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Effect of Alpha-tocopherol with guar gum coating on the shelf life of thompson seedless grape

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ABSTRACT

The search for biodegradable, non-toxic, healthy and eco-friendly treatments to increase the shelf life of fruits results in the use of edible, biodegradable films, or surface coatings. Under tropical conditions prevailing high temperatures coupled with low humidity severely affect the grape quality and reduce shelf life. Guar gum (0.25 %) with different levels of alpha tocopherols viz.; 0.2, 0.4 and 0.6 percent were applied on bunches of Thompson Seedless with objective to improve quality for extended shelf life. Treated bunches of Thompson Seedless were placed at 10°C and 60-65 percent RH for 28 days. Observations showed that the application of guargum with alpha-tocopherol improved overall appearance, delayed pattern of TSS and acidity changes, increased antioxidant activities and total phenol content. A combination of alpha-tocopherol (0.6 %) with guar gum (0.25%) was found more effective over other combinations.

KEYWORDS

Grapes, Guar gum, Alpha-tocopherol, Shelf life, Postharvest Losses

INTRODUCTION

Grape is well adapted in the tropical climatic conditions of India. Maharashtra and Karnataka states contributed about 95% of total grape production (Sharma *et al.*, 2017). India is mainly producing grapes for fresh consumption (72%) and about 27% of the total output is dried for raisin making. Grapes are mainly harvested during February and March in these regions. After harvesting, grape bunches face high temperature and low humidity conditions and these conditions lead to faster deterioration in quality with higher postharvest losses. Sharma *et al.* (2018) stated that postharvest loss in grapes is recorded within the range of 8.23 to 16 percent under Indian conditions. Time of harvesting, the current temperature at the harvesting, presence of moisture on the berries and handling of grape bunches during harvesting are major regulating factors for deciding the quantum of losses. Physiological loss in weight, berry shattering, rachis, and skin browning are the leading causes of high-level quality deterioration in grapes. It is found that the application of the edible coating on berries works as a barrier during the process of handling, grading, packing, and storage. It retards quality deterioration and improves appearance as well as nutritional values and maintain Physico-chemical and sensory attributes (Sanchez *et al.*, 2011). Different types of coatings are found beneficial by retarding dehydration, suppressing respiration and improved textural quality of perishable foods to retain volatile flavor compounds and reducing microbial growth (Debeaufort *et al.*, 1998; Ozdemir *et al.*, 2010). Various materials based on lipids, proteins, and carbohydrates are used to coat the food materials. Among polysaccharide materials, Guar Gum is one of the most economical and useful ingredients available for coating formulations. As guar gum possesses superior water-binding capacity, it affects high viscosity at low usage levels as it is soluble in cold water.Coatings create thin layers of material which act as a barrier against different agents (water vapor, oxygen, and moisture) and it helps in enhancing the quality and increases the storage period of fresh and processed foods. The addition of active compounds such as antioxidants to these films and coatings improves their functional properties and makes them potentially applicable in food preservation (Sanchez *et al.*,2011). Free radicals can be bounded by antioxidants to defend materials against oxidation processes, regardless of the action mechanism (Pokorny, 2007). Alpha-tocopherol is found good radical scavenger and thereby stops the propagation of radical chain reactions. Mahoney and Graf (1986) revealed that due to strong hydrophobicity, the alpha-tocopherol is a significant antioxidant, especially in fat systems. Wu *et al.* (2001) have studied the effect of tocopherol added films in the packaging of precooked ground beef patties. They found that the tocopherol-treated stearic-acid films were more effective in inhibiting lipid oxidation than non-tocopherol films.

Tocopherols have been incorporated into gelatin films, starch-alginate, or acetylated monoglyceride (AMG) coatings and used to protect margarine from lipid oxidation (Guilbert, 1988). Delayed oxidative rancidity in walnuts was recorded by Mate and Krochta(1997). Besides these properties, tocopherols provide several benefits, preventing chronic diseases associated with oxidative stress and also are known to have a vascular smooth muscle cell signaling function (Liang *et al.*, 2011; Montero *et al.*, 1999). Considering the applicability of guar gum in coatings, benefits of tocopherols and shelf-life issues of grapes under the tropical conditions of India, the present study was conducted to study the effects of coatings on the shelf life of Thompson Seedless grapes.

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MATERIALS AND METHODS

The present study was carried out at ICAR-National Research Centre for Grapes, Pune, during the grape season of 2018. Fresh, healthy bunches with the uniform appearance of Thompson Seedless grapes were obtained for the study.

Application of coating material

The main aim of surface preparing was to remove all contaminants that would prevent adequate adhesion of the coating and make a sound, smooth substrate appropriate for strong bonding. The material for coatings was prepared by adding different concentrations of alpha-tocopherol. The iOth Healthy glow natural vitamin E capsules from Elnova pharma were added to maintain concentrations of 0.2, 0.4 & 0.6 percent in 0.25% Guar gum solution. Glycerol was added (0.4%) in the solution as plasticizer. The prepared solution was stirred for 30 min.

Application of Coating

The experiment was laid out in a completely randomized design. Selected grape bunches were dipped in solutions for 2minutes and dried at room temperature after treatment. Treated bunches were placed in air perforated plastic containers and stored at 10^{0}C and 60-65% RH. A total of four treatments were applied (Table 1) and each treatment was replicated five times. Four grape bunches were treated in each replication. Physicochemical parameters such as physiological weight loss (PLW), Total phenol content, percent inhibition, titratable acidity and total soluble solids (TSS) were performed in five replications at weekly intervals up to storage duration of 28 days.

Table 1: Details of treatments

Treatments	Concentration of α-tocopherol (%)
T1	0.2
T2	0.4
T3	0.6
T4	Control

Physiological weight loss (PLW)

The physiological weight loss was determined by gravimetric analysis, using Equation (1) (Restrepo *et al.*, 2010).

$$\%PP = \frac{Pi - Pf \times 100}{Pi} \quad .....(1)$$

Whereas: %PP is the percentage weight loss and Pi and Pf are the initial and final weight of the sample (g), respectively.

Total soluble Solids and Titratable Acidity

Total soluble solids (TSS) contents were determined with a digital refractometer for the juice of 10–20 berries for each treatment. Titratable acidity (TA) was established by titration of 25 ml of filtered juice with the addition of 0.1 N NaOH solution to the juice to reach a pH of 8.2.

Antioxidant Activity

To evaluate the evolution of the antioxidant activity of the grape treatments during storage, the method of 2,2- diphenyl-1-picrylhydrazyl (DPPH during 30 min of reaction) was adopted. The method evaluates the ability to trap radicals after treatment with coatings applied to grapes. (Martinez *et al.*, 2018).

Total phenolic content

Total phenolic content was determined by using the Folin- Ciocalteu method (Singleton *et al.*, 1999), using gallic acid as the standard. The concentration of the total phenolics was expressed as gallic acid equivalent (GAE mg/g) of the sample.

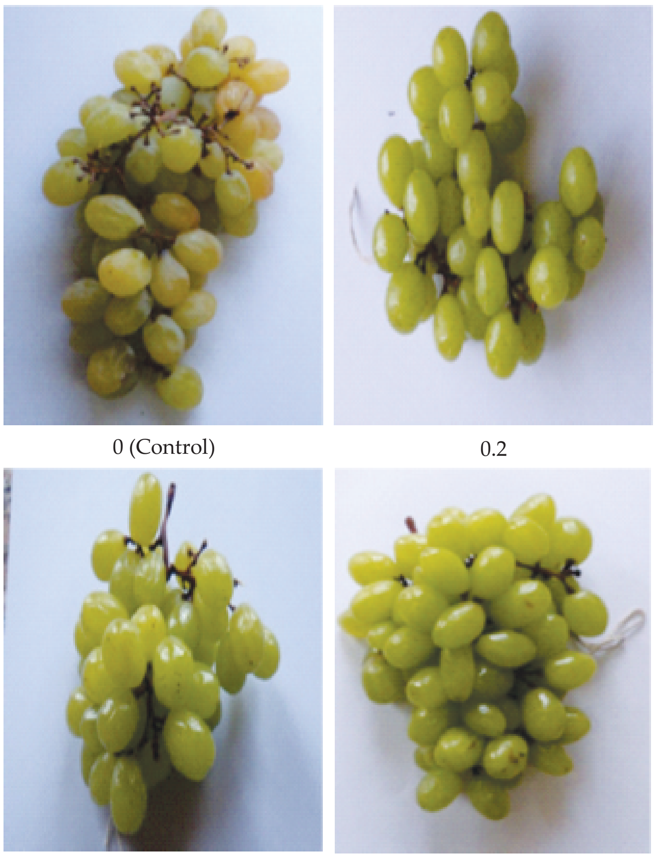
Statistical Analysis

The collected data were analyzed using SAS software under a complete randomized design.

RESULTS AND DISCUSSIONS

Visual Appearance

The coating of grapes with alpha-tocopherol has been proved effective in the present study. Visual appearance clearly showed that alpha-tocopherol delays the browning of the grapes and maintained the qualitative traits of the berries during storage at controlled conditions. The berries from T3 showed maximum glossy appearance and fresh look and followed by T2. While berries from control (T4) were found brownish appearance, decayed and shrunk (Fig. 1). It was clearly showed that the treatment T3 imparted more



Concentration of alpha tocopherol (%)

Fig. 1: Visual Appearance of grapes on the 28^{th} day of storage.

glossiness to grapes than other treatments when stored at 10°C with 60-65% RH. The results are found similar to the findings of El-Anany*et al.* (2009) who observed that the application of the coating on apples enhances the glossiness.

Effect of tocopherol on PLW, TSS, and TA

The main reason behind water loss is attributed to the respiration process and transpiration process, which are essential metabolic processes. Gaseous exchange along with water loss on the fruit's surface, is controlled by the stomatal presence on the outer layer of fruits (Abbasi *et al.*, 2011). Data on PLW during grape storage is presented in Table 2. Non-significant differences were observed among the treatments up to the storage of 14 days after that PLW was significantly affected. Control was recorded with maximum PLW except for the 7th day of storage. Up to the 7th day of storage all treatments had shelf life except T2 where PLW was more than 5%. However, grapes from all treatment were lost shelf life on the next day of data recording i.e. 14th day of storage. On the 28th day of storage, minimum PLW (13.23%) was recorded in T3 followed by T1. Maximum PLW was observed in control on the days of samplings except for the 7th day. Han *et al.* (2004) reported that the alpha-tocopherol acetate and chitosan coating significantly reduced the physiological loss in weight of strawberries and red raspberries under cold storage conditions. Sharma *et al.* (2017) also recorded similar results when chitosan coating was performed on Thompson Seedless grapes.

Data on TSS content in berries during grape storage affected by coatings are presented in Table 2. Non-significant differences were observed among the treatments during storage except sampling on the 28th day of storage. By delaying the sampling, TSS contents were increased. During the storage,increased TSS content was observed and the least increment was registered in T2, i.e. 1.39 °B, while control it was increasedupto a level of 3.71 °B in control. Tanada and Grosso (2005) also recorded similar results when strawberries were coatedwith different wheat-gluten- based coatings and bi-layer coating of wheat gluten and lipids. They found that total soluble solids significantly increased with increased storage duration of all treatments except for fruits covered with bi-layer film but without having significant differences.

The acid content in fruits tends to decrease over time probably due to the organic acid oxidation which occurs with fruit ripening (Islam *et al.*, 2013). A similar trend of decreasing acidity content in the berries was observed in the present study also. Also, in this investigation, acidity decreased over the period, which is similar trend was noted by to Zambrano-Zaragoza *et al.* (2017) when they applied a coating based on nano-dispersion of capsules loaded with alpha-tocopherol also detected a decrease in titratable acidity during storage time. Sharma *et al.* (2017) also recorded a decreasing trend in acidity content of grape berries when chitosan treated bunches were stored at ambient conditions. Here, treatment T3 delayed the change in titratable acidity from 0.47% to 0.35% while in T4 (control), acidity changed from 0.42% to 0.25%.

Table 2: Effect of guar gum-tocopherol composite coating on PLW, TSS and TA

Testing Index	Treatments	Storage Time				
		Day 0	Day 7	Day 14	Day 21	Day 28
	T1	0	4.41 a	7.82 a	10.75 b	17.83 a
	T2	0	5.30 a	8.92 a	13.43 ab	18.11 a
PLW (%)	T3	0	4.76 a	8.54a	13.93 a	13.23 b
	T4	0	4.43 a	9.64 a	14.25 a	18.54 a
LSD at 5%	-	-	NS	NS	2.80	2.41
	T1	19.11 ab	19.94 a	20.44 a	20.76 a	21.84 ab
	T2	20.31 a	20.43 a	20.77 a	21.05 a	21.70 b
TSS (°B)	T3	20.16 ab	20.36 a	20.57 a	20.90 a	22.53 a
	T4	18.82 b	19.53 a	20.34 a	21.37 a	21.99 ab
LSD at 5%		01.41	NS	NS	NS	0.81
	T1	0.42 b	0.38 b	0.35 b	0.32 b	0.29 bc
	T2	0.41 b	0.38 b	0.36 b	0.32 b	0.31 ab
TA (%)	T3	0.47 a	0.44 a	0.41 a	0.38 a	0.35 a
	T4	0.42 b	0.36 b	0.33 b	0.28 b	0.25 c
LSD at 5%	-	0.0273	0.0305	0.0478	0.0487	0.0495

Data on the impact of coating application on inhibition and total phenol content in berries during storage are presented in Table 3. Maximum inhibition (69.08%) was observed in T3 which was followed by T2 with a value of 63.34%. T4 (Non-treated) was recorded with minimum inhibition activity, i.e. 52.73% on the 28th day of storage. The antioxidant activities were decreased in the early stage of storage but it was increased during the whole storage period in coated grapes while the reverse trend was observed in control (T4) where antioxidant activities were decreased with increasing storage duration. Similar results were noted by Shiri *et al.* (2013). Antioxidant capacity of chitosan-coated grapes significantly

Table 3: Effect of guar gum-tocopherol composite coating on Inhibition and Total phenols

Testing Index	Treatments	Storage Time				
		Day 0	Day 7	Day 14	Day 21	Day 28
	T1	55.92 c	54.73 b	56.09 bc	57.06 b	58.06 b
(%)	T2	60.69 a	59.00 a	61.91 a	62.49 a	63.34 a
Inhibition	T3	59.44 a	58.19 a	58.39 b	58.56 b	69.08 b
	T4	57.74 b	57.06 a	54.51 c	53.65 c	52.73 c
LSD at 5%	-	1.30	2.12	2.78	2.51	1.60
	T1	0.89 c	0.87 c	0.88 c	0.90 c	0.96 c
Total	T2	1.08 b	0.99b	0.86 b	1.00 b	1.10 b
Phenols	T3	1.50 a	1.52 a	1.51 a	1.50 a	1.55 a
(mg/g)	T4	0.79 d	0.73 d	0.71 d	0.61 d	0.69 d
LSD at 5%	-	0.06	0.05	0.05	0.06	0.07

reduced during the 60 days of storage (55.8% to 36.3%) DPPH scavenging activity (DPPH) and after that increased (40.3% DPPH) in the last stage. The alpha-tocopherol incorporation retarded lipid oxidation in the model emulsion and the milk cream.

Additionally, Fabra *et al.* (2011)found an essential reduction of oxygen permeability of the calcium caseinate film when alpha-tocopherol was incorporated into the film at the highest concentration (60 mg/g protein). They also revealed that the incorporation of alpha-tocopherol improved the quality of oxygen-sensitive; preventing the oxidation process with reduced aroma compounds.The reduction in total phenol content with increased storage duration might be due to the degradation of phenolic compounds during respiration. The breakdown of cell structure and senescence during storage may also be responsible for the loss of phenolic compounds.

In the present investigation, the concentration of total phenolic compounds was more in coated berries. It was 1.55 mg/gin T3 followed by 1.10 mg/g in T2. Minimum content was observed in control (0.69 mg/g). The coatings may have formed a protective barrier on the surface of the fruit and reduced the supply of oxygen for enzymatic oxidation of phenolics, resulting in better retention of total phenols as compared to control. TPC is also related to the antioxidant capacity of the cell. Thus the addition of antioxidants in the coatings helped in improving the retention of total phenols by enhancing antioxidant capacity and reducing the oxidation rate of phenols (Srivastava, 2015). Higher phenolic compound levels could increase antioxidant activity and also showed a linear correlation between phenolic content and antioxidant activities.

CONCLUSION

In this study, the effect of different concentrations of alpha-tocopherol has been evaluated. Coating of 0.25% guar gum with 0.6g alpha-tocopherol delayed changes in TSS and acidity in berries as compared to control. The same treatment was found to increase total phenol content and antioxidant activities of grape berries. Results of the present study demonstrate the effectiveness of guar gum in combination with alpha-tocopherol improved freshness with PLW at a slower rate when grapes were stored at 10^{0}C. The combination of alpha-tocopherol (0.6 %) with guar gum (0.25%) showed better results and explored commercially.

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