ANTHRACNOSE INCIDENCE, BIOCHEMICAL CHANGES, POSTHARVEST QUALITY AND GAS EXCHANGE OF CHITOSAN–COATED PAPAYA

By

ASGAR ALI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

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DEDICATION

To my father Professor Dr. Abdul, Shakoor Warsi without his support and inspiration this goal could have not been achieved.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman: Associate Professor Mahmud Tengku Muda Mohamed, PhD

Faculty : Agriculture

A study was conducted to investigate the effect of chitosan -1. on growth of *Colletotrichum gloeosporioides,* the causal organism of anthracnose; 2. mechanisms involved in controlling anthracnose disease; 3. biochemical changes; 4. physico-chemical quality characteristics and extension of storage life; 5. fruit surface study using SEM and 6. gaseous exchange of papaya fruit during storage at 12 $\pm$ 1 °C. Data were analyzed using analysis of variance and differences between treatments mean were determined by LSD. The results revealed that mycelial growth of *C. gloeosporioides* was reduced significantly ($P \leq 0.05$) at all concentrations as compared to the control. The maximum percent inhibition in mycelium growth (100%) was obtained at 2% chitosan. Similarly, conidial germination inhibition was 100% for 2.0% and 80.4% for 1.5% chitosan coating. Microscopic studies revealed that when chitosan solution was brought in direct contact with conidia there were marked deformities accompanied with shrunken conidia cellular damage and finally death of the cells at 1.5 and 2%

coatings. Chitosan (1.5%) was found highly effective in reducing of anthracnose disease upto 93.0% during five weeks storage. The reduction was found to be 85.4% during four days of ripening after five weeks of storage. There was no added advantage of 2.0% chitosan on disease reduction during storage. Marked effect on reducing disease demonstrated the fungicidal effect of chitosan. In addition to its direct microbial activity, the study strongly suggested that chitosan induces a series of defense reactions through production of inducible compounds such as phenols, peroxidase, chitinase and β-1, 3-glucanase in papaya fruits with 1.5% chitosan showing greatest activities. 1.5% chitosan coating showed maximum beneficial effect in reducing weight loss, maintaining firmness, delaying changes in peel colour and the slowing changes in soluble solids concentration (SSC) after five weeks of storage. Non-coated and 0.5% coated fruits gave significantly higher SSC compared to fruits coated with higher percentages of chitosan (1, 1.5 and 2%). The titratable acidity declined throughout the storage period with slower rate in coated fruits.

Overall sensory assessment of quality after ripening showed fruits were significantly better in quality when coated with 1.5% chitosan which were assigned higher sensory score than 1% chitosan coated fruits. Two percent coated fruits were rated as zero because of their inability to ripen.

Scanning Electron Microscopy (SEM) showed that there were no deep cracks on the surface of 1.5% chitosan coated fruits whereas in non-coated fruit cracks were found on the surface after four weeks of storage.

Chitosan coatings significantly reduced respiration rate and ethylene evolution. The coating also reduced oxygen and increased carbon dioxide level inside the fruits, thus created modified atmosphere within fruits. Modification of atmosphere was inversely proportional to the concentration applied. The two percent chitosan extremely modified the atmosphere which might be the reason for the fruits being unable to ripen when transferred to ambient temperature. Treatment with 1.5% chitosan seems to produce ideal atmosphere for maintenance of quality of papaya during storage.

The results from all experiments carried out in the study showed that 1.5% chitosan coating reduced the anthracnose disease by 93.0% and extended postharvest life upto five weeks while maintaining acceptable quality. One percent resulted in poorer quality fruits as compared to 1.5% coated fruits. Two percent chitosan seems non-physiological for Eksotika papaya-II in term of maintaining quality. As a non-toxic, biodegradable byproduct from sea food, chitosan has the potential to become a natural preservative for protecting papaya fruits, thus assisting the goal of sustainable agriculture. Extension of storage from upto five weeks would facilitate the export of fruits to long distance markets by sea and thereby cost of export would be reducing making the fruits more competitive in the world market.

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

INSIDEN ANTRAKNOSE, PERUBAHAN BIOKEM, KUALITI LEPAS TUAI DAN PERTUKARAN GAS DARI PEMBERIAN CHITOSAN PADA BETIK

Oleh

ASGAR ALI

May 2006

Pegerusi : Profesor Madya Mahmud Tengku Muda Mohamed, PhD

Fakulti : Pertanian

Suatu kajian telah dijalankan terhadap penggunaan salutan kitosan untuk pengekalan kualiti pascatuai betik Eksotika II semasa penyimpanan. Objektif kajian adalah menilai keberkesanan kitosan didalam mengawal antraknos buah betik diperingkat pascatuai. Data telah dianalisa mengunakan analisis varian dan perbezaan antara min di dalam rawatan telah ditentukan oleh LSD. Keputusan menunjukkan pertumbuhan misilia *C. gloesporioides* telah berkurangan secara signifikan ($P \leq 0.05$) pada semua kepekatan berbanding dengan kawalan. Perencatan yang maksimum (100%) diperolehi dengan penggunaan 2% kitosan. Perencatan percambahan konidia juga adalah sama iaitu 100% dengan penggunaan 2% kitosan, diikuti oleh 80.4% untuk 1.5%, 65% untuk 1% dan 57% untuk 0.5% penyalutan kitosan. Kajian mikroskop menunjukkan larutan kitosan dirawat secara terus kepada konidia telah menyebabkan konidia berubah bentuk diikuti dengan pengecutan konidia akibat

kerosakan sel dan berakhir dengan kematian sel pada kepekatan 1.5 dan 2% penyalutan. Kitosan (1.5%) adalah paling berkesan dalam mengurangankan penyakit anthracnose sehingga 93.0% semasa lima minggu penyimpanan. Selepas penyimpanan selama lima minggu apabila buah yang dirawat diletakkan dalam persekitaran. Pada kawalan penyakit semasa penyimpanan ambient, rawatan 1.5% kitosan berjaya mengawal penyakit sehingga 85%. Tiada perubahan pada penurunan penyakit semasa penyimpanan dengan penggunaan 2.0% kitosan. Penurunan penyakit menunjukkan kesan kitosan sebagai racun kulat. Selain dari pada aktiviti mikrob secara terus, kajian mencadangkan kitosan mengalakkan reaksi pertahanan secara bersiri melalui penghasilan bahan seperti fenol, peroxidas, kitin dan β-1, 3-glucanase dalam buah betik dimana 1.5% kitosan menunjukkan aktiviti yang paling sesuai. Penyalutan 1.5 % kitosan menunjukan kesan yang paling maksimum dalam mengurangkan kehilangan berat, mengawal ketegaran, melambatkan perubahan warna kulit dan perubahan dalam kepekatan pepejal larut selepas lima minggu penyimpanan. Betik yang tidak disaluti dan yang disaluti dengan 0.5% mempunyai SSC yang tinggi berbanding betik yang disaluti dengan peratus kitosan yang tinggi. Asid tertitrat telah menurun masa penyimpanan dengan penurunan yang perlahan dalam buah yang disaluti. SSC dan TA memberikan rasa enak kepada buah betik. Keseluruhan ujian sensori terhadap kualiti telah membuktikan perbezaan yang ketara pada buah yang disaluti dengan 1.5% di mana telah memperolehi 3.99 mata penilaian diikuti dengan 3.14 bagi buah yang disalut dengan 1.0% dalam skala 0-5. Buah yang disaluti dengan 2.0% mempunyai kadar paling rendah dengan tidak memperolehi

sebaran mata penilaian. Buah ini tidak disukai oleh panel penilai. Ini terjadi kerana 2.0% menyebabkan buah tidak dapat diranumkan.

Penyalutan kitosan mengurangkan kadar respirasi secara signifikan evolusi etilena, oksigen dalaman dan menaikkan karbon dioksida dalaman terubahsuai didalam buah seterusnya menghasilan perubahan atmosfera. Kadar perubahan atmosfera adalah bertentangan secara langsong dengan kepekatan yang telah digunakan. Dua peratus kitosan telah mengubah atmosfera dalaman buah secara keterlaluan. Ini mungkin menjadi penyebab kepada buah tidak masak bila dipindahkan kepada suhu pesekitaran. Rawatan dengan 1.5% kitosan dapat menghasilkan atmosfera yang ideal untuk mengekalkan kualiti betik semasa penyimpanan. Semua keputusan menunjukkan salutan dengan kitosan 1.5% mengurangkan penyakit antraknos kepada 93% dan dapat disimpan selama lima minggu dengan pengekalan kualiti yang baik. Rawatan 1% kitosan tidak menunjukkan keputusan yang lebih baik dari pada rawatan 1.5%. Sebagai bahan tidak toksik dan boleh reput secara semulajadi serta dihasilkan daripada makanan laut, kitosan mempunyai potensi untuk menjadi bahan pengawet semulajadi bagi mengawal kualiti buah betik. Ini merupakan hasrat pertanian lestari. Penambahan masa penyimpanan daripada tiga kepada lima minggu telah memberi kemudahan untuk mengeksport betik ke pasaran yang lebih jauh melalui laut yang dapat mengurangkan kos pengangkutan menyebabkan buah ini menjadi tebih kompetitif di pasaran dunia.

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Best of all, all praises and thanks be to Allah the most beneficent and merciful, the creator of this magnificent universe and its constituents for the immeasurable guidance, good health, and direction. His Name shall ever be praised and glorified.

I certify that an Examination Committee has met on 15th May 2006 to conduct the final examination of Asgar Ali on his Doctor of Philosophy thesis entitled "Anthracnose Incidence, Biochemical Changes, Postharvest Quality and Gas Exchange of Chitosan–Coated Papaya" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis 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 are as follow:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

_____

ASGAR ALI

Date:

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