Biological Forum – An International Journal **15(5): 563-568(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Silver Nitrate and Silver Nanoparticles on Shelf Life and Quality of Table Grapes var. Muscat Hamburg

Nishanth A.C.[1], V. Suresh[2*], A. Asha Monicka[2], B. Madhumitha[2], B. Vidhya[3], V. Gopi[2] and Umesh Chimmalagi[2]

[1]M.Sc. Student, School of Agricultural Sciences,
Karunya Institute of Technology and Sciences, Karunya Nagar, Coimbatore (Tamil Nadu), India.
[2]Assistant Professor, School of Agricultural Sciences,
Karunya Institute of Technology and Sciences, Karunya Nagar, Coimbatore (Tamil Nadu), India.
[3]Assistant Professor, Department of Applied Physics,
Karunya Institute of Technology and Sciences, Karunya Nagar, Coimbatore (Tamil Nadu), India.

(Corresponding author: V. Suresh)*
(Received: 04 March 2023; Revised: 15 April 2023; Accepted: 21 April 2023; Published: 20 May 2023)
(Published by Research Trend)

ABSTRACT: The post-harvest losses in fruits include the susceptibility to fungal infections, rotting, spoilage, leading to significant economic losses for farmers and reduced availability of high-quality fruits in the market. Hereby, a study on effect of silver nitrate and silver nanoparticles on shelf life of grapes var. Muscat Hamburg was conducted at School of agricultural sciences, Karunya Institute of Technology and Sciences, Coimbatore during 2023. The experiment was laid out in CRD with nine treatments. The results showed that highest shelf life (14.7 days), weight loss (21.95 per cent), total soluble solids (19.1 per cent), titratable acidity (0.48 per cent) and ascorbic acid (77.26 mg/100g) were recorded by the treatment T_7 (Ag-NPs @ 60 ppm for 3 min). Among the different treatments, the treatment T_6 (Ag-NPs @ 30 ppm for 5 min) registered the lower total sugars (13.3 per cent) and the treatment T_5 (Ag-NPs @ 30 ppm for 3 min) registered the minimum reducing sugars (9.67 per cent).

Keywords: Grapes, Muscat hamburg, quality parameters, silver nanoparticles, shelf life.

INTRODUCTION

Grapes *(Vitis vinifera* L.) variety Muscat Hamburg (Syn. *Panneer Dhirakshaor Gulabi*) belongs to the family vitaceae and its originated in Armenia. One of the most economically important fruit and it is widely cultivated in the sub-tropical condition (Insanu *et al*., 2021). The grape is often a woody vine, trekking via tendrils (modified branches) and at the identical time as untrained frequently engaging in a length of 17 metres (56 feet) or more. Small greenish plant lives in clusters bearing habit, which varies in coloration from nearly black, green, red, and amber (Prathiksha and Hegde 2022). The calyptra stage is a specific stage in the development of the flower. The calyptra is a structure that covers the developing grape flower before it fully opens. It is also called the "cap" or "hood" and is formed by the fusion of two sepals. Fruit is soft and pulpy, oval to oblong and fruit colour may be green and red to purplish black. It is used to table grapes, raisins, grape seed oil, grape juice and wine. Botanically, the fruit is a berry. In numerous forms of fruit develops a whitish powdery coating on above the fruit surface is Natural wax. The seeds found in grapes are typically called grape seeds or grape pips. Seeds are small, hard, brown in color and rich in antioxidants (Nunes *et al*., 2016).

Higher amount of bio-active compounds *viz*., anti-oxidants, flavanols, anthocyanins, polyphenols, tannins, gallic acid, hydroxycinnamicacids, anti-microbial, anti-inflammatory, anti-tumorigenic activities, anti-carcinogenic, anti-viral, cardioprotective and hepatoprotective (Sabra *et al*., 2021). However, grapes are highly perishable nature and postharvest losses *viz*., weight loss, decay, microbial, pedicel desiccation and berry softening (Cefola and Pace 2016).

In order to extend its postharvest self life several treatments such as cold storage, pre-cooling and modified atmosphere packaging have been used (Liguori *et al*., 2021). But these techniques are not adequate to conserve the grapes color, nutritive value, texture, taste, flavor and aroma during storage also this technique were costly to adopt, needs specialized equipment and infrastructure. As a result, the problem of postharvest losses of grapes needs to satisfy supply and demand in both domestic and export markets. Most recently, the silver nanoparticules (Ag-NP's) use as coatings material containing active compounds with antimicrobial properties has been explore as a possible to reduce microbial growth and self life of fruits (Nayab and Akhtar 2023).

According to Elatafi *et al*. (2020) compared the effects of silver nitrate ($AgNO_3$) and silver nanoparticles (Ag-NPs) coatings with different concentrations at different

time interval on the quality of grapes during storage. The result found that 100 ppm for 5 min of dipping of Ag-NPs was the most effective in extending the shelf life of the grapes. It maintaining the quality of grape bunches up to 30 days at cold storage and various responses including weight loss, soluble solids content (SSC), firmness and acidity. Hence, the aims of this research work were grapes coated with $AgNO_3$ and Ag-NPs can reduce postharvest losses to extend shelf life and physicochemical properties of grapes during storage.

MATERIALS AND METHODS

The present experiments on effect of silver nitrate and silver nanoparticles on shelf life and quality of table grapes var. Muscat Hamburg was conducted at division of horticulture, school of agricultural sciences, Karunya Institute of Technology and Sciences, Coimbatore, during 2022-2023. The experiment was laid out in a CRD consisting of nine treatments with three replications. The grapes variety Muscat Hamburg (Syn. *Panneer Dhiraksha*or *Gulabi*), it was purchased from A. Vellodu, Dindigul District, Tamil Nadu, India.

Treatment Details.

Treatment	Treatment Detail
T_0	Control
T_1	$AgNO_3$ @ 1000 ppm for 3 min
T_2	$AgNO_3$ @ 1000 ppm for 5 min
T_3	$AgNO_3$ @ 2000 ppm for 3 min
T_4	$AgNO_3$ @ 2000 ppm for 5 min
T_5	Ag-NPs @ 30 ppm for 3 min
T_6	Ag-NPs @ 30 ppm for 5 min
T_7	Ag-NPs @ 60 ppm for 3 min
T_8	Ag-NPs @ 60 ppm for 5 min

Preparation of silver nitrate ($AgNO_3$) and silver nanoparticles (Ag-NPs). $AgNO_3$ were purchased from (Hi-Media Laboratories pvt Ltd.) and Ag-NPs were prepared by green synthesis method. *Moringa oleifera* leaves were use as a reducing agent for the synthesis of silver nanoparticules and it is a simple, eco-friendly, and cost-effective method. Further, synthesized nanoparticules were characterized by using several techniques UV-vis spectrographic evaluation, Fourier rework infrared spectroscopy (FTIR), X-ray Diffract meter (XRD), Energy-dispersive X-ray (EDX), Scanning electron microscopy (SEM), Zeta Potential and Dynamic Light Scattering (DLS).

The accurate concentration of 1 mM $AgNO_3$ (Hi-Media Laboratories pvt Ltd.) solution was prepared by dissolving 0.085 gm of $AgNO_3$ in 500 ml double distilled water.

Quality Parameters. Data on quality parameters as shelf life, physiological weight loss, total soluble solids, titratable acidity, total sugar content, reducing sugar content and ascorbic acid were recorded.

Statistical Analysis. The data were analyzed statistically and results were interpreted by using methods suggested by Panse and Sukhatme (1985).

RESULT AND DISCUSSION

Shelf Life (Days). In this study the data pertaining to shelf life of grape variety Muscat Hamburg are presented in the Fig 1. From the table it was observed that different treatments effects showed highest significant influence on shelf life. Among the different treatments, the treatment T_7 (Ag-NPs @ 60 ppm for 3 min) recorded higher shelf life of 14.7 days and it was followed by the treatment T_6 (Ag-NPs @ 30 ppm for 5 min) with shelf life value of 12.7 days. Meanwhile, the lowest shelf life registered by the treatment T_0 (control) shelf life of 6.3 days. Kumar *et al.* (2018) reported that fabricated hybrid nanocomposite film consisting of chitosan, gelatin, polyethylene glycol and silver nanoparticles (AgNPs) by solution casting method. The observed that CS-GL-AgNPs at 0.1 g/100 g (0.1%) level film appeared to be a promising protective packaging material which can extend the shelf life of red grapes by 14 days.

Physiological Weight Loss (%). The critical review of the results of the present study on grapes showed that individual effect of $AgNO_3$ and Ag-NPs had significant effect on physiological weight loss and the results are presented in Table 1. The minimum value of weight loss of 7.92 per cent and 15.25 per cent at 3rd and 6th days were recorded by the treatment T_6 i.e. Ag-NPs @ 30 ppm for 5 min respectively. It was followed by Ag-NPs @ 60 ppm for 3 min (T_7) which recorded weight loss values of 9.06 per cent and 15.53 per cent. Meanwhile, the maximum weight loss registered by the treatment T_0 (Control) which recorded weight loss value of 27.57 per cent and 37.09 per cent at 3rd and 6th days. At 9th day the minimum value of weight loss of 21.95 per cent were recorded by the treatment T_7 (Ag-NPs @ 60 ppm for 3 min) and it was followed by the treatment Ag-NPs @ 30 ppm for 5 min (T_6) which recorded weight loss value of 22.26 per cent. Meanwhile, the maximum weight loss registered by the treatment T_0 (Control) which recorded weight loss value of 44.26 per cent at 9th days. Thus, it can be safely suggested that, minimum physiological weight loss per cent was recorded when fruits treated with Ag-NPs @ 60 ppm for 3 min were found most effective in reducing the physiological weight losses of grapes during storage. The main reason for fruit weight loss is mainly due to water evaporation in fruit caused by transpiration and respiration processes during storage periods (Sogvar *et al*., 2016). Several studies indicated that increase in the weight loss percentage range of 5.8-6.6%, control that was 9.3% in cavendish banana during prolonged storage period of 14 days by treated with 0.01% of Ag-NPs (Nayab and Akhtar 2023).

Total Soluble Solids (°BRIX). The data on total soluble solids of grapes is present in the Table 1. From the table it was observed that the $AgNO_3$ and Ag-NPs had significant influence on total soluble solids at shelf life of the present study. The minimum value of TSS of 16.5 °Brix and 16.7 °Brix at 3rd and 6th days were recorded by the treatment T_5 (Ag-NPs @ 30 ppm for 3 min) respectively. It was followed by Ag-NPs @ 60 ppm for 3 min (T_7) which recorded minimum TSS

values of 16.7°Brix and 18.4°Brix. Meanwhile, the maximum TSS registered by the treatment T_0 (Control) which recorded TSS value of 16.7°Brix and 18.4°Brix at 3rd and 6th days. Finally, the minimum TSS value of 19.1°Brix at 9th day were recorded by the treatment T_7 (Ag-NPs @ 60 ppm for 3 min) respectively. It was followed by Ag-NPs @ 30 ppm for 3 min (T_5) which recorded minimum TSS value of 20.3 ^{0}Brix. Meanwhile, the maximum TSS registered by the treatment T_0 (control) which recorded maximum TSS value of 23.8 °Brix at 9th day. Thus, it can be concluded that when grapes are treated with Ag-NPs @ 60 ppm for 3 min were found most effective in maintain the TSS level. The results of the present study are also accordance with the findings of Islam *et al*., (2013) this may be due to the re-conversion of starch into monosaccharides in *Mangifera indica* L. Several studies indicated that increase in TSS during storage of Nagpur mandarin application with green synthesis of silver nanoparticlus (GSNp) tulsi was the most effective in stored the fruit up to 45 days was also reported by Deshmukh (2022).

Titratable Acidity (%). The critical review of the results of the present study on grapes showed that individual effect of $AgNO_3$ and Ag-NPs had significant effect on decrease in titratable acidity and the results are presented in Table 1. The minimum value of acidity of 0.53 per cent at 3rd day were recorded by the treatment T_3 ($AgNO_3$ @ 2000 ppm for 3 min), T_4 ($AgNO_3$ @ 2000 ppm for 5 min) and T_7 (Ag-NPs @ 60 ppm for 3 min) respectively. It was followed by Ag-NPs @ 30 ppm for 3 min (T_5) which recorded minimum acidity values of 0.54 per cent. Meanwhile, the maximum acidity was registered by the treatment T_0 (Control) which recorded acidity value of 0.68 per cent at 3rd day. The minimum acidity value of 0.5 per cent at 6th day were recorded by the treatment T_7 (Ag-NPs @ 60 ppm for 3 min) respectively. It was followed by Ag-NPs @ 30 ppm for 3 min (T_5) and Ag-NPs @ 30 ppm for 5 min (T_6) which recorded minimum acidity value of 0.51 per cent. Meanwhile, the maximum acidity registered by the treatment T_0 (control) which recorded maximum acidity value of 0.67 per cent at 6th day. On 9th day minimum value of acidity of 0.48 per cent were recorded by the treatment T_7 (Ag-NPs @ 60 ppm for 3 min) respectively. It was followed by the treatment Ag-NPs @ 30 ppm for 3 min (T_5) which recorded minimum acidity value of 0.49 per cent. The maximum acidity was registered by the treatment T_0 (control) which recorded the acidity value of 0.65 per cent at 9th day. It can be concluded that grapes when treated with Ag-NPs @ 60 ppm for 3 min can retain gradual decrease in acidity content. Undergo degradation of organic acid during storage due to conversion of acid into sugars was also expressed Singh and Sharma (2017). Changes in respiration process and metabolic changes cause decrease in acidity during storage (Kibar *et al*., 2021). Similar results were observed by Lichanporn *et al*. (2020) on postharvest decay and browning in longkong fruit by using silver particles at the concentration of 0.90 $mg.L^{-1}$ leads to decrease the acidity on longkong fruit for 9 days. Chitosan nanoparticles coating on Valencia orange at the lowest concentration cause decrease the percentage of acidity during the storage for 75 days on room temperature Alshallash *et al*. (2022) which could also be noticed in the present study.

Total Sugar Content (%). The data pertaining to total sugars of grapes are presented in Table 2. From the table it was observed that effect viz., $AgNO_3$ and Ag-NPs effects showed highly significant influence on this trait. The minimum value of total sugars of 12.54 per cent at 3rd day were recorded by the treatment T_6 (Ag-NPs @ 30 ppm for 5 min) respectively. It was followed by Ag-NPs @ 30 ppm for 3 min (T_5) which recorded minimum total sugar values of 12.62 per cent. Meanwhile, the maximum total sugar was registered by the treatment T_1 ($AgNO_3$ @ 1000 ppm for 3 min) which recorded total sugar value of 14.89 per cent respectively. It was followed by the treatment T_0 (control) which recorded minimum total sugar values of 14.84 per cent at 3rd day. The minimum value of total sugars of 12.88 per cent at 6th day were recorded by the treatment T_6 (Ag-NPs @ 30 ppm for 5 min) respectively. It was followed by Ag-NPs @ 60 ppm for 3 min (T_7) which recorded minimum total sugar values of 13.01 per cent. Meanwhile, the maximum total sugar was registered by the treatment T_1 ($AgNO_3$ @ 1000 ppm for 3 min) which recorded total sugar value of 15.20 per cent respectively. It was followed by the treatment T_0 (control) which recorded minimum total sugar values of 15.17 per cent at 6th day. On 9th day minimum value of total sugar of 13.3 per cent were recorded by the treatment T_6 (Ag-NPs @ 30 ppm for 5 min) respectively. It was followed by the treatment Ag-NPs @ 60 ppm for 3 min (T_7) which recorded minimum acidity value of 13.5 per cent. Meanwhile, the maximum total sugar was registered by the treatment T_1 ($AgNO_3$ @ 1000 ppm for 3 min) which recorded total sugar value of 15.53 per cent respectively. It was followed by the treatment T_0 (control) which recorded minimum total sugar values of 15.50 per cent at 9th day. It can be concluded that grapes when coated with Ag-NPs @ 30 ppm for 5 min can retain their total sugar data were significantly superior. This might be due to the direct effect on conversion of complex starch or carbohydrate into simple compound (Islam *et al*., 2013). Similar results were reported by Bishnoi *et al*. (2015) studies on increase in the total sugars on strawberry pulp treated with sodium benzoate @ 500 ppm was effective in maintain the total sugars per cent and other quality parameters. Carboxymethyl cellulose (CMC) and guar gum based silver nanoparticles coated on mango were slowly increase in total sugar up to 28 days at 13°C (Hmmam *et al*., 2021).

Reducing Sugar Content (%). The data pertaining to reducing sugars of grapes are presented in Table 2. From the table it was observed that effect *viz*., $AgNO_3$ and Ag-NPs effects showed highly significant influence on this trait. The minimum value of reducing sugar of 9.40 per cent, 9.65 per cent and 9.67 per cent at 3rd, 6th and 9th days were recorded by the treatment T_5 *i.e*. Ag-NPs @ 30 ppm for 3 min respectively. It was followed

by Ag-NPs @ 30 ppm for 5 min (T_6) which recorded reducing sugar values of 10.23 per cent, 10.31 per cent and 10.53 per cent. Meanwhile, the maximum reducing sugar registered by the treatment T_0 (Control) which recorded reducing suagr value of 13.53 per cent, 13.61 per cent and 13.70 per cent at 3rd, 6th days and 9th days. It can be concluded that grapes when treated with Ag-NPs @ 30 ppm for 5 min can retain their reducing sugar, data were significantly superior to control. Increase in reducing sugars due to the inversion of sucrose to reducing sugars and hydrolysis of polysaccharide into simple sugars (Scrob *et al*., 2022) or Conversion of insoluble carbohydrates into sugars (Nimgade *et al*., 2019). Similar reports were made by Ali *et al*. (2022) on silver nanoparticules coating on loquat for 1 month of storage at 4°C and 8°C leads to slowly increase of reducing sugars during storage

Ascorbic Acid (mg/100g). The critical review of the results of the present study on grapes showed that individual effect of $AgNO_3$ and Ag-NPs had significant effect of ascorbic acid and the results are presented in Fig. 1. The maximum value of ascorbic acid of 77.26 mg/100gm at 9th day were recorded by the treatment T_7 (Ag-NPs @ 60 ppm for 3 min) respectively. It was followed by Ag-NPs @ 30 ppm for 5 min (T_6) which recorded maximum ascorbic acid values of 66.75 mg/100gm. Meanwhile, the minimum ascorbic acid was registered by the treatment T_0 (control) which recorded ascorbic acid value of 44.86 mg/100gm respectively. It can be concluded that grapes when treated with Ag-NPs @ 60 ppm for 3 min can gradual increase in the ascorbic acid content. Retention of ascorbic acid due to highly sensitive to oxidation and leaching into water soluble media during storage (Ajibola *et al*., 2009). Decrease of ascorbic acid mainly due to increase in oxygen level or storage temperature (Khodaei *et al*., 2021). Retain gradual decrease in the ascorbic acid due to oxidative deterioration of ascorbic acid by activity of ascorbic oxidase (Gull *et al*., 2021). Gemail *et al.* (2023) reported that combination of wax and 100 ppm of nano silver increased the vitamin C content in murcott mandarin.

Table 1: Effect of silver nitrate and silver nanoparticles on physiological weight loss, total soluble solids and titratable acidity of grapes var. Muscat Hamburg.

Treatments	Weight loss per cent (%)			Total soluble solids (°B)			Titratable acidity (%)		
	Days								
	3	6	9	3	6	9	3	6	9
T_0	27.57	37.09	44.26	22	23.6	23.8	0.68	0.67	0.65
T_1	12.44	19.73	26.43	18.8	21.4	22.7	0.67	0.64	0.63
T_2	9.13	16.4	23.57	18.2	20.8	20.9	0.64	0.54	0.58
T_3	10.71	18.08	24.5	19	20	20.9	0.53	0.64	0.59
T_4	9.86	16.98	24.62	18.7	20.9	21.9	0.53	0.62	0.53
T_5	12.04	16.95	23.29	16.5	16.7	20.3	0.54	0.51	0.49
T_6	7.92	15.25	22.26	20	20.9	20.9	0.63	0.51	0.5
T_7	9.06	15.53	21.95	16.7	18.4	19.1	0.53	0.5	0.48
T_8	10.61	17.73	24.64	20.1	23.1	23.2	0.67	0.64	0.61
SE (d)	**3.082**	**1.953**	**2.585**	**1.112**	**1.341**	**1.000**	**0.013**	**0.013**	**0.013**
CD (0.05)	**6.526**	**4.134**	**5.472**	**2.355**	**2.84**	**2.118**	**0.027**	**0.027**	**0.027**

Table 2. Effect of silver nitrate and silver nanoparticles on total sugars and reducing sugars of grapes var. Muscat Hamburg.

Treatments	Total sugars (%)			Reducing sugars (%)		
	Days					
	3	6	9	3	6	9
T_0	14.84	15.17	15.50	13.53	13.61	13.70
T_1	14.89	15.20	15.53	13.50	13.52	13.57
T_2	13.61	13.95	14.23	12.03	12.19	12.23
T_3	14.21	14.68	15	12.77	12.89	12.97
T_4	14.42	14.86	15.23	12.10	12.20	12.33
T_5	12.62	13.31	13.6	9.40	9.65	9.67
T_6	12.54	12.88	13.3	10.23	10.31	10.53
T_7	12.81	13.01	13.5	10.47	10.78	10.90
T_8	14.8	15.12	15.43	12.60	12.74	12.83
SE (d)	**0.293**	**0.276**	**0.306**	**0.384**	**0.341**	**0.393**
CD (0.05)	**0.62**	**0.584**	**0.648**	**0.812**	**0.721**	**0.832**

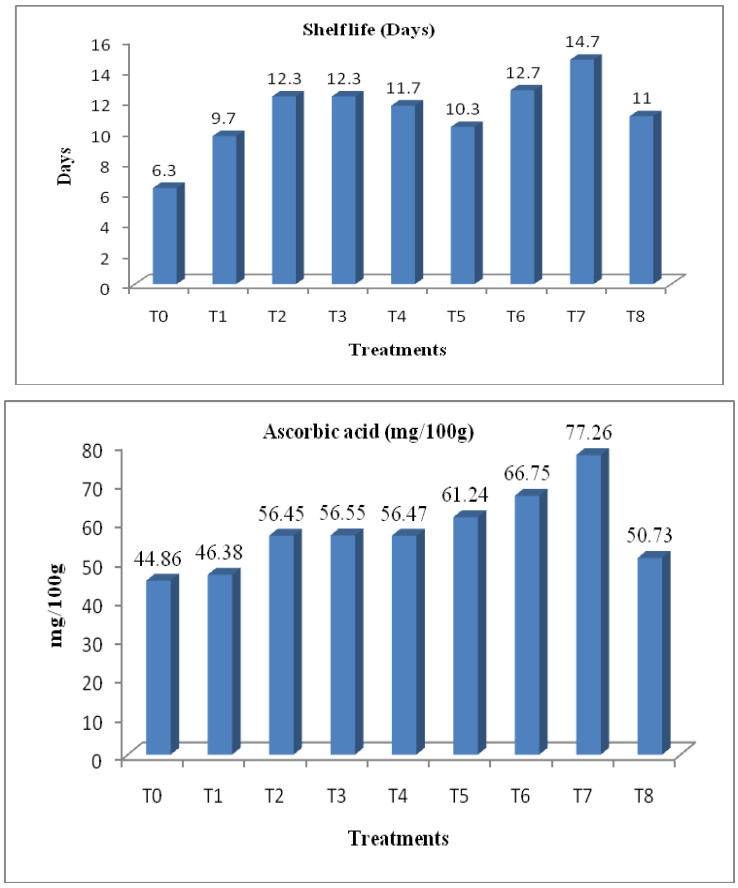

Fig. 1. Effect of silver nitrate and silver nanoparticles on ascorbic acid and Shelf life of grapes var. Muscat Hamburg.

CONCLUSIONS

The present study indicate that the highest shelf life of 14.7 days was observed in grapes var. Muscat Hamburg treats with Ag-NPs @ 60 ppm for 3 min (T_7), this treatment also has an added advantage that it maintains the weight loss percentage, TSS, Acidity and vitamin C when stored under ambient condition. Therefore, Bunches treated with Ag-NPs @ 60 ppm for 3 min were effective in increase the shelf life and quality of grapes var. Muscat Hamburg.

FUTURE SCOPE

The use of silver nanoparticles to enhance the shelf life of fruits shows promising potential in the future. In this field can lead to innovative packaging materials or coatings infused with silver nanoparticles, effectively reducing spoilage and extending fruit freshness. Further studies could explore the optimal concentration and application methods of silver nanoparticles to maximize their antimicrobial properties while ensuring consumer safety. Advancements in nanotechnology and the understanding of nanoparticle interactions with fruit surfaces may lead to scalable and cost-effective solutions for the agricultural industry. Continued exploration of silver nanoparticles effects on fruit quality, nutritional content, and environmental impact can pave the way for sustainable and efficient preservation methods in the future.

Acknowledgement. I extend my sincere thanks to Assistant Professor, Dr. V. Suresh and to my advisory committee members for giving me proper guidance throughout the course of study.
Conflict of Interest. None.

REFERENCES

Ajibola, V. O., Babatunde, O. A. and Suleiman, S. (2009). The effect of storage method on the vitamin C content in some tropical fruit juices. *Trends in Applied Sciences Research*, *4*(2), 79-84.

Ali, M., Ahmed, A., Shah, S. W. A., Mehmood, T. and Abbasi, K. S. (2020). Effect of silver nanoparticle coatings on physicochemical and nutraceutical properties of loquat during postharvest storage. *Journal of Food Processing and Preservation*, *44*(10), e14808.

Alshallash, K. S., Sharaf, M., Abdel-Aziz, H. F., Arif, M., Hamdy, A. E., Khalifa, S. M. and Elkelish, A. (2022). Postharvest physiology and biochemistry of Valencia orange after coatings with chitosan nanoparticles as edible for green mold protection under room storage conditions. *Frontiers in Plant Science*, *13*.

Bishnoi, C., Sharma, R. K., Godara, A. K., Sharma, V. K. and Kundu, S. S. (2015). Effect of storage temperature and duration on sugar content and sensory acceptability of strawberry pulp. *Journal of Applied and Natural Science*, *7*(2), 745-749.

Cefola, M. and Pace, B. (2016). High CO_2-modified atmosphere to preserve sensory and nutritional quality of organic table grape (cv.'Italia') during storage and

shelf-life. *European Journal of Horticultural Science, 81*, 197-203.

Deshmukh, S. D. (2022). Evaluation of nanocomposite skin coatings for improving the quality of Nagpur mandarin. *Scientist, 1*(3), 4000-4007.

Elatafi, E. and Fang, J. (2022). Effect of silver nitrate ($AgNO_3$) and nano-silver (Ag-NPs) on physiological characteristics of grapes and quality during storage period. *Horticulturae, 8*, 419.

Gemail, M. M., Elesawi, I. E., Jghef, M. M., Alharthi, B., Alsanei, W. A., Chen, C. and Gad, M. M. (2023). Influence of Wax and Silver Nanoparticles on Preservation Quality of Murcott Mandarin Fruit during Cold Storage and after Shelf-Life. *Coatings, 13*(1), 90.

Gull, A., Bhat, N., Wani, S. M., Masoodi, F. A., Amin, T. and Ganai, S. A. (2021). Shelf life extension of apricot fruit by application of nanochitosan emulsion coatings containing pomegranate peel extract. *Food chemistry, 349*, 129149.

Hmmam, I., Zaid, N. M., Mamdouh, B., Abdallatif, A., Abd-Elfattah, M. and Ali, M. (2021). Storage Behavior of "Seddik" mango fruit coated with CMC and guar gum-based silver nanoparticles. *Horticulturae, 7*(3), 44.

Insanu, M., Karimah, H., Pramastya, H. and Fidrianny, I. (2021). Phytochemical compounds and pharmacological activities of Vitis vinifera L.: An updated review. *Biointerface Research Applied Chemistry, 11*(13829), 10-33263.

Islam, M., Khan, M. Z. H., Sarkar, M. A. R., Absar, N. and Sarkar, S. K. (2013). Changes in acidity, TSS, and sugar content at different storage periods of the postharvest mango (*Mangifera indica* L.) influenced by Bavistin DF. *International Journal of Food Science, 2013*.

Khodaei, D., Hamidi-Esfahani, Z. and Rahmati, E. (2021). Effect of edible coatings on the shelf-life of fresh strawberries: A comparative study using TOPSIS-Shannon entropy method. *NFS Journal, 23*, 17-23.

Kibar, H., Taş, A. and Gündoğdu, M. (2021). Evaluation of biochemical changes and quality in peach fruit: Effect of putrescine treatments and storage. *Journal of Food Composition and Analysis, 102*, 104048.

Kumar, S., Shukla, A., Baul, P. P., Mitra, A. and Halder, D. (2018). Biodegradable hybrid nanocomposites of chitosan/gelatin and silver nanoparticles for active food packaging applications. *Food packaging and shelf life, 16*, 178-184.

Lichanporn, I., Techavuthiporn, C. and Wongs-Aree, C. (2020). Effect of Silver Particle-longkong Peel Extract Coating on Postharvest Decay and Browning in Longkong Fruit. *The Horticulture Journal, 89*(3), 328-336.

Liguori, G., Sortino, G., Gullo, G. and Inglese, P. (2021). Effects of modified atmosphere packaging and chitosan treatment on quality and sensorial parameters of minimally processed cv.'Italia'table grapes. *Agronomy, 11*(2), 328.

Nayab, D. E. and Akhtar, S. (2023). Green synthesized silver nanoparticles from eucalyptus leaves can enhance shelf life of banana without penetrating in pulp. *Plos one, 18*(3), e0281675.

Nimgade, S. A., Kohale, V. S., Gawli, K. A., Khadse, A., Sarda, A. and Nagmote, A. (2019). Effect of different concentrations of sugar and citric acid on storage quality of guava fruit bar. *Journal of Pharmacognosy and Phytochemistry, 8*(6), 782-785.

Nunes, N. A. S., Leite, A. V. and Castro, C. C. (2016). Phenology, reproductive biology and growing degree days of the grapevine 'Isabel' (*Vitis labrusca*, Vitaceae) cultivated in northeastern Brazil. *Brazilian Journal of Biology, 76*, 975-982.

Panse, V. G. and Sukhatme, P. V. (1985). Statistical Method for Agricultural Workers. Indian Council of Agricultural Research, New Delhi. *347*.

Prathiksha and Hegde, K. (2022). A Review on *Vitis vinifera* L.: The Grape. *International Journal of Pharmaceutical Sciences Review and Research, 74*(1), 142-145.

Sabra, A., Netticadan, T. and Wijekoon, C. (2021). Grape bioactive molecules, and the potential health benefits in reducing the risk of heart diseases. *Food Chemistry: X, 12*, 100149.

Scrob, T., Varodi, S. M., Vintilă, G. A., Casoni, D. and Cimpoiu, C. (2022). Estimation of degradation kinetics of bioactive compounds in several lingonberry jams as affected by different sweeteners and storage conditions. *Food Chemistry: X, 16*, 100471.

Singh, S. K. and Sharma, M. (2017). Review on biochemical changes associated with storage of fruit juice. *International Journal of Current Microbiology and Applied Science, 6*(8), 236-245.

Sogvar, O. B., Saba, M. K. and Emamifar, A. (2016). Aloe vera and ascorbic acid coatings maintain postharvest quality and reduce microbial load of strawberry fruit. *Postharvest biology and Technology, 114*, 29-35.

How to cite this article: Nishanth A.C., V. Suresh, A. Asha Monicka, B. Madhumitha, B. Vidhya, V. Gopi and Umesh Chimmalagi (2023). Effect of Silver Nitrate and Silver Nanoparticles on Shelf Life and Quality of Table Grapes var. Muscat Hamburg. *Biological Forum – An International Journal, 15*(5): 563-568.