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STUDY ON PRACTICABILITY OF HYDROPONICAL CULTURE WITH SOME LEAFY VEGETABLES KNOWN FOR MEDICINAL PROPERTIES IN CHHATTISGARH - INDIA

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ABSTRACT

Soilless plant culture technique known as "Hydoponics" is used to cultivate some green leafy vegetables grown and also used as dietary/medicinal components in central India – Chhattisgarh. Hydroponics is globally well established plant cultivation technique but to some extent unpopular in India. In this study feasibility of green leafy vegetable with Hydroponical cultivation technique in terms of net productivity and plant growth is measured. Final output is compared with traditional method of agriculture, used to cultivate green leafy vegetable. A small non-circulating hydroponic system is developed,which is followed by selection and cultivation of some indigenous species of leafy vegetables such as *Chorchorusolitorius* L. (Chechbhaji), *Amaranthusviridis* (Chaulaibhaji), *Amaranthustricolor* (Lal bhaji), *Spinaceaoleracea* (Palakbhaji), *Trigonellagoenumgraceum* (Methibhaji), *Raphanussativus* (Moolibhaji) and *Amaranthushypochondriacus L.*(Khedabhaji) in Hydroponic system. Cultivation is initiated through seeds purchased from local market. Seed initiation in species such as *C. olitorius*, *A. viridis*, *A. tricolor*, *S. oleracea*and *A. hypochondriacus L.*,was observed within 3 days after propagation in sterilized solid surface, followed by *R. sativus* (after 4-5 days) and *T. graceum*(7 days). Shoot and root formation is clearly observed in *C. olitorius*, *A. viridis*, *A. tricolor*, *S. oleracea* and *A. hypochondriacus L.* was observed after 5 days and *R. sativus*after 7 days. In sp.*T. goenumgraceum*,shoot and root formation was comparatively late and observed after 10 days of seed sowing. Final result reveals that cultivation of all the selected plant species was feasible with hydroponic system. Net productivity was high due prevention of loss due to pest, soil born fungal/bacterial/viral diseases in plant species. All produce was healthier and edible as much as grown in agriculture field.

Keywords: ***Hydroponics, Medicinal, green leafy vegetable, soilless, net productivity, feasibility***

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I INTRODUCTION

Hydroponics is worldwide well established technique of soilless cultivation of Plant species. Many species of vegetable crops, medicinal use and plants of commercial importance are grown successfully in hydroponic system in many developed and developing countries. This technique is identical for "Home Gardening" and cultivation of various ornamental plant sp. at home and offices too. Green leafy vegetables are very popular in Asian territories and major part of daily dietary component. Green leafy vegetables are also known for their medicinal and healthiness importance.Green leafy vegetables are rich in Iron, Fibre, Beta-carotene, Phosphorus, Zinc, Magnesium, Calcium, Carbohydrates, and Vitamins along with substantial amount of proteins and minerals. Moisture content is significantly high in green leafy vegetables. Metal composition and presence of bioactive compounds in green leafy vegetables proves,their importance in our daily diet. Composition of micro and macro-elements may vary from species to species. Along with this productivity of green leafy vegetables.

Problem associated with the green leafy vegetable is their availability throughout the year. Most of them are highly seasonal dependent. Hence to solve this problem a hypothesis is developed in form of Hydroponical plant culture technique. This technique is very useful and can be modified in various form such as indoor and outdoor culture. Whereas indoor hydroponical culture system is comparatively more useful in terms of final productivity. Indoor hydroponical culture system could be facilitate with the maintenance of climatic factors such as temperature, humidity, light intensity etc. Some other essential requirement such as nutrient and water supply is also controlled via. Hydroponic technique in both outdoor and indoor system.

Medicinal Importance: Almost all leafy vegetable species are well known for their medicinal importance (Table 1). Medicinal importance of selected plant species is listed below -

II MATERIAL AND METHOD

Along with the selection of leafy vegetable species, a small scale setup for indoor Hydroponical cultivation is designed to perform an experiment as shown in fig 1. This set up is designed for preliminary analysis may require further modifications after observations and accomplishments.

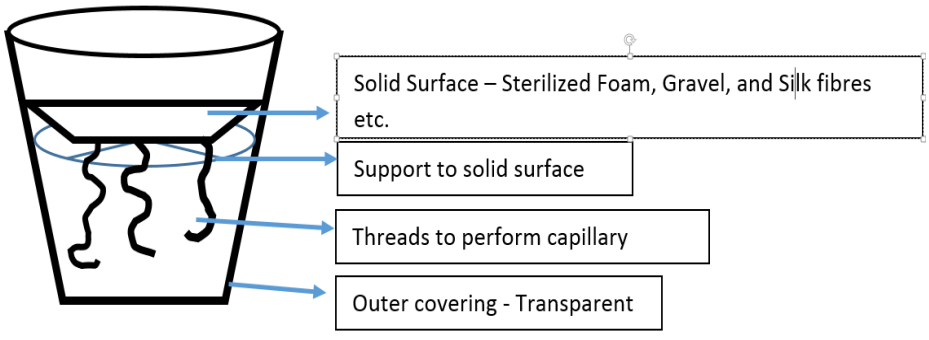


Fig 1. Showing design of Hydroponical setup (Non-Circulating)

(a) **Solid Surface –** This part of the system provides identical solid surface area for sowing seed and expected to bear the weight of the plant including shoot, root, flower etc. This is essential that solid surface should be flexible that can help for easy root and shoot proliferation. Solid surface area can beprepared through sterilized material i.e. silk fibres, coconut fibres, Foam, Gravel etc.

(b) Solid support: Seed initiation is followed by shoot and root growth which causes increase in total mass of plant. Hence, extra support is required to hold shoot area of the plant, above the surface of liquid nutrient media.But, root is completely merged in liquid nutrient medium for absorbing requisite mineral, ions and other substrates.

(c) Capillary threads: This is made up of sterilized fibres that helps to keep solid surface area moist and watery. When the liquid nutrient medium level falls down and makes a significant gap between solid surface and nutrient medium, capillary threads absorbs nutrient and helps in limited upward movement of liquid nutrients. This maintains solid surface area wet and moisten. Because we are designing non-circulatory hydroponical system of plant cultivation so that capillary threads plays an important role of liquid nutrient circulation.

(d) Outer surface: Outer surface is made up of transparent plastic/glass material, hence root growth and proliferation is observed easily for further analysis.

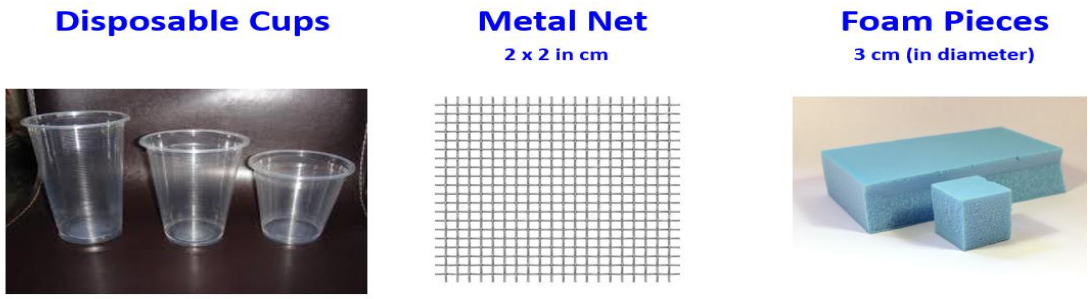


Fig 2: Showing preparation of hydroponical system

Material used for assembling hydroponical unit was collected from local market area. This includes transparent plastic jars, metal net, foam and thread pieces, which are easily available in local market area.

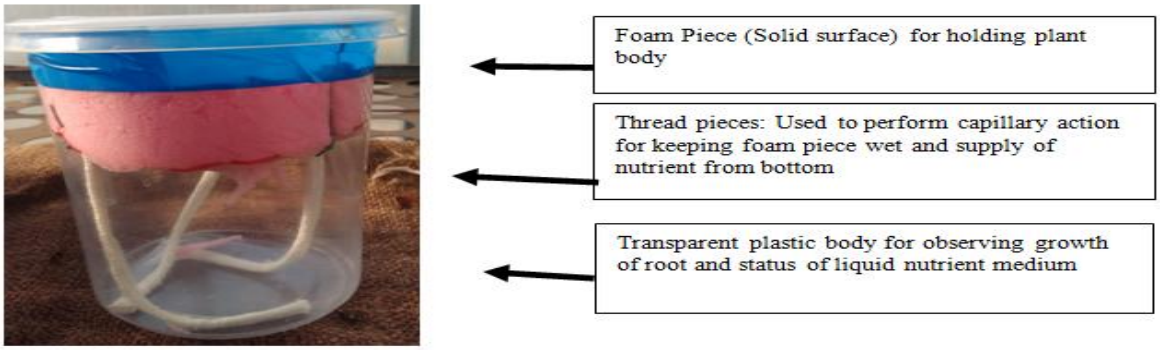


Fig. 3 Final structure of hydroponical system: Indoor use (home and office)

Table 1: Showing medicinal use of plant species selected for cultivation through Hydroponics (Non circulatory method)

Common name Hindi/English	Scientific name	Family	Plant's part of medicinal importance	Medicinal use and other health benefits
Palak/ Spinach	*Spinaciaoleracea*	Amaranthaceae	Leaves	Anaemia, Night Blindness, Acidosis, Jaundice, Heart Diseases, Pregnancy and Urinary
Chauleyi, rajgira/ Spiny pigweed	*Amaranthusviridis.*	Amaranthaceae	Leaves and Root	Stomach pain, jaundice. It is used as anti-inflammatory, antimalarial, antibacterial, antimicrobial, antidiuretic, antiviral, hepatic disorders. Diarrhoea, in excessive menstruation, febrifuge, antipyretic, laxative, diuretic. digestible,
Lal bhaji/ Red calico plant	*Amaranthustricolor*	Amaranthaceae	Leaves	Anti-Inflammatory intestinal cramps, diarrhoea and dysentery (intestinal disorder), and externally as a cooling agent to treat fever. Intestinal inflammation, externally to treat wounds, hepatitis, tight chest, bronchitis, asthma, lung troubles, to stop bleeding and as a hair tonic.
Methi / Fenugreek	*Trigonellafoenumgraceum L.*	Fabacecae	Leaves and seeds	The appetite, relieves fever, alleviates swelling and reduces body fats but vitiates Pitta.Seeds and leaves of fenugreek are used as antitumor, laxative, carminative, uterine tonic etc. and also used in burns.
ChechBhaji / Jute	*Chorchorusolitorius L.*	Tiliaceae	Leaf, Flower and Seeds	Antioxidant, anti-cancerous properties, benign prostatic hyperplasia anti-inflammatory, hepatoprotective, gastroprotective, immunoregulatory and anti-ulcer activities30, and gastroprotective effect.
Khedabhaji	*Amaranthushypochondriacus L.*	Amaranthaceae	Leaves, stems and seeds	Treatment of tumours of the mouth and throat. Leaf extracts are used as antifungal and antibacterial remedies. Some other medicinal use are treating nausea, asthma, burns, stomach distress, anaemia, diabetes and hypertension.
Muli /Radish	*Raphanussativus L.*	Brassicaceae	Leaves and root	whooping cough, cancer, gastric discomfort, liver problems, constipation, dyspepsia, gallbladder problems, arthritis, gallstones, kidney stones etc.

Other Requirement:

Light Source: Requirement of light period is depend upon plant species. Usually plants are categorized into three types such as long day plant, short day plant and day neutral plant. In this study optimum requirement of light is maintained via. DL (Dark and Light) ratio as 12:12**.** This is meant to provide average light requirement to all selected species of plant.

Temperature: Many metabolic reactions inside plant body including transpiration rate is dependent upon environmental temperature. A common routine thermos-sensor associated with air-condition unit is used to maintain temperature around experimental model. Hence, optimum temperature helps to attain maximum growth of the selected plant's species.

Humidity: High humidity is always beneficial for plant growth. Usually humidity above 98% is ideal for plant growth. Humidity is measured by using hygrometer purchased from local market area.

Nutrient Media preparation: Nutrient media is composed of various macro and micro elements mandatory for plant growth. Among them Nitrogen (N), Phosphorus (P), Potassium (K), Magnesium (Mg), Calcium (Ca), Sulphur (S) are categorized as major elements required for plant growth. On the other hand Boron (B), Chlorine (Cl), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Zinc (Zn) can be placed in the category of Micronutrient. In addition Silicon (Si), Sodium (Na), Iodine (I), Cobalt (Co), Selenium (Se) and Vanadium (V) etc. may play significant role in plant growth but it's depend upon requirement of plant species. Most important thing is their concentration in nutrient medium requirement of various elements may vary from species to species except some nutrients and elements. Hence established and successfully applied nutrient medium is prepared, based on earlier report of Jones, 2005.

Table 2: Broad range nutrient solution (Jones, 2005)

Major Elements

Element	Ionic form	Concentration Range mg/L, ppm
Nitrogen (N)	NO_3^-, NH_4^+	100 – 200
Phosphorus (P)	HPO_4^{2-}, $H_2PO_4^-$	15 - 30
Potassium (K)	K^+	100 – 200
Calcium (C)	Ca^{2+}	200 – 300
Magnesium (Mg)	Mg^{2+}	30 – 80
Sulfur (S)	SO_4^{2-}	70 - 150

Micronutrient

Element	Ionic form	Concentration Range mg/L, ppm
Boron (B)	BO_3^{3-}	0.03
Chlorine (Cl)	Cl^-	-

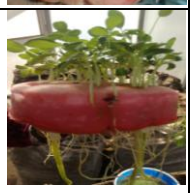
Copper (Cu)	**Cu^{2+}**	**0.01 – 0.10**
Iron (Fe)	**Fe^{2+}, Fe^{3+}**	**2 – 12**
Manganese (Mn)	**Mn^{2+}**	**0.5 – 2.0**
Molybdenum (Mo)	**$Mo0_4^-$**	**0.05**
Zinc (Zn)	**Zn^{2+}**	**0.05 – 0.50**

III RESULT

All the selected species of plants shown significant feasibility with hydroponic system in terms of seed initiation, shoot and root growth. Growth pattern and time was dissimilar between them because of their natural propensity but it was analysed that it was identical in comparison with field cultivation of same species. Result shown seed initiation in *C. olitorius, A. viridis, A. tricolor, S. oleracea* and *A. hypochondriacus L*. was observed earlier (after 3 days of sowing) on the other hand seed initiation in *R. sativus* and *T. foenumgraceum*was observed after 5thand 7thdays after propagating. Shoot and root formation is clearly observed in *C. olitorius, A. viridis, A. tricolor, S. oleracea* and *A. hypochondriacus L.* after 5 days and *R. sativus* after 7 days. In sp. *T. graceum*shoot and root formation was comparatively late and observed after 10 days of seed sowing.

Fig. 4: Showing growth of selected plant species in Hydroponic system

Common name Hindi/English	**Scientific name**	**Family**	**Root-Shoot growth**
Palak/ Spinach	*Spinaciaoleracea*	Amaranthaceae	
Chauleyi, rajgira/ Spiny pigweed	*Amaranthusviridis*.	Amaranthaceae	
Lal bhaji/ Red calico plant	Amaranthustricolor	Amaranthaceae	
Methi / Fenugreek	*Trigonellafoenumgraceum L.*	Fabacecae	

ChechBhaji / Jute	*Chorchorusolitorius L.*	Tiliaceae	
Khedabhaji	*Amaranthushypochondriacus L.*	Amaranthaceae	
Muli (Mooli)/Radish	*Raphanussativus L.*	Brassicaceae	

Establishment and proliferation of small roots in liquid nutrient medium was followed by shoot proliferation over above the solid surface area in all the model plant species. Primary leaf development was also noticed after root generation. All changes and developmental stages were easily apparent and can be analysed by naked eye. Scientifically growth measurement was analysed and expressed, shown in Table 3. Factors considered to analysed plant development were as listed below

1. By measuring length of shoot and root.
2. By measuring total body mass (Weight)
3. By counting no. of leaves

Table 3: Showing measurement of plant growth based on above mentioned factors.

Plant Species	**Weight of Hydroponical setup (A) + Seeds sowed in day 1 (gm) ± 1**	**Weight of liquid nutrient (B) in ml = gm**	**Total Weight C A + B = C (Initial weight)**
		750 = 750 gm	**137+750 = 887**
Spinaciaoleracea	137 gm	750 gm	887 gm
Amaranthusviridis.	138 gm		888 gm
Amaranthustricolor	137gm		887 gm
Trigonellafoenumgraceum L.	137 gm		887 gm
Chorchorusolitorius L.	139 gm		889 gm
Amaranthushypochondriacus L.	138 gm		888 gm
Raphanussativus L.	138 gm		888 gm

Plant Species	Weight after 5 days (D)± 1 C – D	Weight after 10 days (E)± 1 C - E	Weight after 15 days (F)± 1 C - F
Spinaciaoleracea	887 – 890 = 3gm	887 – 896 = 09 gm	887 – 905 =18 gm
Amaranthusviridis.	888 – 893 = 5 gm	888 – 903 = 15 gm	888 – 916 = 28 gm
Amaranthustricolor	887 – 895 = 8 gm	887 – 906= 19 gm	887 – 915 = 28 gm
Amaranthushypochondriacus L.	888 – 891 = 3 gm	888 – 897= 09 gm	888 – 902= 14 gm
Chorchorusolitorius L.	889 – 892 = 7 gm	889 – 906 = 17 gm	889 – 916 = 27 gm
Trigonellafoenumgraceum L.	887 – 888 = 1 gm	887 – 892 = 05 gm	887 – 899= 12 gm
Raphanussativus L.	888 – 891 = 3 gm	888 – 899 = 11 gm	888 – 909 = 21 gm

Note: While measuring weight after 5, 10, 15 days after sowing seed, each time initial weight varies due to evaporation and absorption of nutrient medium. Hence it was externally added to make up weight upto 750 gm (Weight of liquid medium - B).

IV DISCUSSION

Feasibility of hydroponics to cultivated selected plants species used as leafy vegetables in central region of India – Chhattisgarh. Not only in Chhattisgarh are all selected species very popular among other part of Indian Territory. Except spinach all other selected species are seasonally available in local market of India. But applied methodology can solve this problem and make possible availability of these healthy and medicinally important plant species throughout year. Shoot and root growth was observed successfully and comparative study reveals that this could be beneficiary over traditional method of plant cultivation. Truthfully seedlings and flowering was not observed in this short term study. Hence, some more research studies are required to approve this unpopular technology of agriculture at global level. This study is showing potentiality of hydroponic to cultivate plants with minimum requirement and least labour to grow plants, economically and medicinally important for us. Moreover,Quality of produce is in control of hand, obtained by continuous supply of nutrient in right amount. Environmental factors are also controlled in this method, resulting maximum growth of plant.

V CONCLUSION

Many crops plants are being cultivated by farmers in Hydroponic system in many parts of the world. But comparatively area covered by hydroponic system is very smaller in comparison to field cultivation at global level. This may be possible due to effort made for its popularity or beneficiary approach of hydroponic system. However experiment divulges small scale set with fractional experimental output but enough to make conclusion. Scientific studies always strengthens and helps to validate assumption of peoples present in our society. Adopting new and latest technology without disturbing regular source of food supply from traditional method can fulfil requirement of rising population. Necessity of food supply for large human population is still a challenge. This overcome this challenge is only possible through research and developmental approaches.

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