A Study of the Physical Properties of Alginate-Based Coatings Incorporate with Zingiber montanum and Curcuma longa Extracts for Inhibiting *Colletotrichum* spp. in Nam Dok Mai Mangoes.

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Abstract

Nam Dok Mai mango is a widely cultivated variety in Thailand, highly regarded for its sweet flavor, pleasant aroma, and premium quality, making it ideal for export. However, production faces significant challenges from anthracnose disease caused by the fungus *Colletotrichum* spp., which leads to fruit rot and substantial economic losses. This study developed an alginate coating enriched with Cassumunar ginger and turmeric extracts to combat anthracnose in Nam Dok Mai mangoes. Results showed that a 75:25 ratio, using a 95% ethanol solvent, achieved optimal physical properties and a 69.89% antifungal efficiency. This natural alternative effectively extends shelf life and reduces chemical reliance, offering a sustainable solution for the mango export industry.

Keywords : Sodium Alginate, Cassumunar ginger, Curcuma longa, Curcumin, Anthracnose

Introduction

Nam Dok Mai mango is one of the most widely cultivated mango cultivars in Thailand due to its excellent quality, including its sweet flavor, fine texture, and attractive appearance. These characteristics make it highly suitable for commercial production, particularly for export to major markets such as China, Japan, and South Korea, while remaining popular in the domestic market and generating significant income for Thai farmers.

However, maintaining export-quality fruit is challenged by anthracnose disease caused by *Colletotrichum* spp., which produces necrotic lesions on the fruit surface, reduces fruit quality, and causes substantial economic losses. Survey reports have indicated that postharvest losses are particularly severe, with anthracnose damage reaching up to 46% at Talad Thai, the largest wholesale fruit market in Thailand.

To address this problem, alginate-based edible coatings have been investigated as a natural method for reducing water loss, delaying gas exchange, preventing pathogen infection, and extending fruit storage life. In addition, extracts from Zingiber montanum and Curcuma longa have been incorporated into the coating. These extracts contain bioactive compounds with antifungal activity against

Colletotrichum spp. and have the potential to enhance disease resistance while reducing reliance on synthetic fungicides.

The combination of alginate edible coating with Zingiber montanum and Curcuma longa extracts is expected to improve anthracnose control by providing both a physical barrier and antifungal activity. This approach offers a promising, safe, and sustainable strategy for protecting mango quality and supporting commercial production.

Methodology

1) Extraction of Zingiber montanum and Curcuma longa Extracts

1.1 Preparation of Zingiber montanum and Curcuma longa Powders

1. Slice 1 kg each of Zingiber montanum and Curcuma longa rhizomes into thin pieces.

2. Dry the sliced rhizomes in a hot-air oven at 50°C for 2 days, or until completely dry.

3. Grind the dried rhizomes into fine powders.

1.2 Extraction of Zingiber montanum and Curcuma longa

1. Mix the Zingiber montanum and Curcuma longa powders at a 1:1 (w/w) ratio.

2. Add the mixed powders to the extraction solvent consisting of 95% ethanol and distilled water at a 1:4 (w/v) ratio.

3. Shake the mixture using an orbital shaker at 200 rpm for 30 minutes.

4. Filter the extract using a vacuum filtration system.

5. Remove the solvent from the filtrate using a rotary evaporator to obtain the crude extract.

2) Evaluation of the Antifungal Activity of Zingiber montanum and Curcuma longa Extracts

1. Culture *Colletotrichum* spp. on Potato Dextrose Agar (PDA) medium.

2. Evaluate the antifungal activity of the Zingiber montanum and Curcuma longa extracts using the disc diffusion method.

3. Record the diameter of the inhibition zone produced by the extracts.

3) Preparation of Alginate-Based Edible Coatings Containing Zingiber montanum and Curcuma longa Extracts

Prepare the edible coating by mixing sodium alginate with Zingiber montanum and Curcuma longa extracts at different alginate solution-to-extract ratios of 0:100, 25:75, 50:50, 75:25, and 100:0.

4) Evaluation of the Physical Properties of the Alginate-Based Edible Coating Containing Zingiber montanum and Curcuma longa Extracts

1. Determine the curcumin content in the Zingiber montanum and Curcuma longa extracts.

2. Evaluate the antifungal inhibition zone of the extracts.

3. Determine the viscosity and flow velocity of the edible coating according to Stokes' law.

4. Evaluate the deterioration rate of Nam Dok Mai mangoes by measuring the L* (lightness) value.

Result and Discussion

The results of the study entitled "A Study of the Physical Properties of Alginate-Based Coatings Incorporate with Zingiber montanum and Curcuma longa Extracts for Inhibiting *Colletotrichum* spp. in Nam Dok Mai Mangoes" are presented as follows.

Table 1 Recording the Color of Curcumin in Curcuma longa and Cassumunar ginger Extracts

Different Solvents	Color of the extract	
	Color Before Testing	Color After Testing
Control Group (Water)	Clear	Clear
Water	Yellow	Yellow
Ethyl Alcohol 95%	Orange-Yellow	Reddish-Orange

In the aqueous extract, the solution appeared yellow and remained unchanged after the assay. Conversely, the 95% ethanol extract exhibited a yellow-orange coloration, which subsequently shifted to reddish-orange post-testing.

Table 2 Recording the Inhibition Zone of Curcuma longa and Cassumunar ginger Extracts (cm)

Day	Inhibition Zone							
	Water				Ethyl Alcohol 95%			
	Trial 1	Trial 2	Trial 3	Average	Trial 1	Trial 2	Trial 3	Average
1	1.2	1.1	0.7	1.00 ± 0.26	2.1	3.0	2.5	2.53 ± 0.45
2	0.9	1.1	0.6	0.87 ± 0.25	2.2	3.1	2.5	2.60 ± 0.46
3	0.9	1.0	0.6	0.83 ± 0.21	2.3	3.2	2.6	2.70 ± 0.46
4	0.8	0.8	0.5	0.70 ± 0.17	2.3	3.4	2.7	2.80 ± 0.56
5	0.8	0.7	0.4	0.63 ± 0.21	2.4	3.4	2.7	2.83 ± 0.51
Overall average				0.810 ± 0.22				2.692 ± 0.49

The aqueous extract exhibited a mean zone of inhibition of 0.810 cm. In comparison, the extract obtained using 95% ethyl alcohol demonstrated a significantly higher mean inhibition zone of 2.692 cm.

Table 3 Inhibition Zone of Curcuma longa and Cassumunar ginger Extracts

Day	Inhibition Zone					
	Water			Ethyl Alcohol 95%		
	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
1						
2						
3						
4						
5						

Table 4 Movement Rate of Steel Balls in Coating Substances (m/s)

Extract Ratio	Movement Rate of Steel Balls (m/s)
0:100	1.000
25:75	0.215
50:50	0.196
75:25	0.143
100:0	0.122

The results indicated that an increase in the alginate ratio led to a continuous decline in the velocity of the steel ball.

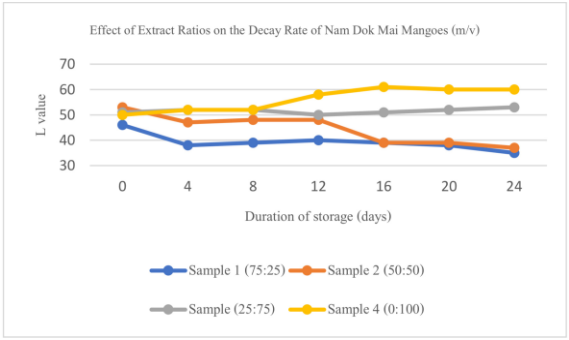

Fig. 1 Effect of Extract Ratios on the Decay Rate of Nam Dok Mai Mangoes (m/v)

Conclusions

This study demonstrated that alginate-based edible coatings containing Zingiber montanum and Curcuma longa extracts effectively inhibited the growth of *Colletotrichum* spp. Extracts prepared with 95% ethanol contained detectable curcumin, whereas curcumin was not detected in extracts prepared with water.

The average inhibition zone of the aqueous extract was 0.81 cm, while the extract prepared with 95% ethanol produced an average inhibition zone of 2.69 cm, corresponding to an inhibition efficiency of 69.89%.

The evaluation of the physical properties of the edible coatings showed that the 75:25 formulation exhibited a steel ball velocity of 0.143 m/s, indicating the most suitable viscosity for fruit coating applications. In addition, formulations containing higher proportions of Zingiber montanum and Curcuma longa extracts were more effective in maintaining the freshness of Nam Dok Mai mangoes and delaying fruit decay. Overall, the 75:25 formulation provided the best balance between antifungal activity, appropriate physical properties, and preservation efficiency, making it the optimal formulation for extending the postharvest quality of Nam Dok Mai mangoes.

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