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Impact of Chitosan Extracted from Fish Scales on the Germination and Growth of Vegetable - Lady's Finger *Abelmoschus esculentus*

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ABSTRACT
The study aimed to extract chitosan from scales of fish and use in the germination and growth of plants. The current research seeks to identify chitosan's impact as an organic fertilizer for the growth of plant and to compare the germination and growth of plant (Vegetable) - Abelmoschus esculentus (Lady's finger) using Control (tap water), chemical fertilizer and organic fertilizer (Chitosan) synthesized from fish scales. The components of the soil which is used for the growth of lady's finger plant before and after the treatment using organic fertilizer and chemical fertilizer were estimated. The results of estimation of nutrients present in soil revealed that the potassium level was high in the organic fertilizer than pH, Electrical Conductivity, Organic matter, Nitrate, Phosphorus, Potassium and Organic carbon. Growth of morphological features of the plant was well developed in organic fertilizer (Chitosan) synthesized from fish scales than the control (tap water) and chemical fertilizer, thereby it indicates that organic fertilizer (Chitosan) is a great alternative for commercial fertilizers.
Keywords: *Soil Parameters, Chitosan, Chemical fertilizer, organic fertilizer, Abelmoschus esculentus, Germination, Morphological features.*

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INTRODUCTION

Human beings have evolved along with the evolution of plants [1] Typically, fertilizers are composed of nitrogen, phosphorus and potassium compounds. Chemical fertilizers are used for healthy growth of plants [2]. But Chemical fertilizers have been found to have detrimental effects on the surrounding [3]. Chitosan is a polysaccharide extracted from chitin. The utilization of chitosan is constrained by its poor solubility in neutral and alkaline solutions [4]. Chitosan may be employed in diverse industrial sectors. Its primary characteristics encompass biocompatibility, biodegradability, antibacterial, emulsifying and chelating attributes, along with non-toxicity [5].

MATERIAL AND METHODS

METHODS

Collection of samples

- *T. mossambica* fish were purchased from a market in Chennai, Tamil Nadu, India. Fishes were cleaned using water to remove contaminants. The scales of fishes were dried at 50° C for 12 hrs and used for further analysis.
- Soil for the germination and growth of plants was collected from the campus of J.B.A.S college for women (Autonomous), Chennai, Tamil Nadu, India.
- Seeds of Lady's finger- *Abelmoschus esculentus* were procured from a local nursery, Chennai, Tamil Nadu, India.

METHODS

Extraction of Chitosan from fish scales:

The extraction of chitosan from fish scales involved a series of processing steps including demineralization, deproteinization, depigmentation, deodorization, and deacetylation, adhering to a specific procedural protocol [6].

Soil Analysis

Soil was analyzed to determine the components of the soil which was used for the growth of lady's finger plant before and after the treatment using organic fertilizer (Chitosan) and chemical fertilizer which were carried out as per the procedure of [7].

Germination and Growth of the Plant:

The containers were loaded with a growing medium. The seeds of Abelmoschus esculentus were planted in the growing medium within the containers. The soil was mixed with organic fertilizer(chitosan) extracted from the fish scales and the chemical fertilizer was applied individually in order to assess the efficacy of each fertilizer on the plant's growth. The vegetative features (i.e) root length, shoot length, number of leaves, flowers and fruits that were recorded at an interval of 15 days will be observed over a span of 60 days as per the procedure [8]. Control was also maintained simultaneously. Experiment was carried out in duplicates.

RESULT AND DISCUSSION

Estimation of Nutrients present in the soil before and after treatment with chemical fertilizer and organic fertilizer (Chitosan) (Table 1)

The soil parameters such as pH, EC, Organic matter, Nitrate, Phosphorus, Potassium and Organic Carbon were determined. The results for the estimation of nutrients present in the soil before and after treatment with chemical fertilizer and organic fertilizer (Chitosan) were determined in Sample A (Untreated soil) Sample B (Control-tap water), Sample C (Chemical fertilizer) and Sample D (Organic fertilizer- Chitosan) revealed that the maximum value of pH 7.34±0.03 was recorded in Sample A(Untreated soil) and minimum value of pH 7.1±0.03 was recorded in Sample D (organic fertilizer- Chitosan). The maximum value of Electrical Conductivity 0.59µmhos/cm±0.007 was recorded int Sample D(organic fertilizer-Chitosan) and minimum value of Electrical Conductivity 0.6µmhos/cm±0.002 was recorded in Sample A (Untreated soil). The maximum value of organic matter 10.78%±0.03 was recorded in sample D (organic fertilizer-Chitosan) and minimum value of organic matter 3.56%±0.03 was recorded in Sample A (Untreated soil). The maximum value of Nitrate 55.8mg/kg±0.02 was recorded in Sample A (Untreated soil) and the minimum value of Nitrate 27.09mg/kg±0.06 was recorded in Sample B (Control-tap water). The maximum value of Phosphorus 244.55mg/kg±0.06 was recorded int Sample D(organic fertilizer-chitosan) and the minimum value of Phosphorus 150.48mg/kg±0.02 was recorded in Sample A (Untreated soil). The maximum value of Potassium 1069.65mg/kg±0.16 was recorded in Sample D (Organic fertilizer- chitosan) and the minimum value of Potassium 904.07mg/kg±0.2 was recorded in Sample B (Control-tap water). The maximum value of organic carbon 6.27%±0.02 was recorded at Sample C (Organic fertilizer-chitosan) and the minimum value of organic carbon 2.06%±0.006 was recorded in Sample A (Untreated soil). Potassium was higher compared to other nutrients in all the four samples of soil such as Sample A (Untreated soil), Sample B (Control- tap water), Sample C (Chemical fertilizer) and Sample D(Organic fertilizer-chitosan). The results of the study were in accordance with the results of [9].

Germination and Growth (Root Length, Shoot Length and Number of leaves) of Lady's finger exposed to Control-tap water, Chemical fertilizer and Organic Fertilizer (Chitosan).

The result of germination and growth (Root length, Shoot length and number of leaves) of lady's finger exposed to control-tap water, chemical fertilizer and organic fertilizer (Chitosan) were shown in table 2.

The result of the study revealed that on Day 15th (Table 2A) in the control plant, the growth of root length was 2.05cm±0.16, shoot length was 14.02±0,16 and number of leaves was 2cm±0.76 were recorded. In plants with chemical fertilizer, the growth of root length was 2.8±0.1, shoot length was 18.16cm±0.18 and number of leaves was 3cm±0.73. In plants with organic fertilizer (Chitosan), the growth of root length was 3.02cm±0.1, shoot length was 19.01cm±0.16 and number of leaves was 4cm±0.57 and the results of the study was supported by the results of [10]. On day 30th (Table 2B) in the control plant, the growth of root length was 5.02cm±0.17, shoot length was 19.91cm±0.29 and number of leaves was 3cm±0.51. In plants with chemical fertilizer, the growth of root length was 5.52cm±0.19, shoot length was 23.5cm±0.13 and number of leaves was 4cm±0.62. Whereas in organic fertilizer (Chitosan), the growth of root length was 6.01cm±0.10, shoot length was 24.98cm±0.23 and number of leaves was 5cm±0.73 [9] were recorded and the results of the study correlates with the results of [10]. On day 45th (Table 2C) the flowers were developed in all the samples (Table 2C). In the control plant, the growth of shoot length was 22.49cm±0.12, number of leaves was 4cm±0.57, number of flowers was 1cm±1.04 were recorded. In plants with chemical fertilizer, the growth of shoot length was 25.08cm±0.30, number of leaves was 5cm±0.76 and number of flowers was 1cm±0.57. In plants with organic fertilizer (Chitosan), the growth of shoot length was 28cm±0.26, number of leaves was 6cm±0.63 and number of flowers was 2cm±0.76 were recorded and the results of the study was supported by the work of [11]. On day 60th (Table 2D) fruits were developed in all the samples. In the control plant, the growth of shoot length was 24.9cm±0.23, number of leaves was

5cm±0.73, number of fruits was 1cm±0.51 were recorded. In plants with chemical fertilizer, the growth of shoot length was 28.95cm±0.42, number of leaves was 6cm±0.57 and number of fruits was 1cm±0.62 were recorded. In organic fertilizer (Chitosan), the growth of shoot length was 31.16cm±0.27, number of leaves was 7cm±0.65 and number of fruits was 2cm±0.76. The results of the study is in agreement with the results of [10], [11].

STATISTICAL ANALYSIS

The data derived from the aforementioned experiments were presented in the form of Mean, Standard Deviation, and Correlation. The data obtained for the soil parameters were expressed in Correlation (Spearman's Rho) which was significant at 0.01% level for Sample A (Untreated soil), Sample B (Control-tap water), Sample C (Chemical fertilizer) and Sample D (Organic fertilizer- Chitosan) and the correlation exhibited statistical significance at the 0.05% level using a one-tailed test.

Table 1: Estimation of Nutrients present in the soil before and after treatment with Chemical Fertilizer and Organic fertilizer-Chitosan

S.No	Parameters	Sample A (Untreated soil)	Sample B (Control-Tap water)	Sample C (Chemical fertilizer)	Sample D Organic fertilizer-Chitosan
1	pH	7.34±0.03	7.31±0.03**	7.18±0.04**	7.1±0.03**
2	EC µmhos/cm	0.6±0.002	0.39±0.004**	0.49±0.004**	0.59±0.007**
3	Organic matter%	3.56±0.03	9.02±0.01**	10.36±0.04**	10.78±0.03**
4	Nitrate mg/kg	55.8±0.02	27.09±0.06**	53.91±0.09**	47.99±0.04**
5	Phosphorous mg/kg	150.48±0.02	236.03±0.03**	209.6±0.04**	244.55±0.06**
6	Potassium mg/kg	928.05±0.13	904.07±0.2**	982.03±0.1**	1069.65±0.16**
7	Organic Carbon %	2.06±0.006	5.23±0.02**	6.02±0.003**	6.27±0.02**

The values were represented as Mean±Standard Deviation. **- Correlation (Spearman's Rho) is significant at 0.01% level. *- Correlation is significant at 0.05% level (1-tailed).

Table 2: Growth of Lady's Finger plant (*Abelmoschus esculentus*) exposed to Control(Tap water), Chemical fertilizer and Organic fertilizer- Chitosan

Table 2A

Day -15				
Interval	**Sample**	**Root length(cm)**	**Shoot length(cm)**	**Number of leaves**
I	Control	2.05±0.16	14.02±0.16	2±0.76
	Chemical fertilizer	2.8±0.1	18.16±0.18	3±0.73
	Organic fertilizer- Chitosan	3.02±0.11	19.01±0.16	4±0.57

The values were represented as Mean±Standard Deviation

Table 2B

Day -30				
Interval	**Sample**	**Root length(cm)**	**Shoot length(cm)**	**Number of leaves**
II	Control	5.02±0.17	19.91±0.29	3±0.51
	Chemical fertilizer	5.52±0.19	23.5±0.13	4±0.62
	Organic fertilizer- Chitosan	6.01±0.10	24.98±0.23	5±0.73

The values were represented as Mean±Standard Deviation

Table 2C

Day -45				
Interval	**Sample**	**Shoot length(cm)**	**Number of leaves**	**Number of flowers**
III	Control	22.49±0.12	4±0.57	1±1.04
	Chemical fertilizer	25.08±0.30	5±0.76	1±0.57
	Organic fertilizer- Chitosan	28±0.26	6±0.63	2±0.76

The values were represented as Mean±Standard Deviation

Table 2D

Day -60				
Interval	**Sample**	**Shoot length(cm)**	**Number of leaves**	**Number of fruits**
IV	Control	24.97±0.23	5±0.73	1±0.51
	Chemical fertilizer	28.95±0.42	6±0.57	1±0.62
	Organic fertilizer- Chitosan	31.16±0.27	7±0.65	2±0.76

The values were represented as Mean±Standard Deviation

CONCLUSION

Chitosan was extracted from fish scales and used as an organic fertilizer after processing. Fertilizers were originally applied to the soil of agricultural crops with the purpose of enhancing plant growth and increasing crop yield. Organic fertilizer (chitosan) is an alternative for the commercial fertilizers. Organic fertilizer (Chitosan) showed maximum growth of plants than the commercially available fertilizer as evidenced from the results of the present study. Chitosan extracted from fish scales was white in colour and powdered form with essential elements which increased the fertility of the soil. There by proving the efficiency of chitosan as an organic fertilizer.

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CONFLICT OF INTEREST

The authors assert the absence of any conflicts of interest.

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