SIMULATION STUDY OF VAPORMATE FUMIGATION TREATMENT AGAINST PINEAPPLE MEALY BUG (*DYSMICOCCUS BREVIPES*) AND PINEAPPLE VAR. MD2 QUALITY EVALUATION MEANT FOR CHINA EXPORT MARKET

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ABSTRACT

Studies on the effect of Vapormate fumigation treatment on the mortality rate of pineapple mealybug (Dysmicoccus brevipes) and post-harvest quality of the pineapple var. MD2 were conducted. Adult stage of mealybugs was treated with dosage 290 ppm of etyhl formate (Vapormate) for 4 hours exposure to determine the mortality rate of treated insect at different evaluation day (removal) post-treatment in providing quarantine security. Fruit samples involves a total of 10,200 individuals of mealy bug with a minimum of 170 individuals for each fruit and 4 replicates. In the control group (ambient and 7 □C) the mealybug samples were maintained according to the same procedures, but no fumigation was applied. Fruits were then stored at 70C for 10 days as simulated the protocol of export by China. Treated and control fruits were removed and evaluated at 10, 14, and 21 days after treatment for mortality result, physical and biochemical changes. Result showed that fruits treated with Vapormate dose of 290 ppm followed by cold storage showed 100% killed of the mealy bug after 10 days storage compared with the non-treated fruits. There also non-significant different in terms of post-harvest quality on parameter of ascorbic acid, titratable acidity, colors of skin (L, a, b, C h) and colors of flesh (L, a b, C) between treated and control fruits. But there showed a significant different in term of texture, pH, soluble solid content and hue of skin. In this study, 290 ppm of vapormate fumigation was concluded as the minimum effective dose for the disinfestation of D. brevipes mealybug but with slightly reduction effect on MD2 pineapple fruit quality.

Key words: biochemical changes, browning, short shelf life, mortality

INTRODUCTION

Malaysia has a high potential for the export of fresh tropical fruits especially MD2 pineapple variety to foreign countries. MD2 is a commercial hybrid for international market. It has sweet taste, attractive skin flesh colour high content of vitamin C but is highly susceptible to chilling injury. The infestation of quarantined pests can seriously disrupt marketing of fresh agricultural products.

LITERATURE REVIEW

The Pseudococcidae mealybugs is considered as one of major quarantine pests of pineapple commodity particularly in Malaysia, (Ithnin et al., 2008). Trade of fresh fruits and vegetables from tropical countries, are restricted due to quarantine requirements and export permit by stringent importing countries such as China, Australia, Japan, New Zealand and the USA (FAO 1999) unless they are treated by an approved method or procedure to eliminate such pests (IAEA, 1999). Quarantine disinfestations treatment is very

important in order to prevent the establishment of pest associated with a commodity to be imported into a country or region where it does not occur or where its presence is restricted (Hallman 1999).

Fumigation is used as a disinfestations or quarantine treatment against targeted pests in empty freight containers, other forms of transport, and stored products (Bell 2000, Rambeau et al. 2001, Campbell et al. 2010). Ethyl formate is a volatile compound which occurs naturally in a variety of products and is generally recognized as safe (GRAS) by the USA Food and Drug Administration (FDA) (FDA, 1984). High concentrations have shown insecticidal properties and it is used as a GRAS fumigant of dried food. Ethyl formate has been tested in a range of fresh commodities, considering the main pest control related with the crop.

Vapormate is a trade name of Ethyl formate has been widely used as a fumigant for pests associated with dried fruit (Vincent and Lindgren 1971, 1972; Desmarchelier et al. 1999). A new formulation of ethyl formate, Vapormate (Linde Gas, Murray Hill, NJ), was recently registered for postharvest insect control in New Zealand, Australia, The Philippines, Israel, South Korea, and Indonesia, and the registration in the United States is expected soon. Vapormate is formulated in a pressure cylinder (57.3 bar) as a mixture that contains 16.7% ethyl formate by weight in liquid carbon dioxide (CO2), which when vaporized gives 11% ethyl formate in gaseous CO2. CO2 reduces ethyl formate ßammability and acts as a propellant during ethyl formate fumigation (Lawrence 2005).

China allowed fresh produce to enter their country by doing the fumigation treatment with Vapormate 290ppm followed by 70C storage for 10 days. In order to meet the requirement of quarantine protocol, the effect of vapormate fumigation treatment on mortality rate of treated insects and towards postharvest quality has been investigated. Thus, this study was conducted to determine the effect of Vapormate treatment on mortality of mealybugs and postharvest quality of the pineapple variety MD2 when exposed to 290ppm of dose ethyl formate. This simulation study had been done to ensure that the protocol that had been developed can eliminate the pest without jeopardize the quality of pineapple itself. Since this quarantine protocol is mainly proposed by China, so this is the first simulation study that targeted to that country.

MATERIALS AND METHODS

Sampel preparation

Pineapple var. MD2 with commercial index was purchased from a private farm in Johor. Fruits were blowed with high force air blower to ensure the fruits get free from other pests before goes to precondition at 100C overnight. Treatment fruits were inoculated with a minimum of 170 individuals of mealybugs (Dysmicoccus brevipes) and covered with muslin cloth to prevent insects from escaping. Fruit samples were packed in corrugated fiber boxes and fumigated with ethyl formate at doses of 0 ppm (control and treatment (290 ppm) then stored at 7°C for 10 days for simulated the actual protocol. Treated and control fruits were evaluated at 1, 7, 10, 14 and 21 removal days after treatment for physical and biochemical changes evaluation. Characteristics evaluated include physical appearances, titratable acidity, total soluble solids, pH, ascorbic acids, flesh colour and texture.

Mortality determination

Mortality rate of treated pests were recorded at day 1, 7, 10 and 14 days after treatment. Total number of dead pest was counted and the percentage of mortality was calculated.

Skin and flesh colour determination

Flesh colour was determined according to CIELAB method by using reflectance colorimeter (model CR-400, Minolta, Japan), and data were presented in terms of colour space L*, a*, b*, hue angle (Hº) and chroma (C*) values. L* is a measure of lightness, where values range from completely opaque (0) to completely transparent (100). a* is a measure of redness (or −a* of greenness) and b* of yellowness (or −b* of blueness) on the hue-circle. The hue angle [H° = arctan (b*/a*)] describes the relative amounts of redness and yellowness where 0°/360° is defined for red/ magenta, 90° for yellow, 180° for green and 270° for blue color. Chroma [C* = (a*2 + b*2)1/2] gives further information on the saturation or intensity of color (McGuire 1992; Voss 1992).

Firmness determination

Firmness was measured in the equatorial position of fruit using a texture analyser (Stable Micro Systems, UK) with the 5 mm diameter stainless steel probe. The maximum value recorded by the probe while passing through the fruit to a depth of 10 mm, in Newton (N), was used as firmness of the fruit.

Total soluble solids determination

Total soluble solids of the flesh were determined from the juice of the blended fresh fruit samples using a digital refractometer (Atago Model DBX -55, Japan). Three drops of liquid sample was applied to the measuring surface of the prism and the results display CD panel was recorded in ºBrix.

Total titratable acidity determination

Blended flesh samples (5 g) were mixed with 20 ml distilled water and were then titrated against 0.1 M NaOH up to pH 8.1 using a pH meter (Microprocessor pH meter pH 2112/HANNA, USA) as the titrimetric indicator. The results were expressed as per cent citric acid according to standard methods (AOAC 1984).

Ascorbic acid determination

Ascorbic acid was determined by extracting 10 g of blended pineapple sample in 100 ml metaphosphoric acid (HPO3), then filtered through Whatman no 1 filter paper. A volume of 10 ml from filtered solution were determined volumetrically with the 2-6 dichlorophenol-indophenol reagent until a slightly pink colouration was observed and persisted for 15 s (Ranganna 1977). The reading of ascorbic acid content was expressed in mg/100 g fruit sample.

Statistical analysis

The experimental design that has been using is a completely randomized design (CRD) with four replications. Statistical analyses of the treatments responses were conducted using Analysis of Variance (ANOVA) and Duncan Multiple Range Test to determine whether the comparison between different treatments and storage life show significant differences ($p < 0.05$)

RESULTS AND DISCUSSION

Effect of Vapormate on pest mortality

The results of effects of Vapormate treatment on mealy bugs are summarized in Table 1. The results showed that the mealybugs (Dysmicoccus brevipes) can be controlled effectively (100% mortality) by vapormate fumigation at dose of 290 ppm started at day 1 after treatment. Adult stage of untreated mealybugs which stored in ambient temperature were survived 14 days while untreated samples chilling at 7 □C were totally killed at 10 days storage. Result proved that by followed the protocol, the pest can be controlled effectively. Ethyl formate has been registered in Australia and New Zealand for control of postharvest pests as Vapormate (BOC Ltd.,Wagga, Australia), containing 16.7% EF by weight dissolved in liquid CO2 solvent/propellant (Ryan and Bishop 2003) and registration in the United States is being pursued by BOC Ltd. (Chatswood, New South Wales, Australia). If registration in the United States is successful, current fumigation chambers and equipment used in California could potentially be modified for use with Vapormate.

Effect of Vapormate on fruits quality

Fruits that treated with Vapormate because faster ripening compare with control. This cause the soluble solid content of fruit significantly increased. (Table 2). Texture of fruit itself significantly lower compare with control. Result showed that there are no significant different on parameter of acid ascorbic content and colour of flesh. This result is correlated with finding of (Warshamana et.all , 2016) which is skin color, flesh color and internal browning of the treated and untreated fruits did not show any significant difference ($p>0.05$) indicating that the fumigant used had no effect on the pigmentation of the treated fruits. This finding is linked with Simpson et al. (2004) reported little to no calyx damage on strawberries after three 1-h applications of 24.7 g/m3 of ethyl formate at 24C. Hue of skin is increasing for treated fruits and this result similar with finding by (Simpson et.,all 2007) which is found that in exposure to 5.0% EF resulted in increased browning of the rachis and stems of table grapes at the first evaluation (2 d after treatment).

Table 1: Mortality Rate (%) of Treated Mealybugs by using Vapormate Fumigation Treatment

Treatment	Removal			
	Day 1	Day 7	Day 10	Day 14
Fumigation (290 ppm)	100 ± 0.0 a	100 ± 0.0 a	100 ± 0.0 a	100 ± 0.0 a
Control (Ambient)	32.9 ± 15.3 b	58.4 ± 9.5 b	51.3 ± 10.4 c	64.9 ± 13.8 b
Control (7 °C)	83.5 ± 9.4 a	49.9 ± 8.3 b	74.3 ± 16.9 b	100 ± 0.0 a

Means within columns followed by the same letter are not significant (95% confidence interval)

Table 2: Changes in colour (soluble solid concentration (SSC), pH, total titratable acidity (TTA), ascorbic acid content and texture of pineapple var. MD2 from different treatment
(Control, Vapormate+Cold Treatment)

	Texture (N)	pH	Soluble Solid Content (⁰ Brix)	Hue of Skin
Rawatan				
T1 - Control	11.95a	3.76b	12.17b	86.91a
T2– Vapormate + Cold Treatment	10.13b	3.84a	13.47a	83.98b
F-Test significant	*	*	*	*

Each value was the mean of three replicates. Means with the same letter are not significantly different at 5% level ($p < 0.05$) according to Duncan Multiple Range Test (DMRT)

CONCLUSIONS

This study found that fumigation of Vapormate (ethyl formate) gas can be considered as an effective and potential phytosanitary treatment for disinfestation of pineapple mealybug Dysmicoccus brevipes. Dose of 290 ppm of vapormate fumigation treatment was concluded as the sufficient effective dose to control the targeted pests but with slightly reduction effect of MD2 pineapple fruit quality for quarantine purposes to unrestricted and overcome the trade barrier of Malaysian pineapple premium variety, MD2. By followed the protocol, pest can be eliminated and the quality if fruit itself still maintain until day the fruits reach at China.

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