Brihata Panchamula* is towards the taproot. While the meaning of synonyms likes *Avaroha*, *Jata*, *Shira*, and *Shipha* are may be indicative of Arial root.

For the stem synonyms like *Prakanda*, *Kanda* and *Danda* have been mentioned whereas, the other synonyms like *Arvagbhaga*, *Bundhya*, and *Nitamba* are also mentioned in the classical text[14]. Hence, *Prakanda* may be considered as the stem of herb and climber while *Nitamba* may indicate the stem of a tree. The stem bark is not only used in medicine but also as a printing material for ages back. There may

be a difference between *Tvaka* and *Valkala*, *Tvaka* can be considered as the outermost dead thin layer which is generally easily removed, or plants may shed it out seasonally whereas *Valkala* is a thick live layer of plant which can be generally used after drying. Similarly, *Patra* may be considered as a mature leaf and *Pallava* as a tender leaf. Moreover, for *Patra* few more synonyms have been quoted like *Parna, Dal, Varha, Palasha, Chhadana*, and *Chhada*, etc. and *Pallava* has *Kishalaya, Pravala*, and *Nava*, etc[15]. Apart from that *Madhi* and *Parnashira* are the synonyms for leaf vein but, the specific separate use of leaf vein couldn't be found.

One can also find the various synonyms for *Pushpa* (flower) like *Sumana, Kusum, Prasuna, Prasavsuma*, and *Sunufullapushpa*, etc. And synonyms *like Jalaka, Kudamala, Kulaksharaka*, and *Kalika* for *Kalika* (bud)[16]. Moreover, the floral inflorescence is to be considered as *Pushpasamucchya* or *Pushpaguchha* having synonyms like *Guhcha, Gulichha, Stavaka, Guchhaka*, and *Kusumocchaya*. Similarly, the *Phala* is having different terms like viz. immature fruit is called *Shalatu*, mature fruit is called as *Shasya* whereas, when it gets dried it is called as *Vaana*. These terms are applied to the food grains. We can also find a specific reference about the ripened and unripe fruit's property and uses in a specific condition. The *Phalavarga* mentioned in various *Nighantu* gives ample insight into the consumption of fruit as *Ahara*, however, *Bija* (seed) is mostly having medicinal properties. The secretions from injured plant tissue which are liquid in nature, white in colour, and having a resemblance with milk are usually called *Kshira* and *Dugdha*. However, the secretions which are colourful, soft in nature, and having fragrance are generally termed as *Niryasa*.

CONCLUSION

Based on individuals understanding plant and plant parts may be differently classified, but this review highlights the majority of plant parts that are exclusively used in an *Ayurveda* drug preparation. It also represents the ancient plant taxonomy in the literature of *Ayurveda* and its necessity of acquaintance to the physicians. But, in present era apart from the taxonomical identification of plant part, understanding of pharmacognostic and physio-chemical makers are much essential for the selection of the suitable plant material for drug preparation.

TABLE 1: The Sanskrit and probable botanical equivalent of plant part and whereof it's a specific example.

Plant Part	**Sub-part**	***Sanskrita* equivalent**	**The Sanskrit and Botanical name of the plant whereof specific part is used in the drug preparation.**
Root	Tap root	*Mula*	*Bilva*[17] [*Aegle marmelos* (L.) Correa]
	Creeping root	*Trinamula*	*Durva* [18] [*Cynodon dactylon* L.]
	Rhizome	*Kanda*	*Haridra* [19] [*Curcuma longa* L.]
			Ardraka [20] [*Zingiber officinale* Roscoe]
	Tuber	*Kanda*	*Shatavari* [21] [*Asparagus racemosus*Willd.]
	Corm	*Kanda*	*Suran Kanda* [22] [*Amorphophallus paeoniifolius* (Dennst.) Nicolson]
	Arial root	*Praroha/ VayaviyaMula*	*Ketaki* [23] [*Pandanus odorifer* (Forssk.) Kuntze]
	Root bark	*MulaTwaka*	*Agnimantha* [24] [*Premna mucronate* Roxb./ *Clerodedrum multiflorum* (Burm.f.) O. Kuntze]
	Root Stalk	*MulaKashtha*	*Ikshu* [25] [*Saccharum officinarum* Linn.]
Stem	Bulb	*Kanda*	*Palandu* [26] [*Allium cepa* L.]
	Stem	*Kaanda*	*Guduchi* [27] [*Tinospora sinensis* (Lour.) Hook. f.& Thomson]
	Stem bark	*Tavka / Valkala*	*Pancha Valkala* [28] *i.e. Nyagrodha* [*Ficus benghaenesis* L.], *Udumbara* [*Ficus racemosa* L.],

			Parisha [*Ficus religiosa* L.], *Ashvatha* [*Thespesia populanea* (L.) Sol. ex Correa], *Plaksha* [*Ficus lacor* Buch.-Ham.]
	Wood	*Kashtha*	*Devadaru* [29] [*Cedrus deodara* (Roxb. Ex D. Don) G. Don]
	Heartwood	*Saara*	*Agaru* [30] [*Aquilaria malaccensis* Lam.]
			Chandana [31] [*Santalum album* L.]
	Prickles	*Kantaka*	*Shalmali* [32] [*Bombax ceiba* L.]
	Pith	*Saara*	*Tala* [33] [*Borassus flabellifer* L.]
	Stolon	*Prarohikanda*	*Yashti* [34] [*Glycyrrhiza glabra* L.]
Leaf	Mature leaf	*Patra*	*Tamala* [35] [*Cinnamomum tamala* Nees & Eberm]
	Tender leaf	*Pallava*	*Pancha Pallava* [36] *i.e. Amra* [*Mangifera indica* L.], *Jambu* [*Syzygium cumini* (L.) Skeels], *Kapittha* [*Feronia limonia* (L.) Swingle], *Bijapuraka* [*Citrus medica* L.], *Bilva* [*Aegle marmelos* (L.) Correa]
	Leaf pulp	*Patramajja*	*Kumari* [37] [*Aloe vera* (L.) Burm.f.]
Flower	Petals	*Pushpadala*	*Utpala* [38] [*Nymphaea nouchali* Burm. f.]
	Bud	*Kalika*	*Lavanga* [39] [*Syzygium aromaticum* (L.) Merr. & L.M. Perry]
	Stamen	*Punkesara*	*Nagakesara* [40] [*Mesua ferrea* L.]
	Whole flower	*Pushpa*	*Japa* [41] [*Hibiscus rosa-sinensis* L.], *Dhataki* [42] [*Woodfordia fruticosa* (L.) Kurz]
	Salk	*Pushpavrinta*	*Kamal Nala* [43] [*Nelumbo nucifera* Gaertn.]
	Style & Stigma	*Streekesara*	*Kumkuma* [44] [*Crocus sativus* L.]
	Pod	*Shimbi*	*Svarnapatri* [45][*Senna alexandrina* Mill.]
	Inflorescence	*Pushpaguccha*	*Arka*][46] [*Calotropis procera* (Ait) R.Br.], *Nirgundi* [47] [*Vitex negundo* Linn.]
Fruit	Pericarp	*Phala*	*Haritaki* [48] [*Terminalia chebula* Retz.]
	Endocarp	*Antaregarbha / Antarstara*	*Narikela* [49] [*Cocos nucifera* L.]
	Glands & Hairs on Fruit	*Phalaraja*	*Kampillaka* [50] [*Mallotus philippensis* (Lam.) Muell. -Arg.]
	Fruit Pulp	*PhalaMajja*	*Aragwadha* [51] [*Cassia fistula* L.]
	Spadix	*Sthulamanjiri*	*Gajapippali* [52] [*Scindapsus officinalis* (Roxb.) Schott]
Seed	Fruit Rind	*PhalaTvaka*	*Dadima* [53] [*Punica granatum* L.]
	Aril	*Koshapatra/ Beejaupanga*	*Jatiphala* [54] [*Myristica fragrans* Houtt]
	Kernel	*Beejamajja*	*Amra* [55] [*Mangifera indica* L.]
	Husk	*Sthulakana/ Bhusi*	*Ashvagola* [56] [*Plantago ovata* Forssk.]
Others	Oil	*Tailam*	*Eranda* [57] [*Ricinus communis*L.]
	Latex	*Kshira*	*Suvarnakshiri* [58] [*Argemone Mexicana* L], *Snuhi* [59] [*Euphorbia neriifolia* L.]
	Oleo Gums	*Niryasa*	*Sarala / Gandhabiroja* [60] [*Pinus roxburghii* Sarg.], *Guggulu* [61] [*Commiphora mukul* (Hook. ex Stocks) Engl.]
	Resin	*Kitagriha* (Gall)	*Karkatshringi* [62] [*Pistacia chinensis* subsp. *integerrima* (J. L. Stewart ex Brandis) Rech. f.]
	Whole plant	*Sampurna Vanaspati*	*Shankhapushpi*[63] [*Convolvulus pluricauluis* Chois]

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