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Microbial Dynamics and Shelf-life Assessment of Indigenous Organic Preparations Beejamrutham, Jeevamrutham and Panchagavya for Sustainable Agriculture

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ABSTRACT

Background: Indigenous organic formulations, such as Beejamrutham, Jeevamrutham and Panchagavya are widely used in sustainable agriculture to enhance soil fertility and crop productivity. These formulations are rich in microbial diversity, which plays a crucial role in nutrient cycling and plant growth promotion. Understanding the dynamics of microbial populations during the storage period of these formulations is essential for determining their optimal usage period on crops. This study aims to characterize the microbial diversity of indigenous organic formulations to identify the best period for their application on crops.

Methods: Experiments were conducted to analyze the microbial populations of Beejamrutham, Jeevamrutham and Panchagavya over different storage periods. The microbial diversity was assessed by counting the populations of phosphate-solubilizing bacteria (PSB), potassium-releasing bacteria (KRB), total bacteria, yeast, and actinobacteria at various time points. The biochemical properties, including total nitrogen, phosphorus, potassium, total sugar, reducing sugars, non-reducing sugars, pH, electrical conductivity, organic carbon, gibberellic acid (GA), ascorbic acid and indole-3-acetic acid (IAA), were also measured to evaluate the nutritional content of the formulations.

Result: The study revealed that in Jeevamrutham, PSB and KRB counts increased until the 10th day post-preparation and then decreased, while total bacterial counts continued to rise. In Panchagavya, total bacteria and PSB populations peaked on the 24th day after preparation before declining and KRB, Actinobacteria and yeast populations also increased with aging. Beejamrutham showed a decrease in microbial population over time, suggesting immediate use after preparation for optimal benefits. Biochemical analysis indicated that Panchagavya had higher total nutrients and IAA content, while Jeevamrutham had greater GA and ascorbic acid concentrations compared to the other formulations. Beejamrutham showed higher non-reducing sugars, IAA content compared to other organic preparations.

Key words: Beejamrutham, Indigenous organic preparations, Jeevamrutham, Microbial population, Panchagavya.

INTRODUCTION

Green Revolution technologies, including high-yielding crop varieties, mechanized tools and synthetic inputs like fertilizers, herbicides, pesticides, and irrigation, have greatly increased agricultural output and improved global food security over recent decades. However, these advancements have had negative impacts on soil health, human health and the environment, leading to soil degradation, groundwater pollution and ecological imbalances. Addressing the need for sustainable agricultural practices is crucial to meet the growing global food demand (Singh, 2000; Sarkar *et al.,* 2021; Pathak *et al.,* 2022).

Organic farming, which emphasizes using on-farm inputs, has gained traction for promoting biodiversity and soil biological activity. This approach focuses on green manures, crop rotations, animal manures, biofertilizers and cow-based organic preparations like Beejamrutham, Jeevamrutham, and Panchagavya, which are effective substitutes for synthetic inputs (Amareswari and Sujathamma, 2014). Indian agriculture has historically relied on cows, providing essential resources such as milk, dung, urine, and their derivatives (Radha and Rao, 2014; Shyamsunder and Menon, 2021).

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Demand for environmentally friendly organic formulations has increased due to their benefits in sustaining agricultural output while maintaining soil nutrient status. Beejamrutham,

Jeevamrutham and Panchagavya, made from cow products like dung, urine, milk, curd and ghee, are cost-effective and eco-friendly alternatives (Khadse *et al.,* 2018). Beejamrutham, an indigenous biofertilizer, is used primarily for seed treatment and protects crops from pathogens during germination (Shyamsunder and Menon, 2021). Jeevamrutham, rich in beneficial microbes and nutrients, promotes plant growth by enhancing soil microbial diversity (Devakumar *et al.,* 2014; Nandhini *et al.,* 2023). Panchagavya, a Vedic concoction, improves soil health and plant growth through its rich microbial content and nutrients (Kumar and Singh, 2021; Bhowate *et al.,* 2023).

These organic preparations support sustainable farming by providing beneficial microbes, essential nutrients, and growth-promoting substances (Bhadu *et al.,* 2023; Mathukia *et al.,* 2023; Orozco-Mosqueda *et al.,* 2023). These preparations play a vital role in rapidly enhancing soil fertility by stimulating the activity of soil microflora and fauna (Sutar *et al.,* 2019). The present study was conducted to analyze the cultivable microbial population beneficial microorganisms, along with the physical, chemical, biochemical properties and to identify the best period for their application on crops of indigenous organic formulations *viz*., Beejamrutham, Jeevamrutham and Panchagavya.

MATERIALS AND METHODS

Preparation of indigenous organic formulations

Beejamrutham, Jeevamrutham and Panchagavya were prepared following established indigenous methods (Pathak and Ram, 2005). Locally available organic materials including cow dung, cow urine, jaggery, banana and coconut water were used as substrates for fermentation. The formulations were prepared in separate containers under controlled conditions to maintain uniformity and consistency in the preparation process.

Microbial analysis of beejamrutham, jeevamrutham and panchagavya

The total microbial count of indigenous organic preparations (Beejamrutham, Jeevamrutham and Panchagavya) was determined at different intervals using the serial dilution spread plate technique. Various agar media were employed: Nutrient agar for total bacteria, Pikovskaya's agar for phosphate solubilizing bacteria, Aleksandrow agar for potassium solubilizing bacteria, Kenknight's medium for Actinobacteria and Sabouraud dextrose agar for yeast.

Freshly collected samples (10 mL) were mixed with 90 mL sterile distilled water in a 150 mL Erlenmeyer flask and shaken at 120 rpm for 15 minutes to create a homogeneous solution. Serial dilutions (up to 10^{-6}) were prepared by transferring 1 mL of the solution into 9 mL of sterile water. A 0.1 mL sample from each dilution was spread on agar plates using a sterilized glass spreader. The plates were incubated in an inverted position at 28±2°C for 2 to 6 days. Colony counts were averaged and multiplied by the dilution factor to determine the number of cells per mL of the formulations.

Physio-chemical analysis of beejamrutham, jeevamrutham and panchagavya

The pH was measured using the pH meter method (Jackson, 1973). Electrical conductivity (EC) was determined by the conductivity meter method (Jackson, 1973). Organic carbon was assessed through the Walkley and Black wet digestion method (Walkley and Black, 1934). Total nitrogen was quantified using the Microkjeldhal method (Jackson, 1973). Total phosphorus was measured by nitric-perchloric (9:4) digestion and spectrophotometric analysis using the vanado-molybdo phosphoric yellow color method (Jackson, 1973). Total potassium was determined by nitric-perchloric (9:4) digestion followed by flame photometry (Jackson, 1973). Total reducing sugar was analyzed using the DNS method (Asana and Saini, 1962). Total non-reducing sugar was also measured using the DNS method (Malhotra and Sarkar, 1979). Indole acetic acid was measured using the spectrophotometric method (Ahmad *et al.,* 2005). Gibberellic acid was determined by the spectrophotometric method (Cho *et al.,* 1979). Ascorbic acid content was assessed using the titrimetric method (Sadasivam and Manickam, 1992).

Statistical analysis

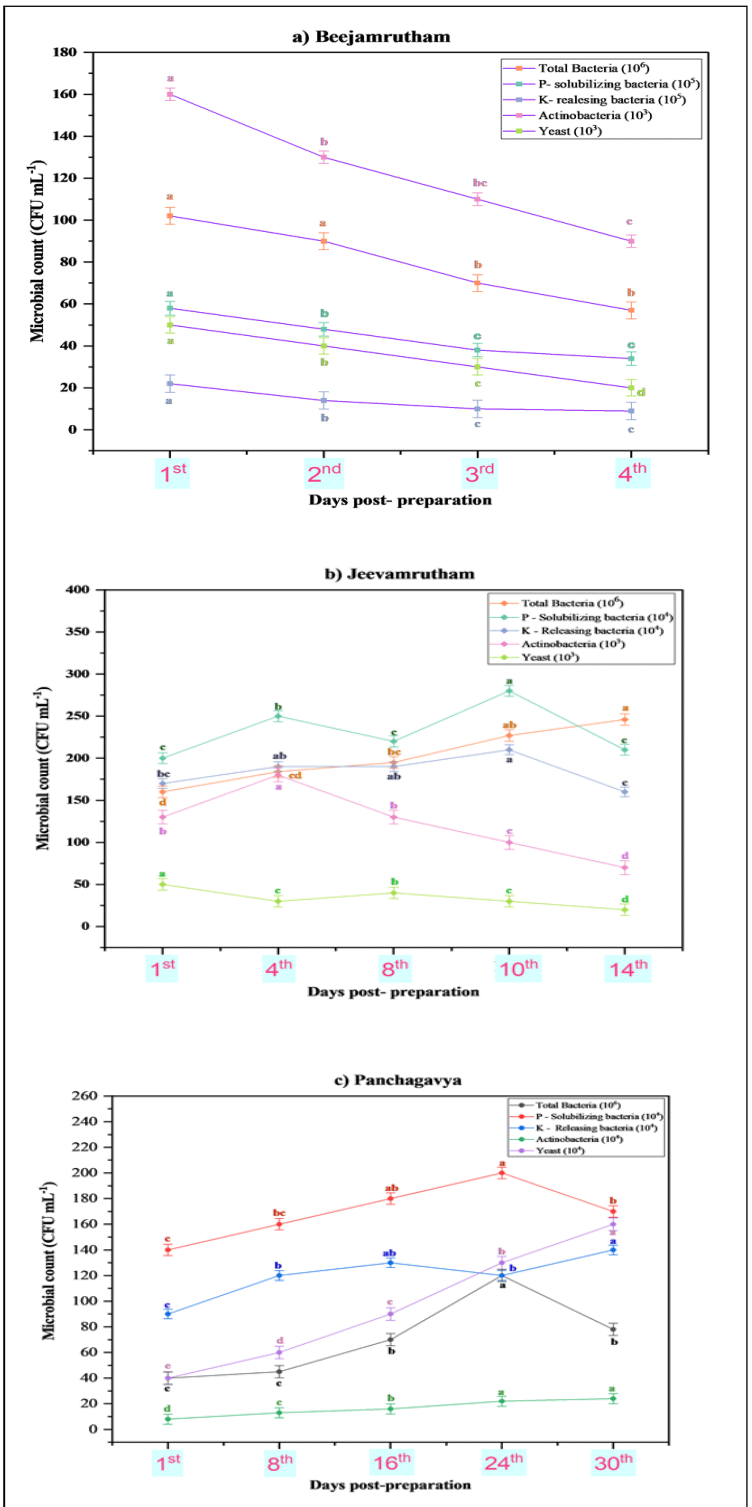
Experiments, conducted with a minimum of three replications, presented mean ± standard deviation of three replicates. Tukey's test at a 5% significance level determined significant differences among treatments. Pearson correlation coefficient assessed the correlation between microbial population and various physical, chemical and biochemical parameters in Bheejamarutham, Jeevamarutham and Panchagavya. All the figures were created using Origin Pro 2024b, version 10.0.5.157.

RESULTS AND DISCUSSION

Microbial analysis of beejamrutham, jeevamrutham and panchagavya

The microbial population of Beejamrutham was analyzed and the high colony-forming units of total bacteria (102×10^6 CFU/mL), phosphate-solubilizing bacteria (58×10^5 CFU/mL), potassium-releasing bacteria (22×10^5 CFU/mL), actinobacteria (160×10^3 CFU/mL) and Yeast (50×10^3 CFU/mL) in Beejamrutham were observed on the day of preparation, with populations decreasing over the next four days as shown in Fig 1a. This decline is attributed to nutrient depletion and the production of inhibitory substances during fermentation. Devakumar *et al.* (2014) also reported similar findings, noting higher microbial populations on the day of Beejamrutham preparation followed by a decrease over time.

Different storage periods significantly influenced the microbial populations, including total bacteria, PSB, KRB,



Values in each column are mean of three replications (± standard error). Mean values in each column followed by same letter(s) are not significantly different at 5% level.

Fig 1: Microbial population dynamics in (a) Beejarutham, (b) Jeevamrutham and (c) Panchagavya during different days post preparation.

actinobacteria and yeasts in Jeevamrutham and the results are presented in Fig 1b. The high populations of total bacteria, PSB and KRB were recorded on the 10th days post-preparation (DPP), peaking on the 14th DPP (246×10^6 CFU/mL). Yeast populations decreased as Jeevamrutham matured, while actinobacteria peaked on the 4th DPP (180×10^3 CFU/mL) and then declined. The steady increase in total bacterial, PSB, and KRB populations over time is attributed to the nutrient-rich composition of Jeevamrutham, including cow dung, cow urine, legume flour, jaggery and fertile soil, which serve as initial inoculum and support microbial growth. Similar results, with higher beneficial microbial populations observed in Jeevamrutham between the 9th and 12th days after preparation (DPP), were reported by Devakumar *et al*. (2014) and Ram *et al*. (2018). Additionally, Rameeza *et al*. (2016) recorded higher populations between the 10th and 12th DPP, while Kulkarni and Gargelwar (2019) reported higher populations between the 8th and 12th DPP.

Different storage periods significantly affected the microbial community in Panchagavya, including total bacteria, PSB, KRB, Actinobacteria and yeasts. The Fig 1c shows a peak in total bacterial population on the 24th DPP (120×10^6 CFU/mL), which then declined. Similar trends were observed for PSB, while KRB, Actinobacteria, and yeast populations increased with storage time. The presence of beneficial microorganisms like *Azospirillum*, *Azotobacter*, *Phosphobacteria*, *Pseudomonas* and *Lactobacillus* in Panchagavya is attributed to its nutrient-rich constituents such as milk, curd, coconut water and cane juice, which foster microbial growth during fermentation. This fermentation process is enhanced by microorganisms in curd and accelerated by sugarcane juice and coconut water. Higher colony-forming units (CFU) in Panchagavya with increased storage were also reported by Ram *et al.* (2018) and Rameeza *et al.* (2016) and Pathak and Ram, (2013) noted more beneficial microorganisms under higher acidity, promoting a disease-suppressive soil environment. Among the three indigenous organic preparations the microbial populations followed the order Jeevamrutham> Panchagavya> Bheejamrutham. Similarly, Jadhav *et al*. (2022) reported the highest microbial population in Jeevamrutham (19.1×10^8 CFU/ml) followed by Panchagavya (3.04×10^8 CFU/ml).

Biochemical properties of beejamrutham, jeevamrutham and panchagavya

The biochemical properties of Beejamrutham, Jeevamrutham, Panchagavya was assessed and results were presented in Table 1. Jeevamrutham exhibited the highest concentrations of gibberellic acid (GA) at 18 µg mL^{-1} and ascorbic acid at 0.4 mg mL^{-1}, compared to Beejamrutham with 12 µg mL^{-1} GA and 0.34 mg mL^{-1} ascorbic acid, followed by Panchagavya with 7.8 µg mL^{-1} GA and 0.2 mg mL^{-1} ascorbic acid. In contrast, Panchagavya recorded the highest amount of indole acetic acid (IAA) at 12.5 µg mL^{-1}, followed by Beejamrutham at 10.4 µg mL^{-1} and Jeevamrutham at 8 µg mL^{-1}. Similar findings were reported by Parvathi and Ushakumari (2017) and Dhanoji *et al*. (2018), who also observed these biochemical properties in Panchagavya and Jeevamrutham. These results underscore the presence of essential macronutrients, micronutrients, vitamins and growth-promoting substances like IAA and GA, as supported by Sreenivasa *et al.* (2010); Mathukia *et al.* (2023); Orozco-Mosqueda *et al.* (2023).

Physico-chemical properties of beejamrutham, jeevamrutham and panchagavya

The mineral nutrient content of Beejamrutham, Jeevamrutham and Panchagavya are presented in Table 2. The chemical composition of organic formulations such as Beejamrutham, Jeevamrutham and Panchagavya varies depending on the materials used, including cow dung, urine, milk and other ingredients, which can differ in quality based on cow breed and diet. Panchagavya stands out with higher levels of macro-nutrients, total sugars and both reducing and non-reducing sugars compared to Jeevamrutham and Beejamrutham. While both Panchagavya and Jeevamrutham exhibit slight acidity, Beejamrutham is slightly alkaline due to lime, cow dung and urine content. These formulations provide a rich source of nutrients, growth hormones, sugars and acids, supporting microbial growth and diverse populations. The acidity levels in Jeevamrutham and Panchagavya, influenced by ingredients like jaggery and milk products, do not hinder plant growth, as reported by Chakraborty and Sarkar, (2019) and Parvathi and Ushakumari (2017), who noted the presence of essential nutrients and growth-promoting factors like IAA, GA and beneficial

Table 1: Biochemical properties of beejamrutham, jeevamrutham and panchagavya.

Parameters	Beejamrutham	Jeevamrutham	Panchagavya
IAA (µg mL^{-1})	10.4 (±0.37)	8 (±0.29)	12.5 (±0.45)
GA (µg mL^{-1})	12 (±0.32)	18 (±0.48)	7.8 (±0.21)
Ascorbic acid (mg mL^{-1})	0.34 (±0.01)	0.4 (±0.01)	0.2 (±0.01)
Total sugars (%)	0.57 (± 0.001)	0.71 (± 0.014)	1.32 (± 0.031)
Reducing sugars (%)	0.35 (± 0.001)	0.54 (± 0.006)	1.02 (± 0.004)
Non-reducing sugars (%)	0.23 (± 0.004)	0.18 (± 0.004)	0.3 (± 0.006)

The values in each column represent the mean of three replications ± SE (standard error).

IAA: Indole acetic acid; GA: Gibberellic acid.

Table 2: Physico-chemical properties of beejamrutham, jeevamrutham and panchagavya.

Parameters	Beejamrutham	Jeevamrutham	Panchagavya
pH	7.95 (±0.29)	5.01 (±0.18)	5.14 (±0.19)
EC (dS/m)	4.76 (±0.13)	2.27 (±0.06)	2.58 (±0.07)
OC (%)	0.69 (±0.02)	0.82 (±0.02)	0.87 (±0.02)
Total nitrogen (%)	0.32 (±0.01)	0.46 (±0.02)	0.98 (±0.04)
Total phosphorus (%)	0.14 (±0)	0.25 (±0.01)	0.23 (±0.01)
Total potassium (%)	0.08 (±0)	0.16 (±0)	0.24 (±0)

The values in each column represent the mean of three replications ± SE (standard error).

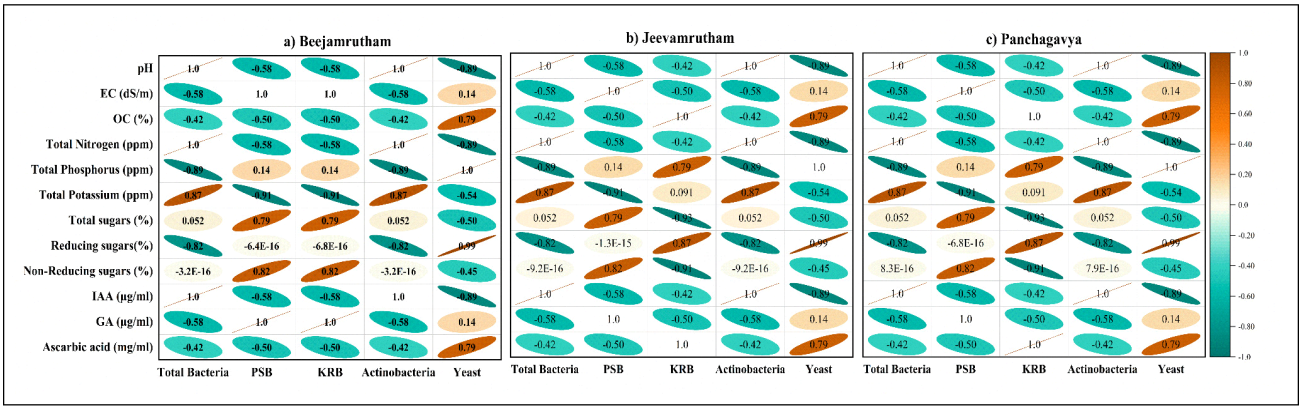


Fig 2: Correlation analysis between the microbial population and physico-chemical and biochemical parameters in (a) Bheejamarutham, (b) Jeevamarutham and (c) Panchagavya.

microorganisms in these formulations (Natarajan, 2007; Sreenivasa *et al.,* 2010).

Correlation analysis between the microbial population and physico-chemical and biochemical parameters in bheejamarutham, jeevamarutham and panchagavya

Correlation studies were conducted to understand the relationship between the microbial population and various physical, chemical and biochemical parameters in Bheejamarutham, Jeevamarutham and Panchagavya, with the results presented in the Fig 2. Regardless of the indigenous organic preparation, the following consistent patterns were observed across all three preparations: Total bacteria and actinobacteria exhibited strong positive correlations with total nitrogen (r ≈1.0) in all preparations, suggesting their crucial role in nitrogen cycling (Hayat *et al.*, 2010). These microbial groups also showed moderate negative correlations with electrical conductivity (r ≈ -0.58), indicating a preference for environments with lower ionic concentrations. PSB and KRB displayed remarkably similar correlation patterns across all preparations. Both groups showed strong positive correlations with total sugars (r >0.7), suggesting a preference for complex carbohydrates as energy sources. Interestingly, PSB showed only weak positive correlations with total phosphorus (r ≈ 0.14), while KRB's correlation with total potassium varied slightly between preparations. This implies that nutrient availability alone may not be the primary determinant of these bacterial populations' abundance (Jaiswal *et al.*, 2016). Yeast populations demonstrated strong positive correlations with growth promoters, specifically gibberellic acid (GA) and ascorbic acid (r ≈ 0.14 to 0.79). This relationship suggests that yeasts may either produce these compounds or thrive in their presence, potentially contributing to the plant growth-promoting effects of these organic preparations. Additionally, yeasts showed moderate positive correlations with organic carbon (OC) (r ≈ 0.79), indicating their involvement in carbon cycling within the preparations.

CONCLUSION

Studies showed that Beejamrutham should be applied on the first day of preparation, Jeevamrutham on the 10th day post-preparation (DPP) and Panchagavya on the 24th DPP. The ingredients used in these preparations determine the fermentation time required to develop a beneficial microbial population. These preparations are excellent sources of phosphate-solubilizing bacteria, potassium-releasing bacteria and nitrogen fixers, which accelerate the decomposition of organic matter and increase nutrient availability. Comprehensive studies highlighted the significant influence of storage periods on microbial populations and their correlation with physical, chemical and biochemical parameters.

Conflict of interest

There are no conflicts of interest to declare on behalf of all authors.

REFERENCES

Ahmad, F., Ahmad, I., Khan, M.S. (2005). Indole acetic acid production by the indigenous isolates of *Azotobacter* and *fluorescent Pseudomonas* in the presence and absence of tryptophan. *Turkish Journal of Biology*. **29(1):** 29-34.

Asana, R.D. and Saini, A.D. (1962). Studies on physiological analysis of yield. *Indian Journal of Plant Physiology*. **5:** 128-131.

Bhowate, R.T., Patel, K.G., Dubey, P.K., Kaswala, A.R., Vyas, T.K. (2023). Effect of different liquid organic formulations on qualitersy of organic rice. *The Pharma Innovation Journal*. **12:** 1253-1256.

Shyamsunder, B. and Menon, S. (2021). Study of traditional organic preparation beejamrita for seed treatment. *International Journal of Modern Agriculture.* **10(2):** 1823-1828.

Chakraborty, B. and Sarkar, I. (2019). Quality analysis and characterization of Panchagavya, Jeevumrutha and Sasyamrutha. *Int. J. Curr. Microbiol. App. Sci.* **8(5):** 2018-2026.

Cho, K.Y., Sakurai, A., Kamiya, Y., Takahashi, N. and Tamura, S. (1979). Effects of the new plant growth retardants of quaternary ammonium iodides on gibberellin biosynthesis in Gibberella fujikuroi. *Plant and Cell Physiology*. **20(1):** 75-81.

Devakumar, N., Shubha, S., Gowder, S.B. and Rao, G.G. E. (2014). Microbial analytical studies of traditional organic preparations beejamrutha and jeevamrutha. *Building Organic Bridges*. **2:** 639-642.

Dhanoji, M.M., Meena, M.K. and Naik, M.C. (2018). Manure and plant extracts for foliar nutrition in organic farming: A review. *International Journal of Chemical Studies*. **6(6):** 1447-1454.

Hayat, R., Ali, S., Amara, U., Khalid, R. and Ahmed, I. (2010). Soil beneficial bacteria and their role in plant growth promotion: A review. *Annals of Microbiology*. **60:** 579-598.

Jackson, M.L. (1973). Soil Chemical Analysis, Pentice Hall of India Pvt. Ltd. New Delhi, India. **498:** 151-154.

Jadhav, S., Singh, S. and Gupte, A. (2022). Isolation and screening of microorganisms from traditional and modified agro-organic formulations. *Journal of Food, Agriculture and Environment*. **19(1):** 87-91.

Jaiswal, D.K., Verma, J.P., Prakash, S., Meena, V.S. and Meena, R.S. (2016). Potassium as An Important Plant Nutrient in Sustainable Agriculture: A State of the Art. *Potassium Solubilizing Microorganisms for Sustainable Agriculture*. pp 21-29.

Khadse, A., Rosset, P.M., Morales, H. and Ferguson, B.G. (2018). Taking agroecology to scale: The zero budget natural farming peasant movement in Karnataka, India. *The Journal of Peasant Studies*. **45(1):** 192-219.

Kulkarni, S.S. and Gargelwar, A.P. (2019). Production and microbial analysis of Jeevamrutham for nitrogen fixers and phosphate solubilizers in the rural area from Maharashtra. *IOSR Journal of Agriculture and Veterinary Science*. **12:** 85-92.

Kumar, C.S. and Singh, G. (2021). Role of Organic Liquid Formulations in Agriculture: A review. *Journal of Emerging Technologies and Innovative Research*. **8:** 250-255.

Malhotra, S.S. and Sarkar, S.K. (1979). Effects of sulphur dioxide on sugar and free amino acid content of pine seedlings. *Physiologia Plantarum*. **47(4):** 223-228.

Mathukia, R.K., Chhodavadia, S.K., Vekaria, L.C. and Vasava, M. S. (2023). Organic cultivation of summer groundnut using cow-based bio-enhancers and botanicals. *Legume Research.* **46(10):** 1351-1355. doi: 10.18805/LR-4431.

Nandhini, D.U. and Somasundaram, E. (2023). Characterising the traditional organic liquid formulations used by the farmers of western agro climatic zone of Tamil Nadu. *Indian Journal of Traditional Knowledge.* **22(2):** 297-306.

Natarajan K. Panchagavya for plant. Proc. Nation. Conf. on Glory of Gomatha. (2007). Dec. 1-3, . S.V. Veterinary Uni., Tirupati, A.P. 72-75.

Orozco-Mosqueda, M.D.C., Santoyo, G. and Glick, B.R. (2023). Recent advances in the bacterial phytohormone modulation of plant growth. *Plants*. **12(3):** 606.

Parvathi, S.U. and Ushakumari, K. (2017). Preparation and characterization of on-farm liquid organic manures. *Trends in Biosciences.* **10(32):** 6880-6885.

Pathak, R.K. and Ram, R.A. (2013). Bio-enhancers: A potential tool to improve soil fertility, plant health in organic production of horticultural crops. *Progressive Horticulture*. **45(2):** 237-254.

Pathak, V.M., Verma, V.K., Rawat, B.S., Kaur, B., Babu, N., Sharma, A., Dewali, S., Yadav, M., Kumari, R., Singh, S. and Mohapatra, A., (2022). Current status of pesticide effects on environment, human health and it's eco-friendly management as bioremediation: A comprehensive review. *Frontiers in Microbiology*. **13:** 962619.

Radha, T.K. and Rao, D.L.N. (2014). Plant growth promoting bacteria from cow dung based biodynamic preparations. *Indian Journal of Microbiology*. **54:** 413-418.

Ram, R.A., Singha, A. and Vaish, S. (2018). Microbial characterization of on-farm produced bio-enhancers used in organic farming. *Indian Journal of Agricultural Sciences*. **88(1):** 35-40.

Rameeza, E.M. and Usha, K.E. (2016). Influence of ageing on quality of jeevamrutham. *International Journal of Applied and Pure Science and Agriculture*. **2(10):** 158-162.

Sadasivam, S. and Manickam, A. (1992). Biochemical Methods for Agricultural Sciences. Wiley Eastern Limited.

Sarkar, S., Gil, J.D.B., Keeley, J. and Jansen, K. (2021). The Use of Pesticides in Developing Countries and their Impact on Health and the Right to Food. European Union.

Singh, R.B. (2000). Environmental consequences of agricultural development: A case study from the Green Revolution state of Haryana, India. *Agriculture, Ecosystems and Environment*. **82(1-3):** 97-103.

Sreenivasa, M.N., Naik, N. and Bhat, S.N. (2010). Beneficial traits of microbial isolates of organic liquid manures. *Plant Growth Promotion by Rhizobacteria for Sustainble Agriculture.* **10:** 223.

Walkley, A. and Black, I.A. (1934). An examination of the degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*. **37(1):** 29-38.

Ram, R.A. and Pathak, R.K. (2005, December). Integration of organic farming practices for sustainable production of guava: A case study. *In International Guava Symposium* **735:** 357-363.

Bhadu, K., Rathore, R.S. and Shekhawat, P.S. (2023). Jeevamrut and panchagavya's consequences on growth, quality and productivity of organically grown crops: A review. *Agricultural Reviews*. **44(4):** 451-459. doi: 10.18805/ag.R-2239.

Amareswari, P.U. and Sujathamma, P. (2014). Jeevamrutha as an alternative of chemical fertilizers in rice production. *Agricultural Science Digest-A Research Journal.* **34(3):** 240-242. doi: 10.5958/0976-0547.2014.01012.X.

Sutar, R., Sujith, G.M. and Devakumar, N. (2019). Growth and yield of cowpea [*Vigna unguiculata* (L.) Walp] as influenced by jeevamrutha and panchagavya application. *Legume Research-An International Journal.* **42(6):** 824-828. doi: 10.18805/LR-3932.