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Review Article

Vrikshayurveda –An ancient literature of liquid bio fertilizer preparation-a comparative review with modern perspective

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Abstract

Vrikshayurveda- is an ancient Vedic literature of India dealing with the agricultural practices of ancient India almost 1000 years ago. Several scholars of that period provided varied prescriptions regarding plant growth and development, plant protection, increased productivity etc. *Vrikshayurveda* was composed and compiled by several ancient authors from time to time during regime of various kings of greater India. This paper deals with three prescriptions of organic manure i.e., *Kunapajala*, *Panchagavya*, (the liquid biofertilizer) and *Panchamula* from the ancient literature and their formulations and nutritional analyses conducted by various modern researchers time to time. These organic manures improve the soil health and fertility, improve growth and development of crop plants and help to produce organic food free from unnecessary health hazards. Application of these liquid biofertilizers may decrease the amount of application of chemical fertilizers and their associated consequences in some extent though 100% replacement of chemical fertilization is not possible at this stage.

Keywords: *Vrikshayurveda*, *Kunapajala*, *Panchagavya*, *Panchamula*, liquid biofertilizer, green farming.

1. Introduction

Agriculture and plant diseases are inter alia with each other from the dawn of the human civilization. Ancient farmers were facing the problem of production loss due to the various biotic and abiotic stresses like pests, pathogens, scarcity of nutrition, environmental stresses etc. and they had adopted various organic methods to cope with these and to promote plant growth. We had learnt these traditional preparations from different ancient literature like- *Varahamitra*, *Brihat Samhita*, *Vrikshayurveda*, *Chavudaraya*, *Lilopakaran*, *Saragandhara* etc. Among these literature *Chavudaraya* contains most details of *Vrikshayurveda*. *Vrikshayurveda* literally meaning "Science of plant" compiled by several ancient authors from the time of Kautilya (296-321 BC) to 13th century AD. In '*Braht Samhita*' '*Vrikshayurveda*' was written by *Varahamihira*, in 1000 AD, *Surapala* composed *Vrikshayurveda*, in '*Lokopakara*' Chavundaraya (1025 AD) composed *Vrikshayurveda* in *Lokopakara*. Chaluky King Someshvardeva composed a chapter on *Vrikshayurveda* in the encyclopedia "*Abhilashitarthachitamani*" [1]. Among these all *Vrikshayurveda*, only one ancient copy which is known as *Surapala's Vrikshayurveda* still exists. This ancient copy was written on palm leaves and it is preserved at Oxford Bodleian Library [2].

2. Plant protection methods prescribed in the Vrikshayurveda

Ancient farmers used to apply plant- and animal-based fertilizer for plant protection and plant growth and for that they had used various plants extracts, organic matter of animal sources. Some examples of such plant species and other organic matter are given into the Table 1.

Table 1. Plant species and organic matters in plant protection in the ancient literature (*Vrikshayurveda*)

Literature	Plants Sources			Animal sources	Application
	Sanskrit name	Sce. Name	Family		
Lokopakara Chapter-VI	*Vayuvilanga*	*Embelia ribes Burm*	Myrsinanceae	Fish meat	Disease control
	Mahishakshi	*Commiphora wightii*	Burseraceae		
	Asisna	*Curma longa*	Zingiberaceae		
	Sasuve	*Brassica nigra*	Brassicacea		
	Mathi	*Terminalla tomentosa*	Combretaceae		
Brihat samihita Chapter-VI	*Vayuvilanga*	*Embelia ribes*	Myrisinaceae	Cow ghee, milk	Ulcers in affected tree

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Sarangadhara	*Vayuvilanga*	*Embelia ribes*	Myrisinaceae	Cow urine, Clarified butter	Pest control
		Mustard, sesamum			
	Honge	*Pongamia glabra*	Fabaceae	Cow's urine	Pest control
	Kakkagida	*Cassia fistula*	Caeslapiniaceae		
	Arishta	*Sapindus laurifolius*	Sapindaceae		
	Saptaparni	*Alstonia scholaris*	Apocynaceae		
	Vayuvilanga	*Embelia ribes*	Myrisinaceae		
	Tengamurte	*Cyperus esculentus*	Cyperaceae		
	Priyangu	*Setaria sp*	Poaceae	Boiled milk	Exudation from tree
	Arjuna	*Terminalia arjuna*	Combretaceae		

In *Vrikshayurveda* combination of several organic matters had been prescribed for the protection of plants from different pathogenic attack, antimicrobial activity, it had also promoted plant growth, flowering and fruiting etc. The most important prescriptions are: 1. *Panchagavya*, 2. *Kunapajala*, and 3. *Panchamula*.

1. Panchagavya

Cow is also known as 'Kamdhenu' or 'Goumata' since prehistorical time of Maharshi Vasistha. Cows not only provide us various products which are economically important, rather it is associated with our culture and rural livelihood [3]. Five organic products from cows are: i) cow dung, ii) curd iii) milk iv) ghee and v) cow urine, and in Sanskrit all these products are individually known as 'Gavya'. Maharshi Dhanvantari prepared a wonder medicine by using these five 'Gavya' which is collectively termed as '*Panchagavya*' which is available in our divine script 'Vedas'. This preparation had been used to protect plant against various diseases like Fusarium wilt and Panama disease of banana. In modern *Panchagavya* (MPG-3) yeast and common salt are added with the other five components, which is currently used in organic farming.

Preparation of *Panchagavya*

In our ancient literature like 'Vedas' '*Vrikshayurveda*' detailed method of preparation had not been mentioned clearly. Combination, doses and composition of different ingredients were standardized by different authors time to time to obtained optimal functionality of '*Panchagavya*' to plant growth and diseased resistance of different plant species.

Natarajan [4] prepared '*Panchagavya*' by mixing fresh Cow dung (7 kg), Cow's urine (10 L), Cow's milk (3L), Cow's curd (2L), Cow's ghee (1 kg), cane jaggery (3 kg in 3 L), tender coconut water (3 L) in a large container, followed by fermentation for 30 days.

According to the Selvaraj et al. [5] and Sarkar et al. [6] '*Panchagavya*' is prepared through the following methods:

In an 80L plastic container, 7 kg of cow dung and 1L of ghee were mixed and stirred thoroughly and kept for 3 days. After that 10 L of cow urine and 10 L of water added to the mixture and kept for 15 days. After 15 days 3 L of cow milk, 2 L curd, 1 L ghee, 3 L tender coconut milk, 3 kg of Jaggery and 12 number of well ripened macerated bananas were mixed and stirred twice daily for 30 days. After 30 days it was filtered through fine cloth and filtrated solution is ready for application.

Suchitra Rakesh et al. [7] made little modification in preparation of *Panchagavya*. They added 2 L of toddy or grape juice along with fresh cow dung (5 kg), cow's urine (3 l), cow's milk (2l), cow's curd (2l), cow's ghee (1/2 kg), jaggery (½ kg in 3 L of watet), tender coconut water (3 L) and ripe macerated banana (12 number). The procedure of preparation are as same as described by the Selvaraj et al. [5] and Sarkar et al. [6].

Nutritional composition of *Panchagavya*

Panchagavya made from various cow products is rich in various nutritional properties. Several authors' works on analysis of nutritional composition are available for *Panchagavya*. Nileema and Sreenivasa [8] reported that *Panchagavya* contains soluble salts (1.88 dsm-1), nitrogen (1000 ppm), phosphorus (175.40ppm), zinc (1.27 ppm), copper (0.38 ppm), iron (29.71 ppm) and total manganese (1.84 ppm) in considerable amounts. Chakraborty and Sarkar[9] analysed the micro- and macro-nutrients present in the *Panchagavya* and reported presence of N (2366 ppm), P (187 ppm), K (1354 ppm), Ca (152 mg/L), Mg (48mg/L), S (485 mg/L), Fe (9.17 mg/L), Mn (0.287 mg/L), Zn (0.268 mg/L), and Cu (2.18 mg/L). Parvathi and Ushakuamri [10] and Dhanoji

et al.[11] also reported considerable amount of N, P, K, Ca, Mg, S, Fe, Mn, Zn and Cu present in *Panchagavya*.

Biochemical component of *Panchagavya*

Considerable amount various plant growth regulators are also present in the *Panchagavya*. Chakraborty and Sarkar [12] reported presence of 4.45 µg/ml IAA, 26.76 µg/ml GA3 and 3.12 µg/ml Cytokinin. Presence of growth regulators are also reported by Parvathi and Ushakuamri [10] and Dhanoji *et al*. [11].

2. Kunapajala

Kunapajala or *Kunapambu*, literally meaning filthy fluid or fermented filth, is one of the oldest preparation of liquid manures prepared from the organic waste [12]. *Kunapajala* was the first attempt of production of fermented organic fertilizer in world agri-history [13]. The name *Kunapajala* was derived from two Sanskrit words '*Kunapa*' meaning smelling like dead body, corpse, and '*Jala*' meaning water [14]. The first report of Kunapajala preparation was found on *Surapala's 'Vrikshayurveda'* written around 1,000 AD in Eastern India and on '*Lokopakara*' compiled by poet Chavundaraya around 1,025 AD in Karnataka of South India [15] . Animal wastes like flesh, dung, urine, marrow and skin are used to prepare *Kunapajala* which contains basic nutrients like sugar, fatty acids, keratins, amino acids and macro- and micro-nutrients which promote plant growth and development.

Preparation of *Kunapajala*

Unlike *Panchyagavya* detailed preparation process and quantity of the different ingredients were not mentioned in our ancient literature like *Vrikshayurveda* or *Lokopakara*. *Lokopakara* mentioned about the beneficial role of the *Kunapajala* in plant growth and productivity only, but the preparation procedure was missing [14].

As per Nene [13] and Sadhale [1] following preparation method was mentioned in *Surapala's Vrikshayurveda* (verses-101-108) for preparation of *Kunapajala*:

Collection and storage of animal waste (like bone marrow, flesh, brain, blood, and excreta of dead boar) and mixed with water along with good amount of rice husk and boiled in an earthen pot. After boiling, it was stored underground. At the time of using the mixture was again cooked by adding with sesame oil cake, black gram soaked in water and honey, ghee etc. But the exact amount of each ingredient needed to prepare *Kunapajala* was not mentioned [16].

After 300 years of *Surapala's* method, another procedure of *Kunapajala* preparation was documented by Sarangandhara in '*Sarangadhara-paddhati*'. Here in a chapter '*Upavanavinoda*' Sarangandhara (a 'baidya' of King Hammira of Sakambhari-desa, currently known as Bundelkhand) described the method of *Kunapajala* preparation without giving details on the quantity of the ingredients [14, 16].

The procedure is as follows: Organic matter like flesh, fat, and bone marrow of animals like deer, pig, sheep, goat, rhinoceros etc., and fishes are boiled in water using a clay pot. Other ingredients like compound milk, sesame oilcake powder, and black gram boiled in honey, pulse decoction, ghee and hot water were mixed into the clay pot and after that the pot was kept in a warm place for 14-20 days.

Another prescription of *Kunapajala* preparation was obtained after 250 years of Saragandhara. This was given by Chakrapani (1577 AD) in his write-up '*Vishvavallabha*' where the preparation method is almost same as given by Saragandhara; only a new ingredient was added into the organic mixture which is animal skin along with the other organic matters [17].

To obtain optimum results on plant growth and development along with plant protection, exact dose and ingredients should be known for the fruitful formulation of any bio fertilizer. Our ancient scholars gave a pathway on green farming. According to the changing pattern of our agricultural system, degradation of biodiversity and environment, modern researchers made slight modification on formulation and preparation of *Kunapajala*. Following methods has been given by various present day researchers which are as follows:

Narayanan [18] used rat pieces (few), cow urine (3 L), cow dung (5 kg), sugar (500g), black gram (250 g), sesame (250 g), cow milk (1 L) and honey (100 ml).

Procedure: all the ingredients are mixed in a plastic container and stirred properly and fermented aerobically for 14 days. After fermentation the mixture is filtered with the help of fine mesh. The obtained liquid has ready for use and which has also called '*Rat Kunapa*'.

Ali et al. [15] used 1kg fish meal, 1 kg cow dung, 1 L cow urine and 2 L water.

Procedure: All the materials are mixed in a large container and kept for 25 days for fermentation. The mixture has stirred regularly twice a day. After 25 day the mixture has filtered with net or clean cloth to obtain the liquid fertilizer.

Nene [2] used 10 kg Bombay duck fish, 4 kg Sesame oilcake powder, 4 kg paddy husk, 4 kg molasses, and cow urine 30 L.
Procedure- all the organic matters are mixed in an 80 L container, and mixed thoroughly for 60 days. The mixture has kept in a shady place and the fermented materials are filtered through clean cloth and filtrate is used.

Jani et al. [19] used 3 kg fish and mutton, 2.5 kg honey, 6 L milk, 500 g sesame, 500 g black gram, 12 L water.
Procedure: in an earthen pot, fish and mutton is cooked with water and 6 L of meat juice is prepared and cooled. Then meat juice is kept into a porcelain jar. The jar is fumigated by using dried Guggule of Marica or Jatamansi before use. The milk, honey, sesame and black gram are added and the mouth of the jar is sealed with cloth and kept for 15 days for fermentation. After 15 days the solution is filtered and use.

Thakur [20] used water (5 L), fish/animal flesh (1 kg), milk (1 L), honey (500 g), and cow urine (1L) for preparation of *Kunapajala*.
Procedure- the procedure is as same as proposed by Narayanan [18].

Nene [21] prepared a basic formulation for making *Kunapajala* for making a start. He used animal flesh (fresh or stale) or Eggs (fresh or old) or Soybean meal or nuggets plus paneer or fish meal or paneer, marrow (crushed boons) or Tofu from soybean, rice husk or any grain husk, available oil cake, cattle dung, cattle urine, black gram, honey, ghee and milk.
Procedure- Cook animal flesh (2 kg), marrow (0.5 kg/ 1 kg), rice husk (1 kg), oil cake (1 kg) and black gram (0.5 kg) together in 5 L of water. After cooling the liquid has transfer to 200 L container and added cattle dung (10 kg), cattle urine (15 L), honey (0.25 kg), ghee (0.25 kg) and milk (1 L) with this. Water has added to the mixture and made it 100 L and stir the mixture twice a day for 1-3 months. After three months fine filtering will required before use.

Some worker has removed the animal waste for the making of *Kunapajala* and prepared herbal version of *Kunapajala*. The composition and procedure of making herbal *Kunapajala* is as follows:
Nene [22] prepared herbal *Kunapajala* which is also called as *Shasyagavya* by using cow dung, cow urine, weed or plant parts or vegetable wastes, and water.

Naik et al.[23] formulated herbal *Kunapajala* by using cow dung (20 kg), cow urine (20 L), sprouted black gram (urd), mustard cake, and crushed jaggery of 2 kg each, 20 L of water, milk 1 L, paddy husk.
Procedure: cow dung, cow urine, sprouted black gram, mustard cake and crushed jaggery and water are mixed into a plastic drum of 200 L capacity. Fresh nettle plants are chopped and mixed into the drum. Paddy husk is boiled in the water for 15-20 minutes and the water is filtered and mixed in the drum along with milk. All the components are then mixed thoroughly by using a wooden stick two times a day (morning and evening) for 20-25 days. The mixture is filtered after preparation and stored.

3. Panchamula

It is a combination of powdered mixture of dried roots of five plants viz., *Aegle marmelos* (bael), *Clerodendrum phlomides* (Agnimantha), *Gmelina arborea* (Gambhari), *Oroxylum indicum* (Sonapatha), and *Steteospermum suaveolens* (Padhal). All these plants have antifungal and antimicrobial activity. Among these plants Bael has antifungal, nematicidal and insect antifeedant properties; Agnimantha has antifungal, antiviral, antibacterial and insect antifeedant properties; Gambhari has antiviral properties, Sonapatha has antimicrobial properties; and Padhal has antifungal and antibacterial properties [2].

Significance of *Vrikshayurveda* in sustainable crop production and soil health maintenance

Indian agriculture has gradually become dependent excessively on chemical fertilizers with the cultivation of high yielding varieties since green revolution. Excessive application of chemical fertilizers is not only destroying the soil microbial environment, it increases chemical hazards which ultimately adversely affect our health and the ecosystem. On the other hand, traditional practices maintain the soil fertility without affecting the environments. Several worker has been working on application of *Vrikshayurveda* prescriptions in wide spectrum of crop plants. Sinha & Mishra [24] and Mishra [25] had prepared a liquid bio-fertilizer from *Brassica alba* extract and applied on a rice variety and reported positive results on growth parameters as well as yield attributing characters of Rice. Khan and Vashistha [26] had also reported positive effects of plant based growth stimulation in Rice yields. Several other workers like Sarkar et al. [27], Narayanan [28], Deshmukh et al. [29] Rajasree *et al.* [30], Swaminahan *et al.* [31] had worked on effects of *Kunapajala* and *Panchagavya* on different crop plants, vegetables and reported these bio-organic fertilizers enhanced the biological efficiency of these crops. The quality and quantity of fruits and vegetables were also increased after the application of these liquid bio-fertilizers. Along with crop improvement application of these liquid bio-fertilizers are also improved the soil microbial activity through increase biomass for the microorganism and it increase the water holding capacity of the soil. Though the production of these fertilizer is very cost effective, it will enhance the sustainability of

agriculture which is invariably associated with sustainable livelihood for small and marginal farmers. Integration of traditional practice in the modern agricultural system is very much important for the sustainability of our agricultural system.

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