ISSN No:-2456 –2165

Modified Atmosphere Storage of 'Honey' Mango by using Ca $(OH)_2$ as Chemical Absorbent

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Abtracts:-Utilization of chemical absorbent in modified atmosphere storage of "Honey" mango has been carried out in order to study the physiological and enzymatic responses of mango during storage of 1, 2 and 3 weeks. Completely Randomyzed Block Design with Least Significant Different at five percents significant level were applied to combine types of packaging and chemical absorbent as followed: unpacked; Plastic of polyethylene (PE) with paper board; PE + $Ca(OH)_2$ (300g/L) with paper board; Plastic of polypropylene (PP) with paper board and PP + $Ca(OH)_2$ (300g/L) with paper board. Data were analysed with ANOVA and continued with LSD at five percents significant level. Respiration and ethylene productions, percentage of decay and weight loss, activity of ACC oxidase were determined at 1, 2 and 3 weeks storage. The production of ethylene and the rate of respiration of mangoes were very low as compared to unpacked mangoes. The result also indicate that decays percentage and weight loss of mangoes that stored at modified atmosphere are lower than that unpacked mangoes. Modification Atmosphere storage inhibited the physical properties, the activity of ACC oxidase, therefore, paralelled the rate of respiration and ethylene productions leads to extention the storage life of mangoes up to three weeks.

Keywords:-Mango, Modified atmosphere, ACC Oxidase, Ethylene, Absorbent.

I. INTRODUCTION

Recently horticultural commodity especially fruit is grown extensively in West Nusa Tenggara Barat (NTB). Mangoes have specific flavor and moderate size are used as a diet very easily obtained and marketed for local or regional area. Almost all regions in NTB grew this valuable commodity with some cultivars such as Honey, Arumanis, Manalagi and Golek (Yuniati and Suhardjo, 1996). The fruit grown area increased gradually during this decade but the problem of short of shelf life at room temperature become constraint that required overcoming. Another major problem of diseases or pest after harvest is major restriction in development in this commodity (Pesis *et al*., 2000).

Shelf-life is consequently a critical issue, and can be determine the marketability of mango. One of the efforts to

extend the storage life is by using plastic packaging combined with absorbent delays the ripening. Polyethylene or propylene plastic combined with vermiculite $KMnO_4$ 400g/L could absorb the ethylene have been applied in banana and extendable the storage life up to three weeks (Wills *et al*., 1998). Application of chemical combined with polyethylene plastic bag which could extend the storage life due to modification of the atmosphere inside the bag and restrain the respiration physiology lead to inactivation of ACC oxidase and ACC synthase that involve in fruit maturation process (Kader, l993). Ethylene is produced from S-adenosyl methionine (SAM) biosynthesis→ 1-aminocyclopropane-1-carboxylyc acid (ACC) → ethylene with involvement of some enzymes. The activity of enzymes inside ethylene biosynthesis of climacteric fruit is affected by the composition of atmosphere inside packaging (Smith *et al*., 1994).

Modified atmosphere packaging (MAP) is one of the methods in order to extend the storage life, beside inactivation of some enzymes due to low oxygen concentration and high carbon dioxide. The activity of enzymes affects maturation of fruit, storage processing, types of packaging, temperature and the method of storage (Smith *et al*., 1994; Pesis *et al*., 2000). In MAP the gas composition within the package is not monitored. Therefore, the term passive atmosphere packaging is sometimes used in this experiment. The course of atmosphere modification is determined by three interacting processes such as respiration of the commodity, gas diffusion through the commodity and gas permeation through the film (Gorris and Peppelenbos, 1999).

Based on the background above thus have been conducted the utilization of chemical absorbent in modified storage of Honey Mangoes in order to know physiological respiration and inactivation of ACC oxidase enzymes, ethylene production and other physical properties during three weeks storage.

II. MATERIAL AND METHODS

Mature mango fruit ((*Mangifera indica* L.) cv. Honey were obtained from North Lombok Regency, NTB then transported 60 km by road to the Food Technology Laboratory. Fruits were sorted for weight uniformity, dipped in 0.2 % "Prochloraz" fungicide solution, dried at 28 ^oC for about 30 minutes and then enclosed in plastic bags and stored in MAP of (1) Polyethylene Plastic with paper board, (2) Polyethylene Plastic + $Ca(OH)_2$ (300g/L) with paper board, (3) Polypropylene Plastic with paper board, (4) Polypropylene

Plastic + $Ca(OH)_2$ (300g/L) with paper board and (5) Air (control). Experimental Design is used Completely Randomized Design (CRD) with five treatments of packaging and chemicals as absorbent with triplicate. Data were analyzed by Analyzed of Variance (ANOVA) and continued with Least Significant Difference (LSD) at five per cent significant levels (Hanafiah, 1994). Chemical absorbent ($Ca(OH)_2$) with different concentration is prepared, then placed inside plastic bags with mangoes. The size of plastic bags was 30 cm length X 20 cm width and 0.10 mm in thickness. The harvested and sampled fruit were stored singly in plastic bags at ambient temperature were then ventilated with humidified air at 8 $L.h^{-1}$. These fruit were used for monitored ethylene and respiration rate until the fruit ripened. Fruit from this experiment were assessed for their ability to ripen, weight loss and percentage of decays, ACC oxidase analysed at days 0, 7, 14 and 21 at 28^oC in MAP (Harris *et al*., 1997; Jobling, 1993; Basuki *et al*., 1997).

III. RATE OF RESPIRATION AND ETHYLENE PRODUCTION

The respiration rate and ethylene production were analyzed using gas chromatograph (gow Mac Model 580, USA) with methods similar to those described by Jobling (1993) and Basuki (2001). The respiration rates were reported as $mLCO_2$ $kg^{-1}.h^{-1}$ and ethylene production of fruit tissues as $\mu L\ kg^{-1}.h^{-1}$. ACC Oxidase analysed.

The activity of ACC Oxidase determined in fruit tissue (Bufler, 1986) with some modification and ACC Oxidase was calculated in $\eta L\ C_2H_4.g^{-1}$ fresh weight (Jobling, 1993; Basuki, 2001). ACC was calculated by formula using the percentage recovery ACC added to the paired samples.

IV. RESULTS AND DISCUSSION

A. The rates of Respiration and Ethylene Production

Freshly harvested mango expressed clear climacteric patterns of CO_2 and ethylene production with peaks recorded on the fourth day (Fig. 1 and 2). The rates of respiration and ethylene production of mango fruit stored in air (controlled) were higher than those of fruit stored in MAP packed with PP and PE bags and $Ca(OH)_2$. The lowest of rates of respiration in fruit stored in MAP packed with PP/PE bags and $Ca(OH)_2$, indicated that production of ethylene is inhibited lead to extend the time of climacteric. The application of PE bags with $Ca(OH)_2$ as absorbent have been applied in Cavendish banana could extend the fruit ripening up to three weeks (Wills *et al*., 1998; Wills *et al*., 2014) thus delaying ripening and extended the storage life.

Similar pattern of changes in respiration rates and ethylene production during ripening at avocados and mangoes (Basuki, 2001; Smith *et al*.,1994). The increases in CO_2 production in mangoes stored in air higher than that fruit stored in MAP, was probably due to ethylene production stimulated by high oxygen of storage in air (Singh, 2000; Zaharah and Singh, 2011).

Inhibition of ethylene production also has been reported at controlled atmosphere storage of avocado (3 % O_2 and 97 % N_2) at 2^oC and 17^oC (Pesis *et al*., 1994). The rate of respiration and ethylene production measured at sample fruit second series after two weeks storage and monitored for 6 days (Figs. 1 and 2). The increase of respiration pattern after storage at CA/MAP is characteristic of climacteric fruit such as mango, avocado and banana (Wang, 1990; Wills *et al*., 2014). Lange and Kader (1997a and b) reported that "Hass avocado" stored in air had higher respiration rates than fruit treated with high CO_2 concentration. Low oxygen and high carbon dioxide concentration are reported to decrease ethylene production and other ripening related changes (Kader, 1986; Pedreschi *et al*., 2004).

V. WEIGHT LOSS

Figure 3 showed all MAP treatments (PE, PE + $Ca(OH)_2$, PP and PP + $Ca(OH)_2$) no significant different at five percent level. There is indication that after one week fruit stored in PP + $Ca(OH)_2$ lowest in weight loss followed by PE + $Ca(OH)_2$. Then after 3 weeks all MAP treatments were almost similar. Whereas after 3 weeks, the highest weight loss was observed in unpacked fruit. These condition is affect by PE bags that make modification of atmosphere condition within the bags (Pantastico, 1997; Singh *et al*., 2013) therefore, reduced weight should be mainly due to the moisture barrier property of the package. The rate of respiration also leads to restriction of weight loss. The application of Ca $(OH)_2$ as absorbent inside bags could absorb CO_2 so according to Kader (1986) that MAP created limitation of respiration rate and transpiration that prolong the storage life of fruit (Artes-Hernandez *et al*.,2004).

A. The percentage of decay

The percentage of decay in fruit was assessed in 3 weeks storage, indicated that there was the more time storage the more increase in decay. Very light decay was observed in fruit stored in MAP treatments after 3 weeks storage (Fig. 4). Lower of percentage of decay in all MAP treatment probably due to PE/PP bags could restrain the moisture loss compared to fruit stored in air (Pantastico, 1997; Khaliqa *et al*.,,2015; Kou *et al*., 2015; Luna *et al*., 2016).

Overall, MAP treatments using MAP gave lowest of percentage of decay. Barmore (l987) reported that the advantage MAP storage using $Ca(OH)_2$ slower the process of ripening because of lower external ethylene content inside the bags (Elhefny *et al*.,2012). Some researchers found out that after ripening fruit may injury especially in overripe fruit

because of degradation process lead to senescence inside cell. Some researchers assumed that during maturation fruit sustain ripening and substrate synthesized process reduce followed by senescence and the occurrence of degradation of cell membrane (Brady, 1992; Tefera *et al*, 2007; Kou *et al*., 2015; Nambi *et al*., 2016).

B. ACC oxidase

After three weeks storage of mango inside PE/PP bags ACC oxidase activity inhibited compared to those stored in air. Statistically there is no significantly different between MAP treatments whereas there was difference of five per cent compared to the fruit stored in air. These data show that there is inactivity of ACC oxidase inside MAP treatments. Similarly parallel change in ACC oxidase has been reported in apple and avocado (Jobling, 1993; Basuki, 2001). These observation is comparable with Gorny and Kader (1997) who reported that induction of ACC oxidase suppressed in MAP treatments of apples, persimmon and mango compared to those storage in air (Kalra *et al*., 1995; Zheng *et al*., 2005; Basuki, 2006). The activity of ACC oxidase of freshly harvested fruit is increased and paralleled with the increasing of carbon dioxide and ethylene production of climacteric fruit (Cua and Lizada, 1990; Sitrit *et al*., 1986; Smith *et al*., 1994; Starret and Laties, 1991).

VI. CONCLUSION

The production of ethylene and the rate of respiration of mangoes were very low as compared to unpacked mangoes. The result also indicated that decays percentage and weight loss of mangoes that stored at modified atmosphere are lower than that unpacked mangoes. Modified atmosphere storage inhibited the physical properties, the activity of ACC oxidase, therefore, paralelled the rate of respiration and ethylene productions leads to extention the storage life of mangoes up to three weeks.

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ISSN No:-2456 –2165

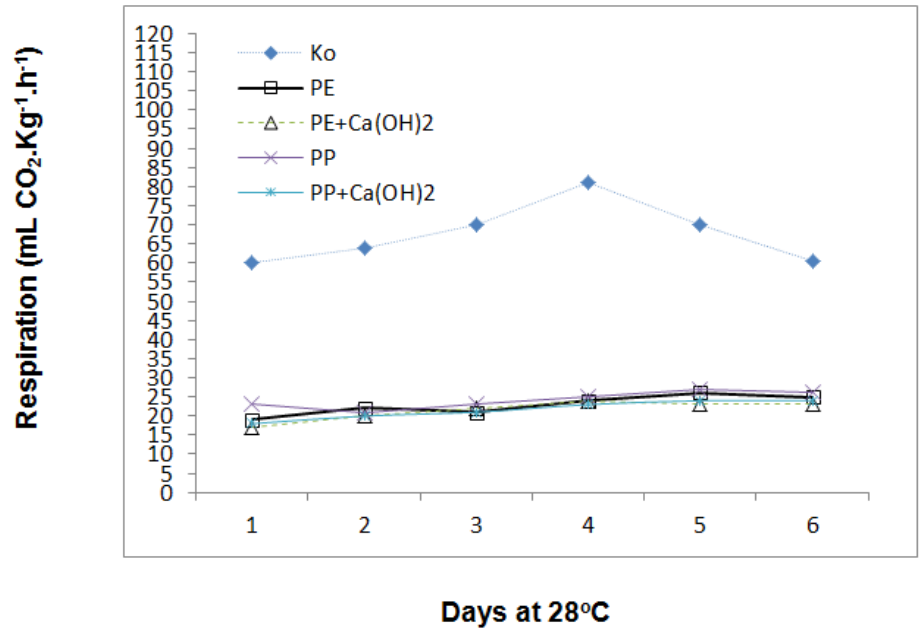

Figure 1. The rates of respiration of mango following transfer from MAP (PE/PP bags with $Ca(OH)_2$) after 6 days at 28°C.

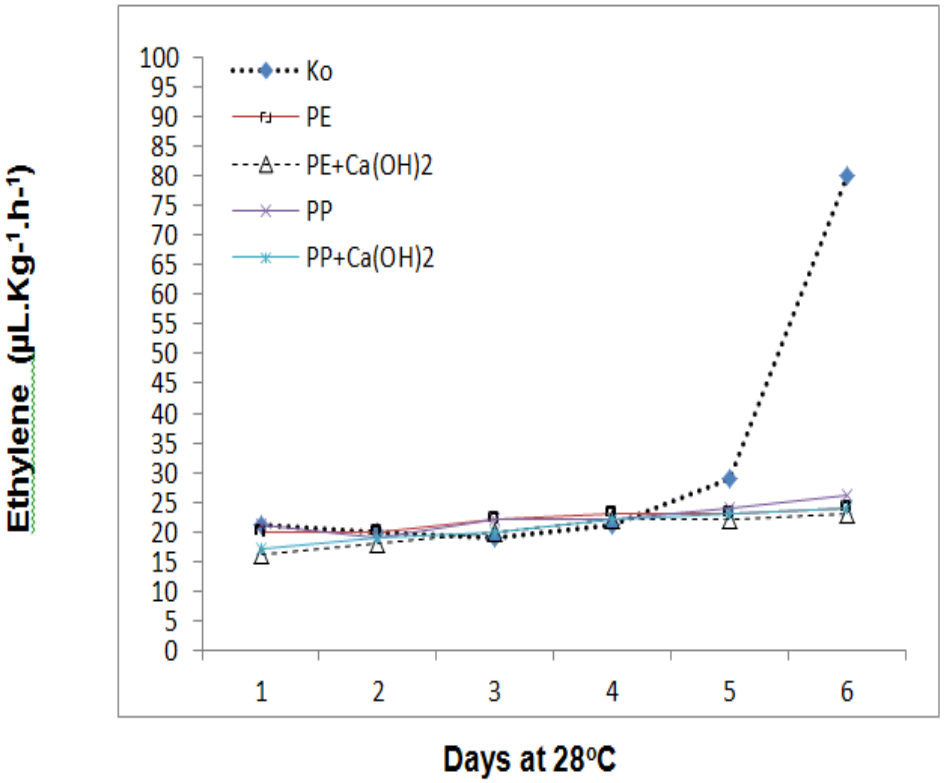

Figure 2. The ethylene production of mango following transfer from MAP (PE/PP bags with $Ca(OH)_2$) after 6 days at 28°C.

ISSN No:-2456 –2165

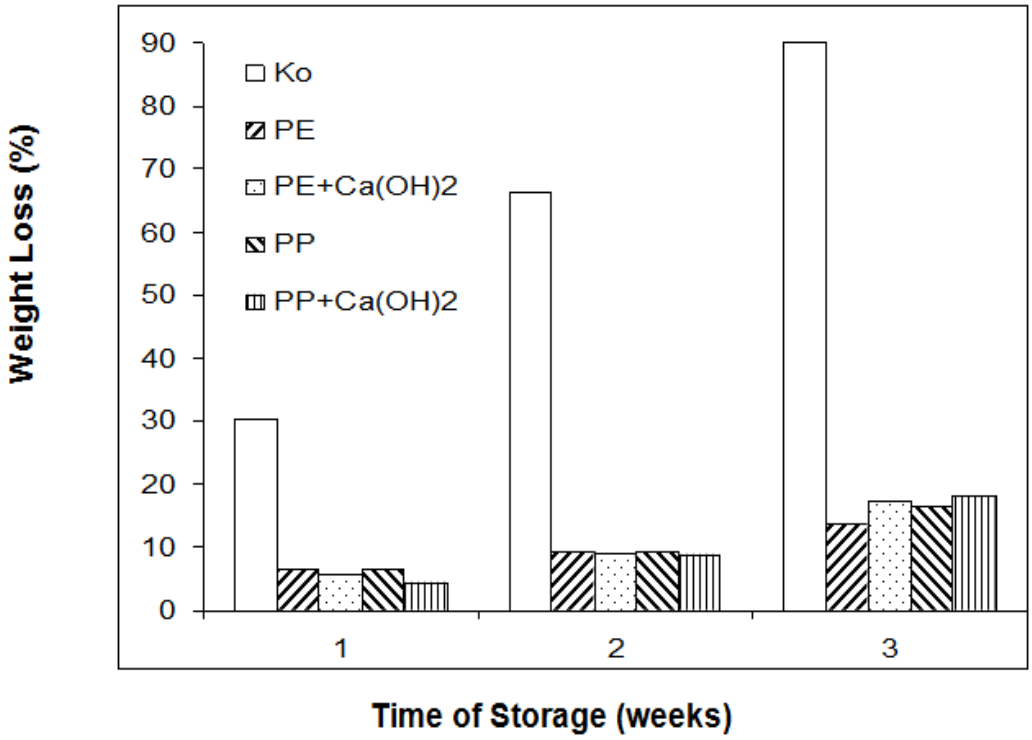

Figure 3. Weight loss of mango stored in MAP for 3 weeks.

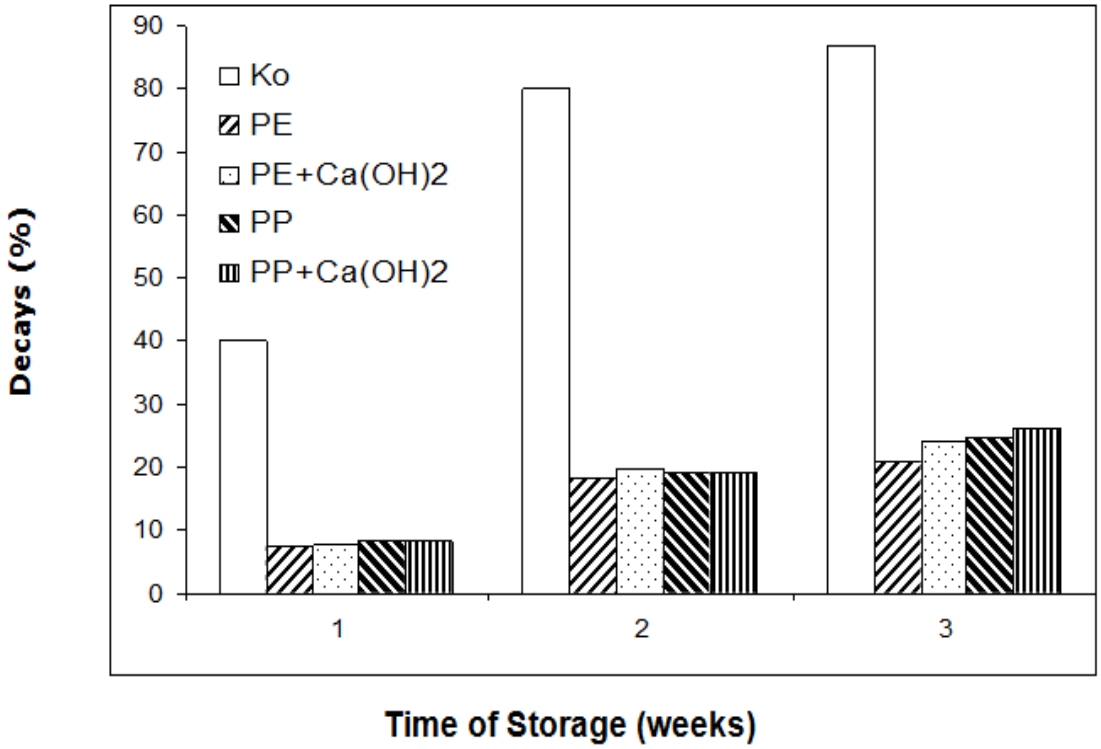

Figure 4. Percentage of decay of mango stored in MAP for three 3 weeks.

ISSN No:-2456 –2165

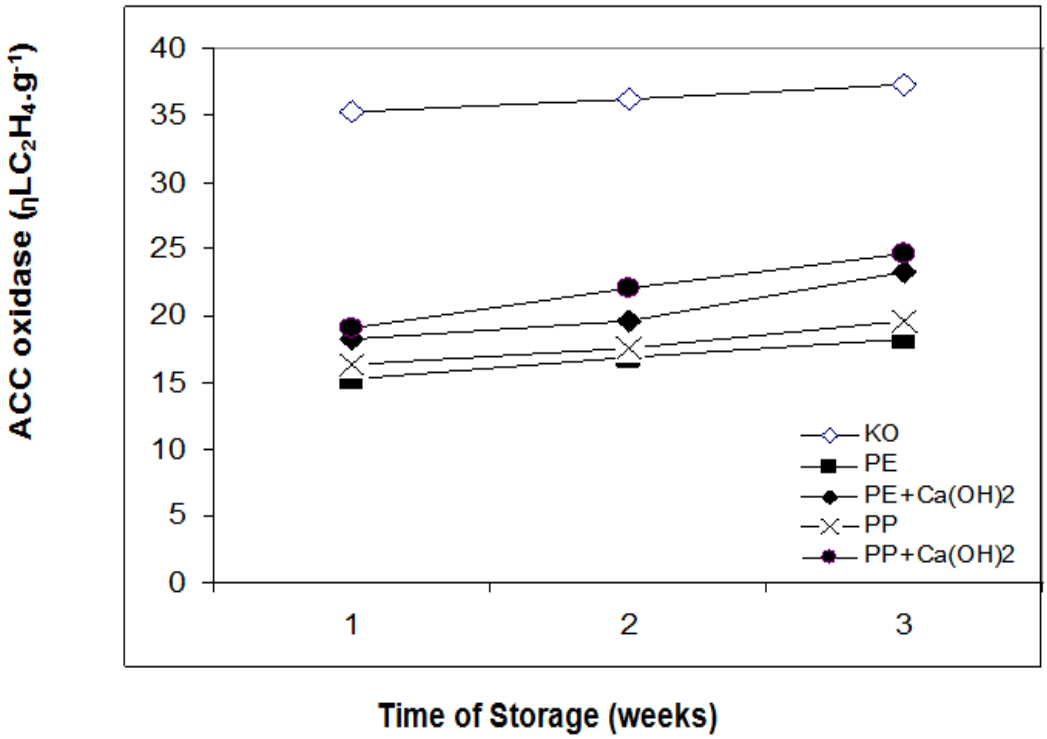

Figure 5. The activity of ACC oxidase in mango fruit after storage inside PE/PP bags with $Ca(OH)_2$ for 3 weeks.