Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 199-203
Received: 19-09-2018
Accepted: 21-10-2018

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Exploitation of *panchagavya*: A novel approach for the sustainable production of vegetable crops in Pindar valley of Uttarakhand

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Abstract
The greatest challenge facing by the nation in the coming years is to demand safe food for the growing population in the country. Inspired by this, organic farming which leads to improving the health of agro-ecosystem has gained wide detection as a valid alternative to conventional food products and confirms safe food for human consumption. Therefore, it is necessary to use natural products like panchagavya to produce chemical residue free food crops and hence panchagavya can play a major role in organic farming. The Pindar valley is encompassing an integral part of the Uttarakhand. The main feature of in this region is agricultural farming is carried out mainly on the by coarse, stony, undulating territory and narrow patches of terraced field. Under such circumstances, cultivation of sustainable vegetable production can help for the livelihood of the populace and can provide more employment to the unemployed youth of the valley.

Keywords: Panchagavya, Pindar valley, sustainable, agro-ecosystem and subsistence farming.

Introduction
Hilly area of Uttarakhand is the home for the cultivation of numerous vegetables, which are grown everywhere in all the geographical location. Diversity in vegetable farming can be seen in the entire regions. In terms of production, some areas are producing high quality of vegetables and at the same time, the quantity of vegetable production is enormous. The villages, which are in the highland, are exporting vegetables, particularly in the regional market and earning a high income. Most of the regions in the midland are producing vegetable domestically, while the environmental conditions are moderately suitable for their production. Most of the people depend on agriculture because of its economic and ecological importance. High yield is the aim of each farmer. Some people believe that chemicals alone could give the high yield. Frequently use of chemicals in agriculture has weakened the ecological base, in addition to degradation of soil, water resources and quality on foods. Soon the adoption of "Panchagavya" as a remedy to cure the ills of modern chemical agriculture, it is very much essential to develop a strong workable and compatible package of nutritional management through organic resources for various crops based on scientific facts, local conditions and economic viability. Panchagavya is a foliar nutrition prepared by organic growers, used widely for various agricultural and horticultural crops (Tharmaraj, 2011) [25].

What is Pindar valley and why it's suitable for sustainable production?
The Pindar valley comprises an integral part of the Uttarakhand. The main feature of in this region is agricultural farming is carried out mainly on the by rough, rugged, undulating terrain and narrow patches of terraced field. Subsistence vegetable & cereal farming is dominating in the entire farming system. The Pindar Basin provides a great scope for production of off-season vegetables. The vegetable farming varies from the valley regions to the mid-slope and highland according to terrain, slope, soil contents and availability of water. On the mid and highlands slope, a potato is grown extensively, while on the terraces of valley regions, onion is the main vegetable. Besides, almost all variety of vegetables is grown in the entire basin, which has high economic value. The vegetable farming can be divided into two vertical zones according to altitude (Sati, 2006) [28].

The need for vegetable farming in the basin
The Pindar Basin stipulates a great scope to produce sustainable vegetables. Because traditionally vegetable and cereal farming is the main profession of the people of the mountain regions. The economic feasibility of these crops is not enough even to assemble the two times

meal. Nature of terrain, an aspect of slope, soil fertility, availability of water and uses of technology in the field of agriculture are the main restraint for food security and sustainable development of the basin.

What is Panchagavya?

Panchagavya means "mixture of five products (cow dung, cow urine, milk, ghee, and curd) of the cow. Of these, the three direct constituents are cow dung, urine, milk and the two derived products are curd and ghee. It has been used in traditional Indian rituals throughout history. It is also called Cowpathy treatment based on products obtained from cows used in Ayurvedic medicine and of religious significance for Hindus. Panchagavya is also used as fertilizers and pesticides in agricultural operations. Panchagavya is an organic product recommended for the improvement in organic agriculture (Sangeetha and Thevanathan, 2010) [15]. In Sanskrit literature, Panchagavya means the blend of five products obtained from cow. Every one of these five products are called 'Gavya' and together termed as 'Panchagavya.' Panchagavya plays an important role in the quality of fruits and vegetables. It is used as a foliar spray, soil application along with irrigation, as well as a seed treatment (Natarajan, 2002) [9]. Farmers in South India practice panchagavya for sustainable agriculture. Use of chemical fertilizers and pesticides in agriculture fields led to environmental degradation and hence as an alternative to chemicals. Panchagavya is also being sought to improve crop establishment and health (Shakuntala *et al.* 2012) [19]. Natarajan (2002) [9] found that the present form of panchagavya is a single organic input, which can act as a growth-promoter and immunity booster. It is essentially a product containing 4 kg gobar gas slurry, 1 kg fresh cow dung, 3 litres of cow urine, 2 litres of cow's milk, 2 litres of cow's curd, 1 kg cow's ghee, 3 litres of sugarcane juice, 12 ripe bananas, 3 litres of tender coconut water, and 2 litres of toddy (if available). This will make about 20 litres of panchagavya. The concoction is stored in a wide-mouthed earthen pot or concrete tank in open. Enough shade should be provided, and the contents should be stirred twice a day, both in the morning and the evening. In seven days, the modified panchagavya will be ready, and it can be diluted before use on plants and animals. Panchagavya is used in different means such as foliar spray, soil application along with irrigation water, seed or seedling treatment etc. Cow dung acts as a medium for the growth of beneficial microbes. Milk provides protein, fat, carbohydrate, amino acid and calcium. Curd provides lactobacillus which acts as a catalyst in the digestion of organic wastes. Ghee provides vitamin A and B, calcium and fat (Saritha and Vijayakumari, 2013) [16]. Cow urine has many beneficial properties particularly in the areas of agriculture and therapeutics. Cow urine contents are water 95%, urea 2.5%, minerals, salt, hormones, and enzymes 2.5%. It is also contains iron, calcium, phosphorus, salts, carbonic acid, potash, nitrogen, ammonia, manganese, iron, sulphur, phosphates, potassium, urea, uric acid, amino acids, enzymes, cytokine, and lactose etc. (Bhadauria, 2002) [3].

How to Prepare Panchagavya Solution.

Prabhu (2009) prepared panchagavya by using the ingredients *viz.*, cow dung (5 kg), cow urine (3 litre), cow's milk (2 litre), curd (2 litre), ghee made from cow milk (1 litre), sugarcane juice (3 litre), tender coconut water (3 litre) and ripened banana (12 Nos). All the above substrates were added to a wide-mouthed mud pot and kept open under shade. The contents were stirred twice a day for about 20 minutes both in the morning and evening to facilitate the aerobic microbial activity. Similarly, modified preparation of panchagavya was reported by Sangeetha and Thevanathan (2010) [15]. It was prepared from seaweed based panchagavya is a containing the aqueous extract of the alga, *Sargassum wightii*. The preparation contained cow dung 5.0 Kg, cow urine 3.0 litres, cow milk 2.0 litres, cow curd 2.0 litres, cow ghee 1.0 Kg, sugarcane juice 3.0 litres, tender coconut water 3.0 litres, banana 12 Nos, yeast powder 100g, jaggery 100g and 2.0 litre of water. The above composition gives approximately 20.0 L of panchagavya. Cow dung and cow ghee were mixed together in a 25.0 L concrete pot and kept for 3 days with intermittent stirring to exhaust methane gas. On the fourth day all the other ingredients were added to the cow dung - ghee mixture along with spores of *Lactobacillus sporogenes* (one SPOROLAC tablet having 60 million spores/tablet) and mixed thoroughly. The mouth of the container was covered with a thin cloth and kept in the open in shade. This mixture was stirred twice every day and after 18 days, 5.0 g of the algal extract residue was added to the preparation and used in experiments. Algal extract residue was prepared by extracting 100.0 g of shade-dried *Sargassum wightii* with 5.0 litres of boiling water for 30 minutes. The extract could cool, filtered through a layer of muslin cloth and dried in vacuo and the dry residue was used. The panchagavya is diluted to three percent and sprayed on crops to get the best results.

Physiochemical and Biological Properties of Panchagavya

Panchagavya contains many macronutrients, essential micronutrients, vitamins, essential amino acids and growth promoting factors like IAA, GA and beneficial microorganisms (Natarajan, 2007 and Sreenivasa *et al.* 2010) [8, 22]. Besides these, growth regulatory substances such as Indole Acetic Acid (IAA), Gibberellic Acid (GA3), Cytokinin and essential plant nutrients from panchagavya influence on the growth rate in *Allium cepa* and panchagavya at 30 days of age recorded better proposition of chemical and microbial composition favourable for utilization as a growth promoter and panchagavya did not have direct antibacterial activity. Mathivanan *et al.* (2006) [7] reported that panchagavya contains growth regulatory substances that help in the development of integrated pest management (IPM) such as IAA, GA, Cytokinin, essential plant and organic farming nutrients and effective microorganisms (Vallimayil, 2012) [26]. Similarly, Papen *et al.* (2002) [11] found that the presence of macro (N. P, K and Ca) and micro (Zn, Fe, Cu, Mn) nutrients besides total reducing sugars (glucose) in panchagavya. Chemolithotrophs and autotrophic Nitrifiers (Ammonifiers and nitrifiers) present in panchagavya which colonize in the leaves increased the ammonia uptake and enhance the total N supply. Effective Micro-Organisms (EMO) in panchagavya were the mixed culture of naturally occurring, beneficial microbes' mostly lactic acid bacteria (Lactobacillus), yeast (Saccharomyces), Actinomyces (Streptomyces), photo synthetic bacteria (Rhodopsuedomonas) and certain fungi (Aspergillus) (Xu, 2001; Swaminathan, *et al.*, (2007). (Mathivanan *et al.*, (2006) [7, 24, 29] observed the pH of panchagavya was lowered to 4.52 at 30 days of fermentation and this might be due to Lactobacillus bacteria in panchagavya, which produced more acids that are organic during fermentation. The total volatile fatty acids (TVFA) were higher at 30 days of fermentation. The Coliforms, Streptococci and Staphylococci counts were not in a detectable range. Panchagavya also contains bio fertilizers such as Azospirillum, Azotobactor, Phosphobacteria, and

Pseudomonas were found beside Lactobacillus in panchagavya (Yadav and Lourduraj, 2005).

Objectives of Panchagavya are

- To maintain the genetic biodiversity of the crop and the environment.
- To encourage the biological cycles within the farming system by using microbe
- To promote the sustainable use of natural resource.
- To maintain the ecological balance between crop production and livestock
- To assess the efficiency of panchagavya in vegetable crops.
- To produce high-quality yield in enough quantity by using panchagavya.

Panchagavya as a growth promoter

Studies have shown increased yields where the farmer has used organic practices (Ramesh *et al.,* 2005) [14] in crops like chilli, moringa (Beaulah *et al.,* 2002) [2], green gram (Somasundaram *et al.,* 2003) [21] and French bean (Selvaraj, 2003) [17]. It can be concluded that panchagavya as an organic growth-promoter for small and marginal vegetable growers (Boomathi, 2006) [4].

Effect of Panchagavya spray on growth parameters

Xu (2001) [29] examined that the Effective Micro Organism (EMO) cultures could synthesize phytohormone i.e., auxins and other growth regulators that stimulated maize plant growth and they contained proactive substances that could significantly affect leaf stomatal response in maize. Leaf stomata of the EMO treated maize opened more rapidly than water treated control plants and when leaves were subjected to dehydration, the stomata closed more slowly (i.e., remained open longer) thus showed that EMO contained bioactive substances that could have significantly affected leaf stomata response and led to increased LAI. The panchagavya is rich in such EMOs.

Vennila *et al.,* (2008) [27] investigated that application of 100% recommended a dose of fertilizer along with panchagavya spray (2%) significantly increased the okra plant height (131.7 cm) and dry matter production (5.90 g plant -1). Panchagavya was tested for different crops such as turmeric, paddy, onion, ginger, sugarcane, banana, vegetables, and curry leaf and it was found that it enhanced the growth, vigour of crops, resistance to pest and diseases and improvement of keeping the quality of vegetables and fruits (Natarajan, 2002) [9]. Biogas slurry with panchagavya combination is adjudged as the best organic nutrition practice for sustainability of maize sunflower-green gram system by its overall performance on growth, productivity, quality of crops, soil health, and economics Somasundharam *et al.,* (2007).

Effect of Panchagavya of quality, Yield and Yield Attributing traits

Ali *et al.,* 2011 [1] observed that the effect of panchagavya on the yield of green gram (*Vigna radiata*), chilli (*Capsicum frutescence)* and mustard (*Brassica campestris)*. Their efficacy was compared by studying the yield contributing characters like plant height, primary branch, secondary branch per plant, number of seeds per fruit, fruit length, the weight of seed, yield per plant, yield per m^2 and the all observation found that the higher than the control. Gore and Sreenivasa, 2011 [11] to investigate that the influence of liquid organic manures *viz*., Panchagavya, Jeevamruth, and Beejamruth on the growth, nutrient content and yield of tomato and found that the panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate biological reactions in the soil and to protect the plants from disease incidence. In the present study, significantly highest plant growth and root length were recorded with the application of RDF + Beejamruth + Jeevamruth + Panchagavya and it was found to be significantly superior over other treatments. The application of Beejamruth + Jeevamruth + Panchagavya was next best treatment and resulted in significantly highest yield as compared to RDF alone. The N, P and K concentration of plants was significantly highest in the treatment given RDF + Beejamruth + Jeevamruth + Panchagavya. Gayathri *et al.,* (2015) [6] the present study was condected on the growth of plants such as tomato, French beans and lady's finger using panchagavya. Panchagavya was prepared and it was initially used to soak the seeds. Later, the germination percentage was observed. The germination percentage was found to be higher in seeds treated with Panchagavya solution than the control seeds. The morphological characters such as a number of leaves shoot length and root length was measured in plants treated with different concentration of Panchagavya solution (5%, 6%, 7%, and 8%). As the concentration increased, the values also increased accordingly in all the tested plants.

An experiment was conducted by Sreenivasa, *et al.,* 2010 [22] to study the effect of different organic liquid manures on the growth, yield and quality of chilli. The population of bacteria, fungi, actinomycetes, phosphate solubilizing microorganisms and nitrogen fixers were enumerated from the soil samples of chilli field at the initial stage and at harvest stage. The numbers of fruits per plant and chilli yield were significantly highest in treatment 9 (RDF + Panchagavya + Jeevamrutha + Beejamrutha) as compared to treatment 1 (only RDF). These results indicated that the integrated use of organic manures and chemical fertilizers has a better effect on crop yield. This study clearly brought out the beneficial effects of organic liquid manures in terms of soil biological activities and quality of chilli.

Effect of Panchagavya on Plant protection and economics

Ramesh *et al.* 2015 [13] to investigate that the influence of organic and inorganic fertilizers on growth yields and early blight disease of tomato. The spray of panchagavya resulted showed less incidence of early blight (22.80%) followed by vermicompost (5 t ha-1), RDF and sprays of panchagavya. Various quality parameters like titrable acidity, soluble solids and shelf life of tomato were also recorded from each treatment.

Francis and Smith, 2006 [5] is calculated that the benefit-cost to farmers was greatest when panchagavya was used as a growth promoter and proved as the cheapest, while Amrit Pani and Bokashi were the costliest alternative input and higher net returns and B: C ratio were evidenced when panchagavya was included in the nutrient management strategies in crops like rice, green gram, and black gram (Swaminathan, *et al.* 2007) [24]. The cost of production of a litre of panchagavya is around Rs. 35, and it can be brought down substantially if the farmers use their own cows' products.

Effect of Panchagavya on nutrient uptake

Beaulah, 2002 [2] reported that the secondary and micronutrients (Ca, S and Fe), macronutrients (NPK) contents of leaves and pods of annual moringa were superior under

poultry manure + neem cake + Panchagavya treatments. Higher nutrient uptake and nutrient use efficiency in both main and ratoon crops of annual moringa were also observed. Similarly, the quality parameters *viz.,* crude fibres, protein, ascorbic acid, carotene content and shelf life were also higher under organic manure applied with Panchagavya spray.

Conclusion

The increasing anxiety for environmental safety and global demand for pesticide residue free food has suggested a keen interest in crop production using eco-friendly products do not leave any harmful toxic residues besides conserving nature. Panchagavya is the best technique to residue free crop productions it contains huge amount macro, micro, growth hormones, and pesticidal properties to produce the chemical free product. Therefore, educating people about the benefits of Panchagavya can provide the solution to problems of shortage of food grains, fuel, nutrition and soil health and an alternate source of energy. Further research identifying optimal combinations for specific agro-ecological and farming systems is needed.

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