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PHENOLOGICAL, POSTHARVEST PHYSICOCHEMICAL AND ULTRASTRUCTURAL CHARACTERISTICS OF TORCH GINGER (Etlingera elatior (Jack) R.M. Smith) INFLORESCENCE AS A CUT FLOWER

CHOON SEA YEAT

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By

CHOON SEA YEAT

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PHENOLOGICAL, POSTHARVEST PHYSICOCHEMICAL AND ULTRASTRUCTURAL CHARACTERISTICS OF TORCH GINGER (*Etlingera elatior* (Jack) R.M. Smith) INFLORESCENCE AS A CUT FLOWER

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June 2016

Chairman : Associate Professor Phebe Ding, PhD
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The extravagant and showy inflorescence of torch ginger (*Etlingera elatior*) with bright colour is suitable to be used as a cut flower. The major weakness of this inflorescence is bract browning that shortens its vase life and reduces marketability. The causes of the bract browning disorder and the timing of its occurrence have not been investigated in detail. Understanding the characteristics of torch ginger and the mechanisms that regulate bract browning is needed for the production of high quality inflorescence. The objective of this work was to assess the potential of torch ginger inflorescence as a cut flower. In study one, the growth and development cycle of torch ginger plant was determined. Results showed that the growth and development cycle of torch ginger plants was divided into vegetative and reproductive phases. The entire inflorescence development period took about 60 days from the inflorescence shoot emergence until blooming stage. In study two, the mechanisms of bract opening and peduncle strength of inflorescence was elucidated. The experiment was conducted in a nested design. Data were analysed using general linear model. The means comparison was performed using Tukey's test. Results showed that fresh weight and respiration rate of inflorescence increased gradually from tight bud to bloom stage. The significant higher respiration rate of inflorescence at bloom stage was coincided with a drastic decrease in soluble sugar content in involucral. This result indicates that soluble sugars depletion is the cause of bract browning. As the inflorescence developed, the cellulose content in involucral and floral bracts decreased significantly. In involucral, the cellulase activity showed a significant increase from tight bud to 6-tip opens stage and decreased thereafter. A significant increase in pectin methylesterase activity was recorded from 6-tip opens to torch shows stage in involucral. In peduncle, the ethanol insoluble residue and cellulose content increased significantly from tight bud to bloom stage. In study three, postharvest performance of inflorescences supplemented with sucrose was evaluated. The experiment was conducted in a randomized complete block design with factorial arrangement. Data were analysed using analysis of variance. There was a significant quadratic relationship ($P \leq 0.05$) between vase life and sucrose concentrations on inflorescences at torch shows stage.

The vase life of inflorescences increased quadratically from 0 to 4% sucrose solutions and decreased thereafter. The changes of fresh weight in inflorescences were positively correlated with vase life (r=0.67). The excessive water loss via transpiration in bract cells is the main factor in reducing vase life. Further study should be conducted to reduce the transpiration rate of inflorescence in order to prolong its longevity.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

CIRI-CIRI FENOLOGI, FIZIKOKIMIA LEPAS TUAI DAN ULTRASTRUKTUR PERBUNGAAN KANTAN (*Etlingera elatior* (Jack) R.M. Smith) SEBAGAI BUNGA KERATAN

Oleh

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Pengerusi : Profesor Madya Phebe Ding, PhD
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Ciri-ciri perbungaan kantan (*Etlingera elatior*) yang menonjolkan dan warna yang menarik adalah sesuai untuk digunakan sebagai bunga keratan. Pemerangan pada brakta merupakan kelemahan pada perbungaan kantan yang memendekkan jangka hayat dan mengurangkan nilai pasarannya. Sebeb berlaku pemerangan pada brakta masih belum disiasat secara terperinci. Pemahaman pada ciri-ciri pokok kantan dan mekanisme yang mengawal pemerangan pada brakta adalah diperlukan untuk pengeluaran perbungaan kantan yang berkualiti tinggi. Objektif kajian ini adalah untuk menilai potensi perbungaan kantan sebagai bunga keratan. Kajian pertama adalah menentukan kitaran tumbesaran dan perkembangan kantan. Keputusan menunjukkan tumbesaran dan perkembangan kantan terbahagi kepada fasa vegetatif dan reproduktif. Tempoh perkembangan perbungaan bermula daripada pertumbuhan pucuk bunga sehingga perbungaan mekar mengambil masa 60 hari. Dalam kajian kedua, mekanisme pengembangan brakta dan kekukuhan tangkai bunga dikaji. Eksperimen ini dijalankan dalam rekabentuk tersarang. Data dianalisa dengan menggunakan model linear am. Perbandingan antara rawatan dengan menggunakan uji Tukey. Keputusan menunjukkan bahawa berat basah dan kadar respirasi meningkat secara beransur-ansur daripada tahap kematangan kudup ketat sehingga mekar. Kadar respirasi perbungaan yang menunjukkan tahap signifikan tinggi pada tahap kematangan mekar diikuti oleh penurunan kandungan gula terlarut dalam brakta. Pengurangan kandungan gula terlarut merupakan punca bagi pemerangan brakta. Apabila tahap kematangan perbungaan melanjut, selulosa dalam brakta menurun secara signifikan. Aktiviti selulase dalam brakta menunjukkan peningkatan secara signifikan daripada kematangan kudup ketat ke 6-hujung brakta terbuka dan menurun selepas itu. Aktiviti pektin metilesterase dalam brakta pula meningkat secara signifikan daripada kematangan 6-hujung brakta terbuka ke bentuk obor kelihatan. Dinding sel bagi brakta dihidrolisis oleh selulase dan pektin metilesterase untuk pengembangan brakta. Di tangkai bunga, sisa etanol tidak terlarut dan kandungan selulosa meningkat secara signifikan daripada tahap kematangan kudup ketat sehingga mekar. Dalam kajian ketiga, penilaian prestasi lepas tuai perbungaan yang dirawat dengan sukrosa telah dijalankan. Eksperimen ini dijalankan dengan

rekabentuk rawak blok lengkap dengan susunan faktorial. Data dianalisa dengan analisis varians. Perbandingan min antara rawatan dijalankan menggunakan uji berjarak ganda Duncan. Keputusan analisis regresi menunjukkan hubungan kuadratik secara signifikan ($P \leq 0.05$) antara jangka hayat dan kepekatan sukrosa pada perbungaan di kematangan kudup ketat, 6-hujung brakta terbuka, bentuk obor kelihatan dan mekar. Jangka hayat perbungaan kantan meningkat secara kuadratik daripada larutan sukrosa pada kepekatan 0-4% dan menurun selepas itu. Analisis korelasi menunjukkan perubahan berat basah perbungaan adalah secara kolerasi positif ($r=0.67$) dengan jangka hayatnya. Kehilangan air yang berlebihan melalui transpirasi dalam sel-sel brakta merupakan faktor utama dalam pemendekkan jangka hayat perbungaan. Kajian selanjutnya perlu dijalankan untuk mengurangkan kadar transpirasi untuk memanjangkan jangka hayat perbungaan.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

1-MCP	1-methylcyclopropene
8-HQC	8-hydroxyquinoline citrate
8-HQS	8-hydroxyquinoline sulphate
$AgNO_3$	Silver nitrate
ANOVA	Analysis of variance
AOA	Aminooxyacetic acid
AVG	Aminoethoxyvinylglycine
ClO_2	Chlorine dioxide
CO_2	Carbon dioxide
C_2H_4	Ethylene
DACP	Diazocyclopentadiene
DICA	Dichloroisocyanuric acid
DMRT	Duncan's multiple range test
DNS	3,5-dinitrosalicylic acid
DW	Dry weight
EIR	Ethanol insoluble residue
FAA	Formalin – acetic acid – ethanol – water
FW	Fresh weight
MVG	Methoxyvinylglycine
PME	Pectin methylesterase
PG	Polygalacturonase activity
SAS	Statistical Analysis Software
SE	Standard error
STS	Silver thiosulphate

CHAPTER 1

INTRODUCTION

Torch ginger (*Etlingera elatior* (Jack) R.M. Smith) is a perennial herbaceous clumping plant that belongs to the family Zingiberaceae. It is native to Malaysia, Indonesia and southern Thailand (Burtt & Smith, 1986; Ong, 2008). The current commercial production of torch ginger in Malaysia is focused in supplying inflorescence buds for culinary purposes. However, the torch ginger inflorescence bud sold in the market is poor in quality. There is no proper postharvest handling to extend their shelf life or to maintain the eating quality. Moreover, the wholesale and retail prices of inflorescence bud are fluctuated according to market demand. Usually, high market demand only occurs during festive celebrations or when the production is low in dry season. When the market demand is low, the wholesale and retail prices are low. The inflorescence bud tend to be negligent and left to bloom, and finally dying on plant. Consequently, studies should be conducted to evaluate its diversity for other usage in order to increase its economic importance.

In recent years, torch ginger has been gaining recognition and planted as an ornamental and landscaping plant in urban areas. The extravagant and showy inflorescence with brilliant colour has demonstrated its potential as a cut flower. The torch ginger inflorescence has been used as floral arrangements in hotels and restaurants in Australia, Brazil, Costa Rica, Hong Kong, Thailand and United States of America (Larsen et al., 1999; Prasongchan et al., 2009; Loges et al., 2011; Carneiro et al., 2014). The use of torch ginger inflorescence as a cut flower is relatively new in Malaysia due to limited supply and the unawareness of growers on the potential usage. There is only small number of florists using the cut inflorescence as bouquet fillers and small scale exportation to Hong Kong during Chinese New Year. However, at farm price, the margin of cut inflorescence is five times higher than young inflorescence bud.

From the observation, bract browning is the major problem in torch ginger inflorescence to be used as cut flower. The bract browning symptom reduces the postharvest quality of the inflorescence and shortens its vase life. This reduces the marketability and export potential of the inflorescence. However, the causes of the bract browning still remain unknown. Consumers demand for high quality flowers. Therefore, reducing bract browning in improving the inflorescence quality is a high priority. There is a need to understand the characteristics of the crop and the mechanisms that regulate bract browning. Thus, the general objective of this work was to assess the potential of torch ginger inflorescence as a cut flower. Three studies were conducted with the aims (i) to determine the growth and development cycle of torch ginger plant; (ii) to elucidate the inflorescence opening and peduncle strength during inflorescence development and (iii) to reveal the postharvest performance of inflorescences at different developmental stages supplemented with sucrose as vase solution. Results from this study would enhance the understanding of this crop as a cut flower.

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