

ASSESSMENT OF THE BOILING PROCESS AND ENRICHED-CO₂ ATMOSPHERE AS METHODS OF ARTIFICIAL RIPENING OF HELALI AND KHESAB DATE FRUITS

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ABSTRACT

There are many astringent date cultivars at maturity (Full coloration) around the world. These fruits could not be consumed at this stage due to the presence of soluble tannins. Growers have to wait until about 50% of these bunches reach to the rutab stage (ripening) which represents a major source of fruit loss due to abscission, birds attack and pathogens. Furthermore, late-maturing cultivars in the Gulf region such as Helali suffer from the lack of conversion to the rutab stage because of the drop in temperature at this time of the year. Thus, there is a great need to induce rutab development in many date fruits. Two separate studies were conducted during 2001 and 2002 seasons. In the first one, Helali and Khesab fruits at the Khalal stage were used to assess the boiling process as a method of artificial ripening especially its adverse effects on fruit quality. Fruits were boiled for 20, 30, 40, 50, and 60 mins by using a water bath provided with thermostat in addition to the control. In the second study, strands of Helali and Khesab were sealed in thick plastic bags for 1, 2, 3, 4, 5 or 9 days in Helali experiment and for 8, 16, 24, 32 hrs or 6 days in Khesab experiment in addition to the control in both cultivars (open, no sealing). Boiling at all durations caused full rutab development in both cultivars. However, such treatment caused a significant increase in electrolyte leakage and in fruit acidity, a significant reduction in vitamin C and the

TSS to acidity ratio while the TSS significantly increased as compared with the control. The assessment was done after five days on the shelf following the treatments. In the second study, sealing the Helali and Khesab fruits in thick plastic bags led to enriched-CO₂ atmosphere which resulted in a significant increase in rutab Helali dates especially after 5 and 9 days while in Khesab sealing for hours was not effective in that mater but a significant increase in rutab development was obtained after 6 days of sealing. Moreover, the effective sealing periods in inducing rutab development led to the reduction in weight loss without an adverse effects on electrolyte leakage, TSS, acidity, TSS to acidity or vitamin C in the fruits of both cultivars. These studies provided evidences that boiling as an artificial method of Khalal dates causes a major loss in nutritional value due to the significant increase in electrolyte leakage and results in adverse effects on fruit quality. On the other hand, enriched-CO₂ atmosphere induced rutab development while reduced water loss and maintained fruit quality.

INTRODUCTION

Date palm is a very important economic crop especially in the Gulf region. It has been providing food, shelter and even medicine to many people around the world. Astringent fruits at the Khesab stage could not be consumed due to the presence of soluble tannins. In spite of the large number of cultivars and clones of date palm, most of them are not edible at the full coloration stage (Bisr or Khalal). Date growers suffer from the prolonged period of rutab development especially when ripening is not uniform in the bunch which exposes fruits to abscission. The initiation of rutab development has been defined as the initiation of ripening in date fruits (Farag, 2005). Date growers are forced to wait until at least about 50% of the bunch is ripe. Moreover, a huge amount of dates must be harvested in a short time. Thus, there is a great need for method to induce rutab development especially in astringent cultivars at the Khalal stage. Use of the ethylene-releasing compound namely Ethrel, before or after harvest was not effective in inducing rutab development in astringent cultivars even at high concentrations. This was attributed to the

presence of soluble tannins that bind to cell proteins preventing the action of ethylene (Farag and Konaissi, 2001). Traditional methods of ripening induction in dates involved boiling fruits at the Khalal stage (date cooking) or dipping in acetic acid and salt. Although the boiling method has been widely used in the Gulf region, no assessment was done to evaluate the adverse effects of such method on fruit quality. The use of acetic acid plus sodium chloride after harvest was found to change the taste of the resulting rutab fruits (Kaira *et al.*, 1977).

Furthermore, fruits produce higher levels of ethanol and acetic acid especially at the initiation of ripening (Reuveni, 1986). Enriched-CO₂ atmosphere around the fruit after harvest might be able to induce ripening of dates as was the case in persimmon (Pesis *et al.*, 1986). The objective of this study were to assess the boiling process as a method of rutab development in terms of its effect on fruit quality and to discover the possibility of using another safe, simple and feasible mean of ripening induction by enriching CO₂ atmosphere around the date fruits.

MATERIAL AND METHODS

This study was conducted during the two successive seasons 2001 and 2002 by using date fruits of two astringent cultivars at the Khalal stage, namely Helali and Khesab. Two separate studies were conducted during that period. The first study aimed at assessing the boiling process as a method of artificial ripening while the second aimed at investigating the effect of enriched-CO₂ atmosphere on rutab development. Both types of studies used fruits of Helali and Khesab cultivars.

I. The Assessment Study:

Helali and Khesab fruits at the Khalal stage were used in this experiment. Fruits were harvested from Al-Kwaitat Experimental Station located at Al-Ain City, United Arab Emirates. Fruits were cleaned in tap water, surface sterilized for 3 mins in sodium hypochlorite (NaOCl) at 0.5%, V/V of 5% stock solution, then washed again in distilled water and left for air drying. A water bath provided with thermostat was used to boil fruits for various durations. Four replications were used with each treatment in a completely

randomized design and 12 fruits per replications. After reaching to boiling, fruits were dipped in the water bath and time was monitored from the beginning of boiling again. Treatments included: control (on shelf at ambient temperature of $22 \pm 2^\circ\text{C}$), boiling for 20 min, boiling for either 30, 40, 50, or 60 mins. After treatments, fruits were left on the bench in foam trays at $22 \pm 2^\circ\text{C}$ for 5 days then the following parameters were taken. Electrolyte leakage of fruit tissue by using a conductivity method (following the treatment and 6 days on shelf then killing the fruit tissues by deep freezing and measuring electrolyte leakage again). Percentage of electrolyte leakage before to after killing was calculated (Inab and Crandall, 1988). Percentage of rutab fruits was also determined in addition to total soluble solids (TSS) by using a hand refractometer, titratable acidity by titration against NaOH, TSS to acidity ratio and vitamin C content by using the endophenol method (A. O. A. C., 1984).

Statistical analyses were performed by using Costat computer software while the means comparisons were done by the least significant difference (at 0.05 level).

II. The Enriched-CO₂ Atmosphere Study:

Helali and Khesab bunches were harvested from the same experimental Station mentioned in the above study. Strands were separated from bunches, cleaned, surface sterilized as mentioned before. Strands were divided into groups. Each group contained 4 strands as one replication. Strands of each replication were placed in thick plastic bags and sealed by electric sealer. Control strands were kept open in the same plastic bags (0.8 mm thickness and 100 ml volume). Treatments included the control (in open bags), sealing for 1, 2, 3, 4, 5 or 9 days in Helali experiment while in Khesab experiments the treatments included: the control (in open bags), sealing for 8 hr, 16 hrs, 24 hrs, 32 hrs and 6 days. Plastic bags of each treatment were opened after the indicated time and strands were kept inside the opened bags until the end of the experiment. Measurements included: percentage of water loss from the initial weight before the treatment and the final weight after the treatment, percentage of rutab fruits, total soluble solids (TSS) by using a hand refractometer, titratable acidity against NaOH, TSS to acidity ratio, vitamin C content by using the endophenol method, and percentage of electrolyte leakage. All

procedures were the same as mentioned under the first study. The experiment was completely randomized with 4 replications per treatment. Analysis of variance and least significant difference (LSD) at 0.5% level were obtained by using Costat compute software.

RESULTS AND DISCUSSION

I. The Assessment Study:

1. Helali Experiments:

The data in Table 1 indicated to rutab development and some quality parameters of Helali date fruits as influenced by the boiling process. The data showed that boiling for all used durations was effective in inducing full rutab development in Helali dates in both seasons. In the control, no rutab fruits were obtained in the first season and significantly much lower percentage than the treatments in the second season. No significant difference in rutab development was found among used boiling durations.

With regard to the percentage of electrolyte leakage of fruit tissues, the data revealed that all boiling durations caused a significant electrolyte leakage as compared with the control. This trend was consistent in both seasons. Such leakage was much higher in boiling treatments for 50 and 60 mins than that obtained with other durations in the first season. However, this trend was not consistent in the second season even though leakage values of all boiling durations were higher than found with 20 mins boiling (Table 1).

Total soluble solids of Helali dates after five days of the treatment were also affected by various treatments. Boiling fruits for 30, 40, 50 and 60 mins caused a significant increase in TSS in both seasons as compared with the control. This increase might be due to the concentration of soluble solids in fruit tissues after 5 days on the shelf due to water loss or the breakdown of more pectic materials in the cell wall as a result of boiling. Even boiling for 10 mins, tended to cause an increase in total soluble solids especially in the first season. Moreover, the long boiling durations, for example 40, 50 and 60 mins, did not significantly vary in TSS in both seasons in Helali dates.

Fruit acidity was also affected by the boiling treatments. It was evident that boiling caused an increase in juice acidity when compared with the control in both seasons. A considerable increase in fruit acidity occurred due to just 20 mins of boiling. The breakdown in cell wall integrity could be a main reason for the release of more acids from its structure as a result of the boiling process. Another possibility could be the conversion of some sugars, such as glucose, to acids through the process of gluconeogenesis. Changes in the TSS to acidity ratio were shown in Table 1. The data indicated to significantly higher TSS / acidity ratio in the control fruits than that found in all boiling durations in both seasons. Meanwhile, no significant difference was found among all boiling durations. The reduction in the ratios of TSS to acidity in Helali dates, in this study, could be mainly attributed to the increase in acidity that was previously reported.

Regarding vitamin C content in the juice of Helali fruits, it was found that all boiling durations led to the breakdown of vitamin C causing a significant reduction in such vitamin as compared with the control in both seasons. Even when boiling was done for a relatively short period such as 20 mins, vitamin C was significantly lower than that of the control. This period seemed to be enough to cause the breakdown of available vitamin C in the tissue since other boiling durations did not cause further reduction in such vitamin (Table 1).

2. Khesab Experiments:

The data in Table 2 showed the effect of boiling for various durations on the percentage of rutab fruits and some quality parameters of Khesab dates. Boiling Khesab fruits for various durations resulted in full development to the rutab stage (Table 2). Even boiling for 20 mins only led to rutab development. The difference was significant between rutab development in the control and that of the treatments. This trend was consistent in both seasons. It did not make a difference to boil Khesab fruits for 20, 30 or even 1 hr in terms of the ability to induce rutab development.

With regard to electrolyte leakage of the fruits, the data indicated that boiling for 40, 50 and 60 mins resulted in a significant increase in electrolyte leakage when compared with the control in both seasons. The least leakage occurred in the control fruits. Electrolyte leakage of the fruits exposed to 30 mins boiling was higher than that of the control. The maximum leakage of electrolytes occurred

especially in the second season. After 50 mins boiling then levelled off since the difference in electrolyte leakage was not significant when comparing leakage at 50 and 60 mins of boiling.

Boiling for various durations also reflected on the percentage of total soluble solids in Khesab fruits (Table 2). After 5 days on the shelf following boiling, TSS of all fruits treated for various durations was significantly higher than that of the control in both seasons. Even boiling for 20 mins resulted in a significant increase in TSS as compared with the control. The concentrations of solutes after boiling and leaving fruits at ambient temperature for 5 days might be the reason for such increase in TSS.

Concerning the changes in fruit acidity as a result of boiling it was found that such treatment caused a significant increase in fruit acidity as compared with the control even after short period of boiling for 20 mins in both seasons. Boiling for longer duration did not result in a proportional increase in fruit acidity. The difference in fruit acidity caused by either 20, 30 or 40 mins boiling was not significant. This trend was consistent in both seasons (Table 2).

The ratio of TSS to acidity was also influenced by the boiling treatments. It was evident that such ratio for the control was higher than that of boiling for used durations in both seasons. The increase in fruit acidity due to boiling could be the reason behind the reduction in the TSS to acid ratio. These trends coincided with what was found in Helali study with regard to change in vitamin C content in the fruit as a result of boiling, the data indicated that there was a significant reduction in such vitamin caused by all boiling durations when compared with the control. Even boiling for a relatively short period, for example 20 mins was able to breakdown vitamin C in fruit tissue in a consistent manner in both seasons. Moreover, boiling for 60 min did not further reduce vitamin C as compared with 20 or 30 mins boiling.

II. The Enriched-CO₂ Atmosphere Study:

1. Helali Experiments:

The data in Table 3 showed the impact of enriched-CO₂ atmosphere around Helali dates by sealing fruits in thick plastic bags for various durations. The data revealed that even for the highly astringent cultivar fruits, enriched-CO₂ atmosphere could enhance rutab development. A remarkable increase in the percentage of rutab

fruits sealed for 5 or 9 days was found in both seasons as compared with the control. Sealing for 1 or 2 days was not enough to generate the necessary conditions required to induce rutab development in both seasons. Sealing Helali fruits at the Khalal stage for 3 or 4 days was not consistent in increasing the percentage of rutab development when comparing the results of both seasons since it gave higher percentage of rutab fruits in the second season.

With regard to electrolyte leakage of Helali fruits at the end of experiment, the data showed that sealing for 5 or 9 days, which were able to induce the highest percentage of rutab fruits as shown above, did not cause any significant increase in electrolyte leakage when compared with the control especially after 9 days of sealing. This result was a strong evidence that sealing for such periods did not cause any damage to fruit tissue especially cell membranes. It has been known for long time that more the damage to the plasma membrane, more the leakage of electrolytes from fruit tissues. In general, there was no significant difference between treatments and the control in most cases in terms of electrolyte leakage of fruit tissues in both seasons (Table 3).

Changes in weight loss from Helali fruits were also determined. The data provided evidences that sealing Khalal of Helali fruits for 1, 2 or 3 days then leaving the plastic bags open for the rest of the experiment did not cause any significant increase in weight loss as compared with the control. Furthermore, sealing for 4 days was not consistent in terms of affecting water loss of Helali fruits. Moreover, sealing for 5 or 9 days, while induced the significant increase in rutab development, varied in their effect on weight loss, since sealing for 5 days tended to reduce water loss but sealing for 9 days was drastically effective in reducing weight loss even when compared with sealing for 5 days or other used durations and when also compared with the control (Table 3). The noticeable increase in weight loss in the second season, as compared with the first one, could be attributed to the induction of much more rutab development in the second season (58.78% and 0.32 for the second and first seasons, respectively).

Percentages of total soluble solids in Helali dates as influenced by sealing treatments were also detected. The data proved that there were no significant changes in TSS of Helali dates due to sealing treatments for any used duration in both seasons. Even sealing for 5 or

9 days which were effective in inducing rutab development in Helali dates did not cause a significant change in TSS when compared with the control (Table 3).

Similar trend of results was obtained when the percentage of fruit acidity was determined in Helali fruits. Sealing for various durations did not cause any significant change in Helali fruit acidity. This trend was consistent in both seasons. Thus, sealing even for 9 days did not have an adverse effect on fruit acidity while induced a significant increase in the percentage of rutab fruits. The ratios of TSS to acidity of Helali dates as influenced by sealing treatments were shown in Table 3. The data indicated that such ratio did not change significantly as a result of sealing for various durations when compared with the control. Variations in TSS to acid ratios were not significant even when fruits were sealed for 9 days.

The response of vitamin C content in Helali fruits due to sealing was shown in Table 3. It was clear that there were no significant changes in vitamin C in fruit tissues in the first season for all used durations of sealing as compared with the control. However, in the second season, there was a slight reduction in vitamin C especially when comparing the content of such vitamin after 1.3 and 9 days with that of the control.

2. Khesab Experiments:

The data in Table 4 showed that sealing Khesab dates at the Khalal stage could induce rutab development. The data indicated that sealing these fruits for 6 days was effective in developing a significant percentage of fruits to the rutab stage while other used durations were not able to cause the conversion to the rutab stage in both seasons when compared with the control.

The increment from 6 to 8 to 16 to 24 hrs of sealing the plastic bags around Khesab fruits did not make a difference in terms of the percentage of rutab fruits. The inductive factor needed more than just few hours to develop and cause rutab induction in Khesab.

Changes in electrolyte leakage of fruits due to the sealing treatment for Khesab dates was also monitored (Table 4). The data proved that there was no significant difference in electrolyte leakage of fruits between the control and sealing treatments for 6, 8, 16 or 24 hrs. However, sealing for 6 days caused a significant reduction in electrolyte leakage of fruits as compared with the control or other

sealing durations. The trend of electrolyte leakage data was in parallel with that was found in rutab development. Thus, it did not seem that sealing treatments had any adverse effect on membrane integrity of the fruits.

Weight loss was also influenced by sealing treatments. The data proved that weight loss was significantly reduced by sealing for 32 hrs when compared with the control. A drastic reduction in weight loss occurred when fruits were sealed for 6 days whether relative to the control or other sealing durations in both seasons (Table 4). Sealing Khesab fruits for 8 or 16 hrs did not result in a significant change of weight loss. Thus, fruits could be converted to the rutab stage by 6 days sealing in plastic bags without any considerable weight loss.

Total soluble solids were also determined in response to sealing treatments of Khesab fruits (Table 4). The data revealed that there was a significant reduction in TSS of fruits sealed for 6 days as compared with the control in both seasons. Moreover, sealing for 32 hrs resulted in a similar TSS to that obtained with the control. Even the relatively short sealing period for 8 hrs did not significantly affect TSS values when compared with the control in both seasons. The reduction in TSS resulting from sealing for 6 days might be due to the fruit respiratory activities during such period since they are detached from the mother plant.

Concerning the changes in fruit acidity in response to sealing treatments of Khesab fruits (Table 4), it was found that such treatments did not cause a significant change in fruit acidity as compared with the control in the first season even when fruits were sealed for a relatively longer duration (for 6 days). There was even a trend of reduced acidity after 6 days of Khesab sealing, after 24 hrs of sealing. Fruit acidity in both seasons, did not vary from that found in the control fruits in most cases. Changes in Khesab fruits in terms of the TSS / acidity ratio reflected the above findings on TSS and acidity results. In general, there was no significant change in TSS to acidity when the control was compared with various sealing treatments. Only TSS to acidity was increased after 6 days of sealing in the second season.

Changes in vitamin C of the fruit in response to sealing Khesab fruits did not have a specific pattern. Vitamin C content in the

first season did not change significantly by all sealing durations. In the second season, sealing treatments led to a considerable increase in vitamin C. Moreover, there was no significant difference in vitamin C between sealing for 32 hrs and other treatments except control.

The experiments conducted in this study, whether by boiling for various durations or sealing in thick plastic bags, provided evidences that there are possibilities to induce rutab induction even in astringent fruits at the Khalal stage. However, boiling or “cooking” the Khalal, as a common term in the Gulf region, could result in adverse effects on fruit quality. Scant studies have paid the attention to assessing this process as a mean of artificial ripening of dates. Dowson and Aten (1962) reported the importance of boiling dates in the Khalal stage to get rid of soluble tannins and the astringent taste. Moreover, Kaira *et al.*, (1976) studied the effect of temperature and the duration of boiling on some physical and chemical characteristics of Indian date cultivars. In another study Kaira *et al.*, (1976) compared the characteristics of their domestic boiled dates with that of improved date cultivars in terms of some physical and chemical prosperities. Furthermore, Yousif *et al.*, (1979, 1982) studied the suitable conditions needed for Khalal matbuukh (cooked or boiled) preparation and the effect of Khalal time picking on the physical, chemical and organoleptic properties of the produced Khalal matbuukh. Yousif *et al.*, (1984) also studied the suitable conditions needed for Khalal matbuukh preparation. From above studies, they found that the best boiling duration was about 30 to 45 mins while the taste of the boiled Khalal was acceptable and flesh color was attractive. Meanwhile, boiling for 15 mins did not completely remove the astringent taste while 60 mins boiling resulted in dark flesh and fruit cracking. All used cultivars proved their ability to convert to the rutab stage by the boiling process such as Zehdi and Sayer which agreed with this study (Yousif *et al.*, 1984).

On the other hand, at the initiation of date ripening, acetic acid concentration increases. The mode of acetic acid in inducing maturation may be connected with acetaldehyde, the major volatile aldehyde produced as fruits start to mature (Samish, 1957; Norman and Fouse, 1977). Since enriched-CO₂ atmosphere induces ethanol and acetaldehyde, and ethanol vapor was able to induce rutab development in Helali dates after harvest (Farag and Konaissi, 2001).

Thus, it was postulated that sealing Khalal fruits in thick plastic bags would be able to induce rutab development in Khalal fruits. The results of this study provided experimental evidences for such postulation. Further studies would be needed to quantitate acetaldehyde and ethanol at the induction or initiation of rutab (ripening) development. Moreover, in astringent fruits such as persimmon, removal of astringency of fruits depended upon the relative amounts of volatile compounds such as ethanol and acetaldehyde produced by seeds during fruit development. The production of ethanol by the seeds is probably triggered by anaerobic conditions and high CO₂ concentrations early in fruit development (Sugiura *et al.*, 1979; Taira *et al.*, 1986). Thus, increasing CO₂ concentration in the fruit atmosphere whether by evacuating O₂ or by vacuum-packing fruits at 20°C (Pesis *et al.*, 1986) led to the accumulation of ethanol and acetaldehyde and the removal of persimmon astringency while maintained high quality and firmness. After the removal of fruits from such enriched-CO₂ atmosphere, volatile compounds are evolved.

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الملخص العربي

تقييم عملية الغليان والجو الغنى بثانى أكسيد الكربون كطرق للإنضاج الصناعي لصنفى الهلالى والخصاب من نخيل البلح

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قسم البساتين (فاكهة)، كلية الزراعة بدمنهور، جامعة الإسكندرية
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هناك العديد من أصناف البلح ذات الطعم القابض عند اكتمال نموها (التلوين الكامل) فى جهات عديدة من العالم لا يمكن استهلاك الثمار فى هذه المرحلة بسبب وجود التانينات الذائبة بها. يضطر مزارعو النخيل للانتظار حتى يصل حوالى 50% من ثمار السباطات إلى مرحلة الرطب (النضج) مما يشكل مصدراً رئيسياً لفقد الثمار نتيجة تساقطها أو مهاجمة الطيور لها أو الكائنات الممرضة الدقيقة بالإضافة لذلك، فإن أصناف البلح المتأخرة فى اكتمال نموها بمنطقة الخليج مثل صنف الهلالى تعاني من انخفاض نسبة الثمار القادرة على التحول لمرحلة الرطب بسبب هبوط درجة الحرارة فى ذلك الوقت من السنة. وهكذا فإن هناك حاجة ماسة لإرطاب الثمار فى عدة أصناف من النخيل. تم إجراء دراستين منفصلتين فى هذا البحث أثناء موسمى 2001 ، 2002. فى الدراسة الأولى، تم استخدام صنفى الهلالى والخصاب فى مرحلة الخلال لتقييم أثر عملية الغليان (طبخ الخلال) كوسيلة للإنضاج الصناعى خاصة من ناحية تأثيراتها السلبية على صفات جودة الثمار حيث تم غلى الثمار لمدة 20 ، 30 ، 40 ، 50 ، 60 دقيقة باستخدام حمام مائى مزود بثرموسنات بالإضافة للكنترول. أما فى الدراسة الثانية، فتم استخدام شماریخ من الهلالى والخصاب حيث وضعت فى أكياس بلاستيك سميكة (0.8مم سمك ، 1000مل حجم) تم إغلاقها لمدة 1 ، 2 ، 3 ، 4 ، 5 أو 9 أيام فى حالة الهلالى ، أو لمدة 8 ، 16 ، 24 ، 32 ساعة أو 6 أيام فى حالة ثمار الصنف خصاب بالإضافة للكنترول (فى أكياس مفتوحة). ولقد أدت كل معاملات الغليان إلى الحصول على ثمار رطب بطريقة كاملة فى كلا الصنفين، ومع ذلك فقد أدت تلك المعاملة إلى زيادة معنوية فى تسرب المواد الأليكتروليتيية من الثمار وكذلك زيادة حموضة الثمار ونقص محتواها من فيتامين ج ومن نسبة المواد الصلبة الذائبة للحموضة بينما أدت لزيادة نسبة المواد الصلبة الذائبة نتيجة لترك الثمار على درجة حرارة الغرفة لمدة خمس أيام بعد إجراء المعاملات. أما فى الدراسة الثانية فإن حفظ شماریخ صنف الهلالى والخصاب فى أكياس بلاستيكية سميكة مغلقة قد أدت لخلق جو غنى فى نسبة ثانى أكسيد الكربون مما أدى لحدوث زيادة معنوية فى نسبة ثمار الهلالى الرطب خاصة بعد 5 أو 9 أيام من إغلاقها بينما فى الصنف خصاب، فإن إغلاقها لمدة ساعات لم يكن مؤثراً فى هذا الشأن لكن تم الحصول على زيادة معنوية فى نسبة الثمار الرطب به عندما أغلقت الثمار لمدة 6 أيام. والأكثر من ذلك أن تلك الفترات التى كانت مؤثرة معنوياً فى زيادة نسبة الثمار الرطب قد أدت لخفض الفقد فى الوزن بدون أى تأثيرات سلبية على تسرب المواد الأليكتروليتيية من الثمار، نسبة المواد الصلبة الذائبة، والحموضة، ونسبة المواد الصلبة الذائبة إلى الحموضة وكذلك محتوى الثمار من فيتامين ج فى كلا الصنفين.

وهكذا فقد أثبتت هذه الدراسات أن استخدام الغليان كوسيلة للإنضاج الصناعى للبلح الخلال يسبب فقداً كبيراً فى قيمته الغذائية حيث يزيد تسرب المواد الأليكتروليتيية بطريقة معنوية كما

يؤثر سلبياً على صفات جودة الثمار، من ناحية أخرى فإن الجو الغنى في نسبة ثاني أكسيد الكربون قد أدى لإرتطاب الثمار خلال بينما قلل من فقد الماء وحافظ على صفات جودة الثمار.

