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Improving the Keeping Quality of *Nephrolepis exaltata*, I. Branches after Cutting

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ABSTRACT

A laboratory experiment was conducted to study the effect of Nano-silver, benzyl adenine, chitosan and glycerol as chemical preservative solutions on enhancing properties of *Nephrolepis exaltata* vegetative branches. Nine individual applications (Nano-silver at 15 and 20 mg/L, benzyl adenine 10 and 20mg/L, chitosan 0.5 and 1.0 g/L as well as glycerol 1.0 and 2.0 cm/L) and control. Moreover adding sucrose at 5.0 gm/L + citric acid 150 mg/L + 0.5 ml of Tween 20 to all treatments mentioned above. At the end of the experiments there were some trends cleared as the maximum shelf-life period presented with glycerol at 2.0 cm/L, in both seasons. Nano-Silver at 15.0 mg/L treatment gave the higher water uptake percentage, while benzyl adenine at 10.0 mg/L was the pioneer in water loss, even Nano-silver at 15mg/L had the highest water balance. Chlorophyll a (mg/g) after 5 days was highest with Nano-silver at 15 mg/L, but got highest with Nano-silver at 20mg/L after ten days. Chlorophyll b (mg/g) after five days was maximum with glycerol at 1.0cm/L, but chitosan at 0.5gm/L got highest with Nano-silver at 20mg/L after ten days. Glycerol at 2.0cm/L was the highest percentage in the day matter after five days. Chitosan at 1.0gm/L was the maximum percentage in the day matter after ten days. Total sugar was the pioneer in Nano silver at 20mg/L after five and ten days. However, chitosan at 0.5gm/L gave the maximum microbial growth after five and ten days.

Keywords: *Nephrolepis exaltata*, Nano-silver, benzyl adenine, chitosan and glycerol.



INTRODUCTION

Extending shelf - life period of the ornamental plants cut parts as keeping these parts verdure is the most economic aim in the floral industry, depending on this aim more studies made on some preservation solutions and methods as a way to prolong the shelf - life period. As Eason (2002) demonstrated that plant growth regulator (PGR) is effective in extending shelf - life period, by delaying the onset of petal, fading and wilting. Boston Fern (*Nephrolepis exaltata* Schott cv. Bostoniensis) is an ornamental foliage plant considered today as one of the most marketable indoor pot plants (Hagiabad *et al.*, 2007). It belongs to the family Nephrolepidaceae and is native to north, Central, and South America (Karmkar *et al.*, 2020)

Nephrolepis exaltata, is a common plant, found in moist, shady places and raised in the ornamental plant's greenhouses. Microbial plant is the main part of the plant's life period cycle, which consists of a horizontal rhizome stem that grows below the surface of the soil and grows on it transverse fibrous roots to stabilize the plant and to absorb water and salts from the soil. Back of the germinative leaves, there are true germinative capsules in the form of round orange pustules, and the precipices appear clear and when these precipitates mature, the germs are liberated (Lubos and Olga 2005).

Nanosized silver presents an enigma, because of size and shape, it could be toxic, so it used for their antibacterial and other destructive behaviors. Hypothetical mechanisms of action include the direct interference of clumps or particles of nano silver that settle on the surface of cells, disrupting cell behavior merely by making contact. Nano silver continued to inhibit photosynthesis. Hongbo *et al*

(2017) recorded that post-harvest treatments with Nano-silver (NS) alleviate bacteria-related stem blockage of some cut flowers to extend their longevity.

Benzyl Adenine is a first generation synthetic cytokinin that elicits plant growth and development responses, setting blossoms and stimulating fruit richness by stimulating cell division. However, it is an inhibitor of respiratory kinase in plants, and increases post-harvest life period of green plants. Benzyl adenine is a synthetic cytokinin which together with auxins elicits plant growth and development responses. Elshawa (2009) clarified that preservative solutions which contained BA recorded the highest value of chlorophyll a, b and total chlorophyll in leaves and reduced proline content.

Chitosan is a linear polysaccharide, made by treating the chitin shells of shrimp and other crustaceans with an alkaline substance, such as sodium hydroxide. Horticultural uses, primarily for plant defense and yield increase, are based on how this glucosamine polymer influences the biochemistry and molecular biology of the plant cell. Subsequent changes occur in cell membranes, chromatin, DNA, calcium, MAP kinase, oxidative burst, reactive oxygen species, callose pathogenesis-related (PR) genes, and phytoalexins, as reported by Lee Hadwiger (2013).

Glycerol is a simple polyol compound, colorless, odorless, viscous liquid that is sweet tasting and non-toxic. Its backbone is found in lipids known as glycerides. Due to having antimicrobial and antiviral properties it is widely used in FDA approved wound and burn treatments. Completely miscible with water and many alcohols and also with many heterocyclic compounds as arranged with Megha *et al* (2019).

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The current study was therefore designed to examine the effect of some chemical preservative solutions on enhancing water uptake, delaying leaf wilting and leaf yellowing for keeping quality and extending the shelf-life period of *Nephrolepis exaltata* L. cut branches.

MATERIALS AND METHODS

This study was carried out at Post Harvest Laboratory of Ornamental Plants, Horticulture Department, Faculty of Agriculture, Mansoura University, Egypt, during 2019 and 2020 seasons to study the effect of some chemical preservative solutions on enhancing water uptake, delaying leaf wilting and leaf yellowing for keeping quality and extending the shelf-life period of *Nephrolepis exaltata* cut branches.

The vegetative branches used in this study were come from *Nephrolepis exaltata*, that were cut in the early morning and transported to the laboratory, then 5 cm from the base of the stem was removed and the old leaves on the third lower part were removed, then gathering every three stems and placed in graduated cylinder (100 ml) filled with the specified pre-prepared preservative solutions and left in the laboratory conditions for the duration of the experiment lighted with fluorescent lamps (1500 Lux) at $22 \pm 2^\circ\text{C}$ and $60 \pm 5\%$ Relative Humidity.

The chemical preservatives solutions are used: two concentrations of Nano-silver at 15 and 20mg/L, benzyl adenine at 10 and 20 mg/L, chitosan at 0.5 and 1.0 g/L and glycerol at 1.0 and 2.0 cm/L and control. Adding Sucrose 5.0 mg /L + Citric acid 150mg/L + 0.5ml of Tween 20 to all treatments mentioned above, pH of all solutions was 5.59. Nano-Silver particles, it was prepared in the Nano-Technology and Advanced Materials Central Laboratory (NAMCL), Agricultural Research Center, Giza, Egypt.

Data in this study was collected from some vegetative parameters as: shelf - life period (days): was estimated as the number of days until 70% of the leaves wilted, water relationships: (1) water uptake (gm/3stems/4days): was measured every 4 days during the shelf - life period by weighting the conical flask without cut foliage and recorded the decrease in the solution weight, (2) water loss (gm/3stems/4days): was calculated as the difference between change in fresh weight every 4days and amount of water uptake every 4days, (3) water balance (gm/3stems/4days) as (water uptake – water loss), total sugar (mg/gm DW) as determined by Dubois *et al.* (1956), Chlorophyll (a & b) as determined by Sumanta *et al.* (2014), dry matter (%) calculated as Hashemabadi *et al.*, (2014) and microbial growth (colonies/ml) was determined in the keeping solution (Allen, 1959) using nutrient agar medium (Atlas, 1997). The medium contained, Peptone 5g; Beef extract 3g; NaCl 5g; Agar 15g; Distilled water 1000 ml and pH 6.8-7.2. Procedure: 1) Prepare different serial dilutions of tested samples by adding 1 ml of sample to 9 ml saline distilled water. 2) Pour five plates from each dilution and prepare by adding the carefully measured 1 ml amounts of the dilutions to the dishes and adding the nutrient agar medium. 3) The plates should be shaken very carefully 5 times in the clockwise direction. 5 times in the counterclockwise direction and several times crosswise. 4) Incubate the plates at 30°C for 3 days. 5) Examine the plates carefully and select the plates of the three dilutions where the counts range between 20 and 300 colonies. 6) Record the number of colonies per plate of the acceptable dilution.

Collected data were statistically analyzed according to Stat Soft as obtained by Weiß (2007) and the differences between the means of the treatments were considered significant when they were equal or more than the least significant difference (L.S.D) at the 1 and 5% levels.

RESULTS AND DISCUSSION

1. Effect of Chemical Preservative Solutions on Shelf - life Period of *Nephrolepis exaltata*:

Shoots' vegetative parameters of *Nephrolepis exaltata* parts i.e., shelf - life period, as affected by Nano-silver, benzyl adenine, chitosan and glycerol, during 2019 and 2020 seasons. Data presented in figure (1) showed highly significant difference for shelf - life period in all tested treatments as compared to the control treatment in both seasons. Also, the data presented in the previous figure is also clarified that treating with chitosan at 0.5gm/L observed as the weakest impression effects as it was 10.33 days in both seasons, even it was lower than control treatment which subsisted for 12.00 and 11.67 days in first and second seasons, respectively.

Comprehensive overview, data irradiated that shelf - life period steadily ascending until giving maximum shelf - life period with glycerol at 2.0cm/L as it scored 14.67 days in both seasons, then followed with nano-silver at 20mg/L as it gave 14.67 and 14.33 days in the first and second seasons, respectively.

Benzyl adenine at 20mg/L, glycerol at 1.0cm/L, nano-silver at 15mg/L, benzyl adenine at 10mg/L and chitosan at 1.0gm/L was the steady descending, respectively. These differences among the treatments in shelf - life period due to the roles of each preservative solution separately in encouraging cell elongation, cells divisions and consequently decreasing activation of photosynthesis and metabolic process which reflected increases in life period longevity. Data showed harmonized trend Avilala *et al.*, (2021), Skutnik *et al.*, (2021) and El-Attar and Sakr (2022).

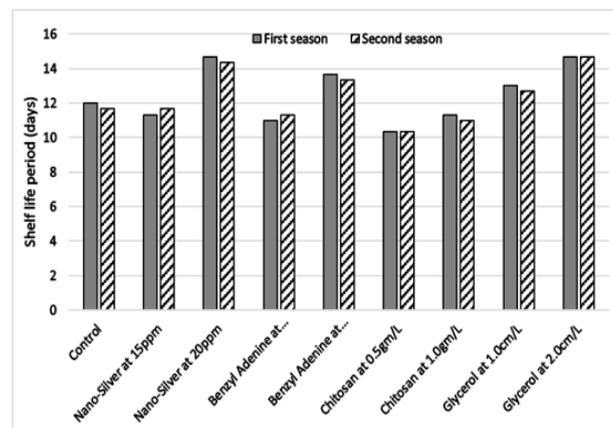


Fig. 1. Effect of nano-silver, benzyl adenine, chitosan and glycerol as a holding solution on the shelf - life period (days) of *Nephrolepis exaltata* in the two seasons.

2. Effect of Chemical Preservative Solutions on Water Relationships of *Nephrolepis exaltata*:

Table (1) indicate that the water uptake of the persevered *Nephrolepis exaltata* in the first season, showed that there are high moral differences very noticeable as compared to among nano-silver, benzyl adenine, chitosan and glycerol as Chemical Preservative Solutions and the control treatment. Data recorded that third and seventh days obtained that nano-silver at 20mg/L took the superiority upon the rest treatments as it gave 8.67 and

4.00gm/3stems/4days, respectively. As in the eleventh day, benzyl adenine at 20mg/L gave the highest value 3.67 gm/3 stems/4days since data in the fifteenth day occurred nano silver at 3.00 gm/3stems/4days.

The results occurred in table (1) with control treatment was normal, it commenced highly with 5.67, 2.67, 3.00 and 1.33gm/3stems/4days in 3rd, 7th, 11th and 15th days, respectively. Concerning to the weakest treatments, data occurred that chitosan at 0.5gm/L showed the lowest water uptake quantity in the third day as it was 2.00 gm/3stems/4days, then took the trend in seventh, eleventh and fifteenth day as it gave 1.33, 1.00 and 1.00 gm/3stems/4days, respectively.

Regarding to changes of water uptake (gm/3stems/4days) of the persevered *Nephrolepis exaltata* in the second season, control treatment gave 5.67, 3.00, 2.67 and 1.00gm/ 3 stems/4days in 3rd, 7th, 11th and 15th days, respectively. Maximum rates were found with benzyl adenine at 10mg/L in the third day. While nano silver at 20mg/L gave highly water uptake in 7th, 11th and 15th day as it was 4.00, 3.00 and 2.33 gm/3stems/4days, respectively. On the other side chitosan at 0.5gm/L appeared as the minimum water uptake rates, as it gave 2.00, 1.67, 1.00 and 1.00gm/3stems/4days in 3rd, 7th, 11th and 15th days, respectively.

Changes in water loss from persevered shoots of *Nephrolepis exaltata* as affected with nano-silver, benzyl adenine, chitosan and glycerol as Chemical Preservative Solutions in the first season, presented in table (1) showed highly significant differences when compared with control treatment. Control treatment gave 4.67, 3.67, 4.67 and 3.67gm/3stems/4days in 3rd, 7th, 11th and 15th days, respectively. Nano silver at 20mg/L was the superiority treatment in the third day as it was 6.67gm/3stems/4days.

Nano silver at 20mg/L and benzyl adenine at 10mg/L were the maximum rates in 7th day as they were 4.67gm/3stems/4days. Glycerol treatment at 1.0cm/L in 11th day was 5.00gm/3stems/4days. Highest water loss in the fifteenth day occurred as affected with benzyl adenine at 10mg/L. On the other hand, chitosan at 0.5 and 1.0gm/L was the lowest effect on 3rd day as they gave 1.00gm/3stems/4days. Even chitosan at 0.5gm/L continued lowly in 7th and 11th days, as it was 2.33 and 2.67gm/3stems/4days, respectively. Chitosan at 1.0gm/L gave 2.00gm/3stems/4days in 15th day as the lowest.

Second season did not go far away from the first season, as control treatment gave 4.67, 3.67, 4.00 and 3.00gm/3stems/4days in 3rd, 7th, 11th and 15th days, respectively. Extreme water loss values occurred with nano silver at 20mg/L in both third and seventh days as it gave 6.67and 4.67gm/3stems/4days, then benzyl adenine at 20mg/L became the highest in the eleventh day which gave 4.67gm/3stems/4days. Glycerol at 1.0cm/L got superiority in 15th day as it gave 4.00gm/3stems/4days. On the contrary, chitosan at 1.0gm/L showed the lowest water loss values in 3rd and 15th day as it gave 0.67 and 2.00gm/3stems/4days, respectively. Chitosan at 0.5gm/L in both 7th and 11th days, which gave 2.67 and 1.67gm/3stems/4days, respectively.

Taking a roundly view about the effect of nano-silver, benzyl adenine, chitosan and glycerol as Chemical Preservative Solutions and comparing them with control treatment on the change of water balance in preserved *Nephrolepis exaltata*, showed highly significant differences. Data in Table (1) illustrated the effect of control gave 1.00, -1.00, -1.70 and -2.33gm/3stems/4days in 3rd, 7th, 11th and 15th days, respectively.

Table 1. Effect of Chemical Preservative Solutions on water relationships during the shelf - life period of *Nephrolepis exaltata* in the season (2019).

Treatments	Water Uptake (gm/3stems/4days)				Water Loss (gm/3stems/4days)				Water Balance (gm/3stems/4days)			
	3rd day	7th day	11th day	15th day	3rd day	7th day	11th day	15th day	3rd day	7th day	11th day	15th day
Control	5.67	2.67	3.00	1.33	4.67	3.67	4.67	3.67	1.00	-1.00	-1.70	-2.33
Nano Silver at 15mg/L	6.00	3.00	3.00	3.00	5.00	4.33	4.67	3.00	1.00	-1.33	-1.70	0.00
Nano Silver at 20mg/L	8.67	4.00	3.33	2.67	6.67	4.67	4.00	4.00	2.00	-0.70	-0.70	-1.33
Benzyl Adenine at 10mg/L	5.67	3.00	3.00	1.67	4.00	4.67	4.33	4.67	1.70	-1.70	-1.33	-3.00
Benzyl Adenine at 20mg/L	7.00	3.00	3.67	2.00	4.67	4.33	4.67	3.67	2.33	-1.33	-1.00	-1.70
Chitosan at 0.5gm/L	2.00	1.33	1.00	1.00	1.00	2.33	2.67	2.33	1.00	-1.00	-1.70	-1.70
Chitosan at 1.0gm/L	2.33	1.67	1.33	1.00	1.00	2.67	3.67	2.00	1.33	-1.00	-2.33	-1.00
Glycerol at 1.0cm/L	7.00	2.67	3.00	2.00	6.00	3.67	5.00	4.33	1.00	-1.00	-2.00	-2.33
Glycerol at 2.0cm/L	5.67	3.00	3.00	1.33	4.33	3.33	4.00	3.67	1.33	-0.33	-1.00	-2.33
LSD at 1%	1.38	1.28	1.53	0.79	1.53	1.96	2.19	2.38				
LSD at 5%	0.99	0.93	1.11	0.58	1.11	1.42	1.59	1.73				

High mostly water balance occurred as affected by benzyl adenine at 20 mg/L, that gave 2.33gm/3stems/4days in 3rd day. While glycerol at 2.0cm/L in the seventh day gave -0.33gm/3stems/4days, as nano silver at 20mg/L in the eleventh day gave -0.70gm/3stems/4days, as the fifteenth day gave 0.00gm/3stems/4days with nano silver at 15mg/L. On the other hand, the lowest value was shown in 3rd day with both Nano silver at 15mg/L, chitosan at 0.5gm/L and glycerol at 1.0cm/L, which gave 1.00gm/3stems/4days. Both of nano silver at 15mg/L and benzyl adenine at 20mg/L shared the same water balance value in the seventh day, as they gave -1.33gm/3stems/4days. However, chitosan at 1.0 gm/L gave -2.33gm/3stems/4days in the eleventh day, as benzyl adenine at 10mg/L which gave -3.00gm/3stems/4days in the fifteenth day.

Data presented in Table (2) clarifies the response of water balance in second season. However, control treatment gave 1.00, -1.33, -1.33 and -2.33 gm/3stems/4days in 3rd, 7th, 11th and 15th day, respectively. The maximum values came from nano silver at 20mg/L and benzyl adenine at 20mg/L, which gave 2.00gm/3stems/4days in the third day. Both of nano silver at 20mg/L, benzyl adenine at 10mg/L and glycerol at 1.0cm/L that gave -0.70 gm/3stems/4days in the seventh day. As chitosan at 0.5gm/L and glycerol at 2.0cm/L gave -0.70 gm/3stems/4days in the eleventh day. Nano silver at 15mg/L gave -0.70 gm/3stems/4days in the fifteenth day. However, chitosan at 0.5gm/L shown the lowest water balance value, it was 1.00 gm/3stems/4days in 3rd day. Glycerol at 2.0cm/L gave -1.70 gm/3stems/4days in the seventh day, as chitosan at 1.0gm/L in the 11th day was -3.00gm/3stems/4days. While both of benzyl

adenine at 10mg/L, glycerol at 1.0cm/L and glycerol at 2.0cm/L gave -2.33 gm/3stems/4days in the fifteenth day.

From the above data, it is clear that increasing in the water content due to preservative treating over the initial one could be explained that shoots tissues after days expanded and absorbed more water than at the initial day, in addition to the effects of the

inhibition of transpiration from leaves by reducing stomata aperture according to Abdel Kader (2012). Same trend occurred with Farazmandi *et al.*, (2020), stated that protecting the structure and increasing sugar content by respiratory and osmotic pressure regulations, the aging process delays, so this factor might have a significant influence on the water uptake.

Table 2. Effect of Chemical Preservative Solutions on water relationships during the shelf - life period of *Nephrolepis exaltata* in the second season (2020).

Treatments	Water Uptake (gm/3stems/4days)				Water Loss (gm/3stems/4days)				Water Balance (gm/3stems/4days)			
	3rd day	7th day	11th day	15th day	3rd day	7th day	11th day	15th day	3rd day	7th day	11th day	15th day
Control	5.67	3.00	2.67	1.00	4.67	3.67	4.00	3.00	1.00	-1.33	-1.33	-2.33
Nano Silver at 15mg/L	5.67	0.033	2.67	2.33	4.33	4.67	4.33	3.00	1.33	-1.33	-1.70	-0.70
Nano Silver at 20mg/L	5.67	4.00	3.00	2.33	6.67	4.67	4.33	3.67	2.00	-0.70	-1.33	-1.33
Benzyl Adenine at 10mg/L	8.67	3.33	2.67	1.33	3.67	4.00	4.00	3.67	1.70	-0.70	-1.33	-2.33
Benzyl Adenine at 20mg/L	5.33	2.67	3.00	1.67	4.67	3.67	4.67	3.00	2.00	-1.00	-1.70	-1.33
Chitosan at 0.5gm/L	2.00	1.67	1.00	1.00	1.00	2.67	1.67	3.67	1.00	-1.00	-0.70	-1.70
Chitosan at 1.0gm/L	2.00	2.00	1.00	1.00	0.67	3.33	4.00	2.00	1.33	-1.33	-3.00	-1.00
Glycerol at 1.0cm/L	6.67	3.00	3.00	1.67	5.33	3.67	4.33	4.00	1.33	-0.70	-1.33	-2.33
Glycerol at 2.0cm/L	6.00	2.67	3.00	1.00	4.67	4.33	3.67	3.00	1.33	-1.70	-0.70	-2.33
LSD at 1%	1.04	0.92	0.79	0.87	1.37	1.50	2.16	2.13				
LSD at 5%	0.75	0.67	0.58	0.63	0.99	1.09	1.57	1.55				

3. Effect of Chemical Preservative Solutions on Dry Matter, Chlorophyll (a & b) and Total Sugars of *Nephrolepis exaltata*:

Concerning to the effect of nano-silver, benzyl adenine, chitosan and glycerol as Chemical Preservative Solutions on chlorophyll content in preserved *Nephrolepis exaltata* shoots, data presented in Table (3) declares that control treatment gave 0.14mg/gm F.W. of chlorophyll a in both seasons after five days and 0.07mg/gm F.W in both seasons after ten days. The greatest rates obtained with nano silver at 15mg/L in both seasons, as it gave 0.32 mg/gm F.W after five days. Nano silver at 20mg/L was the superiority in both seasons after ten days, as it gave 0.14mg/gm F.W. However, benzyl adenine at 20mg/L gave the lowest values in both seasons and both ages, as it was 0.12mg/gm F.W in both seasons after 5 days and 0.02mg/gm F.W 10 days in

both seasons.

Referring to chlorophyll b content as affected with nano-silver, benzyl adenine, chitosan and glycerol in *Nephrolepis exaltata* shoots, table 3 recorded that control treatments gave 0.22 mg/gm F.W after five days in both seasons and 0.09mg/gm F.W after ten days in both seasons. Also, glycerol at 1.0cm/L gave the maximum rate after five days, as it was 0.67 and 0.37mg/gm F.W in first and second seasons, respectively. In this context, chitosan at 0.5gm/L took the pioneer in the tenth day as it gave 0.19 mg/gm F.W in both seasons. Moreover, benzyl adenine at 20mg/L was the lowest treatment in the first season, as it gave 0.18 mg/gm F.W after five days and 0.07 mg/gm F.W after ten days in both seasons, and nano silver at 15mg/L was the lowest rate in the second season after ten days, as it gave 0.12mg/gm F.W.

Table 3. Effect of Chemical Preservative Solutions on Chlorophyll a and b (mg/ml F.W.) during (2019 and2020) seasons.

Treatments	Chlorophyll a (mg/gm F. W)		Chlorophyll a (mg/gm F. W)		Chlorophyll b (mg/gm F. W)		Chlorophyll b (mg/gm F. W)	
	After 5 days		After 10 days		After 5 days		After 10 days	
	2019	2020	2019	2020	2019	2020	2019	2020
Control	0.14	0.14	0.07	0.07	0.22	0.22	0.09	0.09
Nano Silver at 15mg/L	0.32	0.32	0.12	0.12	0.41	0.12	0.14	0.14
Nano Silver at 20mg/L	0.26	0.26	0.14	0.14	0.33	0.33	0.18	0.18
Benzyl Adenine at 10mg/L	0.12	0.12	0.08	0.08	0.23	0.23	0.09	0.09
Benzyl Adenine at 20mg/L	0.12	0.12	0.02	0.02	0.18	0.18	0.07	0.07
Chitosan at 0.5gm/L	0.19	0.19	0.08	0.08	0.29	0.29	0.19	0.19
Chitosan at 1.0gm/L	0.18	0.18	0.05	0.06	0.25	0.25	0.16	0.16
Glycerol at 1.0cm/L	0.20	0.19	0.07	0.07	0.67	0.37	0.15	0.16
Glycerol at 2.0cm/L	0.19	0.19	0.07	0.07	0.24	0.24	0.14	0.14
LSD at 1%	0.01	0.01	6.83	6.78	0.02	0.2	9.18	9.96
LSD at 5%	0.01	0.01	4.95	4.92	0.02	0.02	6.66	7.23

Talking about the dry matter percentages in preserved *Nephrolepis exaltata* shoots as affected by nano-silver, benzyl adenine, chitosan and glycerol, table 4 reported that control treatment were 30.22 and 30.21% in the first and second season after five days, respectively. As the control treatment was 32.47 and 32.50% in the first and second season after ten days, respectively. Majority was glycerol at 2.0cm/L in both seasons after five days, as it was 32.41% in both seasons. Also, chitosan at 1.0gm/L was the highest in the tenth day, as it was 48.98 and 49.18% in first and second season, respectively. Against, glycerol

at 1.0cm/L was the lowest value after ten days in the first season, as it recorded 27.54%. While Nano silver at 20mg/L gave 10.76% in the second season to be the lowest after ten days.

Taking an attention with total sugars content in preserved *Nephrolepis exaltata* shoots as affected by nano-silver, benzyl adenine, chitosan and glycerol, table 4 pointed to the effect of control treatments after five days was 8.29 and 8.33mg/g DW in first and second season, respectively. Then in the tenth day, control was 7.32 and 7.42 mg/g DW in first and second season, respectively.

Nano silver at 20mg/L was the maximum rates in both seasons, even after five and ten days. Total sugars data were 11.18 and 11.25mg/g DW after five days in the first and second seasons, respectively. As it was 8.98 and 8.75mg/g DW after ten days in the first and second seasons, respectively. Oppositely,

benzyl adenine at 10mg/L was the lowest values in both seasons after both five and ten days, as it was 6.30 and 6.34mg/g DW after five days in the first and second season, respectively. As, benzyl adenine at 10mg/L gave 5.85 and 5.64mg/g DW after ten days in first and second seasons, respectively.

Table 4. Effect of Chemical Preservative Solutions on dry matter (%) and total sugars (mg/gm DW) during the shelf - life period of *Nephrolepis exaltata* during (2019 and 2020) seasons.

Treatments	Dry matter (%)		Dry matter (%)		Total sugars (mg/gm DW)		Total sugars (mg/gm DW)	
	After 5 days		After 10 days		After 5 days		After 10 days	
	2019	2020	2019	2020	2019	2020	2019	2020
Control	30.22	30.21	32.47	32.5	8.29	8.33	7.32	7.42
Nano Silver at 15mg/L	31.14	31.13	34.29	34.25	10.21	10.19	8.46	8.51
Nano Silver at 20mg/L	31.75	31.66	30.77	10.76	11.18	11.25	8.98	8.75
Benzyl Adenine at 10mg/L	27.59	27.7	29.01	29.06	6.3	6.34	5.85	5.64
Benzyl Adenine at 20mg/L	28.2	28.27	28.99	25.06	9.21	9.12	7.64	7.58
Chitosan at 0.5gm/L	26.24	28.27	32.05	32.03	7.24	7.27	6.3	6.31
Chitosan at 1.0gm/L	32.38	32.37	48.98	49.18	7.24	9.81	8.62	8.6
Glycerol at 1.0cm/L	31.35	31.33	27.54	27.65	8.37	8.44	6.73	6.56
Glycerol at 2.0cm/L	32.41	32.41	31.59	31.53	10.58	10.39	8.23	8.21
LSD at 1%	0.19	0.16	0.4	0.24	0.59	0.41	0.36	0.41
LSD at 5%	0.14	0.11	0.29	0.17	0.43	0.3	0.26	0.3

These results get agree with Skutnik *et al.*, (2006) who stated that Chlorophyll content was remained high in shoots treated with Benzyl Adenine, and Moradi *et al.*, (2012), they stated that Benzyl Adenine improve the qualitative characteristics such as Anthocyanin content. Even Skutnik *et al.*, (2021) stated that the NS preservative with sucrose improves the overall condition of lisianthus flowers.

4. Effect of Chemical Preservative Solutions on Microbial Growth of *Nephrolepis exaltata*:

The influence of nano-silver, benzyl adenine, chitosan and glycerol as Chemical Preservative Solutions on microbial parameters in preserved *Nephrolepis exaltata* shoots, table 5 shown that control treatment had 2.6×10^5 and 2.5×10^5 cfu/ml microbial growth after five days in the first and second season, respectively. And it gave 5.5×10^5 and 5.4×10^5 cfu/ml microbial growth after ten days in the first and second season, respectively.

Table 5. Effect of Chemical Preservative Solutions on microbial growth of *Nephrolepis exaltata* during (2019 and 2020) seasons.

Treatments	Microbial growth CFU/ml		Microbial growth CFU/ml	
	after 5 days		after 10 days	
	2019	2020	2019	2020
Control	2.6×10^5	2.5×10^5	5.5×10^5	5.4×10^5
Nano Silver at 15mg/L	2.3×10^5	2.3×10^5	3.1×10^5	3.2×10^5
Nano Silver at 20mg/L	1.9×10^5	2.1×10^5	2.1×10^5	2.3×10^5
Benzyl Adenine at 10mg/L	2.4×10^5	2.4×10^5	3.3×10^5	3.4×10^5
Benzyl Adenine at 20mg/L	2.1×10^5	2.2×10^5	2.4×10^5	2.5×10^5
Chitosan at 0.5gm/L	2.5×10^5	2.6×10^5	3.8×10^5	3.9×10^5
Chitosan at 1.0gm/L	2.3×10^5	2.3×10^5	3.1×10^5	3.2×10^5
Glycerol at 1.0cm/L	2.2×10^5	2.3×10^5	2.9×10^5	3.1×10^5
Glycerol at 2.0cm/L	1.9×10^5	2.1×10^5	2.1×10^5	2.3×10^5

Highest amount was obtained with chitosan at 0.5gm/L which gave 2.5×10^5 and 2.6×10^5 cfu/ml microbial growth after five days in the first and second season, respectively. As so, chitosan at 0.5gm/L which gave 3.8×10^5 and 3.9×10^5 cfu/ml microbial growth after ten days in the first and second season, respectively. The lowest values were obtained with both of nano silver at 20mg/L and glycerol at 2.0cm/L, they gave 1.9×10^5 and 2.1×10^5 cfu/ml microbial growth after five days in the first and second season, respectively. As so, chitosan at 0.5gm/L which

gave 2.1×10^5 and 2.3×10^5 cfu/ml microbial growth after ten days in the first and second season, respectively.

The maximum values were occurred with chitosan at 0.5gm/L in both dates and seasons, as it was 4.58 and 4.31cfu/ml after five days in the first and second season, respectively. As chitosan at 0.5gm/L treatment gave 6.21 and 6.44cfu/ml after ten days in the first and second season, respectively. However, the minimum values after five days obtained with glycerol at 2.0cm/L which gave 3.33cfu/ml in first and second season, respectively. After ten days, Nano silver at 20mg/L was the lowest value, as it gave 4.53 and 4.51cfu/ml in both seasons, respectively. It is clear that effective trend come in the same way with Abou El-Ghait *et al.*, (2012), treatment of BA gave high reduction in the number of colonies/ml vase solution. As Rafi and Ramezani (2013) assessed the effect of Nano Silver treatment reduced the number of bacteria by suppressing stomatal opening, decreasing transpiration from leaves and inhibiting bacterial prolife periodration. And Spriçigo *et al.*, (2021) reported that chitosan solution strongly inhibited molds.

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تحسين جودة وحفظ أفرع الفوجير بعد القطف.

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أجريت تجربة معملية لدراسة تأثير الفضة النانوية، بنزول الأدينين، الشيتوزان والجلسرين كمحاليل كيميائية حافظة على نبات الفوجير. تسعة معاملات فردية (الفضة النانوية 15 و 20 جزء في المليون، بنزول أدينين 10 و 20 جزء في المليون، الشيتوزان 0.5 و 1.0 جم/ لتر والجلسرين 1 و 2 سم / لتر) إضافة للمعاملة القياسية. تم إضافة السكر 5 جم / لتر + حامض الستريك 150 جزء في المليون + 0.5 مل من توين 20 لجميع المعاملات المذكورة أعلاه. أعطت الفضة النانوية عند المعاملة 15 جزء في المليون أعلى نسبة امتصاص للماء، بينما كان البنزول أدينين عند 10 جزء في المليون هو الأول في فقد الماء، حتى أن الفضة النانوية عند 15 جزء في المليون كان لها أعلى توازن مائي. كان الكلوروفيل أ (ملغ / جم) بعد 5 أيام أعلى مستوى له مع الفضة النانوية عند 15 جزء في المليون، لكنه حصل على أعلى مستوى مع الفضة النانوية عند 20 جزء في المليون بعد عشرة أيام. كان الكلوروفيل ب (مجم/جم) بعد خمسة أيام بعد أقصى مع الجلسرين عند 1.0 سم / لتر، ولكن الشيتوزان عند 0.5 جم / لتر كان أعلى مع الفضة النانوية عند 20 جزء في المليون بعد عشرة أيام. كان الجلسرين عند 2.0 سم / لتر أعلى نسبة في اليوم بعد خمسة أيام. كانت الشيتوزان عند 1.0 جم / لتر أعلى نسبة مئوية في اليوم بعد عشرة أيام في كلا الموسمين. كان السكر الكلي هو الرائد في صناعة الفضة النانوية عند 20 جزء في المليون بعد خمسة وعشرة أيام. بينما أعطى الشيتوزان عند 0.5 جرام / لتر أقصى نمو ميكروبي بعد خمسة وعشرة أيام.