Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>

Re: FR-2020-718 - Article Published

Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id> Tue, Sep 21, 2021 at 4:49 PM
To: IPB Dase Hunaefi <dashcbdk@apps.ipb.ac.id>

---------- Forwarded message ---------
From: **Food Research** <foodresearch.my@outlook.com>
Date: Sun, Sep 19, 2021 at 7:50 PM
Subject: Re: FR-2020-718 - Article Published
To: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>

Dear Dr Rahmawati,

Kindly be informed that your manuscript has been assigned to Food Research 2021, Vol. 5, Issue 5 (October). Your manuscript is currently available online and in press on our website https://www.myfoodresearch.com. Alternatively, you can download a copy of the manuscript by clicking on the following link:
https://doi.org/10.26656/fr.2017.5(5).718

We encourage you to share your published work with your colleagues. Thank you for your fine contribution. We hope that you continue to submit other articles to the Journal.

Thanks & Regards,
Dr. Vivian New
Editor
Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Wednesday, 15 September, 2021 10:32 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Article Production

Dear Dr Vivian New
Editor
Food Research

Thank you for this information.

Best regards,
Rahmawati

On Tue, Sep 14, 2021 at 8:04 PM Food Research <foodresearch.my@outlook.com> wrote:

> Dear Dr Rahmawati,
>
> Thank you for the payment. I'll notify you of the article publication soon.
>
> Thanks & Regards,
> Vivian New
> Editor
> Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Monday, 13 September, 2021 7:56 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Article Production

Dear Vivian New
Editor Food Research

I hereby send a proof of payment for the manuscript FR - 2020 -718.
Thank you for your kindness

Best recards,
Rahmawati

On Thu, Sep 2, 2021 at 7:48 PM Food Research <foodresearch.my@outlook.com> wrote:

> Dear Dr Rahmawati,
>
> Noted with thanks.
>
> Thanks & Regards,
> Vivian New
> Editor
> Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Wednesday, 1 September, 2021 11:21 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Article Production

Approved, please proceed.
Thank you

On Tue, Aug 31, 2021 at 2:14 PM Food Research <foodresearch.my@outlook.com> wrote:

> Dear Dr Rahmawati,
>
> Please refer to the attachment for the edited galley proof. If the galley proof is fine, please approve the galley proof.
>
> Thanks & Regards,
> Vivian New

Editor
Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Tuesday, 31 August, 2021 1:34 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Article Production

Dear Vivian New
Editor Food Review

There is a little bit of correction.
Thank you for correcting again.

Best regards,

Rahmawati

On Tue, Aug 31, 2021 at 11:00 AM Food Research <foodresearch.my@outlook.com> wrote:

> Dear Dr Rahmawati,
>
> Please refer to the attachment for the edited galley proof. If the galley proof is fine, please approve the galley proof.
>
> Thanks & Regards,
> Vivian New
> Editor
> Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Monday, 30 August, 2021 11:28 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Article Production

Dear Vivian New
Editor Food Review

I hereby convey that, there has been a change in affiliation to the 3rd author Dede Saputra, namely
beginning : Department of Food Technology, Bina Nusantara University, Jl. West Silk Road Lot 21, Tangerang, 15326, Indonesia
now: PT Sigma Fazza Sintesa, Harvest City Cluster Florentina F6 no. 15 Cileungsi, West Java 16820, Indonesia
I hope you can change it. Thank you for your kindness.
Best regards,

Rahmawati

On Sun, Aug 29, 2021 at 9:57 PM Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id> wrote:

> Dear Vivian New

Received with thanks.

Rahmawati

On Sun, Aug 29, 2021 at 3:41 PM Food Research <foodresearch.my@outlook.com> wrote:

Dear Dr Rahmawati,

Please refer to the attachment for the galley proof of your manuscript FR-2020-718 entitled 'Optimizing the tray dryer temperature and time of white corn flour culture' . Please check the content of the galley proof. If there are any mistakes, please comment and highlight in the PDF itself and revert to us within two (2) days of receipt. Once we have finalized the PDF version, your manuscript will be published online for early viewing.

Please see the attachment for the invoice INV21190. We hope that you can make the payment as soon as possible before 19 September 2021 for us to complete the publication of your manuscript. The manuscript information e.g. volume, issue, page numbers and DOI, will be provided once we have received the payment.

Thanks & Regards,
Vivian New
Editor
Food Research

From: Food Research <foodresearch.my@outlook.com>
Sent: Friday, 20 August, 2021 11:19 AM
To: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Subject: Re: FR-2020-718 - Article Production

Dear Dr Rahmawati,

Received with thanks.

Thanks & Regards,
Vivian New
Editor
Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Thursday, 19 August, 2021 11:53 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Article Production

Dear Vivian New
Editor Food Research

I hereby send the manuscript that I have improved.
I hope this manuscript has followed the suggestions that have been given.

Thank you.

Best regards,
Rahmawati

On Sun, Aug 15, 2021 at 10:18 PM Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id> wrote:

Dear Vivian New
Editor Food Research

I will improve my manuscript.
Thank you for your email.

Best regards,
Rahmawati

On Tue, Aug 10, 2021 at 3:15 PM Food Research <foodresearch.my@outlook.com> wrote:

Dear Dr Rahmawati,

Manuscript ID: FR-2020-718
Manuscript Title: Optimizing the tray dryer temperature and time of white corn flour culture

Before we can proceed with the article production, I would like to clarify a few points that I have commented in the manuscript. Please refer to the attachment. Please address the issues raised in the comments.

Please use the attached copy to make your revisions as it has been corrected to the Journal's format. Once you have done, kindly revert the copy to me as soon as possible. Please note the faster you respond, the quicker we will process your manuscript.

Thanks & Regards,
Vivian New
Editor
Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Sunday, 27 June, 2021 12:10 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Decision on your manuscript

Dear :
Vivian New
Editor
Food Research

Thank you for this information.

Regards,

Rahmawati

On Sun, Jun 27, 2021 at 9:18 AM Food Research <foodresearch.my@outlook.com> wrote:

Dear Dr Rahmawati,

Not yet. Due to the high loads in production, please expect some delay.

Thanks & Regards,
Vivian New
Editor
Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Saturday, 26 June, 2021 11:03 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Decision on your manuscript

Dear :
Vivian New
Editor
Food Research

I hope you are fine and healthy.
I just want to inform you, if I have not received the galley proof until now.
Have you not sent it to me? Thank you.

Best Regards,
Rahmawati

On Fri, Apr 23, 2021 at 10:08 AM Food Research <foodresearch.my@outlook.com> wrote:

Dear Dr Rahmawati,

Not yet. Due to the high loads in production, please expect some delay.

Thanks & Regards,
Vivian New
Editor
Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Friday, 23 April, 2021 6:04 AM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Decision on your manuscript

Dear :
Vivian New
Editor
Food Research

I just want to inform you, if I have not received the galley proof until now. Have you not sent it to me? Thank you.

Best Regards,
Rahmawati

On Fri, Apr 16, 2021 at 1:58 PM Food Research <foodresearch.my@outlook.com> wrote:

> Dear Dr Rahmawati,
>
> Received with thanks. I'll contact you once the galley proof is ready for viewing. Due to the high loads in production, please expect some delay.
>
> Thanks & Regards,
> Vivian New
> Editor
> Food Research

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Friday, 16 April, 2021 12:19 AM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: FR-2020-718 - Decision on your manuscript

Dear Dr Vivian New
Editor
Food Research

This is my FR article processing fee form that I have filled.
Thank you.

Best regards,
Rahmawati

On Tue, Apr 13, 2021 at 10:59 AM Food Research <foodresearch.my@outlook.com> wrote:

> Dear Dr Rahmawati,
>
> It is a pleasure to accept your manuscript for publication in Food Research journal. Please refer to the attachment for your acceptance letter.
>
> Please note that all accepted manuscripts are subjected to Article Processing Charges (APC) as the Journal will provide full publishing services. Please fill in the article processing fee form attached with this letter and revert to us within five (5) working days. Once we have received the form, your article will be transferred to production.
>
> Thank you for your fine contribution. We look forward to your continued contributions to the Journal.

Sincerely,
Dr Vivian New
Editor
Food Research

From: Food Research <foodresearch.my@outlook.com>
Sent: Monday, 15 March, 2021 11:10 PM
To: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Subject: Re: Manuscript ID: FR-2020-718

Dear Dr Rahmawati,

Thank you for your inquiry. Your manuscript is currently under technical review by our editors. They will contact you once it's done.
As we are experiencing high loads of publications, please expect some delay from our side.
Thank you for your patience.

Best regards ,
Son Radu, PhD
Chief Editor

Get Outlook for Android

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Monday, March 15, 2021 11:06:27 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: Manuscript ID: FR-2020-718

Dear Prof. Son Radu, PhD.
Chief Editor
Food Research

How are you? I hope you are healthy and happy.
It is almost 2 month I have not yet the information about my manuscript.
Would you like to inform me about that?
What should I do?
Thank you for your kindness.

Best regards,
Rahmawati

On Sun, Jan 24, 2021 at 11:59 PM Food Research <foodresearch.my@outlook.com> wrote:

> Dear Dr. Rahmawati,
>
> Thank you for the revised copy of your manuscript. We will contact you again for further processing.

Best regards,
Son Radu, PhD
Chief Editor

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Sunday, 24 January, 2021 12:00 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: Manuscript ID: FR-2020-718

Dear Professor Dr Son Radu

I hereby submit my manuscript FR 2020-718 entitled "Optimizing the tray dryer temperature and time of white corn flour culture" . There is a slight change in the title based on the reviewer 's comment. I hope this is not a problem. Beside that I sent 2 files, the first was an "**edit**" file, which was a file that had been edited based on the reviewer 's comment and the second was a "**clear edit**" file, which was a file whose comment had been deleted. I apologized sending the manuscript this morning. I hope you are pleased to accept it.
Thank you.

Best regards
Rahmawati

On Mon, Jan 11, 2021 at 9:32 PM Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id> wrote:

> Dear Professor Dr Son Radu,
>
> Thank you for your email. I will try to revise my manuscript as soon as possible.
>
> Best regards,
> Rahmawati
>
> On Sat, Jan 9, 2021 at 4:02 PM Food Research <foodresearch.my@outlook.com> wrote:
>
> > Dear Dr. Rahmawati,
> >
> > Manuscript FR-2020-718 entitled " Optimizing The Tray Dryer Temperature And Time Of White Corn Flour Culture By Response Surface Methodology (RSM) " which you submitted to Food Research, has been reviewed. The comments of the reviewer(s) are included in the attached file.
> >
> > The reviewer(s) have recommended publication, but also suggest some revisions to your manuscript. Therefore, I invite you to respond to the reviewer(s)' comments and revise your manuscript. Once the revised manuscript is prepared, please send it back to me for further processing.
> >
> > Because we are trying to facilitate timely publication of manuscripts submitted to Food Research, your revised manuscript should be submitted before or by 23rd January 2021. If it is not possible for

you to submit your revision by this date, please let us know.

Once again, thank you for submitting your manuscript to Food Research and I look forward to receiving your revised manuscript.

Sincerely,
Professor Dr. Son Radu
foodresearch.my@outlook.com

Chief Editor, Food Research

From: Food Research <foodresearch.my@outlook.com>
Sent: Tuesday, 8 December, 2020 11:36 PM
To: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Subject: Manuscript ID: FR-2020-718

Dear Dr. Rahmawati,

This message is to acknowledge receipt of the above manuscript that you submitted via email to Food Research. Your manuscript has been successfully checked-in. Please refer to the assigned manuscript ID number in any correspondence with the Food Research Editorial Office or with the editor.

Your paper will be reviewed by three or more reviewers assigned by the Food Research editorial board and final decision made by the editor will be informed by email in due course. Reviewers' suggestions and editor's comments will be then made available via email attached file. You can monitor the review process for your paper by emailing us on the "Status of my manuscript".

If your manuscript is accepted for publication, Food Research editorial office will contact you for the production of your manuscript.

Thank you very much for submitting your manuscript to Food Research.

Sincerely,

Professor Dr. Son Radu
Chief Editor
Email: foodresearch.my@outlook.com

From: Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>
Sent: Tuesday, 8 December, 2020 7:14 PM
To: Food Research <foodresearch.my@outlook.com>
Subject: Re: MANUSCRIPT SUBMISSION

On Tue, Dec 8, 2020 at 6:02 PM Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id> wrote:

December, 8th 2020
Professor Dr. Son Radu

Chief Editor
Food Research
foodresearch.my@outlook.com

Dear Sir/Madam,

I/We wish to submit a new manuscript entitled "**OPTIMIZING THE TRAY DRYER TEMPERATURE AND TIME OF WHITE CORN FLOUR CULTURE BY RESPONSE SURFACE METHODOLOGY (RSM)**" for consideration by the Food Research
I/We confirm that this work is original and has not been published elsewhere nor is it currently under consideration for publication elsewhere.

In this manuscript, I/we report the manufacture of AC and CC cultures for making fermented local white corn flour. Previous study indicated that the flour produced was suitable for making cookies, soup cream, and flour dough for fried products. To facilitate fermentation, AC and CC culture were dried. We have dried the culture using oven, but oven drying takes a long time (24-48 hours). To shorten the drying time we have used a tray dryer. Previous research showed that drying AC and CC cultures with a tray dryer for 1.5 - 6 hours at a temperature of 40-50 ^{0}C resulted in good microorganism viability, where the viability for AC dried culture ranged from 8.90 - 9.14 log CFU / g (db), and CC dried culture contain 8.82 - 9.20 log CFU / g (db). In order to produce optimal quality of AC and CC cultures, the drying process was optimized by RSM. The result showed that optimum drying process for AC starter is 40 °C for 10,0 hours, with characterictic response viability 7.944 log CFU / g or 8.79 x 10^7 CFU / g, water activity 0.425, water content 8.90%, and pH 4.05, while CC starter showed optimum drying process on 49 °C for 4.5 hours, with characterictic response viability 7,698 log CFU / g or 4.9 x 10^7 CFU / g, water activity 0.487, water content 7.02%, and pH 3.95.

I/we think that our manuscript appopriate to the scope of the journal international "Food Research" and is of great interest to readers in the area of Food Science, Food Technology, Food Processing and Food Enginering, Food Microbiology, and Food Safety.

Referees for this paper might include:

1. **Muhammad Zukhrufuz Zaman, Ph.D.** (Mr.) (Department of Food Science and Technology, Sebelas Maret University, Indonesia). Expertice on: Fundamental of Microbiology, Food Microbiology, Techniques in Food Analysis (Immunoassay topic), Food Safety, Food Microbiology, Assessment of biogenic amines in food products (e-mail: m_zukhruf@yahoo.com; m_zukhruf@upm.edu.my)

2. **Dr. Ir. S. Joni Munarso, MS** (Mr.) (Indonesian Agency for Agricultural Research and Development, Ministry of Agriculture, Republic of Indonesia/IAARD, Indonesia). Expertice on: Starches Technology, Quality and Food Safety (e-mail: jomunarso@gmail.com)

3. **Dr. Nur Aini, STP, MP** (Mrs) (Department of Food Technology, Soedirman University, Indonesia). Expertice on: Food Processing and Engineering (e-mail: nuraini_munawar@yahoo.com)

4. **Dr. Zita Letviany Sarungallo, STP, MSi** (Mrs) (Agricultural Product Technology Program, Papua University, Manokwari, West Papua, Indonesia). Expertise on: Food Science. (e-mail: zlsarungallo@yahoo.com)

Thank you for your consideration of this manuscript.

Sincerely,

Dr. Rahmawati
rahmafarasara@usahid.ac.id
Sahid University Jakarta, Indonesia

OPTIMIZING THE TRAY DRYER TEMPERATURE AND TIME OF WHITE CORN FLOUR CULTURE BY RESPONSE SURFACE METHODOLOGY (RSM)

Abstract

This research aimed to optimize the tray dryer temperature and time of white corn flour culture by RSM. There were two culture using in this research, namely AC and CC. The independent variables in this study were drying temperature and time, where the quality indicators used were total viability of mold and yeast, water content, water activity, and pH. This research used a factor response surface methodology. Data were analyzed by ANOVA with α level of 95%. The result of this research showed that the optimum drying process for AC starter was 40°C for 10 hours, with characteristic response viability 7.944 log CFU/g or 8.79 x 10^7 CFU/g, water activity 0.425, water content 8.90%, and pH 4.05. CC starter showed an optimum drying process at 49°C for 4.5 hours, with characteristic response viability 7.698 log CFU/g or 4.9 x 10^7 CFU/g, water activity 0.487, water content 7.02%, and pH 3.95.

Keywords: AC culture, CC culture, RSM, tray dryer, white corn flour

1. Introduction

White corn flour is a food commodity with limited use. This flour has a weakness, such as high viscosity, with high retrograde, the paste undergoes syneresis during storage, and low paste stability at high temperature and low pH (Aini et al., 2010). Farasara et al. (2014) showed that fermentation with the addition of indigenous mold and yeast culture could change the characterisitc of white corn flour paste of Anoman 1 after 36 hours fermentation. The indigenous mold and yeast resulted from the isolation and identification of microorganisms in the spontaneous fermentation of white corn varieties of Anoman 1 and was grouped into AC and CC starters (Rahmawati et al., 2013). To simplify the fermentation process and quality control, indigenous mold and yeast cultures were made dried starter. Dried starters have been produced using sun drying and oven drying methods (Rahmawati et al., 2017). The sun-drying method was carried out by drying for 7 days, between 8.00 and 15.00 WIB, with a total drying time of 48 hours. AC starters produced the best characteristics with a viability of 2.7 x 10^8 CFU / g and a moisture content of 13.34%. The sun-drying method has the disadvantage of uncontrolled temperatures and long drying times.

The weakness of this sunlight method may cause the growth of microorganisms to be less optimal. The oven-drying method was carried out at 40°C for 24 , 48 and 72 hours. The starter CC, which was dried for 48 hours, had the best characteristics with a viability of 5.8 x 10^8 CFU / g and a moisture content of 12.57%. This method has the advantage of being temperature controlled, but still takes a long time to dry. In addition, the starter was still wet in the oven when drying for 24 hours (Rahmawati et al., 2017). A more efficient and faster drying method is therefore needed, namely by using a tray dryer.

Rahmawati et al (2019) have carried out the drying method for white corn starter using a tray dryer, where drying was conducted at 40 and 50°C for 1.5-6 hours.This method has a more controlled temperature than the sunshine method and with a shorter time than the oven method. The tray dryer method can reduce the drying area and increase the efficiency of hot air contact with the material (Sari et al., 2017). The dried starter produced by Rahmawati et al (2019) did not have optimal characteristics where the viability of the starters was < 10^6 CFU / g and the water content was > 10%. Therefore, it is necessary to optimize the starter drying process which includes temperature and drying time using the tray dryer method.

Commented [RR1]: Please paraphrase this sentence, and give brief information related to AC and CC

Commented [RR2]: Use the same number after the comma nad use the same unit

Commented [RR3]: Please justify what is the state of the art (main/important finding) of this research and provide conclusion

Formatted

Deleted:

Deleted: ¶

The optimization of the drying process for starters was carried out by using the D-optimal design of the Response Surface Methodology (RSM) method. RSM is a statistical and mathematical technique used primarily for the development, improvement and optimization of the production process (Carley et al., 2004).

2. Materials and methods

2.1 AC and CC Starter Preparation (Rahmawati et al. 2013 and Rahmawati et al. 2017)

AC consists of *Penicillium citrinum, Aspergillus niger, Acremonium strictum, and Candida famata,* while CC consists of *Penicillium chrysogenum, Penicillium citrinum, Aspergillus niger, Rhizopus stolonifer, Rhizopus oryzae, Fusarium oxysporum, Acremonium strictum, Candida famata, Kodamaea ohmeri, Candida krusei/ incospicua.* These microorganisms used were previously isolated and identified from spontaneous fermentation of corn grits.

One loop of each mold was streaked onto fresh Potato Dextrose Agar (PDA) slant and incubated for five days at 30°C. After five days, molds were harvested by scrapping, then suspended in 10 mL sterile water and appropriately dissolved to count using haemocytometer. Yeast culture was prepared as above, but incubation was carried out for two days at 30°C. Yeast was also calculated using haemocytometer.

2.2 Optimization using RSM

The Response Surface Methodology (RSM) method was used to maximize the drying process by using the Design Expert ® 7.0 (DX7) statistical application. The experimental design aims to achieve an optimum response by combining several components (Keshani et al. 2010). The mixed design is D-optimal where it was necessary to have a lower limit (-1) and an upper limit (+1). The independent variables in this study were drying temperature and time. The experimental design was based on RSM (Table 1).

The parameters of the experiment were drying time (hours) and drying temperature (ºC). Drying time between 0-10 hours and drying temperature between 40-50ºC (Rahmawati et al. 2017). The AC and CC starter qualities were determined based on total viability mold-yeast, moisture content (oven method), water activity (aw meter) and pH (pH meter).

There were criteria for each variable and response when performing optimization. The observed response was viability with an importance level of 5 (+ + + + +), while the response to moisture, aw and pH had an importance level of 3 (+ + +). The importance value will determine the process conditions that were closest to the target response. The chosen optimal combination is the one having the highest desired value.

2.3 Making Starters and Drying with a Tray Dryer (Rahmawati et al., 2019)

AC and CC starter culture made by sterilizing corn flour, then put it into a sterile basin and adding sterile distilled water as much as 2/3 of the total weight of corn flour. Prepared culture suspensions (AC) containing 10^6 CFU/mL per microorganism, then piped as much as 10% of the amount of water used. After that, all stir until homogeneous and put ± 17 grams in each petri dish. Petri dishes were then incubated at 30°C for 5 days. Furthermore, the dough is dried using an tray dryer with a range of 40-50°C for 0-10 hours. The dried AC and CC yeast mold culture was made powder using a blender that has been sprayed with 70% alcohol.

Commented [RR4]: The reference should not appears in sub section heading

Commented [RR5]: How did the author prepare the mix culture, what is the proportion of each culture?

Commented [RR6]: State the brand of haemocytometer

Commented [RR7]: Provide brand and type of the equipments

Deleted:

2.4 Response Measurement

Response measurements were carried out on the dried powder sample that was inserted into a plastic clip containing silica gel. The responses measured included total mold and yeast viability, aw, moisture content, and pH.

2.5 Verification of Optimization Results

The results were validated at the highest desirability point for AC and CC starters respectively. The AC and CC starting process was repeated directly using the optimal drying process. In addition, the test process included direct measurement of the overall yeast mold viability, moisture contents, water activity and pH to generate the actual response variable.

2.6 Data Analysis

The data analysis technique used in this study includes linear (y = ax + b) models, quadratic (y = ax2 + bx + c) and 2FI models, using the Response Surface Methodology.

3. Results and discussion

3.1 Viability Test

Viability of total yeast mold starter could be seen at Table 2. Based on Table 2, we can see that a total value of yeast mold AC and CC starters ranged from 10^7-10^8 CFU/g at drying temperatures < 50 ^{0}C. In the meantime, the viability value of the yeast mold AC and CC starters at drying temperatures 50°C and drying time of 7.3 to 10 hours was 0. According to Pitt and Hocking (2009), Aspergillus Niger may grow at a minimum temperature of 6 – 8°C, maximum temperature of 45–47°C, and an optimal growth of 35 to 37°C, while Rhizopus oryzae can grow at a temperature of 7 to 42 °C with an optimal growth temperature of approximately 37 °C. Candida krusei can grow optimally at temperature of 37°C (Scorzoni 2013). The mold and yeast in the beginning were suspected to die at 50°C with a drying time of more than 7.3 hours.

The heat resistance of microorganisms is different, which is represented by D value. The D value is defined as the time in minutes at a given temperature which is to reducing 90 percent or a logarithm of the number of spores or certain vegetative cells. Rahmawati et al. (2019) reported that D value of AC and CC at temperatures of 40 ^{0}C was 271.86 minutes (4.5 hours) and 523.10 minutes (8.7 hours) respectively, while at 50 ^{0}C was 147.06 minutes (2.45 hours) and 127.93 minutes (2.13 hours) respectively.

3.2 Moisture Content

Water content and water activity (aw) are closely linked with starters' shelf-life. These two parameters are indicators of the availability of water in food for the survival of microorganisms. In addition to affecting chemical changes, the water content in food also determines the microbial content of foods (Herawati 2008). Products that have higher water content will relatively have shorter shelf life (Amanto et al. 2015). Table 2 showed the water content for AC and CC starters.

The initial moisture content of the AC starter was 56.00 % and CC starter was 57.30 %. In this study, the desired water content was < 10 percent. With this water content value, it was hoped that the microorganisms will remain alive but did not carry out metabolic activity. Dried starter

Commented [RR8]: All scientific name should be writen in italic

Commented [RR9]: This paragraph seems to be less relevant. The D value is more relevant if the starter is single species. But in this study, the starter is a mixture of microorganism that actually their presence in starter can't be controlled by the author

that drying at 50ºC tended to have a lower moisture content than a lower temperature (40ºC). According to Rahmawati et al. (2019), it caused the drying rate at 50ºC was faster than at 40 ºC. As we know that a higher drying rate resulted in a faster drying time.

Drying time can also reduce the material's moisture content. At a temperature of 40ºC with different drying times, the moisture content of AC starters decreased from 56.00 per cent to 11.67 per cent after 4.5 hours of drying and continued to dry to 8.59 per cent after 10 hours of drying. Likewise, with CC starters, the moisture content of CC starters decreased from 57.30 per cent to 11.01 per cent after 4.5 hours of drying and continued to dry to 10.26 per cent after 10 hours of drying at 40ºC. In line with Fitriani (2008) statement, that drying temperature and time higher will evaporate water molecules more than lower temperature and time. Beside that, this condition will make the products ability to release water from its surface is greater and it will caused water content lower.

3.3 Water Activities value

Free water in food is needed by growing microorganisms for nutritional processes, a medium for enzymatic reactions, and cellular component synthesis (Rahayu and Nurwitri 2012). The free water content determines the product to be stored as it is an indicator of the availability of water in food for living microorganisms (Barbosa-Canovas et al., 2007). Products, that have a water activity value smaller, will have longer shelf life because microorganisms can only live in certain conditions (Sinurat and Murniyati, 2014). So, AC and CC starter were expected having longer shelf life. Table 3 showed the water activity of the AC and CC starter.

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Overall, mold can live at a minimum water activity value. Aspergillus lives at a minimum water activity of 0.98, Rhizopus 0.93, and Penicillium 0.99, where yeast can usually live around 0.88-0.94 (Muchtadi and Sugiono 2013). A low aw value can make starters' microorganisms dormant.

When starters are dried during long period of time, the water content will decrease, and the water activity starters will decrease as well. This is in line with the research undertaken by Leviana and Paramita (2017), which state that the higher the temperature, the more water in the material is evaporated to decrease the material's water content. Likewise, the water activity value, the higher the drying time the lower the water activity value in the material.

3.4 pH value

The pH value is the degree of acidity used to express a substance, or object's acidity or alkalinity. The pH value is defined as a standard H+ activity cologarithm. A normal pH value is 7, while a pH value>7 indicates the alkaline properties of the substance, while a pH value < 7 indicates the acidic properties. A pH of 0 indicates the highest acidity and pH 14 indicates the highest alkalinity (Zulius, 2017). Table 3 showed the pH value for AC and CC starters.

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During the incubation process, the pH value of both AC and CC starters decreased, which becomes slightly sour (3.9-4.5) and was accompanied by a distinctive fermentation aroma. This indicated that the filler substrate (carbohydrates) has been metabolized by the microorganisms added to simpler compounds such as ethanol, carbon dioxide, and organic acids that can lower the pH value. In the fermentation process, metabolism occurs from the

activity of organic acid-producing microorganisms, thereby reducing the pH (Anggraeni and Yuwono 2014). According to Rahmawati et al. (2019), the initial pH value of AC and CC were around 4.00, where this value was appropriate for microorganism growth. The decrease in pH value was due to the activity of microorganisms that converted carbohydrates into acids during the fermentation process.

3.5 Mathematical Model Relationship between Process Parameters and Response

Table 4 showed the math model of drying proses parameter as a response of the AC starter and Table 5 for CC starter model. The linear model indicated that only temperature and drying time influence the response, but not the interactions between them. The quadratic model showed that each factor influences the response and interaction between temperature and drying time. The 2FI model means the response is influenced by the temperature-drying interaction.

3.6 Effect of Drying Process on Starters Viability

Rahmawati et al. (2017) have dried the starter culture using an oven with a temperature below 40ºC resulted the wet starters (not yet dry). It showed that, the starter could be dried at the lowest 40ºC temperature. However, the drying process using tray drier can not generate heat if the temperature is less than 40 ^{0}C were used. Based on this, the drying temperature used was up to 50 ^{0}C (Rahmawati et al. 2019). The results showed that drying at 50 ^{0}C for 6 hours still produced the number of microorganisms that met the minimum requirements for viability of starter microorganisms (10^6 CFU / g). These results were in line with Oliveira et al. (2002) where a good fermented drink produced by the number of bacteria was at least 5.3×10^6 CFU / mL.

Thus, drying starters at a temperature of 40-50 ºC were expected to maintain a significant total viability mold and yeast. Figure 1 and Figure 2 showed the graph of the relationship between temperature and drying time on the viability response of AC and CC starters respectively.

Based on the graph in Figure 1, an increase in temperature and drying time with a tray dryer caused a decrease in yeast viability on the starters. At a temperature of 50 ^{0}C. with a drying time of about 7.3 hours, a value of 0 was produced. Its indicating the absence of mold-yeast during the analized. AC starters are mostly yeast. At this temperature and drying time, the yeast on AC starters was suspected to die. Vegetative yeast cells are killed with humid heat at 50-60°C in 10-15 minutes (Pelczar, 2012).

Figure 1 provided an overview of the AC-starters viability response model. The red color in the figure showed a high viability value, while the blue color showed a low viability value.

Microbes have different heat resistance as expressed by D. According to Rahmawati et al. (2019), the calculation results showed that the values of D starters AC and CC at 40ºC were 271.86 minutes (4.5 hours) and 523.10 minutes (8.7 hours) while at 50 °C were 147.06 minutes (2.45 hours) and 127.93 minutes (2.13 hours) respectively. AC starters were more heat-resistant. It caused AC starter contains fewer types of microbes, so, when making starter cultures the competition between microbes was lower. This resulted in more available microbes. It was indicated by the higher initial microbial viability than CC starter.

The program selected model for appropriate viability response is a linear model with an R^2 value of 0.6237. AC mold-yeast viability response model has a 0.0123 p-value (Prob > F). This showd that the model can still describe the viability response (AC), as it has a p value < 0.05. The results of ANOVA also showed that temperature and drying time had a significant impact on viability response. This is evidenced by the insignificant fit shortage, > 0.05 (0.3702). Therefore, in this study, the viability modeling shows that the temperature factor (40-50ºC) and drying time (0-10 hours) have a significant effect on the AC viability response.

Figure 2 provided a surface overview of the CC dissolved viability response model. The model chosen by the program for the appropriate viability response was a quadratic model with an R^2 value of 0.7894. The CC mold-yeast viability response model has a p value (Prob> F) of 0.0474. This showed that the viability response (AC) can still be described well by the model, because it has a p value <0.05. ANOVA results also showed that the temperature and drying time had a significant effect on the viability response. This is evidenced by the insignificant Lack of fit, which is> 0.05 (0.9033). Therefore, the viability modeling in this study showed that the temperature factor (40-50 ºC) and drying time (0-10 hours) significantly influenced the CC viability response.

3.7 Drying Process on Starters Moisture Content

Apart from the drying process, the fermentation process in making starters also plays a role in reducing levels. Pusparani and Yuwono (2014) stated that during the fermentation process, the breakdown of starch by enzymes produced by microorganisms will produce simple sugars such as glucose and accompanied by the release of water. This is known as starch degradation. Starch degradation is characterized by a decrease in the ability of the material to retain water due to loss of hydroxyl groups. The graph of the relationship between the combination of temperature and drying time to the water content response of AC starters can be seen in Figure 3.

The water content response value from AC starters ranged from 5.63 to 12.52%. Figure 3 provided an overview of the AC starters moisture response model. The image's red color indicated high water content, while the blue color indicated low water content.

The model chosen by the water content response program was the 2FI model with an R^2 value of 0.8382. The AC moisture response model has 0.0016 p-value (Prob > F). This shows that the model can still describe the viability response (AC), as it has a p value<0.05. However, the results of ANOVA did not show that the temperature and drying time had a significant effect on the water content response with a significant fit value shortage, < 0.05 (0.0404). The significant lack of fit value indicates that the temperature (40-50ºC) and drying time parameters (4.5-10 hours) have no significant effect on the water content response in AC starters.

Figure 4 showed the graph of the relationship between the combination of temperature and drying time to CC starter of water content response. The response value to the moisture content generated from CC starters ranged from 5.22-11.53%. The model chosen by the water content response program was the 2FI model with 0.8209 R^2 value. The CC moisture response model has 0.0023 p value (Prob > F). This shows that the model can still describe the viability response (AC), as it has a p value<0.05. However, the results of ANOVA did not show that

the temperature and drying time had a significant effect on the water content response with a significant fit value shortage, < 0.05 (0.0019). The significant lack of fit value indicates that temperature parameters (40-50ºC) and drying time (4.5-10.0 hours) do not significantly affect the response of moisture content in CC starters.

3.8 Effect of Drying Process on Water Activity Value

Apart from the drying process, the fermentation process in making starters also plays a role in reducing the levels. Pusparani and Yuwono (2014) state that during the fermentation process, the breakdown of starch by enzymes produced by microorganisms will produce simple sugars such as glucose and accompanied by the release of water. This is known as starch degradation. Starch degradation is characterized by a decrease in the ability of the material to retain water due to loss of hydroxyl groups. The graph of the relationship between the combination of temperature and drying time to the water content response of AC starters can be seen in Figure 5.

Water activity (aw) indicated the amount of free water in a product. Free water in food was needed by growing microorganisms for nutritional processes, a medium for enzymatic reactions, and cellular component synthesis (Rahayu and Nurwitri, 2012). The lower a product's aw value, the lower the risk of chemically or microbiologically damaging the food product. The smaller a product's aw value, the longer the product's shelf life since bacteria, molds, and yeasts require high aw to grow. Overall, the minimum water activity for bacterial growth is 0.75, mold is 0.60, while the minimum yeast growth is 0.80 (Susilo et al., 2019).

Figure 5 showed the graph of the relationship between temperature and drying time to the response of aw starters of AC. The AC-generated response ranged from 0.372 to 0.558. The red color shows a high aw, while the blue color shows a low aw.

The model selected for the appropriate aw response is the quadratic model. Figure 5 provided an overview of the aw response model. The image's red color indicated high aw value, while the blue color indicated low aw value. The aw (AC) response model has a value of 0.0440 p (Prob > F), indicating that the model was significant and can be described well at 5 % level (p value < 0.05). However, the ANOVA results showed a significant fit shortage, < 0.05 (0.0021). This meant that the temperature and drying time do not affect the AC response.

Meanwhile, the CC-starter aw response ranged from 0.356 to 0.645. The CC-starters water activity parameter (aw) represented the mean mathematical model. This showed that CC starters' mold-yeast viability and moisture content due to treatment occurs randomly and cannot be explained by model. Figure 6 showed the graph of the relationship between temperature and drying time to the aw of CC response.

3.9 Effect of Drying Process on pH Value

Acidity or pH indicates the active concentration of hydrogen ions. The pH value is used to determine the variety of microorganisms that may grow on the product where each microorganism has a specific growth pH. Pratama et al. (2013) stated that the final results of the pH value for yeast bread, tempeh yeast, and Lactobacillus plantarum were 4.37; 3.43; and 3.93 at 96 hours of fermentation respectively. For microorganisms, pH influenced the growth

and survival. Each type of microorganism has an optimum growth pH and pH range. In general, mold and yeast can grow more widely than bacteria (Rahayu and Nurwitri, 2012). Mold has a very wide growth pH ranged from 2.0-8.5, while yeast has a growth pH range from 4.0-4.5 and will not grow well under alkaline conditions (Muchtadi and Sugiyono, 2013).

The group of microorganisms capable of fermenting food nutrients will convert some or all of the food components into fermented products, e.g. lactic acid, ethanol, CO_2, or other organic acids. Organic acid accumulation causes pH to decrease during incubation. According to Kartohardjono et al. (2007), CO_2 gas is often called acid gas because CO_2 gas has acidic properties. CO_2 gas contributes to the pH value. Figure 7 showed the relationship between the combination of temperature and drying time to the pH response of AC starters. The pH response from AC starters ranges from 3.95 to 4.50. The image's red color indicates high pH, while the blue color indicated low pH.

The model chosen by the program is the 2FI model with an R^2 value of 0.8989. The AC pH response model has 0.0002 p value (Prob > F). This shows that the model can still describe the pH (AC) response as it has a p value<0.05. ANOVA results also showed that the temperature and drying time had a significant pH response effect. This is evidenced by the insignificant fit lack, > 0.05 (0.6288). Temperature parameters (40-50^{o}C) and drying time (4.5-10 hours) have a significant impact on pH response on AC starters.

Figure 8 showed the relationship between the combination of temperature and drying time to the pH response of CC starters. The model selected by the program is the 2FI model with an R2 value of 0.8479. The CC pH response model has a 0.0193 p-value (Prob > F). This showed that the model can still describe the pH (CC) response as it has a p value<0.05. ANOVA results also showed that the temperature and drying time had a significant pH response effect. This is evidenced by the insignificant fit lack, > 0.05 (0.0769). Temperature parameters (40-50^{o}C) and drying time (4.5-10.0 hours) influenced the pH response in AC starters significantly.

3.10 Process Optimization with RSM

The process optimization stage aimed to obtain the drying process conditions for starting corn flour with an optimal response value based on the specified criteria. Based on the numerical optimization performed, a corn flour solution starts drying formula with the highest desirability value recommended by RSM for each starter, as presented in Table 6. The desirability value is a parameter showing the best optimization results with a range of 0–10. The closer to 1.0 the recommended solution can fulfill the desires according to the criteria of the stated objectives and interests (Myers et al. 2009). The combination of drying formula for corn flour starters selected by the AC starter program was a temperature of 40^{o}C for 10 hours, while CC starters are 49^{o}C for 4.5 hours.

Based on the data in Table 6, the optimum formula for AC starters has a predictive response of 3.929 log CFU / g or 8.5 x 10^3 CFU / g, 8.60% water content, 0.433 water activity, and pH 3.91. While the optimum CC starter formula (Table 6) has a predictive response of 4.958 log CFU / g or 9.0 x 10^4 cfu / g, 6.48% water content, aw 0.499, and pH 4.13.

3. 11 Results *verification*

Result verification was performed at the point with the highest desirability value, respectively, for AC and CC starters. The process of starting AC and CC was repeated directly using the optimum drying process formula. In addition, the testing process included measuring the total viability of yeast fungi, moisture content, water activity, and pH directly to generate the actual response variable. The predicted response can be compared with AC and CC starters verification results in Tables 6.

Based on the verification, there is a significant difference in the value of starter viability between the formula solution suggested by RSM and the verification. According to Rahmawati et al. (2020), the optimization using RSM was unfit to describe the viability response model. This due to a AC-indigenous cocktail yeast mold culture consists of more than one microorganism. So, the activity of AC during the fermentation process varies, because the optimum conditions for growth during incubation for each microorganism vary and maybe there was competition for nutrients by microorganisms varies. On the other hand, the value of 0 in the viability result affected the design of RSM 's optimum formula.

4. Conclusion

Based on the research results, it can be concluded that the combination of temperature and drying time affects the characteristics of the white corn flour starters. The optimum drying process for AC starters is at a temperature of 40°C for 10.0 hours with viability characteristics of 7.944 log CFU / g or 8.79 x 10^7 CFU / g, 8.90% moisture content, aw 0.425 and pH 4.05. The optimal drying process for CC starters is at a temperature of 49 °C for 4.5 hours with viability characteristics of 7.698 log CFU / g or 4.9 x 10^7 cfu / g, water content of 7.02%, aw 0.487 and pH 3.95.

Conflict of interest - Disclose any potential conflict of interest appropriately.

The authors declare no conflict of interest.

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Tables and Figures

Table 1. Independent variables and the level used in the desain process

Independent variables	**Limits**	
	Lower (-1)	Upper (+1)
Temperatures (^{0}C)	40	50
Times (h)	0	10

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Table 2. The viability, water content, a_w, and pH responses for AC and CC starter

Treatment	Drying Temperature (°C)	Drying time (Hour)	Viability (CFU/g)		Water content (%)	
			AC	CC	AC	CC
1	40	0,0	8 log 6,75	8 log 2,40	56,00	57,30
2	40	4,5	8 log 3,05	8 log 3,00	11,67	11,01
3	40	4,5	8 log 5,50	8 log 2,70	12,52	11,29

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4	40	7,3	8 log 7,50	8 log 1,85	8,66	10,98
5	40	10,0	8 log 5,00	8 log 1,70	8,59	10,26
6	43	0,0	8 log 5,00	8 log 3,00	56.00	57,30
7	43	8,6	8 log 1,00	7 log 2,40	9,16	11,53
8	45	0,0	8 log 5,00	8 log 3,00	55,90	57,30
9	45	5,9	8 log 1,40	7 log 5,20	8,91	9,11
10	45	10,0	7 log 1,40	7 log 4,50	10,61	10,65
11	50	0,0	8 log 3,80	8 log 7,80	55,90	57,30
12	50	4,5	7 log 7,50	7 log 3,00	5,65	5,44
13	50	4,5	7 log 2,00	7 log 1,10	5,79	5,22
14	50	7,3	0,00	0,00	8,66	10,98
15	50	10,0	0,00	0,00	8,91	10,28
16	50	10,0	0,00	0,00	8,80	10,34

Table 3. The water activity and pH value responses for AC and CC starter

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Treatment	Temperature (°C)	Drying time (Hour)	Water activity		pH value	
			AC	CC	AC	CC
1	40	0,0	0,929	0,945	4,20	4,15
2	40	4,5	0,460	0,474	4,22	4,50
3	40	4,5	0,454	0,465	4,26	4,50

4	40	7,3	0,430	0,426	4,00	4,65
5	40	10,0	0,433	0,421	3,95	4,60
6	43	0,0	0,929	0,945	4,28	4,20
7	43	8,6	0,558	0,645	4,05	4,60
8	45	0,0	0,929	0,959	4,28	4,20
9	45	5,9	0,518	0,570	4,20	4,10
10	45	10,0	0,449	0,478	4,26	4,23
11	50	0,0	0,942	0,959	4,20	4,12
12	50	4,5	0,460	0,474	4,33	4,22
13	50	4,5	0,454	0,438	4,50	4,20
14	50	7,3	0,438	0,426	4,40	4,31
15	50	10,0	0,372	0,356	4,44	4,28
16	50	10,0	0,380	0,367	4,50	4,40

Table 4. The math model of drying proses parameter as a response of the AC starter

Parameter	**Math model**	**Significance model (*p*)**	***Lack of fit***	***R squared***	***Adj R^2 model***	***Pred R^2 model***	***Adeq precision***
Viability (CFU/g)	Linier	0,0123 (significant)	0,3702 (not significant)	0,6237	0,5401	0,3511	6,248

Water content (%)	2FI	0,0016 (significant)	0,0404 (significant)	0,8382	0,7775	0,6959	10,565
Water activity (a_w)	Quadratic	0,0440 (significant)	0,0021 (significant)	0,7950	0,6242	0,3560	7,238
pH	2FI	0,0002 (significant)	0,6288 (not significant)	0,8989	0,8610	0,7554	13,784

Information: *Adj= Adjusted; Pred= Predicted; Adeq= Adequated*

Table 5. The math model of drying proses parameter as a response of the CC starter

Parameter	Math model	Significance model (*p*)	*Lack of fit*	*R squared*	*Adj R^2 model*	*Pred R^2 model*	*Adeq precision*
Viability (CFU/g)	Kuadratik	0,0474 (significant)	0,9033 (not significant)	0,7894	0,6139	0,2087	5,656

Water content (%)	2FI	0,0023 (significant)	0,0019 (significant)	0,8209	0,7537	0,6636	8,499
Water activity (a_w)		0,0616 (not significant)	0,0163 (significant)	0,7679	0,5746	0,2841	6,541
pH	Kuadratik	0,0193 (significant)	0,0769 (not significant)	0,8479	0,7211	0,3705	6,974

Information: *Adj= Adjusted; Pred= Predicted; Adeq= Adequated*

Table 6. Comparison of response predictions with verification results of AC and CC starter

Starter and response		Temperature (°C)	Time (Hour)	Viability(log koloni/g)	Water activity (a_w)	Water content (%)	pH
AC	Prediction	40	10,0	3,929	0,433	8,60	3,91

	Actual	40	10,0	7,944	0,425	8,90	4,05
CC	Prediction	49	4,5	4,958	0,499	6,48	4,13
	Actual	49	4,5	7,698	0,487	7,02	3,95

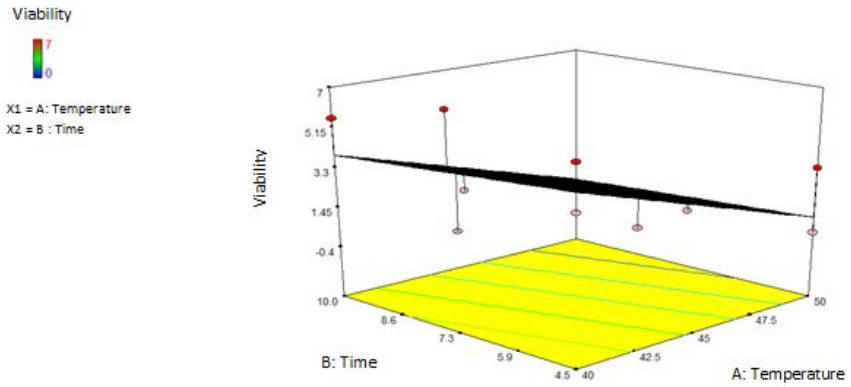


Figure 1. A 3D graphical combination between temperature and drying time to the viability response of AC starters

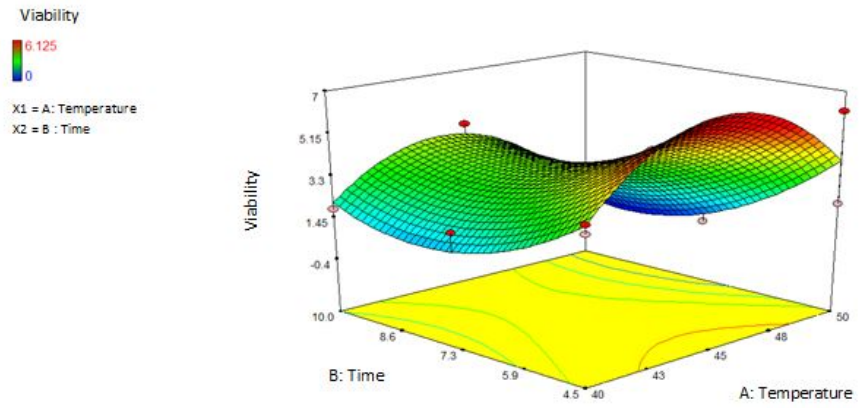


Figure 2. A 3D graphical combination between temperature and drying time to the viability response of CC starters

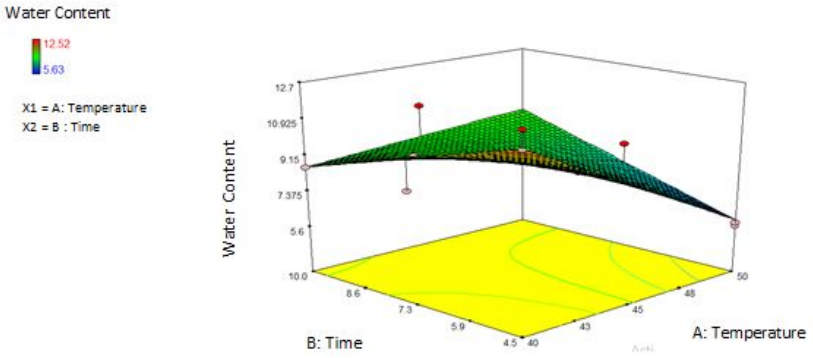


Figure 3. A 3D graphical combination between temperature and drying time to the water content response of AC starters

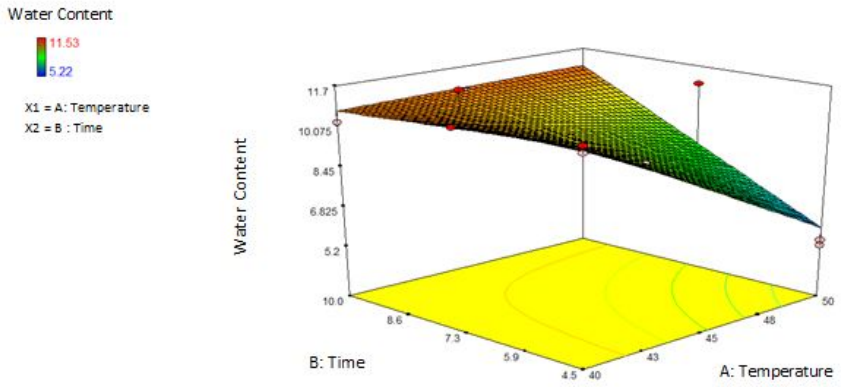


Figure 4. A 3D graphical combination between temperature and drying time to the water content response of CC starters

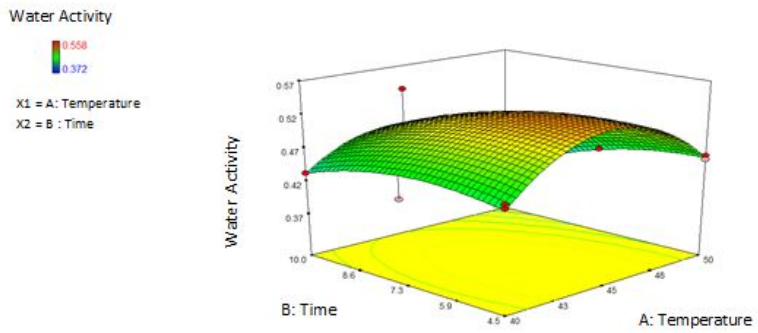


Figure 5. A 3D graphical combination between temperature and drying time to the water activity response of AC starters

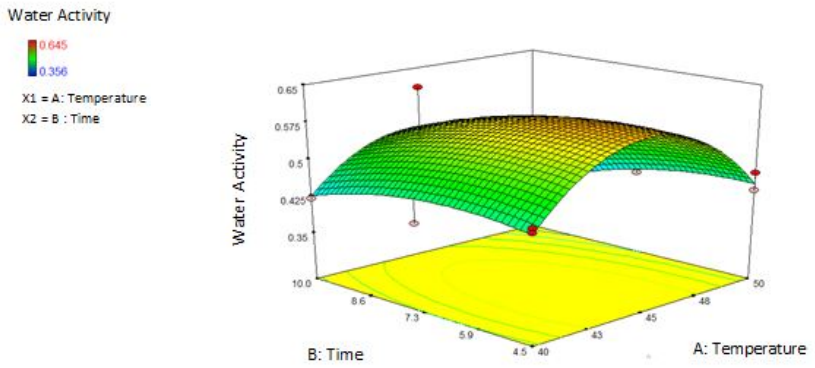


Figure 6. A 3D graphical combination between temperature and drying time to the water activity response of CC starters

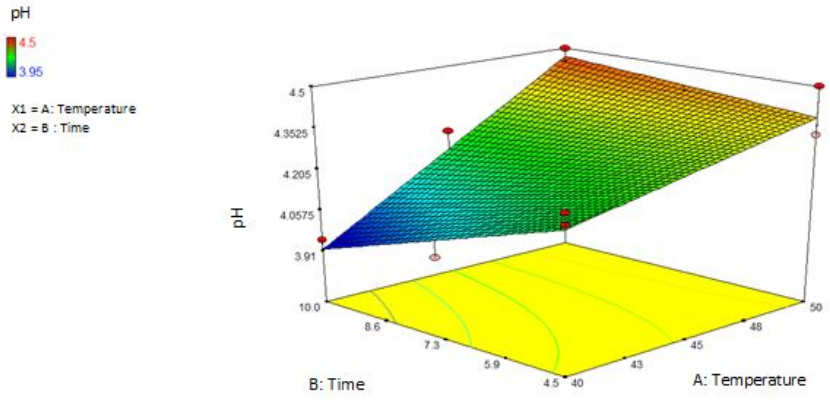
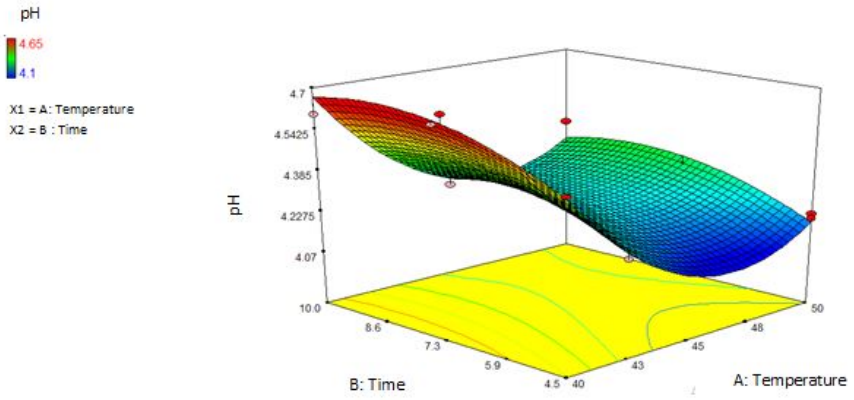


Figure 7. A 3D graphical combination between temperature and drying time to the pH response of AC starters



862
863
864 Figure 8. A 3D graphical combination between temperature and drying time on the pH response
865 of CC starters
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OPTIMIZING THE TRAY DRYER TEMPERATURE AND TIME OF WHITE CORN FLOUR CULTURE BY RESPONSE SURFACE METHODOLOGY (RSM)

Abstract

This research aimed to optimize the tray dryer temperature and time of white corn flour culture by RSM. There were two culture using in this research, namely AC and CC. The independent variables in this study were drying temperature and time, where the quality indicators used were total viability of mold and yeast, water content, water activity, and pH. This research used a factor response surface methodology. Data were analyzed by ANOVA with α level of 95%. The result of this research showed that the optimum drying process for AC starter was 40°C for 10 hours, with characteristic response viability 7.944 log CFU/g or 8.79 x 10^7 CFU/g, water activity 0.425, water content 8.90%, and pH 4.05. CC starter showed an optimum drying process at 49°C for 4.5 hours, with characteristic response viability 7.698 log CFU/g or 4.9 x 10^7 CFU/g, water activity 0.487, water content 7.02%, and pH 3.95.

Keywords: AC culture, CC culture, RSM, tray dryer, white corn flour

1. Introduction

White corn flour is a food commodity with limited use. This flour has a weakness, such as high viscosity , with high retrograde, the paste undergoes syneresis during storage, and low paste stability at high temperature and low pH (Aini et al., 2010). Farasara et al. (2014) showed that fermentation with the addition of indigenous mold and yeast culture could change the characterisitc of white corn flour paste of Anoman 1 after 36 hours fermentation.

The indigenous mold and yeast resulted from the isolation and identification of microorganisms in the spontaneous fermentation of white corn varieties of Anoman 1 and was grouped into AC and CC starters (Rahmawati et al., 2013). To simplify the fermentation process and quality control, indigenous mold and yeast cultures were made dried starter. Dried starters have been produced using sun drying and oven drying methods (Rahmawati et al., 2017). The sun-drying method was carried out by drying for 7 days, between 8.00 and 15.00 WIB, with a total drying time of 48 hours. AC starters produced the best characteristics with a viability of 2.7 x 10^8 CFU / g and a moisture content of 13.34%. The sun-drying method has the disadvantage of uncontrolled temperatures and long drying times.

The weakness of this sunlight method may cause the growth of microorganisms to be less optimal. The oven-drying method was carried out at 40°C for 24 , 48 and 72 hours. The starter CC, which was dried for 48 hours, had the best characteristics with a viability of 5.8 x 10^8 CFU / g and a moisture content of 12.57%. This method has the advantage of being temperature controlled, but still takes a long time to dry. In addition, the starter was still wet in the oven when drying for 24 hours (Rahmawati et al., 2017). A more efficient and faster drying method is therefore needed, namely by using a tray dryer.

Rahmawati et al (2019) have carried out the drying method for white corn starter using a tray dryer, where drying was conducted at 40 and 50°C for 1.5-6 hours.This method has a more controlled temperature than the sunshine method and with a shorter time than the oven method. The tray dryer method can reduce the drying area and increase the efficiency of hot air contact with the material (Sari et al., 2017). The dried starter produced by Rahmawati et al (2019) did not have optimal characteristics where the viability of the starters was < 10^6 CFU / g and the water content was >

Commented [A1]: What is AC and CC starters?

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10%. Therefore, it is necessary to optimize the starter drying process which includes temperature and drying time using the tray dryer method.

The optimization of the drying process for starters was carried out by using the D-optimal design of the Response Surface Methodology (RSM) method. RSM is a statistical and mathematical technique used primarily for the development, improvement and optimization of the production process (Carley et al., 2004).

Objective ?

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2. Materials and methods

2.1 AC and CC Starter Preparation (Rahmawati et al. 2013 and Rahmawati et al. 2017)

AC consists of *Penicillium citrinum, Aspergillus niger, Acremonium strictum, and Candida famata,* while CC consists of *Penicillium chrysogenum, Penicillium citrinum, Aspergillus niger, Rhizopus stolonifer, Rhizopus oryzae, Fusarium oxysporum, Acremonium strictum, Candida famata, Kodamaea ohmeri, Candida krusei/ incospicua.* These microorganisms used were previously isolated and identified from spontaneous fermentation of corn grits.

One loop of each mold was streaked onto fresh Potato Dextrose Agar (PDA) slant and incubated for five days at 30°C. After five days, molds were harvested by scrapping, then suspended in 10 mL sterile water and appropriately dissolved to count using haemocytometer. Yeast culture was prepared as above, but incubation was carried out for two days at 30°C. Yeast was also calculated using haemocytometer.

2.2 Optimization using RSM

The Response Surface Methodology (RSM) method was used to maximize the drying process by using the Design Expert ® 7.0 (DX7) statistical application. The experimental design aims to achieve an optimum response by combining several components (Keshani et al. 2010). The mixed design is D-optimal where it was necessary to have a lower limit (-1) and an upper limit (+1). The independent variables in this study were drying temperature and time. The experimental design was based on RSM (Table 1).

The parameters of the experiment were drying time (hours) and drying temperature (^oC). Drying time between 0-10 hours and drying temperature between 40-50^oC (Rahmawati et al. 2017). The AC and CC starter qualities were determined based on total viability mold-yeast, moisture content (oven method), water activity (aw meter) and pH (pH meter).

There were criteria for each variable and response when performing optimization. The observed response was viability with an importance level of 5 (+ + + + +), while the response to moisture, aw and pH had an importance level of 3 (+ + +). The importance value will determine the process conditions that were closest to the target response. The chosen optimal combination is the one having the highest desired value.

2.3 Making Starters and Drying with a Tray Dryer (Rahmawati et al., 2019)

AC and CC starter culture made by sterilizing corn flour, then put it into a sterile basin and adding sterile distilled water as much as 2/3 of the total weight of corn flour. Prepared culture suspensions (AC) containing 10^6 CFU/mL per microorganism, then piped as much as 10% of the amount of water used. After that, all stir until homogeneous and put ± 17 grams in each

petri dish. Petri dishes were then incubated at 30°C for 5 days. Furthermore, the dough is dried using an tray dryer with a range of 40-50°C for 0-10 hours. The dried AC and CC yeast mold culture was made powder using a blender that has been sprayed with 70% alcohol.

2.4 Response Measurement

Response measurements were carried out on the dried powder sample that was inserted into a plastic clip containing silica gel. The responses measured included total mold and yeast viability, aw, moisture content, and pH.

2.5 Verification of Optimization Results

The results were validated at the highest desirability point for AC and CC starters respectively. The AC and CC starting process was repeated directly using the optimal drying process. In addition, the test process included direct measurement of the overall yeast mold viability, moisture contents, water activity and pH to generate the actual response variable.

2.6 Data Analysis

The data analysis technique used in this study includes linear (y = ax + b) models, quadratic (y = ax2 + bx + c) and 2FI models, using the Response Surface Methodology.

3. Results and discussion

3.1 Viability Test

Viability of total yeast mold starter could be seen at Table 2. Based on Table 2, we can see that a total value of yeast mold AC and CC starters ranged from 10^7-10^8 CFU/g at drying temperatures < 50 ^{0}C. In the meantime, the viability value of the yeast mold AC and CC starters at drying temperatures 50°C and drying time of 7.3 to 10 hours was 0. According to Pitt and Hocking (2009), Aspergillus Niger may grow at a minimum temperature of 6 – 8°C, maximum temperature of 45–47°C, and an optimal growth of 35 to 37°C, while Rhizopus oryzae can grow at a temperature of 7 to 42 °C with an optimal growth temperature of approximately 37 °C. Candida krusei can grow optimally at temperature of 37^{o}C (Scorzoni 2013). The mold and yeast in the beginning were suspected to die at 50^{o}C with a drying time of more than 7.3 hours.

The heat resistance of microorganisms is different, which is represented by D value. The D value is defined as the time in minutes at a given temperature which is to reducing 90 percent or a logarithm of the number of spores or certain vegetative cells. Rahmawati et al. (2019) reported that D value of AC and CC at temperatures of 40 ^{0}C was 271.86 minutes (4.5 hours) and 523.10 minutes (8.7 hours) respectively, while at 50 ^{0}C was 147.06 minutes (2.45 hours) and 127.93 minutes (2.13 hours) respectively.

3.2 Moisture Content

Water content and water activity (aw) are closely linked with starters' shelf-life. These two parameters are indicators of the availability of water in food for the survival of microorganisms. In addition to affecting chemical changes, the water content in food also determines the microbial content of foods (Herawati 2008). Products that have higher water content will relatively have shorter shelf life (Amanto et al. 2015). Table 2 showed the water content for AC and CC starters.

The initial moisture content of the AC starter was 56.00 % and CC starter was 57.30 %. In this study, the desired water content was < 10 percent. With this water content value, it was hoped that the microorganisms will remain alive but did not carry out metabolic activity. Dried starter that drying at 50ºC tended to have a lower moisture content than a lower temperature (40ºC). According to Rahmawati et al. (2019), it caused the drying rate at 50ºC was faster than at 40 ºC. As we know that a higher drying rate resulted in a faster drying time.

Drying time can also reduce the material's moisture content. At a temperature of 40ºC with different drying times, the moisture content of AC starters decreased from 56.00 per cent to 11.67 per cent after 4.5 hours of drying and continued to dry to 8.59 per cent after 10 hours of drying. Likewise, with CC starters, the moisture content of CC starters decreased from 57.30 per cent to 11.01 per cent after 4.5 hours of drying and continued to dry to 10.26 per cent after 10 hours of drying at 40ºC. In line with Fitriani (2008) statement, that drying temperature and time higher will evaporate water molecules more than lower temperature and time. Beside that, this condition will make the products ability to release water from its surface is greater and it will caused water content lower.

3.3 Water Activities value

Free water in food is needed by growing microorganisms for nutritional processes, a medium for enzymatic reactions, and cellular component synthesis (Rahayu and Nurwitri 2012). The free water content determines the product to be stored as it is an indicator of the availability of water in food for living microorganisms (Barbosa-Canovas et al., 2007). Products, that have a water activity value smaller, will have longer shelf life because microorganisms can only live in certain conditions (Sinurat and Murniyati, 2014). So, AC and CC starter were expected having longer shelf life. Table 3 showed the water activity of the AC and CC starter.

Overall, mold can live at a minimum water activity value. Aspergillus lives at a minimum water activity of 0.98, Rhizopus 0.93, and Penicillium 0.99, where yeast can usually live around 0.88-0.94 (Muchtadi and Sugiono 2013). A low aw value can make starters' microorganisms dormant.

When starters are dried during long period of time, the water content will decrease, and the water activity starters will decrease as well. This is in line with the research undertaken by Leviana and Paramita (2017), which state that the higher the temperature, the more water in the material is evaporated to decrease the material's water content. Likewise, the water activity value, the higher the drying time the lower the water activity value in the material.

3.4 pH value

The pH value is the degree of acidity used to express a substance, or object's acidity or alkalinity. The pH value is defined as a standard H+ activity cologarithm. A normal pH value is 7, while a pH value>7 indicates the alkaline properties of the substance, while a pH value < 7 indicates the acidic properties. A pH of 0 indicates the highest acidity and pH 14 indicates the highest alkalinity (Zulius, 2017). Table 3 showed the pH value for AC and CC starters.

During the incubation process, the pH value of both AC and CC starters decreased, which becomes slightly sour (3.9-4.5) and was accompanied by a distinctive fermentation aroma.

This indicated that the filler substrate (carbohydrates) has been metabolized by the microorganisms added to simpler compounds such as ethanol, carbon dioxide, and organic acids that can lower the pH value. In the fermentation process, metabolism occurs from the activity of organic acid-producing microorganisms, thereby reducing the pH (Anggraeni and Yuwono 2014). According to Rahmawati et al. (2019), the initial pH value of AC and CC were around 4.00, where this value was appropriate for microorganism growth. The decrease in pH value was due to the activity of microorganisms that converted carbohydrates into acids during the fermentation process.

3.5 Mathematical Model Relationship between Process Parameters and Response

Table 4 showed the math model of drying proses parameter as a response of the AC starter and Table 5 for CC starter model. The linear model indicated that only temperature and drying time influence the response, but not the interactions between them. The quadratic model showed that each factor influences the response and interaction between temperature and drying time. The 2FI model means the response is influenced by the temperature-drying interaction.

3.6 Effect of Drying Process on Starters Viability

Rahmawati et al. (2017) have dried the starter culture using an oven with a temperature below 40ºC resulted the wet starters (not yet dry). It showed that, the starter could be dried at the lowest 40ºC temperature. However, the drying process using tray drier can not generate heat if the temperature is less than 40 ^{0}C were used. Based on this, the drying temperature used was up to 50 ^{0}C (Rahmawati et al. 2019). The results showed that drying at 50 ^{0}C for 6 hours still produced the number of microorganisms that met the minimum requirements for viability of starter microorganisms (10^6 CFU / g). These results were in line with Oliveira et al. (2002) where a good fermented drink produced by the number of bacteria was at least 5.3×10^6 CFU / mL.

Thus, drying starters at a temperature of 40-50 ºC were expected to maintain a significant total viability mold and yeast. Figure 1 and Figure 2 showed the graph of the relationship between temperature and drying time on the viability response of AC and CC starters respectively.

Based on the graph in Figure 1, an increase in temperature and drying time with a tray dryer caused a decrease in yeast viability on the starters. At a temperature of 50 ^{0}C. with a drying time of about 7.3 hours, a value of 0 was produced. Its indicating the absence of mold-yeast during the analized. AC starters are mostly yeast. At this temperature and drying time, the yeast on AC starters was suspected to die. Vegetative yeast cells are killed with humid heat at 50-60°C in 10-15 minutes (Pelczar, 2012).

Figure 1 provided an overview of the AC-starters viability response model. The red color in the figure showed a high viability value, while the blue color showed a low viability value.
Microbes have different heat resistance as expressed by D. According to Rahmawati et al. (2019), the calculation results showed that the values of D starters AC and CC at 40ºC were 271.86 minutes (4.5 hours) and 523.10 minutes (8.7 hours) while at 50 °C were 147.06 minutes (2.45 hours) and 127.93 minutes (2.13 hours) respectively. AC starters were more heat-resistant. It caused AC starter contains fewer types of microbes, so, when making starter

cultures the competition between microbes was lower. This resulted in more available microbes. It was indicated by the higher initial microbial viability than CC starter.

The program selected model for appropriate viability response is a linear model with an R^2 value of 0.6237. AC mold-yeast viability response model has a 0.0123 p-value (Prob > F). This showed that the model can still describe the viability response (AC), as it has a p value < 0.05. The results of ANOVA also showed that temperature and drying time had a significant impact on viability response. This is evidenced by the insignificant fit shortage, > 0.05 (0.3702). Therefore, in this study, the viability modeling shows that the temperature factor (40-50ºC) and drying time (0-10 hours) have a significant effect on the AC viability response.

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Figure 2 provided a surface overview of the CC dissolved viability response model. The model chosen by the program for the appropriate viability response was a quadratic model with an R^2 value of 0.7894. The CC mold-yeast viability response model has a p value (Prob> F) of 0.0474. This showed that the viability response (AC) can still be described well by the model, because it has a p value <0.05. ANOVA results also showed that the temperature and drying time had a significant effect on the viability response. This is evidenced by the insignificant Lack of fit, which is> 0.05 (0.9033). Therefore, the viability modeling in this study showed that the temperature factor (40-50 ºC) and drying time (0-10 hours) significantly influenced the CC viability response.

3.7 Drying Process on Starters Moisture Content

Apart from the drying process, the fermentation process in making starters also plays a role in reducing levels. Pusparani and Yuwono (2014) stated that during the fermentation process, the breakdown of starch by enzymes produced by microorganisms will produce simple sugars such as glucose and accompanied by the release of water. This is known as starch degradation. Starch degradation is characterized by a decrease in the ability of the material to retain water due to loss of hydroxyl groups. The graph of the relationship between the combination of temperature and drying time to the water content response of AC starters can be seen in Figure 3.

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The water content response value from AC starters ranged from 5.63 to 12.52%. Figure 3 provided an overview of the AC starters moisture response model. The image's red color indicated high water content, while the blue color indicated low water content.

The model chosen by the water content response program was the 2FI model with an R^2 value of 0.8382. The AC moisture response model has 0.0016 p-value (Prob > F). This shows that the model can still describe the viability response (AC), as it has a p value<0.05. However, the results of ANOVA did not show that the temperature and drying time had a significant effect on the water content response with a significant fit value shortage, < 0.05 (0.0404). The significant lack of fit value indicates that the temperature (40-50ºC) and drying time parameters (4.5-10 hours) have no significant effect on the water content response in AC starters.

Figure 4 showed the graph of the relationship between the combination of temperature and drying time to CC starter of water content response. The response value to the moisture content generated from CC starters ranged from 5.22-11.53%. The model chosen by the water content

response program was the 2FI model with 0.8209 R^2 value. The CC moisture response model has 0.0023 p value (Prob > F). This shows that the model can still describe the viability response (AC), as it has a p value<0.05. However, the results of ANOVA did not show that the temperature and drying time had a significant effect on the water content response with a significant fit value shortage, < 0.05 (0.0019). The significant lack of fit value indicates that temperature parameters (40-50^{o}C) and drying time (4.5-10.0 hours) do not significantly affect the response of moisture content in CC starters.

3.8 Effect of Drying Process on Water Activity Value

Apart from the drying process, the fermentation process in making starters also plays a role in reducing the levels. Pusparani and Yuwono (2014) state that during the fermentation process, the breakdown of starch by enzymes produced by microorganisms will produce simple sugars such as glucose and accompanied by the release of water. This is known as starch degradation. Starch degradation is characterized by a decrease in the ability of the material to retain water due to loss of hydroxyl groups. The graph of the relationship between the combination of temperature and drying time to the water content response of AC starters can be seen in Figure 5.

Water activity (aw) indicated the amount of free water in a product. Free water in food was needed by growing microorganisms for nutritional processes, a medium for enzymatic reactions, and cellular component synthesis (Rahayu and Nurwitri, 2012). The lower a product's aw value, the lower the risk of chemically or microbiologically damaging the food product. The smaller a product's aw value, the longer the product's shelf life since bacteria, molds, and yeasts require high aw to grow. Overall, the minimum water activity for bacterial growth is 0.75, mold is 0.60, while the minimum yeast growth is 0.80 (Susilo et al., 2019).

Figure 5 showed the graph of the relationship between temperature and drying time to the response of aw starters of AC. The AC-generated response ranged from 0.372 to 0.558. The red color shows a high aw, while the blue color shows a low aw.

The model selected for the appropriate aw response is the quadratic model. Figure 5 provided an overview of the aw response model. The image's red color indicated high aw value, while the blue color indicated low aw value. The aw (AC) response model has a value of 0.0440 p (Prob > F), indicating that the model was significant and can be described well at 5 % level (p value < 0.05). However, the ANOVA results showed a significant fit shortage, < 0.05 (0.0021). This meant that the temperature and drying time do not affect the AC response.

Meanwhile, the CC-starter aw response ranged from 0.356 to 0.645. The CC-starters water activity parameter (aw) represented the mean mathematical model. This showed that CC starters' mold-yeast viability and moisture content due to treatment occurs randomly and cannot be explained by model. Figure 6 showed the graph of the relationship between temperature and drying time to the aw of CC response.

3.9 Effect of Drying Process on pH Value

Acidity or pH indicates the active concentration of hydrogen ions. The pH value is used to determine the variety of microorganisms that may grow on the product where each

microorganism has a specific growth pH. Pratama et al. (2013) stated that the final results of the pH value for yeast bread, tempeh yeast, and *Lactobacillus plantarum* were 4.37; 3.43; and 3.93 at 96 hours of fermentation respectively. For microorganisms, pH influenced the growth and survival. Each type of microorganism has an optimum growth pH and pH range. In general, mold and yeast can grow more widely than bacteria (Rahayu and Nurwitri, 2012). Mold has a very wide growth pH ranged from 2.0-8.5, while yeast has a growth pH range from 4.0-4.5 and will not grow well under alkaline conditions (Muchtadi and Sugiyono, 2013).

The group of microorganisms capable of fermenting food nutrients will convert some or all of the food components into fermented products, e.g. lactic acid, ethanol, CO_2, or other organic acids. Organic acid accumulation causes pH to decrease during incubation. According to Kartohardjono et al. (2007), CO_2 gas is often called acid gas because CO_2 gas has acidic properties. CO_2 gas contributes to the pH value. Figure 7 showed the relationship between the combination of temperature and drying time to the pH response of AC starters. The pH response from AC starters ranges from 3.95 to 4.50. The image's red color indicates high pH, while the blue color indicated low pH.

The model chosen by the program is the 2FI model with an R^2 value of 0.8989. The AC pH response model has 0.0002 p value (Prob > F). This shows that the model can still describe the pH (AC) response as it has a p value<0.05. ANOVA results also showed that the temperature and drying time had a significant pH response effect. This is evidenced by the insignificant fit lack, > 0.05 (0.6288). Temperature parameters (40-50^{o}C) and drying time (4.5-10 hours) have a significant impact on pH response on AC starters.

Figure 8 showed the relationship between the combination of temperature and drying time to the pH response of CC starters. The model selected by the program is the 2FI model with an R2 value of 0.8479. The CC pH response model has a 0.0193 p-value (Prob > F). This showed that the model can still describe the pH (CC) response as it has a p value<0.05. ANOVA results also showed that the temperature and drying time had a significant pH response effect. This is evidenced by the insignificant fit lack, > 0.05 (0.0769). Temperature parameters (40-50^{o}C) and drying time (4.5-10.0 hours) influenced the pH response in AC starters significantly.

3.10 Process Optimization with RSM

The process optimization stage aimed to obtain the drying process conditions for starting corn flour with an optimal response value based on the specified criteria. Based on the numerical optimization performed, a corn flour solution starts drying formula with the highest desirability value recommended by RSM for each starter, as presented in Table 6. The desirability value is a parameter showing the best optimization results with a range of 0–10. The closer to 1.0 the recommended solution can fulfill the desires according to the criteria of the stated objectives and interests (Myers et al. 2009). The combination of drying formula for corn flour starters selected by the AC starter program was a temperature of 40^{o}C for 10 hours, while CC starters are 49^{o}C for 4.5 hours.

Based on the data in Table 6, the optimum formula for AC starters has a predictive response of 3.929 log CFU / g or 8.5 x 10^3 CFU / g, 8.60% water content, 0.433 water activity, and pH

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3.91. While the optimum CC starter formula (Table 6) has a predictive response of 4.958 log CFU / g or 9.0 x 10^4 cfu / g, 6.48% water content, aw 0.499, and pH 4.13.

3. 11 Results *verification*

Result verification was performed at the point with the highest desirability value, respectively, for AC and CC starters. The process of starting AC and CC was repeated directly using the optimum drying process formula. In addition, the testing process included measuring the total viability of yeast fungi, moisture content, water activity, and pH directly to generate the actual response variable. The predicted response can be compared with AC and CC starters verification results in Tables 6.

Based on the verification, there is a significant difference in the value of starter viability between the formula solution suggested by RSM and the verification. According to Rahmawati et al. (2020), the optimization using RSM was unfit to describe the viability response model. This due to a AC-indigenous cocktail yeast mold culture consists of more than one microorganism. So, the activity of AC during the fermentation process varies, because the optimum conditions for growth during incubation for each microorganism vary and maybe there was competition for nutrients by microorganisms varies. On the other hand, the value of 0 in the viability result affected the design of RSM 's optimum formula.

4. Conclusion

Based on the research results, it can be concluded that the combination of temperature and drying time affects the characteristics of the white corn flour starters. The optimum drying process for AC starters is at a temperature of 40°C for 10.0 hours with viability characteristics of 7.944 log CFU / g or 8.79 x 10^7 CFU / g, 8.90% moisture content, aw 0.425 and pH 4.05. The optimal drying process for CC starters is at a temperature of 49 °C for 4.5 hours with viability characteristics of 7.698 log CFU / g or 4.9 x 10^7 cfu / g, water content of 7.02%, aw 0.487 and pH 3.95.

Conflict of interest - Disclose any potential conflict of interest appropriately.

The authors declare no conflict of interest.

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Tables and Figures

Table 1. Independent variables and the level used in the desain process

Independent variables	**Limits**	
	Lower (-1)	Upper (+1)
Temperatures (^{0}C)	40	50
Times (h)	0	10

Table 2. The viability, water content, a_w, and pH responses for AC and CC starter

Treatment	Drying Temperature (°C)	Drying time (Hour)	Viability (CFU/g)		Water content (%)	
			AC	CC	AC	CC
1	40	0,0	8 log 6,75	8 log 2,40	56,00	57,30
2	40	4,5	8 log 3,05	8 log 3,00	11,67	11,01
3	40	4,5	8 log 5,50	8 log 2,70	12,52	11,29
4	40	7,3	8 log 7,50	8 log 1,85	8,66	10,98
5	40	10,0	8 log 5,00	8 log 1,70	8,59	10,26
6	43	0,0	8 log 5,00	8 log 3,00	56.00	57,30
7	43	8,6	8 log 1,00	7 log 2,40	9,16	11,53
8	45	0,0	8 log 5,00	8 log 3,00	55,90	57,30
9	45	5,9	8 log 1,40	7 log 5,20	8,91	9,11
10	45	10,0	7 log 1,40	7 log 4,50	10,61	10,65
11	50	0,0	8 log 3,80	8 log 7,80	55,90	57,30
12	50	4,5	7 log 7,50	7 log 3,00	5,65	5,44
13	50	4,5	7 log 2,00	7 log 1,10	5,79	5,22
14	50	7,3	0,00	0,00	8,66	10,98
15	50	10,0	0,00	0,00	8,91	10,28
16	50	10,0	0,00	0,00	8,80	10,34

570 Table 3. The water activity and pH value responses for AC and CC starter

Treatment	Temperature (°C)	Drying time (Hour)	Water activity		pH value	
			AC	CC	AC	CC
1	40	0,0	0,929	0,945	4,20	4,15
2	40	4,5	0,460	0,474	4,22	4,50
3	40	4,5	0,454	0,465	4,26	4,50
4	40	7,3	0,430	0,426	4,00	4,65
5	40	10,0	0,433	0,421	3,95	4,60
6	43	0,0	0,929	0,945	4,28	4,20
7	43	8,6	0,558	0,645	4,05	4,60
8	45	0,0	0,929	0,959	4,28	4,20
9	45	5,9	0,518	0,570	4,20	4,10
10	45	10,0	0,449	0,478	4,26	4,23
11	50	0,0	0,942	0,959	4,20	4,12
12	50	4,5	0,460	0,474	4,33	4,22
13	50	4,5	0,454	0,438	4,50	4,20
14	50	7,3	0,438	0,426	4,40	4,31
15	50	10,0	0,372	0,356	4,44	4,28
16	50	10,0	0,380	0,367	4,50	4,40

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Table 4. The math model of drying proses parameter as a response of the AC starter

Parameter	Math model	Significance model (*p*)	*Lack of fit*	*R squared*	*Adj R^2 model*	*Pred R^2 model*	*Adeq precision*
Viability (CFU/g)	Linier	0,0123 (significant)	0,3702 (not significant)	0,6237	0,5401	0,3511	6,248
Water content (%)	2FI	0,0016 (significant)	0,0404 (significant)	0,8382	0,7775	0,6959	10,565
Water activity (a_w)	Quadratic	0,0440 (significant)	0,0021 (significant)	0,7950	0,6242	0,3560	7,238
pH	2FI	0,0002 (significant)	0,6288 (not significant)	0,8989	0,8610	0,7554	13,784

Information: *Adj= Adjusted; Pred= Predicted; Adeq= Adequated*

Table 5. The math model of drying proses parameter as a response of the CC starter

Parameter	Math model	Significance model (*p*)	*Lack of fit*	*R squared*	*Adj R^2 model*	*Pred R^2 model*	*Adeq precision*
Viability (CFU/g)	Kuadratik	0,0474 (significant)	0,9033 (not significant)	0,7894	0,6139	0,2087	5,656
Water content (%)	2FI	0,0023 (significant)	0,0019 (significant)	0,8209	0,7537	0,6636	8,499
Water activity (a_w)		0,0616 (not significant)	0,0163 (significant)	0,7679	0,5746	0,2841	6,541
pH	Kuadratik	0,0193 (significant)	0,0769 (not significant)	0,8479	0,7211	0,3705	6,974

Information: *Adj= Adjusted; Pred= Predicted; Adeq= Adequated*

669 Table 6. Comparison of response predictions with verification results of AC and CC starter

Starter and response		Temperature (°C)	Time (Hour)	Viability(log koloni/g)	Water activity (a_w)	Water content (%)	pH
AC	Prediction	40	10,0	3,929	0,433	8,60	3,91
	Actual	40	10,0	7,944	0,425	8,90	4,05
CC	Prediction	49	4,5	4,958	0,499	6,48	4,13
	Actual	49	4,5	7,698	0,487	7,02	3,95

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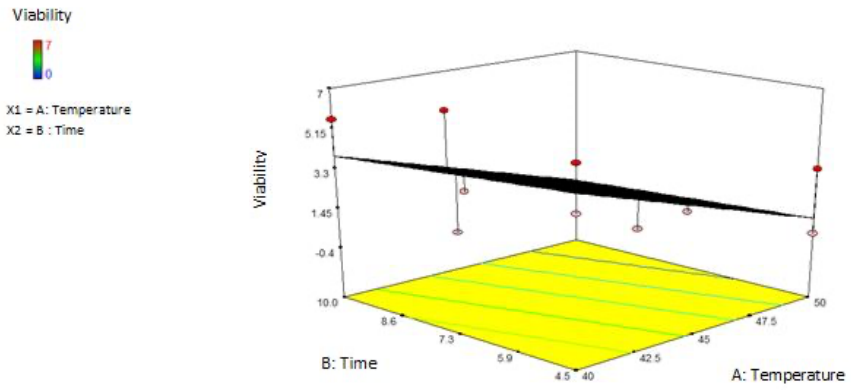

Figure 1. A 3D graphical combination between temperature and drying time to the viability response of AC starters

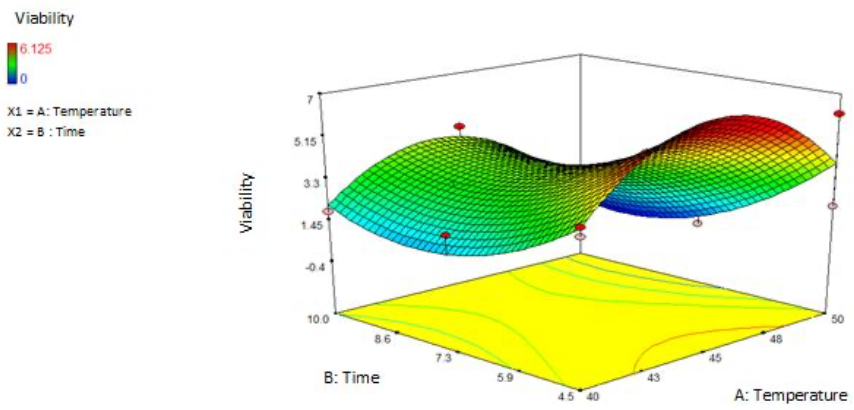

Figure 2. A 3D graphical combination between temperature and drying time to the viability response of CC starters

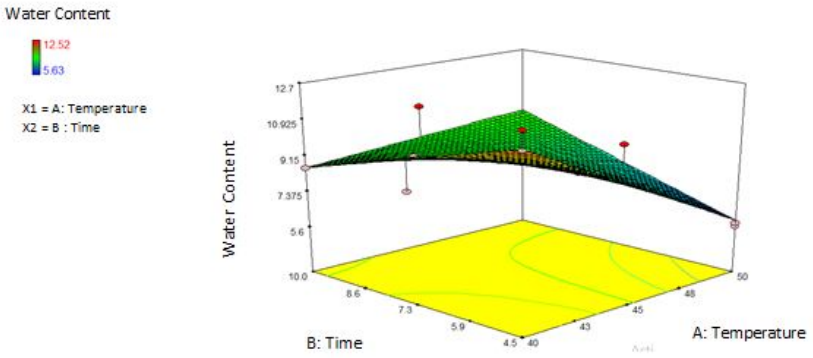

Figure 3. A 3D graphical combination between temperature and drying time to the water content response of AC starters

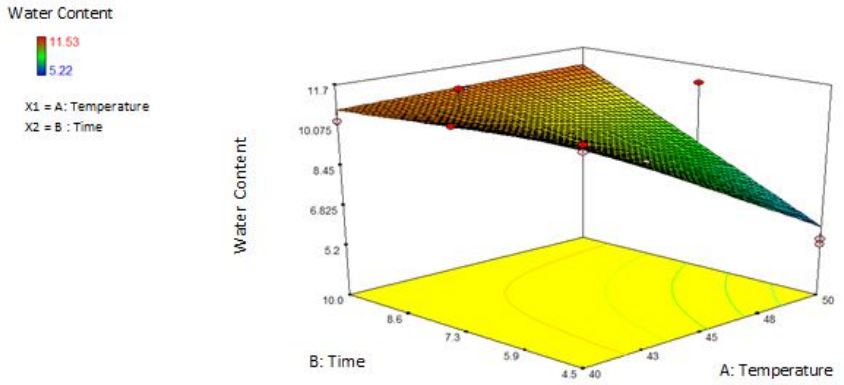

Figure 4. A 3D graphical combination between temperature and drying time to the water content response of CC starters

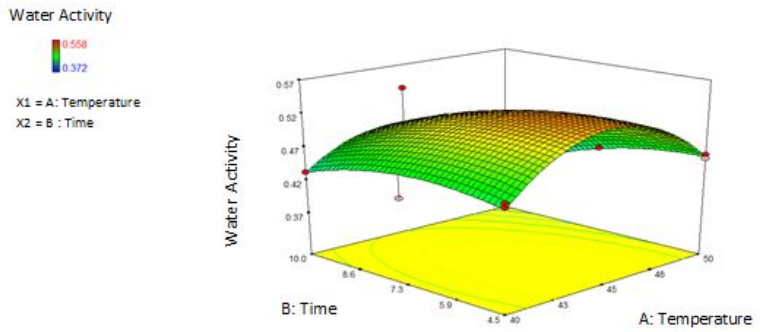

Figure 5. A 3D graphical combination between temperature and drying time to the water activity response of AC starters

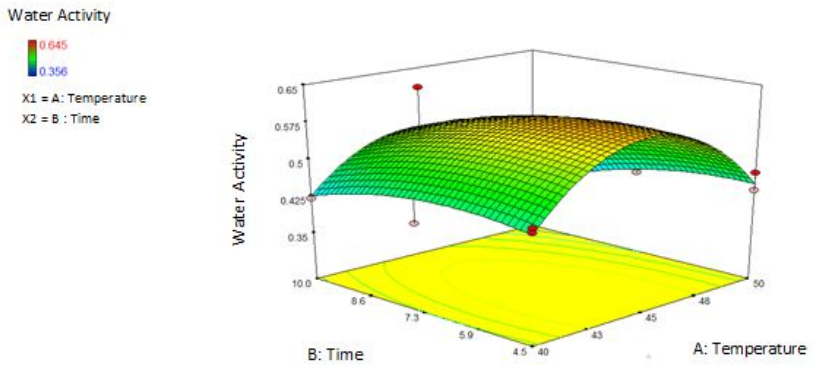

Figure 6. A 3D graphical combination between temperature and drying time to the water activity response of CC starters

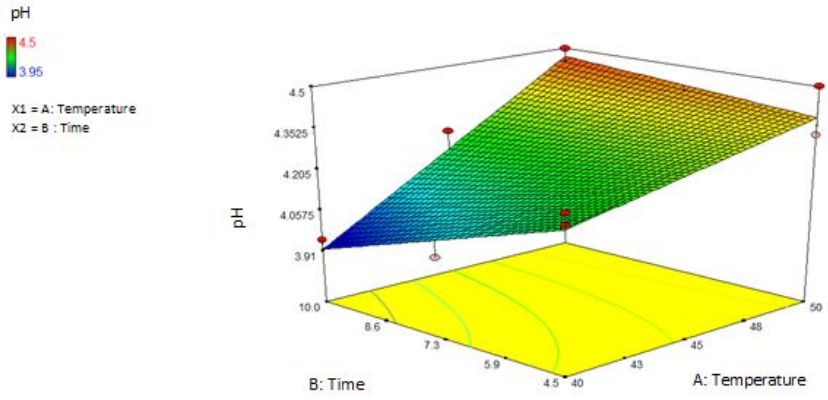

Figure 7. A 3D graphical combination between temperature and drying time to the pH response of AC starters

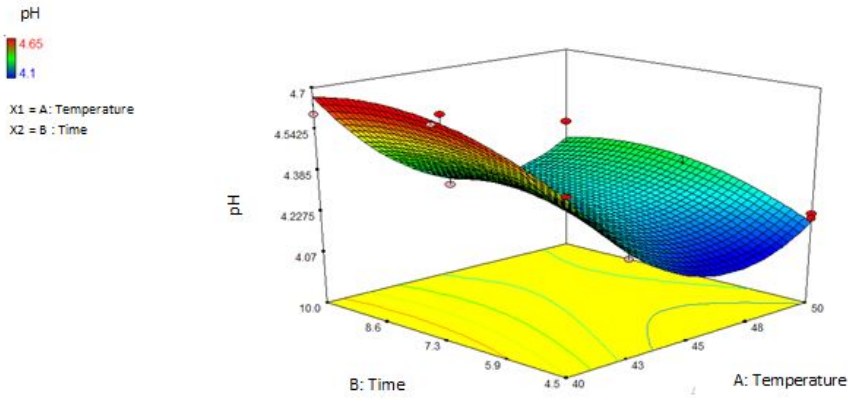

Figure 8. A 3D graphical combination between temperature and drying time on the pH response of CC starters