Thesis Title	Effects of Essential oil and Modified Atmosphere Packaging on Quality and Shelf Life of Chilled Shrimp
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Abstract

This study aimed to test the effectiveness of essential oils from Thai medicinal plants, including garlic, lemongrass and holy basil combined with modified atmosphere packaging (40% CO_2+60% N_2 and 60% CO_2+40% N_2) on shelf life extension of chilled shrimp stored at 8±2 °C. The research was divided into three steps. In the first step, the inhibition efficiency of essential oils from garlic, lemongrass and holy basil was tested by determination of the minimum inhibitory concentration (MIC) and the minimal bactericidal concentration (MBC). In the second step, essential oils from garlic, lemongrass and holy basil in combination with modified atmosphere packaging (MAP) was studied on quality and shelf life of chilled shrimp. Finally, a challenge test by spiking *E. coli* (10^3cfu/mL) on chilled shrimps treated with essential oils from garlic, lemongrass and holy basil and combined with MAP conditions was conducted and numbers of *E. coli* were monitored during chilled storage.

The results of the first step indicated that the minimum inhibitory concentration and minimum bactericidal concentrations (MIC/MBC) of garlic oil for *Escherichia coli, Staphylococcus aureus*, *Salmonella* Typhimurium, *Vibrio parahaemolyticus* and *Shewanella putrefaciens* were 5/15, 2.5/5, 5/10, 2.5/10 and 5/10 mg/mL, respectively. The MIC/MBC of lemongrass oil for *E. coli, S. aureus*, *S.* Typhimurium, *V. parahaemolyticus* and *S. putrefaciens* were 10/20, 5/15, 10/20, 5/15 and 10/20 mg/mL, respectively, while the MIC/MBC of holy basil oil for *E. coli, S. aureus*,

S. Typhimurium, *V. parahaemolyticus* and *S. putrefaciens* were 10/25, 5/20, 5/25, 5/20 and 10/25 mg/mL, respectively. The experimental results showed that garlic oil gave the best inhibition effect against five types of microorganisms used in this research. The kinetics of inhibition by three essential oils showed that D and Z values of garlic oil ranged between 0.58 - 1.05 hours and 5.88 - 7.57 mg/mL, respectively. D and Z values of lemongrass oil ranged between 1.35 - 3.43 hours and 8.84 - 10.41 mg/ml, respectively while D and Z values of holy basil oil ranged between 0.97 - 3.79 hours and 12.41 - 15.75 mg/mL, respectively.

In the second part, the effect of essential oils from garlic, lemongrass and holy basil in combination with modified atmosphere (40% CO_2+60% N_2 and 60% CO_2+40% N_2) conditions on quality and shelf life of chilled shrimp stored at 8$\pm$2 °C was studied. The results showed that the number of total viable counts, TMA, TVB-N and pH values significantly increased with a storage time ($p\leq0.05$). Essential oils and modified atmosphere packaging significantly affected parameters tested. The number of total viable counts of shrimps treated with essential oils from garlic, lemongrass and holy basil were significantly ($p\leq0.05$) lower than that of shrimps untreated with essential oils. However, the modified atmosphere packaging significantly ($p\leq0.05$) provided higher efficiency than essential oil. The results showed that 60% CO_2+40% N_2 condition prolonged the shelf life of shrimp as compared with shrimp packed under 40% CO_2+60% N_2 and normal (air) conditions. Garlic oil incorporation with 60% CO_2+40% N_2 condition was the most effective treatment to reduce the spoilage of shrimp. The maximum specific growth rate (μ_{max}) for total viable counts of shrimps treated with garlic oil incorporation with 60% CO_2+40% N_2 condition was 0.23 log CFU/g.day and the lag phase duration value (L) was 6.71 days. The microbiological and sensory evaluation results indicated that the shelf life of chilled shrimp was 18 days at the storage temperature of 8$\pm$2 ^{o}C.

In the final step, a challenge test by spiking *E. coli* on chilled shrimps treated with essential oils from garlic, lemongrass and holy basil and combined with modified atmosphere (40% CO_2+60% N_2 and 60% CO_2+40% N_2) conditions was conducted and stored at 8$\pm$2 °C. The results showed that type of essential oils and modified atmosphere packaging significantly affected the maximum specific growth rate and lag phase duration values ($p\leq0.05$). Garlic oil was the most effective essential oil to reduce the maximum specific growth rate and extend lag phase duration of *E. coli* with μ_{max} and L values of 0.26 log CFU/g.day and 0.62 day, respectively. μ_{max} and L values for

E. coli of shrimp treated with lemongrass and holy basil oil ranged between 0.29 - 0.31 log CFU/g.day and 1.10 - 1.33 day, respectively while μ_{max} and L values for *E. coli* of shrimp packed under 60% CO_2+40% N_2 condition ranged between 0.19 - 0.24 log CFU/g.day and 1.81 - 2.59 days, respectively. μ_{max} and L values for *E. coli* of shrimp packed under 40% CO_2+60% N_2 condition ranged between 0.23 - 0.31 log CFU/g.day and 1.44 - 2.03 days, respectively. No growth of *E. coli* on shrimps treated with each essential oil incorporation with each MAP condition during the storage was observed.

Keywords: Essential Oil/ Garlic/ Lemongrass/ Holy basil/ Modified Atmosphere /Shrimp