Status and Challenges of Dragon Fruit Production in Malaysia

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ABSTRACT

Dragon fruit or pitaya is a nutritious and exotic fruit that has gained a place in Malaysian fruit industry even though it was not native to this country. Dragon fruit can be harvested all-year round and it bears fruits after one year of planting. Potential yield of dragon fruit is estimated around 10 to 12 metric tons (mt) per hectare (ha) annually. Currently, there are about 680 ha of planted areas, which produce 6,407 mt or US$ 6 million in 2017. About 36% of Malaysian dragon fruit is for export market mainly to Singapore, Taiwan and Hong Kong with average export value of US$ 2 million for the past 5 years. Dragon fruit production area reaches highest peak in 2008 with 2200 hectares and its production reached highest in 2009 with 15,700 mt. In 2017 Johor and Melaka dominated 48% (325.2 ha) of the total planted area, followed by Selangor (80.1 ha) and Negeri Sembilan (68.2 ha). Like many other fruit crops, dragon fruits are susceptible to diseases. In Malaysia, the plants are sensitive to fungal, bacterial and viral infections, which can lead to several complex diseases namely, anthracnose, stem necrosis, stem canker, stem and fruit rot. There were several strategies which have been applied in Malaysia to prevent and control diseases on dragon fruit.

Keywords: Dragon fruit, status of production, diseases

INTRODUCTION

Dragon fruit or pitaya or locally known as ‘buah naga’ and ‘buah mata naga’ was introduced to Malaysia when Malaysians imported dragon fruits from Vietnam since 20 years ago. The suitability of tropical climate, rainfall requirements, light intensity and soil types may contribute to the successful cultivation of dragon fruit in Malaysia (Mohd et al., 2015). Dragon fruit has oval shape, red in color and its fruit is sized between 10-15 cm; weighs between 300 to 500 grams. It has sweet to light sour taste and has many tiny black seeds which are edible. Yellow dragon fruits are small in size, average weight of 100 gram and it is very sweet. Dragon fruit was reported to be a long day plant. It belongs to the Crassulacean Acid Metabolism (CAM) species which means that it only opens its stomata at night for carbon dioxide intake. A dragon fruit plant is an epiphytic where it needs pillars to support it soft stems and branches.

Dragon fruit contains vitamins and minerals that can help to improve the human body’s metabolism. It is good for our digestion and blood circulation. Reports have shown that dragon fruits had positive response to reduce high blood pressure and neutralize toxins in the body. Red flesh dragon fruit has high antioxidants content which had high medical value. Besides being consumed fresh, the red dragon fruit can be processed into cordial, jam, wine and other products. There are reports that the content and the skin of dragon fruit can become natural food coloring and as part of the concoction in the making of...
lipsticks. This natural food coloring is safe to be used because it does not have any side effects and no harm to human health (Zainudin, 2007).

DRAGON FRUIT CULTIVATION IN MALAYSIA

Dragon fruit variety

There are three species of dragon fruits grown in Malaysia namely; white flesh dragon fruits (*Hylocereus undatus*), red flesh dragon fruit (*Hylocereus polyrhizus*) and yellow skin dragon fruit (*Selenicereus megalanthus*). However, there were two varieties that are suitable to be planted in Malaysia i.e. red and white flesh varieties. Currently, Malaysia has two registered variety under the national listing which are HU1 (Pink Dragon Sunlike) and HU2 (Iguana) (Figure 1)

![Figures of dragon fruits](image)

**Figure 1.** Two registered varieties under Malaysian National Listing; a) HU1 (Pink Dragon Sunlike), b) HU2 (Iguana)
Production

Malaysia has hot humid climate which permits the cultivation of many different types of fruits. Some of the fruits grown here are native to this part of the world. These includes indigenous fruits such as mangosteen, durian, rambutan and many species of banana. Dragon fruit production in Malaysia started with the involvement of the public sector and was not concerted in the development plan for Malaysia’s government. After many trials and errors, dragon fruit cultivation has made its way into the Malaysian fruit industry. Unlike Vietnam and Thailand which had long histories of dragon fruit growing, Malaysia is keeping good pace to lead its niche market due to high local demand.

In 2006 until 2009, there was an increase in the number of dragon fruit growers in Malaysia due to the fruit’s high demand and good prices (Zainudin and Hafiz, 2015). This crop also has good returns for investment because it its yield is fast—in fact, the plant starts to bear fruits as early as one year after planting. Besides fruits, growers also make profit in supplying planting materials for new growers and hobbyists by offering high price. Its production reaches highest in 2009 with 15,700 mt compared to 2500 mt in 2006 with average of 12.5 mt per ha of harvested yield. However, the production of this fruit decreased steadily starting in 2011 (1,525 ha) and until 2017 only 680 ha was actively produced. Johor and Melaka dominated 48% (325.2 ha) of the total planted area, followed by Selangor (80.1 ha) and Negeri Sembilan (68.2 ha).

Dragon fruit can be harvested all-year round and the peak seasons are around April and September but in some places, the harvesting time might vary. The average production in one hectare of plantation for second year of planting ranged between 2 and 8 tons and later increased to more than 10 tons per hectare once the crops mature enough. The size of fruits depends on several factors such as good pollination, sufficient water and farm management practices. Bigger fruit size will have higher prices compared to the small ones. Dragon fruits are graded such as ‘AA” for 500-800g, grade ‘A’ for 350-450g, grade ‘B’ for 250-350 g and grade ‘C’ below 250 g (Zainudin and Hafiz, 2015).

Marketing channels

In the Malaysian retail market, dragon fruit is often sold as a fresh product. Figure 2 shows the dragon fruit marketing channel for domestic and international markets. At the farm level, the growers can either sell directly to agents, private traders’ wholesalers or processors. In normal situation, agents and private traders play significant roles as middle men between growers, especially for small scale farms and industry players. In certain places, farmers could also sell directly to consumers through mobile markets or farmers markets or even along the main road or in front of the farmer’s farms. At the wholesaler level, the dragon fruits are generally distributed into conventional retail markets such as hypermarkets, supermarkets, night/wet markets and small market/grocery stores. The wholesaler also acts as a main player to supply fruits to the exporters for the international market. Fresh fruits and vegetables are extremely perishable and have a relatively short shelf life (Nath et al., 2007). Thus, value-added products from dragon fruits will be fully utilized in order to fully consume the fruit. Dragon fruits can be turned into jams, juice, freeze-dried chips or cookies. Food processors may receive supply either from farmers, private traders or even imported from other countries. The consistent quality supply and cost effectiveness are the top priorities required by the processors in the business (Rodrigo, 2016).

Generally, in real domestic market, there are three types of price level; ex-farm price, wholesale price and retail price. The difference between these levels can be considered as the cost of marketing and the margin to the buyers. The ratio of farm to retail price is the share of the consumers’ dollars going to the farmers. The wholesale-farm margin is the difference between the price by the wholesale trader (or the processor) and the ex-farm or producer price. The wholesale-retail margin is the difference between the price retail trader pays and the retail price he charges to consumers (Fatimah et al., 2004). Market price is sensitive due to fluctuations in supply and demand; increase in demand will increase in price and vice versa. Currently, dragon fruit is sold at RM 3.50- RM 4.00/kg at farm level, RM 4.50/kg at wholesale level and RM 5 – RM 6/kg at retail level. The price may change due to size and grading accordingly. Usually, in the hypermarket, supermarket or small retail, dragon fruits will sell by weight (kilogram), however in the wet market, the fruits are sold in bulk (3 to 4 pieces) priced at RM 10.

Singapore, Taiwan and Hong Kong are the main traditional export partners for agricultural produce from Malaysia. In the export trade, dragon fruit is traded under the Harmonization Standard code of 081090 – tropical fruits group as ‘pitahaya’. For the past 5 years, the export value of dragon fruit is valued at US$ 2 million (36% goes to main traditional market) (Table 1). It is forecasted that demand will increase in the domestic and export markets by 3%, shifting due to increase in population.
and food pattern for more consumption of healthy produce from fruits and vegetables among the new generation.

Figure 2. Marketing channel of dragon fruits in Malaysia
Note: Adopted from fruits Malaysian marketing model by Fatimah et al. (2004)
brown color. The disease causes the stem to rot in soft state, occasionally delimited by chlorotic haloes symptoms. From other crops showed that conidia from infected plants and plant residues can become sources of inoculum of Colletotrichum species infection once favorable conditions for infection occur (Buchwaldt et al., 1996).

Mohd et al. (2009) reported the occurrence of stem necrosis in several states of Malaysia (Kelantan, Melaka, Negeri Sembilan, Penang, and Perak) with almost 41% of disease incidence and 25% disease severity. Disease symptom was observed as spots or small, circular, faint pink-to-beige necrotic lesions that generally coalesced as symptoms progressed. The causal agent of stem necrosis was identified as the fungus, Curvularia lunata based on morphological characteristics (Ellis, 1971). Curvularia lunata showed grey colony and black on the backside; produced pale brown multicelled conidia (phragmoconidia; three to five-celled) that formed apically through a pore (poroconidia) in sympodially, elongating and gencilated conidiophores. This disease has been reported to infect dragon fruit stems only in Malaysia but not in other countries (Mohd et al., 2009).

Stem canker was the most destructive disease attacked dragon fruit in Malaysia and has been first reported by Mohd et al. (2013b) with up to 60% disease incidence and 55% disease severity. It was found that the causal agent of stem canker was Neoscytalidium dimidiatum. The initial symptoms of stem canker were brown sunken lesion and the lesion became dark brown with age. Abundant of black pycnidia were formed on the surface of the canker. As the disease progressed, the infected stem subsequently rotted and looked like burning stem (Mohd et al., 2013b).

Stem rot was also recorded as one of the serious diseases of red-fleshed dragon fruit in Malaysia. It was detected with 36% and 25% disease incidence and disease severity, respectively. Two fungal species of Fusarium were recorded to be involved in causing the disease namely F. proliferatum (Mohd et al., 2013a) and F. fujikuroi (Mohd et al., 2017). The disease symptom appeared as circular, brown sunken lesion with orange sporodochia and white mycelial formation on the lesion surface. The causal pathogen of stem rot produced dense-cotyton, whitish aerial mycelium and purplish pigments.

New fungal disease of stem rot caused by Bipolaris cactivora was reported by Shanariah (2019). The infected dragon fruit suffers from a lesion on its stem. Below the lesion part, there is a yellow spot formed with a reddish margin. The infected region looks a little bit swollen but its surface is dry. When the infected region is dissected and observed under a dissecting microscope, there is a few of red spots found. This disease is most severe on mature and ripe fruit. Young stems are susceptible to B. cactivora, mature stems are relatively resistant to infection. In general, this disease favors humid conditions.

Enterobacter cloacae has been reported to cause bacterial stem rot disease of dragon fruit in Malaysia. This stem rot is also known as black rot, because the infected tissue turns to a dark black or brown color. The disease causes the stem to rot in soft state, occasionally delimited by chlorotic haloes symptoms.

Major constrains

This pioneering local dragon fruit farming venture went downhill when disease targeting the crop struck in late 2009. Like many other fruit crops, dragon fruits are susceptible to diseases caused by fungi, bacteria and viruses which can lead to several complex diseases namely, anthracnose, stem necrosis, stem canker, stem and fruit rot as well as one newly found disease known as viral spot disease that is caused by Cactus virus X.

Disease incidence in Malaysia

Improper agricultural practices and environmental factors are among the important reasons that contribute to disease infection in dragon fruits. Anthracnose is the most common disease that infects dragon fruits in Malaysia and cause huge losses in fruit quality, thus rendering large quantity of dragon fruit which are considered unfit for consumption. At least two species of Colletotrichum were involved in causing the disease namely C. gloeosporioides and C. truncatum (Mohd et al., 2008; Masyahit et al., 2009; Suzianti et al., 2014) with 52% disease incidence and 47% disease severity. Both Colletotrichum species produced similar symptom, which is reddish-brown lesions with chlorotic haloes symptoms. Reports from other crops showed that conidia from infected plants and plant residues can become sources of inoculum of Colletotrichum species infection once favorable conditions for infection occur (Buchwaldt et al., 1996).

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Table 1. Export volume and value of dragon fruits in Malaysia for the past 5 years
(Source: Ministry of Agriculture and Agrifood Industry, 2019)

<table>
<thead>
<tr>
<th>Year</th>
<th>(MT)</th>
<th>MYR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1071</td>
<td>1.96M</td>
</tr>
<tr>
<td>2014</td>
<td>1726</td>
<td>3.69M</td>
</tr>
<tr>
<td>2015</td>
<td>2069</td>
<td>5.36M</td>
</tr>
<tr>
<td>2016</td>
<td>2302</td>
<td>6.54M</td>
</tr>
<tr>
<td>2017</td>
<td>3407</td>
<td>10.39M</td>
</tr>
<tr>
<td>2018</td>
<td>4256</td>
<td>13.45M</td>
</tr>
</tbody>
</table>

Note: MT- Metric tonnes; MYR - Malaysian Ringgit; M - million
(Masyahit et al. 2009). Two dragon fruit species (Hylocereus undatus and H. pupusii) were found to be susceptible to these bacteria, the first species being more susceptible than the latter.

Incidence of necrotic spots disease caused by Cactus virus X was also recently reported by Masanto et al. (2018). It has been widely detected in dragon fruit-growing areas in Peninsular Malaysia with necrotic small mottle or spot on base of young shoots and unripe fruits which later turned orange and rotted symptoms. The most severe disease significantly occurred in the state of Malacca, while the fewer occurrences were recorded in the state of Terengganu.

Reddish brown spot disease was revealed as new disease on the stems of dragon fruit in Malaysia (Kee et al., 2019). The causal pathogens were identified as Nigrospora laticolonita and Nigrospora sphaerica. The disease with same symptom observed in Malaysia was also reported in China in 2014 to 2015 (Liu et al., 2016) but the causal pathogen was reported as N. sphaerica. The occurrences of the symptom at two commercial farms each in Negeri Sembilan and Johor were estimated at 20% and 10% for disease incidence and disease severity, respectively. Although the disease only can be found on the stems of dragon fruits in Malaysia, disease occurrence in Guangdong Province showed that both stems and fruits were affected (Liu et al., 2016).

**Disease management**

There were several strategies which were applied in Malaysia to prevent and control the plant pathogenic fungi that caused different diseases on dragon fruit. Chemical control was commonly and widely applied by farmers to control the diseases. From in vitro and plant house testing, benomyl and thiabendazole showed the most effective fungicides against F. proliferatum and F. fujikuroi causing stem rot on dragon fruit (Mohd, 2014). A study by Masyahit et al. (2009) showed that zero incidence of anthracnose disease was recorded in nine dragon fruit plantations in Malaysia (Batu Pahat, Sepang, Marang, Setiu, Batang Merbau, Gua Musang, Merbau Pulas, Gurun and Mata Ayer) due to well sanitation farms and application of copper based-fungicide to control the disease. For stem necrosis and stem canker, mancozeb, captanf and propineb were the recommended fungicides that can be applied to control the diseases.

Besides chemical control, good agricultural practices (GAPs) are important to be applied by farmers to prevent the disease infection on pitaya particularly on the proper techniques of pruning, selection of disease-free seedlings, soil type and condition, sanitation and drainage system. Le Bellec et al. (2006) suggested that damage and entangle stems of dragon fruit should be pruned and this application has been reported to increase the production of dragon fruit as well as reduce the occurrence of fungal diseases. Cultural management includes limiting canopy wetness by irrigating in the morning so plant surfaces can dry quickly throughout the day. Maintain a weed free planting and discard diseased plants promptly when symptoms occur. Controlling insect pests is an integral part of managing the spread of bacteria diseases. Aphids and mites are common pests that can transmit bacteria and viruses to healthy plants.

**Agronomy practices**

Early research on dragon fruits was carried out on yield performances and varietal evaluation. Zainudin (2007) found that dragon fruits yielded from 5 to 8 tons per ha after second year of planting and increased by 10 – 15 % as the crop matures. Red-fleshed cultivar (H. polyrhizus) was found to be accepted more by farmers compared to white fleshe (H. undanthus) basically due to high consumer preferences. Other aspects on flower biology, flower initiation and development were carried by Realiza et al. (2007) and found that poor fruit set of 10-20% in pitaya is the main constraint in producing high yield.

Martini et al. (2008) studied the growth, yield and fruit quality of H. polyrhizus fruit as affected by plant support system and intercropping with long bean (Vigna sinensis). They found that dragon fruit plants grown using the pole system showed 17-38% more flower buds, 15-36% more fruits and 24% heavier total fruit weight compared to those of the T bar trellis and V shape systems, respectively. There were also significant effects of plant support systems on soluble solid concentration (% Brix) where T bar trellis and pole systems showed 7% higher soluble solid concentration than that of the V shape system. Intercropping had no influence on all the parameters measured. Support systems did not have any significant effect on the stem diameter, chlorophyll concentration of stem, and days to attain fruit maturity in H. polyrhizus fruit and in the yield of long bean. Similarly, fruit quality including fruit pH, fruit diameter, fruit length, peel and pulp color and titratable acidity were not affected by different support systems or intercropping.
CONCLUSION

Dragon fruit planting has become one of the potential export fruits for Malaysia apart from the existing local fruits. It has fast returns on investment which could raise farmers income for small and large cultivation. Besides, its future is bright due to untapped downstream activities of its by products which could be developed through the existing agriculture sector. Several steps should be taken to enhance this industry such as disease and resistant planting materials, improved crop management practices, post-harvest handling and storage management, as well as efficient transfer of technology.

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