January 2022

THE SECOND INTERNATIONAL CONFERENCE ON GENETIC RESOURCES AND BIOTECHNOLOGY: Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture

Committees: The Second International Conference on Genetic Resources and Biotechnology

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Preface: The Second International Conference on Genetic Resources and Biotechnology

The Second International Conference on Genetic Resources and Biotechnology, which is the continuation of the first event held in 2018, focuses on topics related to advances in biotechnology to create more opportunities for effective conservation and sustainable utilization of genetic resources for food and agriculture. This year conference's theme is Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture. The conference was organized by Indonesian Agency for Agricultural Research and Development (IAARD), Ministry of Agriculture, Indonesia, in collaboration with Indonesian Biotechnology Consortium and held on 24th-25th of May 2021virtually due to the pandemic of COVID-19.

The conference aims to share and exchange current scientific information and technological developments on biotechnology and their applications for conservation and sustainable use of genetic, to encourage and promote quality, efficiency, and modernization of management and utilization of genetic resources, and to facilitate national and international collaboration among participants. There are five scopes discussed in this conference. They are effective management of conservation and sustainable use of genetic resources for food and agriculture, application of genomics and molecular markers for genetic resource conservation and crop adaptation to climate change, application of innovative crop improvement techniques for conservation and sustainable use of plant genetic resources for food and agriculture, plant cell and tissue culture for conservation and effective utilization of genetic resources, and the use of microbial genetic resources as biological control agents of agricultural pests and diseases, and for soil bioremediation.

Five speakers from the United States of America, Japan, India and Indonesia were invited to discuss about their expertise and knowledge on relevant subjects in the plenary sessions. This conference was attended by more than 100 participants including 75 presenters and 44 listeners worldwide. They came from diverse governmental, private, or academic institutions and also scientific communities. The presented materials have undergone peer review processes and only qualified papers were selected. Furthermore, all papers were subjected to double blind peer-review and expected to meet the scientific criteria of significance and academic excellence to be published in a conference proceedings indexed in a well-known, reputable service.

We would like to express our sincere gratitude to our speakers, presenters and all participants for their contributions in this conference. We would also like to express our appreciation for the generosity of our sponsors that support this conference: PT CropLife, PT ITS Science Indonesia, PT Fajar Mas Murni and PT Prima Instrument Analitika. Lastly, special thanks to all committee members for their exceptional work and contributions in the conference and publication.

Chair of Organizing Committee

Dr. Toto Hadiarto

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Yadi Suryadi, Dwi Ningsih Susilowati, I. Made Samudra, et al.

The Effect of Coating Application Using Chitosan Enzymatic Depolymerization on Anthracnose Disease Suppression in Mango (*Mangifera indica* L.) cv. 'Arumanis'

Yadi Suryadi[1, a)], Dwi Ningsih Susilowati[1], I Made Samudra[1], Alina Akhdiya[1] and Karsinah[2]

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Abstract. Mango cv. 'Arumanis' is more prone to postharvest disease. An alternative anthracnose disease control is necessary to reduce use of synthetic pesticides. The research was aimed to develop bioformulation against *Colletotrichum* spp. Seventeen mango phyllosphere isolates belonging to Gram-positive (7 isolates) and Gram-negative (10 isolates) bacteria were obtained from Bogor and Pasuruan. The FAM 1 isolate produced the highest chitinase (14.7±1.11 ppm). Chitosan (CS) depolymerized with chitinase (D3K, BK2P of Bogor isolates) and mixed with tripolyphosphate (TPP) at a concentration ratio of 5:1 (v/v) could inhibit the growth of *Colletotrichum* spp. compared with control under *in vitro* test, however, the level of inhibition was lower (<50%). Further formulations of CS (depolymerized with chitinase of Pasuruan isolates (EGM 1, FAM 1, and BMH) mixed with tripolyphosphate (TPP) using concentration ratio of 5:2 and 5:3 (v/v) was effective to suppress the fungal growth colonies *in vitro*. The application with a formula CS (FAM 1 isolate) and TPP mixture at ratio 5:2 showed as the highest anthracnose disease suppression *in vivo*. Candidate formulation to reduce *Colletotrichum* spp. infections have been obtained in the laboratory. However, *in vivo* test of various mango cultivars in the field still needs to be done.

INTRODUCTION

Mango (*Mangifera indica* L.) cv. 'Arumanis' is one of the important tropical fruits due to its unique flavor and taste and is considered as the superior cultivar popular among mango farmers and consumers. The mango production in Indonesia during period of 2015–2019 was estimated up to 19.1% [1]. In efforts to develop the production and quality of mango fruit, the problem faced by growers is damage caused by pathogenic fungal infections from the pre-planting to postharvest period. Postharvest deterioration caused by various pathogenic microorganisms resulted in mangoes with an undesirable quality and a shortened storage live. The postharvest economic loss due to fungal infection in horticultural commodities varies from 30 to 50% and in some instances, rot can cause severe loss of production [2].

Anthracnose caused by *Colletotrichum* spp., particularly *C. gloeosporioides*, is one of the main diseases which affect significant postharvest losses of mango worldwide including Indonesia. The fungal pathogen, particularly *C. gloeosporiodes*, was reported as the the main causal agent of anthrachnose in many crops [3]. Anthracnose symptoms are characterized by dark brown, sunken, and round patches on the skin surface. Pathogen colonizes the inflorescence and remains dormant on the mature mango fruit until it begins to ripe, then disease develops during storage [2].

Disease management of anthracnose through the use of resistant varieties and agrochemicals is possible to some extent. However, chemical control with the use of fungicides (i.e. carbendazim, benomyl, and orthiophante-methyl)

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has a negative impact to the environment, and toxic to living things [4, 5]. In addition, the increasing cost of pesticides, as well as the development of resistant pathogenic fungal strains, leading to the need for alternative sustainable postharvest disease management approaches [3]. An eco-friendly approach must ensure that maximum disease inhibition can be achieved without harming the ecosystem [6]. Hence, technology support for the development of preharvest and postharvest aspects of mango commodity through biological control of the diseases is needed.

The use of generally recognized as safe compounds to control postharvest decay and enhance the shelf life of fruits is accepted worldwide as a sustainable and eco-friendly method [2, 3]. Chitosan (CS) polysaccharides (chitin deacetylation product, which is a long-chain polymer of glucosamine (2-amino-2-deoxy-β-[1-4]-D-glucose), is considered as biodegradable material and biocompatible without toxicity or side effects and widely used in controlling pathogens [7].

The use of CS has been suggested for use in sustainable agricultural technology programs due to its safety. For example, in the agricultural product industry, under the regulation EU 2014/563, CS-chloride is included as the first list of basic ingredients for plant protection products [8]. The presence of an amino group (-NH2) in the chemical structure of CS provides an ideal and safe food preservative effect, therefore it can be exploited through the development of coating materials and biodegradable edible films. In addition, CS also has elicitor properties that can increase the natural resistance of fruits, vegetables, and whole grains to pathogenic infections [9, 10].

The long-term effect of the CS coating application of fruit should be considered as anthracnose control to extend the shelf life of horticultural fruit commodities. CS is able to inhibit the rate of respiration and ethylene levels of fruit, induces the formation of calose lignifications on the fruit skin epidermis, and increases levels of total phenolic compounds and total crude protein content of fruits [11].

The preliminary *in vitro* bioassays conducted at ICABIOGRAD revealed the antifungal activity of CS at concentration 3% against anthracnose fungi. The CS nanoparticle had an inhibitory activity to *C. gloeosporioides* up to 85.7%, whilst inhibition to spores germination was 61.2% [12]. The CS-Ag nanoparticle (1%) could inhibit conidial germination of *C. gloeosporioides* and also reduces anthracnose incidence on mango in the field [13, 14].

It is, therefore, necessary to develop compatibility of formulations based on antagonistic microbes (phyllosphere bacteria) enriched with antifungal CS coating to suppress the growth of postharvest fungi (*Colletotrichum* spp.) on mangoes. This study aimed to obtain a CS formulation depolymerized with selected microbial chitinase and sodium tripolyphosphate (NaTPP) mixture to reduce anthracnose infection in mango cv. 'Arumanis'.

MATERIALS AND METHODS

Preparation, Selection of Antagonist, Characterization of Phylosphere Bacteria, and Formulation

Phylosphere bacteria was selected and obtained from mango fruit of Bogor (West Java) and mangoes accession farmyard of Cukurgondang Experimental Station (IP2TP), Indonesian Fruits Research Institute in Pasuruan (East Java). The obtained bacteria isolates were coded as the collection of Biogen CC of IAARD-ICABIOGRAD Gene Bank, Bogor (West Java). Morphological observation of bacteria were based on growth characteristic on media and Gram-reaction assay.

The chitinolytic activity of enzyme solution derived from selected Pasuruan isolates was quantitatively measured for its enzyme concentration, following the procedure of Toharisman *et al*. [15] using commercial N-Acetylglucosamine (GlcNAc) (Sigma) as a standard. The crude extract of chitinase from the selected isolates of Bogor isolates (BK2P, D3K, and E76) and Pasuruan isolates (EGM 1, FAM 1, and BHM) was then added to a solution of CS (0.2%) and NaTPP (0.1%) as the cross-linking agent [16]. The mixture was centrifuged and the pellets were taken, then it was dissolved in 0.2% acetic acid solution and mixed with a magnetic stirrer at medium speed. After addition 80 ml of 2% of Tween 80 and stirring in slow agitation at room temperature for 30–60 min, the suspension was stored in a jar and refrigerated prior to testing.

Bioassay of Formulations against *Colletotrichum* spp. *In Vitro*

The preparation of the formula was carried out by preparing a solution of CS-chitinase mixed with a NaTPP solution to form a solution of formula with various ratios (v/v) (2:1, 3:1, 5:1, 5:2, and 5:3). This formula is used for testing the activity of the formula against *Colletotrichum* spp.

Pathogenic isolates of *Colletotrichum* spp. were isolated from mango fruit samples showing symptoms of anthracnose disease. The diseased fruit was disinfected by rubbing it with a cotton ball soaked in 76% alcohol and dried, then the boundaries between the diseased and healthy parts of the fruit were cut into small pieces, and incubated in a Petri dish containing PDA media. The warm-luke PDA media in a Petri dish were mixed with 1 ml of the formula solution, and allowed to harden, then it was perforated in the middle with a cork borer. The growing pathogenic *Colletotrichum* spp. isolate was placed into the hole, and then it was incubated for 4 days at room temperature. The treatment in the *in vitro* test was carried in three replications. The control treatment contained only PDA media and *Colletotrichum* spp.

Bioassays of Formulations against *Colletotrichum* spp. *In Vivo*

Healthy fruits, mango cv. 'Arumanis' with maturity stage about 90% were washed with running tap water. All fruits were allowed to drip dry for 30 min on a laboratory bench [17]. The efficacy test of the candidate formulation was carried out on mangoes by artificial inoculation [18]. *Colletotrichum* spp. isolates were propagated in a PDA medium. Each medium was inoculated with two culture discs of *Colletotrichum* spp. that were actively growing on Petri dishes (9 cm in diameter). The cultures were incubated at 28±2°C for 2 weeks and used as the source of the inoculum. The treatment was carried out by coating the fruit in a formulation of 15 m/l in a sterile Petri dish using a sterile brush for 2 min, and the excess solutions were allowed to drain. The fruit was inoculated with a colony of *Colletotrichum* spp. using a sterile needle, then incubated at room temperature. The negative control treatments were arranged without fungal inoculation and the formulation solution. The experiment was repeated three times. The fruit was stored on a sterile tray covered with a tissue soaked with alcohol, then the tray was wrapped in polyethylene bags. All treatments and controls were incubated at room temperature 22°C with relative humidity (RH) of 90–95% for 7 days [19].

Assessment of Disease Severity and Statistical Data Analysis

At *in vitro* assay, measurement of the growth of *Colletotrichum* spp. fungal mycelia were observed daily and stopped when untreated fungal colonies fill the control Petri dish. The effectiveness of growth inhibition was determined by the formula as follows:

$$FI = \frac{Gc-Gt}{Gc}\ x\ 100\% \quad (1)$$

where FI = fungi inhibition, Gc = growth of fungi on control, Gt = growth of fungi on treatment.

At *in vivo* assay, the effectiveness of the formulation was determined by calculating the percentage of colony area to the total surface area of the mango. Anthracnose observation of the samples was carried out within 4 days until the 8th day of incubation. Observations were made on the parameters of anthracnose incidence and disease severity. Disease incidence (I) was determined by disease occurrence based on symptomatic injury. The anthracnose disease severity (S) of mango fruits from each treatment was recorded as a percentage of anthracnose disease by comparing with the standard guidelines (4 scales): 1 = no symptoms (severity 0%), 2 = early rot (35% severity), 3 = mycelium begins to appear (65% severity), and 4 = sporulation symptoms (90% severity) [20].

Disease index (DI) was calculated using formula:

$$DI = (S\ x\ I)\ x\ 100 \quad (2)$$

Meanwhile, disease suppression was determined using formula:

$$DS = \frac{DIc-DIt}{DIc}\ x\ 100\% \quad (3)$$

where DS = disease suppression, DIc = disease index in control, and DIt = disease index in treatment.

Data were analyzed based on analysis of variance (ANOVA) and means separation was further analyzed by Duncan's Multiple Range Test (DMRT; p = 0.05%).

RESULTS AND DISCUSSIONS

Isolation and Screening of IAA and Chitinase-Producing Bacteria

The result of bacterial isolates from phyllosphere samples is shown in Table 1. Seventeen isolates was obtained and characterized belonging to Gram-positive (7 isolates) and Gram-negative (10 isolates) bacteria.

TABLE 1. Morphology characterization of mango phyllosphere bacterial isolates.

Isolate code	Origin	Surface	Color	Shape	Gram
D1K	Bogor	Wet	Milky white	Round	+
D2K	Bogor	Wet	Milky white	Round	+
D3K	Bogor	Wet	Pink	Round	–
D4K	Bogor	Wet	Milky white	Round	+
DIB	Bogor	Wet	Milky white	Round	+
D2B	Bogor	Wet	Milky white	Round	+
D3B	Bogor	Wet	Milky white	Round	–
D4B	Bogor	Wet	Milky white	Round	–
BK1	Bogor	Wet	Milky white	Round	–
BK2P	Bogor	Wet	Milky white	Round	–
BK2K	Bogor	Wet	Yellow	Round	–
BH1	Bogor	Wet	Milky white	Round	–
BH2	Bogor	Dry	Milky white	Round	–
EGM 1	Pasuruan	Wet	White	Round	+
FAM 1	Pasuruan	Wet	White	Round	+
BMH	Pasuruan	Dry	Cloudy	Irregular	–
EAG 9	Pasuruan	Wet	White	Round	–

Three Pasuruan bacterial isolates (FAM 1, EGM 1, and BMH) were further selected for the chitinase production (Fig. 1). The chitinase concentrations were ranging from 10.2 to 14.77 ppm. This concentration was considered enough to degrade CS (Fig. 1). Degradation of the biopolymer increases with the concentration of the enzyme-substrate system; it is likely due to the increased binding and catalysis of the glycoside bond [21].

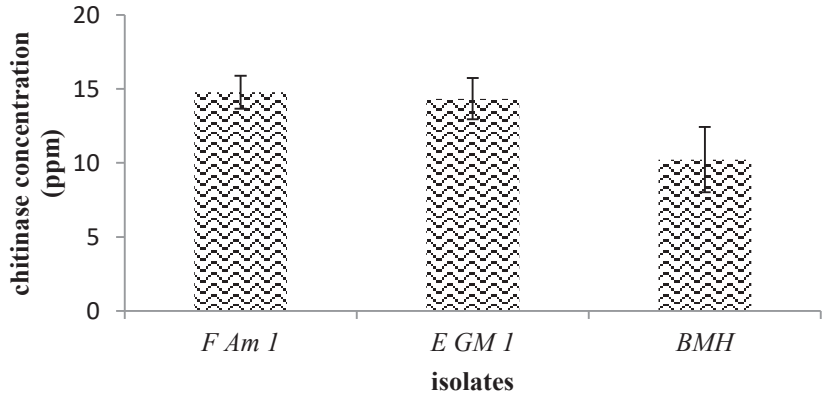

FIGURE 1. Quantitative assay of chitinase concentration (ppm) to isolates FAM 1, EGM 1, and BMH.

Effect of Formula Inhibition (Extracted from Pasuruan Isolates) against *Colletotrichum* spp. *In Vitro*

Fungal *Colletotrichum* spp. growth colony as determined by the growth rate colony area ranged from 47.19 to 63.5 cm^2, whilst growth inhibition rate was ranged from 0 to 25.68%. Based on the previous study, it was known that the CS-TPP formula extracted from bacterial isolates with various ratios has the ability to inhibit the growth of *Colletotrichum* spp. [19]. The control treatment of fungi grew without any inhibition (63.5 cm^2), whereas in the treated fungi, the growth of *Colletotrichum* spp. was retarded. The lowest treatment was shown by the formula CS (extracted with chitinase of BK2P and D3K (Bogor isolates) mixed with TPP (2:1, 3:1, 5:1, 5:2, and 5:3) (Fig. 2a). The CS-TPP formula extracted with chitinase of D3K isolate at a ratio of 3:1 and BK2P isolate at 5:1 showed a higher degree of inhibition (25.68%) compared to the growth of control (*Colletotrichum* spp. alone), however, the inhibition rate tended to decrease at a ratio of 5:2 and 5:3. It was shown also that the use of previous isolates E76 in the enzyme system affected weak in fungal inhibition. In general, the level of inhibition of all ratio treatment was relatively low (<50%) (Fig. 2b).

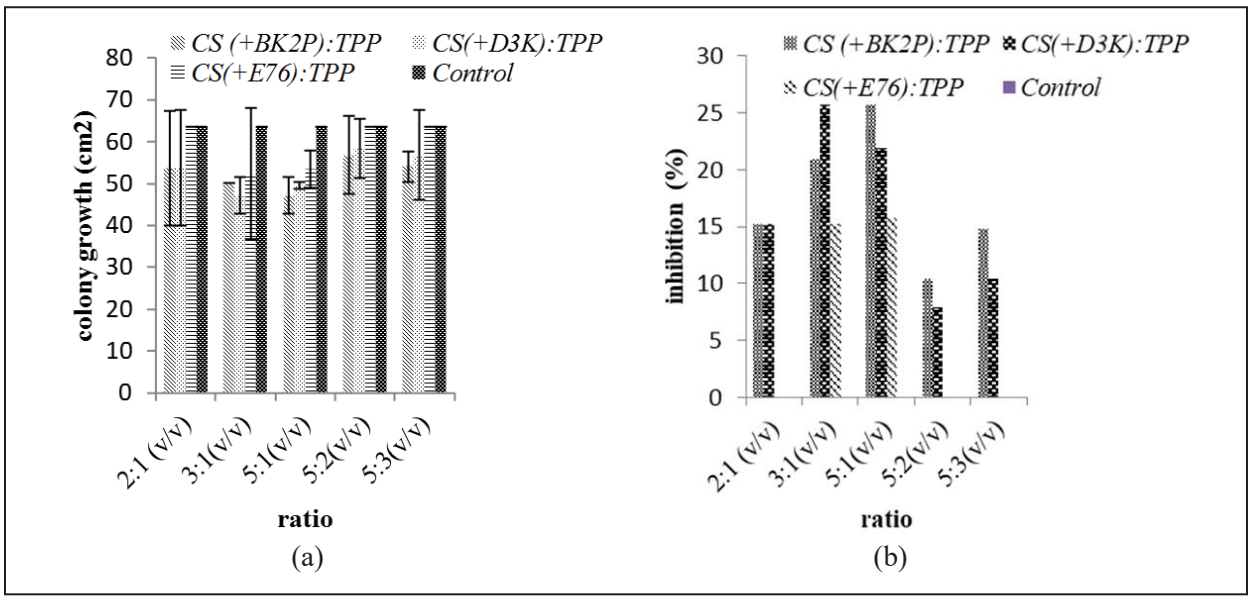

FIGURE 2. Effect of formula (CS-TPP) treatment extracted by bacterial chitinase (Bogor isolates) to fungal colony growth (a) and fungal inhibition (FI) (b).

Effect of Formula Inhibition (Extracted from Pasuruan isolates) against *Colletotrichum* spp. *In Vitro*

The growth area of fungal colonies due to the treatment of the CS-TPP formula depolymerized using BMH, EGM 1, and FAM 1 (Pasuruan isolates) ranged from 17.7 to 28.2 cm^2 with the highest fungal inhibition was shown by CS-TPP FAM 1 isolate at a ratio of 5:2 (Fig. 3).

CS-TPP at a ratio of 5:2 and 5:3 markedly inhibited radial mycelial growth of *Colletotrichum* spp. at *in vitro* assay. In line with this study, Meng *et al*. [21] reported that oligo CS treatment at inhibitory concentrations to *C. musae* showed distortion and thinning of the hyphal cell wall and reduction in fungal colony diameter. Previous work reported that under *in vitro* test, the CS nanoparticle could inhibit the growth of *C. gloeosporioides* in the range of 61.28–96.00% [22]. CS-TPP component was capable of inhibiting the growth and multiplication of microbial cells through different mechanisms of action at the cellular level. Several antifungal components may act synergistically to inhibit the growth of target fungi [23].

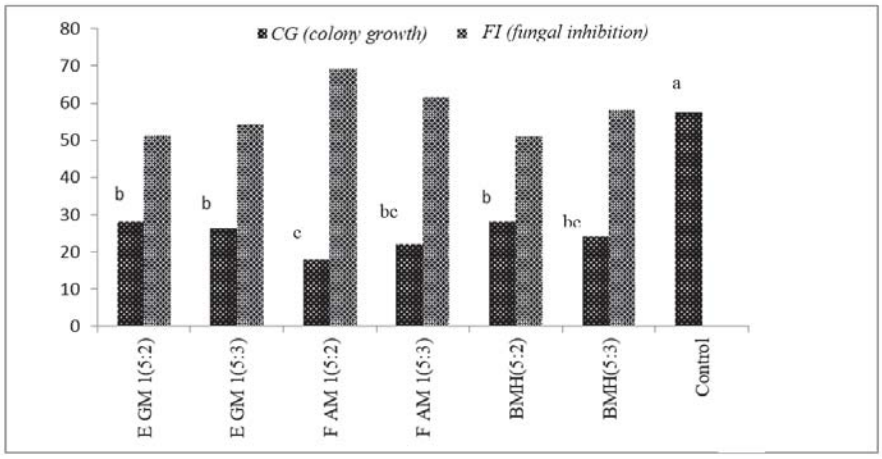

FIGURE 3. *In vitro* formula of CS-TPP extracted using chitinase of FAM 1, EGM 1, and BMH (Pasuruan isolates) mixed with TPP at ratio of 5:2 and 5:3 against colony growth (cm^2) of *Colletotrichum* spp. and fungal inhibition (%). Means value followed by the same letter was not significantly different according to DMRT (P = 0.05).

Effect of Formula Inhibition against *Colletotrichum* spp. *In Vivo*

The anthracnose DI due to the formula treatment of CS-TPP extracted from BMH, EGM 1, and FAM 1 (Pasuruan isolates) was shown in Fig. 4. The highest anthracnose severity (39.48%) was observed in the negative control samples treated with distilled water. Mango cv. 'Arumanis' subjected to coating treatment with different CS-TPP exhibited anthracnose DI values within the range of 13.60–39.48%, which are notably lower when compared to the negative control. CS-TPP (5:2) treated mango exhibited less lesion of anthracnose (data not shown). Disease index of all CS-TPP treated mango were found to be significantly lower than that of the negative control (P = 0.05). Furthermore, it was revealed that there were differences in reducing anthracnose severity. This indicates the variation efficacy of CS-TPP extracted with different chitinase enzyme-producing isolates in controlling anthracnose. The highest DS was shown by CS-TPP formula of FAM 1 isolate (5:2) followed by BMH isolate (5:2) under *in vivo* assay.

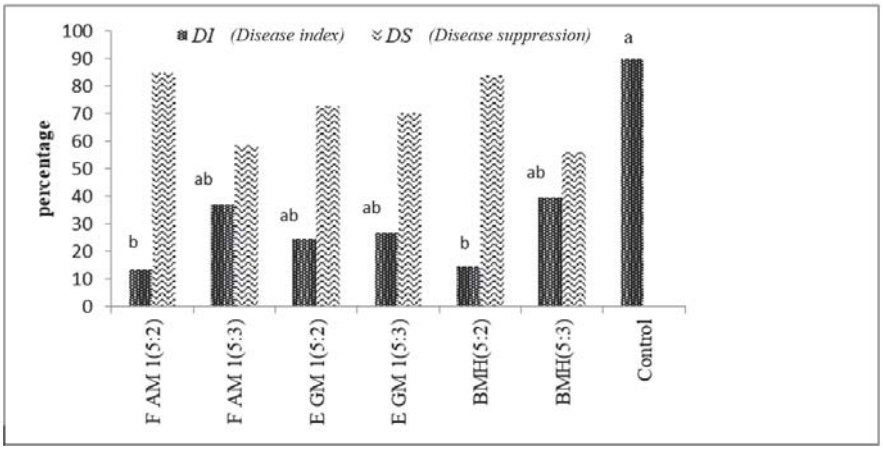

FIGURE 4. Effect of CS-TPP ratio (5:2 and 5:3) formula extracted from chitinase-producing FAM 1, EGM 1, and BMH isolates to disease index and disease suppresion of anthracnose on mango cv. 'Arumanis' at *in vivo* assay. Means value followed by the same letter was not significantly different according to DMRT (P = 0.05).

Certain treatments displayed a significant difference in disease index compared to the untreated negative control (P = 0.05) (Fig. 4). The CS-TPP (5:2) has significantly reduced anthracnose of mango cv. 'Arumanis' due to coating treatment. This result is in accordance with the previous findings that CS-TPP having similar antifungal activity could control anthracnose of mango cv. 'Manalagi' at low ratio. The result of *in vivo* test on mangoes fruit cv. 'Manalagi' showed that CS nanoparticle could effectively inhibit the growth of anthracnose (74.5%) at a concentration of CS (0.3%) and NaTPP (0.1%) with a ratio of 5:2 compared with control. CS-TPP treatments were also effective in reducing the growth of fungi with the disease suppression of 92.55% and it might further delay the deterioration of mango [19].

CS offers a great potential as a water-soluble and biodegradable substance that has antifungal activity. Previous studies have shown that CS could induce resistance in plants against fungal diseases of fruit. Dipping banana fruits in CS solution (5−20 g/l) significantly reduced the diameter of the anthracnose lesion, and at 20 g/l oligo CS almost reached the same inhibitory effect with a synthetic fungicide at 0.5 g/l. To control anthracnose in harvested bananas, treatment with CS >20 g/l may substitute the use of synthetic fungicide [21]. The inhibitory effect of CS is due to the combination of a direct antifungal effect on the pathogen [24, 25], and an indirect effect, whereby the activities induces a series of defense reactions correlated with enzymatic activities and synthesis of specific phytoalexins with antifungal activity. In addition, CS also induces structural barriers by synthesis of lignin-like material [13]. Coating treatment with emulsions of CS-TPP (5:2) efficiently controlled anthracnose of mango cv. 'Arumanis' with less disease symptoms, and hence this is important to reduce the postharvest losses by the pathogen during storage. Therefore, as an alternative biofungicide mixture, CS-TPP has a potential application in controlling anthracnose disease caused by *Colletotrichum* spp. in fruits. However, field experiments on the antifungal effect of CS-TPP should be carried out for a practical application in sustainable agricultural production. To reduce anthracnose infection, more testing on several genotypes of mangoes still needed to be further carried out in the field. In addition, the present study needs to be improved to achieve a lengthened storage-life as well as consideration for long-distance mango transportation.

CONCLUSION

Seventeen isolates of mango phyllosphere bacteria were obtained. Morphological observations and Gram-staining showed that all isolates had a coccus shape. Isolates D1K, D2K, D4K, D1B, D2B, EGM, and FAM 1 were Gram-positive, while D3K, D3B, D4B, BK1, BK2P, BK2K, BH1, BH2, EAg9, and BMH were Gram-negative. The BMH isolates produced the highest IAA (4.30±0.185 ppm), while the highest chitinase-producing isolates was FAM 1 isolate (14.7±1.11 ppm). At *in vitro* test of CS-TPP formulations depolymerized using chitinase of EGM 1, FAM 1, and BMH (Pasuruan isolates) at a ratio of 5:2 and 5:3 treatments were effective in inhibiting the growth of *Colletotrichum* spp., while the mango formula treatment with isolate FAM 1 (5:2) showed the highest disease suppression against anthracnose at *in vivo* test.

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REFERENCES

1. Central Bureau of Statistics and the Directorate General of Horticulture, *https://www.pertanian.go.id/home/index.php?show=repo&fileNum=295* (2019).
2. K. Alemu, J. Biol. Agric. Healthcare **4**, 13–21 (2014).
3. L. C. Karunanayake, G. D. Sinniah, N. K. B. Adikaram and C. L Abayasekara, Acta Hortic. **1144**, 453–460 (2016).
4. L. He, Y. Liu, A. Mustapha and M. Lin, Microbiol. Res, **166**, 207–215 (2011).
5. P. Tripathi and A. K. Shukla, Int. J. Postharvest Technol. Innov. **1**, 405–415 (2009).
6. S. Handiso and T. Alemu, ASRJETS **32**, 303–315 (2017).
7. D. R. Olicón-Hernández, L. Fernando, Z. Giraud and G. Guerra-Sánchez, J. Drug Des. Res. **4**, 2–7 (2017).
8. F. Salamanca-Buentello, D. L. Persad, E. B. Court, D. K. Martin and A. S. Daar, PLoS Med. **2**, e97 (2005).

9. D. Jhurry, Food and Agricultural Research Council, Reduit, Mauritius 109, Agricultural Polymers, AMAS 1997, University of Mauritius, Réduit, 109–113 (1997).
10. Y. Ruiz-García and E. Gómez-Plaza, Agriculture (Switzerland) **3**, 33–52 (2013).
11. A. Aziz, P. Trotel-Aziz, A. Conreux, L. Dhuicq, P. Jeandet and M. Couderchet, "Chitosan induces phytoalexin synthesis, chitinase and β-1,3-glucanase activities, and resistance of grapevine to fungal pathogens," in *Macromolecules and Secondary Metabolites of Grapevine and Wine*, edited by P. Jeandet, C. Clément and A. Conreux (Intercept Publisher, Totnes, 2007), p. 83–88.
12. Y. Suryadi, T. P. Priyatno, I. M. Samudra, D. N. Susilowati, H. Nurzulaika and Syaefudin, J. Fitopatol. Indones. **12**, 209 (2016).
13. S. Bautista-Baños, A. N. Hernandez-Lauzardo, M. G. Velázquez-del Valle, M. Hernández-López, E. A. Barka, E. Bosquez-Molina and C. L. Wilson, J. Crop Prot. **25**, 108–118 (2006).
14. C. Sánchez, F. C. Lidon, M. Vivas, P. Ramos, M. Santos and M. G. Barreiro, Emirates J. Food and Agric. **27**, 206–214 (2015).
15. A. Toharisman, M. T. Suhartono, M. Spindler-Barth, J. K. Hwang and Y. R. Pyun, World J. Microbiol. Biotehnol. **21**, 733–738 (2005).
16. S. A Agnihotri, N. N. Mallikarjuna and T. Aminabhavi, M. J. Controlled Release, **100**, 5–28 (2004).
17. Y Suryadi, I. M. Samudra, M. E. Puteri and T. Kemala, J. Agrobiotechnol. **11**, 48–62 (2020).
18. P. Boonyaritthongchai, C. Chimvaree, M. Buanong, A. Uthairatanakij and P. Jitareerat, Horticulturae **3**, 3–9 (2017).
19. Y. Suryadi, D. N. Susilowati and I. M. Samudra, Sainmatika **16**, 88–97 (2019).
20. G. Corkidi, K. A. Balderas-Ruíz, B. Taboada, L. Serrano-Carreón and E. Galindo, Plant Pathol. **55**, 250–257 (2006).
21. X. C. Meng, Y. X. Tang, A. Y. Zhang, X. M. Huang and Z. Q. Zhang, Fruits **67**, 147–155 (2012).
22. M. Zaker, Agriculturists **14**, 134–141 (2016).
23. B. S. Sekhon, Nanotechnol. Sci. Appl. **7**, 31–53 (2014).
24. N. Ben-Shalom, C. Aki, R. Ardi and R. Pinto, Israel J. Plant Sci. **50**, 199–206 (2002).
25. W. B. Silva, G. M. C. Silva, D. B. Santana, A. R. Salvador, D. B. Medeiros, I. Belghith, N. M. da Silva, M. H. M. Cordeiro and G. P. Misobutsi, Food Chem. **242**, 232–238 (2018).