



## Effect of Nitrous Oxide on Physiological and Biochemical Changes during Fruit Drop of Longkong Postharvest

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**Abstract** Longkong (*Aglaia dookkoo* Griff) is a popular tropical fruit which currently has about 99.37% consumer demand. In the case of exporting, the main problem is that longkong fruit drops from its bunch after harvesting. Therefore, the objective of this research is to study the effect of nitrous oxide on physiological and biochemical changes during fruit drop of longkong postharvest. The addition of 90% nitrous oxide (at times 1, 3, 6, 12 and 24 h) induced the reduction of loosening of longkong fruit after harvest. Exposure to nitrous oxide delayed the onset of fruit drop of the longkong bunches with the most effective treatment being fumigation with 90% nitrous oxide for 6 h. Longkong fruit exposed to 90% nitrous oxide for 24 h, showed an increased respiration rate and ethylene production. While Longkong fruit exposed to 90% nitrous oxide, there was no significant effect on the activity of enzymes polygalacturonase (PG), pectinesterase (PE), cellulase (Cx) and peroxidase (POD) during storage.

**Keywords** longkong, fruit drop, nitrous oxide

### INTRODUCTION

Longkong (*Aglaia dookkoo* Griff.) is a subtropical fruit which can be grown in various parts of Thailand. The quality deterioration of longkong leads to consumer rejection that makes the product cannot be sold. Besides, there is a loss of economic value for both producers and consumers. Senescence of longkong can be seen as browning, disease, and fruit drop, which is a critical problem that results in a lower sales price. The study of morphology shows change in abscission zone (AZ) area which has cell wall degradation in the middle lamella (Oberholster et al., 1991; Sexton et al., 1983) as well as microfibril expansion and disorganization in the primary cell wall in the AZ (Sexton and Robert, 1982). Enzymes associated with degradation of the cell wall are pectin esterase (PE), endo-polygalacturonidase (PG), exopolygalacturonase, rhamnogalacturonase,  $\alpha$ -galactosidase and cellulase (Downs et al., 1992). In grapes, the stem of the fruit becomes detached from the fruit in the area which gradually extends from the sides of the phloem until the middle of the tissue and causes fruit drop. The fruit drop of grapes is related to an increase of the cellulose enzymes hydrolases and polygalacturanase in AZ (Deng et al., 2007). Nitrous oxide (N<sub>2</sub>O) is a natural occurrence of atmospheric gas principally produced by aerobic denitrifying bacteria in soil, which has been demonstrated to inhibit ethylene action and synthesis in higher plants (Frontiera et

al., 1994; Gouble et al., 1995; Leshem and Wills, 1998). N<sub>2</sub>O, like CO<sub>2</sub>, has an isosteric linear structure that confers similar physical properties such as relative stability and high solubility to both molecules (Leshem and Wills, 1998; Benkeblia and Varoquaux, 2003). This biophysical similarity of N<sub>2</sub>O to CO<sub>2</sub> might be pertinent to the control of ethylene in the controlled atmosphere storage of postharvest climacteric fruit (Leshem and Wills, 1998). In addition, N<sub>2</sub>O is not toxic. It is used in medical practice as an anaesthetic (Gouble et al., 1995), and it is a permitted additive for food (Benkeblia and Varoquaux, 2003). Other studies report the inhibition of postharvest decay of fruit by N<sub>2</sub>O, which have also been carried out in the non-climacteric strawberry and mandarin, and in the climacteric fruit apple, persimmon and tomato (Qadir and Hashinaga, 2001). Therefore, in this study, we determined the effects of N<sub>2</sub>O gas on the reduction of fruit drop of longkong after harvest.

## **OBJECTIVES**

The objective of this study was to determine effects of N<sub>2</sub>O gas on the reduction of fruit drop of longkong after harvest.

## **METHODOLOGY**

Freshly harvested bunches of longkong with full yellow fruits were procured from a commercial orchard. Each bunch longkong was separated into individual bunches, which were placed into sealed plastic chambers with 90% N<sub>2</sub>O with 20% O<sub>2</sub> for 0, 1, 3, 6, 12 or 24 hours at 20°C. After treatment, the fruits were stored at 13°C with 90±5% relative humidity. The treatments were replicated three times with 25 fruit bunches per replication. Standard procedures were followed in measuring fruit drop, weight loss, respiration rate (Gemma et al., 1994), ethylene production (Gemma et al., 1994), PG (Lohani et al., 2004; Pathak and Sanwal, 1998), PME (Abu-Goukh and Bashir, 2003; Nagel and Patterson, 1967), Cx and POD activities (Lohani et al., 2004).

## **RESULTS AND DISCUSSION**

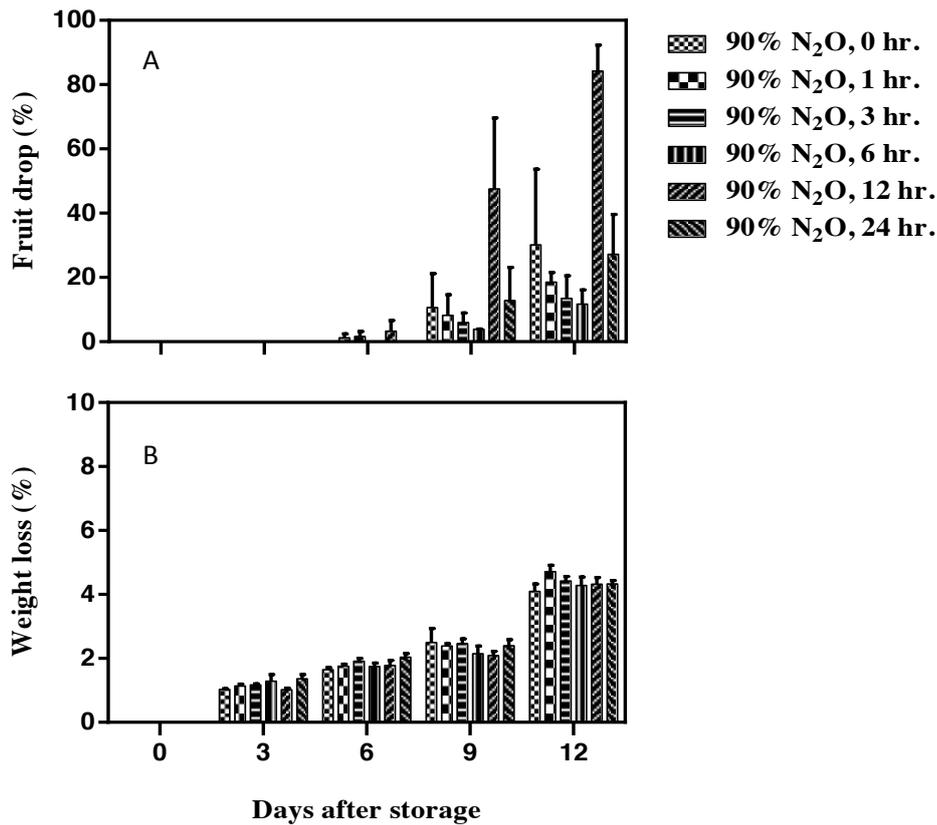
Longkong fruit was fumigated with 90% nitrous oxide (N<sub>2</sub>O) for 0, 3, 6, 12 and 24 hours followed by storage at 13 °C. The result showed that the longkong fumigated with 90% N<sub>2</sub>O for 0, 6 and 24 hours delayed the fruit drop for 6 days. At hour 6, the fruit drop of longkong was 11.69%, whereas longkong fumigated with 90% N<sub>2</sub>O for 12 hours had the highest occurrence of fruit drop with 84.21% on day 12 of storage (Fig. 1A). Weight loss of longkong fumigated with N<sub>2</sub>O increased over the duration of storage, which averaged 4% weight loss (Fig. 1B).

There was no statistical comparison of the relative effect of weight loss and nitrous oxide because the low temperature storage delayed the weight loss and reduced deterioration of the longkong. The respiration rate of longkong fumigated and non-fumigated with N<sub>2</sub>O slowly increased during storage time, the control fruit had a lower respiration rate than the longkong fumigated with N<sub>2</sub>O, especially with fumigation for 24 hours which had the highest rate of respiration in day 12 of storage (76.77 mL CO<sub>2</sub>.kg<sup>-1</sup>.h<sup>-1</sup>) (Fig. 2C).

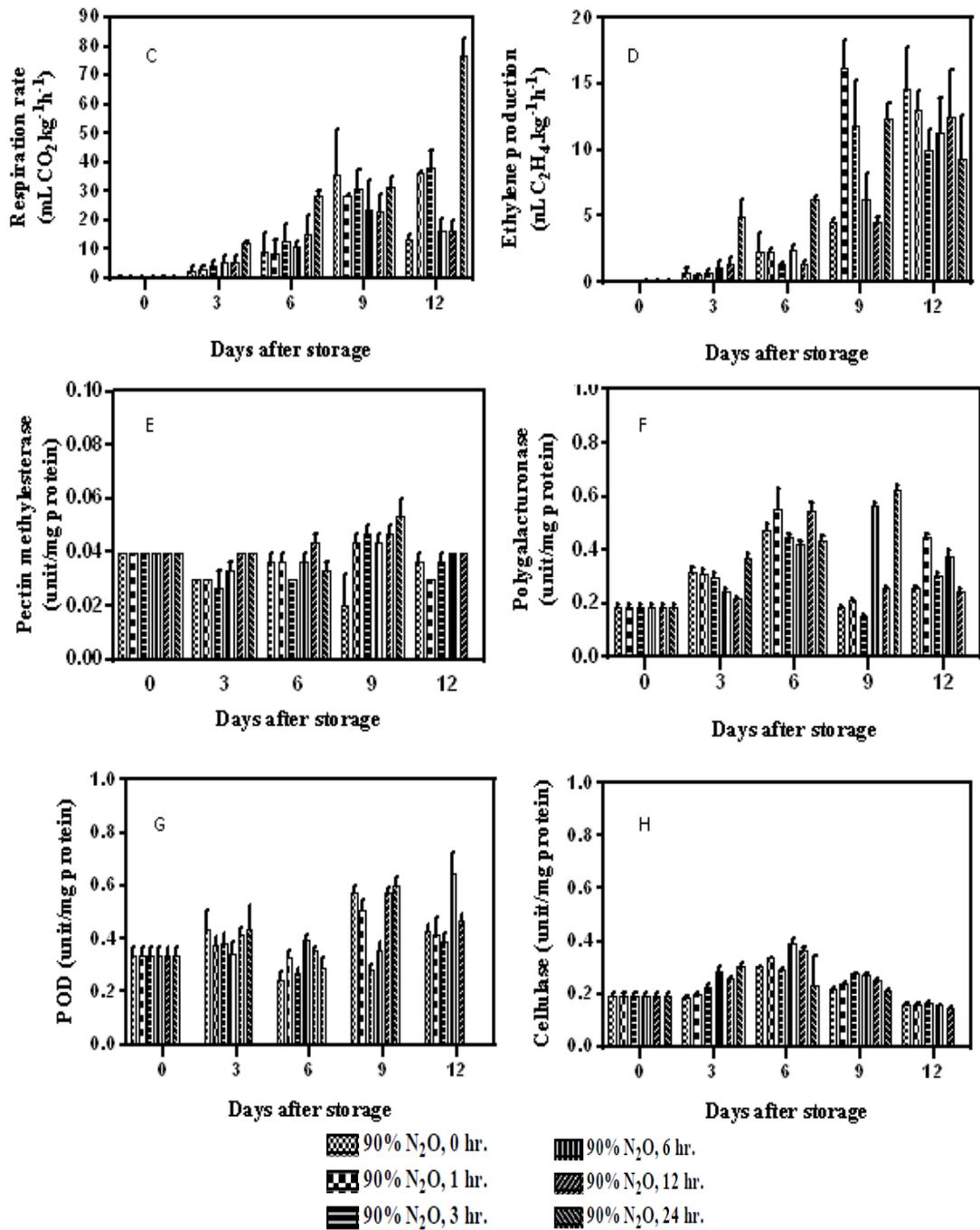
Fruit fumigated with N<sub>2</sub>O for long time may result in an increase in respiration and ethylene production rates (Oszmianski et al., 1985; Macheix et al., 1990). Ethylene production of longkong fumigated with N<sub>2</sub>O for 24 hours rapidly increased more than that of other fumigations on day 3 and day 6 of storage. However, longkong fumigated with N<sub>2</sub>O less than 3 hours had lower the ethylene production on day 3. It is possible that N<sub>2</sub>O may delay deterioration through two mechanical formulas (Gouble et al, 1995; Bemish et al, 1996). In the first form, N<sub>2</sub>O bonded with ethylene. In the second form, N<sub>2</sub>O inhibited ACC Oxidase (ACO) and synthesis ACC synthase (ACS) with N<sub>2</sub>O and CO<sub>2</sub>, which both forms had similar functions. However, the effect of N<sub>2</sub>O and CO<sub>2</sub> maintained the quality of strawberry (Qadir et al., 2000). If N<sub>2</sub>O bonded with ethylene, then ethylene could not bond with itself. It was resulting in delay of the senescence for a short time,

which ripening or senescence occurred. At day 12, there was no significant difference for the ethylene production in all treatments (Fig. 2D).

Research in other fruit species indicates that hydrolytic enzymes, including endo-beta-1, 4-glucanase (cellulose), polygalacturonase (PG), pectinmethylesterase (PME), play a significant role in the abscission stage by affecting middle lamella dissolution and cell-wall degradation and stimulating with exogenous ethylene (Tucker et al., 1984; Taylor et al., 2001), as well as with high activity when there was fruit drop such as with grapes (Deng et al., 2007). As a result, pectin methylesterase (PME) activity in the first day was equal to 0.040 unit/mg protein, after that the activity decreased in the longkong fumigated with N<sub>2</sub>O for 3 hours on day 3 and 6 of the storage. Subsequently, activity of enzymes increased at first and then decreased in the end of storage, while longkong fumigated with N<sub>2</sub>O for 12 and 24 hours maintained the activity of PME during storage (Fig. 2E). Polygalacturonase activity increased after storage until day 6 and reduced over the storage. Longkong fumigated with N<sub>2</sub>O for 6 and 12 hours had lower polygalacturonase activity than the control fruit on 3 day of storage. (Fig. 2F). Cellulase activities increased until the maximum on day 6 and then reduced after that. On day 3, Longkong fumigated with N<sub>2</sub>O for each time period had higher cellulase activity than the control fruit (Fig. 2G). Peroxidase enzymes activities of fumigation and control fruit showed no statistical difference in the peroxidase activity on 3 days of storage, reduced the activity on day 6, and increased on day 9 of storage. Longkong fumigated with N<sub>2</sub>O for 3 and 6 hours had the peroxidase enzyme activity equal to 0.280 and 0.353 unit/mg protein, while longkong fumigated with N<sub>2</sub>O for 0, 1, 12 and 24 hours had the activity equal to 0.570, 0.507, 0.570 and 0.597 unit/mg protein, respectively (Fig. 2H).



**Fig. 1** Change in fruit drop (A), weight loss (B) in abscission zone of longkong exposed to 90% nitrous oxide for 0, 1, 3, 6, 12 or 24 h and then stored at 13 °C



**Fig. 2** Change in respiration rate (C), ethylene production (D), pectin methylesterase (E), polygalacturonase (F), peroxidase (G), cellulase (H) in abscission zone of longkong exposed to 90% nitrous oxide for 0, 1, 3, 6, 12 or 24 h and then stored at 13 °C

## CONCLUSION

Longkong fumigated with 90% N<sub>2</sub>O for 6 hours, delayed the fruit drop but showed no effect on activities of PG, PME, Cx and POD during storage.

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