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Shrink-wrap packaging extend the storage life of mature-dropped durian

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ABSTRACT

The shelf life of mature-dropped durian especially the premium clone Musang King (D197) is very short when store at ambient temperature without any packaging compared to other varieties. Current commercial practice is to vacuum packing the fruit using plastic material of nylon with 0.1mm thickness, helps in avoiding dehiscence up to 7 days storage. However, due to vacuum environment, there is an alteration in taste of the flesh and the core of the fruit become browning. Shrink-wrapping has potential to be used as the plastic material comes in many types and thicknesses. A study was conducted in which durian were packed in two types of packaging, vacuum-packing using nylon bag 0.1mm and shrink-wrapping using LDPE bag 0.04mm. Unpacked fruit was set as control. The quality, gas in the package and incidence of dehiscence were observed during 21 days' storage. By shrink-wrapping the whole fruit durian, it reduced the weight loss and retained the freshness as well as the taste and overall acceptability are still accepted. The storage life of shrink-wrapped durian can be extended up to 14 days at 5°C without any dehiscence occur and maintained the fruit quality.

Keywords: Modified atmosphere, Chilling injury, Dehiscence, Fruit quality, Postharvest, Vacuum-packing.

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1. INTRODUCTION

The packaging is functioned to keep the product from heat, light, moisture, pressure, microorganisms, gaseous emissions and etc. in which they have deteriorative effects. It provides some information to the consumer about the product, time saving and convenience for distribution and mention about the ingredients as well as the sizes (Robertson, 2005; Yam et al. 2005; Marsh and Bugusu 2007). Plastic packaging is still become the most favourite product-packaging material. A practical and good material of plastic will give less negative impact on economic, environmental, and social factors (Borman et al., 2019). Recently, plastic packaging for example vacuum-pack and shrink-wrap are widely used in food packaging technology in order to preserve and prolong the shelf life of fruits. Due to the increase demand for safe packaging and healthy foods, there is an interest in the food industry towards researching on suitable packaging according to the type of the food. A study on minimally processed durian to Hong Kong described several packing systems to ensure product safety and maintain the quality of the product during shipment and market distribution (Nur Azlin et al., 2016). Active and intelligent packaging technologies offer to deliver safer foods with better shelf life.

Durian fruit (*Durio zibethinus Murr*) belongs to the family of *Bombacaceae*. It is one of the most popular seasonal fruit in South East Asia. It has an attractive yellow colour pulp, delicious with strong creamy taste and provides excellent nutrients source properties that are beneficial to human health (Husin et al., 2018). The postharvest loss of durian is a crucial problem that needs to be solved as it has high commercial value and obtains the profitable price especially for Musang King (D197). The loss happens

because of the shelf life is very short when store at ambient temperature without any packaging compared to other varieties. For long distribution like export purpose, Musang King needs an external protection to avoid from dehiscence. Current practice is to pack durian fruit using vacuum-packing using plastic material of nylon with 0.1mm thickness, helps in avoiding dehiscence up to 7 days storage. However, due to vacuum environment, there is an alteration in taste of the flesh and the core of the fruit become browning. Shrink-wrapping has potential to be used as the plastic material comes in many types and thicknesses. When the shrink-wrapping uses a right type of plastic and suitable thickness, it provides certain speciality and advantages when compared to vacuum-packaging. Thus, the application of shrink-wrapping with storage temperature at 5°C has potential in extending the shelf life of Musang King durian.

2. MATERIALS AND METHODS

2.1 Sample Preparation

Musang King durian were purchased from Top Fruit Sdn. Bhd in Batu Pahat, Malaysia and fruit were kept in 10°C after arrived in Postharvest Complex, MARDI Serdang. Fruit were sorted from any obvious dehiscence as well as free of visual defects. Fruit were randomized into three groups of treatments (no-packed (control), vacuum-packed (nylon plastic bag, 0.1mm) and shrink-wrapped (LDPE plastic bag, 0.04mm) and stored at 5°C. Fruit (n = 4) were analyzed initially and every seven days during 21 days' storage. At each analysis, fruit were transferred to 25°C for 24 hours to see if any development of any chilling injury symptoms.

2.2 Quality Analysis

Each evaluation, individual fruit were subjectively rated for external chilling injury symptoms, red lesions area, dehiscence incidence (yes or no) and overall acceptability rating (Table 1). The percentage of weight loss was obtained by measuring the difference in weight before and after storage. The pH value was measured using an Origon digital pH meter (model SA 520) and total titratable acidity was measured by titrating the known volume of homogenates solution with 0.1 N NaOH to an end point of pH 8.1 using digital burette. The total soluble solids (TSS) were determined by a digital refractometer (ATAGO RX-5000, ATAGO, Japan).

2.3 Gases in the Package

The gases in the package were measured weekly. The gas samples (O_2, CO_2 and C_2H_4) were drawn by a syringe through a septum in the package. For ethylene measurement, 1 mL of the gas sample was injected into a Perkin Elmer Auto System XL gas chromatography fitted with flame ionization detector (FID) and a stainless-steel column packed with Porapak T of 100/120-mesh size. Simultaneously, CO_2 was detected using a different detector (thermal conductivity detector; TCD) with a stainless-steel column packed with Porapak R of 80/100-mesh size. The flow rate of the purified helium gas was 30mL/min and the column oven were operated at 50°C and 100°C for CO_2 and ethylene gases, respectively. Three replications were used for each treatment.

2.4 Statistical Analysis

The experimental setup was a completely randomized design and performed for each variable. For this purpose, a one-way ANOVA test was used to evaluate the effects of the treatments on each measurement day. The Duncan Multiple Range test was used for means difference testing. A 95% confidence interval was used for all calculations ($p \leq 0.05$). SAS statistical software version 9.4 was used to perform the statistical analyses.

3. RESULTS AND DISCUSSION

3.1 Appearance and Acceptability Ratings

According to Siriphanich et al. (1994), chilling injury in durian shows symptom like dark colour development along the groove between spines, this later the whole husk turns black. The aril may remain hard or ripen abnormally. In this study, visual appearances of the husk after expose 24 hours in ambient temperature showed that there were no chilling injury symptoms occur as describe above among treatments during 21 days' storage (Table 2). The husk didn't turn black and the aril is soft as normal, might be due to the fruit already mature upon drop. Thus, storage of durian at 5°C with or without packaging do not occur any chilling injury symptoms on the husk of durian. In durian, chilling injury symptoms were observed as red lesions along the suture (core) at the centre of the fruit. After 7 days storage, there were no red lesions area was observed in all treatments. However, after 14 days storage, vacuum-packed fruit started developed red lesions incidence at the core (21%). The red

Table 1. Percentage of chilling injury symptoms, red lesions area and overall acceptability ratings

Chilling injury symptoms and red lesions area (% surface area)	Overall acceptability ratings
0% = No trace	5. Excellent
< 25% = Slightly affected	4. Good
16-25% = Moderately affected	3. Acceptable
25-50% = Badly affected	2. Poor
> 50% = Severely affected	1.Very poor

lesions became obvious after 21 days' storage in vacuum-packed fruit (65%) compare to shrink-wrapped fruit, only 20% (Fig. 1).

No incidence of fungal infection was observed for all treatments throughout the storage period. Packaging is generally can preserve any fruit from mechanical damage and infection. As Kader (1980) said modified atmosphere packaging (MAP) provide a barrier from spreading decay from one unit to another. Storage in low temperature also helps in retarding fungal growth.

Husk dehiscence or cracking is the primary problem limiting the shelf life of durian (Khurnpoon et al., 2008). Table 2 shows that at day 7, durian without packaging already dehisced while vacuum-packed and shrink-wrapped durian still didn't dehisce on day 14. By day 21, most durian despite of any treatment were already dehisced. According to Sriyook et, al. (1994), water loss and ethylene production are the two main factors that cause the mature durian fruit to dehisce. Water loss cause the husk to shrink and pull the carpel from each other along the suture at the middle of each locule. Ethylene weakens the cells in the dehiscence region

Table 2. Severity of external chilling injury, red lesions and disease at stem (% surface area), dehiscence (yes or no) and overall acceptability rating (scale 1-5) for durian stored at 5°C

	Treatment	Day 0	Day 7	Day 14	Day 21
External chilling injury (%)	No-packed (Control)	0.0a	0.0a	0.0a	0.0a
	Vacuum-packed	0.0a	0.0a	0.0a	0.0a
	Shrink-wrapped	0.0a	0.0a	0.0a	0.0a
Red lesions (%)	No-packed (Control)	0.0a	0.0a	2.0bc	11.3b
	Vacuum-packed	0.0a	0.0a	21.0a	62.5a
	Shrink-wrapped	0.0a	0.0a	0.0c	20.0b
Disease at stem (%)	No-packed (Control)	0.0a	0.0a	0.0a	0.0a
	Vacuum-packed	0.0a	0.0a	0.0a	0.0a
	Shrink-wrapped	0.0a	0.0a	0.0a	0.0a
Dehiscence	No-packed (Control)	No	Yes	Yes	Yes
	Vacuum-packed	No	No	No	Yes
	Shrink-wrapped	No	No	No	Yes
Overall acceptability	No-packed (Control)	5.0a	2.0b	1.5b	1.0b
	Vacuum-packed	5.0a	4.0a	2.3b	1.0b
	Shrink-wrapped	5.0a	4.0b	3.5a	2.8a

Means in each column with the same letter are not significantly different separated using Duncan's Multiple Range test.

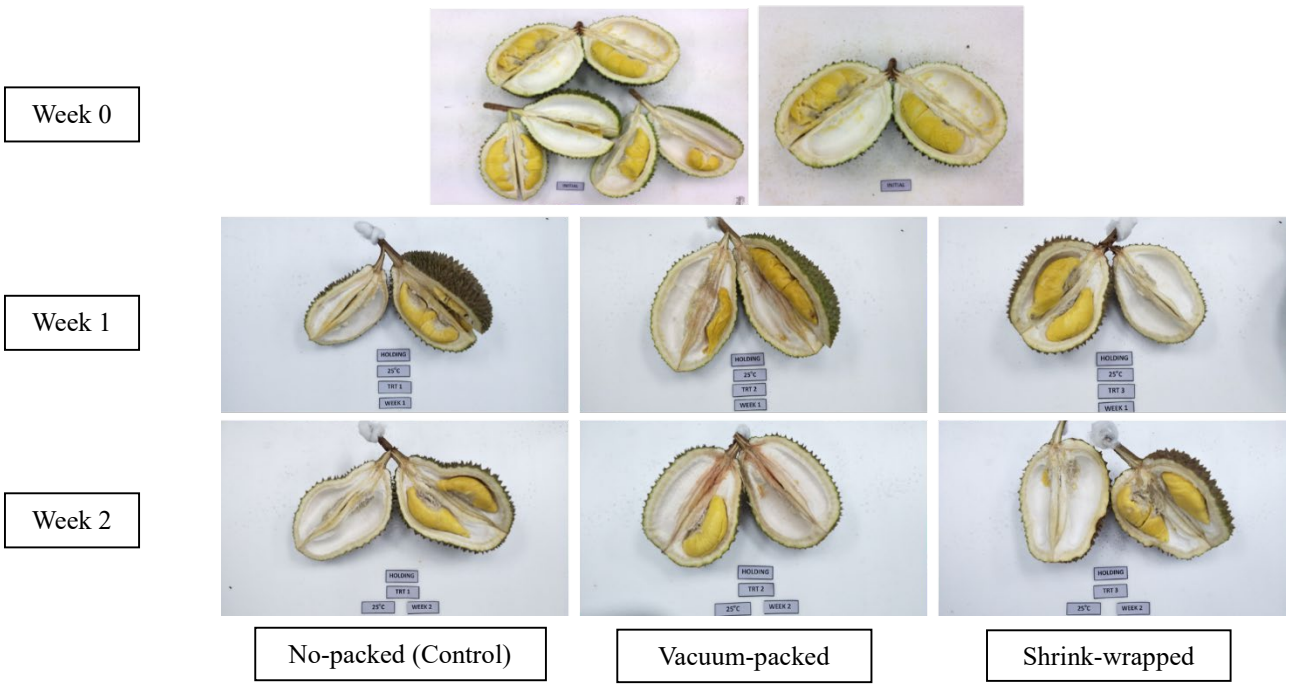

Fig. 1. Red lesions in vacuum-packaging on week 0, 1 and 2 after storage at 5°C followed by 25°C at ambient

that consists of parenchyma cell without chlorophyll. Overall, only shrink-wrapped durian was acceptable until 14 days storage without any red lesions and dehiscence.

3.2 Weight Loss Percentage and Gas in the Package

The highest weight loss percentage was observed in fruits that was without packaging. At the end of storage, unpackaged fruits obviously showed the highest weight loss with 1.82% and vacuum-packed and shrink-wrapped fruits were 0.03% and 0.18%, respectively. Vacuum-pack and shrink-wrap packaging greatly reduced weight loss in durian as shown in Table 3. Water loss in fruits is a main cause of postharvest deterioration and it depends on the respiration characteristics of fruit type (Thakur et al., 2017). Paull and Chen (1989) proved that plastic wrap can reduce weight loss on papaya fruit.

There was a significant different in the percentage of carbon dioxide (CO_2), oxygen (O_2) and ethylene (C_2H_4) gasses in the package (Table 3). Vacuum packaging had highest CO_2 percentage and lowest O_2 level when compared to control and shrink-wrap packaging ($P < 0.05$) (Fig. 2 and 3).

Based on the results, it shows that vacuum-packaging using nylon plastic bag 0.1mm was significantly altered the gasses in the package of the fruits might be due to very low permeability and poor gas exchange. CO_2 percentage was significantly highest after 21 days storage (21.9%) compared to control and shrink-wrap packaging, 1.4% and 0.7%, respectively. This high percentage of CO_2 will incur

Table 3. Gas composition and percentage of weight loss of durian in different packaging after 21 days storage at 5°C

Treatments	CO_2 (%)	O_2 (%)	C_2H_4 (ppm)	Weight loss (%)
No-packed (Control) (T1)	1.39b	16.81a	0.52a	1.82a
Vacuum-packed (T2)	21.91a	4.80b	2.60a	0.03b
Shrink-wrapped (T3)	0.77b	18.27a	0.00a	0.18b

Means in each column with the same letter are not significantly different separated using Duncan's Multiple Range test.

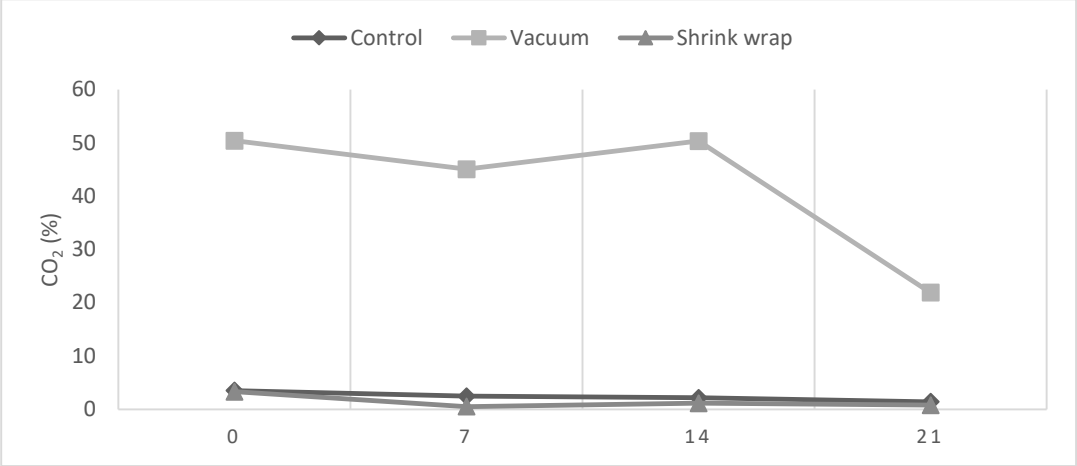

Fig. 2. Percentage of carbon dioxide in the packaging for control and both packaging during storage at 5°C

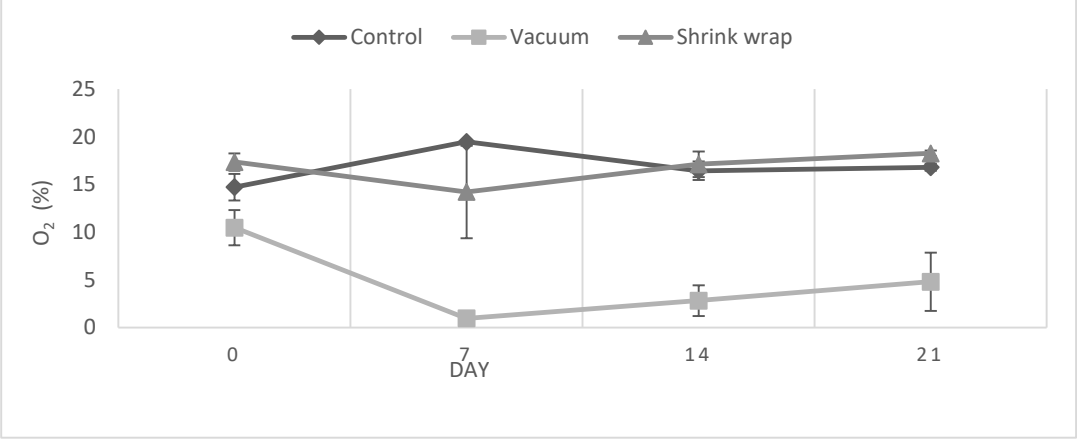

Fig. 3. Percentage of oxygen in the packaging for control and both packaging during storage at 5°C

Table 4. Composition data of durian packed in different packaging for 21 days at 5°C

Treatments	pH	Soluble solid content (%)	TTA (Citric acid, %)	Soluble solids content/TTA
No-packed (Control) (T1)	6.70a	34.40a	0.09a	452.25a
Vacuum-packed (T2)	6.93a	34.50a	0.11a	351.95a
Shrink-wrapped (T3)	6.92a	37.70a	0.09a	446.39a

Means in each column with the same letter are not significantly different separated using Duncan's Multiple Range test.

Table 5. Sensory panel results for freshness, colour, texture, taste, odour and overall acceptability of durian for 21 days storage at 5°C

Treatment	Freshness	Colour	Texture	Taste	Odour	Overall acceptability
No-packed-Control (T1)	5.3a	5.7a	4.4a	4.2a	5.0a	4.6ab
Vacuum packed (T2)	4.9a	5.8a	4.6a	4.2a	4.6a	4.2b
Shrink wrapped (T3)	5.4a	6.0a	4.8a	4.9a	5.0a	4.7a

Means in each column with the same letter are not significantly different separated using Duncan's Multiple Range test.

carbon dioxide injury and the symptoms show as red lesions along the core and alter the taste of the aril. In the case of O_2, vacuum-packaging resulted in decrease of O_2, 10% initially to 4.8% after 21 days of storage (Fig. 3). This result also in line with the report by Pesis et al. (2005) who described that O_2 levels between 0.3% to 3% retained in the bag after vacuum-packed and it depend on the permeability of the plastic film. Very low level of O_2 accumulated in the vacuum-packaging showed a retardation of respiration rate brought by the modification of the atmosphere (Kader, 1994; Pesis et al., 2005). Nevertheless, vacuum-packaging or shrink-wrapping did not affect the C_2H_4 concentration in the package ($P > 0.05$). The C_2H_4 concentration in the vacuum-packaging was higher (2.6 ppm) compare to control and shrink-wrapping (0.5 ppm and 0.0 ppm respectively) might be due to the poor gas exchange and low permeability in 0.1mm nylon plastic bag (Table 3).

3.3 pH, Soluble Solids Content, Total Titratable Acidity and Sugar:Acid Ratio

Results for pH, SSC, TTA, and sugar:acid ratio (SSC:TTA) showed no significant differences due to packaging treatment (means: pH = 6.85, SSC = 35.5%, TTA = 0.1%, SSC:TTA = 416.86) (Table 4).

3.4 Sensory Evaluation

Musang king durian were evaluated for sensory quality each week during storage at 5°C followed by 24 hours at ambient condition. Shrink-wrapped fruits were significantly scored highest for all the sensory parameters evaluated; freshness, colour, texture, taste, odour and overall acceptability when compare to control and vacuum-packaging (Table 5). Vacuum-packaging was less preferred due to slight off-flavour (gaseous and bitter taste) as perceived by the panellists. Accumulation of high CO_2 concentration and decreased respiration inside the vacuum-packaging might have led to anaerobic condition and this later altered the flavour.

4. CONCLUSION

Using a packaging to store Musang King durian at 5°C was found to be advantageous because it helped to prolong the shelf life of whole fruit durian without deterioration in quality of fruit. By using shrink-wrap packaging, it reduced the weight loss, retained the freshness, colour, texture, taste, odour and overall acceptability without any decay. The storage life of shrink-wrapped fresh-dropped Musang King durian can be extended up to 14 days at 5°C without any dehiscence and maintained the fruit quality.

REFERENCES

Borman, M.R., Gabriel, D.S., Nurcahyo, R. 2019. Impact of plastic packaging design on the sustainability of plastic recyclers. Int. J. Appl. Sci. Eng. 16.

Husin, N.A., Rahman, S., Karunakaran, R., Bhore, S.J. 2018. A review on the nutritional, medicinal, molecular and genome attributes of Durian (Durio zibethinus L.), the King of fruits in Malaysia. Bioinformation. 14, 265–270.

Kader, A.A. 1980. Prevention of ripening in fruits by use of controlled atmospheres. Food Technol. 34, 3–51.

Kader, A.A. 1994. Regulation of fruit physiology by controlled/modified atmospheres. Postharvest Physiology of Fruits. 398, 59–70.

Khurnpoon, L., Siriphanich, J., Labavitch, J.M. 2008. Cell wall metabolism during durian fruit dehiscence. Postharvest Biol. and Technol. 48, 391–401.

Marsh, K., Bugusu, B. 2007. Food packaging—roles, materials, and environmental issues. J. Food Sci. 72, 39–55.

Nur Azlin, R., Latifah, M.N., Siti Aisyah, A., Pauziah, M., Zaipun, M.Z., Nurul Adibah, M., Zainab, M.Y., Hairiyah, M., Habsah, M., Razali, M., Zaulia, O., Nur Syafini, G., Joanna, C.L.Y., Nur Alisha, O. 2016. Simulation studies for export of minimally processed durian by air shipment to Hong Kong. Acta Hortic. 1141, 283–288.

Paull, R.E., Chen, N.J. 1989. Waxing and plastic wraps influence water loss from papaya fruit during storage and ripening. J. Am. Soc. Hort. Sci. 114, 937–942.

Pesis, E., Arie, R.B., Feygenberg, O., Villamizar, F. 2005. Ripening of ethylene-pretreated bananas is retarded using modified atmosphere and vacuum packaging. HortScience. 40, 726–731.

Robertson, G.L. 2005. Food packaging: principles and practice. CRC press.

Siriphanich, J., Hassan, A., Kosittrakun, M., Lizada, M.C. 1994. Physiology. In S. Nanthachai (ed.). Durian – fruit development, maturity, handling and marketing in ASEAN. 48–57. Malaysia: ASEAN Food Handling Bureau.

Sriyook, S., Siriatiwat, S., Siriphanich, J. 1994. Durian fruit dehiscence - water status and ethylene. HortScience. 29, 1195–1198.

Thakur, A.K., Kumar, R., Shambhu, V.B., Singh, I.S. 2017. Effectiveness of Shrink-wrap packaging on extending the Shelf-life of Apple. Int. J. Curr. Microbiol. App. Sci. 6, 2365–2374.

Yam, K.L., Takhistov, P.T., Miltz, J. 2005. Intelligent packaging: concepts and applications. J. Food Sci. 70, 1–10.