Analyzing the growth of *Trigonella foenum-graecum* through traditional and modern farming systems

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Abstract
This study aimed to examine the differences among plants grown in soil (Tradition) and hydroponics systems (Modern) and to estimate the quantity of biochemical molecules in the grown-up plant samples. The fruitfulness of the soil had reached its maximum level and usefulness did not increase with the amount of manure applied. The length of root growth of hydroponically grown plants was comparatively higher than that of soil-grown plants.

Similarly, the shoot lengths of hydroponically grown plants were shorter than those of soil-grown plants. The chlorophyll, moisture content, protein, amino acids and carbohydrates were reasonably higher in hydroponically grown plants than in soil-grown plants.

Keywords: Zero soil farming, Biochemical, Qualitative and quantitative analysis.

Introduction
The need for food production depends on the expansion of the population. Considering the reduction in the agricultural landscape, the production is not up to the expected limit. The varying changes like climatic conditions, fertilizers etc., are directly impacting production negatively, thus leading to a food shortage. To overcome such issues, considering the ever-growing population, an alternative modern technology is needed for enhanced production and to increase the farming community's revenue with the limited space available to them. This research attempted to determine possible changes concerning moisture content, carbohydrate, proteins, amino acids etc.

The convenience of using a hydroponics system indoors and outdoors is more suitable and is fit for the purpose, along with controlled climatic considerations increasing yield percentage. The United States of America and the Asia-Pacific region are the two largest markets for hydroponics system usage. Europe ranks in the top three: France, the Netherlands and Spain[15]. Considering the current circumstances, soil-less agriculture is an efficient one. It has been started and explored as a suitable option for raising wholesome crops, vegetables, or food crops[4].

Due to hydroponics, crops are not affected by climate change; hence, they can grow all year round or as off-season crops[10]. This technique makes it easy for the plants to get these three without fighting any soil-borne diseases. The hydroponic method allows plants to grow faster. This could provide us with quite a harvest within the plant season.

Material and Methods
Biomass calculation: *Trigonella foenum-graecum* (Fenugreek) plants were grown in soil and hydroponics systems. After a month, the plants were harvested to find the biomass and moisture content. The experiment was performed in triplicate for both soil and hydroponics-grown plants regarding leaf, roots etc.

Fig. 1: Vertical Hydroponics unit

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Table 1
Tests performed for qualitative analysis of biomolecules

S.N.	Tests
1	CARBOHYDRATES (Iodine Test)
2	LIPIDS (Dichromate Test)
3	AMINO ACIDS (Ninhydrin Test)
4	PROTEINS (Xanthoproteic Reaction)[1]

Fig. 2: Hydroponically grown Fenugreek

Fig. 3: Soil-grown Fenugreek

1. Determination of total carbohydrate (ANTHRONE METHOD): Extraction was done by centrifugation of plant replicates; supernatant was collected and anthrone reagent was added to the standard glucose and test samples. The absorbance was measured at 630 nanometers.

2. Lipids (ZAK'S METHOD): Extraction was done by centrifugation of plant replicates, supernatant was collected and ferric chloride and acetic acid reagents were added to the cholesterol solution and test samples. The absorbance was noted at 560 nanometers.

3. Estimation of total free amino acids (NINHYDRIN METHOD): Extraction was done by centrifuging the plant replicates, the supernatant was collected and the ninhydrin reagent was added to the glycine solution and test samples. The absorbance was noted at 570 nanometers.

4. Protein estimation (LOWRY'S METHOD): Extraction was done by centrifugation of plant replicates, supernatant was collected and Folin-Ciocalteau reagent was added to the bovine serum albumin solution and the test samples. The absorbance was noted at 660 nanometers.

5. Chlorophyll (ACETONE METHOD): Extraction was done by centrifuging the plant replicates and supernatant was collected. Acetone is taken as the blank, which is used as the reagent and the absorbance was read at 645, 652 and 655 nanometers.

Results and Discussion

This experimental setup was used to contrast the traditional soil farming and hydroponic system by growing *Trigonella foenum-graecum* (Fenugreek) seeds on both systems and to estimate the presence of macromolecules. *Trigonella foenum-graecum* (Fenugreek) plants were grown using both soil and hydroponics. After 30 days, the plants were harvested to find the biomass. About 30 plants were taken from both the hydroponic and soil systems. The number of leaves, root length and shoot length were measured and the biomass was calculated.

Qualitative and quantitative tests were performed. The samples considered in this research were the leaves and stems of hydroponically and soil-grown plants. Roots of the plants were not considered due to the presence of higher nutrients than the stem and leaves. In qualitative analysis, the plant samples were tested to estimate the presence and quantity of carbohydrate, protein, lipid and amino acids. In contrast, in quantitative assays, the plant samples were used to estimate the amount of biochemicals present in the sample. The results of these findings were in line with the findings of Ranawade et al[16] in the biochemical analysis of *Spinacia oleracea*.

In quantitative analysis, while comparing the plants grown in hydroponics and soil systems, the hydroponically grown plant shows more carbohydrate (2.54 Au), protein (0.74Au), lipid (0.23Au), amino acid (0.84Au) and chlorophyll

(0.84Au, 0.78Au, 0.35Au) content than the plants grown in the soil system.

Quantitative analysis results: S and T represent the standard solution and the hydroponic samples respectively.

S1- Standard 1; S2 - Standard 2; S3 - Standard 3; S4 - Standard 4; S5 - Standard 5.
T1 – Hydroponic leaf; T2 – Soil leaf; T3 – Hydroponic stem. T4 – Soil stem; T5 – Control.

Fig. 4: Plants grown in soil

Fig. 5: Plants grown in hydroponics

Table 2
Biomass of hydroponically grown Fenugreek (performed in triplicate)

S.N.	Plants	No. of Leaves	Root Length	Shoot Length	Total Length of the Plant
1.	Plant 1	2	4.7	8.6	13.3
2.	Plant 2	2	6	7.6	13.6
3.	Plant 3	2	5.4	8.5	13.9
4.	Plant 4	2	5	7.8	12.8
5.	Plant 5	2	4	8.8	12.8
6.	Plant 6	2	7	6.2	13.2
7.	Plant 7	2	7.3	6.2	13.5
8.	Plant 8	2	7	6.9	13.9
9.	Plant 9	2	5.1	7.4	12.5
10.	Plant 10	2	5.3	8	13.3

Table 3
Biomass of Fenugreek grown in soil (performed in triplicate)

S.N.	Replicate 1 (Plants)	No. of Leaves	Root Length	Shoot Length	Total Length of the Plant
1.	Plant 1	2	5.3	7.4	12.7
2.	Plant 2	2	5.7	8.2	13.9
3.	Plant 3	2	6	7.1	13.1
4.	Plant 4	2	4	8.2	12.2
5.	Plant 5	2	4.2	8.9	13.1
6.	Plant 6	2	5.6	7.1	12.7
7.	Plant 7	2	5.9	8	13.9
8.	Plant 8	2	3.4	10.4	13.8
9.	Plant 9	2	6.2	7.7	13.9
10.	Plant 10	2	6	8.4	14.4

Table 4
Results of Qualitative analysis

S.N.	Test name	Observation	Results of the leaf		Results of the stem	
			Hydroponically grown	Soil grown	Hydroponically grown	Soil grown
1	Carbohydrate	Formation of brownish-red precipitate	+	-	+	-
2	Amino acid	Formation of purple colour	+	+	+	+
3	Lipids	Colour change from brown to blue	+	M	M	+
4	Protein	Formation of yellow colour	+	+	+	M

+ indicates positive; - indicates negative and M indicates moderate results for the tests

Table 5
Estimation of Chlorophyll in hydroponically and soil-grown *Trigonella foenum–graecum* at different nanometers.

Test solution	T1 (Hydroponically grown plants)			T2 (Soil-grown plants)		
Colorimeter readings	645 nm	652 nm	665 nm	645 nm	652 nm	665 nm
1	0.77	0.67	0.33	0.77	0.71	0.32
2	0.87	0.80	0.35	0.87	0.78	0.34
3	0.88	0.87	0.37	0.91	0.8	0.36
Mean	**0.84**	**0.79**	**0.35**	**0.85**	**0.78**	**0.34**

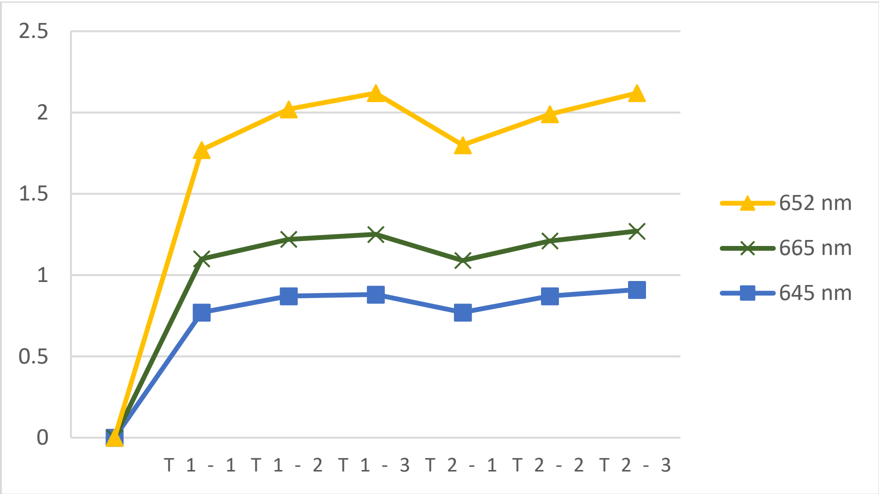

Fig. 6: Estimation of chlorophyll

Table 6
Estimation of Carbohydrates in hydroponically and soil-grown

Stock Solution	Colorimeter Readings (610 nm)			
	1	**2**	**3**	**Mean**
S1	1.30	1.30	1.30	1.3
S2	1.39	1.52	1.52	4.43
S3	1.69	1.69	1.69	3.94
S4	1.09	1.09	1.09	2.54
S5	1.69	1.69	1.69	3.94
T1	1.09	1.09	1.09	**2.54**
T2	0.62	0.69	0.72	1.55
T3	0.58	0.60	0.60	**1.78**
T4	0.40	0.43	0.44	0.97
T5	0.11	0.13	0.14	0.28

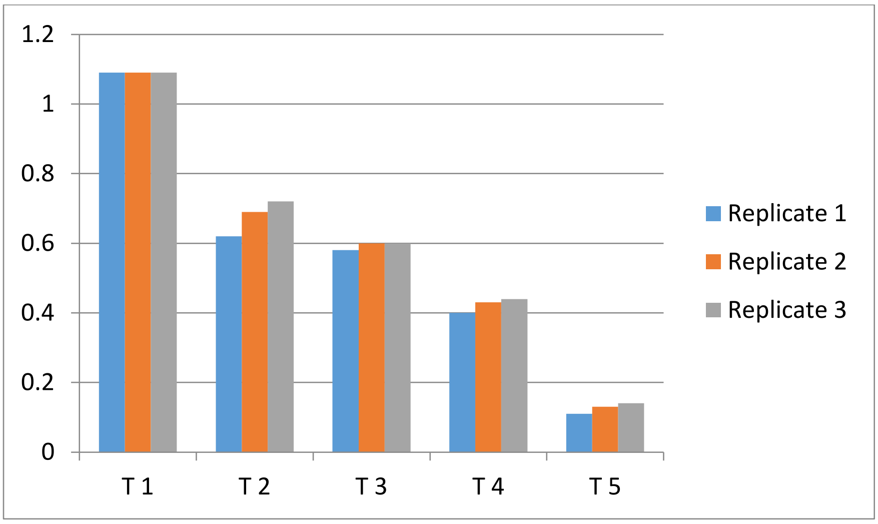

Fig. 7: The bar graph shows the graphical results of carbohydrate estimation in hydroponically and soil-grown *Trigonella foenum-graecum*

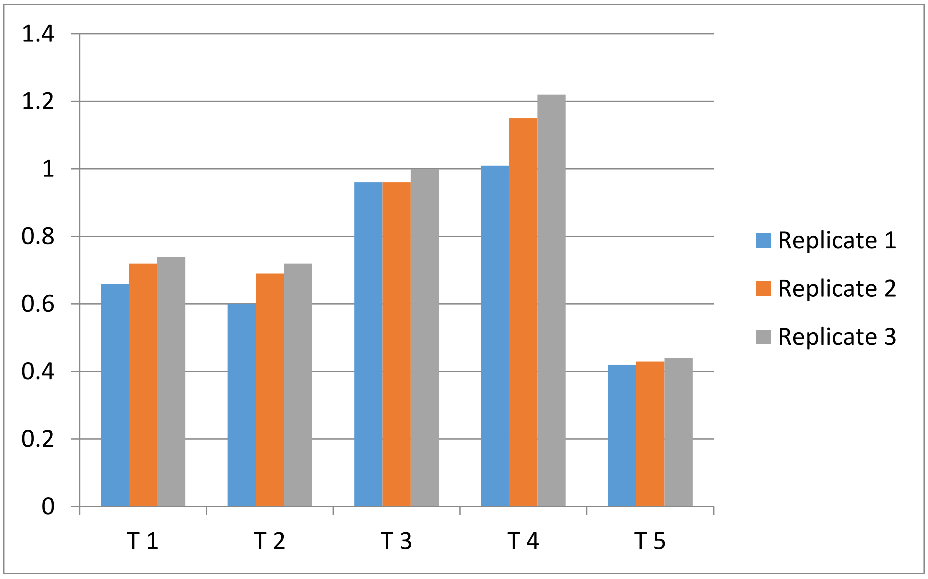

Fig. 8: The bar graph shows the graphical results of protein estimation in hydroponically and soil-grown *Trigonella foenum graecum*

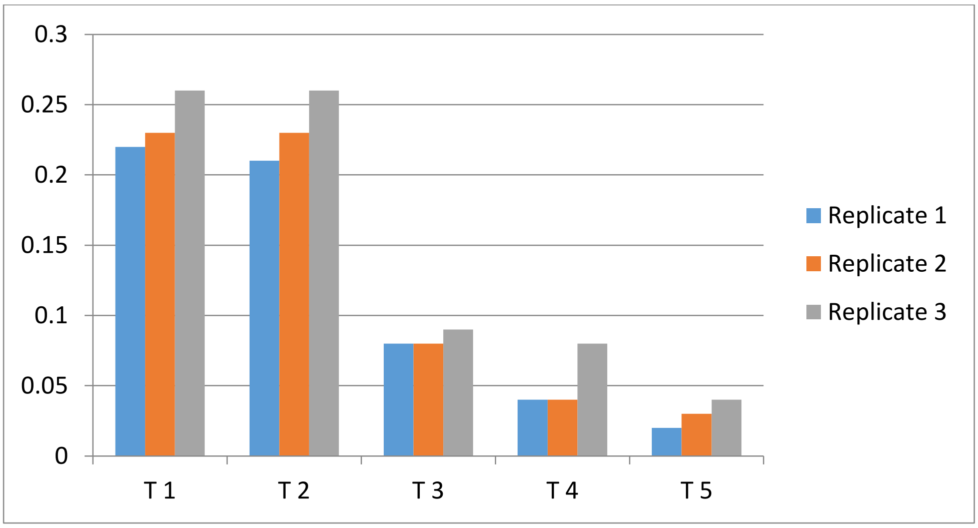

Fig. 9: The bar graph shows the graphical results of lipid estimation in hydroponically and soil-grown *Trigonella foenum-graecum*

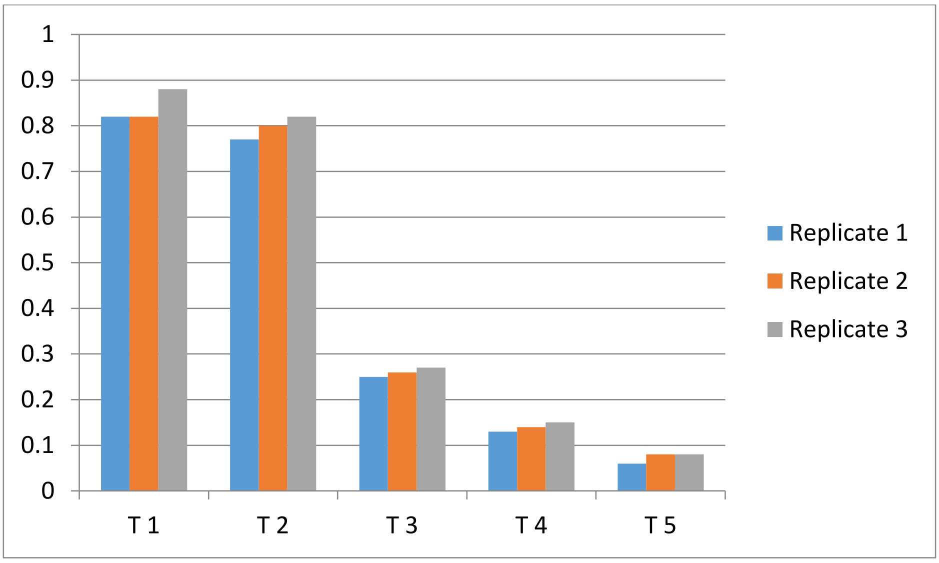

Fig. 10: The bar graph shows the graphical results of amino acid estimation in hydroponically and soil-grown *Trigonella foenum-graecum*

Table 7
Estimation of Protein in hydroponically and soil-grown *Trigonella foenum graecum*

Stock Solution	Colorimeter Readings (610 nm)			
	1	2	3	Mean
S1	0.77	0.77	0.80	0.69
S2	0.72	0.77	0.80	0.76
S3	0.88	0.92	0.96	0.78
S4	0.68	0.62	0.77	0.92
S5	0.80	0.82	0.88	0.83
T1	0.74	0.72	0.66	0.74
T2	0.60	0.69	0.72	0.66
T3	0.96	1.00	0.96	0.97
T4	1.22	1.15	1.01	1.12
T5	0.42	0.43	0.44	0.43

Table 8
Estimation of lipid in hydroponically and soil-grown *Trigonella foenum-graecum*

Stock Solution	Colorimeter Readings (610 nm)			
	1	2	3	Mean
S1	0.05	0.06	0.07	0.06
S2	0.08	0.09	0.09	0.08
S3	0.10	0.11	0.11	0.10
S4	0.14	0.14	0.16	0.14
S5	0.14	0.16	0.16	0.15
T1	0.22	0.23	0.26	**0.23**
T2	0.21	0.23	0.26	**0.23**
T3	0.08	0.08	0.09	**0.08**
T4	0.04	0.05	0.08	0.05
T5	0.02	0.03	0.04	0.03

Conclusion

The research attempted to evaluate the enrichment of proteins, amino acids and carbohydrates through traditional soil farming and modern hydroponic farming of *Trigonella foenum-graecum* (Fenugreek) seeds. The traditional system requires a vast workforce, whereas the hydroponic system requires less power and labor and is cost-effective. pH and nutrient levels must be adequately checked to ensure proper plant growth. The hydroponic planting system showed better results than traditional soil farming and did not significantly affect the length of leaves and plants.

Table 9
Estimation of amino acids in hydroponically and soil-grown *Trigonella foenum-graecum*

Stock Solution	Colorimeter Readings (610 nm)			
	1	2	3	Mean
S1	0.04	0.05	0.06	0.05
S2	0.04	0.05	0.07	0.05
S3	0.04	0.04	0.08	0.05
S4	0.03	0.03	0.05	0.03
S5	0.03	0.03	0.04	0.03
T1	0.82	0.82	0.88	**0.83**
T2	0.77	0.80	0.82	0.79
T3	0.25	0.26	0.27	**0.26**
T4	0.13	0.14	0.15	0.14
T5	0.06	0.08	0.08	0.07

The crops grew faster and taller. The nutrient added to the process does not affect the plant growth. The hydroponics system enhanced the production of proteins, amino acids and carbohydrates compared to traditional/soil farming. A hydroponic system plays a vital role in food production for the entire world population. Hydroponic system uses 99% less water than traditional farming, it is a reservoir method in which the water is recycled again and designed to grow with minimal water. The hydroponic system had an advantage over economically friendly and less time-consuming than traditional soil farming. To encourage traditional farming, it is important to develop cost-efficient hydroponic techniques that, in turn, reduce dependence on human labor and production costs. There are worries about the seasonal changes, as crops can be grown all year round. Healthy crops are grown with high yield, with no chances for insects and pests. The system is more organic, toxin-free and is of better quality, which is observed through the tests compared with traditional soil farming.

Considering the population's growing demand, the increase in dwelling areas and the reduction in farming areas, the hydroponics system should have adopted soon. The research reports support providing the enriched content with less space and water available for circulation, which will benefit the consumer without having the side effects of fertilizers, pesticides and contaminants. This research will pave the way for researchers.

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