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Effect of ethephon on fruit ripening and fruit components of durian cv. 'Monthong' after harvest

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Abstract The study showed that interaction between the duration of fruit ripening and fruit grade. Fruit grade A under natural ripening method (NRM) had significantly the longest duration of fruit ripening at 9 days, followed by grade B (8 days), and grades C, and D (7 days); while under ethephon-induced ripening method (ERM) for all fruit grades A, B, C, and D were only at 5 days. The 5-day ripening duration under ERM was significantly shorter than that of NRM at 3 days. The light fruit weight of fruit grades C and D had significantly shown a high percentage of weight loss per fruit, but short duration of fruit ripening compared with those heavy fruit weights (fruit grades A and B). Fruit grade A had significantly shown the highest fruit weight (3.40 kg/fruit), followed by grade B (2.69 kg/fruit), grade C (1.50 kg/fruit), and grade D (1.34 kg/fruit). Fruit weight did not change under NRM and ERM. But the percentage of weight loss per fruit under ERM was significantly lower than NRM by 7% which mainly due to the short duration of fruit ripening under ERM which is indicated by the value of the positive correlation coefficient (r). The percentage of weight loss per fruit was positively associated with the duration of fruit ripening (r = 0.59). Therefore, the ethephon-induced ripening method (ERM) for 'Monthong' durian cultivar is better than that of the natural ripening method, as it contributed to having heavier fruit weight by 12% and lower percentage of weight loss per fruit by 7%. Under ERM, no effect was found on fruit weight, percentage of aril weight per fruit, percentage of pericarp weight per fruit, thickness of pericarp, and percentage of seeds weight per fruit, as compared with NRM. It is therefore suggested that the ethephon-induced ripening method should be adopted by the producers and exporters to reduce the problem on fruit weight loss and difficulties in managing the duration of durian fruit ripening after harvest.

Keywords: Ethephon, Ripening, Durian, Aril, 'Monthong' cultivar, Weight loss

Introduction

Durian (*Durio zibethinus* Murr.) is a tropical fruit tree, a climacteric fruit, and an important economic crop in Thailand. In 2020, there was 132,362 ha of

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the planting area but only 126,586 ha yielded with 1,111,928 tons (8.78 t/ha) of fruits (OAE, 2020). Durian is grown commercially and is known as the "King of Fruits" due to its unique intense aroma and its sweet custard-like aril (Subhadrabandhu and Ketsa, 2001). 'Monthong' and 'Chanee' are the most popular cultivars in Thailand (Somsri, 2017). 'Monthong' is the most commercially sought after for its full-bodied creamy and mild sweet tasting aril with relatively moderate smell emitted and smaller seeds (DAT, 2011). The aril contains a number of different bioactive compounds, many of which are beneficial to human health (Ketsa *et al*., 2020). The arils typically comprise 15–35% of the fruit weight, and are composed of 67% water, 28% carbohydrate, 2.5% protein and 2.5% fat, with smaller amounts of vitamins, minerals and fiber (Anonymous, N.D.).

It has been reported that the ethylene production and water loss are the two major factors that cause the ripened durian fruit to dehisce. Ethylene weakens the cells in the dehiscence zone which consists of parenchyma cells without chlorophyll. Water loss causes the pericarp to shrink and pull the carpels from each other along the suture at the middle of each locule (Anonymous, N.D.). The ethylene is more important in durian fruit dehiscence than weight loss (Sriyook *et al*., 1994). By applying the ethephon of 26%, or 52% concentrations, on the peduncle of the durian fruit, the results showed that the residue of ethephon did not exceed 2 mg/kg of the edible portion (aril) of durian throughout the storage period at 15±1 ℃ for 10 days. Hence the use of ethephon for ripening of the durian fruit is safe for consumers and the environment (Suttirak *et al*., 2018; CFS, 2017). The ethephon in the form of 2–chloroethyl phosphonic acid can transform into 2–hydroxyethyl phosphonic acid and this will be decomposed and released as ethylene gas (European Food Safety Authority, 2008), thus it stimulates the ripening of the durian fruit. By applying the ethephon on 118 days old durian fruits after full bloom, there was a significant amout of ethylene produced higher than that of durian fruit without any ethephon application (Wisutiamonkul *et al*., 2015). It has also been reported that the concentration of ethylene measured from the air inside the mango bag was increased along with increasing the concentration of ethephon that applied to the mango fruit before bagging (Tan *et al*., 1999). During transportation, exporters often face problems on premature fruits, fruit weight loss, and difficulties in managing the ripening duration after harvest according to the importers' and/or customers' needs. This led to credibility issues in terms of product quality of the importers. It is important to solve these problems by studying the effect of ethephon on fruit ripening and fruit components cv. 'Monthong' after harvest as a way to regain credibility concerning to product quality.

Accordingly, the study aimed to assess the fruit ripening and fruit components of durian cv. 'Monthong' after harvest using two ripening methods: natural and ethephon-induced.

Materials and methods

The experiment was performed at the Department of Agricultural Technology, Rajamangala University of Technology Tawan-Ok at Chanthaburi Campus, Chanthaburi, Thailand from December (2020) to June (2021). The experiment was done in a split plot design which replicated 3 times (one durian fruit per replication). The mainplot treatments were the two ripening methods: 1) ethephon-induced [or applied 52% ethephon concentration (0.02 ml per fruit) at the knife's cut point on the peduncle of the durian fruit]; and 2) natural (no ethephon-induced)**.** The subplot treatments were categorized into four fruit grades based on the weights of 'Monthong' cultivar: a) grade A (3.8-4.1 kg), b) grade B (3.1-3.3 kg), c) grade C (1.9-2.0 kg), and d) grade D (1.1-1.5 kg). At maturity stage, all fruits were simultaneously harvested with their peduncles [or fruit stalks located below the abscission zone (Figure 1)] from three durian trees (5 years and 6 months old trees; with 118 days old fruits after full bloom) and were weighed individually after harvest and then recorded in a unit of kilogram per fruit (kg/fruit).

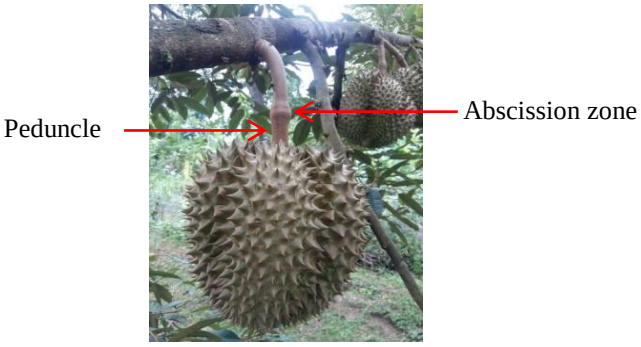

Figure 1. Peduncle with the bulging abscission zone of Durian fruit cv. 'Monthong' at 118 days old

Only 24 selected fruits with their desirable weights {8 fruits per tree: grade A (2 fruits), grade B (2 fruits), grade C (2 fruits), and grade D (2 fruits)} were tested. Three hours after harvest, 24 durian fruits (12 used for natural ripening method and another 12 fruits used for ethephon-induced ripening method) categorized into four grades with various fruit weights were re-weighed and recorded; their weights were then computed for the average fruit

weight (Table 1). The twelve fruits used for natural ripening method and twelve fruits used for ethephon-induced ripened method were placed at room temperature (34.4 ℃ for an average temperature at daytime and 27.6 ℃ for an average temperature at nighttime) until each durian fruit ripened within ten days then its weight was weighed and recorded. Likewise, duration of fruit ripening and other durian fruit components were determined below as follows:

Table 1. Average fruit weight (kg/fruit) of durian cv. 'Monthong' at harvest (maturity stage) before using ethyphon-induced ripened fruits

Ripening method (RM)	**Fruit grade (FG)**				**Mean**
	A	**B**	**C**	**D**	
Natural ripening	4.00	3.20	1.90	1.30	2.60
Ethephon-induced ripening	4.00	3.20	2.00	1.32	2.63
Mean	4.00	3.20	1.95	1.31	

Fruit weight at ripening stage was observed when the fruit gave off an aroma on its second day; each ripened fruit was then weighed and recorded in a unit of kilogram per fruit (kg/fruit). Duration of fruit ripening was counted at the time of harvest together with ethephon application on the tip of peduncle of a fruit until ripening; recorded in a unit of hours and it was converted into a unit of day basis. Percentage of weight loss per fruit was computed from the following formula: Percentage of weight loss per fruit = (Fruit weight at maturity stage – Fruit weight at ripening stage) x 100/ Fruit weight at maturity stage. Percentage of aril (flesh or pulp) weight per fruit was computed from the following formula: Percentage of aril weight per fruit = Aril weight per fruit at ripening stage x 100/ Fruit weight at ripening stage. Note that the aril is the edible portion of the durian fruit. Percentage of pericarp [included all spines and septum of a fruit (Figure 2) weight per fruit was computed from the following formula: Percentage of pericarp weight per fruit = Pericarp weight per fruit at ripening stage x 100/ Fruit weight at ripening stage.

Thickness of pericarp [husk or the walls of a ripened ovary (Figure 1)] was measured from the epicarp (the outermost layer of a pericarp) to the endocarp (the inner layer of a pericarp in a middle part of a carpel then recorded in a unit of millimeter (mm). Percentage of seeds weight per fruit was computed from the following formula: Percentage of seeds weight per fruit = Seeds weight per fruit at ripening stage x 100/ Fruit weight at ripening stage. Number of seeds was counted from each durian fruit and recorded in a unit of number of seeds per fruit.Percentage of peduncle weight per fruit was computed from the following fomula: Percentage of peduncle weight per fruit = Peduncle weight per fruit at ripening stage x 100/ Fruit weight at ripening stage.

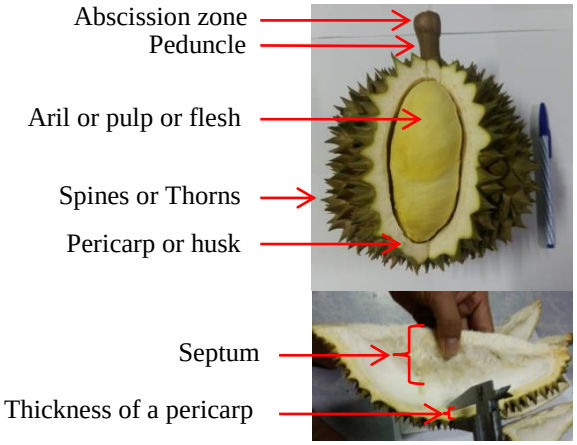

Figure 2. Fruit components of durian cv. 'Monthong' at 123 days old

Statistical analysis system (SAS) program was used to analyse all durian fruit components. Duncan's multiple range test was used for mean comparisons at 0.05 probability level. Relationships among all fruit components were established through correlation analysis. To determine the relationships of percentage of aril weight per fruit with other fruit components, stepwise multiple regression was used.

Results

The ripening duration had interacted between the ripening method (RM) and fruit grade (FG) (Table 2). The duration of fruit ripening of grade A under natural method was significantly reveraled the longest the (9 days), followed by grade B (8 days), grades C and D (7 days); while grades A, B, C, and D under ethephon-induced method had 5 days ripening duration, respectively. There was no interaction between the ripening-induced method and fruit grade on fruit weight (1-3.43 kg/fruit), percentage of weight loss per fruit (13-28), percentage of aril weight per fruit (24-34), percentage of pericarp weight per fruit (62-71), thickness of pericarp (6-7 mm), percentage of seeds weight per fruit (2.7-4.1%), number of seeds per fruit (9-15 seeds), and percentage of peduncle weight per fruit (0.8-1.4) (Tables 3, 4, 5, 6, 7, 8, 9, and 10).

The ripening duration under natural method (8 days) was significantly longer than ethephon-induced method (5 days) (Table 2). Light fruit weight of fruit grades C and D had significantly high percentage of weight loss per fruit but had short ripening duration compared with those heavy fruit weight of fruit

grades A and B (Tables 2, 3, and 4). Fruit weight did not change significantly under natural and ethephon-induced methods (Table 3). Percentage of weight loss per fruit was significantly affected by the ripening-induced method (Table 4). There was a 22% weight loss per fruit under natural method while it was only 15% under ethephon-induced. While the percentage of aril weight per fruit, percentage of pericarp weight per fruit, thickness of pericarp, percentage of seeds weight per fruit, number of seeds per fruit, and percentage of peduncle weight per fruit did not change significantly under the two ripening methods (Tables 5, 6, 7, 8, 9, and 10).

Duration of fruit ripening of fruit grades A and B was 7 days which was significantly longer than that of fruit grades C and D by 1 day (Table 2). Fruit weight differed significantly between fruit grades (Table 3). Fruit grade A had significantly the highest fruit weight (3.40 kg/fruit) followed by fruit grade B (2.69 kg/fruit), fruit grade C (1.50 kg/fruit), and fruit grade D (1.34 kg/fruit), respectively (Table 3 and Figure 3). An average aril weight per fruit varied extensively between fruit grades (Figure 4). Fruit grade A had the highest average fruit weight per fruit (1.12 kg) followed by fruit grade B (0.91 kg), fruit grade C (0.45 kg), and fruit grade D (0.34 kg), respectively. Percentage of weight loss per fruit was significantly among fruit grades (Table 4). Percentage of aril weight per fruit (25-34), percentage of pericarp weight per fruit (62-71), thickness of pericarp (6-7 mm), percentage of seeds weight per fruit (3.3-4.1), number of seeds per fruit or average number of seeds per fruit (10-15 seeds), average seeds weight per fruit (0.05-0.14 kg), and percentage of peduncle weight per fruit (0.9-1.3) were not significantly different between the four fruit grades (Tables 5, 6, 7, 8, 9, 10 and Figure 5).

Table 2. Duration of fruit ripening (days)

Ripening method (RM)	**Fruit grade (FG)**				**Mean**
	A[1/]	**B**	**C**	**D**	
Natural ripening	9a	8b	7c	7c	8a[2/]
Ethephon-induced ripening	5d	5d	5d	5d	5b
Mean	7a[3/]	7a	6b	6b	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

Table 3. Fruit weight (kg/fruit)

Ripening method (RM)	Fruit grade (FG)				Mean
	A[1/]	B	C	D	
Natural ripening	3.37a	2.67a	1.37a	1.00a	2.10a[2/]
Ethephon-induced ripening	3.43a	2.70a	1.63a	1.67a	2.36a
Mean	3.40a[3/]	2.69b	1.50c	1.34d	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

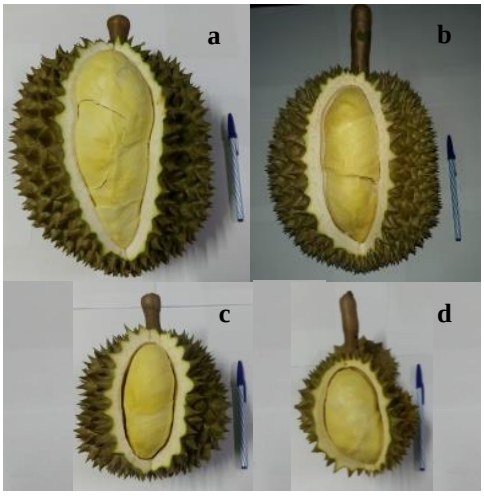

Figure 3. Various fruit grades with an average ripened fruit weight per fruit: a) grade A, 3.40 kg; b) grade B, 2.69 kg; c) grade C, 1.50 kg and; d) grade D, 1.34 kg

Table 4. Percentage of weight loss per fruit

Ripening method (RM)	Fruit grade (FG)				Mean
	A[1/]	B	C	D	
Natural ripening	18a	17a	28a	23a	22a[2/]
Ethephon-induced ripening	14a	16a	18a	13a	15b
Mean	16b[3/]	17b	23a	18ab	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT).

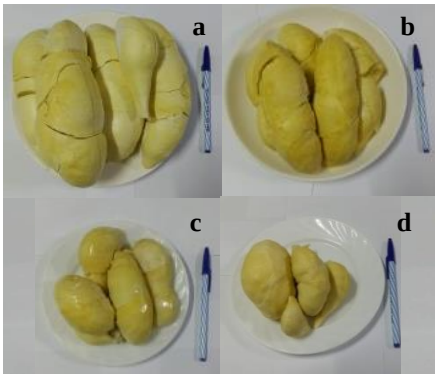

Figure 4. Various fruit grades with an average aril weight per fruit: a) grade A, 1.12 kg; b) grade B, 0.91 kg; c) grade C, 0.45 kg and; d) grade D, 0.34 kg

Table 5. Percentage of aril weight per fruit

Ripening method (RM)	**Fruit grade (FG)**				**Mean**
	A[1/]	**B**	**C**	**D**	
Natural ripening	32a	33a	29a	24a	30a[2/]
Ethephon-induced ripening	33a	34a	31a	26a	31a
Mean	33a[3/]	34a	30a	25a	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

Table 6. Percentage of pericarp weight per fruit

Ripening method (RM)	**Fruit grade (FG)**				**Mean**
	A[1/]	**B**	**C**	**D**	
Natural ripening	63a	62a	66a	71a	66a[2/]
Ethephon-induced ripening	62a	62a	65a	70a	65a
Mean	63a[3/]	62a	66a	71a	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

Table 7. Thickness of pericarp (mm)

Ripening method (RM)	Fruit grade (FG)				Mean
	A[1/]	B	C	D	
Natural ripening	7a	7a	6a	6a	7a[2/]
Ethephon-induced ripening	7a	7a	6a	6a	7a
Mean	7a[3/]	7a	6a	6a	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

Table 8. Percentage of seeds weight per fruit

Ripening method (RM)	Fruit grade (FG)				Mean
	A[1/]	B	C	D	
Natural ripening	4.1a	4.0a	3.8a	3.6a	3.9a[2/]
Ethephon-induced ripening	4.1a	3.2a	2.7a	3.1a	3.3a
Mean	4.1a[3/]	3.6a	3.3a	3.4a	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

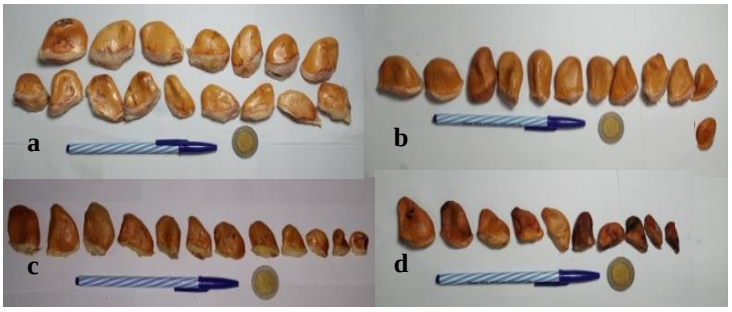

Figure 5. Various fruit grades with an average number of seeds per fruit and average seeds weight per fruit: a) grade A, 15 seeds and 0.14 kg ; b) grade B, 12 seeds and 0.10 kg; c) grade C, 12 seeds and 0.05 kg and; d) grade D, 10 seeds and 0.05 kg

Table 9. Number of seeds per fruit (seeds)

Ripening method (RM)	Fruit grade (FG)				Mean
	A[1/]	B	C	D	
Natural ripening	15a	13a	13a	10a	13a[2/]
Ethephon-induced ripening	14a	11a	10a	9a	11a
Mean	15a[3/]	12a	12a	10a	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

Table 10. Percentage of peduncle weight per fruit

Ripening method (RM)	Fruit grade (FG)				Mean
	A[1/]	B	C	D	
Natural ripening	0.9a	1.0a	1.2a	1.4a	1.1a[2/]
Ethephon-induced ripening	0.9a	0.8a	1.3a	0.9a	1.0a
Mean	0.9a[3/]	0.9a	1.3a	1.2a	

[1/]RMxFG means with the same letter is not significantly different at 0.05 probability level (DMRT); [2/]in the column of RM means with the same letter is not significantly different at 0.05 probability level (DMRT); [3/]in the row of FG means with the same letter is not significantly different at 0.05 probability level (DMRT)

Relationships of percentage of aril weight per fruit with durian fruit components were observed. Durian fruit components most significantly influenced percentage of aril weight per fruit was determined through stepwise multiple regression analysis. Three durian fruit components: percentage of peduncle weight per fruit, percentage of seeds weight per fruit, and percentage of pericarp weight per fruit that significantly determined the percentage of aril weight per fruit under natural and ethephon-induced methods. The equations were proved as follows:

Percentage of aril weight per fruit $_{(\text{Natural ripening})}$ = 99.920 – 1.006 (percentage of peduncle weight per fruit) – 0.993 (percentage of seeds weight per fruit) – 0.999 (percentage of pericarp weight per fruit) (1)

$R^2 = 1.00$*

Percentage of aril weight per fruit $_{(\text{Ethephon-induced})}$ = 100.013 – 0.988 (percentage of peduncle weight per fruit) – 0.999 (percentage of seeds weight per fruit) – 1.000 (percentage of pericarp weight per fruit) (2)

$R^2 = 1.00$*

Percentage of aril weight per fruit under natural and ethephon-induced methods was explained by the percentage of peduncle weight per fruit, percentage of seeds weight per fruit and percentage of pericarp weight per fruit with 100% accuracy (equations 1 and 2). The negative coefficient values

indicated that by reducing the percentage of peduncle weight per fruit, percentage of seeds weight per fruit, and percentage of pericarp weight per fruit, percentage of aril weight per fruit increases.

Discussion

Overall, the natural method across various fruit grades (A, B, C, and D) prolonged the duration of fruit ripening for 2-4 days, significantly longer than the ethephon-induced method. The latter method enhanced the evenly ripening of all tested fruit grades within 5 days after harvest, or shortened storage period of durian fruits; while the former took 7-9 days. Under natural method, fruit grade A had significantly the longest duration of fruit ripening at 9 days, followed by grade B (8 days), grades C and D (7 days); under ethephon-induced method were fruit grades A, B, C, and D at 5 days, respectively, mainly due to the use of the appropriate ripening method and fruit grade. According to Islam *et al*. (2019), the effects of large, medium, and small fruit sizes on fruit quality and shelf life in cherry tomatoes showed that the large tomatoes had lower rates of respiration and ethylene production compared to the small-sized. The rate of fresh weight loss was the highest in small tomatoes while a prolonged shelf life was observed in the large tomatoes. Large tomatoes retained the highest level of firmness and concentrations of titratable acidity and vitamin C whereas small tomatoes contained the highest level of soluble solids.

The duration of fruit ripening under natural method was longer than that of ethephon-induced method by 3 days. It is reported that ethephon is a substance in a form of liquid, but it can release ethelene gas which help stimulates flowering (Wiangsamut and Koolpluksee, 2018), durian fruit dehiscence (Sriyook *et al*., 1994), accelerated ripening in the rabbiteye blueberry (Vaccinium virgatum) cultivars ‘Premier’ and ‘Powderblue’ by increasing the proportion of blue (ripe) and did not generally alter fruit quality characteristics at harvest or during postharvest storage (Wang *et al*., 2018). Fruit grades A and B had fruit ripening duration of 7 days, which was longer than that of fruit grades C and D by a day. It is confirmed that various fruit grades (or durian fruit sizes or durian fruit weights) had a significant difference in duration of fruit ripening when their fruit weights distinguished from each other for at least 1 kg/fruit (i.e. by matching the fruit grades between B and C, A and C, B and D, and A and C: fruit weights differences were of 1.19, 1.90, 1.35, and 2.06 kg/fruit, respectively). The large aril weight per fruit was mainly due to the high fruit weight (fruit grade) at harvest time, or during postharvest storage.

Low percentage of weight loss per fruit, or less water loss through evapotranspiration (evaporation plus transpiration) from the durian fruits under ethephon-induced method consequently shortened the fruit ripening duration yet remained to have high fruit weight, as compared with natural method. According to European Food Safety Authority (2008), the ethephon can release ethylene gas. This gas accelerated the ripening of durian fruit under ethephon-induced method. Durian fruit is a climacteric fruit as same as plantain. Thompson and Burden (1995) cited that plantain undergoes ripening upon maturity by the release of ethylene gas. The ripening of the fruit is characterised by skin colour changes, conversion of starch to sugars, fruit softening, loss of astringency and development of characteristic flavour. Other changes include respiration rate and ethylene production. These changes affect the final eating quality of the fruit (Dadzie and Orchard, 1997; Subedi and Walsh, 2011). Through correlation analysis, percentage of weight loss per fruit was positively associated with the duration of fruit ripening ($r = 0.59$). This means that the longer duration of fruit ripening after harvest, the higher percentage of weight loss per fruit. Under natural method, weight loss of durian fruit was significantly higher than that of ethephon-induced method, mainly due to higher water loss from fruit through evapotranspiration caused by respiration of fruit for a long ripening duration. According to Becker and Fricke (N.D.), respiration is the chemical process by which fruits convert sugars and oxygen into carbon dioxide, water, and heat. Transpiration is the process by which fresh fruits lose moisture. This process includes the transport of moisture through the pericarp of the fruit, the evaporation of this moisture continued from the pericarp surface to the atmosphere. Hence, fruit weight loss of durian cv. ‘Monthong’ under natural ripening method was significantly higher than that of the ethephon-induced method.

Light fruit weight of fruit grades C and D (small sizes of durian fruit) had significantly high percentage of weight loss per fruit and advanced duration of fruit ripening by a day compared with those heavy fruit weight of fruit grades A and B. Through correlation analysis, percentage of weight loss per fruit is negatively associated with the fruit weight ($r = -0.45$). This means that by increasing the percentage of weight loss per fruit, the fruit weight concurrently reduces . This is due to small durian fruit weight had higher pericarp weight to volume ratios and higher aril weight to volume ratios resulted in an increased respiration, which contributed to having high water loss from the durian fruit through evapotranspiration. Similarly, Lallum *et al*. (2004) cited that increased water loss during the inhibition phase of ripening increased the rate of respiration and ethylene production and advanced ripening by 2 days. FAOUN (1989) assessed that the start of fruit ripening is accompanied by a rapid rise in

respiration rate, called the respiratory climacteric. After the climacteric, the respiration slows down as the fruit ripens and develops good eating quality in apple, banana, melon, papaya, and tomato. Likewise, the rate of fresh weight loss was low in large tomatoes but high in small tomatoes as described by Islam *et al*. (2019). El-Ramady *et al*. (2015) explained that larger tomatoes had lower surface area to volume ratios, which conferred relatively less water loss. FAOUN (1989) furthermore cited that ripeness is followed by ageing (often called senescence) and breakdown of the fruit.

In summary, the duration of fruit ripening had an interaction between the ripening method and fruit grade. Fruit grade A (the largest fruit size) under natural ripening method had significantly the longest duration of fruit ripening at 9 days, followed by fruit grade B (larger fruit size) at 8 days, fruit grade C (smaller fruit size) at 7 days, and fruit grade D (the smallest fruit size) at 7 days. The duration of fruit ripening for all fruit grades A, B, C, and D under ethephon-induced method was only 5 days. The 5-day fruit ripening duration under ethephon-induced ripening method was significantly shorter than that of natural repening method by 3 days. Therefore, the ethephon-induced ripening method for 'Monthong' durian cultivar is better than that of the natural ripening method; this contributed to having heavier fruit weight by 12% and lower percentage of weight loss per fruit by 7%. Both ethephon-induced ripening and natural ripening methods did not affect other durian fruit components—fruit weight, percentage of aril weight per fruit, percentage of pericarp weight per fruit, thickness of pericarp, percentage of seeds weight per fruit, number of seeds per fruit and percentage of peduncle weight per fruit. It is therefore suggested that the ethephon-induced ripening method should be adopted by the producers and exporters confronted with problems on fruit weight loss and difficulties in managing the ripening duration of durian fruit after harvest, as a way to regain quality product credibility among consumers.

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