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PROCEEDINGS

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FRUITFLY DISINFESTATION OF MANGO CV GEDONG GINCU USING VAPOR HEAT TREATMENT (VHT) METHOD[1]

Rokhani Hasbullah[2], Elpodesy Marlisa[2], Dadang[3]

ABSTRACT

Mango fruit (Mangifera indica L.) is one of the most popular fruit in Indonesia and its production is the second largest after banana. However, mango fruit are host for Tephritidae fruit flies, especially for the species of oriental fruit fly (Bactrocera dorsalis Hendel). To be accepted by many importing markets, mango fruit must be treated to ensure that it is free of fruit flies. Formerly, chemical fumigation was used for disinfestation treatment, but now had been replaced by chemical-free disinfestations treatment such us heat treatments. There are three methods in the use of heat treatments to control fungal diseases and insect infestation: vapor heat treatment (VHT), hot water treatment (HWT) and forced hot air treatment (FHAT). VHT involves heating air which is nearly saturated with moisture and passing the air stream across the produce. This study was carried out to find out (1) the effect of temperature and exposure time on mortality of oriental fruitly (Bactrocera dorsalis), and (2) the effect of VHT on fruit respiration and quality of 'Gedong gincu' mangos.

The material used in this study were oriental fruitfly (Bactrocera dorsalis) in the egg stage obtained from rearing in laboratorium, and "Gedong gincu" mangos were bought from farmer at Indramayu, West Java. The apparatus used in this research were VHT chamber, hybrid recorder, cold storage, cage for fruitfly rearing, water bath, rheometer, scales, oven, chromameter, etc. The study was divided into two parts: fruitfly mortality and VHT of "Gedong Gincu" mango. Mortality test of oriental fruitfly in the egg stage was done by submerging each of 20 eggs into hot water: (1) at temperature of 46 °C for 5, 10,15,20 and 30 minutes, (2) for 30 minutes at temperature of 40, 43, 46, and 49 °C. After submerging, the eggs were let to hatch by putting it in artificial media as a host for growing the egg to become larva. VHT of the mangos were done at temperature of about 46.5 °C until a fruit core temperature reached 46.0 °C and held for 10, 20 and 30 min. The control fruit were not treated in any way. After treatment, the fruits were immediately cooled in ambient temperature water (25 °C) for 30 min and then allowed to air dry before storage at 13 °C and 90 %RH. The fruit respiration were evaluated every days, while the fruit quality were examined every 4 days of storage consists of weight loss, moisture content, color change, hardness, soluble solid content (SSC) and vitamin C.

The results showed that mortality of the fruitfly attained 100 % in hot water dipping at temperature of 43 °C for at least 30 minutes or at temperature of 46 °C for at least 10 minutes. The same result was reported by Heather et al. (1996) that hot water dipping for 10 minutes at temperature of 46,5 °C produce mortality of 100% for fruitfly of ceratitis capitata. The VHT significantly reduced the fruit

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respiration, however, it was not significantly affect the fruit physiology as shown in the climacteric respiration pattern during storage. There were no significant change in the fruit weight loss, water content, hardness, color, soluble solid content and vitamin C. Some diseases attackted the mango during storage were identified as collectotrichum gloeospoides, pestalotiopsis mangiferae, lasiodiplodia theobromae and cladosporium cladosporoides. Heat treatment significantly reduced disease attack caused by antracnosa and stem end rot in "Gedong gincu" mango. VHT at 46.5 °C for 10-30 minutes were effective to control fruit diseases and fruitfly infested inside the mangos as well as able to maintain mango quality during storage.

Keywords: *mango, fruitfly, disinfestation, vapor heat treatment, VHT.*

INTRODUCTION

Mango fruit (*Mangifera indica* L.) is one of the most popular fruit in Indonesia and its production is the second largest after banana. However, mango fruit are host for *Tephritidae* fruit flies, especially for the species of oriental fruitfly *(Bactrocera dorsalis* Hendel*)*. The characteristic of this fly is polyfagus, attacking more than 20 kind of fruits such as star fruit, orange, mango, papaya, and rip banana (Kalshoven, 1981). The expansion of fruit fly from eggs until imago is passing through 4 stadiums, they are, eggs, larva, pupa, and imago. Female fly is able to lay 100 – 500 eggs. Nearby of its susceptible of pest, fruits also experiencing the same for disease. Some of disease that attacking fruits are anthracnose and stem end root. Anthracnose disease is caused by *Colletotrichum gloeosporiodes* (Penz) Sacc, and stem end root is caused by *Botryodiplodia theobromae* and *Aestalopsiopsis mangiferae*.

On domestic market, fruit invested by fruit fly is giving a fairly impact donation on broadening pest and disease of fruit in the country which furthermore hard to control. Also, mass loss will shadow the production as quality decline. While on international market, in order that fresh product of fruits become delicately acceptable, quarantine procedure must be implemented.

Fruits for export shall acquire a quarantine treatment to get access to the importing country. One of quarantine treatment is pest/disease disinfestations which to execute all stadia of insect, starting from egg until mature insect that probably exist. Disinfestations technique can be implemented by: (1) storage on low temperature (1.5^0 C) for 2 – 4 weeks; (2) irradiation of x-ray; (3) fumigation, and (4) heat treatment. Cold storage is not recommended for tropical fruits since of its time-consuming and can cause chilling injury. An excellent prospect actually can be found on x-ray irradiation treatment, however, consumer has not accept yet due to psychological barrier mainly caused by atomic bomb incident.

Since the use of chemical compound such as ethylene dibromide for pest/disease disinfestation process was prohibited, heat treatment then became the alternative. Several heat treatment methods are using hot water treatment (HWT), vapor heat treatment (VHT), and hot air treatment (HAT) (Couey, 1989; Lurie, 1998). Disinfestation on fruit is executed by heating the fruit on a certain temperature and exposure time to kill the fruit fly and disease without causing damage on the fruit itself. Applying VHT need to consider the characteristics of fruit and type of fruit fly attacking the commodity.

It is realized, that depend on the size and variety of fruit, VHT as a quarantine treatment is implemented at temperature of 46 – 47 °C (Jacobi and Wong, 1992; Sharp, 1986). Practically, heat treatment on mango with VHT is implemented on fruit temperature (near the kernel) at 46.5^0 C for 10 – 30 minutes. This is proven effectively that Oriental fruit fly and Melon fruit fly was killed from "Nang Klangwan" (Thailand) and "Irwin" (Taiwan and Okinawa) mangoes, also capable to control stem end root disease from "Kensington' mango (JFTA, 1996; Coates et al., 1996). Rokhani et al. (2001) reported that by using VHT method, 'Irwin' mango which was produced in Okinawa, was resistant at the temperature of 46.5 °C for 30 minutes. The process was quite effective in reducing anthracnose and end stem root diseases, and also maintained the quality of fruit until 21 days of storage at the temperature of 13 °C.

Various importing country such as Japan and US is issuing a requisite of VHT for their imported fruits. Research and development of VHT method was implemented successfully outside the country such as Philippine, Thailand and Australia for several kind of fruits such as mango and papaya. Nevertheless, in Indonesia, the research is not improved admirably and still far from interest. The research is aimed to: (1) to examine the mortality of fruit fly attacking the tropical fruit, and (2) to examine heat treatment effect of Gedong Gincu fruit quality during storage.

METHOD OF RESEARCH

Material and Instrument

Material used was Oriental fruit fly (*Bactrocera dorsalis*) obtained by isolating papaya from research farm of Seameo Biotrop on Tajur, Bogor which believed had a fairly high level of fruit fly attack. Figure 1 shows the oriental fruit fly. The egg stadium of the fruit fly was obtained from rearing in laboratory. "Gedong gincu" mango was obtained from farmer in Indramayu, West Java. Instrument used was vapor heat treatment chamber, hybrid recorder, cooling chamber, fly cage for fruit fly rearing, lint, water bath, rheometer, weights, oven, chromameter, etc.

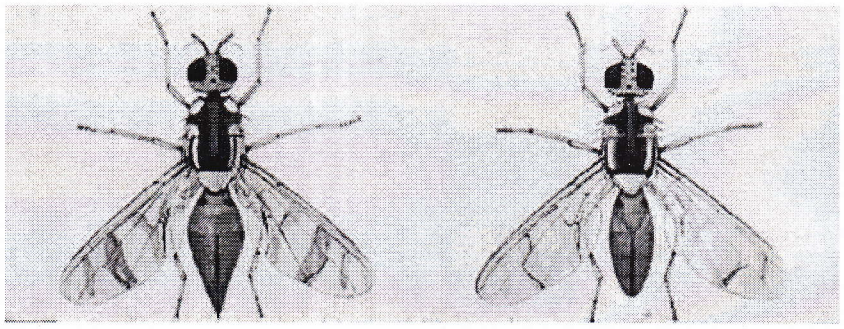


Figure 1. Oriental fruit fly (*Bactrocera dorsalis,* Hendel): female (left) and male (right).

Method

Research was divided in two stages; (1) mortality test of fruit fly, and (2) VHT treatment on mango of Gedong gincu.

(1) Mortality test of fruit fly

To implement the mortality test, rearing of *B. dorsalis* fruit fly (Oriental fruit fly) was conducted initially in the lab to obtain the eggs. Adult Oriental fruit fly then was maintained and breed on the 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.

The mortality test was implemented at egg stadium. Test was conducted by immersing the egg into hot water: (1) at 46 °C for 5, 10, 15, 20 and 30 minutes, (2) for 30 minutes at temperature 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 larvas then was collected and counted as alive fruit fly. Figure 2 shows flow diagram of fruit fly mortality test.

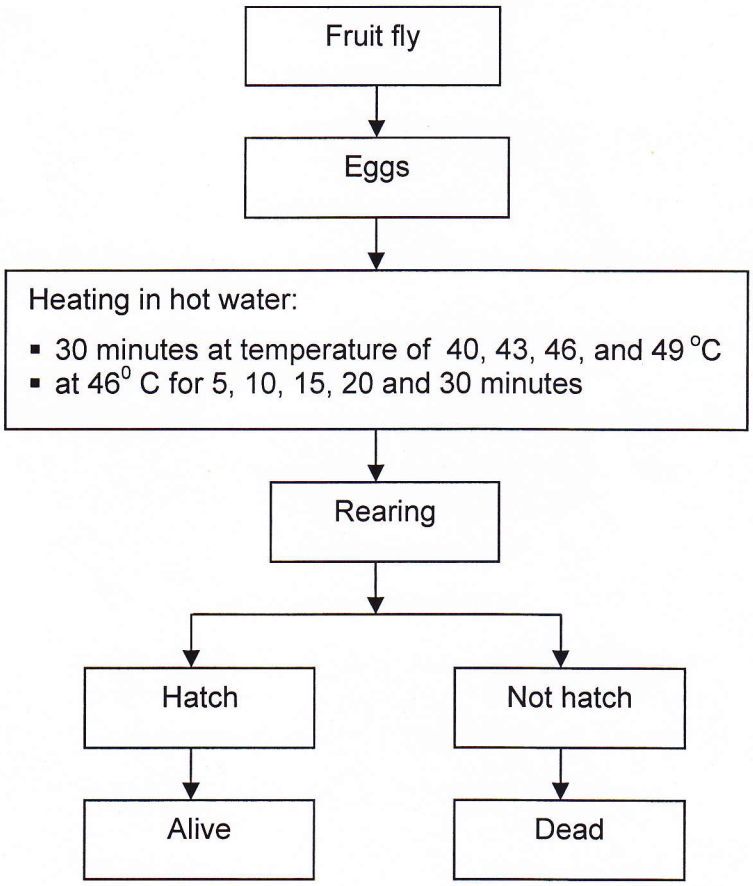


Figure 2. Flow diagram of fruit fly mortality test

(2) Heat treatment of VHT Method

Heat treatment using VHT method was conducted at temperature of 46.5 °C, with time length of research was 0, 10, 20 and 30 minutes after fruit core temperature reached 46 °C. After heat treatment was completed, fruit was

immediately cooled using streaming water until the temperature of fruit core descended into room temperature. The treated mango then stored at temperature of 13 °C. Fruit respiration was measured every day and quality change was examined every three days until 21 days of storage. Quality parameter observed include weight loss, water content, color, hardness, total soluble solid, vitamin C, number of fungi population and organoleptic test. Figure 3 shows the flow diagram of VHT research process on mango.

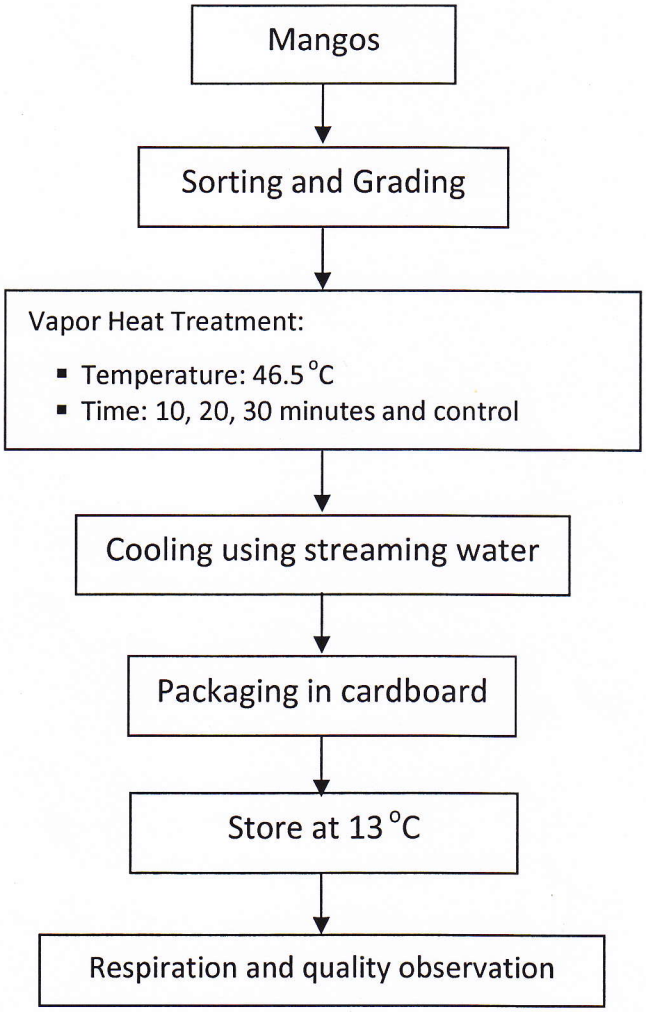


Figure 3. Flow diagram of HVT research on mango

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 test was used to determine the significant differences among the treatments.

RESULT AND DISCUSSION

Fruit fly Mortality

From isolation result of 50 kg of papaya, 139 female and 98 male of *B. dorsalis* fruit fly were obtained. Each day this population produced 60 – 70 of eggs. The fruit fly growth from egg until imago is passing through 4 stadiums, they are; egg, larva, pupa, and imago. The egg stadium is approximately comprised of 2 – 3 days, and then larva will appear. Larva consists of 3 instar, that is, instar 1, 2 and 3. Larva stadium period is 6 – 9 days. After instar 3 was reached, larva will wrinkle its body and forming the puparium. 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 will be used for mortality test.

Mortality test's result of *B. Dorsalis* fruit fly is shown on Table 2 and 3. From the collected data, it was observed that eggs mortality reached 85% on the water submerging at temperature of 40 °C for 30 minutes. On the temperature above 43 °C, the eggs would definitely reach the mortality of 100 %.

Table 2. Test result of mortality test on fruit fly eggs on different temperature upon 30 minutes.

Temp. (°C)	Number of eggs	Number of alive	Number of dead	Mortality (%)
Control	20	20	0	0
40	20	3	17	85
43	20	0	20	100
46	20	0	20	100
49	20	0	20	100

Table 3. Test result of mortality test on fruit fly eggs on temperature of 46 °C with different time length of submerging.

Duration of submerging	Number of eggs	Number of alive	Number of dead	Mortality (%)
0	20	20	0	0
5	20	5	15	75
10	20	0	20	100
15	20	0	20	100
20	20	0	20	100
25	20	0	20	100
30	20	0	20	100

The submerging in water at temperature of 46 °C for 5 minutes had causing the mortality resided on 75%, while the 10 minutes submerging had giving 100 % of mortality (Table 3). The same result was reported by Heather *et al.*, (1996) that the condition of heat treatment for 10 minutes on 46.5 °C is 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 minutes resulting no larva detected after 6 days of storage, indicating that egg inside the mango was not developed or died. Meanwhile on mango used as control there was fruit fly larva of *B. dorsalis*.

The Influence of VHT against the Quality of Mango

(1) Respiration Pattern during Storage

The respiration rate of the mango tend to increase during storage, where peak of respiration occurred on the $6^{th} - 7^{th}$ day of storage which indicate climacteric phase, and after that the respiration tend to decrease. Figure 4 has shown graphic of mango respiration rate expressed in CO_2 production rate. From analysis of variance we know that VHT treatment is significantly influence CO_2 production rate, where the longer exposure time of VHT significantly reduced the respiration rate. Nevertheless, 10-30 minutes of VHT would not give any significant different impact (Table 4).

Respiration rate indicate the self life of produce after harvest since its associations with quality decline rate. The less the respiration rate, the longer the self life of the produce. Klein and Lurie (1990) reported that heat treatment can increase or decrease the peak respiration of climacteric fruits depends on how long the awaiting occurs after treatment. Jacob et al (1995) reported that heat treatment does not influence climacteric time on Kensington mango. The increase or decrease of respiration rate is strongly correlated with cell destruction during treatment.

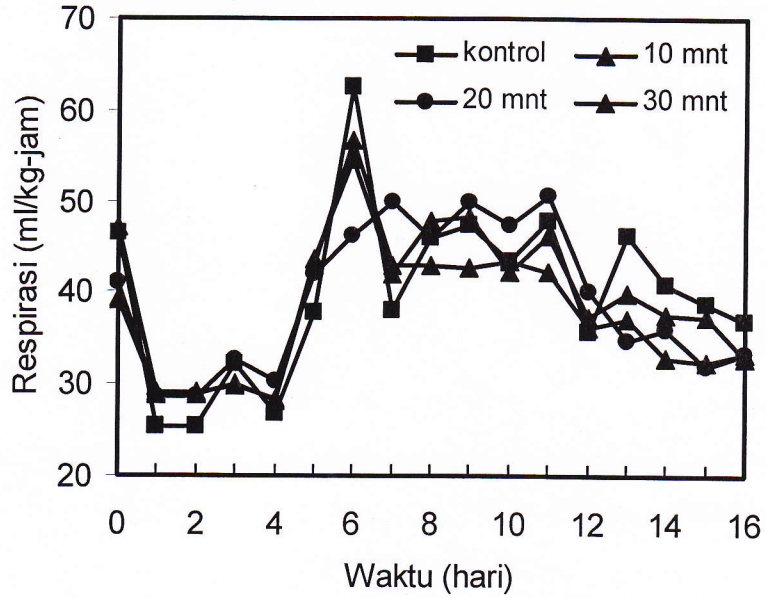


Figure 4. VHT influence on mango respiration rate during storage

Table 4. Influence of VHT period on respiration rate of Gedong Gincu mango on the 14th days of storage

Exposure time of VHT	Respiration (ml/kg-hour)
10 minutes	34.27 ± 2.53 ba*)
20 minutes	35.91 ± 0.02 ba
30 minutes	32.85 ± 0.42 b
control	40.76 ± 5.31 a

*)The same letter shows that there is no tangible effect on the rate of 0.05

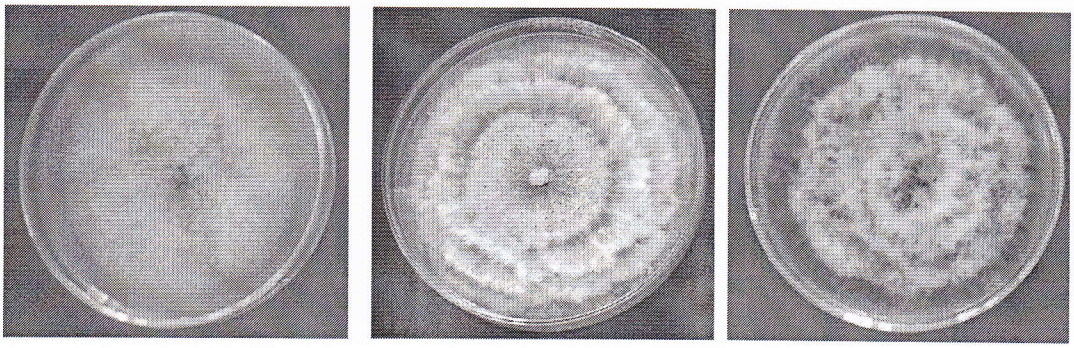
(2) Fruit Quality Change

Heat treatment on mango using VHT method significantly affect on fruit hardness and fungi total population, however, there were no significant effect on weight loss, color change, total soluble solid, water content and vitamin C. Fruit hardness of heat treated mango was significantly higher compared to control especially on the 8th days of storage. Klein and Lurie reported that heat treatment on apple 'Anna' and 'Granny Smith' on the temperature of 38 °C for 4 days was having a higher hardness compared to control. Heat treatment on 46 °C also reported is capable to maintain hardness on papaya (Chan et al., 1981). This probably because hydrolysis pectin is blocked as a consequence of heat treatment in such a way that can slow down enzyme activity in degrading cell wall. Exposure time of VHT for 10-30 minutes is not significantly affect total soluble solid of mango during storage. The same result also reported by Jacobi *et al.* (1995) that VHT on 47 °C for 30 minutes is not generate a different effect on total soluble solid. Sunagawa *et al.* (1987) reported that VHT treatment is not influencing the weight decrease on 'Irwin' mango.

Table 5. Influence of VHT period on the quality of Gedong mango

Exposure time of VHT	Hardness (kg/mm)	Total soluble solid (°brix)	Vitamin C (%)	Fungi Population (coloni/g weight)
10 minutes	0.37 ± 0.07 a	17.24 ± 1.16 a	33.39 ± 3.74 a	90 a
20 minutes	0.49 ± 0.08 b	16.26 ± 1.26 a	22.51 ± 3.13 a	373 b
30 minutes	0.40 ± 0.01 a	15.02 ± 0.42 a	27.43 ± 9.02 a	70 a
Control	0.39 ± 0.05 a	16.57 ± 1.27 a	28.13 ± 2.62 a	11 633 c
Day of observation	24	20	24	12

Types of fungi identified on Gedong gincu mango were *Collectotrichum gloeospoides, Pestalotiopsis mengiferae, Lasodiplodia theobromae* (pathogen) and *Cladosporium cladosporoides* (non pathogen). Figure 5 shows fungi spore identified on mango. Heat treatment is capable to control fungi attack which triggers anthracnose and stem end rot disease on mango. Rokhani (2002) also reported that heat treatment of VHT method can slow down the development of anthracnose caused by *Collectotrichum gloeosporoides* and stem end rot disease caused by *Dothiorella dominicana* on 'Irwin' mango. Visual appearance of mango on the 16th day of storage is shown on Figure 6.



C. gloeosporioides *P. mangiferae* *L. theobromae*

Figure 5. Fungi Spore Identified on Mango

Organoleptic test result on the 12th days of storage showed that the highest score was on mango with VHT treatment for 30 minutes, especially on its color and aroma. Advance test result described that there was no significant difference between heat-treated mango and control that fulfill the desire level from panelist which cover color, aroma, taste, and texture. The same result also reported by Merino et al., (1985) and Unawahuti et al., (1986) that heat treatment is not effecting taste and aroma on mango.

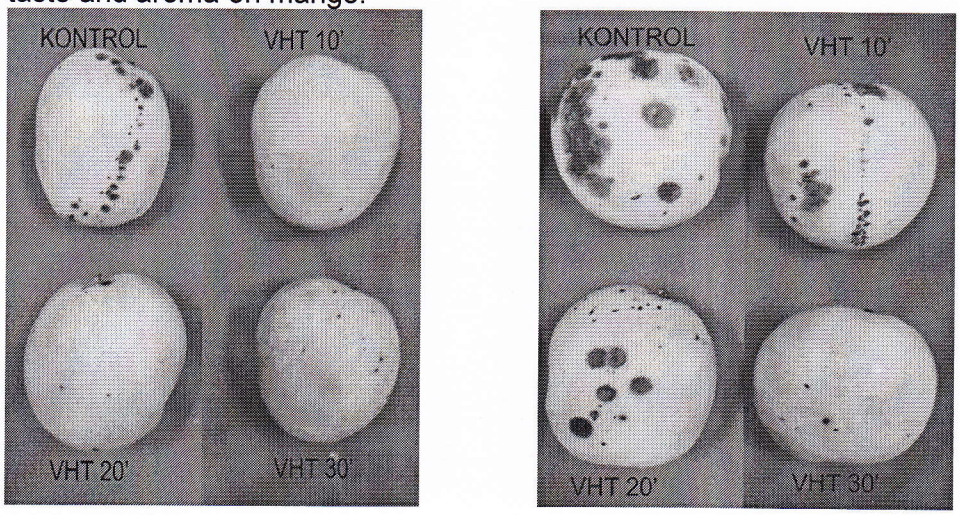


Figure 6. Visual appearance of Gedong gincu mango on the 16th days of storage.

CONCLUSION

1. The mortality of *B. dorsalis* fruit fly was reaching 100 % on heating for 30 minutes at temperature above 43 °C, meanwhile at temperature of 46 °C the mortality achieved 100 % by heating for at least 10 minutes.
2. VHT process on Gedong gincu mango significantly decrease on respiration rate, increase on fruit hardness, and reduce total population of fungi. However, there were no significant effect on weight loss, color change, total soluble solid, water content and vitamin C.

3. Exposure time of VHT for 10-30 minutes was fairly effective in exterminate fruit fly eggs invested inside the mango and capable to maintain the quality of mango during storage.
4. The implementation of VHT method for disinfestations of fruit fly is suggested to be used as a part of postharvest handling practice along with other method such as the using of ethylene absorber and controlled atmosphere storage to prolong self life of the produce during storage.

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