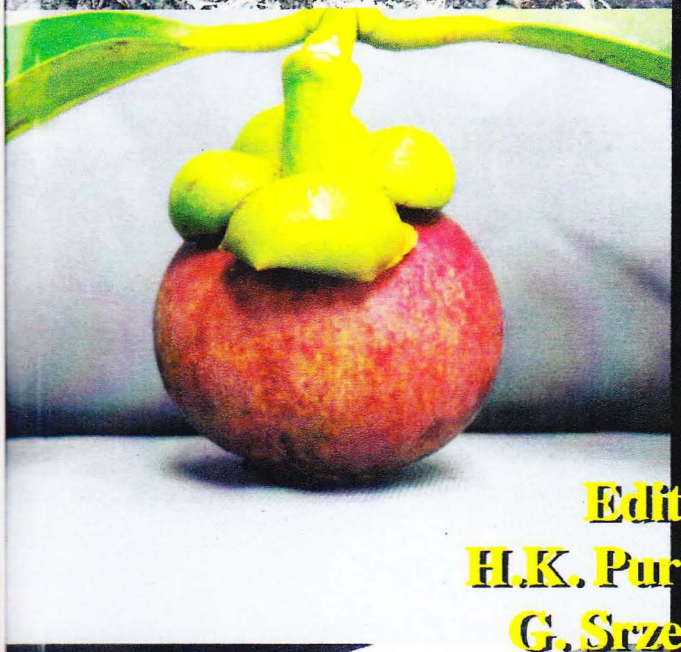
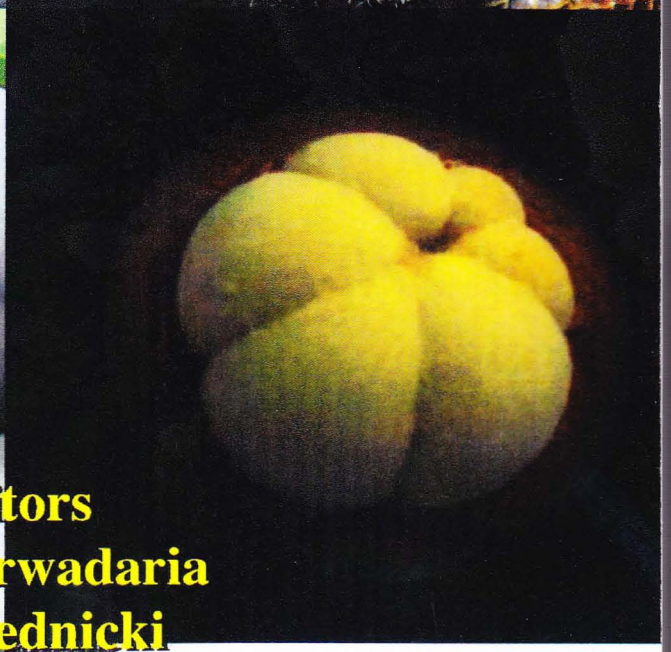
Acta Horticulturae
Number 1011

Proceedings of the Second Asia Pacific Symposium on Postharvest Research, Education and Extension





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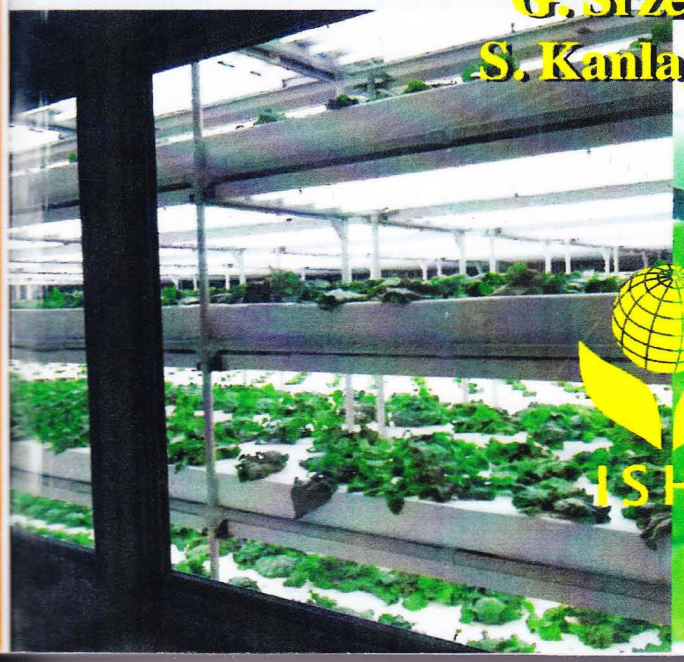

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PROCEEDINGS OF THE IInd ASIA PACIFIC SYMPOSIUM ON POSTHARVEST RESEARCH, EDUCATION AND EXTENSION

Convener

H.K. Purwadaria

Yogyakarta, Indonesia

September 18-20, 2012

ISHS Commission Education, Research Training and Consultancy
ISHS Commission Quality and Postharvest Horticulture
ISHS Commission Economics and Management

Acta Horticulturae 1011
November 2013

ISSN 0567-7572
ISBN 978 90 6605 706 7, Acta Horticulturae n°. 1011
Price for non-members of ISHS: € 111,-
Published by ISHS, November 2013

Executive Director of ISHS: J. Van Assche
Technical Processing: S. Franssens

ISHS Secretariat, PO Box 500, 3001 Leuven 1, Belgium

Printed by Drukkerij Geers, Eekhoutdriesstraat 67, B-9041 Gent (Oostakker), Belgium

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The Second Asia Pacific Symposium on Postharvest Research, Education and Extension

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FOREWORD

The Second APS2012 (Asia Pacific Symposium on Postharvest Research, Education and Extension 2012) was held at Yogyakarta, Indonesia on 18-20 September 2012 organized by the Faculty of Agricultural Engineering and Technology, Bogor Agricultural University (IPB), International Society for Horticultural Science (ISHS), Indonesian Agency of Agricultural Research and Development (IAARD), and Gajah Mada University (UGM), in cooperation with the Swiss German University (SGU). The scopes of the Symposium were recent postharvest technology innovation to achieve product quality and safety standard for export, implementation of GAP and GPP on farm and cold chain distribution to support export of fresh produce, postharvest system and equipment in plant factory, supply chain management and improvement of value chain system for agricultural products, lifelong learning for stakeholders in postharvest value chain of agricultural products, postharvest education and research training development, and policy support to food quality and food safety programs.

The Symposium was addressed and inaugurated at the opening by Dr. Rusman Heriawan, the Vice Minister of Agriculture, Republic of Indonesia, and followed up with 10 keynote papers, 53 oral presentations, and 37 posters in a forum attended by over than 120 participants from 10 countries. Prominent scientists, educators, experts, entrepreneurs, farmers, instrument manufacturers, extension workers, and policy makers contributed in interactive discussion, put up exhibition, shared experiences and best practices, and built networks in the three day symposium that was finalized by a visit to salak (*Salacca edulis*) orchard of farmers form Paguyuban Mitraturindo in Yogyakarta. The participants also observed two of the historical monuments of Indonesia: Borobudur – Buddhist Temple that was one of the first Wonders of the World, and Prambanan – Hindu Temple whose legendary culture of Ramayana could be traced from India.

The symposium papers published in *Acta Horticulturae* were peer reviewed by international experts. They present excellent reference materials for the scientific community and stake holders who are working in the postharvest of horticultural products, grains, and tubers. We would like to greatly appreciate the authors' contribution to this Symposium so it could be carried out as a distinguished scientific forum that resulted in an invaluable scientific publication.

We are most grateful to all the organizers and cooperators of the Symposium ISHS, IPB, IAARD, UGM, SGU, farmer groups, exporters, instrument industries that had supported the event and its preparations. We are especially indebted to Dr. David E. Aldous, Dr. Sirichai Kanlayanarat, and Dr. Peter Oppenheim – ISHS, Dr. George Szrednicki – Australia, Prof. Errol W. Hewett – New Zealand, Prof. Haruhiko Murase – Japan, Prof. Dennis R. Heldman – USA, and Dr. Chalermchai Wongs-Aree – Thailand, and Mr. Michael Earley – Indonesia for their persistent interest and contribution to the Symposium and the Symposium Proceedings.

The Symposium has become a success with the hard work of all the members of the Scientific Committee, and Organizing Committee during the preparation and the course of the event. For them, many thousand thanks. It is our expectation that the Proceedings will benefit all the community in the world.

Hadi K. Purwadaria
Convener

KEYNOTE SPEECH

Distinguished Guests,
Scientists,
Ladies and Gentlemen,

Good morning to all of you.

On behalf of the Government of Indonesia, I would like to extend our warmest welcome to Yogyakarta, Indonesia, in the event of the 2nd Asia Pacific Symposium on Postharvest Research, Education and Extension.

I am honored to have the opportunity to speak in front of you and to declare the inauguration of such an important symposium which is going to discuss frontier developed technology and systems in key issues that we face together in our global world: postharvest technology along the value chain of horticultural and ornamental products, grains and tubers. Furthermore, your participations indicate your keen interests to these issues and to form an international collaboration that we should have to solve any transactional barriers across the borders in effort to make welfare spread out to every corner of the world.

Distinguished Ladies and Gentlemen,

We are most grateful that various international organizations, ISHS (International Society for Horticultural Science), IRRI (International Rice Research Institute), FAO (Food and Agriculture Organization), and UNIDO (United Nations Industrial Development Organization) have joined hands to contribute their thoughts and experiences in this symposium. This symposium with theme: "Integrated Innovation Extension to Achieve Standard Quality and Safety for Export Agricultural Products", has also been set up to address problems in the whole value chain covering GAP (Good Agricultural Practices), GHP (Good Handling Practices), and GPP (Good Packaging Practices), in close relation to food quality and food safety. Global GAP has been practiced worldwide and the certification is carried out by more than 100 independent bodies in more than 80 countries, among others are China, Germany, Indonesia, Iran, Japan, Thailand, the US and Vietnam. The Global GAP provides international acceptance of exported products from a producing country such as in fruits, vegetables, ornamental plants and flowers some of the commodities discussed here. It will also provide higher income for the producers who will gain better price from the market, thus strengthening further the country's economic development.

In this symposium, appropriate technology will be presented along with novel technology in various agricultural systems, the conventional and the new ones such as plant factory and controlled automatic devices. Appreciation is also provided to this symposium since an integrated approached in solving the problems is applied for the three aspects: research, education and extension, thus the developed technology is expected to be transferred and used by the actors along the value chain. The presence of scientists coming from many universities and research institutions all over Asia Pacific, the government officers, and the private sectors, make the cooperation among the triple helix a true realization.

Distinguished Participants,

The Ministry of Agriculture of the Republic of Indonesia has a strategic plan to gain added value, competitiveness, and increase export in horticultural and ornamental products, along with maintaining the self sufficiency of paddy and maize, while reaching self sufficiency of soybean, beef, and sugar. This plan also covers the farmers welfare, and food diversification as well. In effort to do so, we have also developed collaboration with international institutions such as USAID, ACIAR, and EU. Since 2008, a project called AMARTA (Agribusiness Market and Support Activity) has been in operation to boost the product quality, product added value, and income of vegetable farmers.

AMARTA trained the farmers in technology usage, seed production, and postharvest handling of the fresh vegetables along with the cold chain. The project is extended to the second phase starting 2012 providing more focus towards vegetables, fruits and ornamentals in technical assistance across the key value chain links by strengthening farmers associations, supporting the growth of small and medium agribusiness enterprises, and supporting government institutions involved in agricultural technology transfer and technology development. The project will also provide technical assistance in facilitating access to credit, conduct in-depth policy and regulatory analyses, and establish a forum for advocacy and promotion of policy and regulatory reforms.

Distinguished Ladies and Gentlemen,

It is very realistic to say that education is the origin of the research outcome produced by scientists. Research outcomes, at present, have been acknowledged as the foundation of economic development of all progressing nations. However, with the general economic circumstances, the resources for research become rare and scarce. Thus, it is a must that the research outcomes are to be implemented, and to do so we have to consider that extension is a quite different form than research, and also it needs inherently more resource intensive. It is essential, therefore, that researchers identify critical future needs to be elaborated, and include the participation of farmers and other value chain actors in their research design, and also address the problems as one whole system.

In conclusion, I would like to wish all of you a fruitful deliberation in these three days symposium, and to enjoy your stay in this beautiful and historical place, Yogyakarta.

Yogyakarta, 18 September 2012

Dr. Rusman Heriawan
Vice Minister of Agriculture, Republic of Indonesia

PREFACE

The papers contained in this volume of *Acta Horticulturae* report the peer reviewed Proceedings of the Second Asia Pacific Symposium on Postharvest Research, Education and Extension. Keynote speakers and authors of selected contributed oral and poster presentations were given the opportunity to submit a manuscript for publication.

The manuscripts were reviewed by the Editors and members of the Editorial Board. Only those papers judged suitable for publication following the authors' consideration of reviewer suggestions appear in this volume of *Acta Horticulturae*.

The ISHS acknowledges and appreciates the contribution of all editors and reviewers. They have made a significant contribution to improving the quality of this publication.

The ISHS Board of Directors

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Fruit Fly Disinfestations of Star Fruit (*Averrhoa carambola* L.) Using Vapor Heat Treatment (VHT)

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Keywords: fruit fly, pest disinfestation, star fruit, vapor heat treatment

Abstract

This study was carried out to find out (1) mortality of the oriental fruit flies due to heat treatment, and (2) the effect of vapor heat treatment (VHT) on star fruit quality during storage. Oriental fruit fly of *B. carrambola* in the egg stage obtained from rearing in laboratory, while star fruits were bought from farmer in West Java. Mortality test of the fruit flies' egg was done by submerging the eggs into hot water at several levels of temperature (40-49°C) and exposure time (5-30 min). The experiment of VHT on star fruit was carried out at the temperature of 46.5°C for 10, 20 and 30 min. After treatment, the fruits were stored at temperature of 5, 15 and 28°C (90% relative humidity). The fruit quality was examined during storage consisting of respiration rate, weight loss, moisture content, color change, hardness, total soluble solid (TSS) and vitamin C. The results showed that mortality of fruit fly *B. carambola* reached 100% at heating for 30 min with minimal temperature of 43°C; while 100% mortality at 46°C heating was reached at a period of minimal 15 min. The VHT treated-fruit was not significantly affected in the fruit physiology as shown in the respiration pattern during storage. There were no significant changes in the fruit weight loss, moisture content, hardness, color, total soluble solid and vitamin C. Heat treatment significantly reduced disease attack caused by anthracnose and stem end rot. The VHT at temperature of 46.5°C for 20-30 min were effective to kill fruit flies infested in the star fruit. In addition, the VHT treated fruit followed by cold storage at temperature of 5-15°C were able to maintain the fruit quality during storage.

INTRODUCTION

Tropical fruits such as star fruit (*Averrhoa carambola* L.) are very potential to be commercially grown. Market demands on fruits, either fresh or processed, tend to increase from time to time in line with population growth, increase in income and public awareness about the importance of nutritious food. Indonesia has various kinds of fruits such as mango, banana, papaya, orange, pineapple, star fruit, mangosteen, etc. This comparative advantage, if supported by competitive advantage, would increase the competitiveness in entering the global market. However, tropical fruits such as star fruit are host for pest of fruit flies, especially for the species of *Bactrocera* sp. The female fly is able to lay 100-500 eggs. The fruits are also susceptible to diseases such as anthracnose and stem end root.

Infestation of larva of fruit fly and residual content of insecticide inside of fruits

are the main reason for the rejection of Indonesian agricultural products to enter the export market. For example, in 2002 paprika product from Lembang was rejected to enter Chinese Taipei due to the infestation of fruit fly. Besides, the world's concern towards the danger of the fruit fly as pest is quite high. Among others are responses from Australia, Korea, Japan and European countries by imposing "zero tolerant" for fruit fly pests since 2004. Market access or international standard in trading related to fruit fly, among others are the International Standard of Phytosanitary Measures (ISPM) No. 17(2002): Pest Reporting and ISPM No. 26(2006): Establishment of Pest Free Areas for Fruit Flies (*Tephritidae*) (WTO, 2008).

On the domestic market, fruit infested by fruit fly not only causes loss due to the decrease in quality but also contributes substantially to the deployment of pests and diseases of fruits which is difficult to control. While for the international market, the application of quarantine procedures is absolutely needed in order for the fruit products to be accepted by the importing countries. One of the quarantine treatments is the pest/disease disinfestation which executes all stadia of insect. Disinfestation technique can be implemented by means of: (1) storage on low temperature (1.5°C) for 2-4 weeks; (2) irradiation with x-ray; (3) fumigation, and (4) heat treatment. Cold storage is not recommended for tropical fruits since it is time-consuming and can cause chilling injury. An excellent prospect actually can be found in x-ray irradiation treatment. However, the consumer has not accepted it yet due to the psychological barrier mainly caused by the atomic bomb incident.

The use of chemical compounds such as ethylene dibromide for pest/disease disinfestation process has been prohibited since 1984. Therefore, heat treatment then became the alternative. Several heat treatment methods are the utilization of hot water treatment (HWT), vapor heat treatment (VHT), and hot air treatment (HAT). Disinfestation of fruit is conducted by heating the fruit at a certain temperature and exposure time to kill the fruit flies and diseases without causing damage on the fruit itself. Applying VHT needs to consider the characteristics of fruit and type of fruit fly attacking the commodity. Depending on the size and variety of fruit, VHT as a quarantine treatment is implemented at a temperature of 46-47°C (Sharp, 1986).

Various importing countries such as Japan and the US are issuing a requisition for the application of VHT for their imported fruits. Research and development of VHT methods have been successfully applied in many countries abroad such as The Philippines, Thailand and Australia for several kinds of fruit such as mango and papaya. Nevertheless, research and development of VHT in Indonesia has not improved admirably and is still far from interest. Research on heat treatment of tropical fruits in Indonesia has just been carried out since 2002.

Temperature and exposure time are the determining factors for the success of disinfestation process of fruit flies. The use of excessive heat can cause deterioration on fruit (heat injury). On the contrary, if the heat is insufficient the objective of killing fruit fly could not be achieved. The objectives of this research were: (1) to examine the mortality of *Bactrocera carambolae* fruit fly attacking the star fruit, and (2) to examine VHT effect on star fruit quality during storage.

MATERIALS AND METHODS

Material used was fruit fly of *Bactrocera carambolae* by rearing of pupa stage obtained from Entomology Laboratory of Gajah Mada University. The fruit used in this research were star fruit (*Averrhoa carambola*) obtained from farmer in West Java. The instruments used were vapor heat treatment chamber, hybrid recorder, cooling chamber, cage for fruit fly rearing, water bath, rheometer, weights, oven, chromameter, etc.

Research was divided in two stages: (1) mortality test of fruit fly, and (2) VHT on star fruit. Mortality test of fruit fly was implemented at egg stadium. Rearing of *B. carambolae* fruit fly was conducted initially in the laboratory to obtain the eggs. The adult fruit fly was maintained and bred in a wooden cage. Sugar water, as a woof, served at small container with tissue as a mat at the top of it. A whole fruit of papaya was also

served inside the cage as a host for the fruit fly. After getting enough eggs, the mortality test was conducted by immersing the eggs into hot water: (1) at 46°C for 5, 10, 15, 20 and 30 min, (2) for 30 min at temperatures of 40, 43, 46, and 49°C. After heating in hot water at certain temperature and exposure time, eggs were placed into an artificial media made from blended ripe-papaya and let to hatch naturally. After 6-7 days, larva would be visible leaping around the media. These larvae then were collected and counted as live fruit fly.

Heat treatment on star fruit using VHT method was conducted at fruit core temperature of 46.0°C with exposure times of 10, 20 and 30 min. After heat treatment was completed, fruit was immediately cooled using streaming water until the temperature of the fruit core descended into room temperature. The treated fruit was then stored at temperatures of 5, 15 and 28°C (room temperature). During storage, the change of the fruit quality was observed including respiration, weight loss, water content, color change, hardness, total soluble solid (TSS), vitamin C, number of fungi population and organoleptic test. The fruit respiration was measured every day and the quality change was examined every three days until 21 days of storage.

The study was conducted in a simple analysis of variance (Anova) to examine the data with each fruit considered as a replication. Duncan's multiple range tests was used to determine the significant differences among the treatments.

RESULT AND DISCUSSION

Fruit Fly Mortality

The *B. carambolae* fruit fly growth from egg until imago passes through four stadia, i.e., egg, larva, pupa, and imago. The egg stadium is approximately comprised of 1-2 days, and then larva will appear. Larva consists of 3 instars, i.e., instars 1, 2 and 3. Larva stadium period is 6-9 days. After instar 3 is reached, a larva will wrinkle its body and form the pupa. The pupa itself was at inactive stadium with the stadium's duration of 4-10 days. Pupa afterward turned up to become imago, dark brown (blackish) in color. Imago stadium was about 25 days. Male and female imagoes were preserved in cage to produce eggs which then were used for the mortality test. The life cycles of *Bactrocera carambolae* (Drew & Hancock) are shown in Figure 1.

Mortality test's result of *B. carambolae* fruit fly is shown in Tables 1 and 2. From the collected data, it was observed that the egg mortality reached 80% on the water submerging at temperature of 40°C for 30 min. In the temperature above 43°C, the eggs would definitely reach a mortality of 100%. Sharp and Halman (1992) reported that fruit fly mortality of *Anastrepha suspensa* L. invested on carambola reached 98.5% at a temperature of 43°C.

The water submerging at temperature of 46°C for 5 min caused the mortality resided on 77%, while the 10 min submerging gave 97% of mortality (Table 3). The mortality of the fruit fly reached 100% at temperature of 46°C for 15 min. Heather et al. (1996) reported that the condition of heat treatment for 10 min at 46.5°C was already able to generate mortality 100% on *Ceratitis capitata*. In order to pass the quarantine on various mango importing countries, therefore, heat treatment conducted must generate at least 99.9968% of mortality (Jacobi et al., 2000). The fruit fly invested mangos that were treated at temperature of 46.5°C for 10-30 min resulted in no larva detected after 6 days of storage, indicating that egg inside the mango was not developed or died (Hasbullah et al., 2009).

Fruit Respiration

Figure 2 shows graphics of star fruit respiration rate expressed in CO_2 production rate in ml/kg/h unit at temperature storage of 5, 15 and 28°C. Result of the respiration rate measurement indicated that the respiration pattern of star fruit was non-climacteric, where during storage the respiration rate tended to decline without respiration leap until experiencing senescence and deterioration. Deterioration of the fruit is characterized by

abnormal increase of the respiration rate. The increase in respiration was allegedly caused by two things, i.e., CO_2 production by decomposing fungus and CO_2 production due to the fermentation of the fruit. The fermentation took place particularly when oxygen supply was diminished so that the pattern of energy formation changed from respiration to fermentation. When the fruit started to decay a pungent smell like alcohol was detected indicating that fermentation of alcohol occurred resulting in ethanol and CO_2.

The VHT treatment at temperature of 46.0°C for 10-30 min did not give any significant effect on the respiration pattern during storage. The fruit did not experience any physiological disturbance and still conducted the metabolism process normally just liked in the control fruit. Respiration rate of the star fruit was strongly correlated with storage temperatures, while the respiration rate increased with increasing storage temperature.

Respiration rate indicates the shelf life of produce after harvest because of its association with quality decline rate. The less the respiration rate is, the longer the shelf life of the produce. Klein and Lurie (1990) reported that heat treatment could increase or decrease the respiration peak of climacteric fruits depending on how long the awaiting occurred after treatment. Jacob et al. (1995) reported that heat treatment did not influence climacteric time on 'Kensington' mango. The increase or decrease of respiration rate was strongly correlated with cell destruction during treatment.

Fruit Quality

Effect of VHT and storage temperature on the quality of fruit was observed at day-9 (Table 3). The star fruit had high moisture content of around 92.5±0.2 to 94.0±0.1%. VHT did not affect moisture content as well as weight loss of the fruit. On day-9 of storage the weight loss at storage temperature of 13-15°C reached 7.97±0.65%. Increasing storage temperature resulting in a high weight loss of the fruit. The increase of fruit weight loss could occur due to water loss during storage and could cause unattractive appearance due to the wilting and wrinkling of the skin surface. VHT did not affect the fruit hardness value as compared to the control. TSS of the star fruit varied from 4.23 to 5.07°Brix, while VHT and storage temparature did not significantly affect the change of the TSS. The same result was reported by Hasbullah (2002) that heat treatment did not significantly affect the change of the TSS of 'Irwin' mango. Jacobi et al. (1995) also reported that VHT at 47°C for 30 min did not give any effect on the change of TSS of mango. At the beginning of storage the vitamin C content ranged from 24.34 to 31.75 mg/100 g and on day-10 ranged from 31.24 to 45.51 mg/100 g. VHT did not cause the decline in vitamin C.

Visual observation on disease attack indicated the emergence of small blackish brown patches on the star fruit allegedly due to anthracnose disease. This disease was caused by *Colletotrichum gloeosporioides* (penz) Sacc. The symptom of this disease attack was seen on almost ripen fruit in the forms of small dark spots. As the fruit was getting more ripen, the dark spots were getting bigger and decayed forming cavity inwards of the fruit. Small black fungus tissue appeared at the center of the cavity; the spots fused in one big spot so that all parts of the fruit was soft and decayed. Kader (2000) reported that one of the postharvest diseases usually attacking star fruit was caused by *Colletotrichum gloeosporioides* (penz) Sacc. At room storage temperature (28-30°C) the disease attack started to show off at day-10, i.e., on the fruit without VHT treatment. On the VHT treated star fruits, disease attack also occurred during storage but it did not spread as fast as that on fruit without VHT. At storage temperature of 15°C the attack occurred at day-18 on fruit without VHT. At storage temperature of 5°C no attack was detected until the end of the storage period of fruit without VHT, while VHT treated fruit showed better condition. It is shown from the results that heat treatment was capable of controlling the development of fungi during the storage period. Figure 5 shows the visual appearance of star fruit on the 15th day of storage. Heat treatment was capable of controlling the fungi attack which triggered anthracnose and stem end rot disease on star fruit.

CONCLUSIONS

Fruit fly *B. carambolae* underwent full metamorphosis through the phases of egg (1-2 days), larva (6-9 days), pupa (4-10 days) and imago (±25 days).

Mortality of fruit fly *B. carambolae* reached 100% at heating for 30 min with minimal temperature of 43°C; while 100% mortality at 46°C heating was reached at a period of minimal 15 min.

Star fruit had non-climacteric respiration pattern where the respiration rate tended to decline without respiration peak during storage. VHT treatment at 46°C did not affect the respiration pattern. The respiration rate increased with increasing storage temperature.

The VHT treatment at 46°C for 20-30 min followed by cold storage (5-15°C) was capable of maintaining the fruit quality based on parameters of moisture content, weight loss, hardness, TSS and vitamin C content, as well as capable of suppressing the attack of anthracnose disease.

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Tables

Table 1. Mortality of *B. carambolae* fruit fly in the egg stadium on different temperature upon 30 min.

Temp. (°C)	Number of eggs	Number of alive	Number of dead	Mortality (%)
Control	30	30	0	0
40	30	6	24	80
43	30	0	30	100
46	30	0	30	100
49	30	0	30	100

Table 2. Mortality of *B. carambolae* fruit fly in the egg stadium on temperature of 46°C with different exposure times.

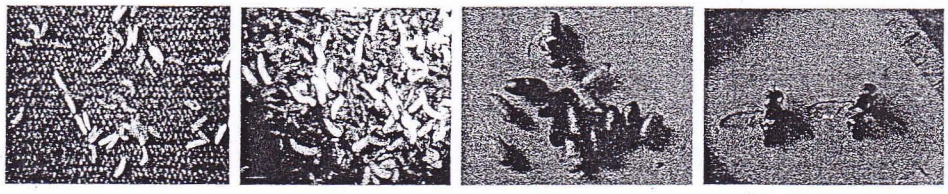
Exposure time (min)	Number of eggs	Number of alive	Number of dead	Mortality (%)
0	30	30	0	0
5	30	7	23	77
10	30	1	29	97
15	30	0	30	100
20	30	0	30	100
30	30	0	30	100

Table 3. Effect of VHT treatment and storage temperature on the change of star fruit quality.

Treatment		Parameter of quality			
Duration of VHT (min)	Storage temperature	M.C. (%)	Weight loss (%)	Hardness (kgf)	Vitamin C
10	5°C	94.5±0.5 b	6.63±0.92 a	0.96±0.09 e	58.55±1.61 e
20		94.6±0.1 b	5.53±0.34 a	1.00±0.16 e	46.75±1.22 cd
30		94.0±0.1 b	5.39±0.17 a	0.97±0.08 e	41.44±1.14 bc
Control		94.4±0.5 b	5.01±0.24 a	0.96±0.16 e	36.53±8.02 ab
10	15°C	94.1±0.1 b	6.96±0.81 a	0.36±0.04 abc	44.40±3.75 cd
20		94.4±0.5 b	7.29±0.52 a	0.52±0.03 cd	43.11±0.44 bcd
30		94.0±0.1 b	7.27±1.14 a	0.55±0.14 d	45.51±4.16 cd
Control		94.3±0.5 b	7.97±0.65 a	0.39±0.05 abcd	31.24±9.69 a
10	28°C	92.6±0.9 a	19.09±2.11 c	0.19±0.03 a	50.42±0.86 d
20		93.0±0.1 a	17.58±2.24 c	0.45±0.03 bcd	45.87±1.67 cd
30		92.5±0.2 a	20.29±6.29 c	0.34±0.13 ab	35.50±2.95 ab
Control		92.8±0.2 a	13.43±0.58 b	0.32±0.12 ab	32.23±3.08 a

Means with different letters within the same column are significantly different at $P<0.01$ based on Duncan multiple range test.

Figures



a. eggs b. larvae c. pupae d. imagoes

Fig. 1. Life cycles of *Bactrocera carambola* (Drew & Hancock).

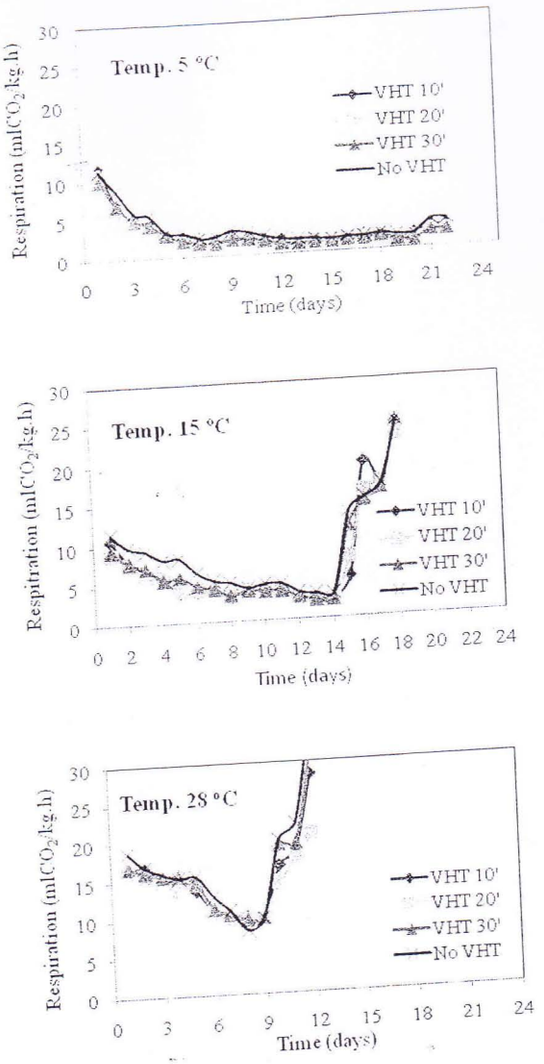


Fig. 2. Respiration pattern of star fruit after VHT treatment at storage temperatures of 5, 15 and 28°C (room temperature).

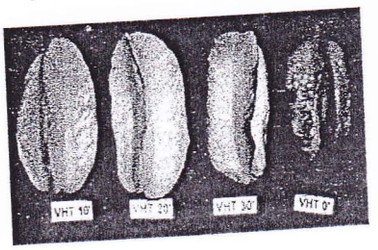


Fig. 3. Visual appearance of star fruit on the 15th days of storage.