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Treatments of Plant Diseases and Pests According to *Vrikshayurveda* Classics: A Review

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Abstract

Ayurveda was theorized more than 5000 years back and is practiced unto this day by more than 50% of the rural population. Like the medical science for humans (Ayurveda) similar science Vrikshayurveda was also developed for plants. Vrikshayurveda mainly deals with various aspects of plants. This paper mainly focusses on the treatments of plant diseases and pests according to the Vrikshayurveda classics. An effort is made here to review several ancient literature and current journal articles on Vrikshayurveda and to extract information on treatments of plant diseases and pests as it is necessary to disseminate this valuable knowledge on ancient practices in the organic production and managing of agricultural crops and medicinal plant diseases. According to the findings, Vrikshayurveda classifies the plant diseases as Nija and Aganthu. Nija disorders are caused by the imbalance of the Tridosha namely vata, pitta and kapha. Whereas Aganthuja disorders are due to external factors as pests and natural disasters, lightning etc. In diseases due to vata origin, plants become slender, occurrence of knots in trunk and leaves, and hard fruits with less juice and flavor. Such diseases can be treated by using flesh, fat, and ghee. Kapha illnesses develop when trees are overwatered with sweet, oily, sour or cold substances in the winter and spring. Plants affected by Kapha disorders, show symptoms such as deformed plant leaves, prolonged bearing of fruits, pale fruits, dwarfed, tasteless, premature, slow ripening of fruits and loss of natural taste. These plants should be treated by using decoctions of bitter, strong and astringent ingredients like the Panchamoola decoction. Pitta dosha related diseases show symptoms like leaves turning yellow, paleness of leaves, flowers and fruits, premature fruit drops, ripening of fruits rotting. As a treatment make a decoction of licorice root (Glycyrrhiza glabra) and bark of Indian butter tress and let it cool down. Then mix it with milk and honey and pour it down at the bottom of the tree. For diseases due to aganthu, treat by watering the tree with cold water for 7 days, sprinkling a mixture of water and oil cake on affected creepers, sprinkling ash and brick dust powder on invading insects. Therefore, these findings on ancient wisdom coupled with modern technologies will benefit the mankind.

Key Words: *Agro techniques, Medicinal plants, Plant diseases, Vrkshayurveda*

1. Introduction

Agricultural practices have existed in India from ancient times. Sri Lanka being an agricultural country, it's agricultural activities have existed for centuries, and agriculture was the main livelihood of the rural population. This country was self-sufficient during those days with sustainable water management and organic agricultural practices. With the Green revolution agricultural activities had taken a drastic change by using chemical fertilizers and pesticides to boost the production in all the sectors of agricultural activities. Research findings revealed that there is severe groundwater pollution in the dry zone areas, and farming communities face serious health hazards such as chronic kidney disease (CKDu), cancer and other water related health problems (De Silva, 2015). In addition, this leads to bio accumulation and bio amplification, which is the accumulation and transmission of chemicals along the food chain causing extreme harm to the organisms. Harmful chemicals present in the many pesticides and fertilizers, especially hard metals, are accumulated in the plants and then finally transfer into the human body due to ingestion of these plants. In today's world, human beings are facing serious health hazards like digestive ailments, cancer, physical and mental ailments, reproductive abnormalities, immune suppression, hormone disruption etc. due to chemical fertilizers and pesticides. Although chemical fertilizers and pesticides are used at the present time to increase the harvest of the flora in agriculture, these are also causing destructive effects on the environment like contamination of air, soil, ground water and declining of beneficial soil micro-organisms. This is purely because our traditional practices of farming have been more or less replaced by modern techniques. Due to the comparatively less amount of side effects and an increasing awareness among the communities for a more herbal and authentic medical practice, there has been a growing gravitation towards the ancient *Ayurveda* and traditional medical systems. With the economic crisis in the country, imports of chemical fertilizers and pesticides have been limited and farming communities face tremendous difficulties to have sustainable agricultural production. Therefore, proper, and reliable measures and methods need to be identified, so that the farmers could adapt those methods for sustainable production of agricultural and medicinal plants at affordable prices.

Ayurveda, theoretically giving the meaning of "knowledge or science of life" is a medical system that was developed and practiced since more than 5000 years ago, so much so that this ancient medical system was called the "Mother of all healing". While *Ayurveda* mainly dealt with the various aspects of human life, another branch developed, which dealt with the science of plant life; *Vrikshayurveda*. *Vrikshayurveda* is a branch of Ayurveda that deals with plant life. The name basically means *Ayurveda* for plant life. By 550 BC, *Vrikshayurveda* had established itself as a unique field. It mainly deals with the cultivation, propagation, healthy growth, productivity, pest control, disease prevention and the preservation of the florae and correlates with modern agroforestry science (Ankitha *et al*, 2022; ICAR, 2003). According to *Vrikshayurveda*, plant physiology, similar to human physiology, is governed by three basic energy principles: *Vata, Pitta* and *Kapha*. *Vata* is responsible for mobility and sensations, *pitta* responsible for cellular transformations, chemical reactions and *kapha* responsible for union and stability. The homeostasis of these three energy principles are the conducive factors for good health, while vitiation of these energies

as diminution or aggravation in either their quantity or quality or both results in the onset of diseases. Therefore, to cure the diseases caused by these vitiations *Vrikshayurveda* has mentioned various herbal and animal materials that facilitate the pacification of the dosha leading to the cure of diseases (Mishra, 2017). However, apart from these internal factors, external factors such as pests and insects are also major influences for such plant diseases, and *Vrikshayurveda* has mentioned many materials and methods for the prevention of infestations, pest colonization and the healing of the resultant ailments. As there is an increasing focus on the *Ayurveda* and traditional medical systems in today's society due to the comparatively less side effects and the remedies being of primarily an organic origin. Nowadays, there is a growing demand for herbs, which leads to plant exploitation, which results in habitat loss. As a result, new ways for cultivating and preserving medicinal plants should be devised. Various ayurvedic and *Krishisastra* texts mention a variety of ways for plant development. Therefore, need to employ the ancient ideas of the Acharyas to improve farming practices. *Vrikshayurveda* the ancient text has already mentioned various herbal and animal material like honey, milk, cow's urine to be used in a number of methods including fumigation to cure plant diseases and prevent pest colonization (Sadhale and Nene, 2009). Therefore, this article aimed to study the methods to control plant diseases and pests in *Vrikshyurveda* classics and to transfer this knowledge to the farming communities to adopt these ideas in the cultivation practices to ensure sustainable productivity of agricultural and medicinal plants.

2. Materials and Methods

Various texts like *Agni Purana, Brihatsamhita, Sharangdhara Samhita* of *Sharangdhara* contain the literature of *Vrikshayurveda*. The details of *Vrikshayurveda* are explained in *Brihatsamhita* and *Agni Purana*, even though the term *'Vrikshayurveda'* was first mentioned in *Koutilya Arthashastra.* Text such as *Vishvavallabha*, *Krishi Parashara*, *Manasollas*, *Shivatatvaratnakara* and *Lokopkara* also contain the information related to the art of plantation. *Surapala* wrote the *Vrikshayurveda* text by 1000AD highlighting the importance of agriculture practices. It is an Independent Ancient Sanskrit Text (325 Shlokas) on Plants. Mr. Y. L. Nene (Chairman Asian Agri-History Foundation) procured a manuscript of *Vrikshayurveda* of *Surapala* from Bodlein Library, Oxford, UK and Dr. Nalini Sadhale did the English translation of the manuscript (Jeerankalagi *et al*, 2022). Due to the limited number of authentic resources on *Vrikshayurveda*, the related information is greatly lessened. However authentic texts such as the translation of *Vrkshayurveda* of *Parashara* (A Treatise on Plant Science) edited and translated by N.N. Sircar and Roma Sarkar were also used extensively (Sircar, 1996). Furthermore, several journal articles were studied and extracted information for the treatment of plant diseases and pests according to *Vrikshayurveda* classics. Additional information regarding various aspects such as the constitution of plants, diseases of the plants due to the imbalance of the *doshas*, the organic remedies that were used to cure plant diseases were collected from several journal articles. Properties of such organic material and plants used in treatments and their medicinal and pharmacological properties were collected from reputed journals and ancient treatises of *Ayurveda*.

3. Results and Discussion

According to the history, the documentation of plants in ancient India must have started around 2570 BCE to 2000 BCE. The experiences of various authors from different parts of India facilitated the conclusion that the practice of recommendations of *Vrikshayurveda* at present time would be profoundly beneficial for present economy. Contents in *Vrikshayurveda* classified plant disorders into two types- *Nija* and *Aganthu*. The *Nija* disorders are caused by the disturbance of three dosas- *Vata, Pitta, Kapha* and *Aganthu* disorders are caused by pests, hail, lightning, and other external factors.

Plant disorders caused by disturbances of *Tridosha* (*Nija)*

In *Ayurveda* theory there are three types of energy principles that are responsible for the physiology of living beings called the *Tridosha* namely, *Vata, Pitta* and *Kapha* (Figure 1). *Vata,* the mobile energy is responsible for mainly the movements at macro and micro levels. It indicates the rough, light, cold, dry, subtle and mobile aspects of physiology. *Vata* is also interpreted as the energy of movement and draws from the basic elements of Space and Air and translates as "wind" or "that which moves things." It is responsible for the energy of movement and the force governing all biological activity. Often called the "King of the Doshas," *Vata* governs the body's greater life force and gives motion to *Pitta* and *Kapha*. *Pitta* is the energy of transformation and derives from the basic elements of Fire and Water. *Pitta* is the primary energy that is responsible for the cellular level transformations including metabolism. *Pitta* dosha indicates the hot, sharp, light, foul-smelling, flowing, fluid and slightly unctuous aspects of physiology. *Kapha dosha* draws from the basic elements of Earth and Water and translates as "that which sticks". The *kapha dosha* is the energy principle that is responsible for union and stability at subtle levels. An imbalance of these dosha leads to the onset of diseases according to the predominance of the vitiated dosha (Sadhale and Nene, 2009).

Figure 01. *Tridosha* in *Ayurveda*

This theory which is most notably applied in aspect of the humans was also applied in relation to plants according to *Vrikshayurveda*. Therefore, *Vata, Pitta* and *Kapha* are considered the basic components of plant physiology, and their disequilibrium leads to a variety of plant diseases. *Surapala* has considered plant life as somewhat equal to humans and mentions that plant life too can be treated in a similar manner to humans (Sadhale and Nene, 2009).

Vata Dosha vitiated diseases and treatments

Due to diseases of *vataja* origin, plants become slender and bent, with knots on the trunk or leaves, and produces hard fruits with less juice and flavor. These are to be treated by the use of flesh, fat and ghee and can also be treated by the sprinkling of *Kunapa jala.* which is the production of fermented liquid manures from organic wastes (Sadhale and Nene, 2009).

Kunapa jala

Kunapa jala is popularly mentioned in *Vrikshayurveda* as the most significant innovation, which was reportedly a first in world Agri history. The literal meaning of *kunapa* is "smelling like a dead or stinking" (Shubhashree *et al*., 2018). *Kunapa jala* is a natural organic product derived from animal and plant products that contain a significant amount of one or more primary nutrients such as nitrogen, phosphorus, and potassium, which are essential for plant growth. It has been found to contain many macro and micronutrients including amino acids, fatty acids, keratins and sugars which facilitate growth and development. The use of this organic manure is also beneficial since it increases the microbial biomass as well as the water holding capacity of soil (Nisar *et al*., 2017.).

Kunapa jala containing many macronutrients, when burnt, releases the growth regulator karrikins and the antimicrobial agent acrolein. Burning incense releases their volatile material containing bio effective properties. Fermented herbal products when burnt, can be expected to release their antimicrobial, antibacterial, anti-viral and antifungal attributes (Nene, 2014).

Surapala's procedure involved collecting and storing animal waste as and when they became available. Surapala enlarged the source of waste to include other animals, particularly those with horns, despite the fact that dead boar waste was stated first. *Kunapa jala* could be made from almost any animal waste, giving farmers more options when it came to procuring their ingredients.

It's also a way to produce an effective liquid fertilizer that involves the fermentation of animal remains which reduces the environmental pollution by damping this waste. To make *kunapa jala*, boil the flesh, fat, and marrow of deer, pig, fish, sheep, goat in water, then transfer the mixture to an earthen pot and add the compound milk, sesamum oil cake powders, honey, boiled *masha*, pulse decoctions, clarified butter, and hot water. There is no set amount of any of these ingredients; however, when the pot is placed in a warm environment for about a fortnight, the combination transforms into kunapa jala.

Surapala's *Vrkshayurveda* mentions the method of producing this organic manure (Parasara, 1996; Sadhale, 1996). It is recommended to take 1.0kg of meat, 250.0gms of sesame seeds, 250.0gms of black gram and 1000.0mL of cow's milk. Initially the meat should be cooked in 5.0 L~~iters~~ of water till water is reduced to half its original amount, then filter the liquid. Then the filtered water is mixed with sesame and black gram and brought to boil. The mixture is then left to cool and after cooling, milk is added. Then the entire preparation is transferred into an earthen pot and buried in the ground to undergo fermentation. After 10 days it is transferred to another pot and left for further fermentation. From the resultant formulation, the liquid is sprayed onto the roots, while the solid is mixed with the soil of the farming field. Another method of formulating *Kunapa jala* is by boiling animal flesh, bone marrow, grain husk and oil cake together in 5.0 L of water then leaving to cool. After which, it is transferred to a 200.0 L container and mixed with cow dung, cow urine, honey, ghee, milk and water to make the volume up to 100.0 L and leave to ferment for 1-3 months while stirring twice a day. Finally, the mixture is filtered and *Kunapa jala* is obtained (Nene, 2012).

Scientific studies of the present day have determined that a mixture of even 50.0 mL of the *Kunapa jala* and 10.0 L of water applied on the plant life could have a larger yield than the usual production (Ankitha *et al*. 2022; Narayanan (2006). Valmiki Sreenivasa Ayangarya was the first to have experimented with *Kunapa jala* and went onto formulate a herbal *Kunapa jala* also called *manujala* or *Sasyagavya* that was a result of the fermentation of vegetable organic waste in human urine (Ayangarya and Valmiki Sreenivasa. 2004). There are also mentions of a *mushika kunapa* (rat kunapa) prepared by Ayangarya, Valmiki Sreenivasa (2006) and that increased plant growth as well as control rodent activity in the fields. In comparison to the chemical fertilizers used in the present day, these liquid bio fertilizers, that is *Kunapa jala* and its variations, has minimal toxic effects on the human body in addition to enhancing the overall growth of plants as well as prevent and cure the plant diseases (Hudar *et al*, 2022).

Blood, cotton seed, fish meal, and emulsion are good sources of nitrogen, whereas compost from bird manures, bone meal, and other sources of phosphorus and potassium help to regulate root, bud, flower and fruit formation, cell division, sugar formation in the sap, chlorophyll production and photosynthesis, and increase crop resistance to disease (Shubhashree *et al*., 2018). Some studies are ongoing now a days regarding the effectiveness of *kunapa jala* (Brageshwar *et al*., 2007 Ankad *et al*.,2017). Along with *kunapa jala, panchagavya* is gaining in popularity these days in India (Shubhashree *et al*., 2018).

Panchagavya

Panchagavya is a combination of five cow-derived items. Cow dung, urine, milk, ghee, and curd are the ingredients. The first three are direct products, whereas the latter two are derivative products. *Gavya* is the brand name for all these goods. It is utilized in seed germination, as a spray for nourishment and to treat various diseases also. For manufacturing *panchagavya*, fresh cow products such as cow dung (3.0 kg), cow urine (3.0L), cow milk (2.0L), curd (2.0 kg), and cow ghee (1.0kg) were collected. The

required quantities of five materials were thoroughly mixed in a container and fermented for seven days, stirred twice daily. In *panchagavya*, effective microorganisms are a mix of naturally occurring microbes, primarily lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria, and specific bacteria. *Panchagavya* contains chemolethotrops and autotrophic nitrifies, which proliferate on the leaves and boost ammonia intake and total Nitrogen supply (Natarajan, 2003). Individual treatments differed in their efficacy, but *panchagavya* and *kunapa jala* were shown to be the most effective in terms of greater leaf nitrogen use, efficient photosynthetic activity, and increased production. *Panchagavya* promotes soil fertility by enhancing macronutrients, micronutrients, and beneficial microbes, resulting in improved soil health. It improves the soil's water holding capacity, increases plant nutrient uptake, and boosts plant development (Natarajan, 2003). Earthworms, as well as their vermicast and body liquid (vermiwash), have been scientifically proven to be both growth promoters and plant. For the improvement of fruiting flowering of various plants, different nourishing formulations were explained in *Vrikshayurveda* classics (Natarajan, 2003).

Kapha Dosha vitiated diseases and treatments

Kapha is mainly predominant in the water and earth aspects. When trees are overwatered with sweet, oily, sour or cold substances in the winter and spring, *kapha* illnesses develop. Accordingly, the diseases that originate due to the vitiation of *kapha dosha* in plants will take a long time to bear fruit and shows symptoms of deformed plant leaves, fruits will be pale, dwarfed, tasteless and premature and slow ripening of fruits and also fruits lose its natural taste. This should be treated by using decoctions of bitter, strong and astringent ingredients like the *Panchamoola* decoction. *Panchmoola* is combination of five plants mainly *Bilva* (*Aegle marmalos L*), *Agnimantha (Clerodendrum phlomides L.*), *Shyonaka* (*Oroxylum indicum Benth*.), *Patala* (*Stereospermum suaveolens Roxb*.), *Gambhari* (*Gmelina arboria Roxb*.) are used in various forms to treat different diseases in plants. It is also used for pest control and as a bio fertilizer to enhance plant yield (Jeerankalagi *et al*, 2022).

Kapha dosha diseases can also be treated by placing *Shita sarshapa kalka* (white mustard paste) and sprinkling *Tilabhuti jala* (the liquid mixture of sesame powder and ashes) at the root of the tree (Sadhale, 1996). There is another remedy for *Kapha* related diseases: make a decoction of catechu bark (Karinkali), neem bark, nut grass, milk wood pine bark, sweet flag and nightshade plant (Kantakari) and pour the decoction at the bottom of the plant for 7 days (Bhandary, 2020).

Pitta Dosha vitiated diseases and treatments

Pitta Dosha is mainly the combination of fire and water. At the end of summer, *Pitta* kind of diseases occur when the clouds vanish and the trees are overly flooded with pungent, sour, salty, and hot and intense factors. Diseases that are caused due to the abnormality of *pitta* show symptoms like leaves turning yellow, paleness of leaves, flowers and fruits, premature fruit drop, ripening of fruits rotting. The roots

are eaten away by insects, the leaves dry out, turn yellow, and become excessively pale, and lose their natural aroma. When trees are exposed to heat or fire, wind, continual shade, overcrowding by birds, excessive creeper development, and weed growth and ultimately trees will die. This is said to be cured by using cool and sweet substances as these properties are opposite in nature to the properties of *pitta* thus leading to the pacification of the vitiated *dosha*. As a treatment make a decoction of licorice root (*Glycyrrhiza glabra*) and bark of Indian butter tress and let it cool down. Then mix it with milk and honey and pour it down at the bottom of the tree. Furthermore, decoction of *triphala* (combination of *Terminalia chebula, Terminalia bellirica* and *Phyllanthus emblica*), ghee and honey can also be used as a remedy for the *pitta* type diseases (Sadhale, 1996.). *Pitta* related diseases can also be treated pouring a decoction of nutgrass (*Cyprus rotundus*) and *vetiver* (*Chrysopogon zizanioides*) mixed with milk, ghee and honey at the bottom of the plant.

Furthermore, researchers have identified various decoctions that are beneficial in the treatment of certain plant diseases. *Adathoda* decoction (*Adathoda vasica*), *Pudhina* decoction, *Thriphala* decoction (*Terminalia chebula, Terminalia bellerica, Phyllanthus emblica*), *Prosophis* decoction, Cow's urine *arka* and sweet flag *arka* and garlic *arka* have been found to be effective against *Helminthosporium* leaf spot in mainly paddy, bacterial leaf blight and leaf folder (Balasubramanian *et al*, 2008.). Arka are the liquid distillations of herbal materials.

Plant disorders caused by *other factors (Aganthu)*

Apart from the *Tridosha*, organisms like bacteria, viruses, fungi and nematodes as well as environmental causes like excessive heat, cold, drought and mechanical injuries are also major factors responsible for plant diseases (Sadhale and Nene, 2009). For *Pandu* diseases (anemia) of plants, irrigation using a liquid mixture of water, *Yava*, *Godhuma*, Milk and honey is said to cure the conditions (Sadhale and Nene, 2009).

To expel insects, measures such as watering the tree with cold water for 7 days, sprinkling a mixture of water and oil cake on affected creepers, sprinkling ash and brick dust powder on invading insects are recommended. Damage that has been caused by insects can be healed by applying a mixture of *vidanga* (*Embelia ribes*), sesame, mustard, cow's urine and ghee applied to the roots of infected plants (Jeerankalagi *et al*, 2022). For worm infestations applying paste of milk, *kunapa jala*, cow dung and water or even applying a mixture of white mustard, *vacha (Acorus calamus), kushta (Saussurea lappa)*, and *ativisha (Aconitum heterophyllum)* on the roots have been suggested. Furthermore, fumigation of the tree using a mixture of white mustard, *ramatha*, *vidanga* (*Embelia ribes*), *vacha*, *usana*, water, beef, buffalo horn, flesh of pigeon and *Bhallataka (Semecarpus anacardium)* powder. Both worm infestation and insects can be treated by sprinkling *vidanga* and ghee, watering 7 days with salt water and applying a paste of sesame and white mustard and beef (Sadhale, 1996.).

Fumigation is a method used since ancient times to cure diseases of plants and control pest colonization, and various plant and animal material have been used for the purpose of fumigation. It is a well-known fact that various parts of the plants

such as leaves, flowers, roots, barks and seeds hold volatile substances, therefore, the burning of these plant parts may release these volatile substances with biological properties giving the expected antimicrobial, antibacterial, antiviral and antifungal effects. According to the many *Vrikshayurveda* texts many substances like animal waste products, cow products, natural products and prepared products have been used for the purpose of fumigation (Nene, 2014.).

Medicinal properties of medicinal plants used in *Vrikshayrurveda*

Additionally, the various herbal material that has been utilized for the purpose of fumigation according to the texts of *Vrkshayurveda* are also mentioned below. White mustard, *Vidanga* (*Embelia ribes*), Arjuna flowers (*Terminalia Arjuna*), Turmeric (*Curcuma longa*), *Triphala* that is combination of *Haritaki (Terminalia chebula), Vibheetaki (Terminalia bellirica*) and *Amalaki (Phyllanthus emblica*), Sesame, Barley, *Ramatha/ hingu* (*Ferula asafetida*), *Guggul (Commiphora wightii)*, *Vacha (Acorus calamus*), *Krihsna/ushna (Piper nigrum*), long pepper (*Piper longum*), plantain leaf, aconite (*Aconitum napellus*), *Bhallataka (Semecarpus anacardium*), *Kushta/* Costas root (*Saussurea lappa), Koshataki* leaves (*Luffa acutangula), Indrabeeja (Citrullus colocynthis*), Kadali leaves (*Musa paradisiaca), unmatta (datura metel), vatarika (*garlic*), shipha (Curcuma domestica), mallika (jasminum sambac), nirgundi(Vitex negundo*), cereal husk, *Yava* (barley), *masha/* black gram (*Vigna mungo), musta (Cyperus rotundus), Sita (Puraria tuberosa), Nimbu (Citrus aurantifolia), kubera (Ficus microcarpa), sarpi (Sansevieria roxburghiana), netra (Opuntia elatior*) and *Asana* seeds (*Pterocarpus marsupium*) are some such herbal substances used for fumigation (Nene,2014.).The plants and their biochemical compounds that are beneficial for the purpose of fumigation is in Table 1.

Table 01. Medicinal Plants used in *Vrikshayurveda* and their properties and actions.

Plant	Biochemical Properties	Actions	Plant specimen
Aconite (*Aconitum heterophyllum*)	Several alkaloids and flavonoids	Antimicrobial	

Arjuna (*Terminalia arjuna*)	Arjunolic acid, tannins, glycosides	Antimicrobial	
Agnimanth (*Clerodendrum phlomides L.*),	Steroids, terpenoids and flavonoids	Antifungal, antiviral, antibacterial, insect antifeedant	
Amlaki *(Phyllanthus emblica)*	Phenolic compounds, tannins, phyllembelic acid, phyllembelin, rutin, curcum-inoids, and emblicol	Antibacterial, Antioxidant	
Asana (*Pterocarpus marsupium*)	Bark has alkaloids, glycosides, flavonoids, phenols, and terpenoids	Antifungal, Antibacterial, and Antiviral	
Bilva (*Aegle marmalos L*),	Carotenoids, phenolics, alkaloids, pectin, tannins, coumarins, flavonoids, and terpenoids	Antifungal, nematocidal, insect antifeedant	

Bhallataka (*Semecarpus anacardium*)	Bi flavonoids, phenolic compounds, bhilawanols	Antimicrobial anti-termites	
Bibhitaki *(Terminalia bellirica)*	Tannic acid, Garlic acid, ellagic acid	Antibacterial	
Catechu Bark *(Acacia catechu)*	Protocatechuic acid, taxifolin, epicatechin, epigallocatechin, catechin, etc	Antimicrobial	
Datura/ Unmatta (*Datura metel*)	Steroidal with ametelin	Antifungal, Antibacterial	
Guggula *(Commiphora wightii)*	Alkaloids, glycosides, steroids, terpenoids, flavonoids, and oleo gum resin	Antibacterial	

Gambhari (*Gmelina arboria Roxb*.)	Root contains oil, resins, alkaloids and little benzoic acid. Fruits contain butyric acid, tartaric acid and tannin, Leaves contain luteolin.	Antiviral	
Haridra *(Curcuma domestica*)	Diferuloylmethane (curcumin) and several curcuminoids	Antibacterial, Antifungal, and Antiviral	
Haritaki *(Terminalia chebula,)*	Gallic acid, chebulinic acid, chebulagic acid, isoterchebulin, punicalagin.	Antioxidant	
Indrabeeja *(Citrullus colocynthis)*	Flavonoids, tannins, terpenoids	Antimicrobial	
Ingudi *(Balanitis aegyptiaca)*	Saponins, glycosides, fatty acids	Antimicrobial and Anthelmintic	

Kalajaji/ upakunchika (Nigella sativa)	Thymoquinone	Antibacterial	
Karanja *(Pongamia pinnata)*	Flavonoids	Antibacterial	
Kebuka *(Costus speciosus)*	Diosgenins, benzoquinones	Antimicrobial	
Kosataki *(Luffa acutangula)*	Terpenoids, steroids, flavonoids, and glycosides	Antifungal and Antibacterial	
Kubera *(Ficus microcarpa)*	Rich in phenolics	Antibacterial and latex is Antifungal	

Karinkali (*Acacia catechu*)	Hydroxybenzoicacid, kaempferol, quercetin, 3, 4, 7-trihydroxyl-3,5-dimethoxyflavone, catechin, rutin, isorhamnetin, epicatechin, afzelechin,epiafzelechin, mesquitol, ophioglonin, aromadendrin, and phenol	Antioxidant, Antimicrobial, Antipyretic	
Kadali leaves (*Musa paradisiaca),*	Flavonoids, sterol glycoside.	Antimicrobial	
Kantakari *Solanum virginianum*	Alkaloids, flavonoids, glycosides, saponins, coumarins, beta-sitosterol and solasodine.	Antibacterial	
Kushta *(Saussurea lappa)*	Phenylpropanoids,esquiterpenoids, and monoterpenes	Insect repellent and insecticidal	
Lasuna/ rasona *(Allium sativum)*	Allicin (organosulfur compound)	Antibacterial, antiviral, antifungal, nematicidal, insect repellent	

Licorice root *(Glycyrrhiza glabra)*	*Glycyrrhizin*	Anti-bacterial and Anti-viral, Anti-microbial	
Mallika *(Jasminum sambac)*	Alkaloids, glycoside, flavonoids, triterpenes, saponins, tannin, resin, and salicylic acids	Antifungal, Antibacterial, and Anthelmintic	
Maricha *(Piper nigrum)*	Volatile oils	Antibacterial	
Masha *(Vigna mungo)*	Mucilage	Suspending agent	
Milk Wood Pine *(Alstonia scholaris)*	Iridoids, coumarins, flavonoids, and steroids, alstonine, echitamine chloride, villalstonine, lupeol acetate, scholaricine, Strictamine	Antiviral activity equivalent to that of acyclovir	

Musta/ Nutgrass (Cyperus *rotundus)*	Oxo-isolongi folene, α-gurjunene, (z)-valerenyl acetate, α-salinene	Antibacterial Antifungal	
Neem (*Azadirachta indica)*	Neem oil contains limnoids (triterpenoids) such as nimbine, nimbinine, nimbidine	Insecticidal and antibacterial	
Netra *(Opuntia elatior*)	Betanin pigment, phenolic, flavonoids, flavonone, tannins, sterols, proteins, pectin, citric acid and vitamin C.	Anti-microbial	
Nirgundi *(Vitex negundo)*	Alkaloids (nishindin and hydrocotylene)	Insecticidal	
Nimbu *(Citrus aurantifolia),*	Ascorbic acid	Antibacterial	

Patala (*Stereospermum suaveolens Roxb.*),	Flavonoids, tannins, gyacosides	Antifungal, antibacterial	
Pippali *(Piper longum)*	Resin, piperine, piper longuminine, one terpenoid	Antibacterial and Anthelmintic	
Ramatha/Hingu (*Ferula assafoetida*)	Oleoresin gum	Antimicrobial	
Rajika *(Brassica nigra)*	Isothiocyanates	Antimicrobial	
Sarpi *(Sansevieria roxburghiana)*	Saponins, flavonoids, phenols, alkaloid, glycosides	Antibacterial Antifungal	

Sita *(Puraria tuberosa)*	Puerarin, daidzein, genistein, quercetin, irisolidone, biochanin A, B, isoorientin and mangiferin	Ant bacterial	
Shyonak (*Oroxylum indicum Benth)*	Stem bark and leaves contain flavonoids namely chrysin, oroxylin-A and baicalien, Ellagic acid. Root bark contains chrysin, baicalein, biochanin-A, and ellagic acid.	Antimicrobial	
Sweet Flag *Acorus calamus*	Beta-asarone, methyl isoeugenol and alpha-asarone, saponins, lecti ns, sesquiterpenoids, li gnans, and steroids.	Anti-insecticidal	
Tilah *(Sesamum indicum)*	Antioxidants and phenols (sesamol, sesamolin, and sesamin)	Antifungal and antibacterial	

Turmeric (*Curcuma longa*)	Curcumin	Pest repellent	
Vetiver *(Chrysopogon zizanioides)*	Esquiterpenes, Sesquiterpenols and Sesquiterpenones.	Termite repelling, prevent nematodes	
Vidanga (*Embelia ribes*)	Embelin	anthelmintic, antibacterial, and antifungal	

(Source: Nene,2014; Pandey *et al*. 2020).

Medicinal properties of other products used in *Vrikshayurveda*

Black mustard

Black mustard (*Brassica nigra*) seeds consist of the enzyme myrosinase while white mustard seeds (*Brassica alba*) consist of sinalbin. Both myrosinase and sinalbin possess the insect antixenosis attribute, which is a resistance mechanism of plants to prevent pest colonization. Additionally, they also possess antifungal, insecticidal, nematicidal, acaricidal properties. However, due to low volatibility, pungent quality and long-lasting residual effect white mustard is comparatively more preferred than its counterpart (Nene, 2012).

Honey

Honey is a well-known antimicrobial containing proline which induces systemic resistance in plants. It also contains increased levels of cytokinin and auxins. Usually, peptides that are rich in proline are potent antimicrobials. In the bee honey *apidaecin* is a unique peptide with antibacterial properties found in immune honeybee lymph (Nene, 2012). Honey caramelizes in high temperatures and results in the formation of flavor compounds/vapours including Diacetyl, Hydroxymethylfurfural (also found in milk) which have antimicrobial effects (Nene, 2014).

Milk

Milk contains various beneficial proteins like lactoferrin, lactogenin, alpha-lactalbumin, lactoglobulin, glycolactin and casein which promotes growth and development of florae. Milk also contains proline previously stated as a general disease resistance inducer in plant life. Additionally, the lactoferrin that is present in bovine milk has been found to possess antibacterial, antiviral, antifungal anti-nematode properties (Nene, 2012). While milk and curd contain proteins, fats and carbohydrates ghee mainly contains fats and burning of this material will release karrikins and acrolein. Karrikin is a substance that promotes growth of plants while acrolein has a microbial killing effect (Nene, 2014).

Neem

Neem (*Azadirachta indica*) is a bitter plant, and its bitterness is due to a variety of chemical compounds called limnoids also called limonoids. Nine limonoids have been identified in the neem seeds as Azadirachtin, Nimbine, Salanine, Salannol, Salannol acetate, diacetyl salanin, 14-epoxy azaradion, gedunin, D-acetyl nimbenin, with the most active compound being Azadirachtin. These compounds modify the biological processes of pests in such a way that they are not able to develop nor function in their normal manner. These include antifeedant, larval repellant, oviposition deterrent, effects on egg sterility, and growth and metamorphosis inhibiting effects. The neem bark contains antibacterial and insecticidal properties (Nene,2012.).

Hair, nails and horns

Hair, nails and horns contain keratin, which contains sulfur-containing amino acids that are beneficial in forming disulfide bridges that give additional strength and rigidity. Furthermore, fumigation of plants by the smoke of these material emits are sulfurous smell which controls diseases and repells pests (Nene,2012.).

Cow dung and Cow urine

Animal waste products such as cow urine and cow dung were also used extensively due to their properties. These waste products have various biologically effective compounds that facilitate the overall growth, development and protection of the plants. These include the many proteins, fats and carbohydrates present. The amino acids that make up proteins have various effects on plant protection, especially glycine and proline which are important for providing plant immunity in abiotic stress situations (Nene, 2014.). Abiotic stress are the negative impacts on the living organisms caused by non-living material like environmental extremes including drought, high and low temperatures. Additionally, cow's urine contains microorganisms that produce substances that have an antibiotic effect and exhibits an anti-microbial activity (Swaminathan, Nandhakumar, 2011.).

Furthermore, cow dung contains many micronutrients that are essential for plant growth including bile pigments, nitrogen, potassium and phosphorus (Nisar *et al*., 2017).

4. Conclusion and Recommendations

Various organic bio fertilizers, organic pesticides and organic remedies of plant and animal origin, mentioned in the *Vrikshayurveda* of ancient times can be used instead of the chemical fertilizers and pesticides to ensure the healthy growth and development of plants along with prevention of diseases and pest colonization. These methods are more beneficial than the use of chemical substances for same purposes, as it prevents the bio accumulation and bio magnification of heavy metals and chemicals along the food chain leading to chronic diseases in humans. Furthermore, bio fertilizers like *Kunapajala*, have been found to produce a high yield in plants. By adopting *Vrikshyurveda* classics in agricultural and medicinal plants, it will be possible to have drugs free from harmful chemicals, availability of potent drugs and more active principles, which can be easily accessed through modern technology. It will certainly promote the sustainable productivity of medicinal plants with value addition which will ultimately enhance the quality as well as production of raw material for ayurveda and traditional medicine. At the present context of the world, *Vrikshayuveda* classics are prime important to produce healthy growth and productivity of agricultural crops and medicinal plants to build ecofriendly and pollution and health hazards free environment. Therefore, this paper will enhance the knowledge of the present generation to adopt ancient wisdom of *Vrikashyurveda* classics for sustainable agricultural and medicinal plants productivity to provide safe food and medicine for the growing population.

5. References

Ankitha H, K., Vani, Joshi Pravin Kumar and Rout Om Prakash (2022). Cultivation practices of plants in classics of *Vrikshayurveda.* Book Review - International Research Journal of Plant Science, 13(5):56-78

Ankad G. M, Hiremath J, Patil R.T., Pramod H. J., Hegade H.V. (2017). Nutrient analysis of Kunapa Jala and Panchgavya and their evaluation on germination of Ashwagandha and Kalamegha seeds; a comparative study. Journal of Ayurveda Integrated Medicine. 9(1):13-19.

Ayangarya, Valmiki Sreenivasa. (2004). Herbal kunapa. Asian Agri-History, 8:315–317.

Ayangarya, Valmiki Sreenivasa. (2006). Mushika Kunapa. Asian Agri-History, 10:157–159.

Balasubramanian, A.V., Arumugasamy, S., Vijayalakshmi, K. & Subhashini, S. (2008), Plant products as Biopesticides: Building on Traditional Knowledge of *Vrikshayurveda*: Traditional Indian Plant Science.

Brageshwar, Joshi A.K., Dey, S. (2007). Effect of Kunapa Jala and fertilizers on Senna (Cassia angustifolia) Indian forester. 133:1235-1240

Bhandary, M.J. (2020) *Alstonia scholaris* in the ethnomedicinal and religious tradition of Coastal Karnataka, India. B io d i v e r s it a s 21 (4) :1569-1577. DOI: 10.13057/biodiv/d210438

De Silva, C.S. (2015). Shallow Groundwater use through Agro wells in the dry and intermediate zones of Sri Lanka and present health hazards. Water Resources Research in Sri Lanka. *Proceedings of the Symposium on Water Professionals Day*, Post graduate Institute of Agriculture, ISBN 978-955-1308-20-9, pp 31-42.

Hudar, N., Mahesh, C.D., Shivamanjunath, M.P., Pradeep, S. (2022), Vrikshayurveda: Ancient Science of Life of Trees. Journal of emerging technologies and innovative research. 9 (11):207-213.

ICAR (2003). Inventory of Indigenous Technological Knowledge in Agriculture: Document 2, Indian Council of Agricultural Research, New Delhi, pp.230-268.

Jeerankalagi A., T Biradar S., P Naik S., N Dhari D., S Pujari V. (2022). The relevance of Vrukshayurveda for organic cultivation of medicinal plants. Journal of Ayurveda and Integrated Medical Sciences. 7(1): 78-90

Mishra, R., (2017), Surapala Vrikshayurveda: A treatise on agricultural technology, *International Journal of Historical Insight and Research*. 3(2): 1-16.

Narayanan, R.S. (2006). Application of gunapajalam (kunapajala) as liquid biofertilizer in organic farms. Asian AgriHistory 10:161–164.

Natarajan, K. (2003). Panchakavya – A Manual. Other India Press, Mapusa 403 507, Goa, India. 32 pp.

Nene, Y.L. (2014), Fumigation of Plants in Vrikshayurveda. *Asian Agri- History*. 18 (1): 23-41

Nene, Y.L. (2012), Potential of Some Methods Described in Vrikshayurvedas in Crop Yield and Increase and Disease Management. *Asian Agri-History*. 16 (1), 45-54.

Nisar, S., Sridevi, V.H., Subrahmanya, R. and Rao, S. (2017), Vrikshayurveda- A Review, *International Journal of Ayurvedic and Herbal Medicine*. 7 (5): 2912-2914.

Sircar, N.N. (Tr) (1996). Vrksayurveda of Parasar:A Treatise on plant Science, Sri Satguru Publication, pp.45-55.

Pandey K, Shevkar C, Bairwa K. (2020). Pharmaceutical perspective on bioactive from Alstonia scholaris: ethnomedicinal knowledge, phytochemistry, clinical status, patent space, and future directions. Phytochem Rev. DOI: 10.1007/s11101-020-09662.

Sarngadhara Samhita (1984). Ancient Science of Life, Vol. IV, No.2 October 1984, Page110-111.

Sadhale, N., Nene, Y.L. (2009). Ancient Indian Traditional and Scientific Thought on Plants: Sir JC Bose and Vrikshayurveda. Asian Agri- History. 13 (2): 101-111.

Sadhale, Nalini (Tr.). (1996). *Surapala's Vrikshayurveda* (The Science of Plant Life by Surapala). Agri-History Bulletin No.1. Asian Agri-History Foundation, Secunderabad 500 009, India.

Shubhashree M. N., Matapathi, S. and Dixit, A. K. (2018). Conservation and preservation of medicinal plants leads from Ayurveda and Vrikshayurveda. International Journal of Complementary & Alternative Medicine. 11(5) 34-56.

Swaminathan, C., Nandhakumar, M. R. (2011). Vrikshayurvedic Farming- A Revisit and Review. Madras Agriculture Journal, 98 (4-6): 99-108