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Research Article

Effect of Bio Formulations on Growth and Yield Parameters of *Centella asiatica* L., Cultivated in Hydroponic and Field Systems: A Comparative Study

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ABSTRACT

Background: *C. asiatica* L is a perennial flowering herb from the *Apiaceae* family having high demand in *Ayurveda* and traditional medicine used to treat a variety of health conditions. This study evaluates the effects of bio formulations like *Kunap Jala* mentioned in *Vrukshayurveda* and Vermiwash, on growth and yield characteristics of *C. asiatica* L. grown by conventional field cultivation method against hydroponic system. **Materials and Methods:** Study consisted of two groups of *Centella asiatica* L.-Field cultivation and Hydroponic cultivation. Based on intervention each group again has two subgroups-*Kunap Jala* and Vermi wash, with 40 samples in each group. Standard package of practice was followed for field cultivation. For Hydroponic group, Nutrient Film Technique system was established with nutrient media. pH maintained at neutral and Total Dissolved Solvents maintained between 1000-1200 ppm. **Results:** Analysis of Bio formulations of *Centella asiatica* showed higher nutrients in *Kunap Jala* in comparison to Vermi wash. In comparison with field group and hydroponics group, field group had better yield; more specifically treatment with Kunapajala showed improved result than Vermi wash **Conclusion:** Both *Kunap Jala* groups on field and hydroponic method yielded better results than Vermi wash group, which may be due to higher nutrient percentage of *Kunap Jala*. Field system showed better results than Hydroponic system.

Keywords: Bio Formulations, *Centella asiatica* L., Hydroponic system, *Vrukshayurveda*.

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INTRODUCTION

Centella asiatica L. is an herbal plant from *Apiaceae* family,[1] it is a perennial herb, used in traditional medicines for many health care problems. It has been recommended as one of the best *Medhya Rasayan* (Memory and Immune enhancer) by *Acharya Charak*.[2] Research have proved that it is useful in wound healing, for treatment of diarrhea, psychological diseases etc. It is known as memory enhancer, immune modulator.[3] Its demand and supply are not balanced enough to meet market needs due to overexploitation and limited cultivation.[4] Additionally, seasonal changes and agro-climatic factors can lead to variations in secondary metabolite production. Therefore, it is essential to enhance and maintain uniformity in these metabolites. Various studies have explored different cultivation methods, including field cultivation and hydroponics for the production of *Centella asiatica* L.[5] However, comparative studies utilizing traditional bio-formulations mentioned in ancient Indian texts of Vrikshayurveda have not been reported. Hence, this study aims to conduct comparative analysis of these two bio-formulations.

Hydroponics is a soilless cultivation system it involves the supply of nutrients and oxygen through liquid/water media mostly suited for small herbs consuming more water. This system helps to reduce plant contamination and ensures plant nutrition through a nutrient solution.[6] Currently, nutrients which are supplied in hydroponic system are sourced from inorganic minerals. Bio formulations are combinations of biologically active factors containing microbial biomass and their metabolites. KJ is liquid manure prepared from animal products like meat, marrow, milk by fermenting. Studies have suggested that it is rich in amino acids, fatty acids, and also micro and macronutrients and also useful for control of pests, diseases.[7] Vermi Wash (VW) is liquid prepared by vermicompost. Vermi compost is produced by earth worms. It is used as fertilizer to improve crop yield, it is also reported preventing diseases and controlling the pests.[8] Presently few studies have been conducted on comparing the on field and hydroponic system of cultivation of plants by using bio formulations, but no studies have been reported on cultivation of *C. asiatica* L. by using KJ. To the best of author's knowledge,

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this is the first study on application of *Kunap Jala* in Hydroponic system cultivation.

MATERIALS AND METHODS

Experimental site and Plant Materials: Study was conducted in KLE's Shri B M K Ayurveda Mahavidyalaya Belagavi, Karnataka, India 15.840278350313543, latitude and 74.51704802332878 Longitude is at a mean altitude of 762 m above sea level. The average annual rainfall of the area is 1153 mm. The Annual high temperature29.52°C (85.14°F) and the Annual low temperature 21.05°C (69.89°F) with average humidity 65.45%.[9,10] Saplings of *C. asiatica* L procured and authenticated (Herbarium No-CRF/Auth/21) at Central Research Facility (CRF) KLE's Shri B M K Ayurveda Mahavidyalaya Belagavi, Karnataka. Materials required for preparation of KJ, VW procured from local market.

Method of Cultivation and preparation

Soil, water and bio formulations analysis was conducted at Government Bio Center, Belagavi, Karnataka, India. Study consisted of two groups (Figure 1)-Field cultivation and Hydroponic cultivation, each group subdivided in-*Kunap Jala* (KJ) and Vermi wash (VW) group, 40 samples in each subgroup. Standard package of practice was followed for field cultivation.

For Hydroponic group, pH maintained neutral and TDS between 1000-1200 ppm.[11] Preparation of Bio formulations: KJ was prepared based on the reference of Ankad *et al.*, a modified form of classical ingredients.[12]

Vermi wash preparation-Vermi wash was extracted from vermicompost using vermiwash collecting system.[13]

Hydroponic System

The type of Hydroponic system used is Nutrient Film Technique (NFT) in this system, water with nutrients flows in pipes in which roots were embedded. Six PVC pipes 4" width were mounted horizontally on metal frame, ensuring proper slope of 1 cm/m of pipe length for easy flow of water.[14] Each horizontal pipe contained 7 holes for accommodating total 42 cups measuring 5.5 cm diameter on surface, 6 cm depth so that roots of the plant get immersed in nutrient media, plant was supported by piece of sponge in the cup. For circulation 160-240 v/50 Hz submersible pump was used which is immersed in 20 L capacity tank containing nutrient media and water, connection was made in such a way that each horizontal pipe directly received sufficient nutrient solution from the tank and shallow stream assisted roots to have a larger air exchange. Monitoring the solution was done by using pH meter and Total Dissolved Solids (TDS) meter (Figure 2).

Assessment Parameters

Soil analysis

The pH in both groups was neutral. Minerals like N, P, K, Zn, Fe were found in the soil within permitted levels.[15] The characteristics of the soil encouraged the viability of C. *asiatica* cultivation.[16]

Growth and physiological attributes

Analysis of nitrogen, phosphorus was done by Kjedhal's method and potassium was done by flame photometric analysis.[17]

Growth Parameters

Root to Leaf length, Stem to Leaf Length and number of leaves in all the four groups were measured on every 0^{th} day, 30^{th} day and 60^{th} day.

Estimation of TOC

Total Organic Carbon analysis was done by dry combustion method.[18]

Estimation of Chlorophyll Content

Leaves from ten plants from each group randomly selected for the of chlorophyll estimation. Leaf samples weighed one gram were taken from each group; it was cut finely into small pieces and washed thoroughly with water. With the help of clean mortar and pestle fine paste was done. To this mixture 20 mL of 80% acetone and 0.5 g of magnesium carbonate powder was added. Then it was triturated properly till homogenized mixtures were obtained and the sample was centrifuged for 5 min at 500 rpm. Then the sample was centrifuged for 5 min at 500 rpm. The surprenant which is obtained was taken and it was transferred to volumetric flask, the total volume was made to 100 mL by adding 80% acetone. Using spectrophotometry at 645 nm and 663nm wavelength colour absorbance was noted against the solvent. Here acetone (80%) was used as a blank.[18]

Formula

$$\text{Chl a}=11.75\times(A)662.6-2.35\times(A)\ 645.6$$

$$\text{Chl b}=18.61\times(A)645.6-3.96\times(A)662.6$$

Where Ca-Chlorophyll a and Cb-Chlorophyll b is the chlorophyll A and chlorophyll B, A is absorbance.

Biomass Analysis

Biomass analysis of *C. asiatica* L harvest was measured after 60 DAP (Figure 3).

Fresh Weight

Whole harvested material of *C. asiatica* L from each group were displaced and cleaned and fresh weight of whole plant material was taken and it was recorded

Air Dried Weight

Whole harvested material of *C. asiatica L* from each group were kept for drying in the shade until the constant weight of the material was obtained.

RESULTS

Analysis of bio formulations

At the end of 30th day KJ was light brown with a characteristic pungent odour. Results revealed that KJ showed higher concentration of N, P, K in comparison to VW. pH, EC macronutrients of KJ and VW tabulated in Table 1.

Overall growth and yield were found comparatively higher in Field group than Hydroponic group. On comparison, KJ group showed higher growth than VW in both the systems. Results are tabulated in Table 2.

DISCUSSION

Vrukshayurveda has insisted on the use of KJ to improve the yield and quality of plants. In organic cultivation, VW is gaining popularity over vermicompost because of its bioavailability and comparatively quick action. Hydroponic system is especially useful for small herbs to avoid or reduce variation in yield and secondary metabolites which are likely caused by multiple factors like variation in soil, irrigation, climate, climatic variation etc. Moreover, it also avoids soil contamination. Unlike field cultivation, in NFT system, Total Dissolved Solids (TDS) serves as an indicator of concentration of nutrients like Nitrogen, Phosphorus, Potassium, micronutrients like Calcium, Magnesium, Iron and play a crucial role in assisting morphological growth and yield. So in this study, nutrient concentration in the liquid media was obtained by measuring TDS, as reported by Resh H M.[20] throughout study pH of NFT system maintained at neutral.

Compared to VW, KJ has shown more nutrient concentration of Nitrogen, Phosphorous and Potash. Overall growth and yield were found more in KJ group of both on field and hydroponic system in comparison to VW groups. This may be due to the presence of high percentage nutrients in KJ than VW. The result of plant yield, chlorophyll contents were in accordance with previous studies conducted by Durah *et al.*, Venktesh *et al.*, which reported presence of Nitrogen, Phosphorous and Potash has

Figure 1: Field cultivation-KJ and VW group.

Table 1: Analysis of KJ and VW.

Sample	pH	EC* dS/m	Nitrogen	Phosphorus	Potash	Total Organic Carbon (TOC)
VermiWash	7.2	0.921	61.23 ppm	4.21 ppm	22.50 ppm	2.9%
Kunapajala	6.8	0.983	92.46 ppm	24.25 ppm	62.45 ppm	3.7%

*EC- Electrical conductivity.

Table 2: Growth and Yield parameters.

Parameter	Kunapa Jala Hydroponic	Vermi Wash Hydroponic	Kunapa Jala Field	Vermi Wash Field
Mean Root to leaf length in cm (Figure 4).	21.88	17.49	23.87	19.00
Mean Stem to leaf length in cm	15.15	12.95	17.65	14.43
Number of Leaves	4.72	2.33	4.83	4.53
Chlorophyll A	7.71	5.75	15.83	9.75
Chlorophyll B	6.55	3.57	15.59	10.57
Total chlorophyll	14.26	9.32	31.42	20.32
Wt of the fresh drug (g)	13.097	12.217	36.697	34.976
Wt of the dried drug (g)	3.382	2.985	12.168	11.889
Loss on drying (g)	74.17	75.56	66.84	66

Figure 2: Hydroponic method-KJ and VW group.

Figure 3: Biomass analysis of *C. asiatica.*

Figure 4: Mean Root to leaf length in cm.

positive impact on plant growth. Nitrogen is mainly responsible for chlorophyll synthesis and consequently in photosynthesis.[21] Venktesh MS reported Nitrogen as a main cause for vegetative growth of plants. Similar results were noted in present study where KJ containing more Nitrogen showed better growth.[22] The Phosphorous enhances cell division and encourages root growth, flowering, metabolism subsequently in storage and energy transfer.[23] Root length, stem length, number of leaves in Field KJ, Field VW, Hydroponic KJ, were higher whereas Hydroponic VW showed poor growth. This may be due to comparatively less nutrients in VW, in comparison to KJ. But Field VW group showed comparable results with KJ group maybe because soil had optimum nutrients required for *C. asiatica* that might have enhanced the growth in comparison to hydroponic group of VW. Loss on drying was more observed in Hydroponic groups than compared to on field group indicating that high moisture content in Hydroponic group. So, this finding enables us to state that Hydroponic system may be suitable for fresh plant for producing juice of *C. asiatica* than using it in dry form.[24] The nutrient values of KJ and VW varied due difference in the ingredients.[25] In present study growth and yield in KJ group was more than the VW group, though previous studies reported VW is rich in many different nutrients, vitamins, growth hormones, which acted as disease and pest suppression agents. But on comparison, KJ

showed better results may be because nutrient content of KJ was more than the VW which is evident in the analysis report of both the bio formulations.[26]

TOC is comparatively more in KJ than VW, yield is directly proportional to TOC value which is reported by Chen, Z *et al.*[27] Highest yield in terms of weight was found in on field group compared to hydroponic group. This may be due to soil having more nutrients when enriched with bio formulations than in Hydroponic system having regulated concentration of nutrients.

CONCLUSION

This study evaluated the growth and yield of *Centella asiatica* L. cultivated using both field and hydroponic methods with bio-formulations, namely *Kunap Jala* and Vermi Wash. The *Kunap Jala* treatment outperformed the Vermi Wash treatment in both cultivation methods, likely due to its higher nutrient content. Additionally, the conventional field-grown plants exhibited superior results compared to those grown in the hydroponic system. This comparative study is conducted for the first time, producing a promising result.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

C. asiatica L.: *Centella asiatica* Linnaeus; **KJ:** Kunap Jala; **VW:** Vermi Wash; **NFT:** Nutrient Film Technique; **pH:** Potential of Hydrogen; **TDS:** Total Dissolved Solids; **TOC:** Total Organic Carbon; **EC:** Electrical Conductivity; **CRF:** Central Research Facility; **N:** Nitrogen; **P:** Phosphorus; **K:** Potassium; **Zn:** Zinc; **Fe:** Iron; **D A P:** Days After Planting; **ppm:** Parts Per Million; **Hz:** Hertz; **A:** Absorbance; **Chl:** Chlorophyll.

SCOPE FOR FURTHER STUDY

Further research is required to assess the impact of *Kunap Jala* on the bioactive constituents of *Centella asiatica* and to compare the phytochemical composition of plants grown in conventional field conditions versus a hydroponic system. Future studies should also explore the optimization of nutrient formulations for hydroponic cultivation, long-term sustainability, and the potential medicinal benefits of *C. asiatica* under different growing conditions.

KEY FINDINGS

Kunap Jala showed higher nutrient concentrations compared to Vermi Wash.

Field cultivation consistently outperformed hydroponic cultivation.

Kunap Jala groups demonstrated better growth and yield than Vermi Wash groups.

Nitrogen content significantly influenced plant growth and chlorophyll synthesis.

The study concluded that *Kunap Jala* treatment was more effective in both cultivation methods, likely due to its higher nutrient content. The field-grown plants exhibited superior results compared to hydroponic plants. This research provides novel insights into alternative cultivation techniques and bio-formulations for *Centella asiatica* L. production.

SUMMARY

This research investigates the effects of two bio-formulations, *Kunap Jala* (KJ) and Vermi Wash (VW), on the growth and yield of *Centella asiatica* L. using field and hydroponic cultivation methods. The study was conducted at KLE's Shri B M K Ayurveda Mahavidyalaya in Belagavi, Karnataka, India.

The research comprised four experimental groups: Field KJ, Field VW, Hydroponic KJ, and Hydroponic VW, with 40 samples in each group. The Nutrient Film Technique (NFT) hydroponic system was used, maintaining neutral pH and Total Dissolved Solids between 1000-1200 ppm.

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