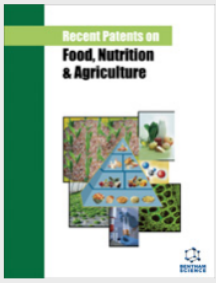


Recent Patents on Food, Nutrition & Agriculture

Continued as: Recent Advances in Food, Nutrition & Agriculture

ISSN: 1876-1429 (Online)
ISSN: 2212-7984 (Print)
This journal supports open access

AIMS & SCOPE

Recent Patents on Food, Nutrition & Agriculture publishes full-length/mini reviews and research articles, and guest edited thematic issues on recent patents in all fields of food science & technology, nutrition and agricultural science & technology. A selection of important and recent patents in the areas covered is also included in the journal. The journal is essential reading for all researchers involved in food, nutrition and agricultural sciences and technology. The journal also covers recent research (where patents have been registered) in fast emerging technologies related to food additives, micro & macro-molecular food supplements, edible alternatives, food technology, nutraceuticals, healthy diet, nutritional value, calorie intake, malnutrition & related diseases, plant derivatives, agricultural technology and products, crop improvement and safety issues related to food, nutrition & agriculture.

Current Issue | Published Contents

Recent Patents on Food, Nutrition & Agriculture , Volume 12 - Number 1

Preface

Preface , 12(1): 1
Bing-Huei Chen
DOI: **10.2174/2212798412012103161O1158**

AIMS & SCOPE

Recent Patents on Food, Nutrition & Agriculture publishes full-length/mini reviews and research articles, and guest edited thematic issues on recent patents in all fields of food science & technology, nutrition and agricultural science & technology. A selection of important and recent patents in the areas covered is also included in the journal. The journal is essential reading for all researchers involved in food, nutrition and agricultural sciences and technology. The journal also covers recent research (where patents have been registered) in fast emerging technologies related to food additives, micro & macro-molecular food supplements, edible alternatives, food technology, nutraceuticals, healthy diet, nutritional value, calorie intake, malnutrition & related diseases, plant derivatives, agricultural technology and products, crop improvement and safety issues related to food, nutrition & agriculture.

Current Issue | Published Contents

Published Contents

Continued as: Recent Advances in Food, Nutrition & Agriculture

Volume 12, 3 Issues, 2021
ISSN: 1876-1429 (Online)
ISSN: 2212-7984 (Print)
This journal supports open access

INDEXING INFORMATION

Abstracted and Indexed in:

- Chemical Abstracts Service/SciFinder
- ChemWeb
- CNKI Scholar
- Dimensions
- EBSCO
- Genamics JournalSeek
- Google Scholar
- J-Gate
- JournalTOCs
- MediaFinder®-Standard Periodical Directory
- MEDLINE/PubMed
- Norwegian Register
- PubsHub
- QOAM
- Scilit
- Scopus
- Suweco CZ
- Ulrich's Periodicals Directory

Book Proposal | Become an Executive Guest Editor | New Journal Proposal | Become a Section Editor
Become a Reviewer | Join Editorial Board | Thematic Issue Proposal | Submit Abstract Online

EDITORIAL BOARD

Editor-in-Chief
Honorary Advisor
Associate Editors
Regional Editors
Section Editor
Editorial Board Members
Associate Editorial Board Members
Executive Guest Editor

Editor-in-Chief

Bing-Huei Chen
Department of Nutrition and Food Science
Fu Jen University
Taipei
Taiwan

FOR LIBRARIANS & READERS

⇨ Contents & Abstracts

QUICK LINKS

⇨ Board Recruitment Workflow
⇨ Short Guide
⇨ Join Editorial Board
⇨ Indexing Information
⇨ Announcements
⇨ Endorsements
⇨ Authors' Comments

FOR AUTHORS

⇨ Author Guidelines
⇨ Graphical Abstracts
⇨ Animated Abstracts
⇨ Increase Visibility of your Article
⇨ Submit Abstracts Online
⇨ Submit Manuscripts Online
⇨ Open Access Funding
⇨ Publishing Ethics and Rectitude
⇨ Archiving Policies
⇨ Manuscript Transfer Facility

FOR REVIEWERS

⇨ Reviewer Guidelines
⇨ Peer Review Workflow
⇨ Become a Reviewer

Editor-in-Chief
Honorary Advisor
Associate Editors
Regional Editors
Section Editor
Editorial Board Members
Associate Editorial Board Members
Executive Guest Editor

Associate Editors

Pin-Der Duh
Department of Food Science and Technology
Chia Nan University of Pharmacy & Science
Tainan
Taiwan

Michael G. Kontominas
Department of Chemistry
American University in Cairo
Cairo
Egypt

Jeng-Leun Mau
Department of Food Science and Biotechnology
National Chung-Hsing University
Taichung City
Taiwan

Fatih Ozogul
Department of Seafood Processing Technology
Cukurova University
Adana
Turkey

Min-Hsiung Pan
Institute of Food Science and Technology
National Taiwan University
Taipei
Taiwan

Associate Editors
Regional Editors
Section Editor
Editorial Board Members
Associate Editorial Board Members
Executive Guest Editor

ASIA

Youcai Xiong
Institute of Arid Agricultural Ecology
Lanzhou University
Lanzhou
China
Biography

Chiu-Chung Young
Department of Soil and Environment Sciences
National Chung Hsing University
Taichung
Taiwan

AUSTRALIA

Kasipathy Kailasapathy
University of Western Sydney
Penrith DC
Australia

EUROPE

Lars P. Christensen
Department of Chemistry and Bioscience
University of Southern Denmark
Odense
Denmark

Maria L.M.F. Estevinho
CIMO/Escola Superior Agrária Instituto Politécnico de Bragança
Campus de Santa Apolónia
Bragança
Portugal

FOR AUTHORS

⇨ Author Guidelines
⇨ Graphical Abstracts
⇨ Animated Abstracts
⇨ Increase Visibility of your Article
⇨ Submit Abstracts Online
⇨ Submit Manuscripts Online
⇨ Open Access Funding
⇨ Publishing Ethics and Rectitude
⇨ Archiving Policies
⇨ Manuscript Transfer Facility

FOR REVIEWERS

⇨ Reviewer Guidelines
⇨ Peer Review Workflow
⇨ Become a Reviewer

FOR LIBRARIANS & READERS

⇨ Contents & Abstracts
⇨ Open Access Articles
⇨ Editor's Choice
⇨ Free Copies Online
⇨ Thematic Issues
⇨ Journal Catalog 2021
⇨ Journal Catalog 2022
⇨ Most Accessed Articles
⇨ Most Cited Articles
⇨ **PURCHASE ARTICLES**
⇨ Order Reprints
⇨ Subscribe
⇨ Trial Requests
⇨ Library Recommendation

QUICK LINKS

⇨ Journal's New Website
⇨ Advertise with Us
⇨ Brand Ambassadors
⇨ Newsletter
⇨ Download PDF Flyer
⇨ Table of Contents Alert

⇨ Submit Manuscripts Online
⇨ Open Access Funding
⇨ Publishing Ethics and Rectitude
⇨ Archiving Policies
⇨ Manuscript Transfer Facility

FOR REVIEWERS

⇨ Reviewer Guidelines
⇨ Peer Review Workflow
⇨ Become a Reviewer

FOR LIBRARIANS & READERS

⇨ Contents & Abstracts
⇨ Open Access Articles
⇨ Editor's Choice
⇨ Free Copies Online
⇨ Thematic Issues
⇨ Journal Catalog 2021
⇨ Journal Catalog 2022
⇨ Most Accessed Articles
⇨ Most Cited Articles
⇨ **PURCHASE ARTICLES**
⇨ Order Reprints
⇨ Subscribe
⇨ Trial Requests
⇨ Library Recommendation

QUICK LINKS

⇨ Journal's New Website
⇨ Advertise with Us
⇨ Brand Ambassadors
⇨ Newsletter
⇨ Download PDF Flyer
⇨ Table of Contents Alert

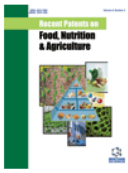
JOURNAL HISTORY

Recent Patents on Food, Nutrition & Agriculture was launched in 2009 and later renamed in 2021 as Recent

Recent Patents on Food, Nutrition & Agriculture

ISSN 2212-7984 (Print)

VISIT PUBLICATION HOMEPAGE



BENTHAM SCIENCE

Recent Patents on Food, Nutrition & Agriculture publishes review and research articles, and guest edited thematic issues on recent patents in all fields of food science & technology, nutrition and agricultural science & technology. A selection of important and recent patents in the areas covered is also included in the journal. The journal is essential reading for all researchers involved in food, nutrition and agricultural sciences and technology. The journal also covers recent research (where patents have been registered) in fast emerging technologies related to food additives, micro & macro-molecular food supplements, edible alternatives, food technology, nutraceuticals, healthy diet, nutritional value, calorie intake, malnutrition & related diseases, plant derivatives, agricultural technology and products, crop improvement and safety issues related to food, nutrition & agriculture.

Publisher: Bentham Science Publishers

31 Issues are available

Issues [31] Fast Track Supplementary Data

More in this subject:

Agriculture (General)
Nutrition & Food

Related Information:

Editorial Board
Information for Authors

Subscribe to this Title

Ingenta Connect is not responsible for the content or availability of external websites

Volume 11, Number 3, 2020

< previous issue all issues next issue >

Contents | Supplementary Data

Add all to Favourites

Abstract

F Graphical Abstracts
pp. i-iv(4)
Favourites: ADD

Editorial

F Meet Our Editorial Board Member
pp. 191-192(2)
Author: *El-Tarabily, Khaled A.*
Favourites: ADD

Research article

F Evaluation of the Cytotoxicity and Apoptotic Induction in Human Liver Cell Lines Exposed to Three Food Additives
pp. 193-201(9)
Authors: *El-Hefny, Ingy M.; Al Senosy, Neima K.; Hozayen, Walaa G.; Ahmed, Amr E.; Diab, Ayman; Basal, Wesam T.*
Favourites: ADD

F Optimization of Pectin Extraction from Sweet Potato Peels Using Citric Acid and its Emulsifying Properties
pp. 202-210(9)
Authors: *Hamidon, Nurul H.; Abang Zaidel, Dayang Norulfairuz; Mohd Jusoh, Yanti Maslina*
Favourites: ADD

F Bioprocess Optimization for Exopolysaccharides Production by Ganoderma lucidum in Semi-industrial Scale
pp. 211-218(8)
Authors: *Alsaheb, Ramzy A.; Zjeh, Koh Zwin; Malek, Roslinda Abd; Abdullah, Jaafar Kamil; El Baz, Ashraf; El Deeb, Nehal; Dailin, Daniel; Hanapi, Siti Zulaiha; Sukmawati, Dalia; El Enshasy, Hesham*
Favourites: ADD

F Antifungal Mechanism of Rhodotorula mucilaginosa and Aureobasidium sp. nov. Isolated from Cerbera manghas L. against the Growth of Destructive Molds in Post Harvested Apples
Favourites: ADD

F Antifungal Mechanism of Rhodotorula mucilaginosa and Aureobasidium sp. nov. Isolated from Cerbera manghas L. against the Growth of Destructive Molds in Post Harvested Apples
pp. 219-228(10)
Authors: *Sukmawati, Dalia; Shabrina, Andisa; Indrayanti, Reni; Kurniati, Tri H.; Nurjayadi, Muktiningsih; Hidayat, Iman; Al Husna, Shabrina Nida; Ratnaningtyas, Nuniek Ina; El Enshasy, Hesham; Dailin, Daniel Joe; Hesham, Abd El-Latif*
Favourites: ADD

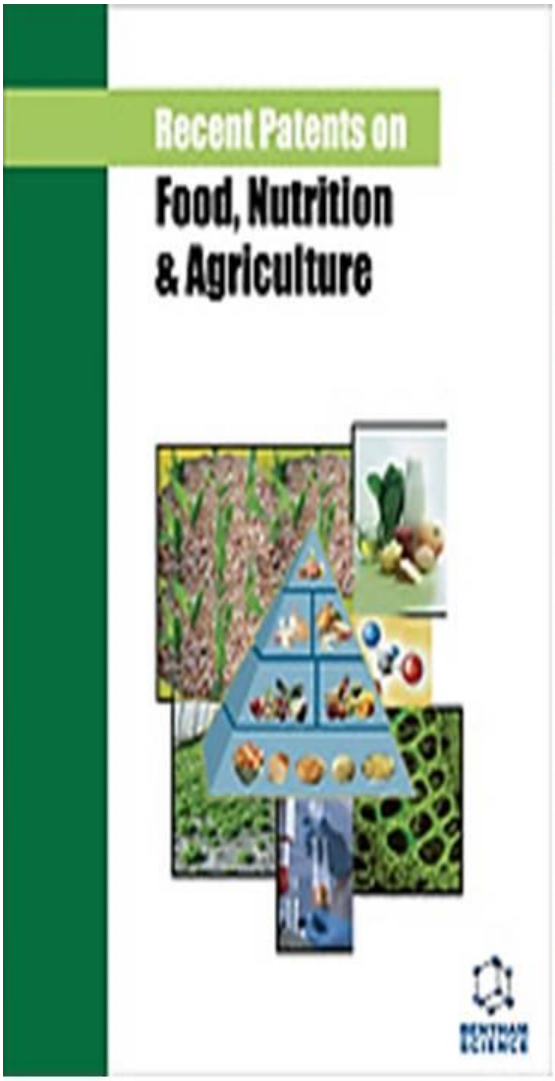
Review article

F Application of Transglutaminase in Developing Cassava-based Wet Noodle for Quality and Shelf Life Improvement: A Review
pp. 229-234(6)
Authors: *Kiyat, Warsono E.; Christopher, Alvin; Rianti, Angelina; Pari, Rizfi F.*
Favourites: ADD

Whole Grains, Dietary Fibers and the Human Gut Microbiota: A Systematic Review of Existing Literature
pp. 235-248(14)
Authors: *Tangestani, Hadith; Emamat, Hadi; Ghalandari, Hamid; Shab-Bidar, Sakineh*
Favourites: ADD

Research article

F Chemical Constituents, Antioxidant, Anticholinesterase and Antiproliferative Effects of Algerian Pistacia atlantica Desf. Extracts
pp. 249-256(8)
Authors: *Achili, Imene; Amrani, Amel; Bensouici, Chaouki; Gül, Fatih; Altun, Muhammed; Demirtas, Ibrahim; Zama, Djamila; Benayache, Fadila; Benayache, Samir*
Favourites: ADD



Antifungal Mechanism of Rhodotorula mucilaginosa and Aureobasidium sp. nov. Isolated from Cerbera manghas L. against the Growth of Destructive Molds in Post Harvested Apples

Authors: Sukmawati, Dalia; Shabrina, Andisa; Indrayanti, Reni; Kurniati, Tri H.; Nurjayadi, Muktiningsih; Hidayat, Iman; Al Husna, Shabrina Nida; Ratnaningtyas, Nuniek Ina; El Enshasy, Hesham; Dailin, Daniel Joe; Hesham, Abd El-Latif

Source: Recent Patents on Food, Nutrition & Agriculture, Volume 11, Number 3, 2020, pp. 219-228(10)
Publisher: Bentham Science Publishers
DOI: https://doi.org/10.2174/2212798411666200423101159

< previous article | view table of contents | next article > ADD TO FAVOURITES

Abstract | References | Citations | Supplementary Data

Background: Apples often experience postharvest damage due to being attacked by mold organisms. Several groups of molds such as Aspergillus sp., Penicilium expansum, Botrytis cinerea, and Venturia sp. can cause a serious postharvest disease exhibited as watery regions where areas of blue-green tufts of spores develop. Current methods using fungicides to control pathogenic fungi can cause resistance if applied in the long term. An alternative procedure using yeast as a biological agent has been found.

Objective: The aim of this study is to screen potential yeast, which has the ability to inhibit the growth of Aspergillus brasielensis (isolate A1) and Aspergillus flavus section flavi (isolate A17) isolated from apple fruits.

Methods: Antagonism test using YMA dual culture medium using in vitro assays and ITS rDNA identification were performed.

Results: The result showed that 3 out of 19 yeast isolated from Cerbera manghas L, T1, T3 and T4, demonstrated the potential ability as a biocontrol agent. ITS rDNA identification demonstrated that T1 has a similarity to Rhodotorula mucilaginosa while T3 and T4 were identified as Aureobasidium sp. nov. The 3 isolates exhibited the ability to reduce the growth of A. brasiliensis sensu lato better than dithane 0.3% with a Disease Incidence (DI) of 100% and a Disease Severity (DS) value of 45%. Only isolate T1 and T3 were able to reduce decay symptoms in apples inoculated with A. flavus sensu lato (with DO and DS were 100% and 25%, respectively) compared to dithane pesticides 0.3%.

Conclusion: This study indicated that competition between nutrients occurs between pathogenic molds and under-yeast in vitro and in vivo conditions. However, further studies in the future might be able to elucidate the 'killer' activity and interaction with the pathogen cells and the bio-product production using Rhodotorula mucilaginosa and Aureoubasidium namibiae strains to control postharvest diseases.

Abstract | References | Citations | Supplementary Data

Background: Apples often experience postharvest damage due to being attacked by mold organisms. Several groups of molds such as Aspergillus sp., Penicilium expansum, Botrytis cinerea, and Venturia sp. can cause a serious postharvest disease exhibited as watery regions where areas of blue-green tufts of spores develop. Current methods using fungicides to control pathogenic fungi can cause resistance if applied in the long term. An alternative procedure using yeast as a biological agent has been found.

Objective: The aim of this study is to screen potential yeast, which has the ability to inhibit the growth of Aspergillus brasielensis (isolate A1) and Aspergillus flavus section flavi (isolate A17) isolated from apple fruits.

Methods: Antagonism test using YMA dual culture medium using in vitro assays and ITS rDNA identification were performed.

Results: The result showed that 3 out of 19 yeast isolated from Cerbera manghas L, T1, T3 and T4, demonstrated the potential ability as a biocontrol agent. ITS rDNA identification demonstrated that T1 has a similarity to Rhodotorula mucilaginosa while T3 and T4 were identified as Aureobasidium sp. nov. The 3 isolates exhibited the ability to reduce the growth of A. brasiliensis sensu lato better than dithane 0.3% with a Disease Incidence (DI) of 100% and a Disease Severity (DS) value of 45%. Only isolate T1 and T3 were able to reduce decay symptoms in apples inoculated with A. flavus sensu lato (with DO and DS were 100% and 25%, respectively) compared to dithane pesticides 0.3%.

Conclusion: This study indicated that competition between nutrients occurs between pathogenic molds and under-yeast in vitro and in vivo conditions. However, further studies in the future might be able to elucidate the 'killer' activity and interaction with the pathogen cells and the bio-product production using Rhodotorula mucilaginosa and Aureoubasidium namibiae strains to control postharvest diseases.

Keywords: Apple; Aureobasidium pullulans; Rhodotorula mucilaginosa; biocontrol fungi; fungicides; molds
Document Type: Research Article
Publication date: November 1, 2020

› More about this publication?

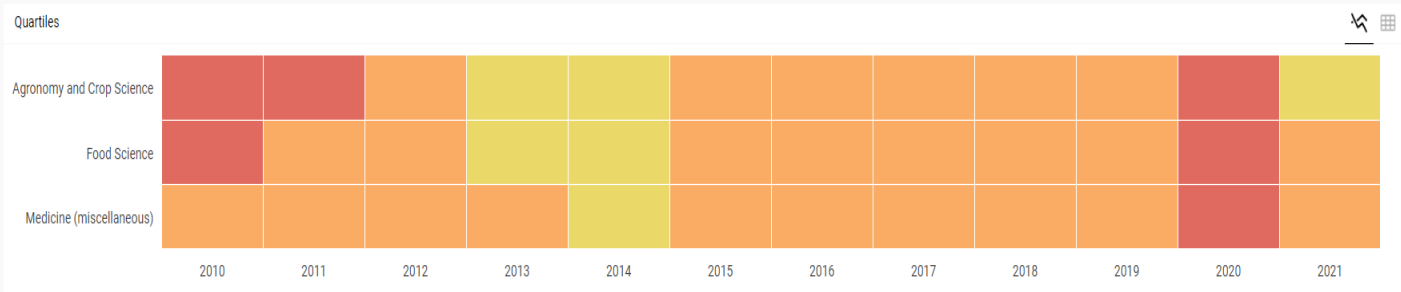
Recent patents on food, nutrition & agriculture

COUNTRY	SUBJECT AREA AND CATEGORY	PUBLISHER	H-INDEX
United Arab Emirates Universities and research institutions in United Arab Emirates	Agricultural and Biological Sciences Agronomy and Crop Science Food Science Medicine Medicine (miscellaneous)	Bentham Science Publishers	29

PUBLICATION TYPE	ISSN	COVERAGE	INFORMATION
Journals	18761429, 22127984	2009-2021	Homepage How to publish in this journal

SCOPE

Recent Patents on Food, Nutrition & Agriculture publishes full-length/mini reviews and research articles, and guest edited thematic issues on recent patents in all fields of food science & technology, nutrition and agricultural science & technology. A selection of important and recent patents in the areas covered is also included in the journal. The journal is essential reading for all researchers involved in food, nutrition and agricultural sciences and technology. The journal also covers recent research (where patents have been registered) in fast emerging technologies related to food additives, micro & macro-molecular food supplements, edible alternatives, food technology, nutraceuticals, healthy diet, nutritional value, calorie intake, malnutrition & related diseases, plant derivatives, agricultural technology and products, crop improvement and safety issues related to food, nutrition & agriculture.



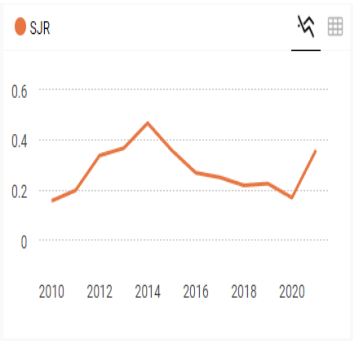
Quartiles

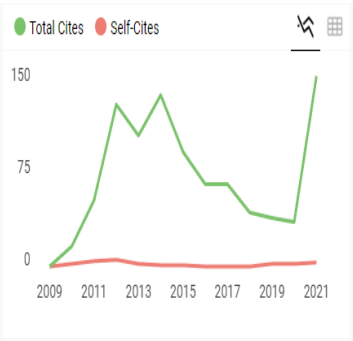
Medicine (miscellaneous)	2013	Q3
Medicine (miscellaneous)	2014	Q2
Medicine (miscellaneous)	2015	Q3
Medicine (miscellaneous)	2016	Q3
Medicine (miscellaneous)	2017	Q3
Medicine (miscellaneous)	2018	Q3
Medicine (miscellaneous)	2019	Q3
Medicine (miscellaneous)	2020	Q4
Medicine (miscellaneous)	2021	Q3

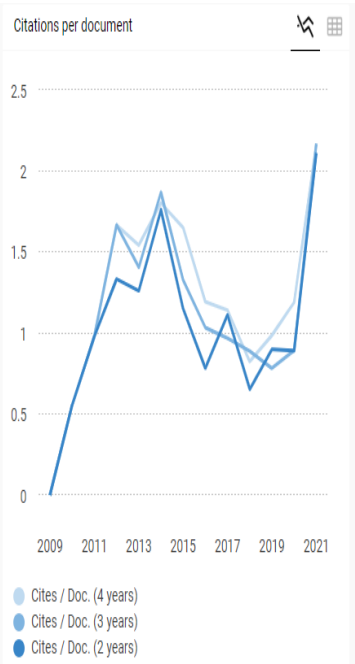
FIND SIMILAR JOURNALS

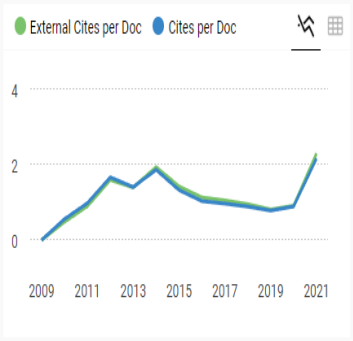
options

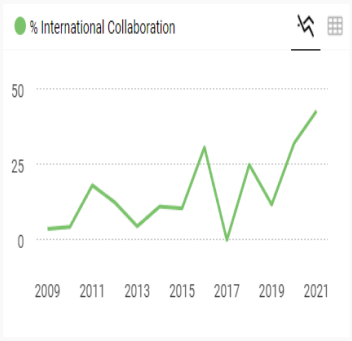
1	2	3	4	5
Current Nutrition and Food Science	Food Quality and Safety	Food Technology and Biotechnology	Critical Reviews in Food Science and Nutrition	Journal of Microbiology, Biotechnology and Food
ARE	GBR	HRV	GBR	SVK
42% similarity	40% similarity	39% similarity	39% similarity	39% similarity

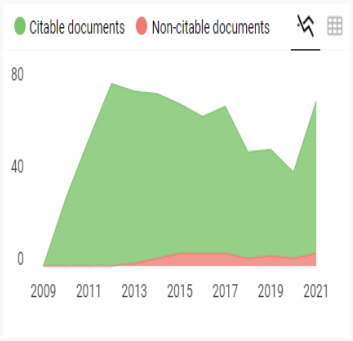


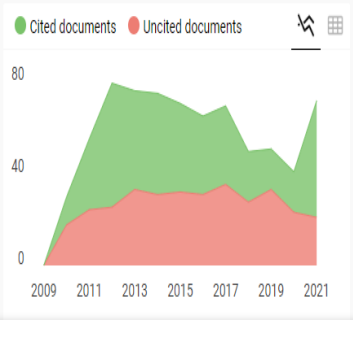


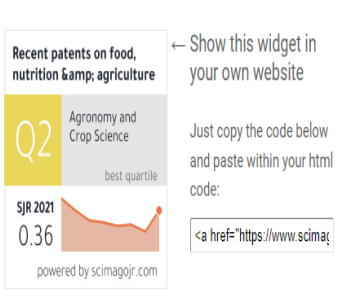












← Show this widget in your own website

Just copy the code below and paste within your html code:

<a href="https://www.scimag

SCImago Graphica

Explore, visually communicate and make sense of data with our new data visualization tool.

Recent Patents on Food, Nutrition & Agriculture, **2020**, *11*, 219-228

RESEARCH ARTICLE

BENTHAM SCIENCE

Antifungal Mechanism of *Rhodotorula mucilaginosa* and *Aureobasidium* sp. nov. Isolated from *Cerbera manghas* L. against the Growth of Destructive Molds in Post Harvested Apples

Dalia Sukmawati[1,*], Andisa Shabrina[1], Reni Indrayanti[1], Tri Handayani Kurniati[1], Muktiningsih Nurjayadi[2], Iman Hidayat[3], Shabrina Nida Al Husna[4], Nuniek Ina Ratnaningtyas[5], Hesham El Enshasy[6,7], Daniel Joe Dailin[6] and Abd El-Latif Hesham[8]

[1]Biology Department, 9th Floor Hasyim Ashari Building, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jakarta, Indonesia; [2]Education of Chemistry Department, 8th Floor Hasyim Ashari Building, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jakarta, Indonesia; [3]Research Centre for Biology, Indonesian Institute of Sciences-LIPI Jl, Raya Jakarta-Bogor KM 46, Cibinong, 16911, West Java, Indonesia; [4]Department of Microbiology, School of Life Sciences and Technology, Institut Teknologi Bandung, Indonesia; [5]Biology Faculty, Jenderal Soedirman University, Jl. Dr. Suparno 63, Grendeng, Purwokerto, Jawa Tengah, 53122, Indonesia; [6]Institute of Bioproduct Development (IBD), Universiti Teknologi Malaysia (UTM), 81130 UTM, Skudai, Malaysia; [7]Department of Bioprocess and Polymer Engineering, School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310, Skudai, Johor, Malaysia; [8]Genetics Department, Faculty of Agriculture, Beni-Suef University, Beni-Suef, Egypt

Abstract: ***Background*:** Apples often experience postharvest damage due to being attacked by mold organisms. Several groups of molds such as *Aspergillus* sp., *Penicilium expansum, Botrytis cinerea*, and *Venturia* sp. can cause a serious postharvest disease exhibited as watery regions where areas of blue-green tufts of spores develop. Current methods using fungicides to control pathogenic fungi can cause resistance if applied in the long term. An alternative procedure using yeast as a biological agent has been found.

***Objective*:** The aim of this study is to screen potential yeast, which has the ability to inhibit the growth of *Aspergillus brasielensis* (isolate A1) and *Aspergillus flavus* section flavi (isolate A17) isolated from apple fruits.

Methods: Antagonism test using YMA dual culture medium using *in vitro* assays and ITS rDNA identification were performed.

Results: The result showed that 3 out of 19 yeast isolated from *Cerbera manghas* L, T1, T3 and T4, demonstrated the potential ability as a biocontrol agent. ITS rDNA identification demonstrated that T1 has a similarity to *Rhodotorula mucilaginosa* while T3 and T4 were identified as *Aureobasidium* sp. nov. The 3 isolates exhibited the ability to reduce the growth of *A. brasiliensis sensu lato* better than dithane 0.3% with a Disease Incidence (DI) of 100% and a Disease Severity (DS) value of 45%. Only isolate T1 and T3 were able to reduce decay symptoms in apples inoculated with *A. flavus sensu lato* (with DO and DS were 100% and 25%, respectively) compared to dithane pesticides 0.3%.

Conclusion: This study indicated that competition between nutrients occurs between pathogenic molds and under-yeast *in vitro* and *in vivo* conditions. However, further studies in the future might be able to elucidate the 'killer' activity and interaction with the pathogen cells and the bio-product production using *Rhodotorula mucilaginosa* and *Aureoubasidium namibiae* strains to control postharvest diseases.

ARTICLE HISTORY

Received: August 06, 2019
Revised: January 23, 2020
Accepted: February 10, 2020

DOI:
10.2174/2212798411666200423101159

Keywords: Apple, *Aureobasidium pullulans*, biocontrol fungi, *Rhodotorula mucilaginosa*, molds, fungicides.

1. INTRODUCTION

Apples are beneficial to consume by people since it is rich in vitamins A, B and C, and minerals such as calcium, phosphorus, iron, chlorine, magnesium, sodium and potassium [1, 2]. Based on the data from the Ministry of Agriculture Indonesia, apple production in 2013 was 255.33 tons, and it decreased to 242.91 tons in 2014 [3]. Several factors contributed to this decline, one of which is the presence of destructive microorganisms such as fungi that causes damage during postharvest production [4, 5]. Destructive molds such as *Aspergillus* sp., *Penicillium expansum*, *Botrytis cine-*

*Address correspondence to this author at the Biology Department, 9th Floor Hasyim Ashari Building, Faculty of Mathematics and Natural Sciences, Universitas Negeri Jakarta, Jakarta, Indonesia;
Tel: +6281316218709; E-mail: Dalia-Sukmawati@unj.ac.id

1876-1429/20 $65.00+.00

rea, Colletotrichum acutatum, Monilia fructigena, Fusarium avenaceum, Mucor sp. and *Rhizopus stolonifer* [6-8] can cause damage to postharvest fruit, especially in apples. *B. cinerea*, for instance, causes gray mold rot (gray mold rot) on postharvest apples [9], while *P. expansum* causes blue mold rot in postharvest apples and also produces mycotoxin patulin and enzyme [10].

Harvest and handling practices have major effects on postharvest decay. Postharvest treatments, such as application of reduced-risk fungicide, biological agents and natural products, heat treatment and edible coating formulations, alone or in combination, can be successfully applied in a range of commodities in order to prevent decay. Until a long time ago, synthetic fungicides as benzimidazole, captan, diphenylalamin, dithane, and dicarboximide [9], have been used for handling of destructive molds on postharvest fruit at the farm level. However, long-term use of fungicide can be accumulated in the human body and imply to cause serious diseases [11, 12]. Therefore, the mode of action of antagonistic yeast in postharvest fruit disease control could be an important tool in postharvest biocontrol strategies, thus providing important guidance for their future application. In addition, mixtures of low-risk fungicides with biological agents should be carried out to identify the best postharvest treatments with the lowest environmental impact and the greatest consumer safety.

Microorganisms such as yeasts can be used as biological agents since it can produce compounds that are beneficial to humans and animals [13, 14]. Yeast has the ability to fight against destructive microorganisms [15, 16]. The ability of epiphytic yeast antagonism is shown through the ability of yeast to inhibit the growth of other microorganisms around it [17-19]. This can be further used as biocontrol agents.

Some epiphytic yeasts have been reported to inhibit mold growth [20, 21]. It has been reported that *Metschnikowia pulcherrima* BIO126 and *M. pulcherrima* GS37 isolated from apple surface can inhibit the growth of pathogenic molds, *Alternaria* sp., in apples [21]. In other research, it is found that glutinised *Rhodotorula* can inhibit the growth of pathogenic molds in apples after harvest period of *P. expansum*, shown by the results of *in vivo* and *in vitro* testing [22, 23]. *R. mucilaginosa* could inhibit the growth of *P. expansum* and *B. cinerea* in postharvest apples. The results of the interaction were demonstrated through the reduction of *B. cinerea* spore germination and reduction of colonies, which was greater than the control [24, 25]. *Candida oleophila* epiphytes isolated from the surface of tomatoes has also shown its ability to inhibit the growth of *Penicillium expansum* and *Botrytis cinerea* in postharvest kiwi fruit through antioxidant mechanisms which can be considered the presence of antioxidant gene expression [26].

Plants are substrates that can be overgrown by yeast [27, 28]. Bintaro (*Cerbera manghas* L.) is one of the plant types that can be overgrown by yeast [20]. The chemical content of leaves, flowers and fruit in Bintaro plants, including saponins, polyphenols, tannins, steroids, and flavonoids [29-31], are widely used in the pharmaceutical industry as ingredients of the medicine. The presence of these chemical contents might be the result of the existence of microorganisms. The identification of molds and yeasts was performed based on the data sequences of ITS regions, which have high variability between species so that they can be used to identify yeast at the species level [27, 32]. The ability of epiphytic yeast to inhibit the growth of destructive molds on fruit can be done by a dual culture method [20, 33]. Therefore, this study was aimed to identify and screen the inhibition activity of yeast isolated from *Cerbera manghas* L. against the growth of destructive molds in apples originating from Malang, Indonesia. Also, this research was expected to find the potential yeast able to act as biocontrol agents to apply in postharvest fruit production, especially in apples.

2. MATERIALS AND METHODS

2.1. Yeasts Collection and Sampling

A total of 19 yeast isolates were collected from the Universitas Negeri Jakarta Culture Collection. It isolated from Bintaro plants. Yeast was cultivated on two media, Peptone Dextrose Yeast Extract (10 g/L yeast extract, 20 g/L peptone and 20 g/L dextrose), and Nutrient Yeast Dextrose Broth (8 g/L nutrient broth, 5 g/L yeast extract and 10 g/L glucose) on a rotary shaker at 180 rpm for 24h at 28°C. The cell suspension was centrifuged at 4000°g for 10 min at 4°C, followed by washing with distilled water to remove the growth medium. Cultivated yeasts were then suspended in the concentration of 1 to 5×10^8 cells/mL.

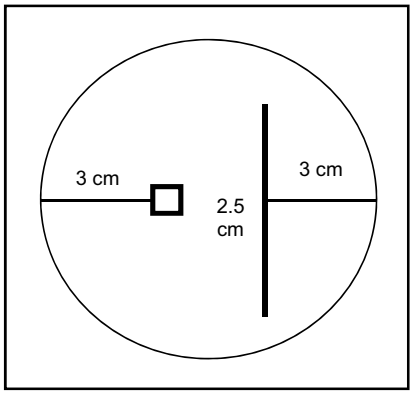
Fresh apples are obtained from the Jatinegara market, with the same size and maturity. The untreated apple fruits were washed, superficially disinfected with 0.2% (v / v) sodium hypochlorite for 3 min and reduced distilled water to eliminate the sodium hypochlorite. The fruits were then wounded to two points at the median region with sterile needles. The destructive mold was obtained from damaged apples and was followed by pathogenicity testing [34]. The two pathogens found were then coded by A1 and A17 isolates and maintained on Potato Dextrose Agar (PDA; 200 g/L extract of boiled potatoes, 20 g/L glucose and g/L agar) at 4°C. Spores of mold isolates with the code A1 and A17 were obtained from 6-day-old cultures on PDA at 25°C and suspended in sterile distilled water containing 0.1 g/kg Tween-80. The concentration of spore suspension was adjusted to the concentration of 1×10^7 spores/mL.

2.2. Identification of Molds Isolates by Amplification of the ITS Regions of the rDNA

Two molds isolates (A1 and A17) were identified based on their genetic material. DNA was extracted from the yeasts using DNA using the Genetic Plant Gneaid kit. ITS (Internal Transcribed Spacer) rDNA amplification was performed using the following primers: forward- ITS5 (5'-GGAAGTAAAAGTCGTAACAAGG-3') and reverse-ITS4 (5'TCCTCCGCTTATTGATATGC-3') according to White *et al*. PCR cycling conditions for yeasts consisted of an initial denaturation step at 95°C for 3 min; 33 cycles of denaturation at 95°C for 30 sec, annealing at 55°C for 30 sec and extension at 72°C for 1 min; and a final extension at 68°C for 10 min.

2.3. In Vitro Screening of Yeast Isolates for Antifungal Activity

The antagonicity tests were performed to all 19 yeast isolates obtained from Bintaro leaves. The antagonism testing method was using a dual culture method based on Sibounnavong *et al*. [35] and Sukmawati *et al*. [20] with modification. Tests were carried out in the Yeast Malt Agar (YMA) medium. For each test, one mold isolate and one yeast isolate were inoculated on the same petri where the distance between the two was 2.5 cm (Fig. **1**). A total of 20 µl of yeast cell suspensions with densities of 1 to 5×10^8 cells/mL were inoculated on the side of one pathogenic mold (A1 and A17) with spore densities of 1×10^7 spores/mL inoculated on the other side. Incubation was carried out for 5 days at 28°C. Observations were made on the fifth day by measuring the width of the inhibition zone between yeast and destructive molds using digital calipers. A completely randomized design with four replications for each of the 3 trials was used. The data were subjected to analysis of variance (ANOVA). The means were tested by Tukey's 5% probability.



Notes: ◻ Mold pathogen

❙ Yeast isolates from apples (with 6 cm long)

Fig. (1). Yeast and mold antagonism test using YMA dual culture medium, incubated at 28°C.

2.4. Calculation of Yeast Cell Growth Curves

Yeast cell growth curves were constructed based on Tang & Amon [36] with modification. The results of the measurement of the number and duration of the yeast log as a reference for the duration of yeast fermentation will be used for biocontrol.

2.5. Identification of Yeast Isolates by Amplification of the ITS Regions of the rDNA

Three yeast isolates (T1, T3 and T4) were identified based on their genetic material. DNA was extracted from the yeasts using the Genetic Plant Gneaid kit. DNA was amplified based on the ITS (Internal Transcribed Spacer) rDNA region using the following primers: forward- ITS5 (5'-GGAAGTAAAAGTCGTAACAAGG-3') and reverse-ITS4 (5'TCCTCCGCTTATTGATATGC-3'), according to White *et al*. [39]. PCR cycling conditions for yeasts consisted of an initial denaturation step at 95°C for 2 min; 33 cycles of denaturation at 95°C for 15 sec, annealing at 58°C for 30 sec and extension at 68°C for 2 min; and a final extension at 68°C for 10 min. The PCR product was purified with first base service. The sequences were aligned and compared with the NCBI database by the Internet using the Basic Local Alignment Search Tool [40].

2.6. *In Vivo* Antagonistic Activity Assays

In vivo method is carried out using the cut method based on Mahunu *et al*. [37] with modifications. Isolates of destructive molds and yeast were suspended under 7 treatments: 1) fresh apples without washing or surface sterilization; 2) apples washed with tap water; 3) apples carried out surface sterilization; 4) apples soaked with yeast suspension; 5) apples inoculated with mold; 6) apples soaked with yeast suspension then inoculated with mold; 7) apples are soaked with dithane M-45 0.3% then inoculated with mold. The prepared apples are soaked with yeast cell densities of 1 to 5×10^8 cells / mL, followed by incubation for 24 hours. Soaked apples with yeast suspension are then inoculated with 20 µl of pathogenic fungus spores 1×10^7 spores/ mL spore density. The treated apple was placed in a plastic tube and covered with clear plastic. The four corners are like wet cotton pads to maintain moisture followed by incubation at 27-28°C for 7 days. Observations were made every day until the seventh day of incubation after inoculation to determine scoring on a scale of 0, 2, 4, 6, and 8 [38]. The identification of plant resilience is done by calculating the percentage of Disease incidence (DI) and Disease Severity [38].

3. RESULTS

3.1. Identification of Mold Isolates by Amplification of the ITS Regions of the rDNA

Sequences of A1 and A17 isolates were then aligned with various sequences of *Aspergillus* species in the NCBI DNA GenBank database. Based on the phylogenetic tree (Fig. **2**), isolates A1 and A17 are in different clades. Isolate A1 was also in a monophyletic clade in the nigri section with *A. heteromorphus* CBS 117.55 and *A. brasiliensis* ATCC MYA-4553 with a bootstrap value of 88%. Meanwhile, isolate A17 was in a monophyletic clade in section flavi with *A. flavus* ATCC 16883, *A. lanosus* NRRL 3648 and *A. oryzae* NRRL 447 with a bootstrap value of 90%.

3.2. *In Vitro* Screening of the Yeast Isolates for Antifungal Activity

The antagonism test showed that yeast isolates from Bintaro leave on the MEA medium could inhibit the growth of apple-damaging molds. This is indicated by the presence of clear zones between mold colonies and yeasts. The clear zone is a zone of inhibition of mold colonies mycelium growth, as seen in Fig. (**3**).

The results of the two-way ANOVA analysis showed that there was an effect of giving yeast isolates to the inhibition of growth of test fungi, which is the Sig. 0.00 <α (0.05%) (Table **1**).

Based on the Duncan test at the level of 5%, it can be seen that yeast isolates with the code of T1 and T4 have no significant differences in inhibition of growth of *A. brasiliensis*

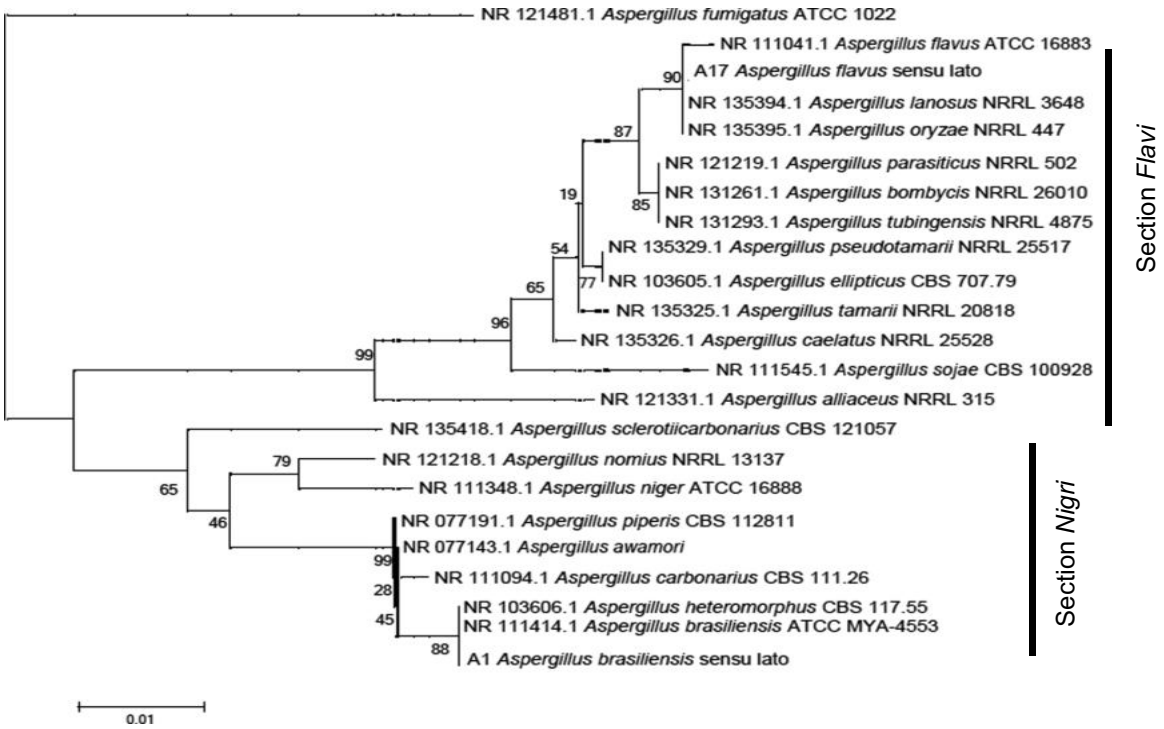


Fig. (2). Phylogenetic tree construction of yeast isolated from damaged apple based on ITS rDNA sequence analysis with neighbor joining method 1000 times bootstrap, MEGA5. *A. fumigatus* ATCC 1022 is used as an outgroup.

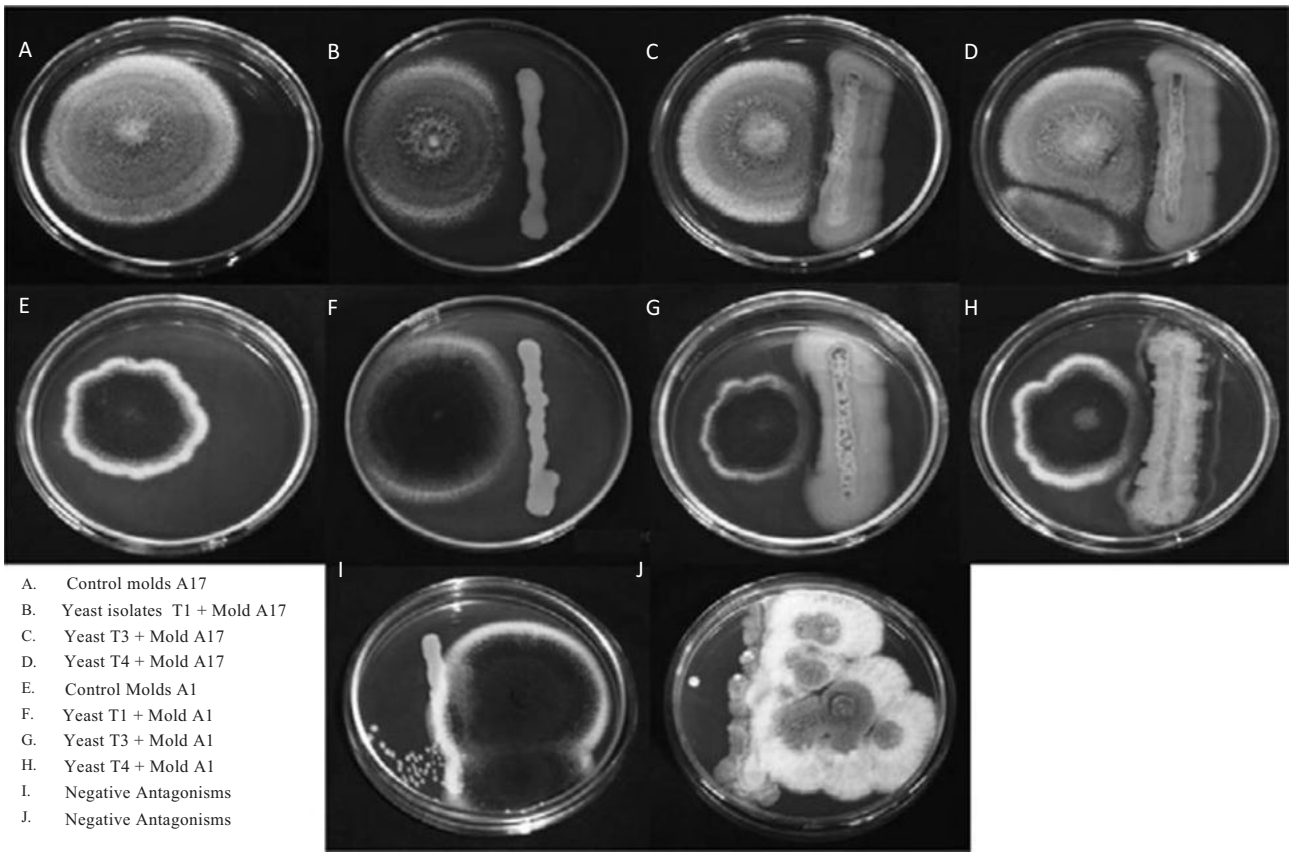


Fig. (3). The antagonistic test results in a zone of inhibition in the MEA medium, incubated for 6 days at 27-28°C. *(A higher resolution / colour version of this figure is available in the electronic copy of the article).*

Table 1. The width of the inhibitory zone formed in the antagonistic test of 19 yeasts originating from Bintaro leaves against two apple decay molds.

A. brasiliensis Sensu Lato		*A. flavus* Sensu Lato	
Yeasts	**Inhibition zone (mm) ±SE**		**Yeasts**
T1	1,06 ±0,26[a]	0,67 ±0,35[a]	T1
T2	0,00	0,00	T2
T3	1,16 ± 0,09[b]	1,52 ±0,08[b]	T3
T4	1,00 ±0.16[a]	0,70 ±0,13[a]	T4
T5	0,00	0,00	T5
T6	0,00	0,00	T6
T7	0,00	0,00	T7
T8	0,00	0,00	T8
T9	0,00	0,00	T9
T10	0,00	0,00	T10
T11	0,00	0,00	T11
T12	0,00	0,00	T12
T13	0,00	0,00	T13
T14	0,00	0,00	T14
T15	0,00	0,00	T15
T16	0,00	0,00	T16
T17	0,00	0,00	T17
T18	0,00	0,00	T18
T19	0,00	0,00	T19

Table 2. The width of the inhibitory zone formed in the test of yeast antagonists from bintaro leaves on two apple-damaging yeasts on PDA medium, incubated in 6 days with a temperature of 27-28°C.

Yeasts	**Inhibition Zone (mm) (Mean[D] ± SE)**
	Molds
T1	0,87[a] ± 0,20
T3	1,33[b] ± 0,18
T4	0,86[a] ± 0,13

Note: Numbers followed by the same letters are not significantly different at α = 0.05 Duncan test. Results that have a 0 zone value (negative) are not displayed.

sensu lato and *A. flavus* sensu lato. This is because the width of the inhibition zone formed against *A. brasiliensis* sensu lato (1.16 ± 0.09c) and *A. flavus* sensu lato (1.52 ± 0.08c) is the largest inhibition zone width (Table **1**). Yeast isolate with the code of T3 has a significant difference compared to the other two yeasts in inhibiting the growth of test fungi. Isolate T3 is the most potential yeast in inhibiting the growth of *A. brasiliensis* sensu lato and *A. flavus* sensu lato (Table **2**).

3.3. Identification of Yeast Isolates by Amplification of the ITS Regions of the rDNA

Sequences of yeast isolate T1, T3 and T4 were aligned with various sequences of *A. namibiae, A. thailandense, A. subglaciale, K. bupleuri, R. glutinis, R. graminis, R. araucariae*, and *R. kratochvilovae* which were downloaded from the DNA database NCBI GeneBank. The search results for ITS rDNA sequence homology using BLAST program showed that isolate T1 was identified as *R. mucilaginosa* with ITS sequence homology of 94% with the closest species, *R. mucilaginosa* CBS 316. Compared to the three sequences, namely *A. pullulans* (0.15%), *K. lines* (0.31%) and *A. namibiae* (0.15%), T3 and T4 isolates showed differences in nucleotide bases (Fig. **4**). Isolate T3 and T4 are later identified as *Aureobasidium* sp. nov.

Phylogenetic trees were made using MEGA 5 software with the Joining Neighboring (NJ) method. Phylogenetic

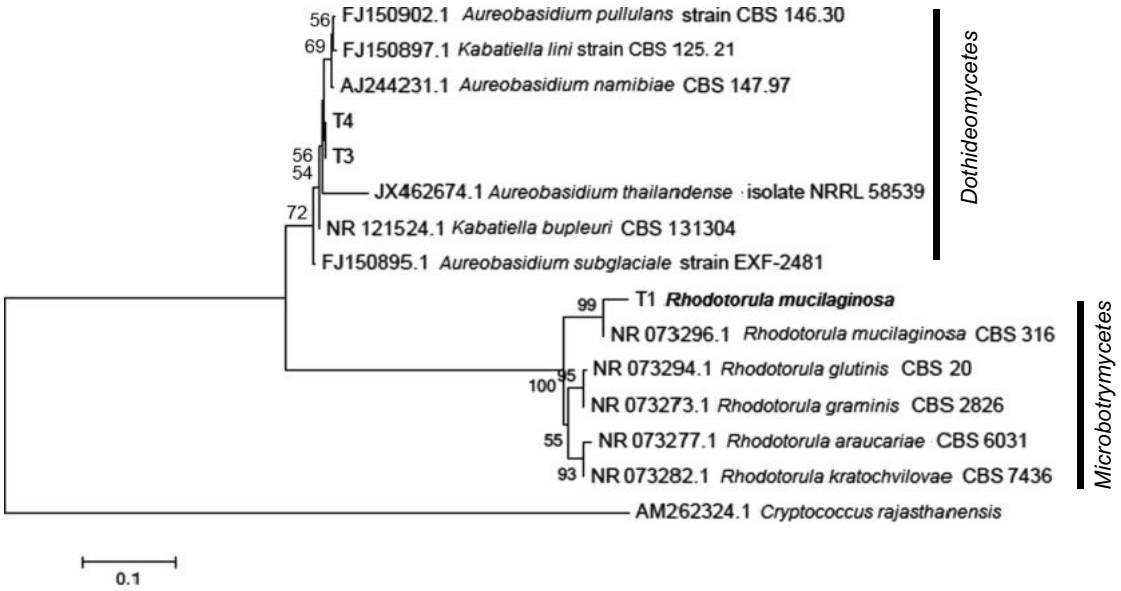
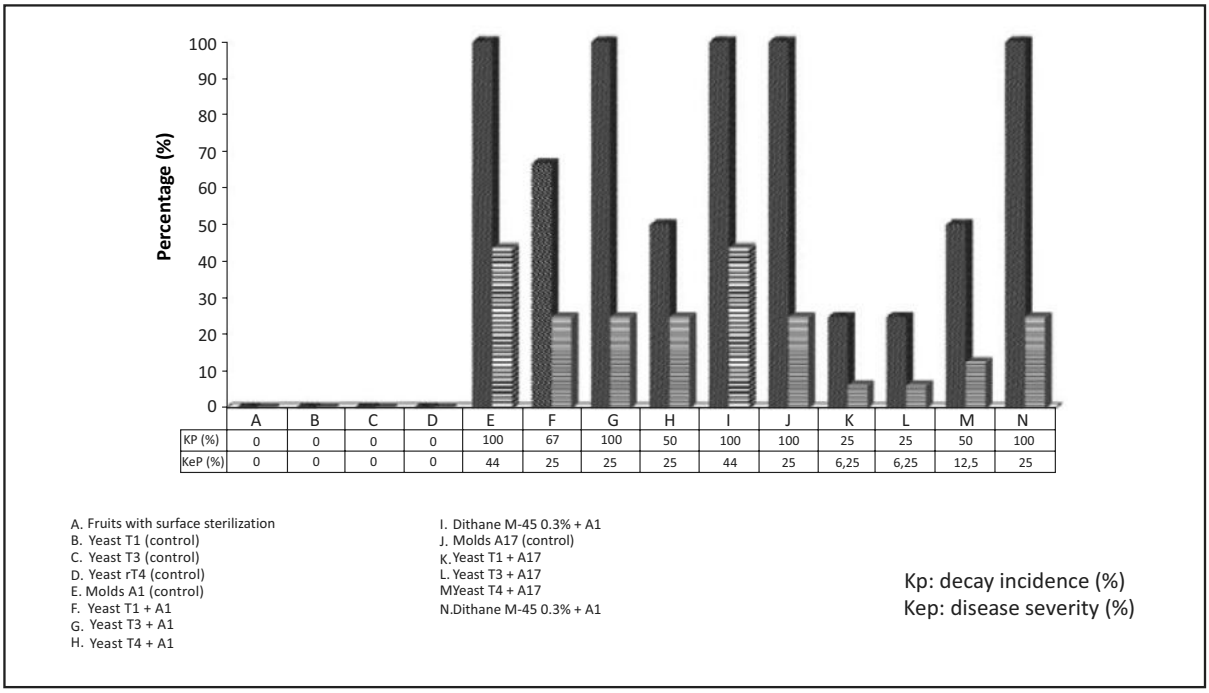


Fig. (4). Phylogenetic tree construction of antagonist yeast isolated from bintaro leaves based on ITS rDNA sequence analysis with Neighbor-Joining method 1000 times bootstrap, MEGA5. *Cryptococcus rajasthanensis* is used as an outgroup.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
KP (%)	0	0	0	0	100	67	100	50	100	100	25	25	50	100
KeP (%)	0	0	0	0	44	25	25	25	44	25	6,25	6,25	12,5	25

Fig. (5). Percentage of decay incidence and disease severity in antagonistic biocontrol T1, T3, and T4 tests against *A. brasiliensis* sensu lato and *A. flavus* sensu lato, incubated for 7 days at 27-28°C.

trees are used to determine kinship relationships between species sampled with various other species. Molecular phylogenetic combines molecular biology techniques with statistics to reconstruct phylogenetic relationships [41].

3.4. *In Vivo* Antagonistic Activity Assays in Damaged Apples

Based on *in vitro* test, isolate T1, T3, and T4 have the potential ability to act as biocontrol agents for *A. brasiliensis* sensu lato and *A. flavus* sensu lato. Yeast isolates showed different abilities from one another. Tests of antagonistic yeast biocontrol on destructive mold showed the percentage of rotten apples that varied with incubation of 6 days. Isolate T4 (decay incidence 50%; disease severity 25%) have the ability as superior biocontrol agents against the growth of *A. brasiliensis* sensu lato compared to isolate T1 (decay incidence 67%; disease severity 25%) and T3 (decay incidence 100%; disease severity 25%). The ability of yeast isolates T1, T3, and T4 to reduce the growth of *A. brasiliensis* sensu lato was better than that of Dithane M-45 synthetic fungicide 0.3% (decay incidence 100%; disease severity 44%) (Figs. **5** and **6**).

Yeast isolates of T1, T3, and T4 can reduce the growth of *A. flavus* sensu lato, thereby reducing apple rot. Yeast iso-

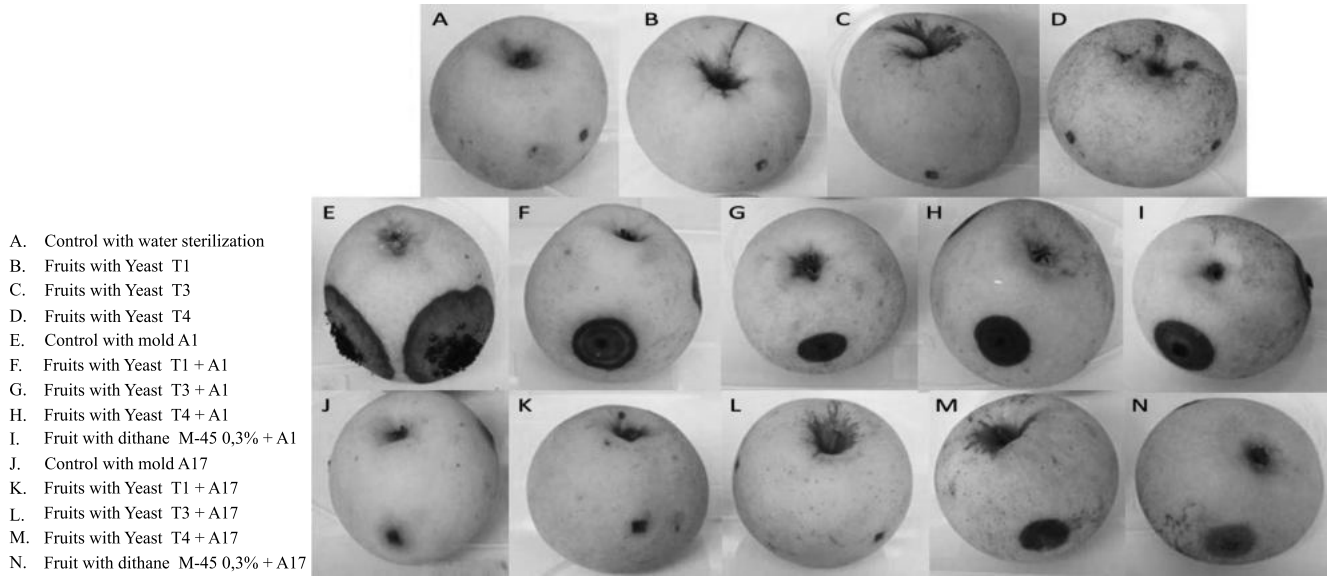


Fig. (6). Biocontrol test of yeast isolated from Bintaro leaves against destructive molds with incubation of 7 days at 27-28°C. *(A higher resolution / colour version of this figure is available in the electronic copy of the article).*

lates T1 and T3 (decay incidence 25%; disease severity 6.25%) have the ability as superior biocontrol agents against the growth of *A. flavus* sensu lato compared to T4 yeast isolates (decay incidence 50%; disease severity 12.5%). The ability of T1 and yeast T3 in reducing the growth of *A. flavus* sensu lato in apple rot is better than that of Dithane M-45 synthetic fungicide 0.3% (decay incidence 100%; disease severity 25%).

4. DISCUSSION

The results of this study showed that 19 yeast isolates tested were obtained from 3 isolates (T1, T3 and T4) of epiphytic yeast from the Bintaro plant which has antagonistic ability to inhibit the growth of mold pathogens that caused damage to postharvest apples (*A. brasiliensis* sensu lato and *A. flavus* sensu lato). It is convergence with other works conducted by other researchers [8, 25, 42] who have reported the successful biological fungal treatment using yeast agents.

The results of the 2-way ANOVA analysis showed that there was an effect of the presence of yeast isolates to inhibit the growth of destructive molds shown by Sig. 0.00 <α (0.05%). This is in line with the statement of Golubev [18] that the ability of yeast antagonism will be more increased against microorganisms from different habitats since they are considered as new competitors that must be defeated to be able to dominate the available space and nutrients. The competition between yeast and mold can be demonstrated by the rise of yeast growth in the medium. Yeast cells have the ability to absorb nutrients in the medium more than mold cells. Molds will get a lack of nutrients to grow at the same medium of yeast growth so that the mycelium formed became less. Mechanism of space and nutrient competition occurs when yeasts try to obtain limited space and nutrients when grown with pathogens [43]. The growth activity of mold colonies is disrupted due to lack of nutrients and space to grow [44-56].

The search results for ITS rDNA sequence homology using the BLAST program showed that *A. brasiliensis* sensu lato is located in a monophyletic clade in the nigiri section with *A. brasiliensis* ATCC MYA-4553 with an ITS sequence homology of 98% with the closest species, *A. brasiliensis* ATCC MYA-4553. This mold is known as *Aspergillus brasiliensis* sp. nov., which can be distinguished from other black aspergilli based on intergenic transcribed region, beta-tubulin and calmodulin gene sequences. It is an aerobic and produced naphtho-gamma-pyrones, tensidol A and B and pyrophen in common with *Aspergillus niger* and *Aspergillus tubingensis.* This species was most closely related to *A. niger*, and was isolated from soil from Brazil, Australia, USA and The Netherlands, and from grape berries from Portugal [53]. In other words, A1 *A. brasiliensis* sensu lato is possible to cause damage in postharvest fruits since it is also found in damaged grape berries.

A. flavus sensu lato is closely related to *A. flavus* ATCC 16883, which is known as aflatoxin-producing mold. This isolate was found on stored products [53] and Argentinean peanuts [54]. *A. flavus* sensu lato has a sequence homology of 99% with *A. flavus* ATCC 16883. From molecular identification result, it can be seen that killer yeast can be found on its natural habitat since plants are good resources for the yeast to grow [53]. The inhibition activity occurs when there is a limitation in nutrients.

The antagonistic test results showed that three antagonistic isolates (T1, T3, T4) have the ability to inhibit the growth of two destructive molds, while the other isolates did not represent inhibitory zones. Isolates T3 is the most potential pathogen-inhibiting yeast for isolate *A. brasiliensis* sensu lato and *A. flavus* sensu lato. The width of the inhibitory

zone by T3 yeast isolates is 1.33 mm, as seen in Table **1**. In this study, it is assumed that the greater number of inhibition zone value formed, the greater the ability of yeast to inhibit mold growth. The inhibition of mycelium growth in mold colonies is predicted due to competition for nutrition and space. The competition between microorganisms for essential environmental factors, such as those of the fundamental mechanisms of biological control [7, 24, 50].

Yeast isolates of T1, T3, and T4 were aligned with various sequences of *A. namibiae, A. thailandense, A. subglaciale, K. bupleuri, R. glutinis, R. graminis, R. araucariae,* and *R. kratochvilovae* which are downloaded from the DNA database NCBI GenBank. Isolate T1 was identified as *Rhodotorula mucilaginosa,* which is located in a monophyletic clade together with *R. mucilaginosa* CBS 316 with a 99% bootstrap value. In recent years, several yeast species (mainly of the genera of *Rhodotorula* and *Crytococcus*) have been claimed to be useful as for the biological control of postharvest disease on storage fruits and vegetables due to their antagonistic activities against common plant pathogens. Among the *Rhodotorula* species reported as potential biocontrol agents, *R. mucilaginosa*, *R. glutinis*, and *R. minuta* are included and have been tested with promising results. Some researchers have carried out antagonistic testing of yeast on apple decay such as yeast antagonism on molds of *Colletotrichum* sp. from strawberries, chili and beans. Yeast *Rhodotorula* sp. is able to inhibit the growth of *Colletotrichum* sp. from chili and strawberry fruits by 40% and 55% with incubation for 10 days [16, 33, 34, 51]. Yeast *Metschnikowia* sp. can inhibit the growth of *Colletotrichum* sp. from chickpea by 35% with incubation for 10 days. *Pichia guilliermomdii* and *R. mucilaginosa* also showed its ability to inhibit the growth of blue mold on apple damage, *Penicillium expansum,* tested using the dual culture method. Antagonist testing using PDA medium with incubation for 18 days at 25°C. The average percentage of inhibition zones formed by *Pich. guilliermomdii* at 57.62% and *R. mucilaginosa* at 34.51% [52].

The broad characteristics occurrence in natural and artificial environments of *Rhodotorula* species, especially of *R. mucilaginosa,* is most certainly a result of their physiological and metabolic plasticity. Such characteristic is also responsible for their frequent appearance in food and beverages. Food and beverages can be a significant source of *Rhodotorula* yeasts, thus posing an additional and probably underestimated risk for susceptible patients.

Based on phylogenetic construction, isolate T3 and T4 are predicted as new species since they formed an independent lineage from their closest sequences, *A. Pullulans, K. line* and A. *namibiae* with a bootstrap value of 56%. This showed that isolate T3 and T4 have a homology level that is not close to the three sequences. Isolate T3 and T4 have unique gene sequences, which do not align with any sequences in the databases and showed a difference in nucleotide bases compared to the three sequences, which are *A. pullulans* (0.15%), *K. lines* (0.31%) and *A. namibiae* (0.15%). T1 isolate sequences have a difference of 0.94% with *A. pullulans* sequences downloaded from NCBI. *Aureobasidium pullulans* is a ubiquitous black, yeast-like fungus that can be found in a wide range of environments. It is well known as a naturally occurring epiphyte or endophyte of many plant species without causing any symptoms of the disease.

CONCLUSION

This study showed that yeasts isolated from Bintaro leaves have antagonism and biocontrol activity against destructive molds isolated from Malang apples. Isolate of T1 which is identified as *Rhodotorula mucilaginosa* and isolates of T3 and T4 which were identified as *Aureobasidium* sp. nov., were found to have the ability to grow against *A. brasilensis* sensu lato *and A. flavus* sensu lato with an inhibition zone of 0,87 ± 0,20, 1,33 ± 0,18, and 0,86 ± 0,13, respectively. The inhibition process in the antagonistic test to the three yeast strains showed inhibition in the sporulation process and the formation of the distance of the inhibition zone between yeast and mold mycelium growth. In this study, it is found that epiphytic yeast isolates from Bintaro leaves have the ability to reduce disease severity and disease incidence by almost 100% of apples compared to Dithane M-45 synthetic fungicide. Yeast application as a biocontrol agent can be used as an alternative in substituting pesticide use, which is very dangerous for both humans and the environment. In future studies, we will further explore how yeast isolates interact with pathogenic molds.

CURRENT & FUTURE DEVELOPMENTS

Further studies will be conducted to determine the environmental factors that affect yeast viability, such as pH, temperature, carbon sources that are expected to increase the role of yeast as a postharvest biocontrol agent in apples. This study contributes to biocontrol research that epiphytic yeast obtained from Bintaro plants can be used as a biocontrol agent in controlling pathogenic fungi in postharvest fruit.

AUTHOR CONTRIBUTIONS

DS, IH, MN conceived and designed the experiments; AS and RI performed the experiments; DS, DJD, IH analyzed the data; DS, SNA, THK, NIR, HEE, AEH wrote the paper.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No animals/humans were used for studies that are basis of this research.

CONSENT FOR PUBLICATION

Not applicable.

FUNDING

The authors are very grateful to DRPM Kemenristekdikti 2020, Hibah Penelitian Terapan Unggulan Perguruan Tinggi (PTUPT) on behalf Dalia Sukmawati with contract number 4/SP2H/DRPM/LPPM-UNJ/II/2019.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

We thank the Lab. Microbiology and Universitas Negeri Jakarta Culture Collection (UNJCC) for the facilities provided to run this study.

REFERENCES

[1] Wulandari A. Antibacterial ability of manalagi apple extracts against *Salmonella thyposa*. J Healthy Sci AAKMAL 2002; 2: 1-3.

[2] Oro L, Feliziani E, Ciani M, Romanazzi G, Comitini F. Volatile organic compounds from *Wickerhamomyces anomalus*, *Metschnikowia pulcherrima* and *Saccharomyces cerevisiae* inhibit growth of decay causing fungi and control postharvest diseases of strawberries. Int J Food Microbiol 2018; 265: 18-22. http://dx.doi.org/10.1016/j.ijfoodmicro.2017.10.027 PMID: 29107842

[3] Donowarti I, Winahyu ST. Economic analysis of apple production in Poncokusumo village, Malang Regency. Primordia 2008; 4(2): 150-6.

[4] Semangun H. Horticultural Crop Diseases in Indonesia. 3rd ed. Gajah Mada University Press: Yogyakarta 2007.

[5] Aladdin A, Dib JR, Abd MR, Enshasy HE. Killer Yeast, a Novel Biological Control of Soilborne Diseases for Good Agriculture Practice. In: Zakaria ZA, Ed. Sustainable Technologies for the Management of Agricultural Wastes. Singapore: Springer 2018: 71-86. http://dx.doi.org/10.1007/978-981-10-5062-6_6

[6] Maxin P, Williams M, Weber RWS. Control of fungal storange rots of apples by hot water treatments: a northern Eurpoean perspective. Erwerbs-Obstbau 2014; 56: 25-34. http://dx.doi.org/10.1007/s10341-014-0200-z

[7] da Cunha T, Ferraz LP, Wehr PP, Kupper KC. Antifungal activity and action mechanisms of yeasts isolates from citrus against *Penicillium italicum*. Int J Food Microbiol 2018; 276: 20-7. http://dx.doi.org/10.1016/j.ijfoodmicro.2018.03.019 PMID: 29653393

[8] Santoso B. Postharvest Diseases of Horticultural Commodities. Rineka Cipta: Jakarta 2008.

[9] Vico I, Duduk N, Vasic M. Identification of *Penicillium expansum* causing postharvest blue mold decay of apple fruit Pestic phytomedicina 2014; 29(4): 257-66.

[10] Soemirat J. Environmental Toxicology. Gadjah Mada University Press: Yogyakarta 2003.

[11] Mahyuni EL. Risk factors in the use of pesticides for health complaints to farmers in Berastagi District, Karo Regency. Kesmas 2015; 9: 79-89.

[12] Abdel-Aziz SM, Gupta VK, Sukmawati D, Fadel M. Role of nutrient in microbial developments and microbial metabolic diversity. Microbial Applications 2016; 7: 151-76. http://dx.doi.org/10.1515/9783110412789-009

[13] Enshasy HE, Dailin DJ, Manas NHA, *et al.* Current and future applications of phytases in poultry industry: a critical review. J Adv VetBio Sci Tech 2018; 3(3): 65-74. http://dx.doi.org/10.31797/vetbio.455687

[14] Sperandio EM, Martins do Vale HM, Moreira GAM. Yeasts from native Brazilian Cerrado plants: occurrence, diversity and use in the biocontrol of citrus green mould. Fungal Biol 2015; 119(11): 984-93. http://dx.doi.org/10.1016/j.funbio.2015.06.011 PMID: 26466874

[15] Sukmawati D, Puspitasari SI, Wahyudi P, *et al.* Screening mold *Aspergillus* spp. producing aflatoxin in corn pipeline at Bekasi, West Java Area. Al-Kauniyah. J Biol 2018; 11(2): 151-62.

[16] Yun W, Yulin L, Weidong X, *et al.* Exploring the effect of β-glucan on the biocontrol activity of *Cryptococcus podzolicus* against postharvest decay of apples and the possible mechanisms involved. Biol Control 2018; 121: 14-22. http://dx.doi.org/10.1016/j.biocontrol.2018.02.001

[17] Golubev WI. Antagonistic Anteractions among yeast. In: Peter G, Rosa C, Eds. Biodiversity and Ecophysiology of Yeasts. Germany: Springer 2006: 197-219.

[18] Lopes MR, Klein MN, Ferraz LP, da Silva AC, Kupper KC. *Saccharomyces cerevisiae*: a novel and efficient biological control agent for *Colletotrichum acutatum* during pre-harvest. Microbiol Res 2015; 175: 93-9. http://dx.doi.org/10.1016/j.micres.2015.04.003 PMID: 25960430

[19] Sukmawati D. Antagonism mechanism of fungal contamination animal feed using phylloplane yeasts isolated from the Bintaro plant (*Cerbera manghas*) Bekasi in Java, Indonesia. Int J Curr Microbiol Appl Sci 2016; 5(5): 54-62. http://dx.doi.org/10.20546/ijcmas.2016.505.007

[20] Perez MF, Isas AS, Aladdin A, Enshasy HE, Dib JR. Killer Yeasts as Biocontrol Agents of Postharvest Fungal Diseases in Lemons. In: Zakaria ZA, Ed. Sustainable Technologies for the Management of Agricultural Wastes. Singapore: Springer 2018: 87-98. http://dx.doi.org/10.1007/978-981-10-5062-6_7

[21] Spadaro D. Biological control of postharvest diseases of pome fruit using yeast antagonist. PhD Thesis, University of Turin, Turin, Italy, 2003.

[22] Widyastuti S. Post harvest diseases control of *Penicillium expansum* against yeast *Rhodotorula glutinis*. *Proceedings of Agricultural Engineering National Seminar*. Yogyakarta. 2008.

[23] Liu Y, Wang W, Zhou Y, Yao S, Deng L, Zeng K. Isolation, identification and *in vitro* screening of Chongqing orangery yeasts for the biocontrol of *Penicillium digitatum* on citrus fruit. Biol Control 2017; 110: 18-24. http://dx.doi.org/10.1016/j.biocontrol.2017.04.002

[24] Liu Z, Du S, Ren Y, Liu Y. Biocontrol ability of killer yeasts (*Saccharomyces cerevisiae*) isolated from wine against *Colletotrichum gloeosporioides* on grape. J Basic Microbiol 2018; 58(1): 60-7. http://dx.doi.org/10.1002/jobm.201700264 PMID: 29105800

[25] Wang Y, Luo Y, Sui Y, *et al.* Exposure of *Candida oleophila* to sublethal salt stress induces an antioxidant response and improves biocontrol efficacy. Biol Control 2018; 127: 109-15. http://dx.doi.org/10.1016/j.biocontrol.2018.09.002

[26] James RB, Ed. Nutritional control of growth and development in yeast. Genetics 2012; 192(1): 73-105.

[27] Agrios GN. Plant Pathology. 5th ed. University of Florida: Florida 2005.

[28] Utami S. Insecticide activity of bintaro against *Eurema* sp. on a labora-tory scale. J Plantation Forest Res 2010; 7(4): 211-0.

[29] Awad HM, El-Enshasy HA, Hanapi SZ, Hamed ER, Rosidi B. A new chitinase-producer strain *Streptomyces glauciniger* WICC-A03: isolation and identification as a biocontrol agent for plants phytopathogenic fungi. Nat Prod Res 2014; 28(24): 2273-7. http://dx.doi.org/10.1080/14786419.2014.939083 PMID: 25078877

[30] Peréz-Sariñana BY, Fernandoa SEL, Sergio ST, Eapen D, Sebastian PJ. Evaluation of agro-industrial wastes to produce bioethanol: case study - mango (*Mangifera indica* L.). Energy Procedia 2014; 57: 860-6. http://dx.doi.org/10.1016/j.egypro.2014.10.295

[31] Hall BG. Phylogenetic trees made easy: A how to manual for molecular biologists. Sinaeur Associates Inc: Sunderland 2001.

[32] Sukmawati D, Oetari A, Hendrayanti D, Atria M, Wellyzar S. Identification of phylloplane yeasts from paper mulberry (*Broussonetia papyrifera* (L.) L'Her.ex Vent.) in Java, Indonesia. Malays J Microbiol 2015; 11(4): 324-40.

[33] Shabrina A, Sukmawati D, Hidayat I. Isolation and pathogenicity test of destructive molds in Malang apples (*Malus sylvestris* Mill.) post harvest. Bioma 2018; 14(1): 4.

[34] Sibounnavong P, Soytong K, Divina CC, Kalaw SP. *In-vitro* biological activities of *Emericella nidulans*, a new fungal antagonist, against *Fusarium oxysporum* f. sp. lycopersici. J Agr Technol 2009; 5(1): 75-84.

[35] Tang YC, Amon A. Gene copy number alterations: a cost-benefit analysis 2013; 152: 394-405. http://dx.doi.org/10.1016/j.cell.2012.11.043

[36] Mahunu GK, Zhang H, Yang Q, Zhang X, Li D, Zhou Y. Improving the biocontrol efficacy of *Pichia caribbica* with phytic acid against postharvest blue mold and natural decay in apples. Biol Control 2015; 92: 172-89. http://dx.doi.org/10.1016/j.biocontrol.2015.10.012

[37] Wan M, Li G, Zhang J, Jiang D, Huang HC. Effect of volatile substances of *Steptomyces platensis* F-1 on control of plant fungal diseases. Biol Control 2008; 46: 552-9. http://dx.doi.org/10.1016/j.biocontrol.2008.05.015

[38] White TJ, Bruns T, Lee S, Taylor JW. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand DH, Sninsky JJ, White TJ, Eds. PCR Protocols. New York: Academic Press Inc 1990: 315-22. http://dx.doi.org/10.1016/B978-0-12-372180-8.50042-1

[39] Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. Basic local alignment search tool. J Mol Biol 1990; 215(3): 403-10. http://dx.doi.org/10.1016/S0022-2836(05)80360-2 PMID: 2231712

[40] Hidayat T, Pancoro A. Molecular phylogenetic studies and its role in providing basic information for improving the quality of orchid genetic sources. J Agro Biogen 2008; 4: 35-40.

[41] Lutz C, Gramisci BR, Lutz MC, Lopes CA, Sangorrín MP. Enhancing the efficacy of yeast biocontrol agents against postharvest pathogens through nutrient profiling and the use of other additives. Biol Control 2018; 121: 151-8. http://dx.doi.org/10.1016/j.biocontrol.2018.03.001

[42] Janisiewicz WJ, Korsten L. Biological control of postharvest diseases of fruits. Annu Rev Phytopathol 2002; 40: 411-41. http://dx.doi.org/10.1146/annurev.phyto.40.120401.130158 PMID: 12147766

[43] Sharma RR, Singh D, Singh R. Biological control of postharvest diseases of fruits and vegetables by microbial antagonists: a review. Biol Control 2009; 50: 205-21. http://dx.doi.org/10.1016/j.biocontrol.2009.05.001

[44] Vermeersch L, Perez-Samper G, Cerulus B, *et al.* On the duration of the microbial lag phase. Curr Genet 2019; 65(3): 721-7. http://dx.doi.org/10.1007/s00294-019-00938-2 PMID: 30666394

[45] Mahreni SS, Ferlany I. Agustina. Production of (*Sacharomyces cerevisiae*) (Fncc-3049) in The Flour of Banana Skin Culture in The Aerobic Condition. *The 1st ACIKITA International Conference of Science and Technology*. 2 February 2011.

[46] Asaduzzaman MD. Standardization of yeast growth curves from several curves with different initial sizes. Master's Thesis, University of Technology and Goteborg University SE, Goteborg, Sweden, 2007.

[47] Iriani S, Maria B, Nur M. Potentially antihyperglycemic from biomass and phycocyanin of Spirulina fusiformis Voronikhin by *in vivo* test. Procedia Chem 2015; 14: 211-5. http://dx.doi.org/10.1016/j.proche.2015.03.030

[48] James SA, Collins MD, Roberts IN. Use of an rDNA internal transcribed spacer region to distinguish phylogenetically closely related species of the genera *Zygosaccharomyces* and *Torulaspora*. Int J Systemastic Bacteriol 1996; 46(1): 180-94.

[49] Becker B, Schmitt MJ. Yeast killer toxin k28: biology and unique strategy of host cell intoxication and killing. Toxins 2017; 9(10): 333. http://dx.doi.org/10.3390/toxins9100333 PMID: 29053588

[50] Ferraz LP, Cunha TD, da Silva AC, Kupper KC. Biocontrol ability and putative mode of action of yeasts against *Geotrichum citri-aurantii* in citrus fruit. Microbiol Res 2016; 188-189: 72-9. http://dx.doi.org/10.1016/j.micres.2016.04.012 PMID: 27296964

[51] Jalal G, Etebarian HR, Sahebani NA, Roustaee A. Characterization of biocontrol activity of two yeast strains from iran against blue mould of apple in order to reduce the environmental pollution. J Int Environ Appl Sci 2009; 4(1): 28-36.

[52] Monika W, Kordowska-Wiater M. The occurrence of killer activity in yeasts isolated from natural habitats. Acta Biochimica 2015; 46: 237-46.

[53] Varga J, Kocsubé S, Tóth B, *et al. Aspergillus brasiliensis* sp. nov., a biseriate black *Aspergillus* species with world-wide distribution. Int J Syst Evol Microbiol 2007; 57(Pt 8): 1925-32. http://dx.doi.org/10.1099/ijs.0.65021-0 PMID: 17684283

[54] Kozakiewicz Z. Aspergillus species on stored products. Taylor & Francis, Ltd: Florida 2008. http://dx.doi.org/10.1099/ijs.0.65123-0 PMID: 18319485

[55] Dellanerra D, Risandi A, Anggun S, *et al.* Screening and characterization of amylolitic mold originated from ghost crab (*Ocypode* sp.) in Cidaon, Ujung Kulon National Park, Indonesia. *AIP Conference Proceedings 2120.* 2019.

[56] Sukmawati D, Dellanerra D, Risandi A. Screening the capabilities of Indonesian indigenous mold in producing cellulase enzyme. Mat Sci Eng 2018; 434(1) 012125. http://dx.doi.org/10.1088/1757-899X/434/1/012125