UNIVERSITI PUTRA MALAYSIA

THE EFFECTS OF COOLING DELAY ON THE COOLING RESPONSE AND THE PHYSICO-CHEMICAL PROPERTIES OF EKSOTIKA PAPAYA

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By

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AF3	Fruits stored under 13°C ± 2°C, 72 hours after harvest and analysed after ripening at room temperature (26°C ± 2°C)
AF4	Fruits stored under 13°C ± 2°C, 96 hours after harvest and analysed after ripening at room temperature (26°C ± 2°C
ANOVA	Analysis of Variance
ASAE	American Society of Agricultural Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
CI	Chilling Injury
FAMA	Federal Authority of Malaysia Agriculture
MARDI	Malaysian Agricultural Research Development Institute
NAP	National Agricultural Policy
RH	Relative Humidity
RC1	Fruits stored under 13°C ± 2°C, 24 hours after harvest and analysed before ripening at room temperature (26°C ± 2°C)
RC2	Fruits stored under 13°C ± 2°C, 48 hours after harvest and analysed before ripening at room temperature (26°C ± 2°C)

RC3	Fruits stored under 13°C ± 2°C, 72 hours after harvest and analysed before ripening at room temperature (26°C ± 2°C)
RC4	Fruits stored under 13°C ± 2°C, 96 hours after harvest and analysed before ripening at room temperature (26°C ± 2°C)
TA	Titratable Acidity
TSS	Total Soluble Solids

LIST OF SYMBOLS

A	Surface area
t	Temperature at any point
t_f	Fluid temperature surrounding an object
t_i	Initial temperature
t_a	Ambient temperature
V	Volume
C	Specific heat
Q	Heat Supplied
w	Specific weight
j	Lag Factor
θ	Time
h	Unit surface conductance
R,r	Distance from centre of a cylinder or sphere
k	Thermal conductivity
α	Thermal diffusivity
L	Distance from centre of a slab
ρ	Mass density
η	Fluid viscosity
v	Fluid velocity
J	Moisture flow rate per unit area
d	Characteristic diameter of the crop

D	Diffusivity of the moisture in the air
K_s	Mass transfer coefficient of the surface layer
δp	Overall vapour pressure difference
Re	Reynolds Number
Sc	Schmidt Number

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Handling papaya in bulk can result in cooling delay of up to forty-eight hours due to equipment, cost and labour factors. The effects of cooling delay on chilling injury, quality and storage life of papaya were studied to develop effective strategies in postharvest handling and storage.

Sound fruits of maturity index 2 were stored at 26°C±2°C (control) and in the cool room (13°C±2°C) approximately 24, 48, 72 and 96 hours after harvest. Storage and fruits' temperature were monitored using data acquisition system to obtain cooling rates. Physico-chemical properties namely weight loss, moisture content, firmness, rupture force, colour, titratable acidity (TA), citric acid content, total soluble solids (TSS) and pH were recorded. Fruits were also access for chilling injury symptoms. Data were taken for fruits at ambient condition, room cooled fruits before (labelled as RC1, RC2, RC3 and RC4 for 1, 2, 3 and 4 days of cooling delay respectively) and after they have ripened

(labelled as AF1, AF2, AF3 and AF4 for 1, 2, 3 and 4 days of cooling delay respectively) upon weekly removal from the cool room. Data were compared for significant differences.

Longer cooling delay (RC3/AF3 and RC4/AF4) resulted in higher half-cooling time, higher weight loss, better colour development, higher TSS and lower in firmness and lower in chilling injury occurrences when compared to the shorter cooling delay (RC1/AF1 and RC2/AF2). No good correlation were found for moisture content, rupture strength, pH, TA and citric acid content in relation to cooling delay. All treatments had acceptable quality up to the second week of storage for the cool room treatments, while the control had acceptable quality up to nine days. The results show that Eksotika papaya can tolerate up to ninety-six hours of cooling delay for a storage life of up to two weeks. This can help reduce the refrigeration cost.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia bagi memenuhi syarat keperluan untuk mendapatkan ijazah Master Sains.

KESAN PENAGGUHAN PENYEJUKAN KEATAS TINDAKBALAS PENYEJUKAN DAN SIFAT FIZIKO-KIMIA BETIK EKSOTIKA.

Oleh

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Pengendalian betik secara pukal boleh menyebabkan penyejukan tertangguh sehingga empat puluh lapan jam. Ini disebabkan oleh faktor peralatan, ekonomi dan buruh. Oleh itu, informasi mengenai kesan penyejukan tertangguh terhadap kecederaan dingin, kualiti dan hayat penyimpanan boleh digunakan untuk menyusun strategi yang lebih efektif dalam pengendalian lepas tuai.

Buah betik Eksotika (indeks 2) yang bebas dari kecederaan disimpan pada 26°C±2°C (kontrol) dan dalam bilik sejuk ((13°C±2°C) selepas 24, 48, 72, dan 96 jam dipetik. Sistem pengumpulan data berkomputer digunakan untuk merekodkan suhu buah dan tempat penyimpanan. Data tersebut digunakan untuk pengiraan kadar penyejukan. Sifat-sifat fiziko-kimia iaitu kehilangan berat, kandungan lembapan, kekukuhan (firmness), daya pecah (rupture force), warna, kandungan asid tertitrat, asid sitrik, jumlah pepejal larut (JPL), dan pH direkodkan. Jumlah kecederaaan sejuk pada buah juga dinilai. Data diambil bagi

buah pada suhu bilik. Bagi buah yang disejukkan, data diambil sebelum dimasakkan (label RC1, RC2, RC3, RC4 untuk masing-masing 1, 2, 3 dan 4 hari penyejukan tertangguh) dan selepas dimasakkan (label AF1, AF2, AF3, AF4 untuk masing-masing 1, 2, 3 dan 4 hari penyejukan tertangguh) selepas pengeluaran dari bilik sejuk pada setiap minggu. Semua data dibandingkan untuk mendapatkan perbezaan bererti.

Penyejukan tertangguh yang lebih lama (RC3/AF3 dan RC4/AF4) memberi nilai yang lebih tinggi terhadap masa separuh penyejukan, kehilangan berat, perubahan warna, JPL, dan nilai yang lebih rendah bagi kekukuhan dan kecederaan dingin, apabila dibandingkan dengan penyejukan tertanggguh yang pendek (RC1/AF1 dan RC2/AF2). Tiada korelasi yang baik terhadap penyejukan tertangguh didapati untuk kandungan lembapan, daya pecah, pH, asid tertitrat dan kandungan asid sitrik. Buah yang disimpan di dalam bilik sejuk didapati dalam keadaan memuaskan sehinggga minggu kedua, manakala buah kontrol sehingga hari yang kesembilan. Keputusan keseluruhan menunjukkan bahawa betik Eksotika mempunyai toleransi terhadap penyejukan tertangguh sehingga sembilan puluh enam jam untuk jangka hayat selama dua minggu. Ini juga dapat mengurangkan kos penyejukan.