CURING TECHNIQUE AFFECTS PHYSICOCHEMICAL CHANGES OF SHALLOT

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ABSTRACT

The curing technique is the first postharvest handling process that is carried out after the shallots are harvested. Curing is a drying process intended to dry off the bulbs' necks and outer scale leaves to prevent moisture loss. The drying process may take 7-10 days. Good quality shallot had around 80-84% moisture content of bulbs after curing occurs. The optimum curing process is expected to improve the shallot's storage to extend its shelf life. Therefore, this research aimed to evaluate the effects of curing techniques on shallot quality. The result showed that the in-door drying treatments with temperatures 33-35°C and 60% RH gave the best quality than other treatments. The in-door drying process is three days faster than direct sun-drying and in-door ambient drying conditions (28-37°C and 65-70% RH). There were drastic decreases in moisture content from 84.0% to 82.0% in three days of drying that had been the optimum moisture content in shallot, respectively. It could minimize damage and weight loss, maintaining colour and is significantly better than direct sun-drying treatment.

Keywords: *conventional curing, mechanical curing, postharvest quality, moisture content*

INTRODUCTION

Shallots (*Allium cepa* L. var. aggregatum) are a perennial crop grown annually for its cluster of small bulbs or cloves (Shahrajabian, et al., 2020). According to Sukasih, E. (2015), domestic consumers frequently use shallots as cuisine ingredients, daily staples, and medicinal purposes. Shallots are a staple in many Asian diets and are commonly used as spices or to flavour food, as well as for health reasons (Djali, M. and Putri, S. (2013). Statistics Malaysia (2021) said that to meet consumer demand, Malaysia imported shallots and onions totalling about 484,867 metric tonnes of RM 902.5 million. The average annual intake per person was 17.0 kg, while the average monthly consumption was 1.4 kg. This indicates that Malaysians had a high consumption need for shallots. Therefore, Malaysia has to initiate the production of shallots and be able to decrease the number of imported shallots as one of the primary causes to combat the demand for shallots.

Shallot harvest handling must be done immediately after harvest because these commodities are easily damaged. The curing process is the first postharvest handling operation that is carried out after the shallots are harvested for long-term storage

(Brice et al., 1997; Brewster, 2006 and Sabaragamuwa et al., 2011). Bulb curing can be carried out outdoors using natural air convection or indoors using artificial curing chambers, according to Gorreapti et al. (2016). Heating and adequate ventilation, ideally with low humidity, are necessary for curing. The curing process aimed to lower the water content around the shallot bulbs and leaves. The word "curing" is preferable, according to Gorreapti et al. (2016), because moisture is only removed from the outer scale and not the entire bulb. The curing procedure must be considered to obtain a shallot of good quality and extend its shelf life while being stored (Djali, M. and Putri, S. 2013). The bulbs are cured when the neck is narrowed, and the outer scales are dried until they rustle (Currah, et al. 2012). The characteristics change of shallot bulbs during curing, especially the outer shell and bulbs is essential to reveal, because in the principle this process aims to condition the parts so that the shallot is not easily damaged during storage. In the article by Amiarsi et al. (2019), the colour, moisture content, hardness, and durability of the freshness of the shallot bulbs during storage following the curing procedure were used to assess the quality of shallot bulbs. Therefore, this study aims to investigate bulbs' characteristics and physicochemical changes throughout the curing process.

MATERIALS AND METHODS

The research was conducted at the Horticulture Research Center Farm, Malaysia Agriculture Research and Development Institute, Selangor, Malaysia. Shallot var. SA02 plants were grown and harvested when 70–80% of the leaves had turned yellow, i.e., 65–70 days after planting. The shallots are pulled by hand after they have obtained a diameter of at least 1.0 – 2.0 cm. The outer skin is peeled off and the roots are trimmed. Then, the bulbs were divided into three groups of curing treatments after sorting and processing at the packing house. Each group contains around 60-70 kg bulbs. The attempted treatment was: T1: Conventional drying; directly under sunlight, T2: In-store drying; room drying and T3: In-store drying; solar drying house.

Conventional drying (T1)
The shallot drying process was performed by the sun drying method. Shallot was harvested at 65-70 days, cleaned from the soil, arranged on a stacking rack, and dried under the sun. Bulbs were cured at a minimum temperature of 25°C and maximum temperature of 37°C for 10 days with average relative humidity at 65–67%. The curing temperature depends on climate change.

In-store drying; room drying (T2)
The shallot drying process was performed by the artificial drying method. Shallot was harvested at 65-70 days, cleaned from the soil, arranged on a stacking rack, and dried with controlled conditions using an air-conditioner. Bulbs were cured at 25°C for ten days with high relative humidity at 75%.

In-store drying; solar drying house (T3)
The shallot drying process was performed by the in-store drying method. Shallot was harvested at 65-70 days, cleaned from the soil, arranged on a stacking rack, and dried under the solar house. The heat source of in-store drying from sunlight. Tin roofs deliver heat from the sun and trap heat in the drying house. This causes the temperature in the dryer room to always be hotter than the ambient temperature. The solar house also covered the area with good ventilation. Bulbs were cured at an average temperature of 33-35°C for ten days with low % relative humidity at 60%.

During curing treatments, all the conditions were recorded within one-hour intervals using a temperature / relative humidity data logger (Onset's HOBO U10, United States). The observation parameters for curing treatments include physical properties (weight loss, tuber size (diameter), bulb freshness and outer skin colour). Chemical properties included the moisture content, total soluble solids (TSS) and total sugar content.

Statistical Analysis
The experimental design was a completely randomized design with four replications. The obtained data were analyzed using analysis of variance (ANOVA) and mean comparison was conducted on the data collected using the Statistical Analysis System Version 9.4. The means were separated by the Duncan Multiple Range at the 5% level of significant treatment effects within the analysis of variance. Unless otherwise specified, all significant differences in this paper were $p \leq 0.05$.

RESULTS AND DISCUSSION

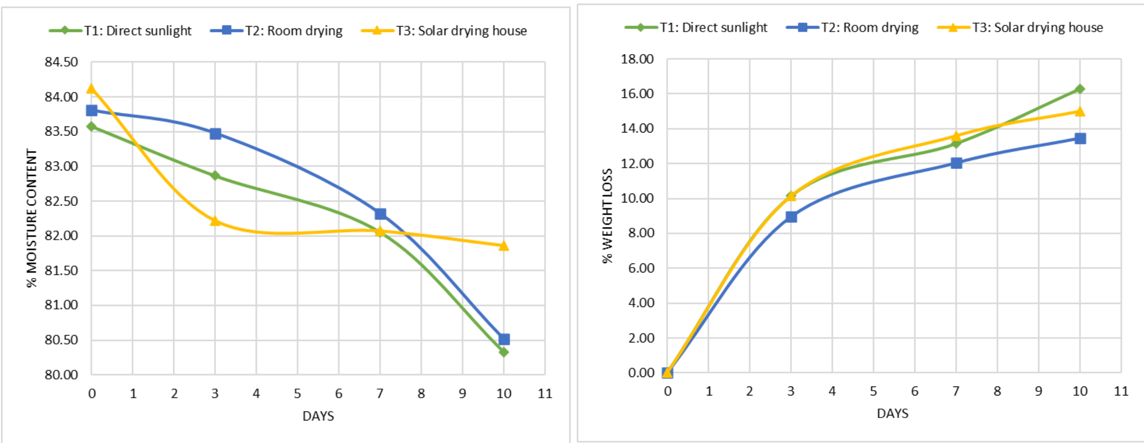
During curing, the outer skin shallots were out gradually and had papery outer skin. This dryness indicates a well-cured shallot and adds to its quality appearance (Figure 1). The bulbs have remained intact without any signs of damage or decay. The bulbs showed firm, plump, and free from bruises or blemishes. The outer skin colour was changed from purplish-red to reddish-brown and the bulb felt dry. The overall quality appearance of all curing treatments involves dry and intact bulbs, freshness, uniform colour and minimal sprouting. These characteristics contribute to the visual appeal and longevity of the shallots during storage. According to Petropoulos et al. (2017), a similar finding was found after curing onion improves the quality and reduces diseased infection during storage. A similar result by Shankar et al. (2017) reported that the appearance of onion after the curing process improves bulb colour and minimal sprouting significantly during storage. Onions are cured to form a complete, dry outer skin that reduces water loss, suppresses the incidence of disease, and can promote a darker skin colour (Downes, et al. (2009).

Figure 1: Changes of shallot during curing treatment using solar drying house.

0 day curing 7 days curing 10 days curing

Figure 2 shows that the curing process significantly decreased the moisture content from shallot bulbs until ten days of curing durations. Shallot bulbs at harvest have 84.12% moisture content and after curing with a solar drying house, the moisture content was reduced to 81.86%. Solar drying house decreased faster in the next three days of drying than the other treatments. The weight loss increases due to the outer shell loss of moisture contents that enclose bulbs have dried up. Curing directly under sunlight and solar drying house has a similar weight loss percentage, respectively. The weight loss of room drying shallot was higher than that of conventional drying and solar drying. From the result, there were shown that proper curing can help reduce shallots' moisture loss and promote the formation of a complete, dry, outer skin, which reduces water loss and suppresses the incidence of disease (Gorrepati et al., 2017). Besides that, Amiarsi et al., (2019) stated that the weight loss of shallots during storage can be affected by the storage temperature and relative humidity. Shallots stored at room temperature (28°C) with a relative humidity of 65% had a weight loss ranging from 16.22% to 34.87% after six days of storage.

Figure 2: Effect of different curing treatments on the percentage of shallots' moisture content (left) and weight loss (right) after ten days of curing time.



The effect of curing treatments on the physical changes of the shallot is presented in Table 1. Curing treatment had no significant effects on the shallot's skin colour and tuber size. In contrast, the findings of Djali, M. and Putri, S. (2013) reported that the quality of the shallot bulb can be improved as indicated by the increased size of the bulb diameter and tuber hardness. Similarly, onions are cured to form a complete can promote a darker skin colour (Downes et al., 2009). From the result in Table 2, curing shallots can significantly increase their quality and chemical compounds, allowing them to be stored for longer periods.

A significant difference in the total soluble solids (TSS) content of bulbs subjected to curing treatments was observed until the end of ten days of curing. Curing at a solar drying house the highest level of TSS appeared, which was 12.97%, respectively, compared to directly under sunlight and room drying. Total sugar content, including sucrose, glucose and fructose, presented a significant difference during curing treatment. Total sugar content was the highest level during the solar drying house. A study on onion bulbs during storage found that curing at different temperatures affected fructose, sucrose, and glucose concentrations (Chope, G. A. et al., 2012). Similarly reported by Kosseva, M. R. (2013) stated that the curing step consists of a drying-out process that can affect the concentration of soluble carbohydrates, including glucose, fructose, sucrose and fructooligosaccharides (FOS) of dry bulb onions.

Table 1: The effect of different curing techniques on physical properties (outer skin colour and tuber size (diameter, mm) of shallots after treatment.

Factor (Curing treatment)	**Outer Skin Colour**			**Tuber size (diameter, mm)**
	L*	**a***	**b***	
T1 – Directly under sunlight (Conventional drying)	49.75±2.77	24.06±3.48	10.98±5.39	2.47±1.91
T2 – Room drying	47.75±3.58	24.54±4.40	8.15±2.36	2.63±3.77
T3 – Solar drying house	49.97±2.84	24.84±2.58	8.63±4.43	2.10±3.19
F-Test significant	ns	ns	ns	ns

Means separation within columns and main effect by DMRT test at $p \le 0.05$.
L*= lightness (white to black), a*= measure of redness and b* = measure of the yellow and blue.
ns, *, ** Non-significant or significant or highly significant at $p \le 0.05$, respectively.

Table 2: The effect of different curing techniques on physiochemical properties (total soluble solids (TSS), sucrose, glucose and fructose concentrations) of shallots after treatment.

Factor (Curing treatment)	**Total soluble solids (TSS)**	**Total sugar content**		
		Sucrose (mg/100g)	**Glucose (mg/100g)**	**Fructose (mg/100g)**
T1 – Directly under sunlight (Conventional drying)	12.07±0.57^{b}	100.67±52.81^{b}	109.73±23.48^{b}	143.68±68.30^{c}
T2 – Room drying	11.23±0.40^{c}	105.47±38.09^{b}	116.78±20.54^{a}	152.43±76.71^{b}
T3 – Solar drying house	12.97±0.99^{a}	114.90±41.69^{a}	112.73±23.45^{ab}	157.77±74.08^{a}
F-Test significant	**	*	*	**

Means separation within columns and main effect by DMRT test at $p \le 0.05$.
ns, *, ** Non-significant or significant or highly significant at $p \le 0.05$, respectively.

CONCLUSION

Shallot curing with in-store drying; solar drying house at the temperature of 33-35°C and RH 60 % for ten days produces bulbs with a good appearance that involves drying out properly to improve their storage life and quality. During the curing process, there might be an improvement of shallot bulbs by lowering weight losses, decreasing the moisture content of the outer shell and producing the highest level of TSS and total sugar content. Shallot with curing at a solar drying house has the best quality bulbs that are applied for shallot production. Conventional drying under the sunlight can be an alternative practice. However, this practice depends on the climatic conditions and time durations.

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