Effect of static magnetic field on ripening of Thai cavendish bananas

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Abstract. This study aimed to investigate the effects of static magnetic fields on the ripening of Thai cavendish banana fruits. The cavendish bananas were received from an agriculturist in Kanchanadit District, Surat Thani province, Thailand. NeFeB magnets were used to generate the maximum static magnetic fields of 300 mT and 600 mT. The ripening of the banana fruits was recorded in terms of weight loss, color change and firmness after exposure to a magnetic field. The results showed that the weight loss of the banana fruit when exposed to magnetic field was higher than in the not exposed control group. Increasing the magnetic field strength to 600 mT increased the weight loss further from that with 300 mT. The effects of magnetic field on weight loss of bananas were statistically significant, but there were no statistically significant differences in color or firmness from the control group.

1. Introduction
Banana is a climacteric fruit and its peel color changes from mature to ripe stage. Bananas are normally harvested in mature stage (green color) and are sold at mature or ripe stages. The stage of maturation at which any fruit is harvested greatly influences its green-life. Postharvest techniques to increase shelf life are mainly based on controlled atmospheres. Song et al. [1] investigated the effects of CO$_2$ treatment on the ripening of banana. They found that bananas stored in 20% CO$_2$ environment had retarded ripening. It was suggested that the CO$_2$ in controlled atmosphere might inhibit respiration rate of bananas. Hence, modified CO$_2$ rich atmosphere can be used to slow down the ripening. In addition, Amin and Hossain [2] investigated extending the shelf-life of bananas with a hot water treatment. The shelf-life of bananas increased with treatment duration in 47 °C water. In contrast, mature bananas were dipped into ethrel solutions and were then kept on newspapers on the laboratory table at room temperature [3]. The results showed that the ethrel treatment accelerated the ripening of bananas. When the concentration of ethrel was increased, the firmness decreased and weight loss increased. It is possible that the respiration causes weight loss by evaporation of water.

Alternative methods are being investigated to neither delay nor accelerate the shelf-life of fruits. Treatment with a magnetic field is an interesting alternative. Generally, magnetic fields have been widely researched for growth stimulation of seedlings or for germination of seeds [4,5]. However, the effects of a magnetic field on fruit ripening are still not clear. Bourget et al. [6] studied the effects of a
low static magnetic field (2.5 mT) on the ripening and senescence of tomatoes, observing no significant differences in color of weight loss between control and magnetic field exposed samples. They suggested that a higher intensity of magnetic field may be necessary to impact the ripening of tomatoes.

However, no effects of a magnetic field on the ripening of bananas have been reported. We hypothesized that exposure to a stronger magnetic field (> 2.5 mT) might affect the ripening of bananas. Here we report on the effects of magnetic field on weight loss, color change, and firmness of bananas after harvesting.

2. Materials and methods
Thai cavendish bananas were received from an agriculturist in Kanchanadit District, Surat Thani province, Thailand. The number of bananas for each experimental condition was nine fruits, collected from the same bunch. Each bunch of bananas for these experiments was collected from the same stalk. The bananas were exposed to a static magnetic field of either 300 mT or 600 mT intensity, and compared to a control group of not exposed bananas.

The maximum magnetic field of 300 mT was generated with rectangular NeFeB magnets (length 100 mm, width 10 mm, and thickness 5 mm); and cylindrical NeFeB magnets generated the maximum magnetic field of 600 mT. The magnetic fields were measured with a tesla meter.

Banana ripening was evaluated on days 2, 4, 6 and 8 of storage. The observed characteristics were weight, firmness and color. The weight loss was calculated from initial weight. Firmness was measured in a penetration test with a 5-mm cylindrical probe for the bananas, using a texture analyzer (TATX2). Color was monitored with Minolta colorimeter, and is expressed with b* coordinate in the CIE L*a*b* space.

3. Results and discussion

Figure 1. Effects of static magnetic field (300 mT) on (a) weight loss, (b) firmness, and (c) color of Thai cavendish bananas.
This investigation showed that 300 mT and 600 mT magnetic fields affected the ripening of Thai cavendish bananas. The magnetic field accelerated the ripening of bananas. Figures 1 and 2 show the effects of static magnetic fields on observed weight loss, firmness, and colour. The weight losses of bananas exposed to 300 mT or 600 mT fields were higher than in the control group, as seen in figures 1(a) and 2(a), and the differences were statistically significant. Further, the difference between control and actual treatment was larger with 600 mT than with 300 mT field intensity. Banana is a climacteric fruit losing water during its ripening [3], and this shows in the weight loss. The results suggest that a magnetic field accelerates the respiration of the bananas, increasing the loss of water and weight. In addition, a magnetic field reduces the “degree of polymerization” in water [7]. Then water could more easily diffuse within a banana and escape by evapotranspiration.

The firmness of bananas decreased with ripening. Exposure to a magnetic field, 300 mT or 600 mT, gave larger decrease than in the control group, as seen in figures 1(b) and 2(b), but these effects were not statistically significant. On the other hand, the green color of bananas exposed to a magnetic field tended to change to yellow more rapidly than in the control group, as shown in figures 1(c) and 2(c) and 3. However, statistical significance was not reached by these differences either. Color of bananas in control and magnetic groups was green at the beginning, but the shade of green color had slight initial differences as seen in figure 1(c). Nevertheless, the bananas in these experiments were all collected from the same stalk.
Figure 3. The photographs of bananas from unexposed control group (a) at the beginning and (b) after storage for 6 days, and from magnetic field (300 mT) exposed group (c) at the beginning and (d) after storage for 6 days.

4. Conclusions
Magnetic fields of 300 mT and 600 mT intensities accelerated ripening of Thai cavendish banana fruit. The weight loss of bananas obviously increased after exposure to magnetic field for 8 days, relative to untreated control. Both treatment intensities tended to decrease firmness and accelerate color change, but these differences from the control group were not statistically significant.

Acknowledgements
This research was partially supported by Prince of Songkla University, Surat Thani Campus (Through the student project scholarship, 2017).

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