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***Research paper***

# The Effects of Rice Flour Solution and ZnO Nanoparticles Coated on Mango to Inhibit Anthracnose Disease

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## Abstract

Nowadays nanotechnology is used in many applications including electronic devices, sensor, solar cell, pharmaceutical and food and agriculture industry as well. One of the main contributions of nanotechnology in agrotechnology industry is preservation of post-harvest product through coating process. A mango fruit is very perishable and so has a short shelf life, which both marketers and consumers would like to be longer. In this study, mango fruit was coated with ZnO and rice flour solution of 3 mg/ml and 5 mg/ml manually and was stored at room temperature for 7 days to observe the growth of black spot daily. The weight loss was also evaluated. The mixed coating materials which is ZnO and rice flour inhibited the growth of microorganisms. The results in SEM show that the nanoparticles agglomerates. The data revealed that applying ZnO coating effectively prolonged the quality attributes and extends the shelf life of mango fruit.

***Keywords***: *nano-ZnO, rice flour coating, mango fruit, shelf life, anthracnose*

## 1. Introduction

Nanotechnology is an interdisciplinary area of knowledge towards the application of nanotechnology. Nanotechnology can be applied in many areas such as electronics and communication, medicine and food and agriculture industry. Nanotechnology is always associated with green technology and has potential for sustainable technology and products. Therefore, nanotechnology has very good potential for use in food security initiatives to sustain agricultural food supply.

One of the important contribution of nanotechnology on sustainable agriculture product is through nanocoating to extend the freshness and inhibit fungal growth. It also has potential to increase agriculture yield by using nano-fertilizer, nano pesticide control and nano-stimulant. In food product industry, nanotechnology is widely used for packaging, improving the taste and food safety as well as to improve shelf life.

Mango (*Mangifera indica L.*) fruit is a climacteric fruit with high commercial value on the international market. Mango is a delicious fruit with fine taste, high palatability, sweet fragrance, attractive colour and high nutritional value. Mango contains a good source of vitamin A and B-complex. Although, mango is easy to cultivate but the main problem of mango is the Anthracnose disease in Mango which can occur when it is cultivated.

Anthracnose disease is the main post harvesting disease in mango. It is caused by *Collectotrichum gloeosporioides* [1]. It can damage mango and make the yield of mango decrease [2]. It also has effects on the consumer market who refuse to purchase when they see mango with black spots. Anthracnose disease can damage the plant form young, sapling, inflorescence, flower and also during fruiting period [3]. In this research, the focus is to study the growth of black spots after harvesting. The symptom of anthracnose disease is the black spot on mango. The spot changes from brown color to black color. In addition, it can penetrate deeply into the fruit when the fruit is ripe [4]. Therefore, anthracnose disease affects the economy due to loss of yield. Most agriculture venture use fungicide to prevent anthracnose disease in mango to prevent the disease from occurring.

Nanotechnology in food sector is mostly used in food packaging as bio-nanocomposite. Normally, nanoparticles use metallic oxide to generate nanoparticles for example silver, zinc and titanium. In this research zinc oxide nanoparticles were used because zinc oxide nanoparticles are safe for human health with certification from GRAS by Food and Drug Administration (SGOCS, 2009). Nanoparticles in food packaging can increase shelf life and prevent microbial growth. There are many ways to inhibit microbial growth using nanoparticles for example nanoparticle as free metal toxicity arising from dissolution of the metal from surface of nanoparticle and oxidative stress to generate reactive oxygen species on surface [5]. Therefore, nanoparticles as food packaging is more environmentally friendly. It doesn't require the use of plastic or non-degradable package because nanoparticles can be used with biodegradable substance for example starch, cellulose, gelatin etc. The biodegradable substance can introduce inorganic particle to be attached to the surface and increase surfactant function [6]. The objective of this research is to optimize zinc oxide nanoparticles with starch coating on mango and determie the coating effect on anthracnose disease in mango.

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## 2. Experimental

### 2.1 Fruit Material

Fresh waterlily mango was purchased and graded for their uniformity in size, shape and color, and fruit without any blemishes were selected for the study. The ripening grade was based on the standard chart. Mold was isolated from the mature water lily mango in Malaysia and cultivated in potato dextrose agar and incubated at $30^0$ C for 7 days.

### 2.2 Preparation of coating formulations

500 ml of distilled water was prepared to make glutinous starch solution. ZnO nanoparticles with different weight was added to the distilled water and stirred to mix it uniformly, to produce different percentage of ZnO nanoparticles in solution. Then, the solution is mixed with starch solution to produce 3 mg/ml and 5 mg/ml of ZnO nanoparticles as gel coating solution.

### 2.3 Coating process

The mango was cleaned by distilled water to remove any dirt and was dried at room temperature. After that it was dipped in 3 mg/ml and 5 mg/ml gel coating solution for 5 minutes. The control samples are uncoated with ZnO nanoparticles-starch solution. The samples were dried and kept in a plastic tray for incubation for 7 days. It is observed every 2 days periodically until day 7.

### 2.4 Determination of disease Severity by percentage area of black spot

The samples were observed periodically according to number of days. The black spots on mango were used indicator of fungal growth. The black spot area was measured and analyzed using ImageMeter apps. The percentage area of black spot can be represented as disease severity and show the improvement of shelf life.

### 2.5 Determination of weight loss

The mango samples were weighed as coated and every two days until day 7. The difference between the initial and final weight of the fruit was considered as total weight loss and the results were expressed as the percentage loss of the initial weight as per the standard method of the AOAC [7].

## 3. Results and Discussion

### 3.1 Disease severity of mango

Fig. 1 shows uncoated mango (control) and mango coated with 3 and 5 mg/ml zinc oxide nanoparticles with glutinous flour. During storage for 7 days at room temperature, anthracnose disease on control mango occurred at day 2 with increase in percentage of disease severity when compared to the coated mango. For the coated mango, anthracnose disease occurred on day 4 with percentage of disease severity much less than the control mango because zinc oxide nanoparticle has antifungal properties which can reduce the percentage of disease severity on mangoes [10]. The results thus show that zinc oxide can retard anthracnose disease. Fig. 2 shows the percentage of Anthracnose disease severity on mango. Percentage of disease severity increased linearly up to 100 % at day 7. The sample coated with 3mg/ml solution shows improvement of disease severity at only around 45 % at day 7. While for sample coated with 5mg/ml gave better improvement with low disease severity, lower than the sample coated with 3 mg/ml at day 4 and day 6. Hhowever, it reaches similar percentage at day 7. Thus ZnO nanoparticles is effective to inhibit the growth of anthracnose disease on mango.

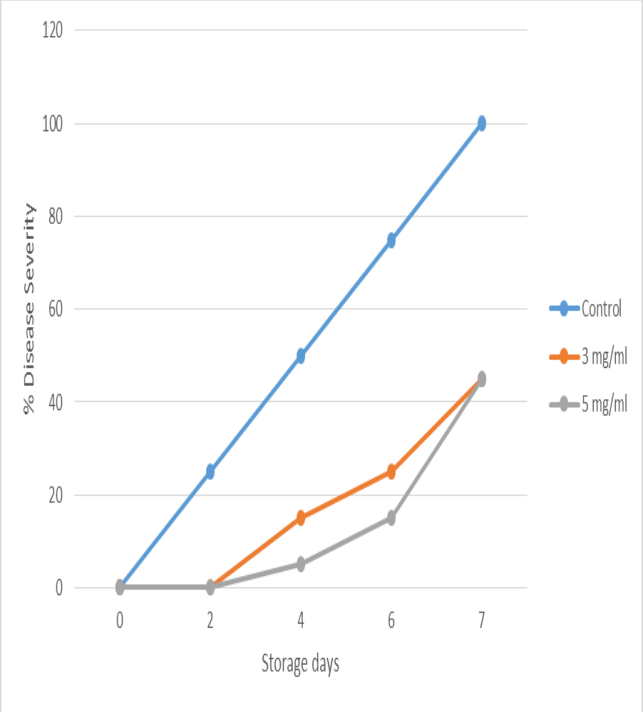


**Fig. 2:** Percentage of Anthracnose disease severity on mango every 2 day

Anthracnose disease in mango is caused by *collectrotrichum gloeosporioides* that makes the black spot on mango [4]. This disease affects fruit quality and consumer acceptance [8]. Therefore, many agriculturist use fungicides to inhibit or reduce anthracnose disease on mangoes. The use of fungicide can inhibit anthracnose disease on mango, however, it has many other effects such as Benomyl can change the skin of mango from green to yellow [9].

### 3.2 Particle distribution of Zinc Oxide nanoparticles

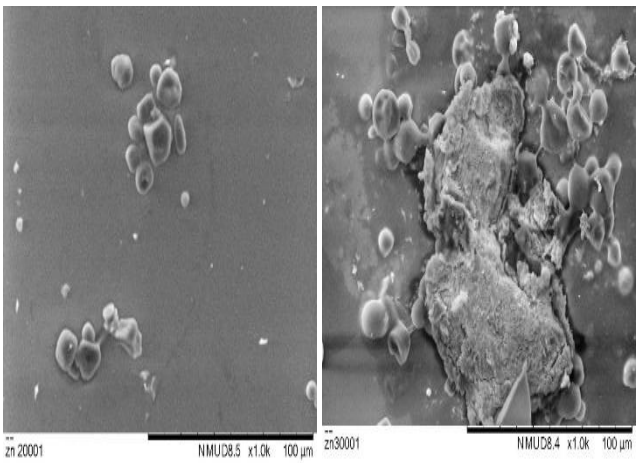


**Fig. 3**: FESEM micrograph of a) 3 mg/ml and b) 5 mg/ml of zinc oxide nanoparticle with glutinous flour solution coated on mango

Fig. 3 shows the FESEM micrograph of 3 mg/ml and 5 mg/ml ZnO nanoparticle with glutinous flour coat on mangoes. ZnO nanoparticle can be attached on mango because of the use of glutinous flour [6] but the distribution is not uniform due to short time of dipping. Also, zinc oxide nanoparticles tend to agglomerate. Therefore, it reduced the efficiency of zinc oxide nanoparticle since the particle is big. Better physical, chemical and biological properties are obtained if the ZnO nanoparticles were smaller in size and if there is less agglomeration [11].

| Condition | Day 0 | Day 2 | Day 4 | Day 6 | Day 7 |
|---|---|---|---|---|---|
| Control (uncoated) | | | | | |
| 3 mg/ml of Zinc oxide nanoparticle with glutinous flour solution | | | | | |
| 5 mg/ml of Zinc oxide nanoparticle with glutinous flour solution | | | | | |

**Fig. 1:** shows the mango with and without coated with ZnO nanoparticles in several day observation.

### 3.3 ZnO nanoparticles existence on Coated Mango

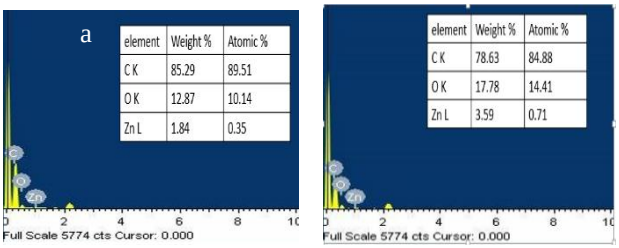


**Fig. 4**: EDX analysis of (a) control mango, (b) 3 mg/ml ZnO nanoparticles with glutinous flour solution and (c) 5 mg/ml ZnO nanoparticles with glutinous flour solution

Fig. 4 shows the EDX results which provide valuable information about the presence of elements. In the control mango, 3 mg/ml and 5 mg/ml of zinc oxide nanoparticles with glutinous starch solution, the percentage weight of Zn is 0 %, 1.84% and 3.59% respectively. In addition, carbon was also detected in all samples.

### 3.4 Percentage of weight loss

Water loss or transpiration can be considered as a major factor that affects the storage life and postharvest quality of most fruits. During our experiment, weight loss increased during the storage for all mango fruits, although a significantly ($p< 0.05$) higher weight loss percentage was noted in the control fruit as shown in Fig. 5. When zinc oxide nanoparticle with glutinous flour solution is coated on mangoes, the percentage of weight loss is less than the control mangoes. So the zinc oxide nanoparticles with glutinous flour can reduce weight loss because glutinous flour is polysaccharide that works as oxygen barrier, moisture barrier and hence reduced water loss from the fruit [12]. At the 7$^{th}$ day of storage period, the weight loss in control mango fruit was highest while the lowest weight loss was noted in 5 mg/ml of zinc oxide nanoparticle with glutinous flour solution. The postharvest water loss can lead to wilting and shriveling, both of which reduces the marketability of the product.

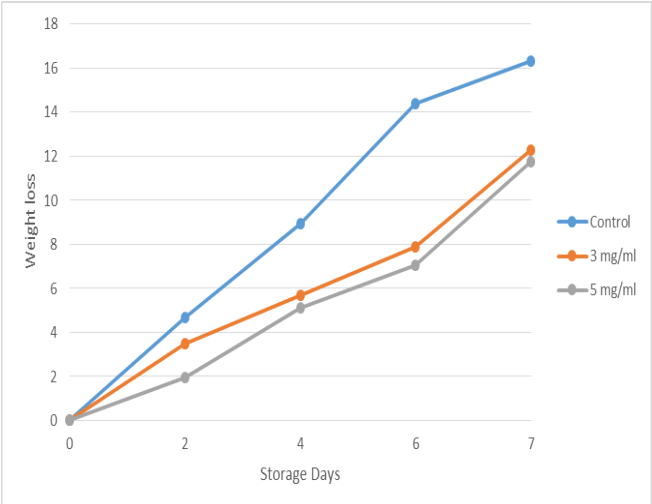


**Figure 5:** Percentage of weight loss in mango that uncoated and coat zinc oxide nanoparticle with glutinous solution during storage for 7 days.

## 4. Conclusion

ZnO nanoparticles with glutinous starch solution can inhibit anthracnose disease in mango and improve its shelf-life. Through this method of coating the distribution of ZnO nanoparticle on mango is considered to be fair. ZnO nanoparticle with glutinous flour solution help to reduce weight loss from mango which is one of the important indicator of the effectiveness of the inhibition process.

## Acknowledgement

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## References

[1] J. J. (1989) Dodd, "Management strategies to control latent infectionin tropical fruits," *Manag. Strateg. to Control latent Infect. Trop. fruits*, pp. 49–46.

[2] R. C. Ploetz., "Anthracnose of mango:Management of the most important pre- and post- harvest disease. Florida: University of Florida, TREC- Homestead.," *Anthracnose mangoManagement Most important pre- post- harvest Dis. Florida Univ. Florida, TREC- Homestead.*, 2012.

[3] S. C. (2008). M. anthracnose (Colletotrichum gloeosporioides). P. disease. Nelson, "Mango anthracnose (Colletotrichum gloeosporioides).," *Mango anthracnose (Colletotrichum gloeosporioides). Plant Dis.*, 2008.

[4] S. C. Nelson, "Mango anthracnose (Colletotrichum gloeosporioides)," *Plant Dis.*, 2008.

[5] A. T. Besinis, "The antibacterial effects of silver, titanium dioxide and silica dioxide nanoparticles compared to the dental disinfectant chlorhexidine on Streptococcus mutans using a suite ofbioassays.," *Nanotoxicology*, p. 1–16.

[6] K. J. Sozer N, "Nanotechnology and its applications in the food sector," *Trends biotechnol*, p. 82–89., 2009.

[7] Anon., "Official method of analysis," vol. 16th ed, no. Assoc.Off.Anal.Chem (AOAC).

[8] S. M. A. Sirelkhatim, "Review on zinc oxide nanoparticles: antibacterial activity and toxicity machanism," *Nano micro*, pp. 219–242, 2015.

[9] I. Muirhead, "Post-harvest control of mango anthracnose with benomyl and hot water," *Exp. Agric. Anim. Husbandry*, pp. 600–603, 1976.

[10] M. j. M. Hajirasouliha, "Effect of novel chitosan nano-particle coating on postharvest qualities of strawberry.," 2012.

[11] B. R. Nicole J, "Antibacterial activity of ZnO nanoparticle suspensions on abroad spectrum of microorganisms," *FEMS Microbiol Lett.*, 2008.

[12] N. P. Gol, "Improvement of quality and shelf-life of strawberries with edible coatings enriched with chitosan.," *Postharvest Biol. Tecnol.*, 2013.