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(Original Article)

Enhancing Berry Quality and Coloration of King Ruby Grapes by Some Preharvest Treatments

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Abstract

King ruby berry grape quality such as color and firmness were important for local and export custom. In this experiment, the results proved that all preharvest treatments especially lysophosphatidylethanolamine (LPE) decreased berry leakage as compared with control. The results also indicated that jasmonic acid, phenylalanine and LPE increased berry anthocyanin content as compared with control. In addition, berry–treated with Jasmonic acid decreased berry electrolyte leakage and berry acidity. On the other hand, increased berry anthocyanin content and TSS. Phenylalanine treatment enhanced berry chemical properties such as TSS and anthocyanin content. LPE treatment enhanced physical and chemical characteristics of king ruby berries such as berry size, weight, diameter, TSS and berry anthocyanin content. After three days on shelf, all preharvest treatments containing LPE decreased berry weight loss and shatter percentage. In conclusion, preharvest application of jasmonic acid plus phenylalanine and LPE at berry verasion enhanced berry color and physiochemical properties of "king ruby" grapes.

Keywords: *Anthocyanin; Grapes; Firmness; Quality; LPE.*

Introduction

King Ruby" grape cultivar is one of the important red seedless table grapes in Egypt. It has a large crop, resists sun burning, moderate berry size and successfully cultivated under Egyptian conditions. The main problems of this cultivar were soft berry tissues and poor red color which cause a major loss in production. Jasmonic acid is a kind of plant growth regulators which plays an important role in regulating plant stress response, plant growth, development and fruit ripening (Khan and Singh, 2007; Aubert *et al*., 2015). Using methyl jasmonate at 50% bunch coloring of "Flame seedless" improving berry coloring and keeping the berry quality after harvesting (Salem, 2019). Foliar application of Jasmonic acid on "Flame seedless" at 10% berry coloration increased berry TSS, and anthocyanin contents (Samy, 2021). Phenylalanine is an important amino acid in grapes. It is the precursor of anthocyanin pigments by the phenyl propanoid pathway and played an important role in plant growth and secondary metabolite production (Portu *et al*., 2015 and Calvo *et al*., 2014). Preharvest

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foliar application of phenylalanine improved phenolic composition of grapes and anthocyanin pigment (Garde-Cerdan *et al*., 2014).

Lysophosphatidylethanolamine (LPE) is a promising plant growth regulator which influences fruit quality properties such as fruit ripening, senescence, and ethylene production. Such influence dependent on the ripening stage of fruit (Ryu *et al*., 1997; Ozgen *et al*., 2004 and Hong, 2008). Thompson seedless grapes treated with LPE at 200 ppm after fruit set and one month later enhanced cluster stems quality and berry characteristics. On the other hand, lowered electrolyte leakage percentage of berries (Attia and Farag, 2017). Thus, the main purpose of this work was to evaluate the effect of preharvest foliar application of Jasmonic acid, phenylalanine and lysophosphatidylethanolamine on berry quality and coloration of "king ruby" grapes under Elalamin condition, Matrouh governorate, Egypt.

Material and Methods

5-years-old "King Ruby" grapevines grown in a private orchard at El-Alamin region, Matrouh governorate, Egypt was conducted for this experiment during the two seasons 2020 and 2021. The vines were planted in sandy soil under drip irrigation system and grown on freedom rootstock. Seven treatments were adopted and replicated three times. The following foliar preharvest treatments were used as follow: control (water only), Jasmonic acid at 400ppm, phenylalanine at 200ppm, lysophosphatidylethanolamine (LPE) at 400ppm, Jasmonic acid plus phenylalanine, Jasmonic acid plus LPE and Jasmonic acid plus phenylalanine plus LPE. The vines received the treatments at two times at 10-15% berry coloration and seven days later. At harvest time (1/7/2020 and 19/6/2021 during the two seasons, respectively), three bunches from each replicate were picked to determine the physical and chemical characteristics of "king ruby" grapes: electrolyte leakage of berries (%), berry weight (g), berry size (cm^3), berry diameter (cm) and berry length (cm). In juice of berries, total soluble solids (TSS) were determined according to hand refractometer, juice acidity as tartaric acid was determined according to AOAC, (1985) and skin berry anthocyanin content (mg/100g) was determined according to Fuleki and Francis (1968). To assess berry weight loss and berry shatter percentage after storage on room temperature (20± 2°C) for three days, another two bunches were used from each replication according to the methods mentioned by Attia, (2018). The experiment was arranged in a completely randomized block design (RCBD) and seven treatments were used (7 treatments with three replication). SAS, 2000 software was used for analyzing the experiment data. The LSD at 5% was used to separate treatments means according to Sendecor and Cochran (1980).

Results

The data in Table 1 showed that all preharvest treatments foliar application reduced electrolyte leakage of "King Ruby" berries as compared with control treatment. Moreover, the lowest value of electrolyte leakage was obtained by LPE treatment (19.21 and 19.99) and the highest value was obtained by control

treatment (31.9 and 30.3). Spraying LPE with either jasmonic acid or phenylalanine treatment significantly reduced electrolyte leakage of berries as compared with the individual treatments and control.

Table 1. Influence of preharvest foliar application of jasmonic acid, phenylalanine, lysophosphatidylethanolamine (LPE) on some physical properties of "King Ruby" grapes during 2020 and 2021 seasons

Treatments*	Berry Electrolyte leakage (%)		Berry Size (cm^3)		Berry Weight (g)		Berry Diameter (cm)		Berry Length (cm)	
	2020	2021	2020	2021	2020	2021	2020	2021	2020	2021
T1	31.90a	30.30a	3.80c	3.63c	3.67c	3.57c	1.73b	1.67c	1.83b	1.73c
T2	25.31c	25.49b	3.83c	3.70c	3.73c	3.50c	1.77b	1.63c	1.80b	1.73c
T3	27.19b	25.30b	3.87c	3.63c	3.67c	3.53c	1.77b	1.67c	1.77b	1.70c
T4	19.21e	19.99d	4.33a	4.17a	4.17a	3.93a	1.97a	1.90a	1.99a	1.94a
T5	25.34c	25.11b	3.83c	3.67c	3.73c	3.47c	1.73b	1.60c	1.80b	1.70c
T6	22.30d	22.41c	4.10b	3.87b	3.97b	3.77b	1.93a	1.80b	1.97a	1.86b
T7	22.56d	22.18c	4.13b	3.83b	4.03b	3.73b	1.90a	1.77b	2.00a	1.83b

*T1: Control, T2: Jasmonic acid at 400 ppm, T3: phenylalanine at 200 ppm, T4: lysophosphatidylethanolamine (LPE) at 400 ppm, T5: Jasmonic acid plus phenylalanine, T6: Jasmonic acid plus LPE and T7: Jasmonic acid plus phenylalanine plus LPE. Similar letters of each column were not significantly different according to the least significant difference (LSD) at 0.05 levels.

Regarding to the data in Table 1, the results illustrated that foliar application of LPE, LPE plus jasmonic acid and LPE plus jasmonic acid plus phenylalanine at berry verasion stage significantly increased berry size as compared with control and the individual treatments of both jasmonic acid and phenylalanine. Similar trend of results was obtained for berry weight.

Results showed that application of LPE at berry verasion stage significantly possessed the highest value of berry diameter as compared with all other treatments and control in both seasons of study in a consistent manner. The recorded value was (1.97 and 1.90) respectively during 2020 and 2021 seasons. Furthermore, the addition of LPE with jasmonic acid and phenylalanine in one formulation increased berry diameter as compared with individual treatments. The data also showed that there were no significant differences between jasmonic acid, phenylalanine and control treatment on berry diameter in both seasons of study in a consistent manner. Similar trend of results was obtained for berry length.

The data presented in Table 2 showed that all preharvest foliar spraying significantly increased berry TSS as compared with control treatment in both seasons of study in a consistent manner. Jasmonic acid treatment alone or in combination with either LPE or phenylalanine gave the highest value of berry TSS.

Data showed in Table 2 illustrated that the highest value of berry acidity was obtained by control treatment (0.76 and 0.74) in a consistent manner in both seasons. The data also showed that the lowest value of berry acidity was obtained by jasmonic acid especially in the first season. LPE treatment gave higher value of berry acidity as compared with jasmonic acid but less than control treatment.

Table 2. Influence of preharvest foliar application of jasmonic acid, phenylalanine, lysophosphatidylethanolamine (LPE) on some chemical properties of "King Ruby" grapes during 2020 and 2021 seasons

Treatments*	TSS (%)		Titratable Acidity (%)		Anthocyanin (mg/100g)	
	2020	2021	2020	2021	2020	2021
T1	17.23e	17.60d	0.76a	0.74a	26.66d	26.37f
T2	19.20ab	19.20a	0.67f	0.69e	39.92a	42.06a
T3	18.63d	18.43c	0.71c	0.71cd	37.06b	38.42d
T4	18.97c	18.90b	0.72b	0.73b	30.65c	32.08d
T5	19.33a	19.23a	0.68e	0.69e	42.06a	40.36bc
T6	19.20ab	19.30a	0.69d	0.71cd	39.92a	39.92c
T7	19.23a	19.23a	0.71c	0.71cd	42.06a	41.7ab

*T1: Control, T2: Jasmonic acid at 400 ppm, T3: phenylalanine at 200 ppm, T4: lysophosphatidylethanolamine (LPE) at 400 ppm, T5: Jasmonic acid plus phenylalanine, T6: Jasmonic acid plus LPE and T7: Jasmonic acid plus phenylalanine plus LPE. Similar letters of each column were not significantly different according to the least significant difference (LSD) at 0.05 levels.

Data in Table 2 showed that all preharvest treatments increased skin berry anthocyanin content of "King Ruby" berries as compared with control treatment in both seasons. Moreover, the lowest value was obtained by control (26.66 and 26.37) and the highest value was obtained by jasmonic acid (42.06 and 41.7). The addition of jasmonic acid with either LPE or phenylalanine treatment significantly increased berry anthocyanin content as compared with LPE alone or phenylalanine alone.

Data in Table 3 showed that all preharvest foliar application reduced berry weight loss percentage of "King Ruby" grapes after storage on room temperature for three days as compared with control treatment. Moreover, the lowest value of weight loss percentage was obtained by LPE treatment (5.09 and 5.13) and the highest value was obtained by control treatment (10.98 and 10.55) in a consistent manner in both seasons of study. The data also showed that combination of LPE with jasmonic acid or phenylalanine or both in one formulation lowered berry weight loss as compared with the individual treatments. Similar trend of results was obtained by berry shatter percentage in both seasons of study.

Table 3. Influence of preharvest foliar application of jasmonic acid, phenylalanine, lysophosphatidylethanolamine (LPE) on berry weight loss and berry shatter percentage of "King Ruby" grapes during 2020 and 2021 seasons

Treatments*	Berry weight loss (%)		Berry shatter (%)	
	2020	2021	2020	2021
T1	10.98a	10.55a	10.91a	11.73a
T2	7.85c	7.90c	7.54c	7.62c
T3	9.43b	9.04b	9.04b	10.75b
T4	5.09f	5.31d	4.98e	4.80e
T5	8.94c	7.95c	7.81c	7.36c
T6	6.02e	5.09d	5.55d	6.41d
T7	6.03e	5.39d	5.93de	5.98d

*T1: Control, T2: Jasmonic acid at 400 ppm, T3: phenylalanine at 200 ppm, T4: lysophosphatidylethanolamine (LPE) at 400 ppm, T5: Jasmonic acid plus phenylalanine, T6: Jasmonic acid plus LPE and T7: Jasmonic acid plus phenylalanine plus LPE. Similar letters of each column were not significantly different according to the least significant difference (LSD) at 0.05 levels.

Discussion

Berry firmness, color and quality of "King Ruby" grapes are important characteristics for Egyptian growers. The decreased of berry electrolyte leakage treated with LPE obtained with in study might be attributed to its effect on reducing senescence of fruit during ripening stage, reducing polygalactouronase enzyme activity and membrane leakiness (Farag and Palta, 1993: Hong *et al*., 2008 and Ryu *et al*., 1997). The data in Table 1 showed that LPE-treated grape berries at verasion enhanced physical characteristics of grapes such as berry size, weight, diameter and length. The improvement of fruit physical properties indicated in this experiment could be attributed to their roles in reducing leaf senescence and enhanced photosynthesis process (Kaur and Palta, (1997). The results of present study are in line with those obtained by Attia and Farag, (2017) on "Thompson seedless", Salem (2019) on "Flame seedless" and Kotb *et al*. (2018) on "Anna" apples. The data in Table 2 showed that preharvest application of jasmonic acid, phenylalanine and LPE increased berry TSS and peel berry anthocyanin content. On the other hand, decreased berry acidity and berry chlorophylls. The positive effect of jasmonic acid on berry coloration might be attributed to their roles in enhancing synthesis of ethylene, chlorophyll degradation and increased fruit anthocyanin content (Ashish *et al*., 2015: Rudell *et al*., 2002). The results of the current study are in line with those obtained by Hattori *et al*. (2019), Marín-San Román *et al*. (2020) and El-Akad *et al*. (2021). The data in Table 3 illustrated that LPE and Jasmonic acid treatments reduced weight loss and shatter percentage of King ruby grapes after three days on shelf. The positive role of LPE might be attributed to its influence on membrane and cell wall structure (Farag and Attia, 2016). The positive role of Jasmonic acid could be attributed to its influence on increasing antioxidant system and free radical scavenging mechanism which reflects on berry quality (Wang *et al*., 2008). Preharvest treated "Crimson seedless" with Jasmonic acid at 4 and 8 mM reducing berry weight loss and berry shatter percentage after shelf life and cold storage (Abd El-Gawad, 2020).

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تحسين جودة ولون ثمار العنب صنف كنج روبي بواسطة بعض معاملات ما قبل الجمع

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الملخص

يعتبر لون وصلابة حبات العنب صنف كنج روبي من أهم صفات الجودة المطلوبة سواء للانتاج المحلي أو التصدير. وتشير نتائج هذه الدراسة الي أن كل معاملات ما قبل الجمع وخاصة المعاملة بالليزوفوسفاتيدل ايثانول امين أدت الي تقليل التسرب الاليكتروليتي لحبات العنب مقارنة بالكنترول وتشير النتائج أيضا الي أن المعاملة بحمض الجاسمونيك، الفينايل الانين والليزوفوسفاتيدل ايثانول أمين أدت الي زيادة محتوي الحبات من صبغة الأنثوسيانين. هذا بالاضافه الي أن الثمار المعاملة بحامض الجاسمونيك أدت الي تقليل التسرب الاليكتروليتى للحبات، والحموضة بينما أدت الي زيادة محتواها من المواد الصلبة الذائبة ومحتواها من صبغة الانثوسيانين. أدت المعاملة بالحامض الأميني الفينايل الانين الي تحسين صفات حبات العنب الكيميائية مثل المواد الصلبة الذائبة الكلية ومحتواها من صبغة الأنثوسيانين. كما أدت المعاملة بالليزوفوسفاتيدل ايثانول أمين الي تحسين الصفات الفيزيائية والكيميائية لحبات العنب صنف كنج روبي مثل حجم الحبات ووزنها وقطرها وطولها، بالاضافة الي محتواها من المواد الصلبة الذائبة الكلية، وصبغة الأنثوسيانين. بعد وضع حبات العنب على الرف لمدة ثلاثة أيام، ادت كل المعاملات المحتوية على الليزوفوسفاتيدل ايثانول أمين الي تقليل فقد الوزن والفرط لعنقود العنب.

نستخلص من الدراسة أن معاملة صنف العنب كنج روبي خلال مرحلة ال verasion بحمض الجاسمونيك، الفينايل الانين والليزوفوسفاتيدل ايثانول أمين أدت لتحسين الصفات الفيزيائية والكيميائية للثمار.