Inactivation Of ACC Oxidase (Acco) During Modified Atmosphere Storage (MAS) Of Mango

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ABSTRACT: Inactivation ACC Oxidase (ACC_O) during Modified Atmosphere Storage (MAS) of Mango were carried out at Food Technology Laboratory, University of Mataram from by using Completely Randomized Design and continued with Least Significant Different at five percent significance level. Mangoes were stored at Polyethylene (PE) bags; PE + $KMnO_4$; Polypropylene bags (PP); PP + $KMnO_4$ and unpacked (Control) for three weeks. The physical properties of fruit such as weight loss and decay percentage were determined, while physiological properties such as the rate of respiration, ethylene production including ACC_O activity. Inactivation of ACC_O occurred to almost half-time of its activity in mango stored at MAS as compared to unpacked mango. Therefore, paralleled the rate of respiration and production of ethylene at MAS leads to extend the storage life of mangoes. Weight loss and decay percentage of mango kept in MAS for 3 weeks were lower than unpacked.

Key word: ACC_O, Polyethylene, Polypropylene, KMnO4, Modified Atmosphere Storage and Mangoes.

INTRODUCTION

In Indonesia, especially Nusa Tenggara Barat (NTB) Province, the area and production of mangoes increase gradually every year [7], indicated that recently horticultural commodities have been developed rapidly. It produces in almost all regency in NTB province. The most highly economic value varieties of mangoes that cultivated are Madu, Arumanis, Manalagi, and Golek [32]. However they have short time storage at ambient temperature [24] which one of the important constraint that should be managed. Besides, other postharvest factor (pest and pathological decay) which developed rapidly during storage. One of the method to inhibit the fruit ripening by using polyethylene/polypropylene bags packed with ethylene adsorbent (KMnO4) have been applied in bananas. The experiment on banana's storage by KmnO4 (400g/L) with vermiculite could extend the shelf life up to three weeks [31]. It application was combined with Plastic Polyethylene bags that created modified atmosphere which slow down the physiological properties and leads to inhibit the activity of enzyme [13]. The enzyme was involved in fruit ripening by process ethylene biosynthesis (S-adenosyl methionine (SAM) → 1-aminocyclopropane-1-carboxylic acid (ACC) → ethylene), called 1-aminocyclopropane 1-carboxylic acid oxidase (ACC_O). The activity of ACC_O involved in the process from ACC to produce ethylene in climacteric fruit is affected by oxygen concentration inside the bags [28]. Its activity is catalyzed by enzyme and required oxygen, highly regulated and closely parallels the level of ethylene biosynthesis [16,17]. Modification Atmosphere Storage of Mangos is not only applicable methods in order to extend the shelf life, but also finding out the level of oxygen and carbon dioxide that inhibited the activity of ACC_O. Sitrit, [27] explained that ACC_O is affected by fruit phase of ripening, type of packaging, and storage temperature. In this study was examined the effect of modified atmosphere storage in plastic bags by using ethylene absorbent in relation to activity of ACC_O.

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The aims of this study were to observe ACC_O activity, the rate of respiration, ethylene production, and weight losses and decay percentage during three weeks storage of mangoes.

MATERIAL AND METHODS

This study was conducted at Food Technology Laboratory, University of Mataram using Completely Randomized Design. The fruits were stored at : Plastic Polyethylene bags (PE)+ corrugated fiber board; PE + $KMnO_4$ (450g/L)+ corrugated fiber board; Plastic Polypropylene bags (PP)+ corrugated fiber board; PP + $KMnO_4$ (450g/L) + corrugated fiber board and Unpackaged (Controlled). Data was performed with Analysis of Variance (ANOVA) five percent significance level continued by Least Significant Difference LSD [9]. Fresh harvested mangoes var Madu from West Lombok was sorted, packed and stored by MAS at ambient temperature (25-28^oC) for three weeks. Parameters to be recorded were weight losses and decay's percentage [21]. The rate of respiration and ethylene production during ripening days phase [11,3]. The activity of ACC_O was determined in pulp tissue section according to Bufler methods [4] with following modification. The pulp of tissues was taken from equatorial region with a cork borer and sliced with a razor blade yielding 1 g FW. Then the samples was placed in 25 X 180 mm test tubes containing 10 mL of solution comprising 0.1 mM ACC dissolved in 0.4 M Sucrose and 0.02 M $CaCl_2$ in distillated H_2O. After 30 minutes the pulps were removed from the solution and they were quickly blotted dry with tissue paper and placed in a 10 mL plastic syringe. Immediately after enclosure in the syringe, CO_2 was added to establish 5 % concentration. After 30 minutes the accumulated ethylene was measured by removing 1 mL gas sample and analyzed with Gas Chromatography (Varian 3300) fitted with PID detector. Saturating concentrations of ACC were supplied to ensure that ACC_O activity was not limited by substrate availability. ACC_O activity (the ability to convert ACC to ethylene) was expressed in ηL $C_2H_4.g^{-1}$ of fruit tissue [11,3].

RESULTS AND DISCUSSION

Inactivation of ACC_O

After 3 weeks storage of mangos ACC_O activity was measurable although the concentration was very low. The activity of ACC_O in MAS packed fruit was inhibited in

comparison with unpacked fruit. The activity of ACC_O following removal from PE and PP bags every week stored was non significant (Figure 1). These data indicated that inactivity of ACC_O occurred in PE/PP bags with or without $KMnO_4$, otherwise $_{in}$ air storage fruit ACC_O activity was normal. Inactivation of ACC_O occurred to almost half of its activity in mangoes stored in MAS as compared to air storage. ACC_O activity in mangoes also paralleled to the changes of ethylene and be correspondent the change of the rate of respiration. This observation agree Gorny and Kader [8] who showed that induction of ACC_O is suppressed in CA treatments of apples compared to storage in air [14]. Similar parallel changes in ACC_O activity and ACC concentration have been reported in apple [11], avocado [3] and tomato [6]. ACC_O activity in freshly harvested fruit ripened at ambient temperatures rises constantly throughout the lag period increasing substantially at the onset of ethylene production in climacteric fruit [27,5,28,29].

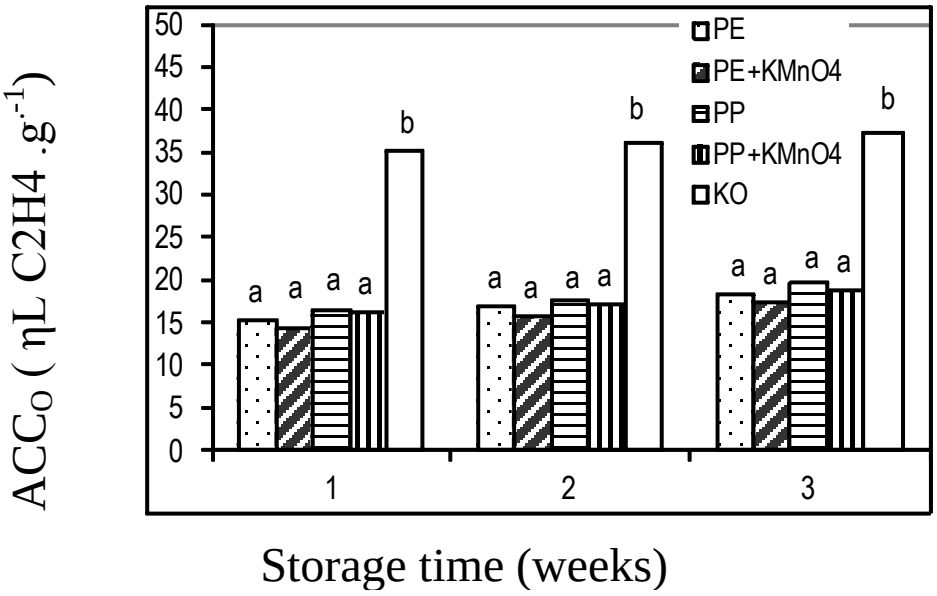

Figure 1. *ACC_O activity at climacteric peak of mangoes during 1, 2, and 3 week's storage in MAS. The graph that followed by the same letter at the same time storage indicated no significant differences according to LSD 5 %.*

The rate of respiration and ethylene production

Climacteric patterns of CO_2 and ethylene production in freshly harvested fruit expressed clearly with peak recorded on the 5th days during this experiment (Figure 2). The rate of respiration and ethylene production of fruit stored in air (control) was higher than fruit stored in MAS with or without ethylene absorbent. The lowest ethylene production found in fruit kept in PE bags with $KMnO_4$, this indicated that MAS inhibited the production ethylene; therefore fruit climacteric time would be extended. MAS of mangoes by using PE/PP bags with ethylene absorbent ($KMnO_4$) decrease the rate of respiration and ethylene production (Figure 3). Application of $KMnO_4$ inside PE bags has been conducted in banana Cavendish that delayed the ripening up to three weeks [31].

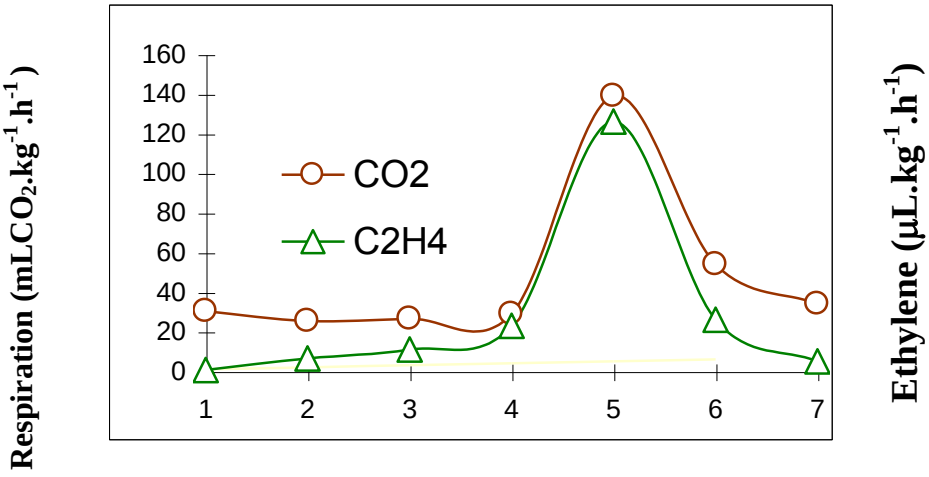

Figure 2. *The rate of respiration and ethylene production of freshly harvested Mangoes during ripening phase at ambient temperature.*

The respiration pattern and ethylene production of mangoes during ripening [26] seem to be similar with respiration pattern of avocado [3]. The climacteric rise and ethylene production during mangoes ripening was accelerated by temperature and type of packaging, it seem that the production of CO_2 of mangoes stored in air higher than in MA. The rate of respiration was related to ethylene production, if high ethylene production which accelerated respiration rate and ripening [10]. Furthermore, high CO_2 concentrations in MAS reduced the rate of respiration of banana [20]. CO_2 production was lower in avocado pre treated in low O_2

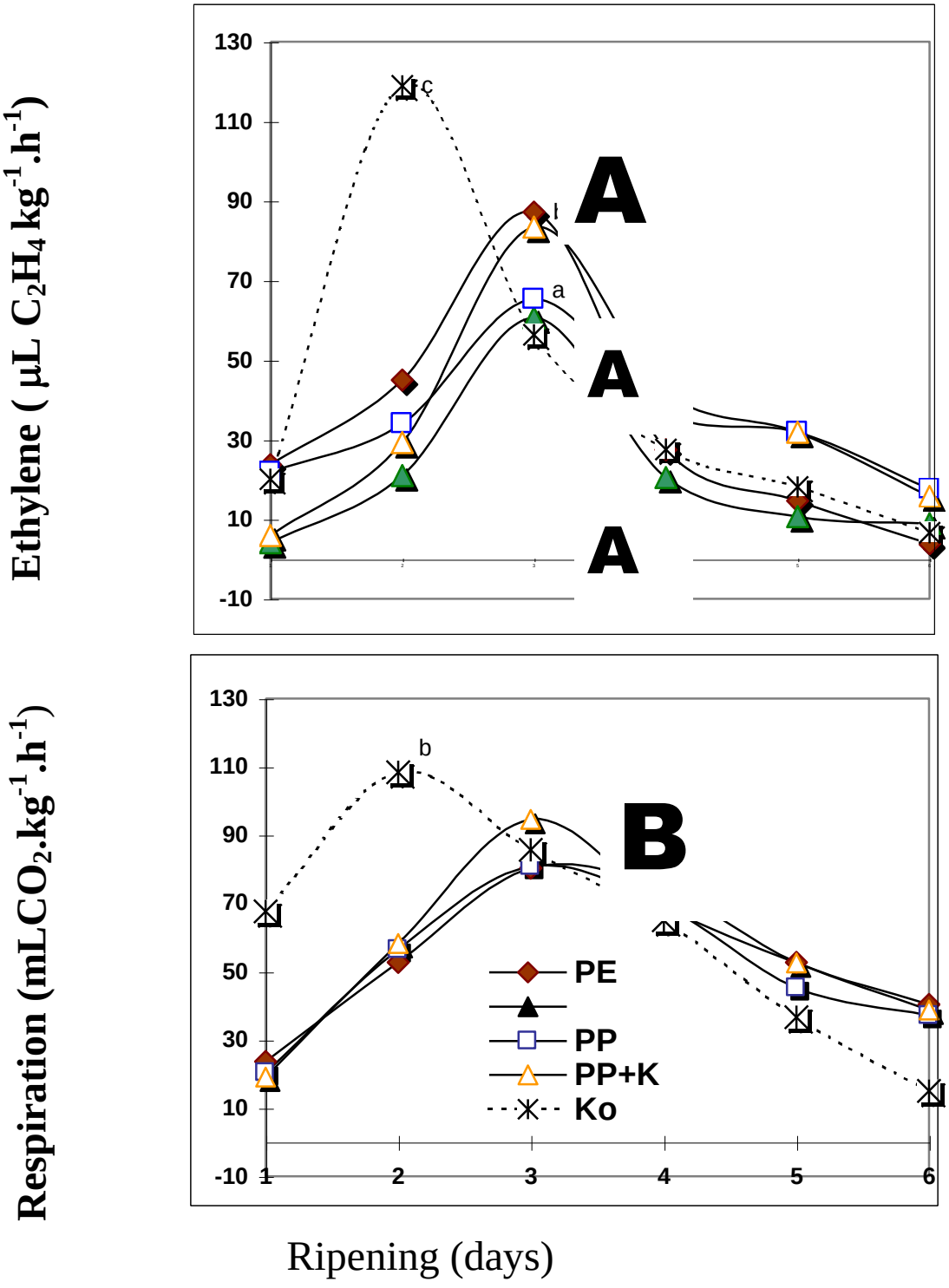

Figure 3. *Ethylene production (A) and the rate of respiration (B) of mangoes during ripening process following transfer from MAS after 2 weeks storage. The graph that followed by the same letter at the same time storage indicated non significant difference according to LSD 5 %.*

Atmosphere (3 % O_2 and 97 % N_2) during storage at 2 ^oC and 17 ^oC [23]. The rate of respiration and production of ethylene measured in sample after 2 weeks and monitored every day during 6 days (Figure 3). The increase of rate respiration following stored in CA or MA indicated that specific type of climacteric fruit [30]. Lange and Kader [18,19] reported that avocado stored in air had higher respiration rates than fruit treated with high CO_2 concentration.

Weight losses

FigFigure. 4 showed that all treatments indicated no significant difference. After one week storage mangoes packed by PE + $KMnO_4$ showed the lowest weight losses, while unpacked mangoes showed the highest percentages compared to MAS treatments. Then, after removal from package all treated fruit indicated similar in weight losses. However, PE bags showed the lowest weight loss after 3 weeks storage in MAS. Therefore, the rate of respiration was inhibited as wells as weight losses. Meanwhile, unpacked fruit showed the highest weight loss due to normal respiration rate and transpiration. These indicated that application of KMnO4 as ethylene absorbent is suitable for inhibit respiration process. This result agrees Kader [12] that MAS combined with KMnO4 would delay the rate of respiration and transpiration of fruit [15,1].

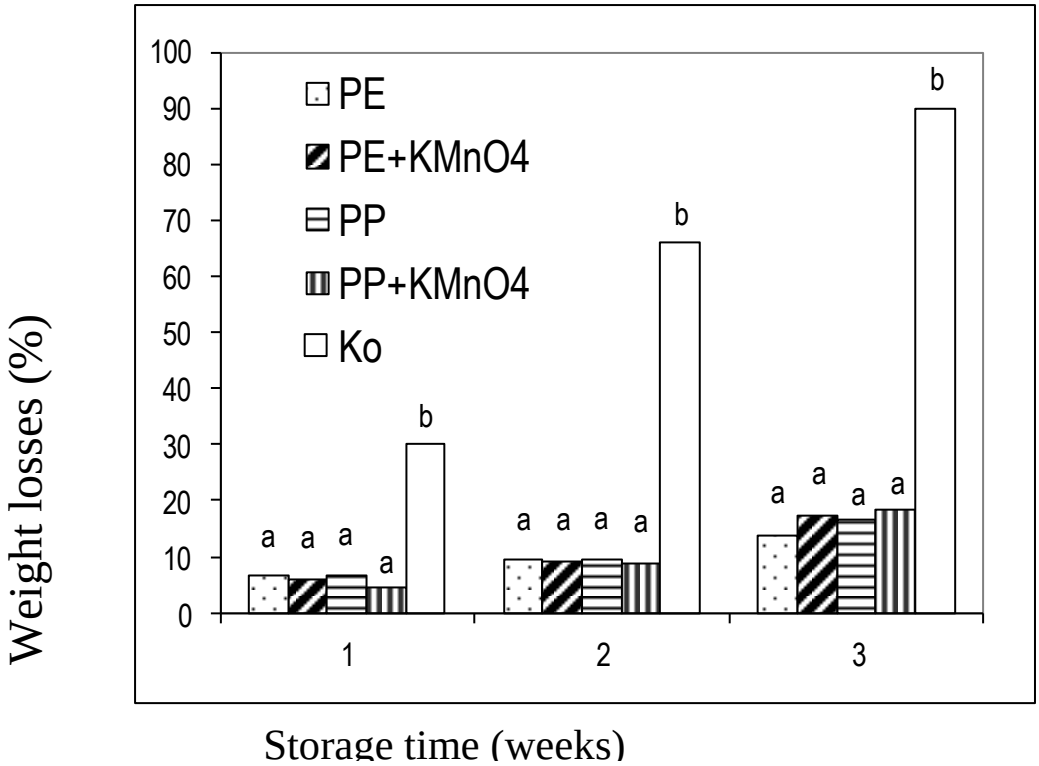

Figure 4. *Weight losses of mangoes stored in MAS for 1, 2 and 3 weeks. The graph that followed by the same letter at the same time storage indicated no significant according to LSD 5 %.*

Decay's percentage

The decay's percentage of mangoes during storage increase, only fruit kept in PE plastic bags after three weeks indicated the lowest decay (Figure 5). It assumed that the lowest value because of PE plastic bags provide suitable condition of storage lead to low water release by respiration/ transpiration [22]. The symptoms of decays in mangoes were notice on the skin changes from green to brownish green lesions after 2 weeks storage. Barmore [2] stated that the advantage of MAS with KMnO4 was delayed ripening process due to low external ethylene in package. Supported by Porat [25] who found that MAS reduced postharvest rind disorders in citrus fruit.

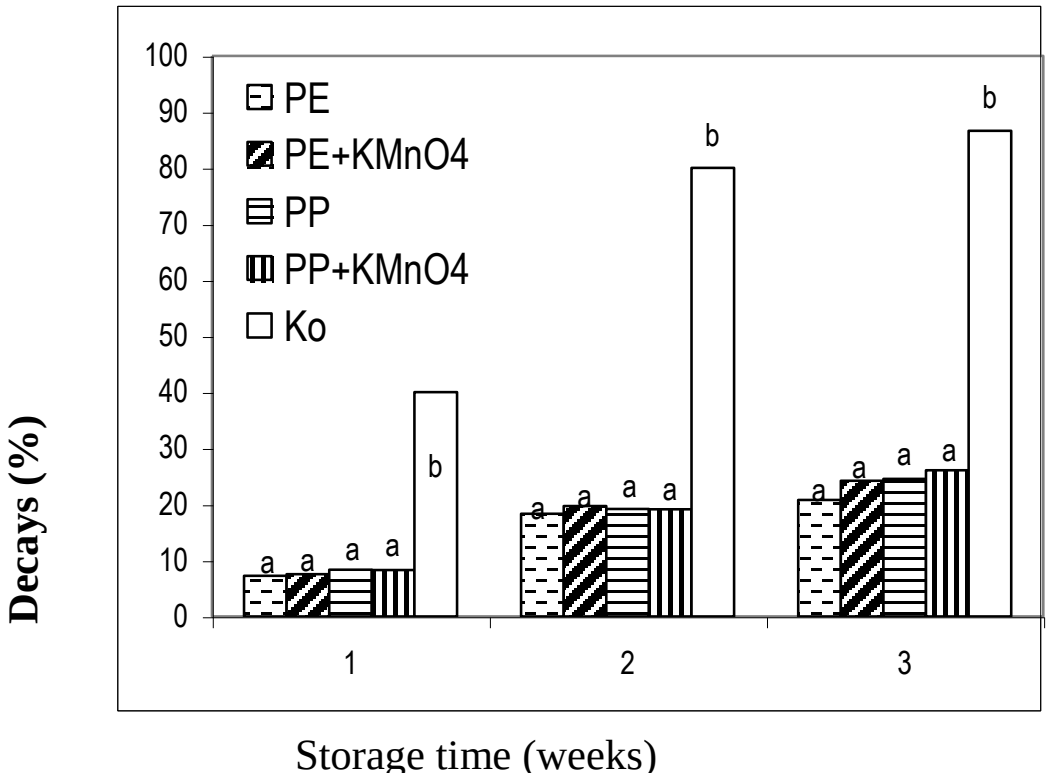

Figure 5. *Decays percentage of mangoes stored in MAS for 1,2 and 3 weeks. The graph that followed by the same letter at the same time storage indicated no significant according to LSD 5 %.*

CONCLUSSION

1. Inactivation of ACC_O occurred to almost half-time of its activity in MAS as compared to air storage.
2. The rate of respiration and production of ethylene at MAS was inhibited leads to extend the storage life of mangoes.
3. Weight losses and decay's percentage of mangoes kept in MAS for 3 weeks were lower than unpacked.

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