Chitin Nanofiber for Growth, Yield and Postharvest Quality of Coriander (*Coriandrum sativum* L.)

A THESIS

BY

STUDENT ID- MS 230815

A Thesis submitted to the Agrotechnology Discipline in Partial Fulfillment of the requirements for the degree of Masters of Science in Horticulture

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JUNE, 2024

Dedicated

To My Beloved

Father- Swapan Kumar Bagchi

&

Mother- Sandhya Rani Bagchi

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June, 2024 The Author

Abstract

Coriander is a popular annual herb particularly for its fresh leaves and dried seeds. A field experiment and a lab experiment evaluated the effect of chitin nanofiber (CNF) on the growth, yield (field experiment) and postharvest quality (lab experiment) of coriander cv. BARI dhania 2 at the Dr. Purnendu Gain Field Laboratory and Horticulture Laboratory of Agrotechnology discipline Khulna University, Khulna from February to April, 2024. The field experiment was planned following a randomized complete block design (RCBD) with seven replications and the lab experiment was designed with completely randomized design (CRD) with three replications. The field experiment consisted of five treatments: control, urea (recommended dose), and three concentrations of CNF (CNF 1 = 13 ml 1% CNF, CNF 2 = 26 ml 1% CNF, and CNF 3 = 39 ml 1% CNF). Top dressing of urea and foliar spraying of CNFs were done twice during the growing period. The harvested coriander plants were also evaluated in the lab for postharvest quality attributes including shelf life. Foliar application of CNF resulted in either similar or higher plant height, leaf number, leaflet number, node number, individual plant fresh weight and plot leaf yield of coriander to urea. CNF treated leaves also maintained more freshness and tenderness with low shrinkage. It also retained better TSS, TA, TSS: TA, and vitamin C content. CNF treatment also increased shelf life of coriander by one and a half days compared to the control. Overall, CNF promoted growth and yield attributes of coriander and maintained postharvest quality along with extended shelf life. Therefore, CNF can be used in combination of urea or instead of urea to grow coriander and to maintain postharvest quality including shelf life.

Keywords: Chitin nanofiber, coriander, growth, chemical attributes, shelf life

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of Rangpur District (The Financial Express, 2019). Bangladeshi farmers are getting good yields in coriander cultivation. Farmers of Rangpur produced 2,124 tons of coriander from 923 hectares and get a good price (Dhaka Tribune, 2020). In 2023, cultivators of Rangamati and other hilly areas of the district are practicing this crop to find a way for their lively hood (The Financial Express, 2023). In Bangladesh, coriander plant is a minor crop. But this crop has a great potential to carry out a huge amount of money only through the cultivation as a leafy vegetable and thus it can help in turning over the fate of Bangladeshi youth.

The major problem of this potential crop is its high perishability with a very short shelf life. There are many vegetables produced in Bangladesh majorly like brinjal, tomato, papaya, and other leafy vegetables where preservation is a problem for the crops to transport or for further processing.

Various carcinogenic, mutagenic, neurotoxic, teratogenic, and respiratory toxic chemicals like copper sulfate, rhodamine oxide, malachite green, and deadly carbide are used unscrupulously to preserve fruits and vegetables which may give a vibrant look and a good postharvest life but creates health issues in humans (Ray, 2023). Moreover, people use fungicides, insecticides, and many other synthetic harmful chemicals which cause health damage. In addition to this, cultivators and other stakeholders of the coriander plant use hazardous preservative chemicals to increase the shelf life of the plant.

Regarding the above problems, there should be a way for the farmer and the other people involved in this business to have a good yield with the application of nonhazardous chemicals to have a greater cost-benefit ratio and better postharvest results for the preservation of this herb.

Chitin Nano Fiber (CNF) can be an alternative for both the main input for the nutrition of plant growth and for the postharvest preservative.

Chitin nanofiber is composed of chitin which is the polymer of amino sugars of repeating β (1, 4)-N-acetyl glucosamine (Song et al. 2012).The Chitin Nano Fiber (CNF) is produced from the shell of crabs and shrimps (Ifuku & Saimoto, 2012). The shell of crabs and shrimp is composed of chitinous substance, which is also a precursor for the production of chitosan, also a product that is used as fertilizer, and preservative.

Chitin is considered the second most abundant natural polysaccharide after cellulose (Song et al. 2012). It is most commonly a non-hazardous substance made of protein and sugars. Moreover,

2.5.3 CNF promotes disease inhibition

Chitin, the precursor of chitosan, plays a vital role in stimulating plant defense responses by activating defense-related genes, producing reactive oxygen species, and synthesizing antimicrobial compounds upon interaction with plant cells (Parada et al., 2018; Riseh et al., 2024).

Oligochitosan, a derivative of chitin, further enhances plant stress tolerance mechanisms by significantly influencing crucial plant hormone signaling pathways such as salicylic acid (SA), jasmonic acid (JA), and abscisic acid (ABA) (Sun et al., 2023).

chitosan induces robust defense mechanisms in plants by stimulating the production of various defense-related substances such as phytoalexins, PR proteins, and reactive oxygen species (ROS), while also activating crucial signaling pathways like GPCR, PLC/PK, MAPK, and H2O2 burst (Muzzarelli, 2010; Ahmad et al., 2020). Soil treated with CNF shows systemic resistance against pathogens, reduces lesion formation, upregulates defense-related genes in strawberry and cabbage. Moreover, low concentration of CNF induces plant growth (Parada et al., 2018).

2.5.4 CNF reduces weight loss

Chitosan treated longan show reduced weight loss during shelf life (Jiang & Li, 2001).

Chitosan aids in reducing water loss by improving water retention in the root zone and acting as a barrier against drought stress (Shahrajabian et al., 2021).

2.5.5 CNF and TSS

Chitosan @ 2% treated longan fruit shows highest total soluble solids than other treatments (Jiang & Li, 2001).

2.5.6 CNF and TA

Consistent declination of TA was observed on longan fruit whent treated with chitin. It shows the highest TA at 2 % chitosan (Jiang & Li, 2001).Chitosan treated peach exhibits higher amount of TA after 12 days of storage than other treatments (Li & Yu, 2000).

2.5.7 CNF and Vitamin C

In longan fruit when treated with chitosan @ 2 % results the highest ascorbic acid content (Li & Yu, 2000).

Peach fruit exhibits higher amount of Vitamin C content when treated with chitosan, a derivative of chitin (Li & Yu, 2000).

2.5.8 Conclusion

Agricultural cultivation with sustainability is a must in the era of this massive exploitation of soil nutrients with chemical fertilizer. The production of crops have been increased in this decades. But focusing the sustainability and environmental protection, it has become a matter to bear in mind that not only the cultivation is enough to cope the environmental and increasing population issues but also the cultivation of sustainable agriculture is essential to cope with the natural hazards of environment. To establish a sustainable cultivation chitin and its derivatives has shown promising effect as a natural polymer. Moreover, chitosan has revealed its success in various application and can be served as oligochitosan, chitooligosaccharides and so on. However, Chitin nanofiber, being a derivative of chitin, has a great scope to be exploited in agriculture as it has possess some characteristics to make cultivation in a sustainable way. Harvesting the nutrients through intensive cultivation with fertilizers of chemical composition is affecting our environment badly. To mitigate the issues biodegradable chitin nanofiber should be involved in cultivation of vegetables, culinary herbs and leafy vegetables to harness the vitamins, minerals, and other nutrients in a protective way.

CHAPTER III

MATERIALS AND METHODS

Two experiments were conducted to observe the growth, yield and postharvest quality of coriander plant.

3.1 Experiment I

3.1.1 Experimental site

The experiment was conducted in Dr. Purnendu Gain Field Laboratory of Khulna University from February to April, 2024. The location of this field laboratory is 22°47'57.4"N latitude and 89°31'51.0"E longitude. For the experiment, a land of 42 m^2 was selected there.

3.1.2 Land preparation

Land preparation was done on 20 February, 2024 by ploughing with a tractor to make the soil favorable for the cultivation. Three ploughing was done with shovel after tractor ploughing to make the soil more mold on the following days.

3.1.3 Planting Material

The planting material was BARI Dhania 2 and the seeds were collected from Bangladesh Agricultural Research Institute (BARI) of Magura on December 10, 2023 for the experiment.

BARI Dhania 2 was released by Bangladesh Agricultural Research Institute 2016. It possesses a of height 100-135 cm, leaf number plant^{-1} 18-21, umbel plant^{-1} 63, and umbel let umbel^{-1} 6 on average. The yellowish seeds of this coriander has a weight of 11.53 per thousand seed. The leaf yield of this plant is 3-4 ton ha^{-1} (Azad et al., 2020).

3.1.4 Preparation of Chitin Nanofiber (CNF):

The CNF Preparation from shrimp shells was conducted through a series of extraction treatments followed by mechanical treatment with the help of a high-speed grinder (Shams et al. 2011; Ifuku, 2014).

3.1.5 Experimental treatments and design:

This experiment was designed in randomized complete block design (RCBD) and consisted of five treatments, T1 = control, T2= urea (recommended dose, 6.5 g $plot^{-1}$), T3= CNF 1 (6.5 ml $plot^{-1}$), T4= CNF 2 (13 ml $plot^{-1}$), T5= CNF 3 (19.5 ml $plot^{-1}$) and replicated seven times. Urea and CNFs were applied at 15 and 30 days after germination, thus a total of 13 gm Urea, 13 ml CNF, 26 ml CNF, and 39 ml CNF were applied for urea, CNF 1, CNF 2, and CNF 3 treatments respectively. Treatment 2 (Urea) was applied in the soil. On the other hand different doses of Chitin Nanofiber (Treatment 3, 4, 5) was applied as foliar spray. For uniform spraying of CNF, they were diluted three times with water. The treatments were applied in each plot at two split dose. Grossly a land of $42m^2$ (6m × 7m) was designed to contain 35 plots of 0.8 m^2 (0.8m × 1m) of which 5 plots were included at a distance of 20 cm in each replication. Plot to plot distance was maintained to 30 cm.

3.1.6 Seed sowing and cultural practices

After 7 days of ploughing, on 27 February, 2024 Vermicompost @ 400 gm, TSP @ 10gm, MOP @ 8 gm, Gypsum @ 9gm, Zinc @ 250mg and Boron @ 12 mg were applied as basal dose in each plot following a light irrigation afterward.

The seeds were soaked in water on March 01, 2024 for four days before sowing. Later they were sown line by line @ 25-30 kg ha^{-1} in the selected field on March 4, 2024.After seed sowing the land was irrigated with water.

Germination of the seed was observed after 8 days of sowing on 12 March, 2024. Regular irrigation was done in an alternate day basis. Weeding was done at 10 days interval after seed emergence. Hoeing was carried out after 10 days of the seed emergence. At 15 days after germination (DAG), First split was applied on 27 March, 2024. And at 30 DAG on 11 April, 2024 the second split was applied.

3.1.7 Data Collection

Data collection was started after 7 days interval of the application of 1st treatment on April 3, 2024.One representative plant sample was collected from each plot for the observation. The measured data during growth were plant height (mm), plant fresh weight (gm), number of leaves per plant and, number of leaflet per plant. Plant height was measured with millimeter scale. Plant fresh weight was measured with an electric balance. The number of leaves and leaflet was measured through counting. 2nd split was applied after 15 days of 1st split application.

3.2 Experiment II

3.2.1 Location

This experiment was conducted in the Horticulture Laboratory under Agrotechnology discipline of Khulna University from April 24 to April 29, 2024.

3.2.2 Materials

The pre-treated coriander plants are selected here as experimental materials.

3.2.3 Treatment and experimental design

We grew coriander plant under different doses of CNF in experiment I where the treatments were T1 = control, T2= Urea (recommended dose), T3= CNF 1 (13 ml), T4=CNF 2 (26 ml), T5= CNF 3 (39 ml). To evaluate the effect of these treatment on postharvest shelf life of coriander, we used those pre-treated coriander plant. However, in the experiment II the design was completely randomized design (CRD) with three replications and each replication consisted of 50 plants.

3.2.4 Data collection

Data collection was started on daily basis to observe the postharvest shelf life of coriander plants under different treatments. During this study some physical and chemical parameters were measured.

3.2.5 Physical parameters

Physical parameters like daily weight loss (g), color change (using colorimeter), freshness, shrinkage, and tenderness were measured. Freshness, shrinkage and tenderness were measured through eye inspection following a numerical scale. For freshness, the scale ranged from 1-5, where 1= not fresh (0 %), 2 = slightly fresh (1-10 %), 3 = moderately fresh (11-25 %), 4 = fresh (26-50 %), 5 = very fresh (51-100 %). For tenderness the scale ranged from 1-5, where 1 = Tough (0 %), 2 = slightly tender (1-10 %), 3 = moderate tender (11-25 %), 4 = Tender (26-50 %), 5 = Very tender (51-100 %). Similarly for shrinkage the scale ranged from 1-5, where 1 = no shrinkage

[a] The value represents mean (average of seven measurements) ± SE (standard error). CNF 1 = 13 ml CNF (1%), CNF 2 = 26 ml CNF (1%), and CNF 3 = 39 ml CNF (1%). Means followed by dissimilar letters differed significantly according to Tukey's Honestly Significance Difference (HSD) test @ 5% level of significance.

4.1.3.4 Plant node number

The number of node plant^{-1} was observed from the 4 weeks after germination.

Coriander plant node number differed significantly at 29 DAG and at 43 DAG (Table 5).

At 29 DAG, the highest node number (6.43) was obtained from CNF 3 which was statistically similar with CNF 2 (4.43), CNF 1 (4.14) and Urea (3.86) and the lowest node number was obtained from control. But at 43 DAG maximum node number (12.14) was recorded from CNF 1 which was statistically similar with CNF 2 (11.43), Urea (10.29) and CNF 3 (10.00).

Table 5. Effect of chitin nanofiber (CNF) on node number of coriander plant^{-1} at different days after germination (DAG).

Treatment	Number of node plant^{-1} [a]		
	29 DAG	36 DAG	43 DAG
Control	1.1±0.2b	9.3±1.169	6.6±0.7b
Urea	3.7±0.6ab	8.3±0.918	10.3±0.6ab
CNF 1	4.1±0.5a	7.8±1.100	12.1±0.6a
CNF 2	4.4±0.4a	9.7±0.944	11.4±0.7ab
CNF 3	6.4±0.5a	9.0±0.617	10.0±0.5ab
P	<0.01	0.657	0.28

[a] The value represents mean (average of seven measurements) ± SE (standard error). CNF 1 = 13 ml CNF (1%), CNF 2 = 26 ml CNF (1%), and CNF 3 = 39 ml CNF (1%). Means followed by dissimilar letters differed significantly according to Tukey's Honestly Significance Difference (HSD) test @ 5% level of significance.

4.1.3.5 Plant branch number

Branching on coriander plant was not distinct during the 1st 4 weeks of growth. After 5 and 7 weeks the branch were distinctly identifiable. However number of branch on coriander plant did not show any significant difference (Table 6).

Table 6. Effect of chitin nanofiber (CNF) on branch number of coriander plant^{-1} at different days after germination (DAG).

Treatment	Plant Branch Number [a]	
	36 DAG	43 DAG
Control	5.4 ± 1.1	5.1 ± 1.0
Urea	6.4 ± 0.7	9.4 ± 1.0
CNF 1	6.7 ± 0.8	9.0 ± 1.2
CNF 2	6.4 ± 0.7	9.4 ± 1.1
CNF 3	6.7 ± 0.8	9.4 ± 1.3
P	0.805	0.76

[a] The value represents mean (average of seven measurements) ± SE (standard error). CNF 1 = 13 ml CNF (1%), CNF 2 = 26 ml CNF (1%), and CNF 3 = 39 ml CNF (1%). Means followed by dissimilar letters differed significantly according to Tukey's Honestly Significance Difference (HSD) test @ 5% level of significance.

4.1.3.6 Plant fresh weight during growth

Plant fresh weight during growth did not show any significant difference at early stages such as 22 DAG, 29 DAG and 36 DAG (Table 7). But at 43 DAG, differences were found among treatments. The highest pant fresh weight (6.81g) was obtained from the Urea which was statistically similar with CNF 3 (6.36 g) and CNF 2 (5.5 g) (Figure 2).However, the lowest fresh weight (3.14 g) was obtained from the control and statistically shows similarity with CNF 1 and CNF 2 (Figure 2).

Table 7. Effect of chitin nanofiber (CNF) on plant fresh weight of coriander at different days after germination (DAG).

Treatment	Plant Fresh weight plant^{-1}(g)[a]		
	22 DAG	29 DAG	36 DAG
Control	0.8±0.1	1.4±0.3	4.6±0.9
Urea	1.1±0.1	2.8±0.5	5.9±0.7
CNF 1	1.1±0.2	2.0±0.4	4.8±0.9
CNF 2	1.3±0.1	2.4±0.6	5.2±1.4
CNF 3	1.0±0.1	2.2±0.2	6.0±1.6
P	0.494	0.201	0.904

ᵃ The value represents mean (average of seven measurements) ± SE (standard error). CNF 1 = 13 ml CNF (1%), CNF 2 = 26 ml CNF (1%), and CNF 3 = 39 ml CNF (1%). Means followed by dissimilar letters differed significantly according to Tukey's Honestly Significance Difference (HSD) test @ 5% level of significance.

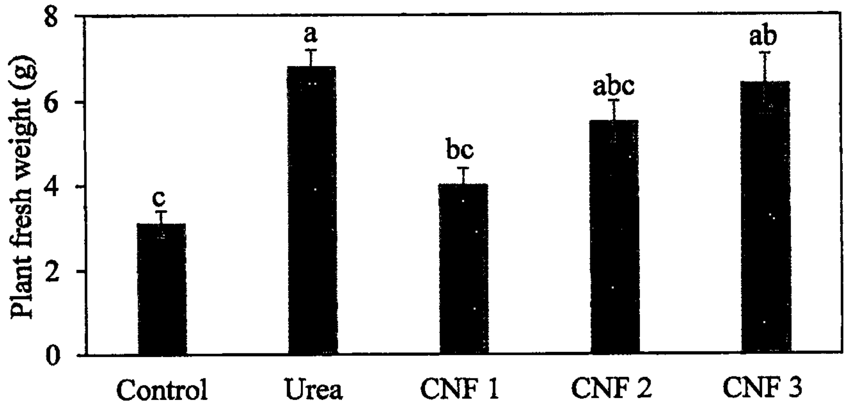

Figure 2. Effects of CNF on plant fresh weight of coriander (*Coriandrum sativum* L.) at 43 DAG.The error bar represents mean ± S.E (Standard error).The treatment means (average of seven measurements) are separated by Tukey's HSD test at $\alpha = 5\%$

4.1.3.7 Plant fresh weight plot^{-1} at harvest

Plant fresh weight at harvest differs significantly among treatments. The highest plant fresh weight (363 g) was observed from the Urea treated plot which was statistically similar with CNF 2 (207.67g) (Figure 3.). The lowest fresh weight (90.67 g) from CNF 1 which shows similarity with control (102g) (Figure 3).

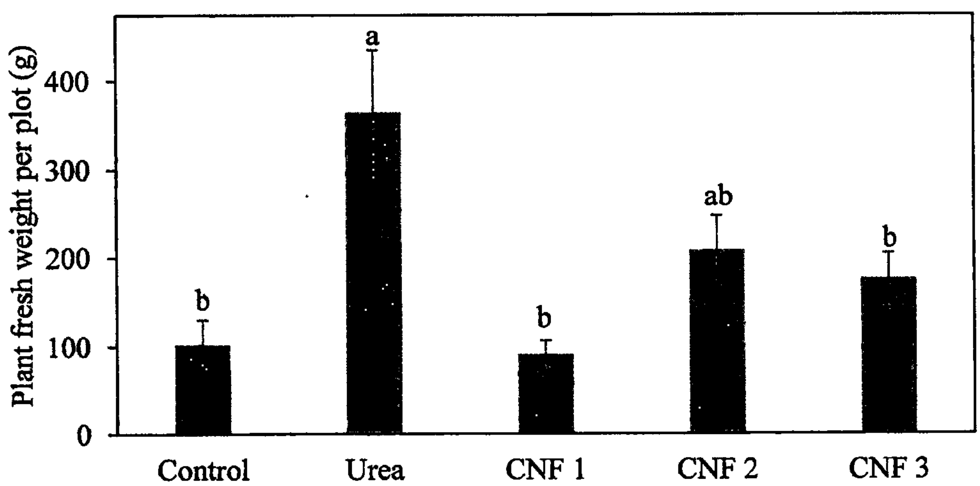

Figure 3. Effects of CNF on plant fresh weight of coriander (*Coriandrum sativum* L.).The error bar represents mean ± S.E (Standard error).The treatment means (average of seven measurements) are separated by Tukey's HSD test at $\alpha = 5\%$

4.1.4 Postharvest attributes

4.1.4.1 Micro Environment

Table 8. Daily temperature and humidity record of the postharvest experimental site.

Date	Morning humidity % (10.00 AM)	Afternoon humidity % (3.00 PM)	Morning temperature (^{0}C) (10.00 AM)	Afternoon temperature (3.00 PM)
24-Apr-2024	---	60	---	29.5
25-Apr-2024	72	51	30.1	29.6
26-Apr-2024	72	69	30.1	30.8
27-Apr-2024	67	70	31.9	31.9
28-Apr-2024	77	66	31.1	30.7

4.1.5 Physical parameters

4.1.5.1 Plant daily weight loss

Plant daily weight loss was higher in between day 3 and day 4 after harvest. However, plant weight loss did not differ significantly among the treatments (Table 9.).

Table 9. Effect of chitin nanofiber (CNF) on plant daily weight losst of coriander at different DAH.

	Weight loss table (%) [a]			
Treatment	Day 2	Day 3	Day 4	Day 5
Control	35.2±1.5	30.2±1.2	19.9±1.5	14.5±1.0
Urea	32.3±1.0	29.4±1.2	20.8±1.5	17.2±1.8
CNF 1	32.5±1.4	29.3±0.4	17.7±0.03	15.4±1.1
CNF 2	28.4±1.5	28.8±0.8	19.5±0.4	15.6±1.0
CNF 3	29.8±2.7	28.4±0.4	20.1±0.2	17.9±1.7
P	0.107	0.689	0.285	0.429

[a] The value represents mean (average of three measurements) ± SE (standard error). CNF 1 = 13 ml CNF (1%), CNF 2 = 26 ml CNF (1%), and CNF 3 = 39 ml CNF (1%). DAH =days after harvest. Means followed by dissimilar letters differed significantly according to Tukey's Honestly Significance Difference (HSD) test @ 5% level of significance.

4.1.5.2 Plant freshness

Freshness of coriander plant differed significantly at 3, 4, and 5 days after harvest. The highest freshness (5) at 3 days after harvest was observed from CNF 3 which was statistically similar with CNF 2 (5.0) and urea (4.7) (Table 10). At 4 days after harvest CNF 3 also showed the highest freshness (4.0) which was statistically similar with Urea (4.0) and CNF 2 (3.3). Similarly at day 5 after harvest, highest fresh ness was recorded from CNF 3 (3.0) which was statistically similar with Urea (3.0) and CNF 2 (2.3).However the lowest freshness was obtained from control.

Table 10. Effect of chitin nanofiber (CNF) on plant freshness of coriander at different DAH.

	Freshness [a]				
Treatment	Day 1	Day 2	Day 3	Day 4	Day 5
Control	5	5	4.0±0.0 b	3.0±0.0 b	2.0±0.0 b
Urea	5	5	4.7±0.4 ab	4.0±0.0 a	3.0±0.0 a
CNF 1	5	5	4.0±0.0 b	3.0±0.0 b	2.0±0.0 b
CNF 2	5	5	5.0±0.0 a	3.3±0.4 ab	2.3±0.4 ab
CNF 3	5	5	5.0±0.0 a	4.0±0.0 a	3.0±0.0 a
P	---	---	0.01	0.01	0.01

[a] The value represents mean (average of three measurements) ± SE (standard error). CNF 1 = 13 ml CNF (1%), CNF 2 = 26 ml CNF (1%), and CNF 3 = 39 ml CNF (1%). DAH =days after harvest. For freshness, the scale ranged from 1-5, where 1= not fresh (0 %), 2 = slightly fresh (1-10 %), 3 = moderately fresh (11-25 %), 4 = fresh (26-50 %), 5 = very fresh (51-100 %). Means followed by dissimilar letters differed significantly according to Tukey's Honestly Significance Difference (HSD) test @ 5% level of significance.

4.1.5.3 Plant tenderness

Tenderness in coriander leaf did not show significant difference at early days but from day 4 after harvest, highest tenderness (4) was observed from CNF 3 and Urea which shows statistically similar result with CNF 2 (3.33) (Table 11).

4.1.6 Chemical analysis

4.1.6.1 Total soluble solids

The highest TSS was recorded from urea (8.1) which was statistically similar with CNF 3 (8.0) and control (7.9) (Figure. 4.). However, the lowest TSS was obtained from CNF 1 (7.2).

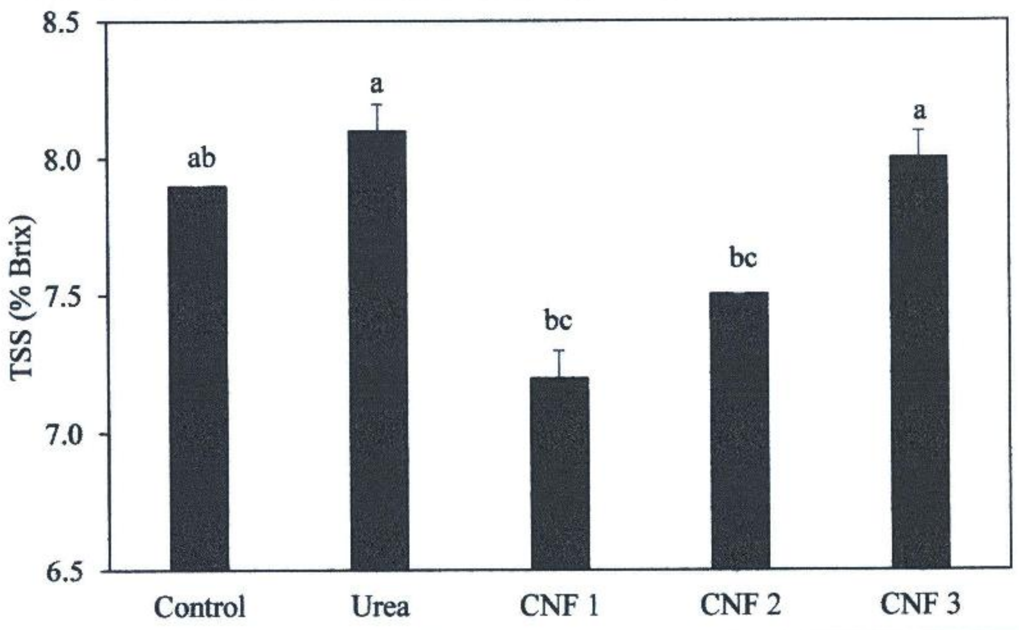

Figure 4. Effects of CNF on TSS (% Brix) of coriander (*Coriandrum sativum* L.).The error bar represents mean ± S.E (Standard error).The treatment means (average of seven measurements) are separated by Tukey's HSD test at $\alpha = 5\%$

4.1.6.2 Titratable acid

The highest TA was obtained from the CNF 2 (10.4) which was statistically similar with control (9.5) and CNF 1 (9.6) and control (9.5) (Figure. 5.).The lowest TA was recorded from CNF 3 (8.8).

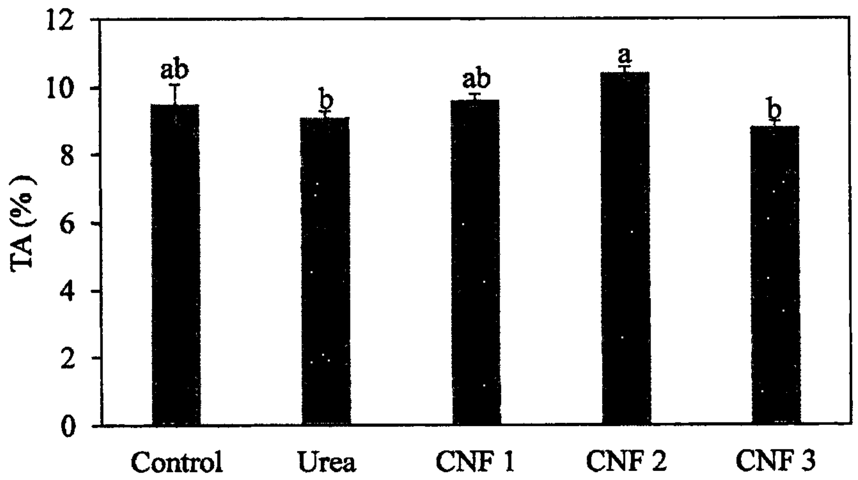

Figure 5. Effects of CNF on TA (% Brix) of coriander (*Coriandrum sativum* L.).The error bar represents mean ± S.E (Standard error).The treatment means (average of seven measurements) are separated by Tukey's HSD test at α = 5%

4.1.6.3 TSS: TA

The highest TSS: TA ratio was recorded from CNF 3 (0.9) which was statistically similar with urea (0.9) and control (0.8) (Figure 6.).However the lowest TSS: TA ratio was obtained from both CNF 1 (0.7) and CNF 2 (0.7).

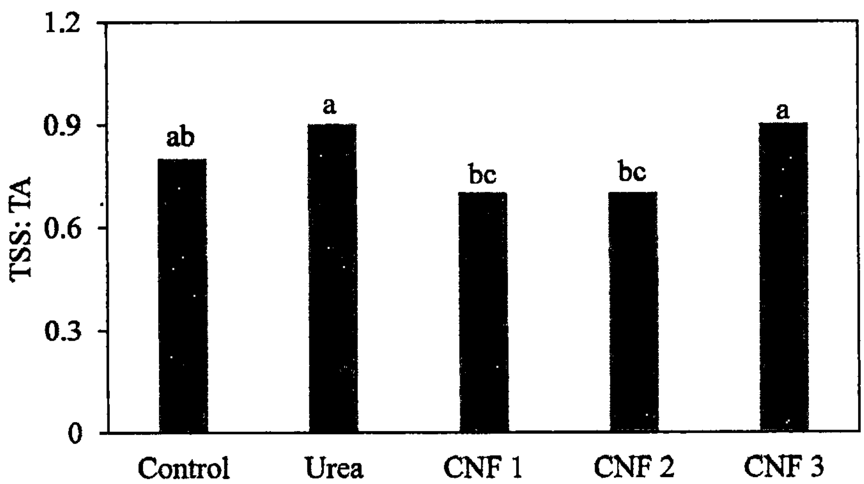

Figure 6. Effects of CNF on TSS: TA of coriander (*Coriandrum sativum* L.).The error bar represents mean ± S.E (Standard error).The treatment means (average of seven measurements) are separated by Tukey's HSD test at $\alpha = 5\%$

4.1.6.4 Vitamin C content

The highest vitamin C content was obtained from CNF 2 (15.6) which was statistically similar with CNF 1 (15.5) and the lowest one was recorded from CNF 3 (11.2) (Figure 7).

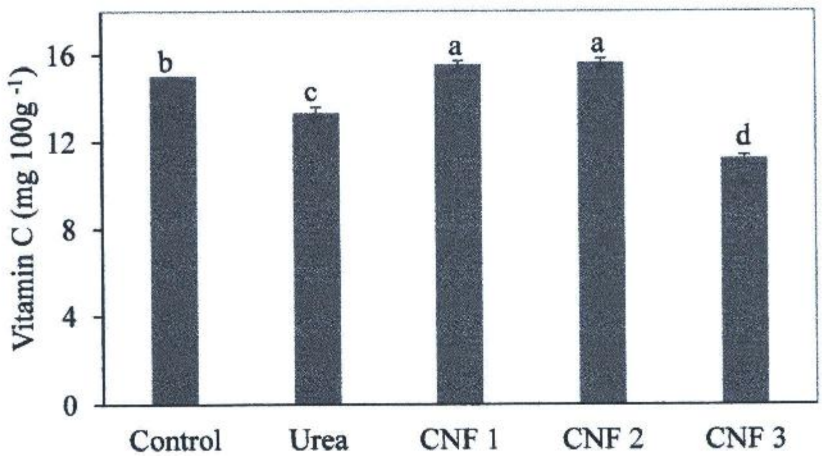

Figure 7. Effects of CNF on Vitamin C (mg $100g^{-1}$) of coriander (*Coriandrum sativum* L.).The error bar represents mean ± S.E (Standard error).The treatment means (average of seven measurements) are separated by Tukey's HSD test at $\alpha = 5\%$

4.1.7 Shelf life

Shelf life of coriander differed significantly among the treatments. The highest shelf life was observed from CNF 3 (4.63) which was statistically similar with CNF 2 (4.33), CNF 1 (3.85) and urea (3.78) (Figure 8.). However the lowest shelf life was obtained from control.

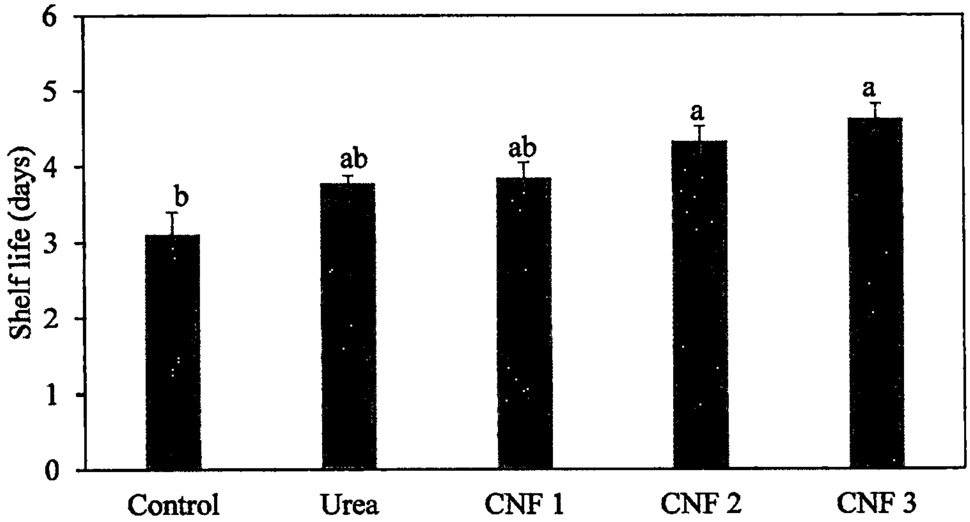

Figure 8. Effects of CNF on shelf life (days) of coriander (*Coriandrum sativum* L.).The error bar represents mean ± S.E (Standard error).The treatment means (average of seven measurements) are separated by Tukey's HSD test at $\alpha = 5\%$

4.2 Discussion

4.2.1 Growth attributes

Though plant height of coriander differed significantly at 29 and 43 DAGs, it was non-significant at 36 DAG. Prevailing of continuous high temperature before 36 DAG may arrest the growth of plant that might cause the results. Like our study, urea also increased plant height of coriander (Sharma et al., 2016; Tehlan & Thakral, 2008; Sharangi et al., 2011).

Leaf number, leaflet number, node number was significant only at last DAG (43 DAG) which might be due to cumulative effect of treatments that has been applied two split before. The results support the increased leaf evidences found with chitin nanofiber (Egusa et al., 2020), oligo-chitosan (Sultana et al., 2015) and chitosan (Barka et al., 2003; Nurliana et al., 2022).

Individual plant fresh weight did not show any significant differences at earlier DAGs but finally, as a cumulative effect, it showed variations among the treatments and urea resulted in higher plant fresh weight. Like our study, other studies reported highest plant fresh weight from urea/nitrogen treatments (Sharma et al., 2016; Tehlan & Thakral, 2008; Sharangi et al., 2011).

4.2.2 Yield

Coriander plant fresh weight after harvest was highest in case of urea which shows the distinct effect of the treatment. This result also showed consistent with green amaranths (TONOYA, 2014), Basil (Nurzynska-Wierdak et al., 2011).However, as the yield of nitrogen treated plant showed statistically similarity with that of CNF 2, thus it creates a potentiality of CNF to be used as partial source of nitrogen. It is reported that nitrogen uptake efficiency was upregulated in hydroponically grown tomato when treated with CNF (Egusa et al., 2020). Moreover chitosan, a derivative of chitin was reported to increase the leaf number in lettuce even under drought condition (Nurliana et al., 2022). Though CNF in our study did not show the highest yield but CNF along with spent mushroom substrate promotes growth of *Arabidopsis thaliana* (Li et al., 2022).

4.2.3 Physical analysis

In our study plant freshness tenderness and shrinkage provides the significant differences among the treatments. Freshness of cucumber when treated with CNF coating was reported (Tanpichai et al., 2023).

4.2.4 Chemical parameters

It is noticed that our treatments did not affect total soluble solids (TSS), titratable acidity (TA), TSS : TA ratio, and vitamin C content of coriander. TSS content was also not affected by chitosan application in peach (Du et al., 1997), papaya (Bautista-Baños et al., 2003). However, chitosan/gallic acid/chitin nanofiber films increased TSS content on strawberry (Cabrera-Barjas et al., 2024). In another study chitosan @ 2% treated longan fruit shows highest total soluble solids than other treatments (Jiang & Li, 2001). Tomato was found to report increased amount of TA when treated with chitosan (Ghaouth et al., 1992; Sucharitha et al., 2018).

4.2.5 Shelf life

The shelf life of coriander increased as the CNF concentration increased (Figure 8.) and the highest shelf life was obtained from CNF 3. Similar result was obtained from cucumber when coated with deacetylated CNF of 120 and 240 minutes (Tanpichai et al., 2023). Moreover Chitosan, Irradiated chitosan showed enhanced shelf life on bananas (Jia et al., 2023), uncut mangoes (Abbasi et al., 2009) and sliced mango (Chien et al., 2007).

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

The present experiments were conducted with chitin nanofiber (CNF) for the growth, yield and postharvest quality of coriander. The main objectives were to evaluate the effect of CNF on growth and yield of coriander plants and to identify the effect of CNF on postharvest quality and shelf life of coriander leaf. Two studies were conducted of which experiment I was performed in Dr. Purnendu Gain Field Laboratory of Khulna University from February to April, 2024 for plant growth study and experiment II was carried out in the in the Horticulture Laboratory under Agrotechnology discipline of Khulna University from April 24 to April 29, 2024 for post-harvest quality study.

For experiment I, a land of 42 m^2 was prepared, and cultivated. Coriander seeds were sown in the land with a randomized complete block design (RCBD) of 0.8 m^2 plot of five treatments and replicated seven times. BARI dhania 2 was used as the variety and the treatments were T1 = control, T2= urea (recommended dose, 6.5 g $plot^{-1}$), T3= CNF 1 (6.5 ml $plot^{-1}$), T4= CNF 2 (13 ml $plot^{-1}$) and T5= CNF 3 (19.5 ml $plot^{-1}$). During the experiment data were collected on plant height (mm), plant fresh weight (gm), number of leaves per plant and, number of leaflet per plant. At the end of the experiment fresh weight per plot were measured as yield.

For experiment II, Horticulture Laboratory under Agrotechnology Discipline of Khulna University was laid out with completely randomized design (CRD) and pretreated 50 coriander plants were arranged in each plot with three replication to assess the postharvest shelf life of different treatments. Some physical parameters (daily weight loss (g), color change (using colorimeter), freshness, shrinkage, and tenderness) and some chemical parameters (total soluble solids (TSS), Titratable acid (TA), and vitamin C content) were measured.

5.2 Conclusion and Recommendation

Significant variation was observed among the treatments for growth attributes. CNF resulted in either similar or higher plant height, leaf number, leaflet number, node number, individual plant fresh weight and plot leaf yield of coriander to urea. Plant fresh weight per plot was obtained the highest from urea. In postharvest observation CNF treated plant exhibits either superior or similar results with urea in case of freshness, tenderness and shrinkage. CNF treated plants resulted higher TA, TSS, TSS: TA and vitamin C content. CNF treatment also increased shelf life of coriander by one and a half days compared to the control. As there is very few researches has been done with CNF and leafy vegetables, more experiments of similar kind should be conducted to make a definite conclusion.

CHAPTER VI

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Appendix

Figure 1: Experimental field

Figure 2: Seedling stage of coriander

Figure 3: Plot treated with treatment

Figure 4: Sample collected in zip-lock bag

Figure 5: CNF application in field plots

Figure 6: Weighing Coriander plants

Figure 7: Postharvest experimental layout