



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

---

## Re: FR-2020-718 - Article Published

---

Dr. Rahmawati, ST, M.Si. <rahmafarasara@usahid.ac.id>  
To: IPB Dase Hunaefi <dashcbdk@apps.ipb.ac.id>

Tue, Sep 21, 2021 at 4:49 PM

----- 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](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](mailto: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](mailto:rahmafarasara@usahid.ac.id)>

**Sent:** Monday, 13 September, 2021 7:56 PM

**To:** Food Research <[foodresearch.my@outlook.com](mailto: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 regards,  
Rahmawati

On Thu, Sep 2, 2021 at 7:48 PM Food Research <[foodresearch.my@outlook.com](mailto: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](mailto:rahmafarasara@usahid.ac.id)>

**Sent:** Wednesday, 1 September, 2021 11:21 PM

**To:** Food Research <[foodresearch.my@outlook.com](mailto: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](mailto: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. <rahmafariasara@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. <rahmafariasara@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. <rahmafariasara@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](mailto: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](mailto:foodresearch.my@outlook.com)>  
**Sent:** Friday, 20 August, 2021 11:19 AM  
**To:** Dr. Rahmawati, ST, M.Si. <[rahmafarasara@usahid.ac.id](mailto: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](mailto:rahmafarasara@usahid.ac.id)>  
**Sent:** Thursday, 19 August, 2021 11:53 PM  
**To:** Food Research <[foodresearch.my@outlook.com](mailto: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. <rahmafariasara@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. <rahmafariasara@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](mailto: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](mailto:rahmafarasara@usahid.ac.id)>  
**Sent:** Friday, 16 April, 2021 12:19 AM  
**To:** Food Research <[foodresearch.my@outlook.com](mailto: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](mailto: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](mailto:foodresearch.my@outlook.com)>  
**Sent:** Monday, 15 March, 2021 11:10 PM  
**To:** Dr. Rahmawati, ST, M.Si. <[rahmafarasara@usahid.ac.id](mailto: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](mailto:rahmafarasara@usahid.ac.id)>  
**Sent:** Monday, March 15, 2021 11:06:27 PM  
**To:** Food Research <[foodresearch.my@outlook.com](mailto: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](mailto: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](mailto:rahmafarasara@usahid.ac.id)>  
**Sent:** Sunday, 24 January, 2021 12:00 PM  
**To:** Food Research <[foodresearch.my@outlook.com](mailto: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](mailto: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](mailto: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](mailto:foodresearch.my@outlook.com)

Chief Editor, Food Research

---

**From:** Food Research <[foodresearch.my@outlook.com](mailto:foodresearch.my@outlook.com)>  
**Sent:** Tuesday, 8 December, 2020 11:36 PM  
**To:** Dr. Rahmawati, ST, M.Si. <[rahmafariasara@usahid.ac.id](mailto:rahmafariasara@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](mailto:foodresearch.my@outlook.com)



---

**From:** Dr. Rahmawati, ST, M.Si. <[rahmafarasara@usahid.ac.id](mailto:rahmafarasara@usahid.ac.id)>  
**Sent:** Tuesday, 8 December, 2020 7:14 PM  
**To:** Food Research <[foodresearch.my@outlook.com](mailto: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](mailto:rahmafarasara@usahid.ac.id)> wrote:

December, 8<sup>th</sup> 2020

**Professor Dr. Son Radu**

Chief Editor  
Food Research  
[foodresearch.my@outlook.com](mailto: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 °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 characteristic response viability 7.944 log CFU / g or  $8.79 \times 10^7$  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 characteristic response viability 7,698 log CFU / g or  $4.9 \times 10^7$  CFU / g, water activity 0.487, water content 7.02%, and pH 3.95.

I/we think that our manuscript appropriate 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 Engineering, 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). Expertise 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](mailto:m_zukhruf@yahoo.com); [m\\_zukhruf@upm.edu.my](mailto: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). Expertise on: **Starches Technology, Quality and Food Safety** (e-mail: [jomunarso@gmail.com](mailto:jomunarso@gmail.com))
3. **Dr. Nur Aini, STP, MP** (Mrs) (Department of Food Technology, Soedirman University, Indonesia). Expertise on: **Food Processing and Engineering** (e-mail: [nuraini\\_munawar@yahoo.com](mailto:nuraini_munawar@yahoo.com))
4. **Dr. Zita Letvianny Sarungallo, STP, MSi** (Mrs) (Agricultural Product Technology Program, Papua University, Manokwari, West Papua, Indonesia). Expertise on: **Food Science.** (e-mail: [zisarungallo@yahoo.com](mailto:zisarungallo@yahoo.com))

Thank you for your consideration of this manuscript.

Sincerely,

**Dr. Rahmawati**

[rahmafarasara@usahid.ac.id](mailto:rahmafarasara@usahid.ac.id)

Sahid University Jakarta, Indonesia

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

4 **Abstract**

5 This research aimed to optimize the tray dryer temperature and time of white corn flour culture by  
6 RSM. There were two culture using in this research, namely AC and CC. The independent  
7 variables in this study were drying temperature and time, where the quality indicators used were  
8 total viability of mold and yeast, water content, water activity, and pH. This research used a factor  
9 response surface methodology. Data were analyzed by ANOVA with  $\alpha$  level of 95%. The result  
10 of this research showed that the optimum drying process for AC starter was 40°C for 10 hours,  
11 with characteristic response viability 7.944 log CFU/g or  $8.79 \times 10^7$  CFU/g, water activity 0.425,  
12 water content 8.90%, and pH 4.05. CC starter showed an optimum drying process at 49°C for 4.5  
13 hours, with characteristic response viability 7.698 log CFU/g or  $4.9 \times 10^7$  CFU/g, water activity  
14 0.487, water content 7.02%, and pH 3.95.

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

16 **1. Introduction**

17  
18  
19 White corn flour is a food commodity with limited use. This flour has a weakness, such as high  
20 viscosity, with high retrograde, the paste undergoes syneresis during storage, and low paste  
21 stability at high temperature and low pH (Aini et al., 2010). Farasara et al. (2014) showed that  
22 fermentation with the addition of indigenous mold and yeast culture could change the characterisitc  
23 of white corn flour paste of Anoman 1 after 36 hours fermentation. The indigenous mold and yeast  
24 resulted from the isolation and identification of microorganisms in the spontaneous fermentation  
25 of white corn varieties of Anoman 1 and was grouped into AC and CC starters (Rahmawati et al.,  
26 2013). To simplify the fermentation process and quality control, indigenous mold and yeast  
27 cultures were made dried starter. Dried starters have been produced using sun drying and oven  
28 drying methods (Rahmawati et al., 2017). The sun-drying method was carried out by drying for 7  
29 days, between 8.00 and 15.00 WIB, with a total drying time of 48 hours. AC starters produced the  
30 best characteristics with a viability of  $2.7 \times 10^8$  CFU / g and a moisture content of 13.34%. The  
31 sun-drying method has the disadvantage of uncontrolled temperatures and long drying times.  
32 The weakness of this sunlight method may cause the growth of microorganisms to be less optimal.  
33 The oven-drying method was carried out at 40°C for 24 , 48 and 72 hours. The starter CC, which  
34 was dried for 48 hours, had the best characteristics with a viability of  $5.8 \times 10^8$  CFU / g and a  
35 moisture content of 12.57%. This method has the advantage of being temperature controlled, but  
36 still takes a long time to dry. In addition, the starter was still wet in the oven when drying for 24  
37 hours (Rahmawati et al., 2017). A more efficient and faster drying method is therefore needed,  
38 namely by using a tray dryer.  
39 Rahmawati et al (2019) have carried out the drying method for white corn starter using a tray dryer,  
40 where drying was conducted at 40 and 50°C for 1.5-6 hours. This method has a more controlled  
41 temperature than the sunshine method and with a shorter time than the oven method. The tray dryer  
42 method can reduce the drying area and increase the efficiency of hot air contact with the material  
43 (Sari et al., 2017). The dried starter produced by Rahmawati et al (2019) did not have optimal  
44 characteristics where the viability of the starters was  $< 10^6$  CFU / g and the water content was  $>$   
45 10%. Therefore, it is necessary to optimize the starter drying process which includes temperature  
46 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:

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

## 54 2. Materials and methods

### 55 2.1 AC and CC Starter Preparation (Rahmawati et al. 2013 and Rahmawati et al. 2017)

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

61  
62 One loop of each mold was streaked onto fresh Potato Dextrose Agar (PDA) slant and  
63 incubated for five days at 30°C. After five days, molds were harvested by scrapping, then  
64 suspended in 10 mL sterile water and appropriately dissolved to count using haemocytometer.  
65 Yeast culture was prepared as above, but incubation was carried out for two days at 30°C.  
66 Yeast was also calculated using haemocytometer.

### 68 2.2 Optimization using RSM

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

75  
76 The parameters of the experiment were drying time (hours) and drying temperature (°C).  
77 Drying time between 0-10 hours and drying temperature between 40-50°C (Rahmawati et al.  
78 2017). The AC and CC starter qualities were determined based on total viability mold-yeast,  
79 moisture content (oven method), water activity (aw meter) and pH (pH meter).

80  
81 There were criteria for each variable and response when performing optimization. The  
82 observed response was viability with an importance level of 5 (++++), while the response  
83 to moisture, aw and pH had an importance level of 3 (+++). The importance value will  
84 determine the process conditions that were closest to the target response. The chosen optimal  
85 combination is the one having the highest desired value.

### 87 2.3 Making Starters and Drying with a Tray Dryer (Rahmawati et al., 2019)

88 AC and CC starter culture made by sterilizing corn flour, then put it into a sterile basin and  
89 adding sterile distilled water as much as 2/3 of the total weight of corn flour. Prepared culture  
90 suspensions (AC) containing 10<sup>6</sup> CFU/mL per microorganism, then piped as much as 10%  
91 of the amount of water used. After that, all stir until homogeneous and put ± 17 grams in each  
92 petri dish. Petri dishes were then incubated at 30°C for 5 days. Furthermore, the dough is dried  
93 using an tray dryer with a range of 40-50°C for 0-10 hours. The dried AC and CC yeast mold  
94 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:

96  
97  
98  
99  
100  
101  
102  
103  
104  
105  
106  
107  
108  
109  
110  
111  
112  
113  
114  
115  
116  
117  
118  
119  
120  
121  
122  
123  
124  
125  
126  
127  
128  
129  
130  
131  
132  
133  
134  
135  
136  
137  
138  
139  
140  
141

#### 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 ( $y = ax^2 + bx + c$ ) 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  $< 50^\circ\text{C}$ . In the meantime, the viability value of the yeast mold AC and CC starters at drying temperatures  $50^\circ\text{C}$  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  $6 - 8^\circ\text{C}$ , maximum temperature of  $45 - 47^\circ\text{C}$ , and an optimal growth of  $35$  to  $37^\circ\text{C}$ , while *Rhizopus oryzae* can grow at a temperature of  $7$  to  $42^\circ\text{C}$  with an optimal growth temperature of approximately  $37^\circ\text{C}$ . *Candida krusei* can grow optimally at temperature of  $37^\circ\text{C}$  (Scorzoni 2013). The mold and yeast in the beginning were suspected to die at  $50^\circ\text{C}$  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  $40^\circ\text{C}$  was 271.86 minutes (4.5 hours) and 523.10 minutes (8.7 hours) respectively, while at  $50^\circ\text{C}$  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 written 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



142 that drying at 50°C tended to have a lower moisture content than a lower temperature (40°C).  
143 According to Rahmawati et al. (2019), it caused the drying rate at 50°C was faster than at 40  
144 °C. As we know that a higher drying rate resulted in a faster drying time.  
145

146 Drying time can also reduce the material's moisture content. At a temperature of 40°C with  
147 different drying times, the moisture content of AC starters decreased from 56.00 per cent to  
148 11.67 per cent after 4.5 hours of drying and continued to dry to 8.59 per cent after 10 hours of  
149 drying. Likewise, with CC starters, the moisture content of CC starters decreased from 57.30  
150 per cent to 11.01 per cent after 4.5 hours of drying and continued to dry to 10.26 per cent after  
151 10 hours of drying at 40°C. In line with Fitriani (2008) statement, that drying temperature and  
152 time higher will evaporate water molecules more than lower temperature and time. Beside that,  
153 this condition will make the products ability to release water from its surface is greater and it  
154 will caused water content lower.  
155

### 156 3.3 Water Activities value

157 Free water in food is needed by growing microorganisms for nutritional processes, a medium  
158 for enzymatic reactions, and cellular component synthesis (Rahayu and Nurwitri 2012). The  
159 free water content determines the product to be stored as it is an indicator of the availability of  
160 water in food for living microorganisms (Barbosa-Canovas et al., 2007). Products, that have a  
161 water activity value smaller, will have longer shelf life because microorganisms can only live  
162 in certain conditions (Sinurat and Murniyati, 2014). So, AC and CC starter were expected  
163 having longer shelf life. Table 3 showed the water activity of the AC and CC starter.  
164

Commented [RR10]: These sentence are not necessary

165 Overall, mold can live at a minimum water activity value. Aspergillus lives at a minimum  
166 water activity of 0.98, Rhizopus 0.93, and Penicillium 0.99, where yeast can usually live  
167 around 0.88-0.94 (Muchtadi and Sugiono 2013). A low aw value can make starters'  
168 microorganisms dormant.  
169

170 When starters are dried during long period of time, the water content will decrease, and the  
171 water activity starters will decrease as well. This is in line with the research undertaken by  
172 Leviana and Paramita (2017), which state that the higher the temperature, the more water in  
173 the material is evaporated to decrease the material's water content. Likewise, the water activity  
174 value, the higher the drying time the lower the water activity value in the material.  
175

### 176 3.4 pH value

177 The pH value is the degree of acidity used to express a substance, or object's acidity or  
178 alkalinity. The pH value is defined as a standard H<sup>+</sup> activity cologarithm. A normal pH value  
179 is 7, while a pH value >7 indicates the alkaline properties of the substance, while a pH value <  
180 7 indicates the acidic properties. A pH of 0 indicates the highest acidity and pH 14 indicates  
181 the highest alkalinity (Zulius, 2017). Table 3 showed the pH value for AC and CC starters.  
182

Commented [RR11]: These sentences are not necessary

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



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

### 193 3.5 Mathematical Model Relationship between Process Parameters and Response

194 Table 4 showed the math model of drying proses parameter as a response of the AC starter and  
195 Table 5 for CC starter model. The linear model indicated that only temperature and drying  
196 time influence the response, but not the interactions between them. The quadratic model  
197 showed that each factor influences the response and interaction between temperature and  
198 drying time. The 2FI model means the response is influenced by the temperature-drying  
199 interaction.  
200

### 201 3.6 Effect of Drying Process on Starters Viability

202 Rahmawati et al. (2017) have dried the starter culture using an oven with a temperature below  
203 40°C resulted the wet starters (not yet dry). It showed that, the starter could be dried at the  
204 lowest 40°C temperature. However, the drying process using tray drier can not generate heat  
205 if the temperature is less than 40 °C were used. Based on this, the drying temperature used was  
206 up to 50 °C (Rahmawati et al. 2019). The results showed that drying at 50 °C for 6 hours still  
207 produced the number of microorganisms that met the minimum requirements for viability of  
208 starter microorganisms ( $10^6$  CFU / g). These results were in line with Oliveira et al. (2002)  
209 where a good fermented drink produced by the number of bacteria was at least  $5.3 \times 10^6$  CFU  
210 / mL.  
211

212 Thus, drying starters at a temperature of 40-50 °C were expected to maintain a significant total  
213 viability mold and yeast. Figure 1 and Figure 2 showed the graph of the relationship between  
214 temperature and drying time on the viability response of AC and CC starters respectively.  
215

216 Based on the graph in Figure 1, an increase in temperature and drying time with a tray dryer  
217 caused a decrease in yeast viability on the starters. At a temperature of 50 °C. with a drying  
218 time of about 7.3 hours, a value of 0 was produced. Its indicating the absence of mold-yeast  
219 during the analized. AC starters are mostly yeast. At this temperature and drying time, the yeast  
220 on AC starters was suspected to die. Vegetative yeast cells are killed with humid heat at 50-  
221 60°C in 10-15 minutes (Pelczar, 2012).  
222

223 Figure 1 provided an overview of the AC-starters viability response model. The red color in  
224 the figure showed a high viability value, while the blue color showed a low viability value.  
225 Microbes have different heat resistance as expressed by D. According to Rahmawati et al.  
226 (2019), the calculation results showed that the values of D starters AC and CC at 40°C were  
227 271.86 minutes (4.5 hours) and 523.10 minutes (8.7 hours) while at 50 °C were 147.06 minutes  
228 (2.45 hours) and 127.93 minutes (2.13 hours) respectively. AC starters were more heat-  
229 resistant. It caused AC starter contains fewer types of microbes, so, when making starter  
230 cultures the competition between microbes was lower. This resulted in more available  
231 microbes. It was indicated by the higher initial microbial viability than CC starter.  
232  
233

234 The program selected model for appropriate viability response is a linear model with an R<sup>2</sup>  
235 value of 0.6237. AC mold-yeast viability response model has a 0.0123 p-value (Prob > F). This  
236 showed that the model can still describe the viability response (AC), as it has a p value < 0.05.  
237 The results of ANOVA also showed that temperature and drying time had a significant impact  
238 on viability response. This is evidenced by the insignificant fit shortage, > 0.05 (0.3702).  
239 Therefore, in this study, the viability modeling shows that the temperature factor (40-50°C)  
240 and drying time (0-10 hours) have a significant effect on the AC viability response.  
241

242 Figure 2 provided a surface overview of the CC dissolved viability response model. The model  
243 chosen by the program for the appropriate viability response was a quadratic model with an R<sup>2</sup>  
244 value of 0.7894. The CC mold-yeast viability response model has a p value (Prob > F) of  
245 0.0474. This showed that the viability response (AC) can still be described well by the model,  
246 because it has a p value < 0.05. ANOVA results also showed that the temperature and drying  
247 time had a significant effect on the viability response. This is evidenced by the insignificant  
248 Lack of fit, which is > 0.05 (0.9033). Therefore, the viability modeling in this study showed  
249 that the temperature factor (40-50 °C) and drying time (0-10 hours) significantly influenced  
250 the CC viability response.  
251

### 252 3.7 Drying Process on Starters Moisture Content

253 Apart from the drying process, the fermentation process in making starters also plays a role in  
254 reducing levels. Pusparani and Yuwono (2014) stated that during the fermentation process, the  
255 breakdown of starch by enzymes produced by microorganisms will produce simple sugars such  
256 as glucose and accompanied by the release of water. This is known as starch degradation.  
257 Starch degradation is characterized by a decrease in the ability of the material to retain water  
258 due to loss of hydroxyl groups. The graph of the relationship between the combination of  
259 temperature and drying time to the water content response of AC starters can be seen in Figure  
260 3.  
261

262 The water content response value from AC starters ranged from 5.63 to 12.52%. Figure 3  
263 provided an overview of the AC starters moisture response model. The image's red color  
264 indicated high water content, while the blue color indicated low water content.  
265

266 The model chosen by the water content response program was the 2FI model with an R<sup>2</sup> value  
267 of 0.8382. The AC moisture response model has 0.0016 p-value (Prob > F). This shows that  
268 the model can still describe the viability response (AC), as it has a p value < 0.05. However, the  
269 results of ANOVA did not show that the temperature and drying time had a significant effect  
270 on the water content response with a significant fit value shortage, < 0.05 (0.0404). The  
271 significant lack of fit value indicates that the temperature (40-50°C) and drying time parameters  
272 (4.5-10 hours) have no significant effect on the water content response in AC starters.  
273

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

280 the temperature and drying time had a significant effect on the water content response with a  
281 significant fit value shortage,  $< 0.05$  (0.0019). The significant lack of fit value indicates that  
282 temperature parameters (40-50°C) and drying time (4.5-10.0 hours) do not significantly affect  
283 the response of moisture content in CC starters.  
284

### 285 *3.8 Effect of Drying Process on Water Activity Value*

286 Apart from the drying process, the fermentation process in making starters also plays a role in  
287 reducing the levels. Pusparani and Yuwono (2014) state that during the fermentation process,  
288 the breakdown of starch by enzymes produced by microorganisms will produce simple sugars  
289 such as glucose and accompanied by the release of water. This is known as starch degradation.  
290 Starch degradation is characterized by a decrease in the ability of the material to retain water  
291 due to loss of hydroxyl groups. The graph of the relationship between the combination of  
292 temperature and drying time to the water content response of AC starters can be seen in Figure  
293 5.  
294

295 Water activity ( $a_w$ ) indicated the amount of free water in a product. Free water in food was  
296 needed by growing microorganisms for nutritional processes, a medium for enzymatic  
297 reactions, and cellular component synthesis (Rahayu and Nurwitri, 2012). The lower a  
298 product's  $a_w$  value, the lower the risk of chemically or microbiologically damaging the food  
299 product. The smaller a product's  $a_w$  value, the longer the product's shelf life since bacteria,  
300 molds, and yeasts require high  $a_w$  to grow. Overall, the minimum water activity for bacterial  
301 growth is 0.75, mold is 0.60, while the minimum yeast growth is 0.80 (Susilo et al., 2019).  
302

303 Figure 5 showed the graph of the relationship between temperature and drying time to the  
304 response of  $a_w$  starters of AC. The AC-generated response ranged from 0.372 to 0.558. The  
305 red color shows a high  $a_w$ , while the blue color shows a low  $a_w$ .  
306

307 The model selected for the appropriate  $a_w$  response is the quadratic model. Figure 5 provided  
308 an overview of the  $a_w$  response model. The image's red color indicated high  $a_w$  value, while  
309 the blue color indicated low  $a_w$  value. The  $a_w$  (AC) response model has a value of 0.0440 p  
310 (Prob  $> F$ ), indicating that the model was significant and can be described well at 5 % level (p  
311 value  $< 0.05$ ). However, the ANOVA results showed a significant fit shortage,  $< 0.05$  (0.0021).  
312 This meant that the temperature and drying time do not affect the AC response.  
313

314 Meanwhile, the CC-starter  $a_w$  response ranged from 0.356 to 0.645. The CC-starters water  
315 activity parameter ( $a_w$ ) represented the mean mathematical model. This showed that CC  
316 starters' mold-yeast viability and moisture content due to treatment occurs randomly and  
317 cannot be explained by model. Figure 6 showed the graph of the relationship between  
318 temperature and drying time to the  $a_w$  of CC response.  
319

### 320 *3.9 Effect of Drying Process on pH Value*

321 Acidity or pH indicates the active concentration of hydrogen ions. The pH value is used to  
322 determine the variety of microorganisms that may grow on the product where each  
323 microorganism has a specific growth pH. Pratama et al. (2013) stated that the final results of  
324 the pH value for yeast bread, tempeh yeast, and *Lactobacillus plantarum* were 4.37; 3.43; and  
325 3.93 at 96 hours of fermentation respectively. For microorganisms, pH influenced the growth

326 and survival. Each type of microorganism has an optimum growth pH and pH range. In general,  
327 mold and yeast can grow more widely than bacteria (Rahayu and Nurwitri, 2012). Mold has a  
328 very wide growth pH ranged from 2.0-8.5, while yeast has a growth pH range from 4.0-4.5 and  
329 will not grow well under alkaline conditions (Muchtadi and Sugiyono, 2013).  
330

331 The group of microorganisms capable of fermenting food nutrients will convert some or all of  
332 the food components into fermented products, e.g. lactic acid, ethanol, CO<sub>2</sub>, or other organic  
333 acids. Organic acid accumulation causes pH to decrease during incubation. According to  
334 Kartohardjono et al. (2007), CO<sub>2</sub> gas is often called acid gas because CO<sub>2</sub> gas has acidic  
335 properties. CO<sub>2</sub> gas contributes to the pH value. Figure 7 showed the relationship between the  
336 combination of temperature and drying time to the pH response of AC starters. The pH  
337 response from AC starters ranges from 3.95 to 4.50. The image's red color indicates high pH,  
338 while the blue color indicated low pH.  
339

340 The model chosen by the program is the 2FI model with an R<sup>2</sup> value of 0.8989. The AC pH  
341 response model has 0.0002 p value (Prob > F). This shows that the model can still describe the  
342 pH (AC) response as it has a p value < 0.05. ANOVA results also showed that the temperature  
343 and drying time had a significant pH response effect. This is evidenced by the insignificant fit  
344 lack, > 0.05 (0.6288). Temperature parameters (40-50°C) and drying time (4.5-10 hours) have  
345 a significant impact on pH response on AC starters.  
346

347 Figure 8 showed the relationship between the combination of temperature and drying time to  
348 the pH response of CC starters. The model selected by the program is the 2FI model with an  
349 R<sup>2</sup> value of 0.8479. The CC pH response model has a 0.0193 p-value (Prob > F). This showed  
350 that the model can still describe the pH (CC) response as it has a p value < 0.05. ANOVA results  
351 also showed that the temperature and drying time had a significant pH response effect. This is  
352 evidenced by the insignificant fit lack, > 0.05 (0.0769). Temperature parameters (40-50°C) and  
353 drying time (4.5-10.0 hours) influenced the pH response in AC starters significantly.  
354

### 355 *3.10 Process Optimization with RSM*

356 The process optimization stage aimed to obtain the drying process conditions for starting corn  
357 flour with an optimal response value based on the specified criteria. Based on the numerical  
358 optimization performed, a corn flour solution starts drying formula with the highest desirability  
359 value recommended by RSM for each starter, as presented in Table 6. The desirability value is  
360 a parameter showing the best optimization results with a range of 0–10. The closer to 1.0 the  
361 recommended solution can fulfill the desires according to the criteria of the stated objectives  
362 and interests (Myers et al. 2009). The combination of drying formula for corn flour starters  
363 selected by the AC starter program was a temperature of 40°C for 10 hours, while CC starters  
364 are 49°C for 4.5 hours.  
365

366 Based on the data in Table 6, the optimum formula for AC starters has a predictive response  
367 of 3.929 log CFU / g or 8.5 x 10<sup>3</sup> CFU / g, 8.60% water content, 0.433 water activity, and pH  
368 3.91. While the optimum CC starter formula (Table 6) has a predictive response of 4.958 log  
369 CFU / g or 9.0 x 10<sup>4</sup> cfu / g, 6.48% water content, aw 0.499, and pH 4.13.  
370

### 371 *3.11 Results verification*

372 Result verification was performed at the point with the highest desirability value, respectively,  
373 for AC and CC starters. The process of starting AC and CC was repeated directly using the  
374 optimum drying process formula. In addition, the testing process included measuring the total  
375 viability of yeast fungi, moisture content, water activity, and pH directly to generate the actual  
376 response variable. The predicted response can be compared with AC and CC starters  
377 verification results in Tables 6.  
378

379 Based on the verification, there is a significant difference in the value of starter viability  
380 between the formula solution suggested by RSM and the verification. According to Rahmawati  
381 et al. (2020), the optimization using RSM was unfit to describe the viability response model.  
382 This due to a AC-indigenous cocktail yeast mold culture consists of more than one  
383 microorganism. So, the activity of AC during the fermentation process varies, because the  
384 optimum conditions for growth during incubation for each microorganism vary and maybe  
385 there was competition for nutrients by microorganisms varies. On the other hand, the value of  
386 0 in the viability result affected the design of RSM 's optimum formula.  
387

#### 388 4. Conclusion

389 Based on the research results, it can be concluded that the combination of temperature and  
390 drying time affects the characteristics of the white corn flour starters. The optimum drying  
391 process for AC starters is at a temperature of 40°C for 10.0 hours with viability characteristics  
392 of 7.944 log CFU / g or  $8.79 \times 10^7$  CFU / g, 8.90% moisture content, aw 0.425 and pH 4.05.  
393 The optimal drying process for CC starters is at a temperature of 49 °C for 4.5 hours with  
394 viability characteristics of 7.698 log CFU / g or  $4.9 \times 10^7$  cfu / g, water content of 7.02%, aw  
395 0.487 and pH 3.95.  
396

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

398 The authors declare no conflict of interest.  
399

#### 400 Acknowledgments

401 The Authors would like to acknowledge to the Indonesian Ministry of Research and Higher  
402 Education – Directorate of Research and Community Empowerment for the grant research No.  
403 28/AKM/PNT/2019.  
404  
405  
406  
407  
408  
409  
410  
411  
412  
413

#### 414 References

415 Aini N, Hariyadi P, Muchtadi TR, Andarwulan N. 2010. *Hubungan antara waktu fermentasi grits*  
416 *jagung dengan sifat gelatinisasi tepung jagung putih yang dipengaruhi ukuran partikel.* J  
417 *Tekno dan Industri Pangan* 21: 18-24

Commented [RR12]: Please reformat the reference  
rewarcord

- 418 Amanto BS, Siswanti, Atmaja A. 2015. *Kinetika pengeringan temu giring (Curcuma heyneana*  
419 *valeton & van zipp) menggunakan cabinet dryer dengan perlakuan pendahuluan*  
420 *blanching*. Jurnal Teknologi Hasil Pertanian. 8(2): 107-114.
- 421 Barbosa-Canovas, G.V., Fontana, A.J.Jr., Schmidt, S.J. and Labuza, T.P. (2007). *Water Activity*  
422 *in Foods: Fundamentals and Applications*. Iowa, USA: IFT Press – Blackwell Publishing.  
423 [https:// doi.org/10.1002/9780470376454](https://doi.org/10.1002/9780470376454)
- 424 Anggraeni YP, Yuwono SS. 2014. *Pengaruh fermentasi alami pada chips ubi jalar (Ipomoea*  
425 *batatas) terhadap sifat fisik tepung ubi jalar terfermentasi*. Jurnal Pangan dan  
426 Agroindustri. 2(2): 59-69
- 427 Carley KM, Kamneva NY, Reminga J. 2004. *Response Surface Methodology*. Pittsburgh (US):  
428 Carnegie Mellon University.
- 429 Farasara R, Hariyadi P, Fardiaz D, dan Dewanti-Hariadi R 2014. *Pasting Properties of White Corn*  
430 *Flours of Anoman 1 and Pulut Harapan Varieties as Affected by Fementation Process*.  
431 *Food and Nutrition Sciences*, 2014, 5, 2038-2047
- 432 Fitriani, S. 2008. *Pengaruh Suhu dan Lama Pengeringan terhadap Beberapa Mutu Manisan*  
433 *Belimbing Wuluh (Averrhoa bilimbi L) Kering*. Jurnal Sagu. 7(1): 32-37.
- 434 Herawati H. 2008. *Penentuan umur simpan pada produk pangan*. Jurnal Litbang Pertanian, 27(4):  
435 124-130.
- 436 Kartohardjono S, Anggara, Subihi, dan Yuliusman. 2007. *Absorbansi CO<sub>2</sub> dari campurannya*  
437 *dengan CH<sub>4</sub> atau N<sub>2</sub> melalui kontaktor membrane serat berongga menggunakan*  
438 *pestarterst air*. Jurnal Teknologi. 11(2): 97-102.
- 439 Keshani, S., Luqman, C.A., Nourouzi, M.M., Russly, A.R. and Jamilah, B. (2010). *Optimization*  
440 *of concentration process on pomelo fruit juice using response surface methodology (RSM)*.  
441 *International Food Research Journal*, 17(3), 733-742.
- 442 Lay, B.W. 1994. *Analisis Mikrobiologi di Laboratorium*. Jakarta. Raja Grafindo Persada.
- 443 Leviana W dan Paramita V. 2017. *Pengaruh Suhu Terhadap Kadar Air Dan Aktivitas Air Dalam*  
444 *Bahan Pada Kunyit (Curcuma Longa) Dengan Alat Pengering Electrical Oven*. METANA.  
445 Vol. 13(2):37-44.
- 446 Muchtadi TR dan Sugiyono. 2013. *Prinsip Proses dan Teknologi Pangan*. Bandung (ID): Alfabeta.
- 447 Myers RH, Montgomery DC, Anderson-Cook CM. 2009. *Response Surface Methodology: Process*  
448 *and Product Optimization Using Designed Experiments (3rd ed.)*. New York (US): John  
449 Wiley & Sons Inc.
- 450 Oliveira, M.N., Sodini, I., Remeuf, R., Tissier, J.P. and Corrieu, G. (2002). *Manufacture of*  
451 *Fermented Lactic Beverages Containing Probiotic Cultures*. *Journal of Food Science*,  
452 67(6), 2336–2341. [https:// doi.org/10.1111/j.1365-2621.2002.tb09550.x](https://doi.org/10.1111/j.1365-2621.2002.tb09550.x)
- 453 Pelczar MJ dan Chan ECS. 2012. *Dasar-dasar Mikrobiologi 2*. Jakarta. UI Press
- 454 Pitt JI, Hocking AD. 2009. *Fungi and Food Spoilage 3<sup>rd</sup> Edition*. Springer.
- 455 Pratama AY, FebrianiRN dan Gunawan S. 2013. *Pengaruh Ragi Roti, Ragi Tempe dan*  
456 *Lactobacillus Plantarum terhadap Total Asam Laktat Dan pH Pada Fermentasi*  
457 *Singkong*. . E-journal ITS Vol 2.No 1.
- 458 Pusparani T dan Yuwono SS. 2014. *Pengaruh Fermentasi Alami Chips Ubi Jalar (Ipomoea*  
459 *batatas) terhadap Sifat Fisik Tepung Ubi Jalar*. Jurnal Pangan dan Agriindustri Vol. 2 No.  
460 4 p. (137 – 147).
- 461 Rahayu WP dan Nurwitri CC. 2012. *Mikrobiologi Pangan*. Bogor (ID): IPB Press.

462 Rahmawati R, Dewanti-Hariyadi R, Hariyadi P, Fardiaz D, Richana N. 2013. *Isolasi dan*  
463 *identifikasi mikroorganisme selama fermentasi spontan tepung jagung putih*. J. Teknol.  
464 Dan Industri Pangan. 24: 38-44.

465 Rahmawati R, Maulani RR, Saputra D. 2017. *Karakteristik ragi kapang khamir indigenus untuk*  
466 *pembuatan tepung jagung putih lokal fermentasi*. Prosiding Seminar Nasional PATPI  
467 2017. Bandar Lampung (ID): Universitas Lampung.

468 Rahmawati R, Hunaefi D, Basriman I, Saputra D, Aozora WD dan Jenie BSL. 2019. *The*  
469 *characteristics of "indigenous yeast mold" dried culture using tray dryer*. IOP Conf.  
470 Series: Earth and Environmental Science 383 (2019) 012036.

471 Rahmawati, R., Hunaefi, D., Basriman, I., Saputra, D., Apriliani, A.A. and Jenie, B.S.L.  
472 Optimization of temperature and drying time of indigenous cocktail yeast mold culture  
473 using response surface methodology (RSM). Food Research 4 (2) : 389 - 395 (April 2020).

474 Sari DA, Hakiim A, Sukanta. 2017. *Pengeringan terasi lokal Karawang: sinar matahari- tray*  
475 *dryer*. Jurnal Sains dan Teknologi. 6(2): 311 – 320.

476 Sinurat E dan Murniyati. 2014. *Pengaruh Waktu Dan Suhu Pengeringan Terhadap Kualitas*  
477 *Permen Jeli*. Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan 9 (2) : 133-142

478 Susilo A, Rosyidi D, Jaya F, dan Apriliyani MW. 2019. *Dasar Tekonologi Hasil Ternak*. Hal: 30-  
479 31. UB Press

480 Zulus A. 2017. *Rancang bangun monitoring ph air menggunakan soil moisture sensor di SMK*  
481 *N 1 Tebing Tinggi Kabupaten Empat Lawang*. JUSIKOM. 2(1): 37-43.

482 Scorzoni L, de Lucas MP, Mesa-Arango AC, Fusco-Almeida AM, Lozano E, Cuenca-Estrella M,  
483 Mendes-Giannini MJ, Zaragoza O. 2013. Antifungal Efficacy during *Candida*  
484 *krusei* Infection in Non-Conventional Models Correlates with the Yeast *In*  
485 *Vitro* Susceptibility Profile. Plos One 8 (3) : 1-13 (e60047).  
486 <https://doi.org/10.1371/journal.pone.0060047>

487  
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500 **Tables and Figures**

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

Independent variables	Limits	
	Lower (-1)	Upper (+1)
Temperatures (°C)	40	50
Times (h)	0	10

Commented [RR13]: In English

504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543

Table 2. The viability, water content, a<sub>w</sub>, 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

**Commented [RR14]:** Table must self explanatory, the table's title still not meet that requirement



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

544  
545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569

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

Commented [RR15]: Same as above related to title of table

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

570  
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594

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

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

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

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

596  
597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630

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

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

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

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

632  
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668

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 <sub>w</sub> )	Water content (%)	pH
AC Prediction	40	10,0	3,929	0,433	8,60	3,91

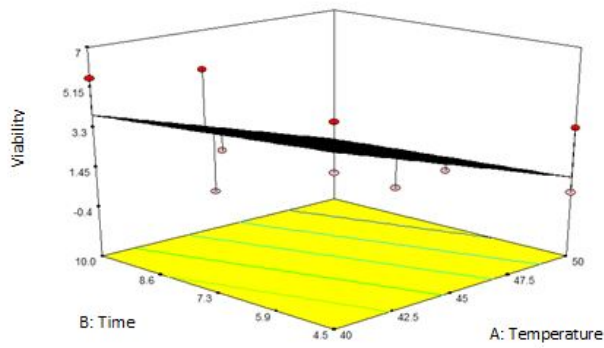
	Actual	40	10,0	7,944	0,425	8,90	4,05
CC	Prediction	49	4,5	4,958	0,499	6,48	4,13
	Actual	49	4,5	7,698	0,487	7,02	3,95

669  
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695

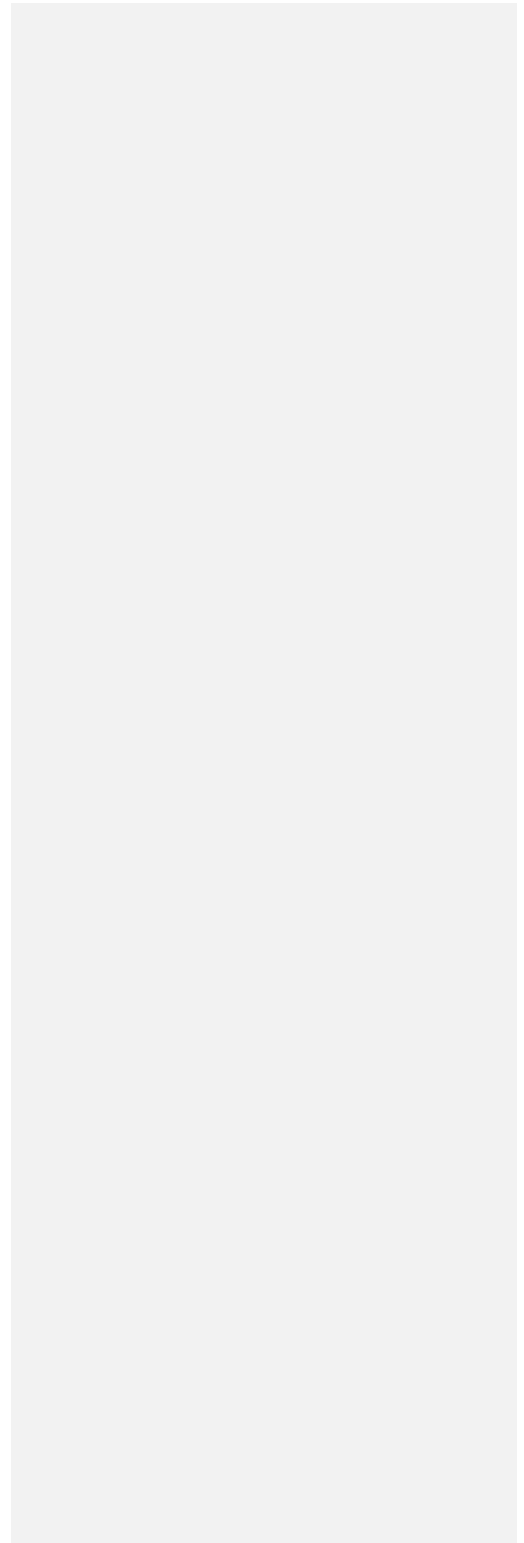
Viability



X1 = A: Temperature  
X2 = B : Time

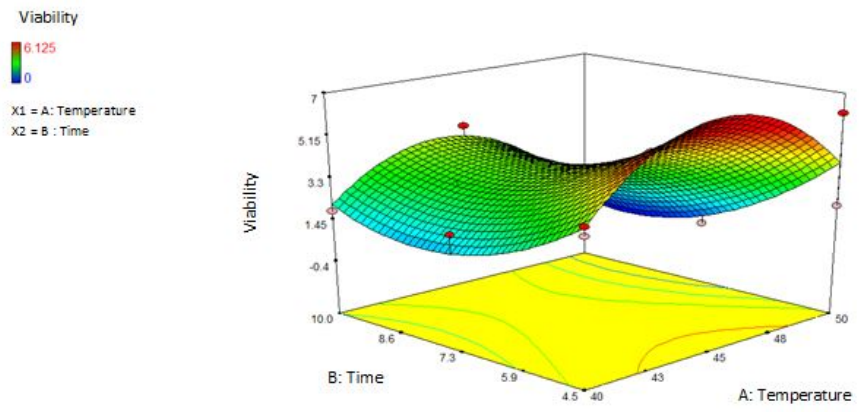


696  
697



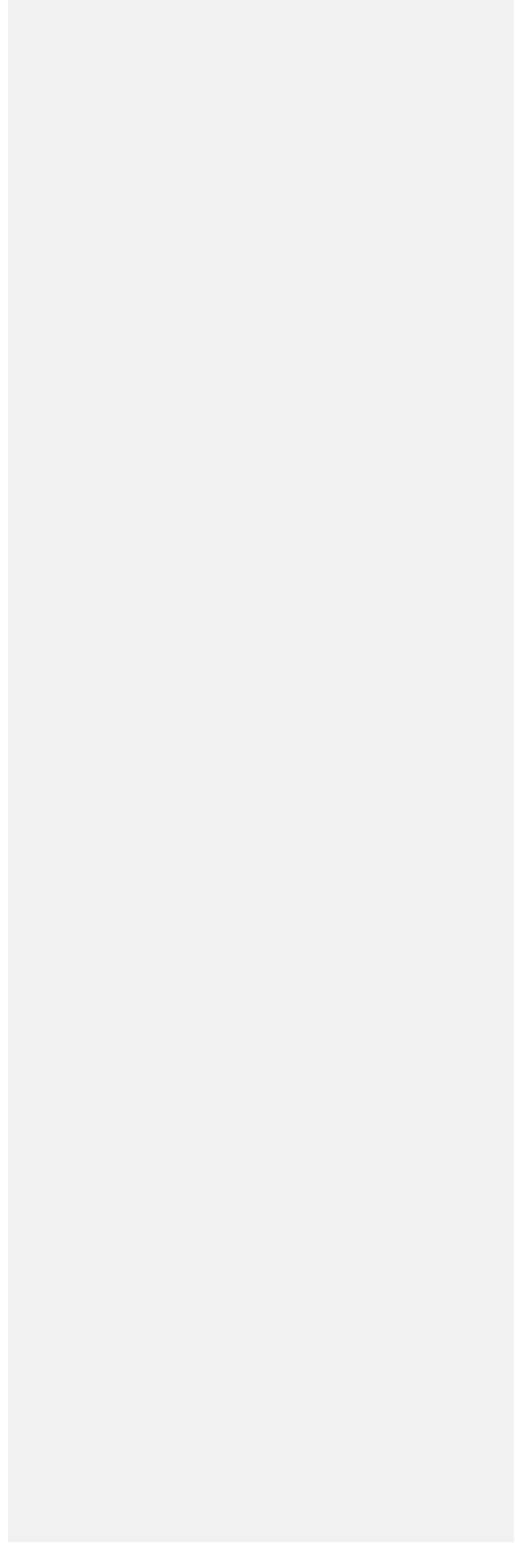
698 Figure 1. A 3D graphical combination between temperature and drying time to the viability  
699 response of AC starters

700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716

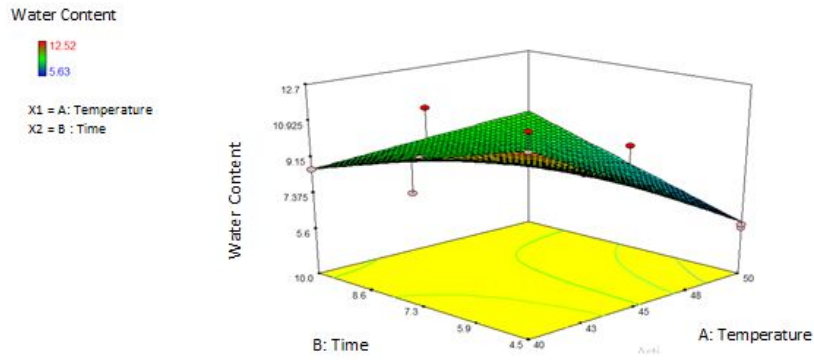


717  
718  
719  
720 Figure 2. A 3D graphical combination between temperature and drying time to the viability  
721 response of CC starters

722  
723  
724  
725  
726  
727  
728

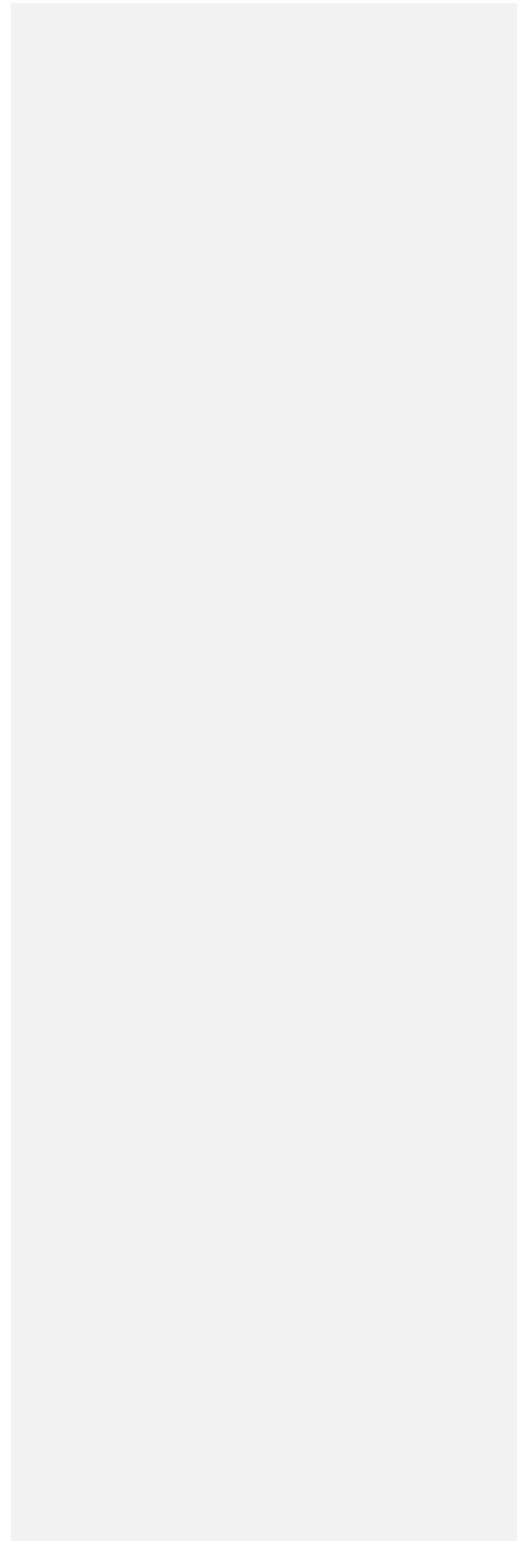


729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747



748  
749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761

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

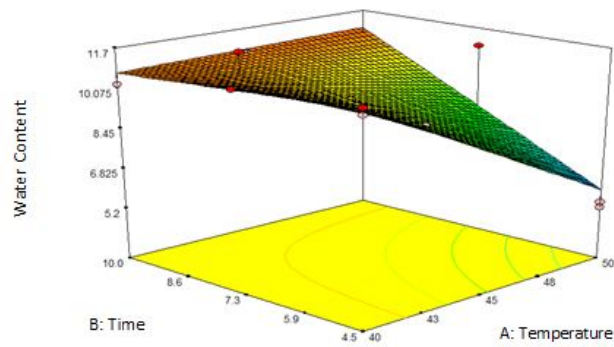


762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773

Water Content

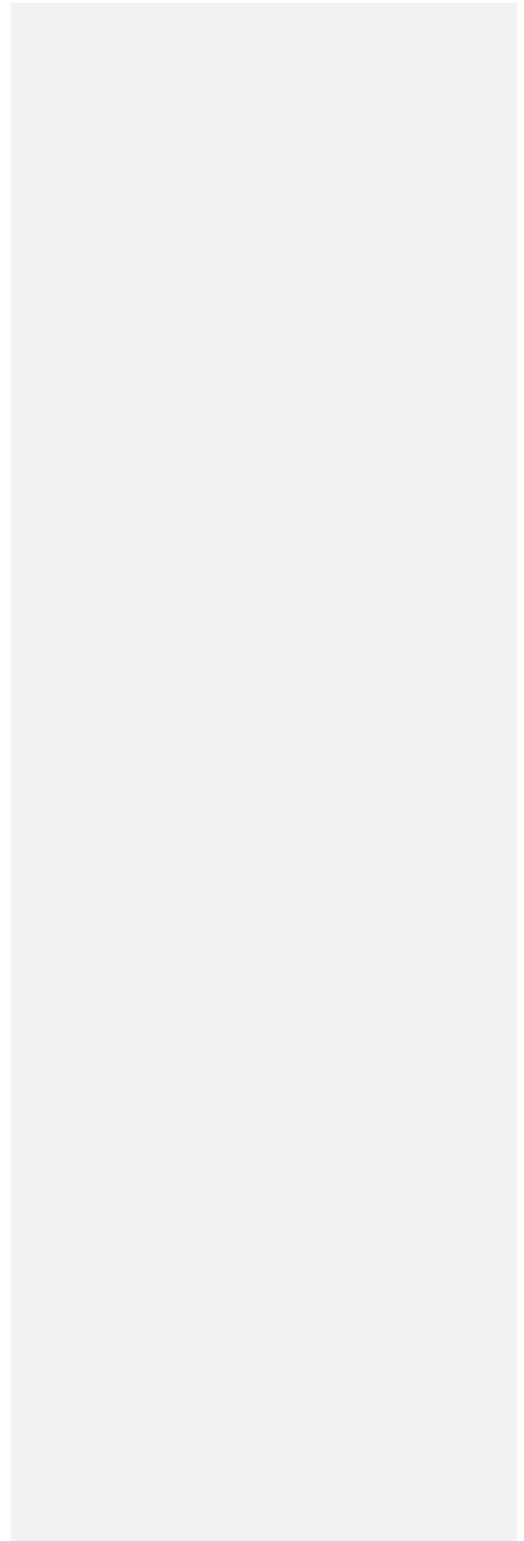


X1 = A: Temperature  
X2 = B: Time



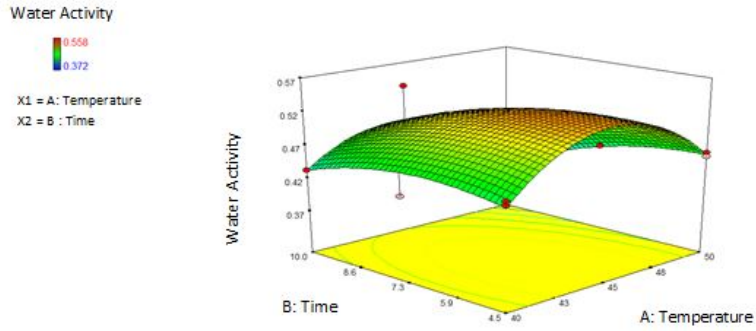
774  
775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793

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



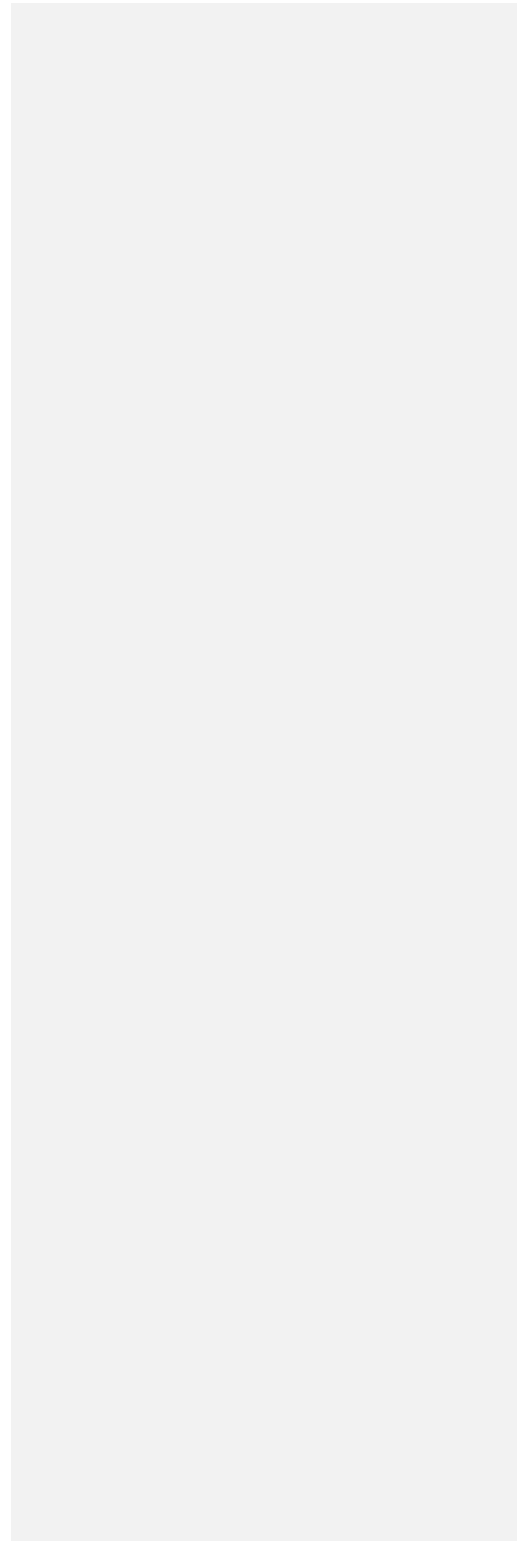


794  
795  
796



797  
798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821

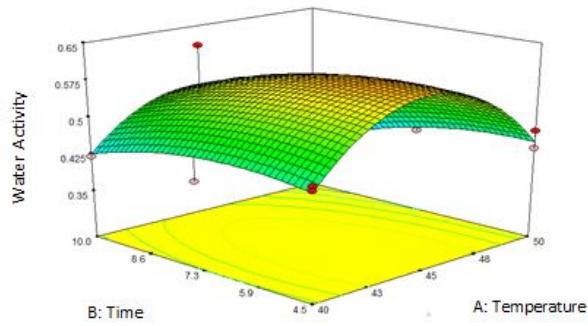
Figure 5. A 3D graphical combination between temperature and drying time to the water activity response of AC starters



Water Activity

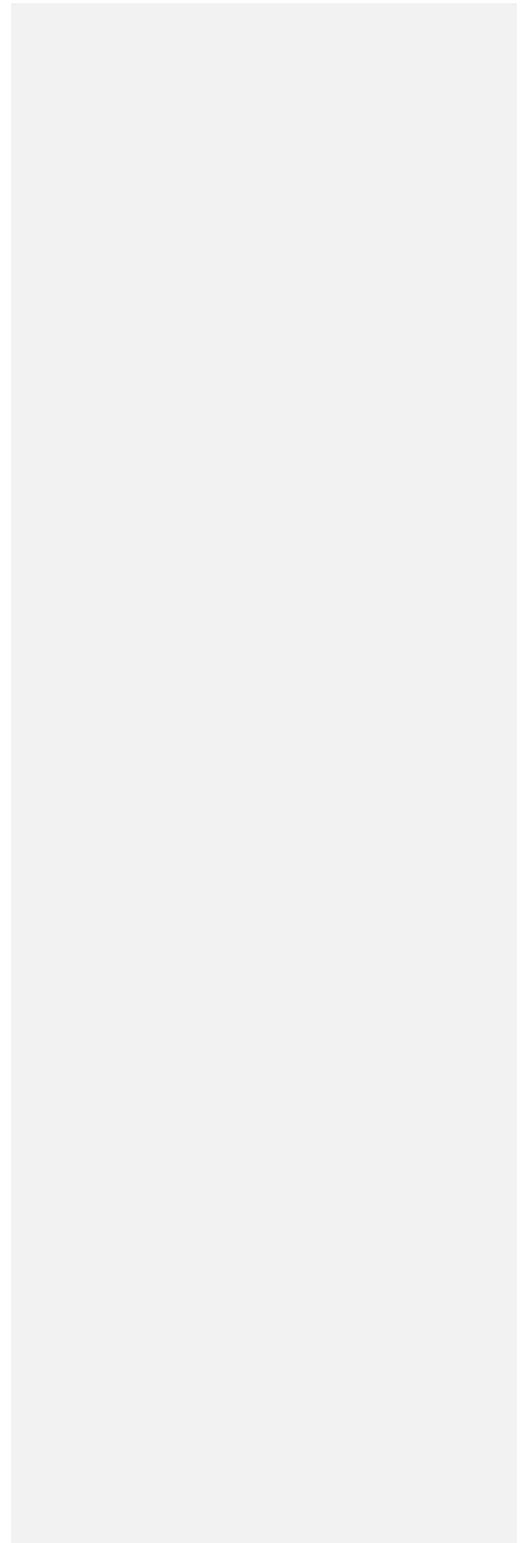


X1 = A: Temperature  
X2 = B: Time



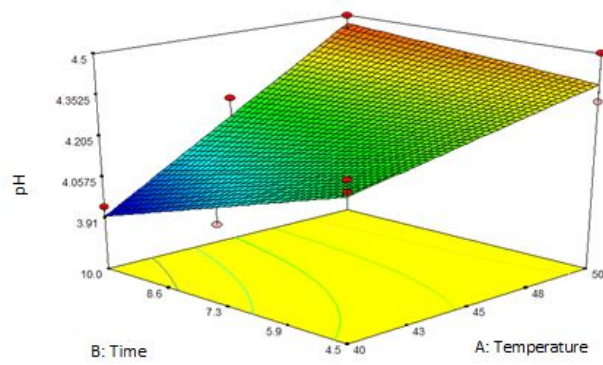
822  
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842

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



pH  
4.5  
3.95

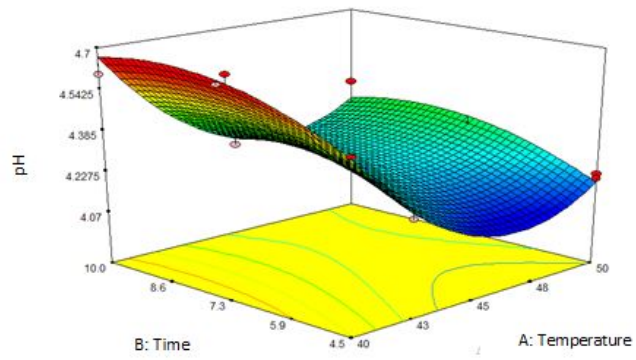
X1 = A: Temperature  
X2 = B: Time



843  
844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861

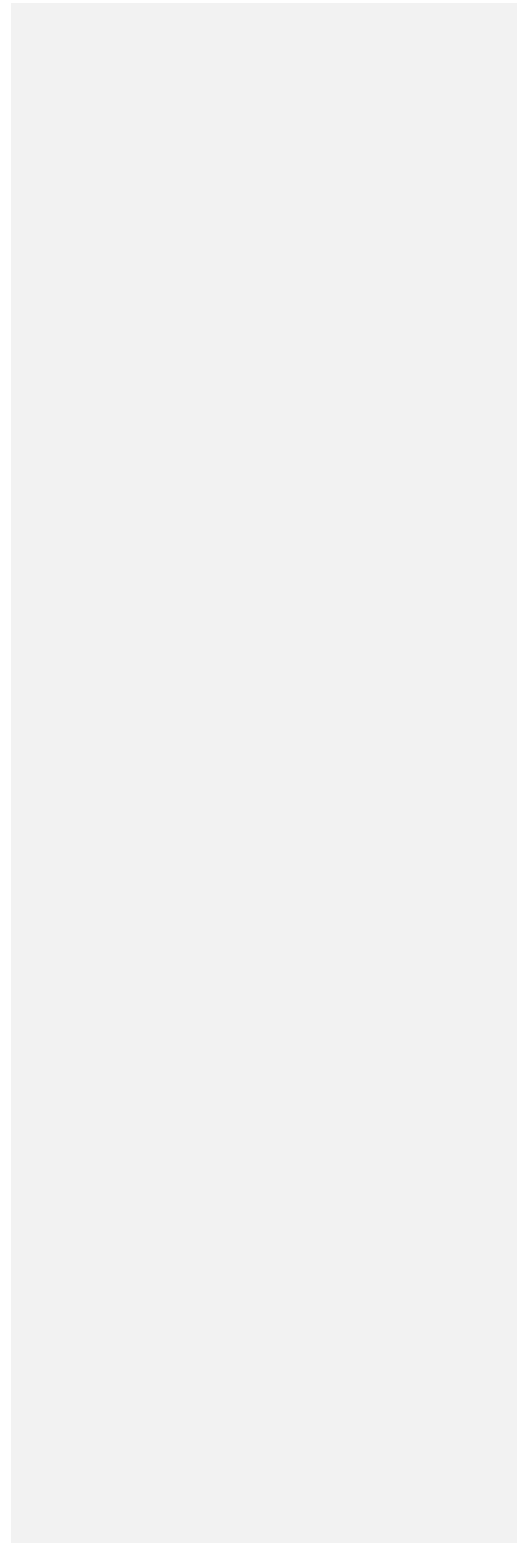
Figure 7. A 3D graphical combination between temperature and drying time to the pH response of AC starters

pH  
4.65  
4.1  
X1 = A: Temperature  
X2 = B: Time



862  
863  
864  
865  
866  
867

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



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

4 **Abstract**

5 This research aimed to optimize the tray dryer temperature and time of white corn flour culture by  
6 RSM. There were two culture using in this research, namely AC and CC. The independent  
7 variables in this study were drying temperature and time, where the quality indicators used were  
8 total viability of mold and yeast, water content, water activity, and pH. This research used a factor  
9 response surface methodology. Data were analyzed by ANOVA with  $\alpha$  level of 95%. The result  
10 of this research showed that the optimum drying process for AC starter was 40°C for 10 hours,  
11 with characteristic response viability 7.944 log CFU/g or  $8.79 \times 10^7$  CFU/g, water activity 0.425,  
12 water content 8.90%, and pH 4.05. CC starter showed an optimum drying process at 49°C for 4.5  
13 hours, with characteristic response viability 7.698 log CFU/g or  $4.9 \times 10^7$  CFU/g, water activity  
14 0.487, water content 7.02%, and pH 3.95.

15  
16 **Keywords:** AC culture, CC culture, RSM, tray dryer, white corn flour

17  
18 **1. Introduction**

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

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

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

40 Rahmawati et al (2019) have carried out the drying method for white corn starter using a tray dryer,  
41 where drying was conducted at 40 and 50°C for 1.5-6 hours. This method has a more controlled  
42 temperature than the sunshine method and with a shorter time than the oven method. The tray dryer  
43 method can reduce the drying area and increase the efficiency of hot air contact with the material  
44 (Sari et al., 2017). The dried starter produced by Rahmawati et al (2019) did not have optimal  
45 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?

Commented [A2]: Sun-drying?

Commented [A3]: What's the meaning ? drying time?

46 10%. Therefore, it is necessary to optimize the starter drying process which includes temperature  
47 and drying time using the tray dryer method.  
48 The optimization of the drying process for starters was carried out by using the D-optimal design  
49 of the Response Surface Methodology (RSM) method. RSM is a statistical and mathematical  
50 technique used primarily for the development, improvement and optimization of the production  
51 process (Carley et al., 2004).

52 Objective ?

Formatted: English (US)

## 54 2. Materials and methods

### 55 2.1 AC and CC Starter Preparation (Rahmawati et al. 2013 and Rahmawati et al. 2017)

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

61  
62 One loop of each mold was streaked onto fresh Potato Dextrose Agar (PDA) slant and  
63 incubated for five days at 30°C. After five days, molds were harvested by scrapping, then  
64 suspended in 10 mL sterile water and appropriately dissolved to count using haemocytometer.  
65 Yeast culture was prepared as above, but incubation was carried out for two days at 30°C.  
66 Yeast was also calculated using haemocytometer.

### 67 2.2 Optimization using RSM

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

74  
75 The parameters of the experiment were drying time (hours) and drying temperature (°C).  
76 Drying time between 0-10 hours and drying temperature between 40-50°C (Rahmawati et al.  
77 2017). The AC and CC starter qualities were determined based on total viability mold-yeast,  
78 moisture content (oven method), water activity (aw meter) and pH (pH meter).

79  
80 There were criteria for each variable and response when performing optimization. The  
81 observed response was viability with an importance level of 5 (+ + + + +), while the response  
82 to moisture, aw and pH had an importance level of 3 (+ + +). The importance value will  
83 determine the process conditions that were closest to the target response. The chosen optimal  
84 combination is the one having the highest desired value.

### 85 2.3 Making Starters and Drying with a Tray Dryer (Rahmawati et al., 2019)

86  
87 AC and CC starter culture made by sterilizing corn flour, then put it into a sterile basin and  
88 adding sterile distilled water as much as 2/3 of the total weight of corn flour. Prepared culture  
89 suspensions (AC) containing 10<sup>6</sup> CFU/mL per microorganism, then piped as much as 10% of  
90 the amount of water used. After that, all stir until homogeneous and put ± 17 grams in each  
91

92 petri dish. Petri dishes were then incubated at 30°C for 5 days. Furthermore, the dough is dried  
93 using an tray dryer with a range of 40-50°C for 0-10 hours. The dried AC and CC yeast mold  
94 culture was made powder using a blender that has been sprayed with 70% alcohol.  
95

#### 96 *2.4 Response Measurement*

97 Response measurements were carried out on the dried powder sample that was inserted into a  
98 plastic clip containing silica gel. The responses measured included total mold and yeast  
99 viability, aw, moisture content, and pH.  
100

#### 101 *2.5 Verification of Optimization Results*

102 The results were validated at the highest desirability point for AC and CC starters respectively.  
103 The AC and CC starting process was repeated directly using the optimal drying process. In  
104 addition, the test process included direct measurement of the overall yeast mold viability,  
105 moisture contents, water activity and pH to generate the actual response variable.  
106

#### 107 *2.6 Data Analysis*

108 The data analysis technique used in this study includes linear ( $y = ax + b$ ) models, quadratic ( $y$   
109  $= ax^2 + bx + c$ ) and 2FI models, using the Response Surface Methodology.  
110

### 111 **3. Results and discussion**

#### 112 *3.1 Viability Test*

113 Viability of total yeast mold starter could be seen at Table 2. Based on Table 2, we can see  
114 that a total value of yeast mold AC and CC starters ranged from  $10^7$ - $10^8$  CFU/g at drying  
115 temperatures < 50 °C. In the meantime, the viability value of the yeast mold AC and CC starters  
116 at drying temperatures 50°C and drying time of 7.3 to 10 hours was 0. According to Pitt and  
117 Hocking (2009), *Aspergillus Niger* may grow at a minimum temperature of 6 – 8°C, maximum  
118 temperature of 45–47°C, and an optimal growth of 35 to 37°C, while *Rhizopus oryzae* can  
119 grow at a temperature of 7 to 42 °C with an optimal growth temperature of approximately 37  
120 °C. *Candida krusei* can grow optimally at temperature of 37°C (Scorzoni 2013). The mold and  
121 yeast in the beginning were suspected to die at 50°C with a drying time of more than 7.3 hours.  
122

123 The heat resistance of microorganisms is different, which is represented by D value. The D  
124 value is defined as the time in minutes at a given temperature which is to reducing 90 percent  
125 or a logarithm of the number of spores or certain vegetative cells. Rahmawati et al. (2019 )  
126 reported that D value of AC and CC at temperatures of 40 °C was 271.86 minutes (4.5 hours)  
127 and 523.10 minutes (8.7 hours) respectively, while at 50 °C was 147.06 minutes (2.45 hours)  
128 and 127.93 minutes (2.13 hours) respectively.  
129

#### 130 *3.2 Moisture Content*

131 Water content and water activity (aw) are closely linked with starters' shelf-life. These two  
132 parameters are indicators of the availability of water in food for the survival of  
133 microorganisms. In addition to affecting chemical changes, the water content in food also  
134 determines the microbial content of foods (Herawati 2008). Products that have higher water  
135 content will relatively have shorter shelf life (Amanto et al. 2015). Table 2 showed the water  
136 content for AC and CC starters.  
137

138 The initial moisture content of the AC starter was 56.00 % and CC starter was 57.30 %. In this  
139 study, the desired water content was < 10 percent. With this water content value, it was hoped  
140 that the microorganisms will remain alive but did not carry out metabolic activity. Dried starter  
141 that drying at 50°C tended to have a lower moisture content than a lower temperature (40°C).  
142 According to Rahmawati et al. (2019), it caused the drying rate at 50°C was faster than at 40  
143 °C. As we know that a higher drying rate resulted in a faster drying time.

144  
145 Drying time can also reduce the material's moisture content. At a temperature of 40°C with  
146 different drying times, the moisture content of AC starters decreased from 56.00 per cent to  
147 11.67 per cent after 4.5 hours of drying and continued to dry to 8.59 per cent after 10 hours of  
148 drying. Likewise, with CC starters, the moisture content of CC starters decreased from 57.30  
149 per cent to 11.01 per cent after 4.5 hours of drying and continued to dry to 10.26 per cent after  
150 10 hours of drying at 40°C. In line with Fitriani (2008) statement, that drying temperature and  
151 time higher will evaporate water molecules more than lower temperature and time. Beside that,  
152 this condition will make the products ability to release water from its surface is greater and it  
153 will caused water content lower.

### 154 3.3 *Water Activities value*

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

162  
163 Overall, mold can live at a minimum water activity value. *Aspergillus* lives at a minimum  
164 water activity of 0.98, *Rhizopus* 0.93, and *Penicillium* 0.99, where yeast can usually live  
165 around 0.88-0.94 (Muchtadi and Sugiono 2013). A low aw value can make starters'  
166 microorganisms dormant.

167  
168 When starters are dried during long period of time, the water content will decrease, and the  
169 water activity starters will decrease as well. This is in line with the research undertaken by  
170 Leviana and Paramita (2017), which state that the higher the temperature, the more water in  
171 the material is evaporated to decrease the material's water content. Likewise, the water activity  
172 value, the higher the drying time the lower the water activity value in the material.

### 173 3.4 *pH value*

174  
175 The pH value is the degree of acidity used to express a substance, or object's acidity or  
176 alkalinity. The pH value is defined as a standard H<sup>+</sup> activity cologarithm. A normal pH value  
177 is 7, while a pH value>7 indicates the alkaline properties of the substance, while a pH value <  
178 7 indicates the acidic properties. A pH of 0 indicates the highest acidity and pH 14 indicates  
179 the highest alkalinity (Zulius, 2017). Table 3 showed the pH value for AC and CC starters.

180  
181 During the incubation process, the pH value of both AC and CC starters decreased, which  
182 becomes slightly sour (3.9-4.5) and was accompanied by a distinctive fermentation aroma.  
183



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

### 192 3.5 Mathematical Model Relationship between Process Parameters and Response

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

### 199 3.6 Effect of Drying Process on Starters Viability

200 Rahmawati et al. (2017) have dried the starter culture using an oven with a temperature below  
201 40°C resulted the wet starters (not yet dry). It showed that, the starter could be dried at the  
202 lowest 40°C temperature. However, the drying process using tray drier can not generate heat  
203 if the temperature is less than 40 °C were used. Based on this, the drying temperature used was  
204 up to 50 °C (Rahmawati et al. 2019). The results showed that drying at 50 °C for 6 hours still  
205 produced the number of microorganisms that met the minimum requirements for viability of  
206 starter microorganisms (10<sup>6</sup> CFU / g). These results were in line with Oliveira et al. (2002)  
207 where a good fermented drink produced by the number of bacteria was at least 5.3 × 10<sup>6</sup> CFU  
208 / mL.

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

212 Based on the graph in Figure 1, an increase in temperature and drying time with a tray dryer  
213 caused a decrease in yeast viability on the starters. At a temperature of 50 °C. with a drying  
214 time of about 7.3 hours, a value of 0 was produced. Its indicating the absence of mold-yeast  
215 during the analized. AC starters are mostly yeast. At this temperature and drying time, the yeast  
216 on AC starters was suspected to die. Vegetative yeast cells are killed with humid heat at 50-  
217 60°C in 10-15 minutes (Pelczar, 2012).

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

220 Microbes have different heat resistance as expressed by D. According to Rahmawati et al.  
221 (2019), the calculation results showed that the values of D starters AC and CC at 40°C were  
222 271.86 minutes (4.5 hours) and 523.10 minutes (8.7 hours) while at 50 °C were 147.06 minutes  
223 (2.45 hours) and 127.93 minutes (2.13 hours) respectively. AC starters were more heat-  
224 resistant. It caused AC starter contains fewer types of microbes, so, when making starter  
225  
226  
227  
228  
229

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

232  
233 The program selected model for appropriate viability response is a linear model with an R<sup>2</sup>  
234 value of 0.6237. AC mold-yeast viability response model has a 0.0123 p-value (Prob > F). This  
235 showed that the model can still describe the viability response (AC), as it has a p value < 0.05.  
236 The results of ANOVA also showed that temperature and drying time had a significant impact  
237 on viability response. This is evidenced by the insignificant fit shortage, > 0.05 (0.3702).  
238 Therefore, in this study, the viability modeling shows that the temperature factor (40-50°C)  
239 and drying time (0-10 hours) have a significant effect on the AC viability response.

Deleted: showd

240  
241 Figure 2 provided a surface overview of the CC dissolved viability response model. The model  
242 chosen by the program for the appropriate viability response was a quadratic model with an R<sup>2</sup>  
243 value of 0.7894. The CC mold-yeast viability response model has a p value (Prob> F) of  
244 0.0474. This showed that the viability response (AC) can still be described well by the model,  
245 because it has a p value <0.05. ANOVA results also showed that the temperature and drying  
246 time had a significant effect on the viability response. This is evidenced by the insignificant  
247 Lack of fit, which is > 0.05 (0.9033). Therefore, the viability modeling in this study showed  
248 that the temperature factor (40-50 °C) and drying time (0-10 hours) significantly influenced  
249 the CC viability response.

### 250 3.7 Drying Process on Starters Moisture Content

251 Apart from the drying process, the fermentation process in making starters also plays a role in  
252 reducing levels. Pusparani and Yuwono (2014) stated that during the fermentation process, the  
253 breakdown of starch by enzymes produced by microorganisms will produce simple sugars such  
254 as glucose and accompanied by the release of water. This is known as starch degradation.  
255 Starch degradation is characterized by a decrease in the ability of the material to retain water  
256 due to loss of hydroxyl groups. The graph of the relationship between the combination of  
257 temperature and drying time to the water content response of AC starters can be seen in Figure  
258 3.  
259

Deleted: degradation is

260  
261 The water content response value from AC starters ranged from 5.63 to 12.52%. Figure 3  
262 provided an overview of the AC starters moisture response model. The image's red color  
263 indicated high water content, while the blue color indicated low water content.

264  
265 The model chosen by the water content response program was the 2FI model with an R<sup>2</sup> value  
266 of 0.8382. The AC moisture response model has 0.0016 p-value (Prob > F). This shows that  
267 the model can still describe the viability response (AC), as it has a p value <0.05. However, the  
268 results of ANOVA did not show that the temperature and drying time had a significant effect  
269 on the water content response with a significant fit value shortage, < 0.05 (0.0404). The  
270 significant lack of fit value indicates that the temperature (40-50°C) and drying time parameters  
271 (4.5-10 hours) have no significant effect on the water content response in AC starters.

272  
273 Figure 4 showed the graph of the relationship between the combination of temperature and  
274 drying time to CC starter of water content response. The response value to the moisture content  
275 generated from CC starters ranged from 5.22-11.53%. The model chosen by the water content

278 response program was the 2FI model with 0.8209 R<sup>2</sup> value. The CC moisture response model  
279 has 0.0023 p value (Prob > F). This shows that the model can still describe the viability  
280 response (AC), as it has a p value<0.05. However, the results of ANOVA did not show that  
281 the temperature and drying time had a significant effect on the water content response with a  
282 significant fit value shortage, < 0.05 (0.0019). The significant lack of fit value indicates that  
283 temperature parameters (40-50°C) and drying time (4.5-10.0 hours) do not significantly affect  
284 the response of moisture content in CC starters.  
285

### 286 *3.8 Effect of Drying Process on Water Activity Value*

287 Apart from the drying process, the fermentation process in making starters also plays a role in  
288 reducing the levels. Pusparani and Yuwono (2014) state that during the fermentation process,  
289 the breakdown of starch by enzymes produced by microorganisms will produce simple sugars  
290 such as glucose and accompanied by the release of water. This is known as starch degradation.  
291 Starch degradation is characterized by a decrease in the ability of the material to retain water  
292 due to loss of hydroxyl groups. The graph of the relationship between the combination of  
293 temperature and drying time to the water content response of AC starters can be seen in Figure  
294 5.  
295

296 Water activity (aw) indicated the amount of free water in a product. Free water in food was  
297 needed by growing microorganisms for nutritional processes, a medium for enzymatic  
298 reactions, and cellular component synthesis (Rahayu and Nurwitri, 2012). The lower a  
299 product's aw value, the lower the risk of chemically or microbiologically damaging the food  
300 product. The smaller a product's aw value, the longer the product's shelf life since bacteria,  
301 molds, and yeasts require high aw to grow. Overall, the minimum water activity for bacterial  
302 growth is 0.75, mold is 0.60, while the minimum yeast growth is 0.80 (Susilo et al., 2019).  
303

304 Figure 5 showed the graph of the relationship between temperature and drying time to the  
305 response of aw starters of AC. The AC-generated response ranged from 0.372 to 0.558. The  
306 red color shows a high aw, while the blue color shows a low aw.  
307

308 The model selected for the appropriate aw response is the quadratic model. Figure 5 provided  
309 an overview of the aw response model. The image's red color indicated high aw value, while  
310 the blue color indicated low aw value. The aw (AC) response model has a value of 0.0440 p  
311 (Prob > F), indicating that the model was significant and can be described well at 5 % level (p  
312 value < 0.05). However, the ANOVA results showed a significant fit shortage, < 0.05 (0.0021).  
313 This meant that the temperature and drying time do not affect the AC response.  
314

315 Meanwhile, the CC-starter aw response ranged from 0.356 to 0.645. The CC-starters water  
316 activity parameter (aw) represented the mean mathematical model. This showed that CC  
317 starters' mold-yeast viability and moisture content due to treatment occurs randomly and  
318 cannot be explained by model. Figure 6 showed the graph of the relationship between  
319 temperature and drying time to the aw of CC response.  
320

### 321 *3.9 Effect of Drying Process on pH Value*

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

324 microorganism has a specific growth pH. Pratama et al. (2013) stated that the final results of  
325 the pH value for yeast bread, tempeh yeast, and *Lactobacillus plantarum* were 4.37; 3.43; and  
326 3.93 at 96 hours of fermentation respectively. For microorganisms, pH influenced the growth  
327 and survival. Each type of microorganism has an optimum growth pH and pH range. In general,  
328 mold and yeast can grow more widely than bacteria (Rahayu and Nurwitri, 2012). Mold has a  
329 very wide growth pH ranged from 2.0-8.5, while yeast has a growth pH range from 4.0-4.5 and  
330 will not grow well under alkaline conditions (Muchtadi and Sugiyono, 2013).

331  
332 The group of microorganisms capable of fermenting food nutrients will convert some or all of  
333 the food components into fermented products, e.g. lactic acid, ethanol, CO<sub>2</sub>, or other organic  
334 acids. Organic acid accumulation causes pH to decrease during incubation. According to  
335 Kartohardjono et al. (2007), CO<sub>2</sub> gas is often called acid gas because CO<sub>2</sub> gas has acidic  
336 properties. CO<sub>2</sub> gas contributes to the pH value. Figure 7 showed the relationship between the  
337 combination of temperature and drying time to the pH response of AC starters. The pH  
338 response from AC starters ranges from 3.95 to 4.50. The image's red color indicates high pH,  
339 while the blue color indicated low pH.

340  
341 The model chosen by the program is the 2FI model with an R<sup>2</sup> value of 0.8989. The AC pH  
342 response model has 0.0002 p value (Prob > F). This shows that the model can still describe the  
343 pH (AC) response as it has a p value < 0.05. ANOVA results also showed that the temperature  
344 and drying time had a significant pH response effect. This is evidenced by the insignificant fit  
345 lack, > 0.05 (0.6288). Temperature parameters (40-50°C) and drying time (4.5-10 hours) have  
346 a significant impact on pH response on AC starters.

347  
348 Figure 8 showed the relationship between the combination of temperature and drying time to  
349 the pH response of CC starters. The model selected by the program is the 2FI model with an  
350 R<sup>2</sup> value of 0.8479. The CC pH response model has a 0.0193 p-value (Prob > F). This showed  
351 that the model can still describe the pH (CC) response as it has a p value < 0.05. ANOVA results  
352 also showed that the temperature and drying time had a significant pH response effect. This is  
353 evidenced by the insignificant fit lack, > 0.05 (0.0769). Temperature parameters (40-50°C) and  
354 drying time (4.5-10.0 hours) influenced the pH response in AC starters significantly.

### 355 356 3.10 Process Optimization with RSM

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

366  
367 Based on the data in Table 6, the optimum formula for AC starters has a predictive response  
368 of 3.929 log CFU / g or 8.5 x 10<sup>3</sup> CFU / g, 8.60% water content, 0.433 water activity, and pH

369 3.91. While the optimum CC starter formula (Table 6) has a predictive response of 4.958 log  
370 CFU / g or  $9.0 \times 10^4$  cfu / g, 6.48% water content, aw 0.499, and pH 4.13.

371  
372 **3. 11 Results verification**

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

379  
380 Based on the verification, there is a significant difference in the value of starter viability  
381 between the formula solution suggested by RSM and the verification. According to Rahmawati  
382 et al. (2020), the optimization using RSM was unfit to describe the viability response model.  
383 This due to a AC-indigenous cocktail yeast mold culture consists of more than one  
384 microorganism. So, the activity of AC during the fermentation process varies, because the  
385 optimum conditions for growth during incubation for each microorganism vary and maybe  
386 there was competition for nutrients by microorganisms varies. On the other hand, the value of  
387 0 in the viability result affected the design of RSM 's optimum formula.

388  
389 **4. Conclusion**

390 Based on the research results, it can be concluded that the combination of temperature and  
391 drying time affects the characteristics of the white corn flour starters. The optimum drying  
392 process for AC starters is at a temperature of 40°C for 10.0 hours with viability characteristics  
393 of 7.944 log CFU / g or  $8.79 \times 10^7$  CFU / g, 8.90% moisture content, aw 0.425 and pH 4.05.  
394 The optimal drying process for CC starters is at a temperature of 49 °C for 4.5 hours with  
395 viability characteristics of 7.698 log CFU / g or  $4.9 \times 10^7$  cfu / g, water content of 7.02%, aw  
396 0.487 and pH 3.95.

397  
398 **Conflict of interest - Disclose any potential conflict of interest appropriately.**

399 The authors declare no conflict of interest.

400  
401 **Acknowledgments**

402 The Authors would like to acknowledge to the Indonesian Ministry of Research and Higher  
403 Education – Directorate of Research and Community Empowerment for the grant research No.  
404 28/AKM/PNT/2019.

405  
406  
407  
408  
409  
410  
411  
412  
413  
414

415 **References**

- 416 Aini N, Hariyadi P, Muchtadi TR, Andarwulan N. 2010. *Hubungan antara waktu fermentasi grits*  
417 *jagung dengan sifat gelatinisasi tepung jagung putih yang dipengaruhi ukuran partikel*. J  
418 Teknol dan Industri Pangan 21: 18-24
- 419 Amanto BS, Siswanti, Atmaja A. 2015. *Kinetika pengeringan temu giring (Curcuma heyneana*  
420 *valeton & van zipp) menggunakan cabinet dryer dengan perlakuan pendahuluan*  
421 *blanching*. Jurnal Teknologi Hasil Pertanian. 8(2): 107-114.
- 422 Barbosa-Canovas, G.V., Fontana, A.J.Jr., Schmidt, S.J. and Labuza, T.P. (2007). *Water Activity*  
423 *in Foods: Fundamentals and Applications*. Iowa, USA: IFT Press – Blackwell Publishing.  
424 [https:// doi.org/10.1002/9780470376454](https://doi.org/10.1002/9780470376454)
- 425 Anggraeni YP, Yuwono SS. 2014. *Pengaruh fermentasi alami pada chips ubi jalar (Ipomoea*  
426 *bataas) terhadap sifat fisik tepung ubi jalar terfermentasi*. Jurnal Pangan dan  
427 Agroindustri. 2(2): 59-69
- 428 Carley KM, Kamneva NY, Reminga J. 2004. *Response Surface Methodology*. Pittsburgh (US):  
429 Carnegie Mellon University.
- 430 Farasara R, Hariyadi P, Fardiaz D, dan Dewanti-Hariadi R 2014. *Pasting Properties of White Corn*  
431 *Flours of Anoman 1 and Pulut Harapan Varieties as Affected by Fementation Process*.  
432 *Food and Nutrition Sciences*, 2014, 5, 2038-2047
- 433 Fitriani, S. 2008. *Pengaruh Suhu dan Lama Pengeringan terhadap Beberapa Mutu Manisan*  
434 *Belimbing Wuluh (Averrhoa bilimbi L) Kering*. Jurnal Sagu. 7(1): 32-37.
- 435 Herawati H. 2008. *Penentuan umur simpan pada produk pangan*. Jurnal Litbang Pertanian, 27(4):  
436 124-130.
- 437 Kartohardjono S, Anggara, Subihi, dan Yuliusman. 2007. *Absorbansi CO<sub>2</sub> dari campurannya*  
438 *dengan CH<sub>4</sub> atau N<sub>2</sub> melalui kontaktor membrane serat berongga menggunakan*  
439 *pestarterst air*. Jurnal Teknologi. 11(2): 97-102.
- 440 Keshani, S., Luqman, C.A., Nourouzi, M.M., Russly, A.R. and Jamilah, B. (2010). *Optimization*  
441 *of concentration process on pomelo fruit juice using response surface methodology (RSM)*.  
442 *International Food Research Journal*, 17(3), 733-742.
- 443 Lay, B.W. 1994. *Analisis Mikrobiologi di Laboratorium*. Jakarta. Raja Grafindo Persada.
- 444 Leviana W dan Paramita V. 2017. *Pengaruh Suhu Terhadap Kadar Air Dan Aktivitas Air Dalam*  
445 *Bahan Pada Kunyit (Curcuma Longa) Dengan Alat Pengering Electrical Oven*. METANA.  
446 Vol. 13(2):37-44.
- 447 Muchtadi TR dan Sugiyono. 2013. *Prinsip Proses dan Teknologi Pangan*. Bandung (ID): Alfabeta.
- 448 Myers RH, Montgomery DC, Anderson-Cook CM. 2009. *Response Surface Methodology: Process*  
449 *and Product Optimization Using Designed Experiments (3rd ed.)*. New York (US): John  
450 Wiley & Sons Inc.
- 451 Oliveira, M.N., Sodini, I., Remeuf, R., Tissier, J.P. and Corrieu, G. (2002). *Manufacture of*  
452 *Fermented Lactic Beverages Containing Probiotic Cultures*. *Journal of Food Science*,  
453 67(6), 2336–2341. [https:// doi.org/10.1111/j.1365-2621.2002.tb09550.x](https://doi.org/10.1111/j.1365-2621.2002.tb09550.x)
- 454 Pelczar MJ dan Chan ECS. 2012. *Dasar-dasar Mikrobiologi 2*. Jakarta. UI Press
- 455 Pitt JI, Hocking AD. 2009. *Fungi and Food Spoilage 3<sup>rd</sup> Edition*. Springer.

- 456 Pratama AY, FebrianiRN dan Gunawan S. 2013. *Pengaruh Ragi Roti, Ragi Tempe dan*  
457 *Lactobacillus Plantarum terhadap Total Asam Laktat Dan pH Pada Fermentasi*  
458 *Singkong*. . E-journal ITS Vol 2.No 1.
- 459 Pusparani T dan Yuwono SS. 2014. *Pengaruh Fermentasi Alami Chips Ubi Jalar (Ipomoea*  
460 *batatas) terhadap Sifat Fisik Tepung Ubi Jalar*. Jurnal Pangan dan Agriindustri Vol. 2 No.  
461 4 p. (137 – 147).
- 462 Rahayu WP dan Nurwitri CC. 2012. *Mikrobiologi Pangan*. Bogor (ID): IPB Press.
- 463 Rahmawati R, Dewanti-Hariyadi R, Hariyadi P, Fardiaz D, Richana N. 2013. *Isolasi dan*  
464 *identifikasi mikroorganisme selama fermentasi spontan tepung jagung putih*. J. Teknol.  
465 Dan Industri Pangan. 24: 38-44.
- 466 Rahmawati R, Maulani RR, Saputra D. 2017. *Karakteristik ragi kapang khamir indigenus untuk*  
467 *pembuatan tepung jagung putih lokal fermentasi*. Prosiding Seminar Nasional PATPI  
468 2017. Bandar Lampung (ID): Universitas Lampung.
- 469 Rahmawati R, Hunaefi D, Basriman I, Saputra D, Aozora WD dan Jenie BSL. 2019. *The*  
470 *characteristics of "indigenous yeast mold" dried culture using tray dryer*. IOP Conf.  
471 Series: Earth and Environmental Science 383 (2019) 012036.
- 472 Rahmawati, R., Hunaefi, D., Basriman, I., Saputra, D., Apriliani, A.A. and Jenie, B.S.L.  
473 Optimization of temperature and drying time of indigenous cocktail yeast mold culture  
474 using response surface methodology (RSM). Food Research 4 (2) : 389 - 395 (April 2020).
- 475 Sari DA, Hakiim A, Sukanta. 2017. *Pengeringan terasi lokal Karawang: sinar matahari- tray*  
476 *dryer*. Jurnal Sains dan Teknologi. 6(2): 311 – 320.
- 477 Sinurat E dan Murniyati. 2014. *Pengaruh Waktu Dan Suhu Pengeringan Terhadap Kualitas*  
478 *Permen Jeli*. Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan 9 (2) : 133-142
- 479 Susilo A, Rosyidi D, Jaya F, dan Apriliyani MW. 2019. *Dasar Tekonologi Hasil Ternak*. Hal: 30-  
480 31. UB Press
- 481 Zulus A. 2017. *Rancang bangun monitoring ph air menggunakan soil moisture sensor di SMK*  
482 *N 1 Tebing Tinggi Kabupaten Empat Lawang*. JUSIKOM. 2(1): 37-43.
- 483 Scorzoni L, de Lucas MP, Mesa-Arango AC, Fusco-Almeida AM, Lozano E, Cuenca-Estrella M,  
484 Mendes-Giannini MJ, Zaragoza O. 2013. Antifungal Efficacy during *Candida*  
485 *krusei* Infection in Non-Conventional Models Correlates with the Yeast *In*  
486 *Vitro* Susceptibility Profile. Plos One 8 (3) : 1-13 (e60047).  
487 <https://doi.org/10.1371/journal.pone.0060047>

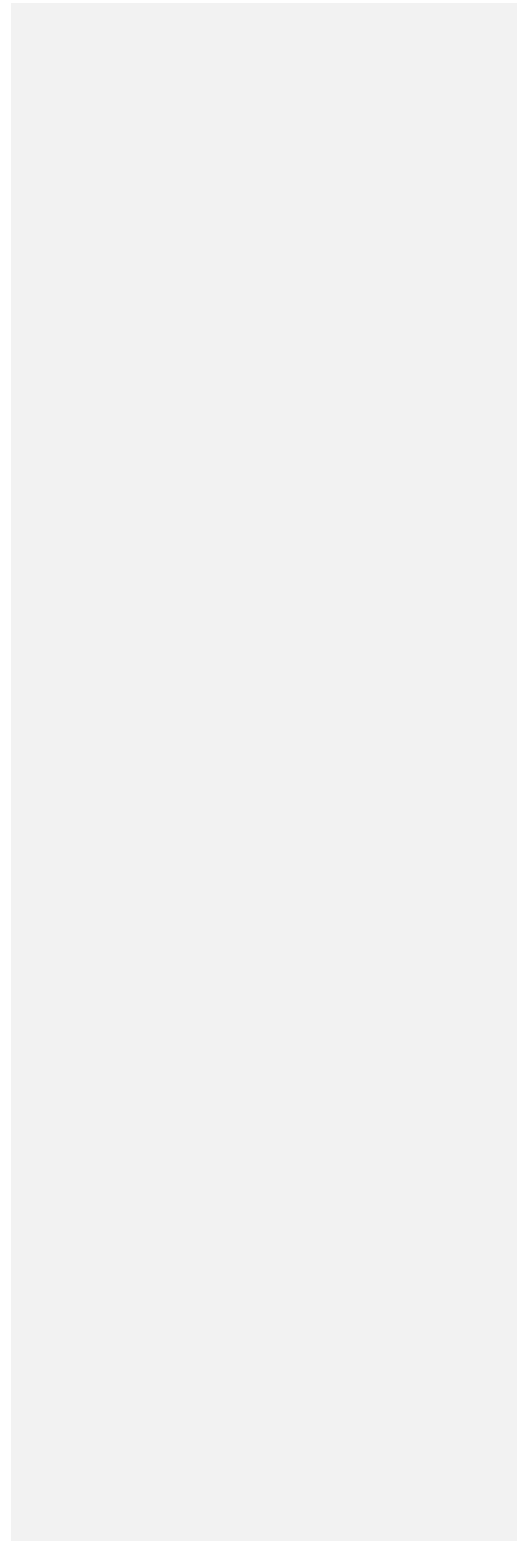
488  
489  
490  
491  
492  
493  
494  
495  
496  
497  
498  
499  
500  
501

**Tables and Figures**

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

Independent variables	Limits	
	Lower (-1)	Upper (+1)
Temperatures (°C)	40	50
Times (h)	0	10

503  
504  
505  
506  
507  
508  
509  
510  
511  
512  
513  
514  
515  
516  
517  
518  
519  
520  
521  
522  
523  
524  
525  
526  
527  
528  
529  
530  
531  
532  
533  
534  
535  
536  
537  
538  
539  
540  
541  
542  
543





544 Table 2. The viability, water content, a<sub>w</sub>, 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

545  
546  
547  
548  
549  
550  
551  
552  
553  
554  
555  
556  
557  
558  
559  
560  
561  
562  
563  
564  
565  
566  
567  
568  
569

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

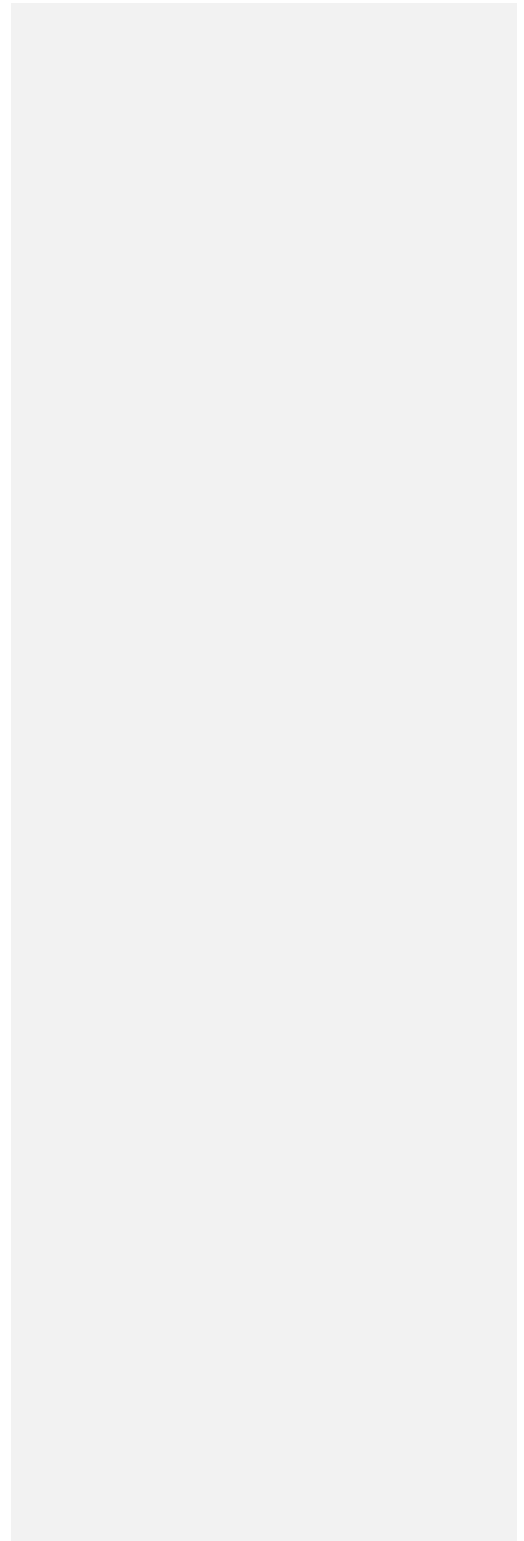
571  
572  
573  
574  
575  
576  
577  
578  
579  
580  
581  
582  
583  
584  
585  
586  
587  
588  
589  
590  
591  
592  
593  
594  
595

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

Parameter	Math model	Significance model ( <i>p</i> )	Lack of fit	<i>R</i> squared	Adj <i>R</i> <sup>2</sup> model	Pred <i>R</i> <sup>2</sup> 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 <sub>w</sub> )	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

597  
598  
599  
600  
601  
602  
603  
604  
605  
606  
607  
608  
609  
610  
611  
612  
613  
614  
615  
616  
617  
618  
619  
620  
621  
622  
623  
624  
625  
626  
627  
628  
629  
630  
631

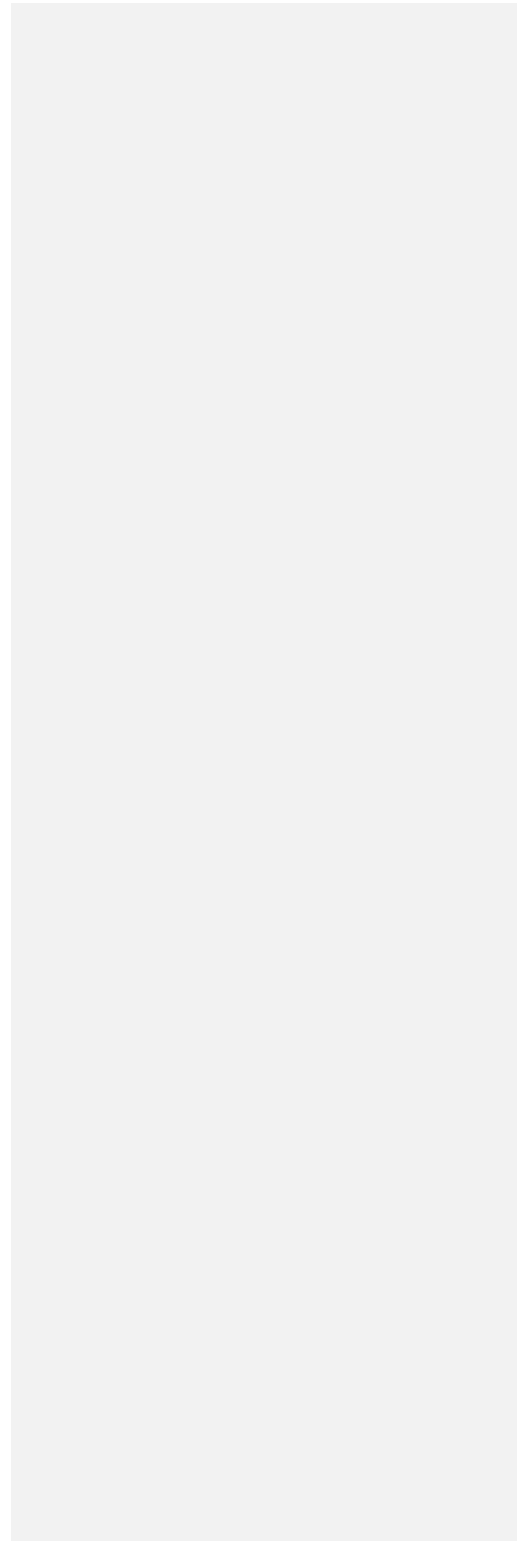


632 Table 5. The math model of drying proses parameter as a response of the CC starter

Parameter	Math model	Significance model ( <i>p</i> )	Lack of fit	<i>R squared</i>	<i>Adj R<sup>2</sup> model</i>	<i>Pred R<sup>2</sup> model</i>	<i>Adeq precision</i>
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 <sub>w</sub> )		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

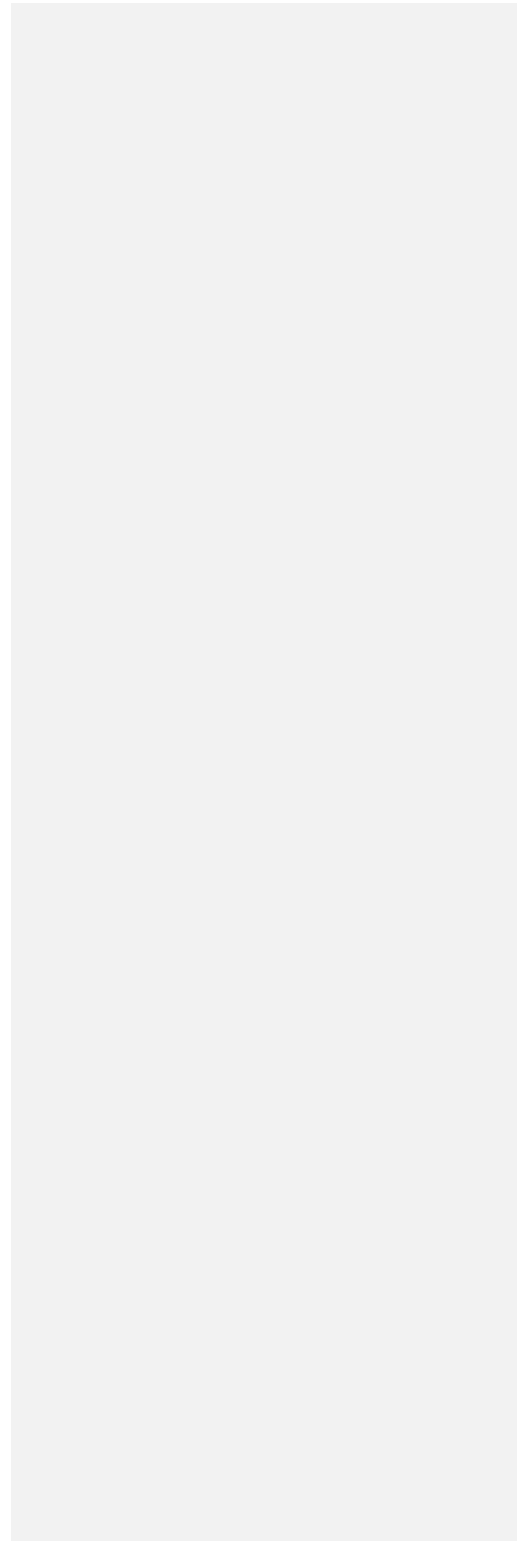
633  
634  
635  
636  
637  
638  
639  
640  
641  
642  
643  
644  
645  
646  
647  
648  
649  
650  
651  
652  
653  
654  
655  
656  
657  
658  
659  
660  
661  
662  
663  
664  
665  
666  
667  
668



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 <sub>w</sub> )	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

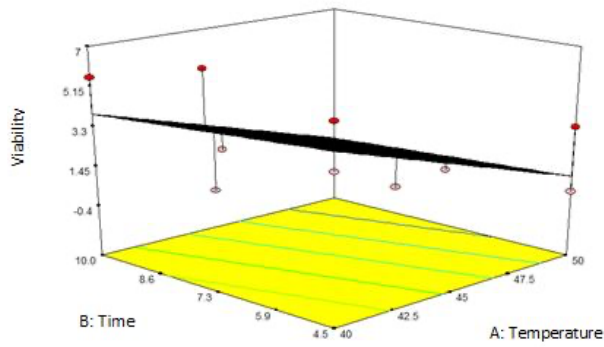
670  
671  
672  
673  
674  
675  
676  
677  
678  
679  
680  
681  
682  
683  
684  
685  
686  
687  
688  
689  
690  
691  
692  
693  
694  
695  
696



Viability

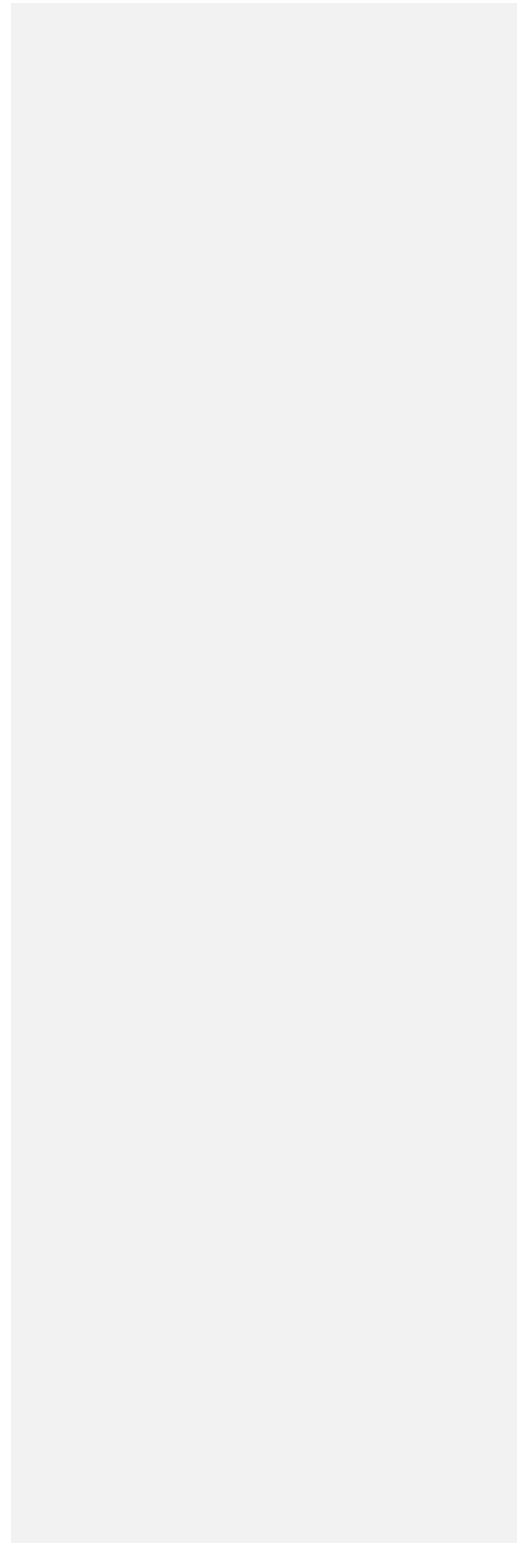


X1 = A: Temperature  
X2 = B : Time



697  
698  
699  
700  
701  
702  
703  
704  
705  
706  
707  
708  
709  
710  
711  
712  
713  
714  
715  
716  
717

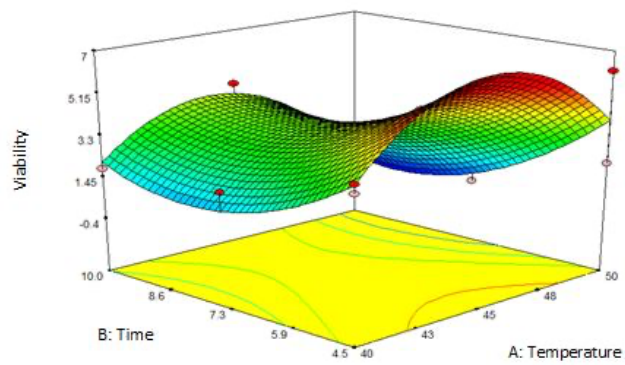
Figure 1. A 3D graphical combination between temperature and drying time to the viability response of AC starters



Viability

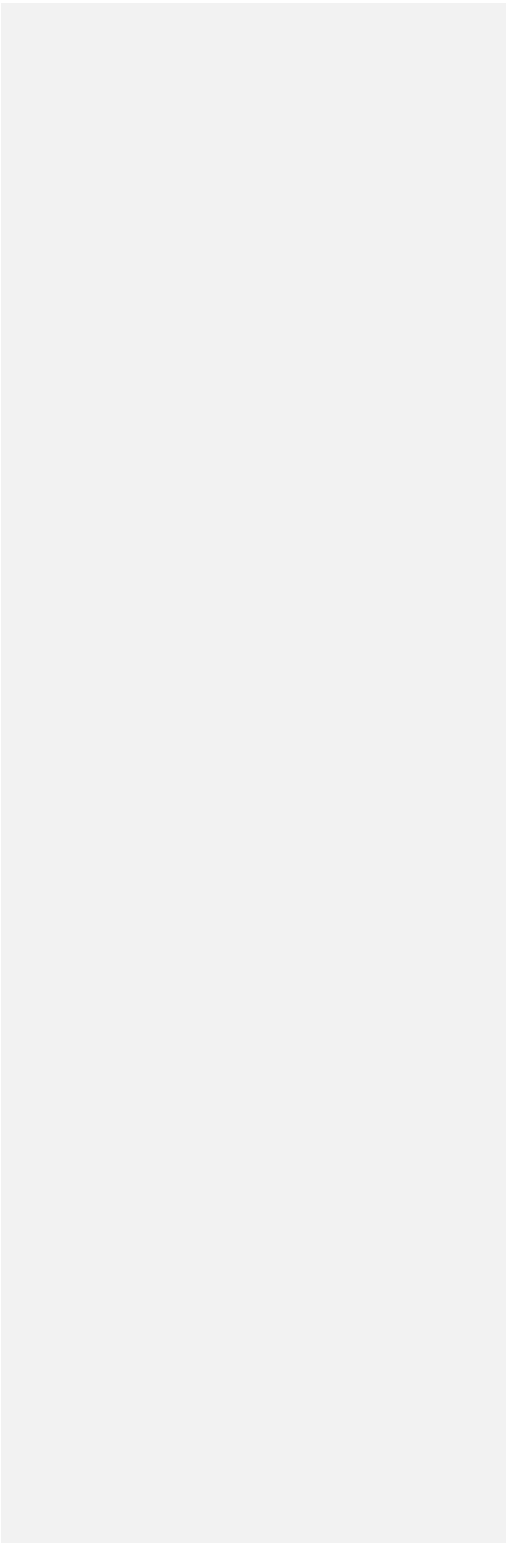


X1 = A: Temperature  
X2 = B : Time



718  
719  
720  
721  
722  
723  
724  
725  
726  
727  
728  
729  
730  
731  
732  
733  
734  
735  
736  
737  
738  
739  
740  
741  
742  
743  
744  
745  
746  
747  
748

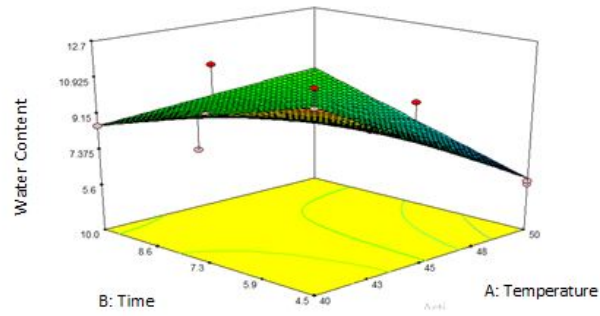
Figure 2. A 3D graphical combination between temperature and drying time to the viability response of CC starters



Water Content

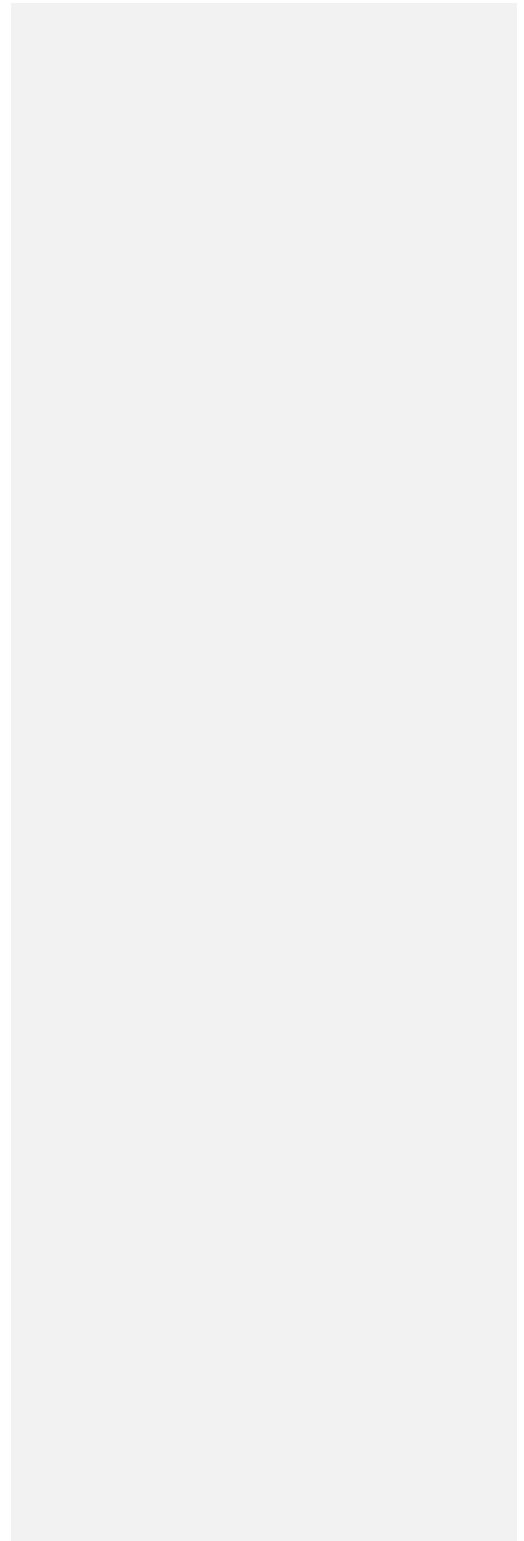


X1 = A: Temperature  
X2 = B : Time



749  
750  
751  
752  
753  
754  
755  
756  
757  
758  
759  
760  
761  
762  
763  
764  
765  
766  
767  
768  
769  
770  
771  
772  
773  
774

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

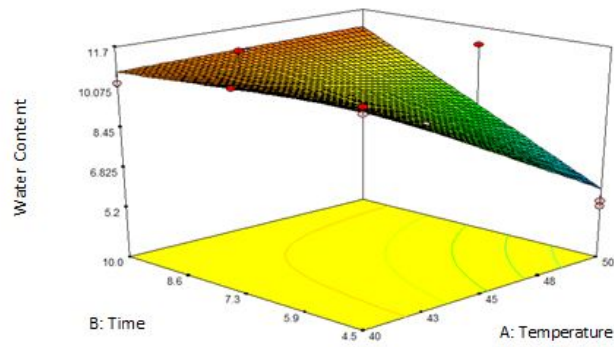




Water Content

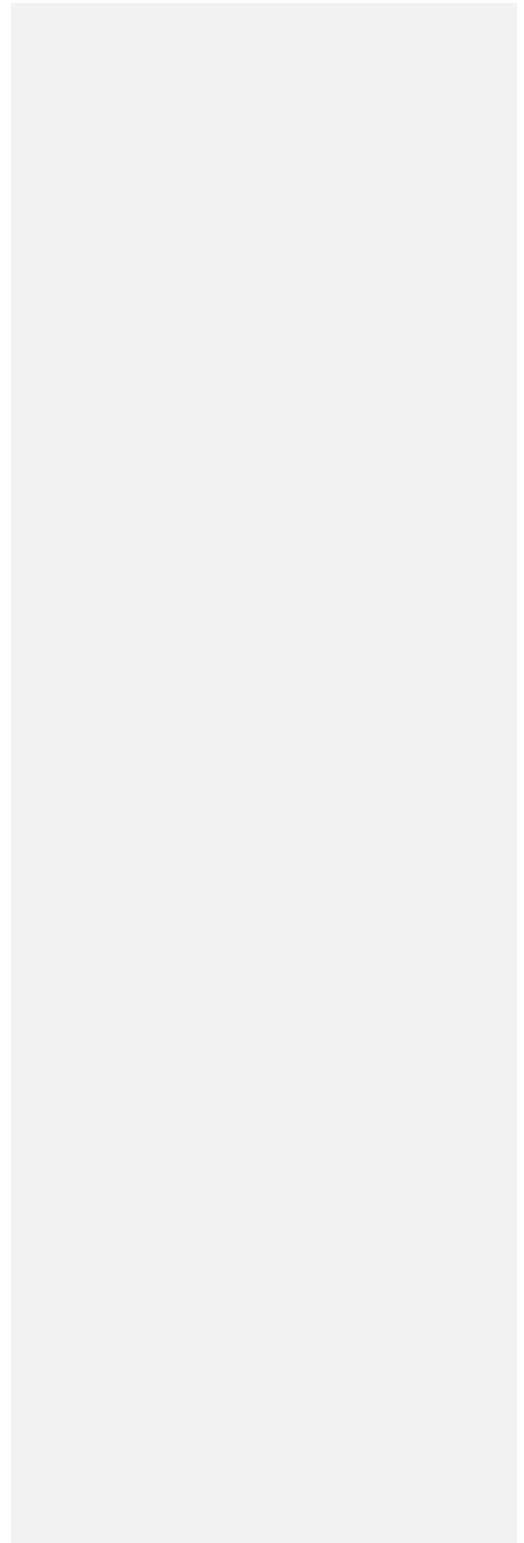


X1 = A: Temperature  
X2 = B: Time



775  
776  
777  
778  
779  
780  
781  
782  
783  
784  
785  
786  
787  
788  
789  
790  
791  
792  
793  
794  
795  
796  
797

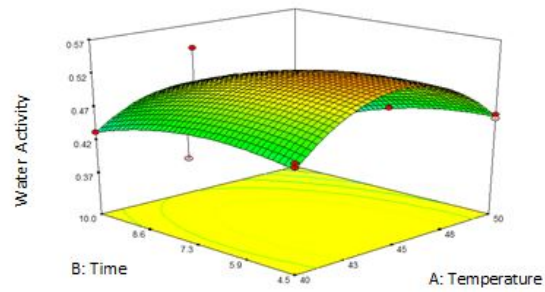
Figure 4. A 3D graphical combination between temperature and drying time to the water content response of CC starters



Water Activity

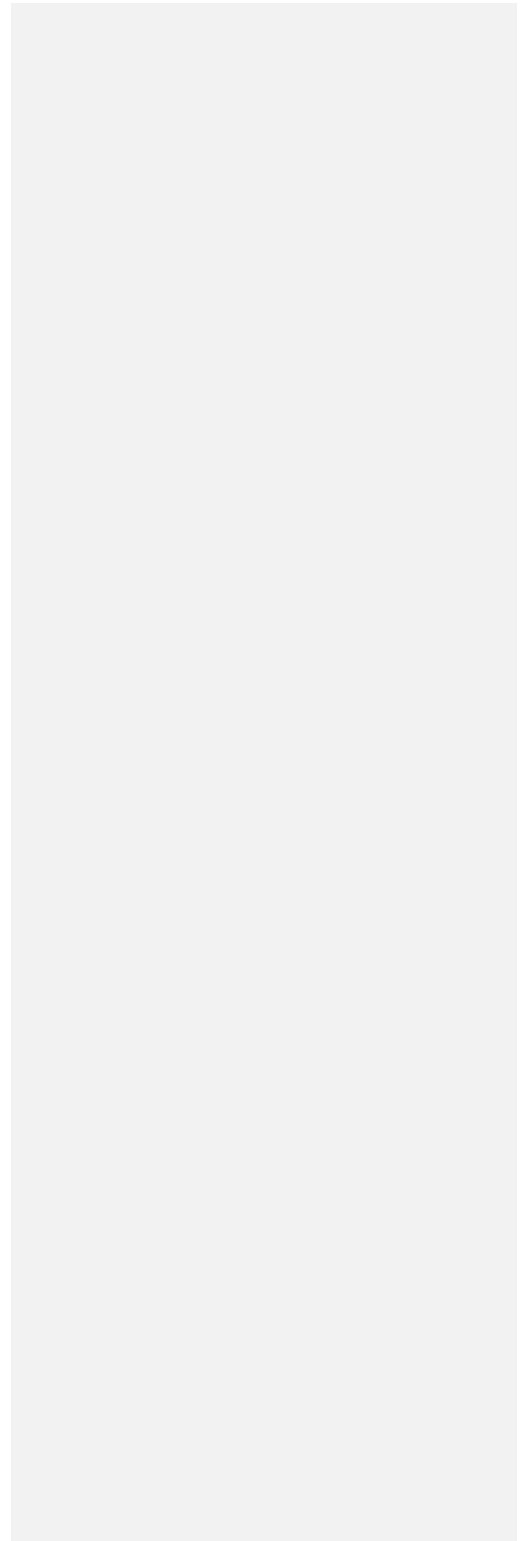


X1 = A: Temperature  
X2 = B : Time



798  
799  
800  
801  
802  
803  
804  
805  
806  
807  
808  
809  
810  
811  
812  
813  
814  
815  
816  
817  
818  
819  
820  
821  
822

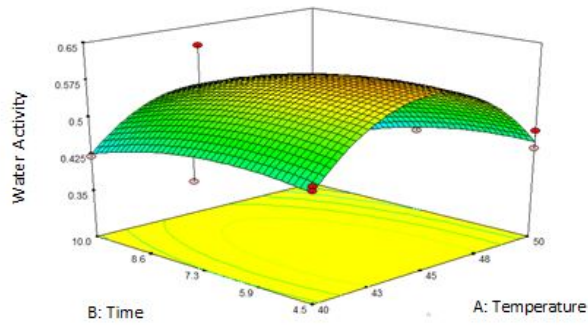
Figure 5. A 3D graphical combination between temperature and drying time to the water activity response of AC starters



Water Activity

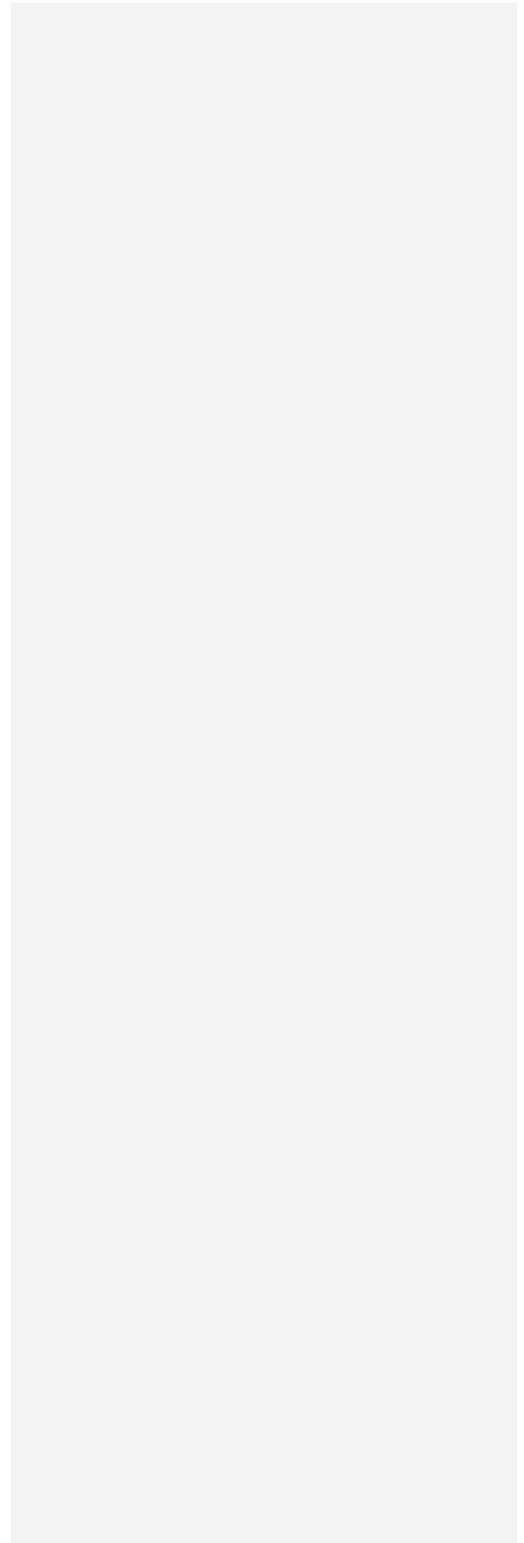


X1 = A: Temperature  
X2 = B: Time



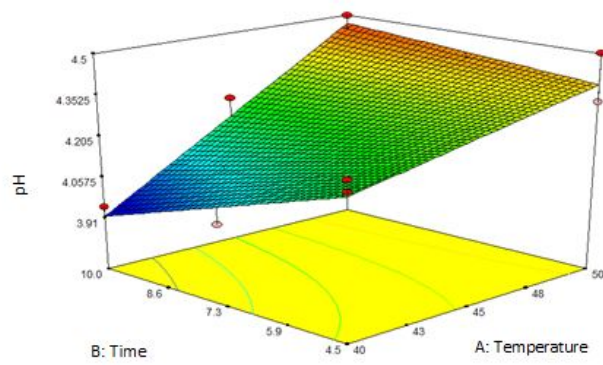
823  
824  
825  
826  
827  
828  
829  
830  
831  
832  
833  
834  
835  
836  
837  
838  
839  
840  
841  
842  
843

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



pH  
4.5  
3.95

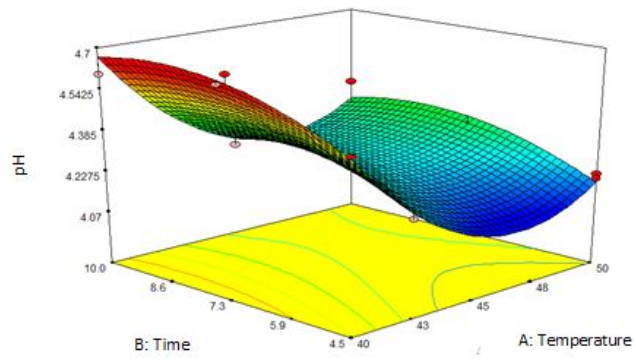
X1 = A: Temperature  
X2 = B: Time



844  
845  
846  
847  
848  
849  
850  
851  
852  
853  
854  
855  
856  
857  
858  
859  
860  
861  
862

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

pH  
4.65  
4.1  
X1 = A: Temperature  
X2 = B: Time



863  
864  
865  
866  
867  
868

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