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Effect Of Jeevamrutham On The Cultivation Of Leafy Vegetable *Hibiscus Sabdariffa L.*

Uma Maheswari P[1], Sunanda Kumar E[2], Tirupathi Swamy N[3]

[1 & 2] Department of Botany, V.S.U. College, Kavali

[3] Department of Botany, TRR Government Degree College, Kandukur

ABSTRACT

Organic farming is a production system, which substantially reduces the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives. Organic farming is a holistic agricultural system that enhances soil quality. Jeevamrutham is a traditional organic fertilizer and soil conditioner derived from natural ingredients such as cow dung, cow urine, jaggery, gram flour, and water. It's a concoction rich in beneficial microorganisms, nutrients, and organic matter, widely used in organic farming to enhance soil fertility, promote plant growth and improve crop yield. *Hibiscus sabdariffa*, annual herbaceous shrub belongs to the family malvaceae, commonly known as Roselle. It is widely used as leafy vegetable having rich nutrients besides therapeutic characteristics included antihypertensive, anti-hyperlipidemic, anti-inflammatory, antimicrobial, diuretic, uricosuric, and anemia-treating effects. The study investigates that application of jeevamrutham on *Hibiscus sabdariffa* enhanced the physicochemical properties of the soil such as pH, EC, N, P, K and organic carbon content. The quantity of Photosynthetic Pigments, Carbohydrates and Proteins are also increased in addition to an increase in biomass, shoot length, root length, number of branches and leaves. This finding suggests that Jeevamrutham can be efficiently used as organic fertilizer to improve growth, development and yield of *Hibiscus sabdariffa.*

Keywords: Organic Farming, Jeevamrutham, Soil Fertility, Yield, *Hibiscus sabdariffa.*

1.INTRODUCTION

Organic farming has gained importance in recent years as an environmentally sustainable alternative to conventional farming. This system of agriculture is based on the avoidance of synthetic chemicals, focusing instead on natural substances to maintain soil health and promote plant growth. One such organic fertilizer is Jeevamrutham, a concoction made from cow dung, cow urine, jaggery, gram flour, and water. Jeevamrutham is a rich source of beneficial microorganisms, essential nutrients, and organic matter. It has been widely adopted in organic farming to improve soil quality, increase fertility, and enhance crop yields.

Hibiscus sabdariffa L., commonly known as Roselle, belongs to the family Malvaceae. It is a herbaceous plant cultivated for its nutritional and therapeutic values, offering antihypertensive, anti-inflammatory, diuretic, and antimicrobial properties. Traditionally, its leaves are used as leafy vegetables in many cultures. The present study aims to investigate the effects of Jeevamrutham on the growth, development, and biochemical properties of Hibiscus sabdariffa under organic farming conditions. We assess soil nutrient content, water quality parameters, morphological characteristics, photosynthetic pigments, carbohydrates, and protein levels in treated and control plants.

Jeevamrutham is one of the important components of Zero Budget Natural Farming (ZBNF) (Bishal Chakraborty et al., 2019). Jeevumrutham is extremely cost effective for the grower (FAO, 2016). Liquid organic manures can be used to alleviate temporary nutritional shortages. When nutrient uptake through the roots is interrupted, foliar spray stimulates growth (Nitin and Purohit, 2021).

Jeevamrutham is only required for the first three years of the transition; then after, the system is self-sufficient (Mahanta et al., 2021). One of the most difficult challenges for organic farmers is identifying regionally appropriate crop cultivars that can grow in organic management set- tings without chemical inputs (Nooprom and Bueraheng, 2021). Relevant scientific data on the time and frequency of application of jeevamrutham, as well as the effect of jeevamrutham doses in various quantities on crop productivity, are lacking in Zero Budget Natural Farming. Following the application of jeevamrutham, improvements in the physicochemical characteristics of the soil, particularly soil OC, were also validated by Sharma and Adekiya et al (2022). In calcareous soil, PSB as a biofertilizer has the ability to neutralize the effects of induced salinity or alkalinity and increase P availability through soil acidification.

Additionally, among the issues include a lack of funds to purchase chemical fertilizers abroad and an inadequate supply of fertilizer (Adeyemi, Komolafe & Akindele, 1989; Olufolaji et al. 1987). Organic farming has its roots in traditional agricultural practices that evolved in countless villages and farming communities over the millennium (Veni et al. 2020). Kulkarni and Gargelwar (2019) analyzed Jeevamrutham for nitrogen fixers and phosphate solubilizers, highlighting its microbial efficacy and application in sustainable agriculture. La Via Campesina (2016) documented case studies on agroecology, including Zero Budget Natural Farming in India, showcasing the successful application of organic practices in diverse agricultural contexts. Moreira et al. (2018) compared soil management methods and sowing depths in corn cultivation, illustrating how organic practices can optimize soil conditions and enhance crop yields. Murugesan, A. G., and Rajakumari, C. (2019) authored a comprehensive textbook on environmental science and biotechnology, covering theoretical and practical aspects.

Jeevamrutham serves as the rich source of the microorganism that fixes nitrogen, solubilize phosphorus. Also, it is the rich source of carbon, nitrogen, phosphorus, potassium and many micronutrients (Devakumar et al. 2014; Sreenivasa et al. 2010). The use of Jeevamrutham is the best alternative to chemical fertilizer and our bio-enhancer could be potent source to improve soil fertility, crop productivity and quality (Kulkarni & Gargelwar, 2019). Impact of Jeevamrutham formulations and biofertilizers on soil microbial and chemical attributes during potato cultivation (Gurjar, R. P. S., Bhati, D., & Singh, S. K. (2024)).

Objective: To study the effect of Jeevamrutham on Physicochemical and morphological parameters with regard to the cultivation of leafy vegetable *Hibiscus sabdariffa L.*

2.MATERIALS AND METHODS

2.1 Study Area and Plant Material

The experiment was conducted at the V.S.U. College Botanical Garden in Kavali, Andhra Pradesh. Seeds of Hibiscus sabdariffa were sourced from a certified organic farm and sown in prepared beds.

2.2 Experimental Design

The experiment was conducted in a randomized block design with two treatments. Control (C): Plants grown without Jeevamrutham application. Treatment (T): Plants grown with regular applications of Jeevamrutham. The experiment was carried out over a period of 45 days, with regular monitoring of growth parameters.

2.3 Jeevamrutham Preparation and Application

Cow dung: 5 kg, Cow urine: 5 liters, Jaggery: 500 g, Gram flour: 500 g, Water: 100 liters. The mixture was stirred thoroughly and allowed to ferment for 7 days. Once ready, Jeevamrutham was diluted at a ratio of 1:10 with water and applied to the treatment plots every 10 days.

2.4. Physicochemical Analysis of Soil

Soil samples were collected before and after the experiment. Parameters such as pH, electrical conductivity (EC), organic carbon (OC), nitrogen (N), phosphorus (P), potassium (K), and micronutrients like zinc (Zn), iron (Fe), manganese (Mn), copper (Cu), boron (B), and sulfur (S) were measured.

2.5 Water Quality Analysis

Irrigation water used for the experiment was analyzed for pH, EC, bicarbonates (HCO3), calcium (Ca), magnesium (Mg), chloride (Cl), sodium (Na), and residual sodium carbonate (RSC) levels. Sodium Adsorption Ratio (SAR) was calculated to assess the water quality.

2.6. Plant Growth and Physiological Measurements

Morphological parameters such as plant height, shoot length, leaf length, leaf width, mid-vein length, lateral veins, root length, number of branches, and number of leaves were measured weekly. Physiological parameters, including photosynthetic pigments (chlorophyll a, b, and carotenoids), were estimated following DMSO extraction technique as described Hiscox and Israelstam (1979) method. Biomass was also calculated by harvesting selected plants at the end of the experiment.

2.7. Biochemical Analysis

Carbohydrate and protein content in the leaves was determined using standard methods (Anthrone method for carbohydrates and Biuret method for proteins).

2.8. Statistical Analysis

The data were analyzed using paired sample t-test, and significant differences between control and treatment groups were determined at 5% significant level.

3.RESULTS AND DISCUSSION

3.1. **Soil Nutrient Content**

Application of Jeevamrutham significantly enhanced the physicochemical properties of the soil. The pH of the soil decreased slightly from 8.1 to 7.2 in the treatment plot, indicating improved soil condition for nutrient availability. Organic carbon (OC) content increased, promoting microbial activity and nutrient retention. Levels of nitrogen, phosphorus, and potassium were also higher in the treated plots compared to the control (N: 163 mg/kg in T vs. 151 mg/kg in C; P: 20 mg/kg in T vs. 15 mg/kg in C).

Variety of Nutrients	**Hibiscus sabdariffa**	
pH	Control	Treatment
pH	7.2	8.1
Ec	0.2	0.4
Oc	0.38	0.11
N	151	163
P	15	20
K	129	103
Zn	0.52	0.62
Fe	6.07	7.00
Mn	0.3	0.5
Cu	0.1	0.3
B	0.6	08
S	93	33

Table 1. Showing soil nutrient parameters

3.2. Water Quality Parameters

Water quality parameters were within acceptable limits for plant growth, with a stable pH of 7.3 and low EC of 0.9 dS/m. The Sodium Adsorption Ratio (SAR) was calculated as 1.295, indicating no risk of soil degradation due to sodium.

Variety of nutrients	Hibiscus sabdoriffa (Irrigated water)
pH	7.3
Ec	0.9 dS/m
HCO3	5.68 meq/L
Ca + Mg:	6.64 meq/L
Cl	5.92 meq/L
Na	2.36 meq/L
R.S.C	-0.96 meq/L
S.A. R	1.295

Table 2. Showing water quality nutrient parameters

3.3 Physiological and Morphological Characteristics

The data from a T-test with descriptive statistics, comparing control and treatment groups across different plant parameters such as plant height, shoot length, leaf length, and more, at different time points.

Plant Height (cm)

1. **April 8th (0804)**: **Control**: Mean = 4.10, Std. Dev = 0.10, **Treatment**: Mean = 4.33, Std. Dev = 0.05774, Slight increase in plant height with treatment.
2. **April 15th (1504)**: **Control**: Mean = 5.25, Std. Dev = 0.05, **Treatment**: Mean = 5.48, Std. Dev = 0.10408, Continued height increase in the treated plants.
3. **April 22nd (2204)**: **Control**: Mean = 7.38, Std. Dev = 0.16073, **Treatment**: Mean = 7.82, Std. Dev = 0.07638, Treated plants have shown significant growth.
4. **April 29th (2904)**: **Control**: Mean = 8.05, Std. Dev = 0.08660, **Treatment**: Mean = 8.33, Std. Dev = 0.15275, Growth remains consistent, with treated plants slightly taller.
5. **May 6th (0605)**: **Control**: Mean = 8.78, Std. Dev = 0.20207, **Treatment**: Mean = 9.73, Std. Dev = 0.25166, Treated plants show a substantial increase in height compared to the control.
6. **May 13th (1305)**: **Control**: Mean = 10.20, Std. Dev = 0.10, **Treatment**: Mean = 11.30, Std. Dev = 0.10, Both groups have grown, with the treated group taller than the control.

Shoot Length (cm)

1. **April 8th**: **Control**: mean = 2.73, std. Dev = 0.15275, **Treatment**: mean = 2.97, std. Dev = 0.20817, Treated plants show marginally greater shoot length.
2. **April 15th**: **Control**: Mean = 3.07, Std. Dev = 0.15275, **Treatment**: Mean = 4.07, Std. Dev = 0.15275.A significant increase in shoot length for treated plants.
3. **April 22nd**: **Control**: Mean = 3.50, Std. Dev = 0.10, **Treatment**: Mean = 4.30, Std. Dev = 0. 26458.Clear improvement in shoot length for the treated plants.
4. **April 29th**: **Control**: Mean = 4.17, Std. Dev = 0.28868, **Treatment**: Mean = 4.43, Std. Dev = 0. 15275.Treated plants continue to outgrow the control group.
5. **May 6th**: **Control**: Mean = 4.25, Std. Dev = 0.05, **Treatment**: Mean = 4.85, Std. Dev = 0.05. Continued increase in treated plants' shoot length.
6. **May 13th**: **Control**: Mean = 4.78, Std. Dev = 0.02887, **Treatment**: Mean = 5.35, Std. Dev = 0.05. Treated plants exhibit further shoot length growth.

Leaf Length (cm)

1. **April 8th**: **Control**: Mean = 4.88, Std. Dev = 0.02887, **Treatment**: Mean = 6.05, Std. Dev = 0. 08660.Significant improvement in leaf length for treated plants.
2. **April 15th**: **Control**: Mean = 5.18, Std. Dev = 0.02517, **Treatment**: Mean = 9.60, Std. Dev = 0.10. Remarkable increase in leaf length with treatment.
3. **April 22nd**: **Control**: Mean = 5.28, Std. Dev = 0.02887, **Treatment**: Mean = 10.25, Std. Dev = 0.05. Further increase in leaf length in the treated group.
4. **April 29th**: **Control**: Mean = 5.15, Std. Dev = 0.05, **Treatment**: Mean = 11.80, Std. Dev = 0.10. Treated plants show exceptional leaf growth.
5. **May 6th**: **Control**: Mean = 5.93, Std. Dev = 0.07638, **Treatment**: Mean = 12.35, Std. Dev = 0.05. Treated plants continue to outperform in leaf growth.
6. **May 13th**: **Control**: Mean = 6.88, Std. Dev = 0.02646, **Treatment**: Mean = 12.70, Std. Dev = 0.26388. Treated plants have a significant leaf size advantage.

Root Length (cm)

1. **April 8th**: **Control**: Mean = 3.92, Std. Dev = 0.07638, **Treatment**: Mean = 4.85, Std. Dev = 0.04509. Treated plants have a larger root system.
2. **April 15th**: **Control**: Mean = 4.32, Std. Dev = 0.07638, **Treatment**: Mean = 4.90, Std. Dev = 0.10. Moderate root length increases in treated plants.
3. **April 22nd**: **Control**: Mean = 4.92, Std. Dev = 0.10408, **Treatment**: Mean = 5.38, Std. Dev = 0.02000. Treated plants continue to have longer roots.
4. **April 29th**: **Control**: Mean = 5.15, Std. Dev = 0.05, **Treatment**: Mean = 5.75, Std. Dev = 0.05. Similar trend with treated plants showing better root growth.
5. **May 6th**: **Control**: Mean = 5.32, Std. Dev = 0.07638, **Treatment**: Mean = 5.78, Std. Dev = 0.20664. Slight improvement in root length with treatment.
6. **May 13th**: **Control**: Mean = 5.78, Std. Dev = 0.02887, **Treatment**: Mean = 6.36, Std. Dev = 0.05292. Treated plants exhibit better root development.

Branch and Leaf Number

1. **Branch Number**:
   - Treated plants consistently show a higher number of branches, especially by the later dates (e.g., 9.83 branches on May 13th, compared to 8.88 in the control group).
2. **Leaf Number**:
   - By the end of the study, treated plants exhibit a higher number of leaves, with 17.97 leaves on May 13th compared to 15.93 in the control group.

General Observation:

In all parameters, treated plants (with treatment) show consistently higher growth metrics than control plants across various time points. The treatment positively influenced plant height, shoot length, leaf dimensions, root growth, branch and leaf numbers. This indicates the treatment provided a beneficial effect on overall plant development.

Results

A paired sample t-test was conducted to evaluate the effect of treatment on various plant morphological parameters (plant height, shoot length and width, leaf length and width, root length, number of branches, number of leaves, mid-vein length, and lateral veins) at different time points.

Plant Height:

- **April 8th (Pair 1):** The mean difference between control and treated plants was significant, with treated plants showing a reduction in height (M = -0.233 cm, p = 0.020), indicating a 23.3% lower height in the treated plants.
- **April 22nd (Pair 3):** A significant difference was also observed (p = 0.039), with treated plants being shorter (M = -0.433 cm).
- **May 6th (Pair 5):** The largest decrease in height was observed on this date (M = -0.950 cm, p = 0.001), suggesting a substantial impact of treatment on plant height over time.

Shoot Length and Width:

- **April 8th (Pair 7 & 8):** Shoot length showed a significant reduction (M = -0.233 cm, $p = 0.020$), while shoot width also decreased, though not statistically significant ($p = 0.053$).
- **May 13th (Pair 17 & 18):** A significant decrease in shoot length was noted (M = -0.566 cm, $p = 0.001$). Shoot width also showed a sharp decrease (M = -4.466 cm, $p < 0.001$), indicating a more pronounced effect on shoot width at this stage.

Leaf Dimensions:

- **April 8th (Pairs 20 & 21):** A significant reduction in leaf length was observed (M = -1.166 cm, $p = 0.003$), while leaf width decreased drastically by 2.86 cm ($p < 0.001$).
- **May 13th (Pair 30):** An increase in leaf length was observed (M = 7.946 cm, $p < 0.001$), while leaf width showed a decrease ($p < 0.001$), indicating a differential response in leaf dimensions to the treatment.

Root Length:

- **May 6th (Pair 49):** A notable decrease in root length was observed (M = -0.463 cm, $p = 0.037$), indicating that the treatment had a significant effect on root development at this time point.

Mid-Vein and Lateral Veins:

- **Mid-Vein Length (Pairs 33-38):** Mid-vein length showed a significant reduction at all time points, with the most extreme decrease occurring on May 13th (M = -5.903 cm, $p < 0.001$).
- **Lateral Veins (Pairs 39-44):** Lateral vein count also decreased consistently, with
- significant differences observed at all stages. The largest decrease was recorded on May 6th (M = -1.016 cm, $p = 0.001$).

Number of Branches:

- **April 8th (Pair 51):** A significant decrease in the number of branches was observed (M = -0.967, $p = 0.001$).
- **April 29th (Pair 54):** A similar pattern continued with a mean reduction of 1 branch ($p = 0.001$).

Number of Leaves:

- **April 8th (Pair 57):** The number of leaves also decreased significantly (M = -1.000, $p = 0.001$).
- **May 6th (Pair 60):** A further significant reduction in the number of leaves was observed (M = -3.017, $p < 0.001$).

Plants treated with Jeevamrutham showed enhanced growth, as indicated by increased plant height, shoot length, and leaf area (Table 1). For example, plant height increased by 14% in the treatment group by the end of the experiment. Leaf length and width were also significantly greater, contributing to improved photosynthesis. The number of branches and leaves was higher in treated plants, resulting in better overall plant development.

Table 3. Showing control and treated morphological parameters of **Hibiscus sabdariffa**

	8/4/2024		15/4/2024		22/4/2024		29/4/2024		6/5/2024		13/5/2024	
	C	T	C	T	C	T	C	T	C	T	C	T
Plant Height	4.2	4.4	5.2	5.6	7.5	7.9	8.1	8.5	9.0	10.0	10.1	11.4
Shoot length & Width	2.9	3.2	3.2	4.2	3.6	4.4	4.0	4.6	4.3	4.9	4.8	5.4
	0.3	0.4	0.3	0.5	0.4	0.6	0.6	0.7	0.7	0.8	0.9	0.10
Leaf length & Width	4.9	6.1	5.2	9.6	5.3	10.3	5.2	11.9	6.0	12.4	6.9	13.0
	1.1	2.4	2.1	2.9	2.9	3.2	3.4	3.6	4.0	4.8	4.8	5.3
Mid vein Length	2.4	4.8	4.4	7.8	5.1	8.9	5.4	9.0	6.0	11.1	6.4	12.3
Lateral veins	2	4	3	5	6	7	7	8	8	9	9	10
Root Length	4.0	4.9	4.4	5.0	5.0	5.4	5.2	5.8	5.4	6.0	5.8	6.4
No of Branches	3	4	4	5	6	7	7	7	8	8	9	10
No of Leaves	4	4	5	5	7	7	7	10	13	15	16	18

3.4. Photosynthetic Pigments

Jeevamrutham application significantly boosted the levels of chlorophyll a, chlorophyll b, and carotenoids, resulting in enhanced photosynthetic efficiency. This increase in photosynthetic pigments likely contributed to the improved growth observed in treated plants.

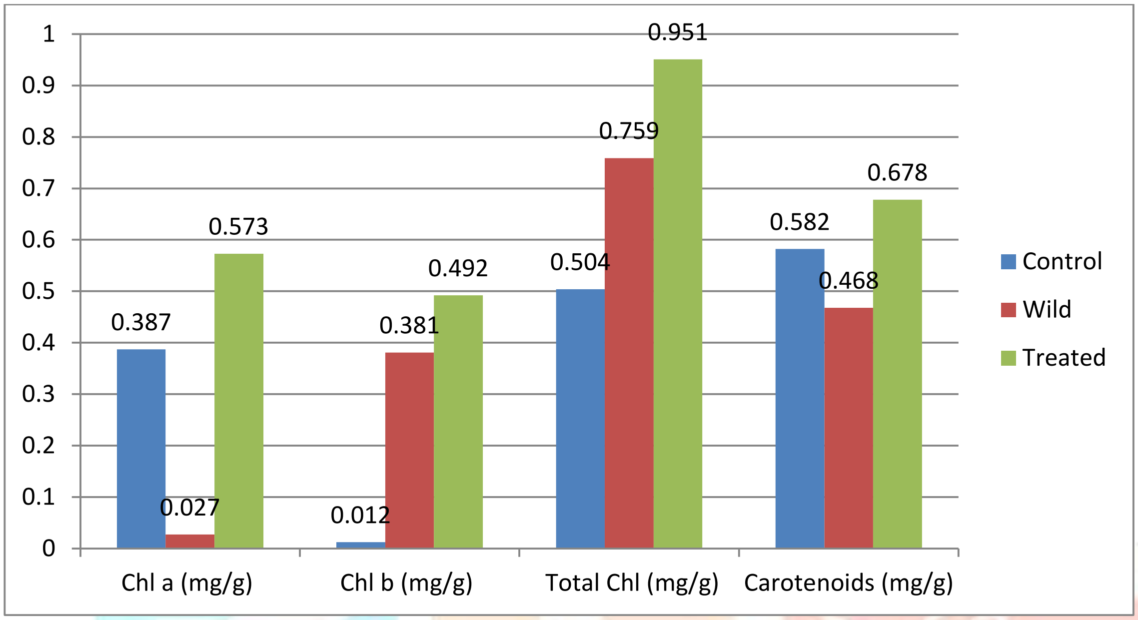

Figure 1. Chlorophyl pigments data on **Hibiscus sabdariffa**

3.5 Carbohydrates

Biochemical analysis showed that treated plants had higher carbohydrate content compared to control plants. This suggests that Jeevamrutham not only improved growth but also enhanced the nutritional quality of the leaves.

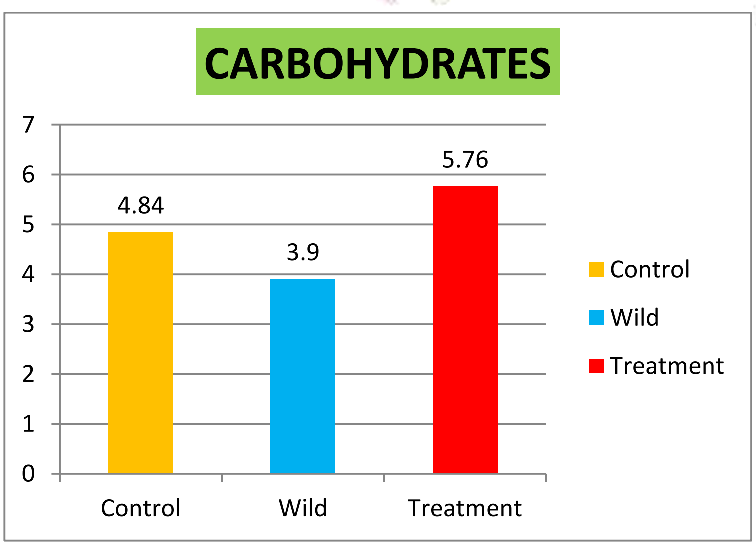

Figure 1. Carbohydrates data on **Hibiscus sabdariffa**

3.6 Proteins

The protein estimation in Hibiscus sabdariffa samples reveals that the Treatment sample has the highest protein content, followed by the Control sample, with the Wild sample having the lowest. This reveals that Jeevamrutham not only improved carbohydrate content and also enhanced the protein content of the leaves.

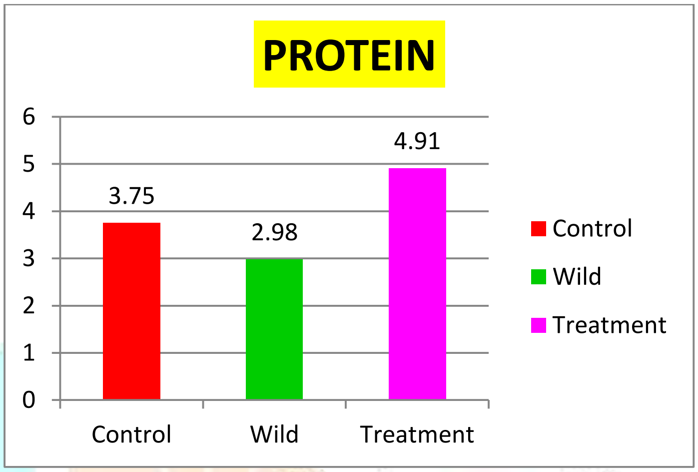

Figure 1. Proteins data on **Hibiscus sabdariffa**

4.**DISCUSSION:**

The application of Jeevamrutham significantly improved various growth parameters and nutrient content in Hibiscus sabdariffa. The increase in soil pH, reduction in electrical conductivity, and changes in organic carbon and nutrient levels indicate the bio-fertilizer's impact on soil quality. Enhanced growth performance, increased photosynthetic pigments, and higher carbohydrate and protein content in treated plants demonstrate the effectiveness of Jeevamrutham in promoting plant health and productivity.

5.CONCLUSION

The study demonstrated that Jeevamrutham, a traditional organic fertilizer, can significantly improve the soil nutrient content, water quality, and plant growth parameters in Hibiscus sabdariffa cultivation. The treatment enhanced photosynthetic pigments, carbohydrate, and protein levels, resulting in increased biomass and better plant development. These results suggest that Jeevamrutham is an effective organic fertilizer that can be employed in sustainable agriculture for leafy vegetables like Hibiscus sabdariffa.

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