International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(3): 2741-2746

Received: 25-03-2019
Accepted: 27-04-2019

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Panchgavya: Cow-based bio-enhancers and botanicals for organic farming

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Abstract
The current global scenario firmly emphasizes the need to adult eco-friendly agricultural practices for sustainable agriculture. Chemical agriculture has made an adverse impact of the health-care of not only soil but also the beneficial soil microbial communities and the plants cultivated in these soil. This eventually has led to a high demand organic produce by the present day health conscious society and sporadic attempts are being made by farmers all over the world to detoxify. The land by switching over to organic farming dispenses with chemical fertilizers, pesticides, fungicides and herbicides. In India, organic farming was a well-developed and systematized agricultural practice during the past and this "ancient wisdom" obtained through Indian knowledge systems such as Vedas, specify the use of Panchagavya in agriculture. The increasing concern for environmental safety and global demand for pesticide residue free food has evoked keen interest in crop production using eco-friendly products which are easily biodegradable and do not leave any harmful toxic residues besides conserving nature. So 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.

Keywords: Panchgavya, organic farming, sustainable agriculture

Introduction
Recognizing the adverse impact of excessive use of chemicals on soil health, human health and environment, Government of India promoting organic farming through various schemes and projects like **"**Demonstration, Development and Awareness Programme of organic Farming in South Gujarat Region". Organic farming has been included as special category of farming in the National Agriculture Policy approved by the Government of India during 2000. Recently the Government of Gujarat declared "Gujarat Organic Farming Policy-2015" to support scientifically evolved organic farming practices for sustainable farming system along with the trustworthy marketing and supply chain of the produce. It is aimed to promote technically sound, economically viable, environmentally non-degrading, and socially acceptable use of natural resources in favour of organic agriculture. The policy seeks to actualize the area and crop potential for organic farming, sustaining soil fertility, conserving bio-resources, strengthening rural economy, promoting value addition, accelerating the growth of agro-business and securing a fair standard of living for the farmers and agricultural workers and their families.

Panchagavya is an organic product derived from five products evolving from cow, and it has been used in Indian medicine since time immemorial. ``I have modified this Panchagavya by adding a few more ingredients and the modified version has a lot of beneficial effects on a variety of crops and livestock", said Dr. K. Natarajan, President of the Rural Community Action Centre (RCAC), a non-governmental organization, actively engaged in promoting the concepts of organic farming and biodiesel in the rural areas of Tamil Nadu. An allopathic medical practitioner with deep conviction in ecological farming and sustainable agriculture, Dr. Natarajan combined his traditional knowledge and wisdom on the value of cow's products and medicinal herbs to develop this Panchagavya. He has done extensive research with his Panchagavya on various crops, animals and even earthworms. His findings have been validated by leading research institutes in the country, and he was awarded the prestigious "Srishti Sanman" by a leading developmental organization in Ahmedabad. The literatures on Vedic (Vrkshayurveda) depict organizations of the practices that the farmers practice Panchagavya at field level. It has a place, in a theoretical framework and also has certain plant

growth stimulants. National Centre for Organic Farming and National Horticulture Mission included such cow-based bio-enhancers in package of practices for organic cultivation of different crops.

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 seed treatment (Natarajan, 2002) [19]. 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) [31]. In India, organic farming was a well-developed and systematized agricultural practice during the past and this "ancient wisdom" obtained through Indian knowledge systems such as Vedas, specify the use of Panchagavya in agriculture. Panchagavya is a foliar nutrition prepared by organic growers of Tamil Nadu and widely used for various agricultural and horticultural crops. In Sanskrit, Panchagavya means a combination of five products obtained from cow. When suitably mixed and used, these have miraculous effects. In the present study a preliminary attempt has been made to find out the effect of Panchakavya spray on the growth, biochemical and yield parameters of *Abelmoschus esculentus* (L.) Moench. Panchagavya is a bio promoter with a combination of five products obtained from the cow *viz.*, dung, urine, milk, curd and ghee.

Panchagavya acts as growth promoter (75%) and immunity booster (25%) and exactly fills the missing link to sustain the organic farming without any yield loss (Vedivel, 2007) [39]. Biochemical properties of panchagavya revealed that it contains almost all the major nutrients like N, P, K and micronutrients necessary for plant and growth hormones like Indole acetic acid (IAA) and Gibberalic acid (GA) required for crop growth as well as the predominance of fermentative microorganisms like *yeast, azotobacter, phoshobacteria* and *lactobacillus* (Selvaraj, 2003) [30]. Conventional agriculture has made an adverse impact on soil and plant health. This eventually, leads to high demand for organic farming to protect soil and plant health. Organic farming in recent years is gaining impetus due to realization of inherent advantages as it confers in sustaining crop production and also in maintaining dynamic soil nutrient status and safe environment (Lokanath and Parameshwarappa, 2006) [14].

Effect of Panchgavya on Various Parameters

1. Effect on Growth Parameters

Two sprays of panchagavya in sesame at 30 DAS and flowering stage recorded significantly highest total dry matter production and growth parameters, number of capsule per plant (18.13), seed weight per capsule (0.13 g) and seed yield/ha (239kg/ha) over no spray of panchagavya and was on par with one spray of panchagavya at 30 DAS, which further did not differ significantly with no spray of panchagavya (Ravusaheb, 2008) [24].

Sadar *et al.* (2009) [25] reported that 4% panchagavya seed treatment was proved to be significant in improving the seed germination (83%), root length (10cm), shoot length (24cm) and seedling vigour index (2,822) in soybean over un-inoculated control as (50%, 2cm, 13cm and 300) due to its beneficial effect as a plant growth promoter in crop plants.

Sunil *et al.* (2012) [34] revealed that foliar application of panchagavya and plant leaf extracts exhibited significant effects on crop growth, seed yield and yield attributes in cumin. Plant height (32.71 cm), branches per plant (9.45), umbels per plant (24.73) and seeds per umbel (22.65) increased significantly with application of neem + panchagavya. Compared to control, neem + panchagavya increased seed, straw and biological yield by 58%, 72% and 65% respectively. This is due to increase in chlorophyll content, nitrate reductase activity and supply of all required plant nutrients.

Saritha *et al.* (2013) on 60th and 90th day number of leaves (4.34 ± 2.3 and 10 ± 1.4), root length (21.23 ± 3.8 cm and 23.27 ± 5.6 cm), root volume (0.87 ± 0.09 and 2.10 ± 0.9), fresh weight (7.82 ± 1.45 g and 19.97 ± 2.5 g) and dry weight (1.09 ± 0.09 g and 4.42 ± 1.4 g) respectively were improved by panchagavya foliar spray compared to control in cluster bean due to supply of major and micro nutrients and growth hormones like indole-3-acetic acid and Gibberelic acid by panchagavya.

Thamaraisevi (2001) [37] observed that the rose cultivars Edourd and Red rose, a treatment combination of calcium acetate 0.5% + Panchagavya 5% proved to be effective in improving the growth of the bush (48.88 cm and 84.86 cm) in both the cultivars on 30th and 60th days in cv. Edourd rose and cv. Red rose, respectively.

Jayashankar *et al.* (2000) reported that a foliar spray of 3% panchagavya on field bean increased the flowering and fruiting substantially after a week period.

Panchal *et al.,* (2017) [23] found that foliar spray of *panchagavya* @ 4% at branching + flowering stage recorded maximum values of number of root nodules per plant (15.67) and fresh and dry weight of root nodules (157.67mg and 52.67mg, respectively) per plant The increase in number of root nodules per plant, fresh and dry weight of nodules per plant might be due to the better availability of nutrients. The IAA and GA present in *panchagavya* when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system ultimately stimulated the necessary growth and development.

Somasundaram *et al.* (2003) [32] reported that green gram with panchagavya foliar spray @ 3% had higher number of pods per plant (79.25) and 100 grain weight (3.99g) than recommended dose of fertilizers (76.75 and 3.87 respectively).

Balkrishnamurthy *et al.* (2006) [4] undertook to find out the effect of different bio regulants on turmeric variety BSR-2 and revealed that application of panchagavya 3% recorded highest growth parameters like plant height (141.99cm), number of tillers (3.67), leaf length (60.55cm), leaf breadth (17.54cm) and stem girth (10.04cm) followed by panchagavya 3% spray over control (110.83, 2.67, 39.51, 12.87 and 8.32cm, respectively).

Sangeetha and Thevanathan (2010) [27] studied the effect of foliar application of seaweed based *panchagavya* on leaves of seedling of the pulses viz., *Vigna radiata*, *Vigna mungo* and *Arachis hypogea*. An application of *panchagavya* @ 3% brought increase in the root nodule formation.

Anuja, S and Vijayalakashmi, C.N. (2014) recorded that the application of FYM @ 25t/ha and vermi compost @ 5t/ha along with *panchagavya* 3 per cent foliar spray increased plant height 46.10 cm in season 1 and 43.20 cm in season 2, respectively.

Vennila *et al.* (2008) [40, 41] revealed that application of 100% recommended 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 $^{-1}$).

V.N. Maheswari *et al.* (2016) [38] found that better effect was found in 10:3% vermiwash and panchagavya treated plot in which, the diameter of the internode was increased to 7.64 mm after 90 days.

Vimalendran Loganathan and K. Wahab (2014) [42] studied the experimental treatments, application of 100% recommended dose of fertilizer along with four sprays of three per cent panchagavya at 15, 25, 35 and 45 DAS recorded the tallest plants of 188.2, 199.0 cm during first and second seasons, respectively.

Vimalendran Loganathan and K. Wahab (2014) [42] found that highest leaf area index of 5.55 and 5.77 was recorded under 100% RDF + 4 times spray of 3% Panchagavya. Leaf expansion due to the presence of growth regulators such as IAA, GA, *etc.* in panchagavya might enhanced the Leaf Area Index which produced bigger leaves as experienced by Natarajan (2002) [19] in vegetables and legumes.

Carol Lyngdoh *et al.,* (2017) [7] was conducted a field experiment at Horticulture farm, Department of Horticulture, SHUATS, Allahabad. The experiment consisted of two Bulky organic manures (FYM and Vermi compost), two liquid organic supplements (Fish Amino Acid (FAA) and Panchagavya) and Bio fertilizers [*Rhizobium* and Phosphate Solubilizing Bacteria (PSB)]. The result revealed that treatment T_{14} (Vermi compost + Fish Amino Acid + Panchagavya + Bio fertilizers) was found to be best in terms of plant height (56.17 cm), number of leaves (57.07), number of branches (28.93), number of root nodules (21.73), length of pods (36.84cm), width of pods (0.69cm), days of germination (3.3) followed by T_{13} (Vermi compost + Panchagavya + Bio fertilizers) with plant height (56.04cm), number of leaves (56.93), number of branches (27.67), number of root nodules (20.37), length of pods (36.19cm), width of pods (0.66cm), days of germination (3.7).

2. Effect on Yield Parameters

Two sprays of panchagavya in sesame at 30 DAS and flowering stage recorded significantly highest total dry matter production and seed yield/ha (239kg/ha) over no spray of panchagavya and was on par with one spray of panchagavya at 30 DAS, which further did not differ significantly with no spray of panchagavya (Ravusaheb, 2008) [24].

Vimalendran Loganathan and K. Wahab (2014) [42] found that the highest fodder yield of baby corn is observed in the 100% RDF + spray of 3% Panchagavya at 15, 25, 35 and 45 DAS (31.78 and 33.37tha^{-1}) in both the years, respectively.

Mohanalakshmi (2008) [17] revealed that application of poultry manure (5 t ha^{-1}) + Panchgavya (3%) in aswagandha exhibited significantly superior performance by registering the highest root yield of 1354.50kg ha^{-1}.

Vennila *et al.,* (2008) [40, 41] revealed that application of 100 per cent recommended dose of fertilizer along with panchagavya spray (2%) significantly increased the longest pod (16.72cm), pod number per plant (14.53), pod yield per plant (293.75g) and fruit yield (79q ha^{-1}) of okra.

Kanimozhi (2003) [12] revealed that application of Panchagavya at 4 per cent spray was found to be superior in respect of root yield (2.5times kg/plot) when compared to control in *Coleus forskohili.*

Panchal *et al.,* (2017) [23] found that foliar spray of *panchagavya* @ 4% at branching + flowering stage recorded the maximum seed yield (2054 kg/ha) and stover yield (2483 kg/ha). This might be attributed to the favorable effect on vegetative growth, *i.e.* plant height and reproductive growth parameters. These findings are in the line with those reported by Kumawat *et al.* (2009) [13].

Vimalendran Loganathan and K. Wahab (2014) [42] found that the highest yield of baby corn is observed in the 100% RDF + spray of 3% Panchagavya at 15, 25, 35 and 45 DAS (7439 and 7476Kg ha^{-1}) in both the years, respectively. This might be due to adequate supply of nutrients at different growth stages of the crop as well as presence of growth regulators in Panchagavya contributing to higher cob yield (Sridhar *et al.*, 2001) [33].

Anuja, S and Vijayalakashmi, C.N. (2014) [2] recorded that the application of FYM @ 25t/ha and vermicompost @ 5t/ha along with *panchagavya* 3 per cent foliar spray increased yield of 6.75t ha^{-1} in season 1 and 6.22t ha^{-1} in season 2, respectively.

Carol Lyngdoh *et al.,* (2017) [7] was conducted a field experiment at Horticulture farm, Department of Horticulture, SHUATS, Allahabad. The experiment consisted of two Bulky organic manures (FYM and Vermi compost), two liquid organic supplements (Fish Amino Acid (FAA) and Panchagavya) and Bio fertilizers [*Rhizobium* and Phosphate Solubilizing Bacteria (PSB)]. The result revealed that treatment T_{14} (Vermi compost + Fish Amino Acid + Panchagavya + Biofertilizers) was found to be best in terms of number of pods per plant (37.70), number of seeds per pod (14.10), pod weight (17.63), pod yield (254.03 q/ha) (4.7) followed by T_{13} (Vermi compost + Panchagavya + Bio fertilizers) with number of pods per plant (37.17), number of seeds per pod (13.93), pod weight (17.10), pod yield (240 q/ha).

Patel *et al.* (2013) [21] studied the effect of panchagavya on growth and yield of cowpea at Agronomy Instructional Farm, C P College of Agriculture, SDAU, Sardarkrushinagar during summer 2011. The treatment T6 (Foliar spray of Panchagavya 3% at 20 & 40 DAS) found to be superior and recorded maximum dry matter accumulation, 38.73g, 66.67g and 92.00g at 30 DAS, 60 DAS and at harvest in that order. Similarly, the foliar spray of Panchagavya 3% at 20 & 40 DAS recorded highest seed yield per plant (8.33g), seed yield (1509kg/ha) and stover yield (2373kg/ha) was also recorded under this treatment. Therefore, it was recommended for the cowpea growing farmers of Gujarat for getting maximum seed as well as stover yield that foliar spray of Panchagavya @ 3% should be followed two times, once at vegetative stage (20 DAS) and second at flowering stage (40 DAS) along with seed treatment of Rhizobium culture, as the positive effect of Panchagavya was noticed on growth and yield parameters in cowpea.

Swaminathan *et al.* (2007) [35, 36] found that application of Panchagavya at 3% as foliar spray on 15, 25, and 40 days after sowing (DAS) on black gram recorded the highest grain yield of 1195kg/ ha.

Gopal *et al.,* (2017) [9] showed that the application of panchagavya 4% gave higher seed yield (801kg ha^{-1}), straw yield (1735kg ha^{-1}), biological yield (2536 kg ha^{-1}) of black gram over the control, 2%, 6%, 8% and 10% panchagavya and indigenous panchagavya 2%.

3. Effect on Quality Parameters

Beaulah *et al.* (2002b) [5] reported that the organic manure applied with *panchagavya* as spray the quality parameters *viz.* protein, crude fiber, ascorbic acid and carotene content in annual moringa were also higher.

B. Vijayakumari *et al.,* (2012) [3] found that among all the treatments, protein contents and ascorbic acid were maximum

in T_3 treated seeds (Panchagavya 10% + Humic acid 2% + Micro herbal) fertilizer as 1.37 and 0.72 mg g^{-1}, respectively.

The presence of auxin in panchagavya controls the water regulation in developing fruits of okra. Regular and uniform water supply to the developing fruits resulted in increased ascorbic acid content, Barletts index and crude protein content (Vennila and Jayanthi, 2008) [40, 41]. Therefore, it is now considered as an efficient plant growth stimulant.

Fazulla and Sajjan (2017) [8] found that organic foliar spray of 3% panchagavya recorded significant difference in protein content percentage (23.11%). This might be due to enzymatic activity of nitrate reductase and glutamate synthase results in higher protein content percentage.

Sailaja *et al.* (2014) [26] studied the effect of foliar and soil application of panchagavya on growth and development of leafy vegetable *Spinacia oleracea* and revealed that soil application 10% panchagavya solution was increased organic carbon (21.45±3.7), Moisture content (26.4±4.56), TVC (470±57.90), Total Rhizobial Count (235±23.87), Total Azospirillum Count (112±14.6), IAA (0.879±0.029 mg/Kg), GA_3 (0.984±0.022mg/Kg), Abscisic acid (0.957±0.044mg/Kg) and p^H (7.0±0.03) followed by control with organic carbon (7.83±1.2), Moisture content (8.7±1.23), TVC (175±27.78), Total Rhizobial Count (85±9.45), Total Azospirillum Count (62±23.2), IAA (0.469±0.12 mg/Kg), GA_3 (0.564±0.13 mg/Kg), Abscisic acid (0.810±0.09 mg/Kg) and p^H (5.3±0.02).

4. Effect on Anti-fungal activity

Jandaik and Sharma (2016) [10] have recently reported the antifungal activity of panchagavya against three pathogens *Rhizoctonia solani*, *Fusarium oxysporium* and *Sclerotium rolfsii*. In their study, panchagavya exhibited antifungal activity against all the three pathogens at three different concentrations *ie* 5, 10 and 15%. However, 15% concentration was most effective and exhibited 82% of inhibition against *F. oxysporium*.

Interestingly, panchagavya had the highest population of total bacteria, *actinomycetes, phosphate solubilizers, pseudomonads fluorescent* and *nitrifiers.* In addition, dehydrogenase activity and microbial biomass carbon were also found to be higher in panchagavya (Amalraj *et al.* 2013) [1].

Sangeetha, V and Thevanathan, R (2010) [28] found that increasing the concentration of panchagavya resulted in concomitant increases in the activity of glutathione peroxidase of the seedlings exhibiting positive correlation between the two Seedlings that received 3% panchagavya treatment recorded 12 to 20% more activity for the enzyme than that of the respective control seedlings.

5. Effect on Soil physical, biological and chemical properties

B. Vijayakumari *et al.,* (2012) [3] found that The N, P, K content of the soil before the experiment was 67, 6.2 and 180 kg ha^{-1} and in the post harvested soil more content of NPK was observed in T_3 (Panchagavya 10% + Humic acid 2% + Micro herbal fertilizer 10 g per pot) treated soil as 88, 8.6 and 325 kg ha^{-1}, respectively.

Effective Micro Organisms (EMO) in panchagavya were the mixed culture of naturally occurring, beneficial microbes' mostly lactic acid bacteria (Lactobacillus), yeast (*Saccharomyces*), actinomyces (*Streptomyces*), photosynthetic bacteria (*Rhodop suedomonas*) and certain fungi (*Aspergillus*) (Xu, 2001; Swaminathan, *et al.* (2007) [35, 36].

Presence of macro (N. P, K and Ca) and micro (Zn, Fe, Cu, Mn) nutrients besides total reducing sugars (glucose) in panchagavya. Chemo lithotrops and autotropic nitrifies (ammonifers and nitrifers) present in panchagavya which colonize in the leaves increased the ammonia uptake and enhance the total N supply Papen *et al.* (2002) [20]. 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 organic acids during fermentation (Mathivanan, *et al.* 2006) [16]. Further, they have reported the acetate, propionate and butyrate levels in panchagavya were ranged from 60.05 to 68.28, 14.39 to 17.79 and 6.40 to 7.65 percent, respectively, during the period from 10 to 40 days of fermentation. *Lactobacillus* count was increased from 8.62 at 10 days of fermentation to 8.71cfu/g at 30 days of fermentation. The total volatile fatty acids (TVFA) were higher at 30 days of fermentation.

According to Panchagavya also known to contain bio fertilizers such as Azospirillum, Azotobactor, Phospho bacteria and Pseudomonas were found besides *Lactobacillus* in Panchagavya (Yadav and Lourduraj, 2005). Besides these, growth regulatory substances such as Indole Acetic Acid (IAA), Gibberlic Acid (GA3), Cytokinin and essential plant nutrients from panchakavya (Perumal *et al.*, (2006) [22] which caused a tremendous influence on the growth rate in *Alium 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) [16].

6. Act as Insect-Pest Control

In annual moringa sprayings of Panchagavya doubled the stick yield besides giving resistance to pests and diseases (Vivekananda, 1999) [43] and Boomiraj *et al*. (2004) [6] reported that Panchagavya was effective against leaf hopper (*Amrasca biguttula biguttula*) and white fly, (*Bemisia tabacci*) in bhendi.

Panchagavya + NSKE proved as best in managing *Spodoptera litura* larvae followed by panchagavya + *Vitex nigundo* and calotropis in groundnut and soybean. Whereas, Neelakanth (2006) noted that panchagavya + cow urine in combination with NSKE proved next best over spinosad in controlling DBM (*Plutella xylostella*) in cabbage and shootfly in sorghum (Mudigora *et al.* (2009) [18].

7. Effect on Benefit Cost ratio

Panchal *et al.* (2017) [23] reported that the highest gross realization (74,373/ha), net realization (50,008/ha) was incurred under the treatment of foliar spray of *panchagavya* @ 4% at branching + flowering stage with the BCR value of 3.05 of.

Gopal *et al.* (2017) [9] showed that application of panchagavya 4% increased the gross return (89642ha^{-1}), net return (67042 ha^{-1}) and B: C (2.96) ratio of black gram as compared to control and other doses of panchagavya.

Conclusions

Panchagavya is an organic formulation made from cow goods. The usage of fermented organic formulations with supportive beneficial microorganisms as foliar nourishment has been come into the picture of modern agriculture for giving rise to good quality non-residue protected food and played a significant role in providing resistance to pests and

diseases, resulting in increased overall yields. Consequences of Panchagavya application are superior growth, yield and quality of crops.

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