LAPORAN KEMAJUAN 100% 
PENELITIAN TERAPAN UNGGULAN PERGURUAN TINGGI

KAJIAN APLIKASI PENGEMBANGAN MODEL PRODUKSI INDUSTRI HIJAU BAGI MASYARAKAT DI INDONESIA
(Tahun ke 3)

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Prof.Dr. Ir. H.Eddy Yusup SP, Msi,M.Kom
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Sesuai dengan kontrak Penelitian Tahun Anggaran 2019

UNIVERSITAS PASUNDAN
NOVEMBER 2019
HALAMAN PENGESAHAN

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Biaya Tahun Berjalan : Rp 137,775,000
Biaya Keseluruhan : Rp 137,775,000

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13 - 11 - 2019

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Assalamualaikum, Wr. Wb.

Syukur Alhamdullah penulis panjatkan kehadirat Allah SWT Yang Maha Pengasih dan Maha Penyayang, yang senantiasa melimpahkan segala Rahmat dan Karunia-Nya sehingga penulis dapat menyelesaikan LAPORAN KEMAJUAN PENELITIAN TERAPAN UNGGULAN PERGURUAN TINGGI dengan judul KAJIAN APLIKASI PENGEMBANGAN MODEL PRODUKSI INDUSTRI HIJAU BAGI MASYARAKAT DI INDONESIA untuk tahun ke tiga.

Akhir kata penulis mengucapkan terima kasih kepada semua pihak, semoga Laporan Kemajuan ini dapat menjadi gambaran serta arahan untuk penelitian lanjutan yang akan dilaksanakan pada tahun-tahun berikutnya

Wassalamualikum Wr.Wb

Penulis
DAFTAR ISI

DAFTAR ISI ........................................................................................................................ iii
1. IDENTITAS PENELITIAN ............................................................................................. 1
   1.1. JUDUL PENELITIAN ......................................................................................... 1
   1.2. BIDANG, TEMA, TOPIK, DAN RUMPUN BIDANG ILMU .............................. 1
   1.3. KATEGORI, SKEMA, SBK, TARGET TKT DAN LAMA PENELITIAN .......... 1
2. IDENTITAS PENGUSUL .............................................................................................. 1
3. MITRA KERJASAMA PENELITIAN .......................................................................... 2
4. LUARAN DAN TARGET CAPAIAN ........................................................................... 2
5. KEMAJUAN PENELITIAN .......................................................................................... 3
   RINGKASAN ............................................................................................................. 3
   HASIL PENELITIAN ................................................................................................. 4
   STATUS LUARAN .................................................................................................. 5
   PERAN MITRA ........................................................................................................ 5
   KENDALA PELAKSANAAN PENELITIAN ........................................................... 5
   RENCANA TAHAPAN SELANJUTNYA ................................................................. 5
   DAFTAR PUSTAKA ................................................................................................. 6
LAMPIRAN ........................................................................................................................ 8
1. Lampiran HKI (paten dalam tahap substantif) .......................................................... 8
2. Lampiran Artikel ilmiah (Internasional) .................................................................. 16
4. Lampiran Kegiatan Seminar Internasional (Status Paper, Abstract, Sertifikat ICFB 2019, Paper foto kegiatan) ................................................................. 43
4. Seminar Internasional Joint Seminar University Barcelona, Spanyol (Sertifikat, Manuscript dan Foto Kegiatan) ................................................................. 60
5. Lampiran Data Analisis dan Foto Produk yang di Analisis .................................. 75
LAPORAN KEMAJUAN PENELITIAN

1. IDENTITAS PENELITIAN

1.1. JUDUL PENELITIAN

KAJIAN APLIKASI PENGEMBANGAN MODEL PRODUKSI INDUSTRI HIJAU BAGI MASYARAKAT DI INDONESIA

1.2. BIDANG, TEMA, TOPIK, DAN RUMPUN BIDANG ILMU

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<th>Bidang Fokus RIRN/ Bidang Unggulan Perguruan Tinggi</th>
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<th>Topik (jika ada)</th>
<th>Rumpun Bidang Ilmu</th>
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<tr>
<td>Penelitian Terapan Unggulan Perguruan Tinggi</td>
<td>Produk Pangan Hijau Organik</td>
<td>Industri Pangan Hijau</td>
<td>Teknologi Pangan</td>
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1.3. KATEGORI, SKEMA, SBK, TARGET TKT DAN LAMA PENELITIAN

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<thead>
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<th>Kategori (Kompetitif Nasional/ Desentralisasi/ Penugasan)</th>
<th>Skema Penelitian</th>
<th>Strata (Dasar/ Terapan/ Pengembangan)</th>
<th>SBK (Dasar/ Terapan/ Pengembangan)</th>
<th>Target Akhir TKT</th>
<th>Lama Penelitian (Tahun)</th>
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2. IDENTITAS PENGUSUL

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<th>Nama, Peran</th>
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<tbody>
<tr>
<td>Dr. Ir. Hj. Hasnelly, M.Sc. 195712121986012002</td>
<td>Universitas Pasundan</td>
<td>Teknologi Pangan</td>
<td>Manajemen Operasi dan Teknologi Pangan</td>
<td>6000797</td>
<td>..........</td>
</tr>
</tbody>
</table>
| Prof. Dr. Ir. Eddy Yusuf  
1954041019932001 | Universitas Pasundan  
Marketing  
Pemasaran  
6004062 | .......... |
| Yelliantty S.S.I, M.S.I | Universitas pasundan  
Teknologi Pangan  
Biologi, Biokimia dan Rekayasa  
5975557 | .......... |

### 3. MITRA KERJASAMA PENELITIAN

<table>
<thead>
<tr>
<th>Mitra</th>
<th>Nama Mitra</th>
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</thead>
<tbody>
<tr>
<td>Naturales</td>
<td>Silvia Pirena Yudi</td>
</tr>
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### 4. LUARAN DAN TARGET CAPAIAN

#### Luaran Wajib

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<th>Status Target Capaian (accepted, published, terdaftar atau granted, atau status lainnya)</th>
<th>Keterangan (url dan nama jurnal, penerbit, url paten, keterangan sejenis lainnya)</th>
</tr>
</thead>
</table>
| 2019         | Paten Produk | Substantif                                                                            | Penerbit: Kementrian Hukum dan hak Asasi manusia RI  
Direktorat jenderal Kekayaan Intelektual |

#### Luaran Tambahan

<table>
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<th>Jenis Luaran</th>
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<tbody>
<tr>
<td>2019</td>
<td>Seminar Internasional (Abstract dan Proceeding)</td>
<td>Accepted</td>
<td>International Conference on food and Bio-Industry,</td>
</tr>
</tbody>
</table>
| 2019         | Seminar Internasional (Abstract dan Proceeding/Jurnal) | Accepted | Joint Seminar University  
Barcelona, Spanyol |
5. KEMAJUAN PENELITIAN

RINGKASAN

Revolusi industry 4.0 memberikan tantangan baru inovasi teknologi diperlukan dalam peningkatan produktivitas dan meminimumkan biaya proses. Terciptanya inovasi yang dapat membantu proses olahan produk pangan. Isu lingkungan pada industri pangan diharapkan dapat berperan memproduksi bahan alami dan produk ramah lingkungan. Kemasan bioplastik antimikroba merupakan produk ramah lingkungan kemasan berbahan tepung komposit dan rumput laut serta limbah pangan yang dapat terurai dalam beberapa bulan dibandingkan kemasan plastik dan memiliki ketahanan terhadap mikroba. Penerapan teknologi dan berbagai inovasi mampu meningkatkan efisiensi, efektivitas, produktivitas usaha pangan, dan kesejahteraan pelaku usaha khususnya serta masyarakat umumnya.

Produk sehat atau healthy kedepannya akan meningkat dengan konsumen yang cerdas. Banyak produk yang beredar saat ini menggunakan bahan pengawet dan bahan kimia lainnya untuk memperpanjang umur simpan produk. Alasan tersebut mendorong munculnya produk pangan hijau yang kembali ke alam dan minimalisir senyawa kimia serta berbahan baku lokal bebas gluten serta mengurangi import terigu.

Tujuan jangka panjang dari penelitian ini adalah membangun organisasi yang membahagiakan dan berkinerja optimal dan menjadi organisasi positif paripurna, industri hijau berkelanjutan sebagai produk masa depan dalam menghadapi era globalisasi memberikan kontribusi dalam dunia industri di Indonesia baik terhadap pencemaran lingkungan, lapisan ozon yang semakin menipis yang pada saatnya dapat meningkatkan perekonomian masyarakat setempat. Target khusus pertama adalah mengembangkan industri produk hijau berbahan baku lokal dari umbi dan ubi bebas gluten berkelanjutan yang aman dengan kemasan bioplastik antimikroba ramah lingkungan yang berasal dari kulit coklat, kulit nanas, dengan tambahan tapioka dan rumput laut, mengembangkan diversifikasi produksi industri hijau, mengembangkan penganekaragaman produk hijau, dan melakukan pengaplikasian serta uji pada industri produk hijau berkelanjutan sesuai standar yang diterapkan pemerintah.

Metode kegiatan yang akan dilakukan dalam penelitian ini meliputi studi pustaka, uji aktivitas produk hijau yang berstandar SNI, pembuatan percontohan produk hijau yang diaplikasikan dan diimplementasikan terhadap masyarakat secara umum. Luaran
yang akan dicapai dari hasil penelitian ini adalah paket inovasi produksi teknologi diversifikasi industri produk hijau non gluten berbahan baku local umbi dan ubi berkelanjutan, kemasan bioplastik antimikroba dari kulit coklat, kulit nanas dengan tambahan rumput laut dan tapioka, luran lain berupa peningkatan sumber daya, peningkatan pendapatan, peningkatan keahlian, peningkatan teknologi industri serta dapat mempersingkat mata rantai antara petani dan konsumen dengan adanya digital business, publikasi ilmiah dalam jurnal Nasional, jurnal internasional dan seminar, buku ajar dan memperoleh paten (HKI).

Hasil penelitian terdahulu dari hibah fundamental tentang pengembangan model industry pangan hijau, dilanjutkan dengan inovasi nilai produk dan formulasi dari hibah terapan, hibah terapan unggulan perguruan tinggi dengan topik kajian aplikasi pengembangan produksi pangan hijau yang menghasilkan produk dengan tingkat sesuai dengan standar SNI dalam skala laboratorium sehingga perlu berkelanjutan untuk diimplementasikan kepada masyarakat dengan peningkatan teknologi sampai dengan TKT 4, 5, dan 6.

Kebaharuan dari penelitian ini adalah paket inovasi produksi teknologi pembuatan diversifikasi produk hijau bebas gluten berkelanjutan berbahan dasar ubi dan umbi dengan pengemasan bioplastik antimikroba dari limbah kulit coklat, kulit nanas yang di tambahkan rumput laut atau tapioka bersifat ramah lingkungan, dan pengujian aktivitas industri produk hijau berkelanjutan dengan pendekatan ekonomi. Penelitian ini merupakan lanjutan setelah aplikasi pengembangan model produksi industri hijau.

HASIL PENELITIAN

ubi jalar dan penambahan tinta cumi-cumi sedang menunggu proses penelaahan mitra bebestari di jurnal teknologi dan industri pangan (paper terlampir 2). Produk yang dibuat sedang menunggu proses paten, saat ini masuk tahap pemeriksaan substantif, ada 8 produk non gluten berbasis tepung komposit (terlampir 3). Gambar-gambar produk dan analisis.

Lampiran : sertifikat dan bukti-bukti publikasi

**STATUS LUARAN**

Status luaran wajib yang ditargetkan untuk hak paten produk yang dibuat saat ini sedang menunggu proses paten dalam tahap pemeriksaan substantif, terdiri dari 8 produk non-gluten berbasis tepung komposit (terlampir 3). Sedangkan untuk luaran tambahan yang ditargetkan berupa Seminar Internasional (Abstract dan Proceeding) terdapat dua seminar, yaitu International Conference on food and Bio-Industry telah selesai dilaksanakan (terlampir 4) dan Joint Seminar University Barcelona, Spanyol masih berstatus terdaftar yang akan dilaksanakan bulan November 2019.

**PERAN MITRA**

Mitra (Naturales) berperan dalam menyediakan bahan baku pembuatan produk pangan organik, alat produksi, ruang produksi, juga bertanggung jawab dalam melakukan pelatihan proses pengolahan produk pangan organik tersebut yang kemudian di ikut-sertakan dalam pameran-pameran produk pangan organik

**KENDALA PELAKSANAAN PENELITIAN**

Kendala pelaksanaan penelitian ini ialah kurangnya pengembangan industri pangan hijau berbasis sehat dan halal, serta kurangnya pengetahuan masyarakat mengenai produk olahan pangan yang sehat dan halal karena ditinjau dari aspek ekonomi (harga jual produk) yang relatif lebih mahal dari produk yang tidak berbasis sehat dan halal. Sedangkan kendala dalam mencapai target luaran yaitu lamanya proses publikasi artikel serta pengajuan HKI. Hal tersebut dikarenakan adanya beberapa tahapan yang harus dilalui, mulai dari pengajuan, peninjauan, penelaah, substantif hingga accepted.

**RENCANA TAHAPAN SELANJUTNYA**

- Aplikasi model pengembangan produk hijau bebas gluten berbasis sehat dan halal
- Menguji industri produk hijau bebas gluten berbasis sehat dan halal berbahan baku local berkelanjutan
- Mengembangkan diversifikasi industri produk hijau bebas gluten berbasis sehat
dan halal berbahan baku local berkelanjutan secara komersial dan memberikan
nilai tambah terhadap kesehatan dan lingkungan.
- Sosialisasi dan promosi produk hijau bebas gluten berbasis sehat dan halal yang
dapat dikomersialisasikan/diimplementasikan sebagai produk ekspor unggulan
guna menunjang perekonomian daerah tersebut penghasil produk hijau berbasis
sehat dan halal berkelanjutan.
- Kemasan bioplastik dari limbah kulit coklat dan kulit nenas serta campuran
rumput laut atau tapioka sehingga ramah lingkungan
- Pilot project industri skala kecil

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Satisfaction and its Implications on Customer Loyalty of Green Food Product. J.
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Philippines Institute of Industrial Engineers. NO.2/VOL. 8. December. ISSN
1656-2798. p. 30-39
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production of organic food products in Indonesia. J. International Progress in
ISSN 2094-8239.
5. Surna T (2014), Green Ekonomi/ Ekonomi Hijau
LAMPIRAN

1. Lampiran HKI (paten dalam tahap substantif)
Formulir Permintaan
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Telepon : 0811215018
NPWP : 78.438.192-0-029.000

yang telah mengajukan permintaan
paten Sendiri/melalui Konsultan
Patent

(74) Nama Konsultan Patent
Nomor Konsultan Patent
Email
Telepon

dengan :
(65) Nomor pendaftaran paten: Phb201904264
(22) Tanggal pemberitahuan
permintaan paten: 21 Mei 2019
(54) Judul Inovasi: CRACKERS SAYURAN BEBAS GLUTEN
DENGAN CAMPURAN IKAN

mengajukan permintaan pemeriksaan substansif
untuk permintaan paten tersebut di atas.

Bersama ini, saya/kami simpan:
[ ] Biaya pemeriksaan substansif paten sebesar Rp. 3.000.000,00
( Tiga Juta Ribuan )
[ ] Biaya klaim yang belum dibayar ......... buah @ Rp.
Segajian Rp.
(...)
[ ] Keserumpakan-kekerapan lain yang rincian ringkasan tersebut
dalam lampiran formulir ini.

Yang mengajukan permintaan:

(20) [signature]

(Dr. Ir. Hj. Hasnelly, M.Si.)

Form No. 017/P/HAKI/1999
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DIREKTORAT JENDERAL KEKAYAAN INTELEKTUAL

Formulir Permintaan
Pemeriksaan Substantif Paten

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paten Sendiri/melalui Konsultan Paten

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Email :
Telepon :

(65) Nomor permintaan paten : P00201904265
(22) Tanggal penerimaan
permintaan paten : 21 Mei 2019
(54) Judul Invenasi : DENDENG ASAP IKAN LELE ORGANIK

mengajukan permintaan pemeriksaan substantif
untuk permintaan paten tersebut diatas.

Bersama ini, saya/kami sampaikan :

[ ] Biaya permeriksaan substantif paten sebesar Rp. 3.000.000,00
    ( Tiga Juta Rupiah )
[ ] Biaya klaim yang belum dibayarkan : 
    hub @ Rp
    Sejumlah Rp
    ( 
[ ] Kekurangan-kekurangan lain yang rincian ringkasnya tersebut
    dalam lampiran formulir ini.

Yang mengajukan permintaan

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(Dr. Ir. Hj. Hazrelly, M.Si.)

Form No. 017/P/HAKI/1999
Formulir Permintaan
Pemeriksaan Substantif Paten

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NPWP: 70.470.192-9-029.000

yang telah mengajukan permintaan pemeriksaan substansif paten dengan melalui Konsultan Paten

(74) Nama Konsultan Paten: 
Nomor Konsultan Paten: 
Email: 
Telepon: 

dengan:

(65) Nomor permintaan paten: P000201902840
(22) Tanggal penerimaan permintaan paten: 4 April 2019
(54) Judul Inovasi: DENDENG GILING IKAN LELE SUBSTITUSI RUMPUT LAUT

mengajukan permintaan pemeriksaan substansif untuk permintaan paten tersebut diatas.

Bersama ini, saya/kami sampaikan:

[ ] Biaya pemeriksaan substansif paten sebesar Rp. 3.000.000,00

(Tiga Juta Rupiah)

[ ] Biaya klaim yang belum dibayar sebanyak @ Rp. 

(Sejumlah Rp. 

( 

[ ] Kekurangan-kekurangan lain yang rincian ringkasnya tersebut dalam lampiran formulir ini.

Yang mengajukan permintaan

(Dr. Ir. H. Hasnelly, M.Si.)

Form No. 017/P/HAKI/1979
Formulir Permintaan
Pemeriksaan Substantif Paten

Dengan ini saya / kami (1),

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Alamat 2) : JL. Serangang No. 69

Warga Negara : Indonesia
Email : hannelly.sriyono@gmail.com
Telepon : 08112315018
NPWP : 79.479.192-9-429.000

yang telah mengajukan permintaan
paten Sendiri/melalui Konsultan

(74) Nama Konsultan Paten :
Nomor Konsultan Paten :
Email :
Telepon :

(65) Nomor permintaan paten : P00201902839
(22) Tanggal penerimaan permintaan paten : 4 April 2019
(54) Judul Inovasi : FLAKES ORGANIK BEBAS GLUTEN DARI
BERAS MERAH, BERAS COKLAT, SORGUM,
KACANG HIJAU, DAN KACANG MEPAH

mengajukan permintaan pemeriksaan substantif
untuk permintaan paten tersebut diatas.

Bersama ini, saya/kami sampaikan :

[ ] Biaya pemeriksaan substantif paten sebesar Rp. 3.000.000,-
( Tiga Juta Rupiah )

[ ] Biaya klaim yang belum dibayar ....... buah @ Rp. .....
Sejumlah Rp. ..........................................................
( .................................................................)

[ ] Kelebihan-kelebihan lain yang rinciannya ringkasnya tersebut
dalam lampiran formulir ini.

Yang mengajukan permintaan

(Dr. Ir. Hj. Hannelly, M.Si.)
Formulir Permintaan
Pemeriksaan Substantif Paten

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NPWP : 79.478.192-9-429.000

yang telah mengajukan permintaan
paten Sendiri/melalui Konsultan
Patent [ ]

(74) Nama Konsultan Paten [ ]
Nomor Konsultan Patent [ ]
Email [ ]
Telepon [ ]

dengan [ ]

(65) Nomor permintaan paten : P00201904267
(22) Tanggal penerimaan
permintaan paten : 21 Mei 2019
(54) Judul Invenisi : FOODBAR BEBAS GLUTEN DARI TEPUNG KOMPOST

mengajukan permintaan pemeriksaan substantif
untuk permintaan paten tersebut diatas [ ]

Bersama ini, saya/kami sampaikan [ ]

[ ] Biaya pemeriksaan substantif paten sebesar Rp. 3.000.000,00
   ( Tiga Juta Rupiah )

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   Sejumlah Rp. [ ]

[ ] Kekurangan-kekurangan lain yang rincian ringkasnya tersebut
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Yang mengajukan permintaan

[Signature]
(Dr. Ir. Hj. Hasnelly, M.Si.)

Form No. 017/P/HAKI/1999
Formulir Permintaan Pemeriksaan Subs tantif Paten

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yang telah mengajukan permintaan paten Sendiri/melalui Konsultan Paten

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- [ ] Biaya claim yang belum dibayar boleh @ Rp.
- [ ] Sejumlah Rp.
- [ ] Kekurangan-kekurangan lain yang rincian ringkasannya tersebut dalam lampiran formulir ini.

Yang mengajukan permintaan

(Dr. Ir. Hj. Hasnelly, M.Sie.)

Form No. 017/P/HAKI/1999
Formulir Permintaan Pemeriksaan Substantif Paten

Dengan ini saya / kami ①:
(71) Nama : Dr. Ir. Hasnelly, M.Si.
(2) Alamat : Jl. Semarang No. 69
Warga Negara : Indonesia
Email : hasnelly.riyono@gmail.com
Telepon : 0811213018
NPWP : 79.479.192-9-429.000

yang telah mengajukan permintaan paten Sendiri/melalui Konsultan Paten
(74) Nama Konsultan Paten :
Nomor Konsultan Paten :
Email :
Telepon :

dengan :
(65) Nomor permintaan paten : P00201904266
(22) Tanggal penerimaan permintaan paten : 21 Mei 2019
(54) Judul Invenasi : KAMABOKO TINTA CUMI

mengajukan permintaan pemeriksaan substantif untuk permintaan paten tersebut diatas.

Bersama ini, saya/kami sampaikan :
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( Tiga Juta Rupiah )
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Sejumlah Rp.

[ ] Kekurangan-kekurangan lain yang rincian ringkasnya tersebut dalam lampiran formulir ini.

Yang mengajukan permintaan

(Dr. Ir. Hasnelly, M.Si.)

Form No. 017/PHAKI/1999
2. Lampiran Artikel ilmiah (Internasional)
   Dalam proses review editor

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Your manuscript entitled "PRODUCT INNOVATION AND OPTIMIZATION USING RESPONSE SURFACE METHODOLOGY" by Hasnelly, Hasnelly; Nurulhidayati, Yeyen; hervelly, Hervelly; Suhodo, Tanto; Jusuf, Eddy, has been successfully submitted online and is presently being given full consideration for publication in the Journal of Product Innovation Management.

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Thank you for submitting your manuscript to Journal of Product Innovation Management.

Sincerely,
Journal of Product Innovation Management Editorial Office
PRODUCT INNOVATION AND OPTIMIZATION USING RESPONSE SURFACE METHODOLOGY

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Abstract

This study aims to obtain empirical data regarding the application of the Design-Expert program in the development of a linear program. The objective is to obtain the optimal formula for gluten-free vermicelli products that can be used to reduce production costs in the green food industry. The method that is used in this study is linear, and it computes with the Design-Expert program version 11.0. The results of this study are expected to find the best formula of gluten-free products in the green food industry using The Design-Expert program. The result showed that the Design-Expert program had given verified similar data with laboratory analysis. This program has been accepted to be applied both in gluten-free products and the green food industry product optimization. This paper highlights the used of the Design-Expert program in the manufacturing industry to optimize the product formula and reduce the time of formulation trial. Although the studies of Design-Expert program have been conducted for several years, the used
of Design-Expert program to optimize gluten-free product is still unknown. This study considers the relationship among the Design-Expert program, time of production trial, and cost-saving of industrial practice.

**Keywords** Gluten-free product, Green food industry, Design-expert program, Innovation product, Production

**Introduction**

The organizations have applied green practices as their initiative innovations of competitiveness because of global and local issues. Many factors have been affected by green industrial practices (Aziz *et al.*, 2018) such as internal factors of organization which has explained green practice diversity (Li *et al.*, 2019). Many industrial activities have made formulating progress in green strategy, which was shown that implementation and innovation competencies were crucial (Moini, Sorensen, and Szuchy-Kristiansen, 2014). So-called "green food" products are the result of innovations in food industries. That partially fuel current consumer trends towards minimizing the use of ingredients that have a negative health impact. Consumers choose green food products not only because they are attractive, but also because of their health benefits (Junior, da Silva, Gabriel, and Braga, 2015). The green food industry is considered an essential sector of the food industry. It processes and handles green food products by standardized requirements in order to maintain their benefits (Sari and Hasnelly, 2012).

Hasnelly and Sari (2012) researched the importance of implementing resource-based strategies in the green food industry. They concluded that the industry must provide new recipes, implement advanced skills in producing products, and market these products in an easily accessible manner in order to maintain high customer value and satisfaction. The green industry
needs to innovate and develop their product, which creates new value, low cost, and beneficial advantage (Foo et al., 2019).

Green food companies must be able to influence consumer perception of their products in order to achieve their target goals. Customer perception of product value, which heavily influences consumer purchasing, will directly influence how companies produce their products (Sari and Hasnelly, 2012).

In order to achieve increased product value, companies may implement cost-effective strategies and reduce activities that do not add product value (Hasnelly and Yusuf, 2012). Industries used regular regression to analyze their performance to increase the improvement presence (Knol et al., 2019). The linear method has made it possible for business enterprises in many sectors to save tens to hundreds of millions of dollars in production costs (Hillier and Lieberman, 1980).

Product reports allow management to evaluate possible strategies for each product, which can harmonize the focus of strategy and operational activities (Lee Park and Paiva, 2018). This strategy can be used to increase a company's cash flow, increase market segmentation, or to reduce production costs. The report can also provide information to management about which products should be optimized to provide further investment. Product analysis per value focuses on the strategic direction for each product (Heizer and Render, 2014). Industries will be set the product customization strategy to oppose the standard product (Sousa and da Silveira, 2019). They are optimizing the old product to be more competitive and valuable. The main challenge in product optimization is the high number of parameters that need to be optimized simultaneously. The challenge is often exacerbated by the fact that not all parameters are initially known (Schmidt, Schöbel, and Thom, 2019). One such strategy involves leveraging operational research
(OR) to find the optimal formula for raw materials with low production costs in the manufacturing of green food products.

Gluten-free products are intended for consumers who have gluten-intolerance, but gluten-free products must still be formulated so that the quality is not inferior to products that contain gluten. Gluten-free products are reformulated using composite flour, which can replace the role of flour containing gluten (Drabińska, Ciska, Szmatowicz, and Krupa-Kozak, 2018).

This study will discuss the processes of gluten-free vermicelli optimization using composite flour. The gluten-free vermicelli was made from a comparison among brown rice flour, mung bean flour, and arrowroot starch flour. Brown rice contains anthocyanin and proanthocyanidin as color pigments. These color primers provide health benefits like antioxidants (Huang and Lai, 2016). Mung beans are known to be one source of vitamin B1. Mung beans are very popular in Indonesia because they are easy to process and cheap (Gunarti, Rahmi, and Sadikin, 2013). Arrowroot starch flour has excellent digestibility, good gel-forming ability, and other advantages of physicochemical properties. It contains high amylose content (16-27%), which can be used as an additional ingredient (Nogueira, Fakhouri, and de Oliveira, 2018). This study aimed at how Design Expert software can be used to optimize the gluten-free, high product in the green food industry.

**Conceptual Background**

Gluten-free product characteristics have to be similar to gluten products. Gluten-free products have to be reformulated to reach that goal. Reformulated products were done with many trial and error experiments by the NPD department of food industries. Goal parameters have become the goal of product formulated optimization. The linear method, or linear operations research programming, is commonly utilized in order to minimize production costs. Product
optimization software can shorten the trial and error step and time. Design-Expert program can be used to multi-parameter optimization. One of the products that can be optimization by the software was vermicelli. The research was optimized the vermicelli formula to get gluten-free vermicelli characteristics which have similarities with common vermicelli. At the end of the research, the product was analyzed in the laboratory by physical and chemical characteristics.

**Methodology**

This study demonstrated how linear programs could be applied in the green food industry. Statistical analyses were carried out by Design-Expert software (version 11.0 licensed by Stat-ease Co., Minneapolis, MN). The research is found the optimal formulas for gluten-free, organic vermicelli, using the D-optimal method. This method allows the optimization of variables based on a chosen optimality criterion and model fitting, enabling quick optimization with limited resources.

Three independent variables were used in researching optimum formulas: brown rice flour (A), mung bean flour (B), and arrowroot starch flour (C). Initially, The Design-Expert software produced several draft product formulas with varying combinations of the variables mentioned above. These formulas were then created and laboratory-tested in terms of four responses: ash content, water content, protein content, and cooking loss. The results were then entered into The Design Expert program for statistical analysis, resulting in recommended optimum formulas. Finally, the optimum formulas were verified through laboratory tests. Formulas were created and laboratory-tested based on the four responses mentioned above to compare the results.
Result and Discussion

The Design-Expert software produced original product formulas that were produced and tested in a laboratory. The results of the tests were then statistically analyzed to determine the effects of the independent variables on the formulas. These are represented by the following test responses: ash content, water content, protein content, and cooking loss. Design Expert was used to producing a mathematical model that could predict the extent to which each of these test responses was affected by the three independent variables and in what combinations.

Ash Content

Design Expert recommended a linear model connecting the independent variables to the ash content of the formula. The model recommendations were selected based on the smallest p-value, where the p-value for the particular linear model was 0.0560 (Table 1).

The results of the analysis of variance (ANOVA) for the ash content response with a p = 0.05 level of significance showed a non-significant variance analysis with a calculated p-value "prob. > F" of 0.056 (Table 2). The three parameters mentioned above do not influence the ash content of gluten-free, organic vermicelli.

Design Expert formulated an equation for the prediction of ash content in terms of brown rice flour (A), mung bean flour (B), and arrowroot starch flour (C):

$$\text{Ash Content} = 1.58A + 0.9388B + 0.3926C$$

The equation shows that the ash content is strongly influenced by the amount of brown rice flour. This relationship is illustrated (Figure 1).

Water Content

Regarding the water content response, Design Expert recommended an exclusive cubic model with a p-value of 0.0883 (Table 3). Similar to the ash content response, ANOVA was also
conducted for the water content response at the level of significance of p = 0.05. A non-significant result with a p-value "prob. > F" of 0.2142 was obtained (Table 4). This also shows that neither brown rice flour, mung bean flour, nor arrowroot starch flour had any effect on the water content response of gluten-free, organic vermicelli products.

The mathematical model for the effect of brown rice flour (A), mung bean flour (B), and arrowroot starch flour (C) on water content is as follows:

Water Content = 123.51A + 6.25B + 8.44C - 123.33AB - 132.08AC + 13.31BC - 97.56ABC

The equation shows that an increase in all three variables does not affect the water content of gluten-free, organic vermicelli. Individuals increased the variables, as well as the interaction between the B and C variables, does increase the water content. Meanwhile, the interactions between variable pairs AB and AC, and also between all three variables A, B, and C, reduce the water content. These results suggest that brown rice flour is the main factor affecting the water content of gluten-free, organic vermicelli.

A contour plot of the various formulas containing different combinations of each type of flour shows a low water content value (blue) of 7.69% and a high water content value (red) of 11.43% (Figure 2).

**Protein Content**

The recommended polynomial model for the protein content response is a cubic model with a p-value of 0.1404 (Table 5). The ANOVA analysis for the protein content response also produced a non-significant result with a p-value of 0.5330 (Table 6), indicating that the brown rice flour, mung bean flour, and arrowroot starch flour formulations do not influence the protein content of gluten-free, organic vermicelli products.
The resulting equation for the relationship between protein content and the three aforementioned variables is as follows:

Protein Content = -0.4147A + 6.32B + 5.33C + 2.38AB + 14.96AC - 0.8397BC - 60.36ABC

This model shows that the addition of brown rice flour, mung bean flour, or arrowroot starch flour does not influence the protein content of gluten-free, organic vermicelli. The addition of components B and C separately or two components of AB and AC does increase the protein content, as indicated by a positive coefficient. The interaction of two components of BC and the interaction between the components of ABC reduces the protein content. The addition of mung bean flour strongly influences the protein content level.

The magnitude of the relationship between the three types of flour and their effects on the protein content is shown (Figure 3). The lowest protein content response recorded (blue) was 4.24%, while the highest protein content response (red) was 6.73%.

**Cooking Loss**

Similar to the ash content response, the recommended polynomial model for the cooking loss response is a linear model with a p-value of <0.0001 (See Table 7). The ANOVA analysis of the effects of varying flour content on cooking loss resulted in a significant link, with a p-value of less than 0.0001 (Table 8). The table shows that brown rice flour, mung bean flour, and arrowroot starch flour significantly affect the cooking loss response of gluten-free, organic vermicelli products.

A simple linear relationship was found between the cooking loss response and brown rice flour (A), mung bean flour (B), and arrowroot starch flour (C), as shown in the following equation:

Cooking loss = 14.58A + 18.13B + 10.25C
While all three types of flour greatly affect the cooking loss response of the vermicelli products, mung bean flour was found to be the most significant factor. The effect can also be seen from a contour graph depicting the magnitude of the effects of different flour content on cooking loss (Figure 4). Large amounts of mung bean flour in the formulation resulted in the highest cooking loss (17.43%, red), while arrowroot starch flour had the least influence on cooking loss (10.55%, blue).

**Selected Optimal Formula**

Design Expert was able to optimize the independent variables and formulate several solutions according to the desired optimization targets. The most optimal formula was then selected based on a "desirability" score. The desirability value ranges from zero to one; a value that approaches "one" indicates that the formula reaches the optimal formula according to the desired response variables.

Each optimized variable is given a particular weight, called the "importance" value (Table 9). The importance value for each variable can be adjusted to fine-tune the optimization process in order to achieve an optimal formula that reflects current market demand or product standards.

The desirability value generated for each potential formulation is influenced by the number and complexity of the components, the range of flour content, the test responses, and the target to be achieved in obtaining the optimal formula. A higher number and a greater complexity of components decreases desirability, as does a broad range of flour content, due to more significant difficulties in determining the optimum formula. The contour plot and the three-dimensional diagram based on the desirability value of the selected gluten-free, organic vermicelli formula can be seen (Figure 5).

**Verification Data**
Using the selected optimum formula, Design Expert could predict the quality of the formula with a 95% confidence interval in terms of water content, ash content, protein content, and cooking loss. The calculated quality parameters were then verified through laboratory tests (Table 11). The verification results show that laboratory verification of the quality parameters did not significantly differ from the calculated values.

**Implications**

Through the use of the D-optimal method, this study has demonstrated that Design Expert can be used in the optimization of product formulations with multiple parameters in the vermicelli sample. This method also could be applicable in each type product of the green food industry. The Design Expert can reduce the trial and error process and production costs. The time needed for formulating green food products can also be shortened. The program also makes it possible for manufacturers to adjust quickly to the demands and needs of consumers.

**Limitations and Future Research**

The application of Design-Expert software in food industries was not used too much, so the similar study of Design-Expert program has to develop. The replication may be added to the software by the user to decrease the error level of the research.

**Acknowledgment**

This study was funded by the Higher Education Leading Research Program of the Ministry of Research and Technology for 2017, 2018, and 2019, in conjunction with Pasundan University.
REFERENCE


California: Holden-Day.


Sari, H. and Hasnelly. 2012. Factors Determining Green Companies Performance in Indonesia: A


Table 1. Polynomial Model of Gluten-free Organic Vermicelli in Ash Content Response

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Table 2. ANOVA for The Linear Model of Gluten-free Organic Vermicelli in Ash Content Response

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Table 3. Polynomial Model of Gluten-free Organic Vermicelli in Water Content Response

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Table 4. ANOVA for The Linear Model of Gluten-free Organic Vermicelli in Water Content

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Table 5. Polynomial Model of Gluten-free Organic Vermicelli in Protein Content Response

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<td>-1.5616</td>
</tr>
<tr>
<td>Sp. Quartic vs. Quadratic</td>
<td>0.8087</td>
<td>-0.9268</td>
<td>-18.4425</td>
</tr>
<tr>
<td>Quartic vs. Cubic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartic vs. Sp. Quartic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. ANOVA for The Linear Model of Gluten-free Organic Vermicelli in Protein Content

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-value</th>
<th>p-value</th>
</tr>
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<tbody>
<tr>
<td>Model</td>
<td>4.54</td>
<td>6</td>
<td>0.7569</td>
<td>0.9805</td>
<td>0.5330</td>
</tr>
<tr>
<td>Linear</td>
<td>0.3677</td>
<td>2</td>
<td>0.1838</td>
<td>0.2381</td>
<td>0.7985</td>
</tr>
<tr>
<td>Mixture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not significant</td>
</tr>
<tr>
<td>AB</td>
<td>0.0008</td>
<td>1</td>
<td>0.0008</td>
<td>0.0010</td>
<td>0.9766</td>
</tr>
<tr>
<td>AC</td>
<td>0.0314</td>
<td>1</td>
<td>0.0314</td>
<td>0.0407</td>
<td>0.8500</td>
</tr>
<tr>
<td>BC</td>
<td>0.0168</td>
<td>1</td>
<td>0.0168</td>
<td>0.0217</td>
<td>0.8899</td>
</tr>
<tr>
<td>ABC</td>
<td>1.31</td>
<td>1</td>
<td>1.31</td>
<td>1.70</td>
<td>0.2621</td>
</tr>
<tr>
<td>Residual</td>
<td>3.09</td>
<td>4</td>
<td>0.7720</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core Total</td>
<td>7.63</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7. Polynomial Model of Gluten-free Organic Vermicelli in Cooking Loss Response

16
Table 8. ANOVA for The Linear Model of Gluten-free Organic Vermicelli in Cooking Loss

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-value</th>
<th>p-value</th>
<th>Significance</th>
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<tr>
<td>Model (1) Linear</td>
<td>71.88</td>
<td>2</td>
<td>35.94</td>
<td>245.49</td>
<td>&lt;0.0001</td>
<td>Significant</td>
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<tr>
<td>Mixture Residual</td>
<td>1.17</td>
<td>8</td>
<td>0.1464</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core Total</td>
<td>73.06</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9. Importance of Interests for Selected Formula on Gluten-Free Organic Vermicelli Optimization

<table>
<thead>
<tr>
<th>Name</th>
<th>Optimization target</th>
<th>Lower Limit *</th>
<th>Upper Limit *</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>In range</td>
<td>33.4</td>
<td>34.8</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>In range</td>
<td>0</td>
<td>6.2</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>In range</td>
<td>21</td>
<td>28.6</td>
<td>3</td>
</tr>
<tr>
<td>Water Content</td>
<td>Minimize</td>
<td>7.69</td>
<td>11.43</td>
<td>3</td>
</tr>
<tr>
<td>Protein Content</td>
<td>In range</td>
<td>4.24</td>
<td>6.729</td>
<td>3</td>
</tr>
<tr>
<td>Ash Content</td>
<td>Minimize</td>
<td>0.2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Cooking Loss</td>
<td>Minimize</td>
<td>10.55</td>
<td>17.43</td>
<td>3</td>
</tr>
</tbody>
</table>

Note: * in %
A: Brown rice flour
B: Mung bean flour
C: Arrowroot starch flour

Table 10. Optimal Formula for Gluten-free Organic Vermicelli

<table>
<thead>
<tr>
<th>Brown Bean</th>
<th>Mung Bean</th>
<th>Arrowroot Starch</th>
<th>Water Content</th>
<th>Protein Content</th>
<th>Ash Content</th>
<th>Cooking Loss</th>
<th>Desirability</th>
</tr>
</thead>
</table>

17
<table>
<thead>
<tr>
<th>Response</th>
<th>Results (%)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prediction</td>
<td>Verification</td>
</tr>
<tr>
<td>Water Content</td>
<td>7.996</td>
<td>8.94</td>
</tr>
<tr>
<td>Ash Content</td>
<td>0.437</td>
<td>0.50</td>
</tr>
<tr>
<td>Protein Content</td>
<td>5.652</td>
<td>4.96</td>
</tr>
<tr>
<td>Cooking Loss</td>
<td>10.413</td>
<td>10.6</td>
</tr>
</tbody>
</table>
Figure 1. Contour Plot Graphs and Three-Dimensional Graph of Gluten-free Organic Vermicelli Ash Content

Figure 2. Contour Plot Graphs and Three-Dimensional Graph of Gluten-free Organic Vermicelli Water Content Response
Figure 3. Contour Plot Graphs and Three-Dimensional Graph of Gluten-free Organic Vermicelli Protein Content Response

Figure 4. Contour Plot Graphs and Three-Dimensional Graph of Gluten-free Organic Vermicelli Cooking Loss Response
Figure 5. Contour Plot Graph and Three-Dimensional Graph of Desirability of the Selected Gluten-Free Organic Vermicelli Formula


3. Lampiran Artikel Ilmiah (Dalam tahap Review)

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<th>AUTHORS</th>
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<td>47467</td>
<td>07-09</td>
<td>ART</td>
<td>Hasmely, Fitriani, Ayu, Harielly</td>
<td>PENGARUH BERBUAT PENYOSOHAN TENTANG MUTU BERAS MERAH...</td>
<td>IN REVIEW: REVISIONS REQUIRED</td>
</tr>
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Pengaruh Derajat Penyosohan Terhadap Mutu Beras Merah, Beras Putih, dan Beras Hitam

The Effects of Hulling Level in Red Rice, White Rice, and Black Rice Quality

Hasnelly¹, Evi Fitriani, Shelvy Ayu, Harvelly

¹Prodi Teknologi Pangan, Fakultas Teknik, Universitas Pasundan, Jl. Dr. Setiabadi No. 193, Bandung, Indonesia
Email: hasnelly.sriyono@gmail.com / hasnelly@unpas.ac.id

ABSTRAK

Beras dengan perlakuan penyosohan yang tinggi mengalami penurunan nilai gizi dan mutu karena beberapa nutrisi makro banyak terkandung dalam lapisan yang terbuang. Penelitian ini bertujuan untuk mengetahui pengaruh derajat penyosohan terhadap mutu dan karakteristik beras merah, beras hitam, dan beras putih. Metode yang digunakan pada penelitian ini adalah metode linier. Respon yang dianalisis untuk mengetahui pengaruh tingkat penyosohan yaitu kadar air, kadar lemak, kadar abu, kadar karbohidrat, kadar antosianin, mutu beras, rendemen beras, daya cerna pati, mutu giling, dan derajat putih beras. Hasil penelitian menunjukkan bahwa derajat penyosohan memberikan pengaruh pada kadar proksimat dan sifat fisik beras.

Kata kunci: Derajat sosoh, Beras, Agroindustri, Mutu Beras

ABSTRACT

The nutrition and quality of rice will be decreased with high level of hulling process, because the macro nutrient that contained in the alleuron will be wasted. This study aims to know the effects of hulling level to the quality and characteristic of red rice, black rice, and white rice. Method that used in this study was linear. The responses that analysed in this study were water content, fat content, ash content, carbohydrate content, anthocyanin content, rice quality, rendemen, starch digestibility, milled quality, and color degree of rice. The results of this study showed that hulling level would be affected the proximate content and physical characteristics of rice.

Keywords: Hulling level, Rice, Agroindustry, Rice Quality

PENDAHULUAN

Padi (Oryza sativa) merupakan tanaman pangan utama di sebagian besar wilayah Asia yang kaya karbohidrat sehingga menjadi makanan pokok bagi sebagian besar masyarakat di dunia. Menurut data International Rice Research Institute (IRRI) pada tahun 2017 produksi

¹ Corresponding Author
gabah kering giling di Indonesia mencapai 37 juta ton. Rata-rata konsumsi beras di Indonesia mencapai 114,6 kg/kapita/tahun, jauh melebihi konsumsi rata-rata dunia sebesar 60 kg/kapita/tahun. Beras yang beredar dipasaran pada umumnya berupa beras sosoh sempurna (100%) atau beras regular dengan variasi derajat sosoh (80-95%).

SNI 6128-2015 mensyaratkan kelas mutu beras medium I mengandung beras kepala minimal 78% dan beras patah maksimal 20% dengan derajat sosoh 95% dan kadar air beras maksimal 14%. Semakin turun kelas mutu beras ke medium II dan medium III, maka semakin turun pula persyaratan persentase beras kepala dan derajat sosoh. Beras mutu terbaik menurut SNI ditentukan oleh kandungan beras kepala sebesar minimal 95% dan beras patah maksimal 5% dengan derajat sosoh 100% dan kadar air maksimal 14%.


Derajat sosoh (DS) dapat berpengaruh terhadap mutu dari beras yang dihasilkan. Semakin tinggi derajat sosoh, maka mutu beras tersebut akan semakin rendah karena beras giling yang dihasilkan akan makin rendah. Derajat sosoh yang semakin tinggi dapat menyebabkan persentase beras patah semakin banyak. Kondisi inilah yang dapat memberi dampak terhadap daya terima dan minat masyarakat terhadap beras. DS yang semakin tinggi dapat pula mempengaruhi nilai beberapa komponen gizi utama dari beras seperti kadar serat
dan kemampuan nilai cerna patinya. DS yang semakin tinggi akan menyebabkan tingkat kecerahan yang semakin tinggi (putih) dikarenakan pigmen merah (antosianin) pada lapisan terluar beras merah dan hitam banyak yang terbuang (Aryunis, 2012).

Tujuan penelitian ini untuk mengetahui derajat penyosohan dan dampaknya terhadap sifat fisikokimia beberapa jenis beras, sehingga didapatkan derajat sosoh yang terbaik dengan kandungan nutrisi yang masih tinggi.

METODE PENELITIAN

Bahan

Bahan yang digunakan dalam penelitian ialah gabah varietas Setra Ramos untuk beras putih, gabah varietas Inpari 24 untuk beras merah, dan gabah varietas Cempo Ireng untuk beras hitam, dengan masing-masing gabah sebanyak 4 kg. Bahan yang digunakan untuk analisis diantaranya adalah larutan H$_2$SO$_4$ 6N, batu didih, aquadest, alkohol 95%, larutan H$_2$SO$_4$ 0,3 N, larutan NaOH 30%, larutan Na$_2$S$_2$O$_3$ 0,1 N, larutan NaOH 0,1 N, larutan HCl 0,1 N, larutan n-hexan, indikator phenolphthalein.

Alat

Alat-alat yang digunakan dalam penelitian ini adalah mesin penggiling gabah merek Re-Rice, neraca digital, tabung reaksi, spatula, gelas kimia, pengaduk, autoclave, sendok, lumpang dan alu, pipet tetes, pipet volumetri, pembakaran bunsen, labu Kjeldahl, tang krus, tanur, eksikator, kawat kassa, kaca arloji, kertas timbang, labu takar 100 ml, penangas air, labu Erlenmeyer 250 ml, alat destilasi, kondensor, labu bundar, soxhlet, buret, statif, klem, pipet tetes, dan botol semprot. spektrofotometer UV-Visible Serial No. A116652 (Shimadzu, Jepang), kuvet, kertas saring, dan rice grader.

[ICFB2019] Editor Decision

Bambang Nurhadi
Oct 25, 2019, 3:56 PM

Hasnally, Andini Fitria, Wisnu Cahyadi, Haswidyia:

We have reached a decision regarding your submission to ICFB 2019, "The Study of Process Innovation Of African Catfish (Clarias gariepinus) Gluten-Free Product".

Our decision is to: Accept Submission

Bambang Nurhadi
Department of Foods Technology, Faculty of Agriculture Industrial Technology, Padjadjaran University,
bnhnur@gmail.com

International Conference on Foods and Bio-Industry ICFB 2019
Website: http://nachiconference.fhq.unc.ac.id/index.html
Peer-review system: http://uias.icf.foundation.or.id/index.php/ICFB2019
APPLICATION OF WHEY POWDER FROM GOAT'S MILK IN PROCESSED FOOD

Yelliantty
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Abstract. Whey is a by-product of cheese making. Generally whey is widely used derived from cow's milk. Although usually dumped into waste, but whey still has a beneficial nutritional content. Whey can also be obtained from goat's milk. Allegedly, whey goat milk also has health potential. In this study we developed whey powder from goat's milk as food ingredient and applied it into several processed food such as beverage and bread. Whey in this study is a by-product of Kefir making. Whey powder was obtained using spray dry method with maltodextrin carrier. Its application showed that addition whey powder could increase protein content and also improved the taste. It concluded that whey powder can be used as food ingredient in processed food.
FPP-2-3-3

APPLICATION OF AGROINDUSTRIAL ORGANIC YARD FOR ORGANIC VEGETABLE CULTIVATION

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Abstract. Availability of organic vegetables is still low because it needs quite large yard to cultivate. System of organic yard utilizes the available yard as a place to cultivate the organic vegetables. Application of organic yard aims to increase total production of organic vegetables with very limited yard, and even it can be applied in home yard. Method that uses to apply organic yard is counseling and coaching how to apply organic yard to people society as the target. The output of organic yard is availability of organic vegetables which can be marketed as fresh or processed vegetable products. Housewife can apply this method to supply the daily needs of organic vegetable as an application of organic healthy lifestyle.

Keywords: Organic yard, Vegetable, Agroindustry
Application Of Agroindustrial Organic Yard For Organic Vegetable Cultivation

Hasnelly*, Shelvi Putri, Rizal Maulana

Department of Food Technology, Engineering Faculty, Pasundan University Jl. Dr. Setiabudi No. 193, Bandung, 40153, Indonesia
*Email : hasnelly.sriyono@gmail.com / hasnelly@unpas.ac.id

ABSTRACT

The availability of organic vegetables is still low because it needs a quite large yard to cultivate. The system of organic yard utilizes the available yard as a place to cultivate the organic vegetables. The application of organic yard aims to increase the total production of organic vegetables with a very limited yard, and even it can be applied in the home yard. The research aims to apply kimchi and pickle as the product of organic crops. Kimchi and pickle which made will be analyzed in the laboratory to know the quality. The method that uses to compute the data analysis is Randomized Group Design to know the effect of interaction between factors. Result of this research was known that kimchi and pickle are the fermented product which can make easily at home and produce in large scale. Kimchi and pickle had acceptable organoleptic value tested by panelists. Compounds contained in kimchi and pickle had known as chemical characteristics such as acidity, vitamin C, antioxidant, and lactic acid. Total microbes that contained in products have been known. Those characteristic responses told that kimchi and pickle that has been made had high qualified.

Keywords: Organic yard, Vegetable, Fermented product, Kimchi, Pickle

1 INTRODUCTION

The organic farm is one of many answers to supply healthy and safe food. The organic farming system is planted cultivation without chemical material added such as fertilizer, pesticide, and other chemical compounds. People now days start to apply a healthy lifestyle, so organic farm cultivation is important to concern (Arofi, 2017). This consumer preference will increase the demand for organic farming products (Pracaya, 2012).

The organic yard is one of organic farming engineering results, which utilize the house yard to plant organic vegetables. Organic yard can be one solution to increase organic vegetable availability for daily family consumption.

The application of organic vegetable cultivation in the house yard has to obey the Indonesian organic farm standard which is ruled in SNI number 6729: 2016. Soil which uses as growing media derived from non-contaminated inorganic chemical soil. Materials that are allowed to use as soil fertilizer can be seen in Table 1. optimizing in-situ utilization of nutrients in organic vegetable cultivation yard can be done in many ways such as barrier plants can be used as green fertilizer and compost. Organic fertilizer from manure waste can be used from organic stockbreeding which composted (Arofi, 2017).

This research will use vegetable seeds which will seed in the house yard. The seeds which use in this research are tomato, chili, cucumber, and Chinese cabbage. The crops of vegetables will be used as kimchi and pickle main materials.

Vegetable crops commonly process into simple products to eat. Kimchi and pickle are samples of processed vegetables which are process easily by fermentation with salt, sugar, and/or other ingredients added necessarily. Organic yard crops can be utilized as the raw material of kimchi and pickle. This paper research aims to apply kimchi and pickle to optimize organic crops into a long shelf-life product and to increase the vegetable product value.
Table 1. List of allowing material in organic cultivation

<table>
<thead>
<tr>
<th>No.</th>
<th>Material</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Green fertilizer</td>
<td>Turi, lamtoro, sesbana, orok – orok, and legumes.</td>
</tr>
<tr>
<td>2.</td>
<td>Livestock manure</td>
<td>Made of organic livestock waste. Factory farming can be composted for two weeks.</td>
</tr>
<tr>
<td>3.</td>
<td>Livestock urine</td>
<td>Made of organic livestock liquid waste, can be applied after fermented and diluted.</td>
</tr>
<tr>
<td>4.</td>
<td>Plant residue</td>
<td>It can be used in organic farming.</td>
</tr>
<tr>
<td>5.</td>
<td>Straw mushroom compost media</td>
<td>It can be used in media and straw made of organic farming.</td>
</tr>
<tr>
<td>6.</td>
<td>Organic vegetable waste compost</td>
<td>It can be used in organic farming.</td>
</tr>
<tr>
<td>7.</td>
<td>Green algae</td>
<td>It can be used in media and straw made of organic farming.</td>
</tr>
<tr>
<td>8.</td>
<td>Azolla</td>
<td>Natural source of nitrogen.</td>
</tr>
<tr>
<td>10.</td>
<td>Molasses</td>
<td>Organic material which added in compost making.</td>
</tr>
<tr>
<td>11.</td>
<td>Organic fertilizer</td>
<td>Local Non-GMO mikroorganisme</td>
</tr>
<tr>
<td>12.</td>
<td>Rhizobium</td>
<td>Nitrogen enhancer microorganisms which are symbiosis with roots of legume plants.</td>
</tr>
<tr>
<td>13.</td>
<td>Decomposer</td>
<td>Non-GMO</td>
</tr>
<tr>
<td>14.</td>
<td>Natural ZPT</td>
<td>Not made of synthetic ZPT.</td>
</tr>
</tbody>
</table>

(Source: Arofi, 2017)

Kimchi is one of the pickled products which is the most popular in Korea. Kimchi is made by vegetables with fermentation process and spicy seasoning addition. Kimchi is made by washing vegetables and salting. All parts of the vegetable must be submerged by saltwater to prevent the growth of other unwanted microorganisms, then fermented vegetables are mixed with seasoning. Pickle is one of fermented product. Pickle is the product of processing fruit or vegetables using salt and preserved with acid, with or without adding sugar and spices as a spice.

2 RESEARCH METHODS

Kimchi will be made in two variances, which are Chinese cabbage kimchi and cucumber kimchi. Additional ingredients used to make kimchi are salt, chili powder, sugar, ginger, garlic, onion, and fish sauce. Kimchi will be fermented for 48 hours at room temperature.

Tomato and chili will be used as pickle main ingredients. Pickle was fermented by sugar and salt solution added. The vegetable is put in the sterilized jar, sugar and salt solution is added into the jar, then close the jar tightly. Pickle will be fermented for 14 days at room temperature.

All fermented products will be analyzed in the laboratory to know the quality of the products. Responses which will be tested are organoleptic, chemical, and microbiological characteristic such as antioxidant activity, lactic acid, vitamin C, acidity, and total microbes of the products. The data from analyst computed with randomize group design method to know the correlation between factors that have determined before.

3 RESULTS AND DISCUSSION

Kimchi

Taste

The higher the concentration of salt and two-day fermentation the higher the cucumber kimchi taste value. Salt can give salty taste in sensory. Too long fermentation time can cause dislike taste
which is disliked by the panelists. The higher concentration of salt can increase product saltiness and lactic acid content formed by the fermentation process. Growth of lactic acid bacteria during fermentation will make several changes in products which can limit the growth of pathogenic microbes, inhibit product decay, and produce various special flavors made by organic acid accumulation, so that is obtained final results product which is different from raw materials (fathonah, 2009).

**Texture**

Different times of fermentation can give different cucumber kimchi texture in the sensory score. Microbe which is caused softening in cucumber kimchi texture is not grown in large amount on two days of fermentation because it is in adaptation phase, but in four days of fermentation microbe starts developing in logarithmic phase, and in six days of fermentation microbe starts stationary phase which the growth of microbe is not grown significantly, so the softening of cucumber kimchi texture will get different scores (Ramdan, 2007).

**Aroma**

Different time of fermentation can give different aroma responses of cucumber kimchi, the aroma of cucumber kimchi is obtained from lactic acid content which is affected by nutrients and proteolytic microbes. *Enterobacter* and *flavobacterium* will grow first in the fermentation process. They will create acid odor excessively which is not significantly different from other long fermentation times (Ramdan, 2007).

**Total Microbe**

The length of fermentation time the higher of the total microbe which contains in cucumber kimchi. Total microbe enhancement from the different varieties of fermentation time will increase differently because the total microbe in the first stage of fermentation is still low. Commonly the total microbe population will continue to grow because one type of microbe population which has been destroyed will be replaced with other microbe populations which are more suitable to grow in that situation. The enhancement of total microbe during the fermentation process, allegedly because the condition of substrate is still possible for the microbe to carry out their metabolic activities even in a small level, however, at a certain time of fermentation the bacteria activities will decrease again because it is hampered by acid production (Harioanto, 2017). The enhancement of total lactic acid bacteria is caused by a long time of fermentation, so the total microbe that grows and evolves will be more and more. It will increase the total microbe of products. This situation is directly proportional to total lactic acid results which tell that the higher of acidity the higher of total microbe colony growth because total acid comes from microbe metabolism results.

**Water Content**

The water content result showed that the higher the concentration of salt solution added, the lower the water content of cucumber kimchi. Salt has higher osmotic pressure, so the pressure differential caused by salt will absorb the water content in the material until the equilibrium point between them. Rochima (2005) said that during the fermentation process there was degradation of water content because the equilibrium of the product has disturbed. Salt will absorb water of product then sign in to the system of product, so water content will be decreased. Herawati (2008) appended that water content on food material not only affected the chemical changes but also determined the total microbe on the product. Salt has a hygroscopic characteristic which means that salt absorbed water easily. Therefore, the water content of cucumber kimchi will be decreased after the fermentation process.

**Vitamin C**

Vitamin C is one of vitamin group that can dissolve in water, so the longer time of fermentation, the lower vitamin C content on cucumber kimchi. The damage of vitamin C on cucumber kimchi can be caused because during the fermentation process there is a loss of carbon dioxide gas where it can prevent the damage of vitamin C through the formation of anaerobic conditions. Four-day and six-day fermentation did not give significantly different because the damage of vitamin C can be prevented by the acid condition. In that situation, cucumber kimchi already in an acid condition which will decrease
the damage of vitamin C. Ramdan (2007) said that from all vitamin that contains in food material, Vitamin C can be damaged easily. Vitamin C easily oxidizes, and that process can be accelerated by high temperature, ray, alkali enzyme, oxidizer, and catalyst (Cu and Fe). Oxidation will be hampered if Vitamin C saved in acid and low temperature.

Two-day, four-day, and six-day fermentation is decreased because of the oxidation of water. Vitamin C will be oxidized by oxygen by giving 2 electrons to the oxidizer. Vitamin C might be utilized by a microbe in the metabolism process so that the percentage of vitamin C in the product decreased.

Puspitasari (2017) said that CO₂ will react and form ascorbic acid (vitamin C) with water. The longer time of fermentation will spend sugar content so that vitamin C content will be decreased until the optimum value because microorganisms have run out of food.

Lactic Acid Content

The concentration of salt and different time of fermentation give a different score of cucumber kimchi lactic acid. Miyayani (2008) said that total acid increased along with fermentation duration. Long-time fermentation will give the microbe chance to fermented longer and change the substrate from carbohydrate into lactic acid. Misigiarie (2002) said that lactic acid produced by lactic acid bacteria (LAB) will be secreted outside the cell and accumulated, so it will increase acidity. The bacteria group which grew first was Leconostoc mesenteroides which produced lower sour than other groups of bacteria. This group will grow naturally in fermented cucumber and make an ideal environment situation. When total acid which produced increased, this group growth will be hampered. Pederson (1979) told that there was another growth of LAB named Laktobacillus Brevis which produced higher lactic acid (0,4-0,6%). Next stage more resistant bacteria will grow, named Lactobacillus Plantarum. This group produced higher lactic acid than Lactobacillus Brevis. Fermentation continues with Pediococcus cerevisiae grew which produced twice higher lactic acid than Leconostoc mesenteroides. Lactobacillus Plantarum produced lactic acid and Lactobacillus Brevis completed the fermentation.

The highest lactic acid content in this research was 0,63% with six days of fermentation. This is higher than research conducted by Lestari (2016) which told that the higher lactic acid was 0,57% with seven days of fermentation and 2% of salt concentration in 20°C. The time differential fermentation and salt concentration were two of the factors which determine the lactic acid percentage. The higher concentrations of salt and the longer the time of fermentation, the higher the percentage of lactic acid on products.

Antioxidant Activity

Analysis result of antioxidant activity in this research was known that cucumber kimchi had 93871,21 mg/L of antioxidant value. Antioxidant activity stated in percent inhibition to know the value of IC₅₀, which was the concentration value of the material that can hamper 50% DPPH activity. A lower IC₅₀ showed that the product had high antioxidant activity (Molyneux, 2004). Strong antioxidant has alpha-tocopherol with 5,1 mg/L of IC₅₀ value. Medium antioxidant has 48,6 mg/L of IC₅₀ (Damayanthi, 2010).

Pickel Taste

Different concentrations of sugar will affect the taste of pickles. Sucrose acts as a nutrient for lactic acid bacteria growth, so sugar is an important ingredient in pickle fermentation. Commonly pickle tasted acid which produced by lactic acid bacteria contained in a pickle. Lactic acid which has been produced influenced by substrate composition, so a higher amount of sugar added will make pickle more acidic.

Texture

Different concentrations of salt will affect the texture of pickles. The salting process is an important section in the pickle fermentation process. The salt solution serves to remove liquid from the material due to the osmosis process. When liquid material out, the salt will be absorbed, so products
become firm and crunchy (Suryadi, 2012). Salt has a more important part in forming a texture of pickle than sugar.

**Aroma**

Different concentrations of salt will affect the aroma of a pickle. Lactic acid-forming and volatile components can provide acidic taste and aroma in a fermented pickle (Widodo, 2002). The type of bacteria that plays a role in the formation of aroma is *Lactobacillus*, while other bacteria play a role in producing taste (Eren, 2008). Tomato has volatile components which are carboxyl, ester, lactone, acetal, ketal, and sulphur (Viranda, 2009).

**Lactic Acid Content**

Pickle is made by spontaneous fermentation, which is fermentation without microorganism starter addition, but it utilizes natural microorganisms that grow spontaneously because the environment is suitable for producing lactic acid and acetic acid (Alifian, 2016).

The fermentation process of pickle will produce lactic acid. Pickle had 1.06% of lactic acid which tested by laboratory analysis. That percentage is appropriate with pickle standard in SNI No. 01-2600-1992 which stated that pickle contained 1-2% of lactic acid. The total of lactic acid bacteria is directly proportional to the fermentation period. The enhancement of total lactic acid bacteria during the fermentation process is caused by substrate allow the metabolism of LAB (Abdarianzah, 2014). Bacteria growth will be decreased because of environmental changing during the fermentation. That produced acidity situation, so bacteria growth will be hampered (Krisno, 2011). 0.8-2% of acidity that has been produced stated as lactic acid in 5-15% salt solution. That situation will make only lactic acid bacteria growth (Suryadi, 2012). Pickle fermentation is a heterofermentative fermentation type, which produces lactic acid, alcohol, and CO₂.

**Vitamin C**

Tomato as a raw material has 40% of vitamin C, while tomato pickle contains 62.97 mg/100 mL of vitamin C. Fermentation can affect the vitamin C content of pickle product.

**Acidity**

Tomato pickle had 1.95 of acidity, including the category of very acidic. Tomato itself had 3.34 of acidity. Lactic acid which was produced in pickle fermentation can demote acidity. Pickle was made by the addition of a higher concentration of salt solution than vegetable sauerkraut, which used 10-15% of a salt solution commonly.

Lactic acid had the bactericidal effect which demoted the pH of solution into 3-4.5. This condition will hold up decay bacteria (Krisno, 2011). The use of carbohydrate sources greatly affects the final pH of fermentation. The higher the lactic acid content, the lower the pickle pH produced (Ahsyaf, 2014).

**Total Microbe**

Tomato pickle which had been analyzed had 5.7x10⁷ CFU/mL of total microbes. Vegetable fermentation commonly uses lactic acid bacteria. The period of fermentation time influences the group of microorganisms that grow (Abdarianzah, 2014). The temperature during the fermentation process determines the type of dominant microbes that will grow. Lactic acid bacteria are the homofermentative group that will produce lactic acid, CO₂, acetic acid, and ethanol. Examples of the bacteria group are *Lactobacillus Brevis* and *Leuconostoc mesenteroides* (Suryadi, 2012).

**4 CONCLUSION**

House yard can be utilized in organic farm cultivation. Maintenance of organic plant is chemical-free, without pesticide and chemical fertilizer, so this can give a healthy impact. Organic yard crops can be processed into some types of products such as juice, pickle, kimchi, and others. Kimchi was made by vegetables fermented and so do pickle. Panelists told that kimchi and pickle which have been analyzed in this research has acceptable organoleptic value, high vitamin C, high antioxidant activity, acceptable total microbe, and strong acidity. The process of organic crops can increase product value and make product shelf-life longer.
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STUDY OF PROCESS INNOVATION OF AFRICAN CATFISH
(\textit{Clarias gariepinus}) GLUTEN-FREE PRODUCT

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Abstract. African catfish (\textit{Clarias gariepinus}) is one of fish types which is rarely processed into products. This study aims to review cookies, biscuits, sausage, jerked meat, milled jerky meat, and abon made from african catfish to increase value of local food resources as one of diversification products and also increases the functional and economics value. Method that uses in this diversification of African catfish is determining the formula of main ingredients and additional ingredients of the product. Design model which uses in this study is random group design with factorial scheme, and the research variables are African catfish as main ingredient and others additional ingredients that will be added. Responses which will be analysed are physical, chemical, and organoleptically responses. The result of this study shows an influence effect in quality and product. The interaction of main ingredient and additional ingredient concentration affect the quality of the product.

Keywords: Abon, Biscuits, Cookies, Jerky, Sausage
Study Of Process Innovation Of African Catfish (Clarias gariepinus) Gluten-Free Product

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ABSTRACT

Ground dendeng was used as one of innovations of African catfish gluten-free product in this research. The research aims to determine how temperature of drying and addition seaweed could affect African catfish ground dendeng characteristic. Method that used on this research is a randomized block design (RBD). First stage of this research was aimed to determine the best formula of the product and analyze, protein content, water content, and fat content in African catfish meat. This research consisted of 2 factors, that were temperature of drying factor and additional seaweed substitution factor. The research was analyzed in chemical, physical, organoleptical, and microbiological responses. Results of this research showed that water content and taste attribute of African catfish ground dendeng was not affected by temperature of drying and additional substitution of seaweed. The aroma, color, and texture attribute, also carbohydrate, protein, and fat content of African catfish ground dendeng was affected.

Keywords: African Catfish, Additional Seaweed, Ground Dendeng

1 INTRODUCTION

Catfish are much liked by the community because it contains many benefits for human body and health. Catfish originated from Africa and it was first imported to Indonesia in 1984. Catfish are easily accepted by indonesian people because what it contains high nutrition value, rapid growth, high adaptability to the environment, good taste, and low price. Nutritional composition of catfish includes protein content (17.7%), fat (4.8%), minerals (1.2%), and water (76%) (Astawan, 2008).

The advantages of catfish compared with other animal products are its leucine and lysine containing. Catfish processed into many varieties of menus. Starting from the “pecel” menu that is often wanted by customer. Innovations in catfish-based food products become shredded catfish products, catfish bone chips, catfish crackers, catfish ice cream, catfish nuggets, and catfish “dendeng” (Ashriyiah, 2015).

Dendeng is one of the traditional preserved meat products that is very popular in Indonesia (Astawan, 2008). In general the usual “dendeng” that sold in market are made from meat such as cows, chicken or ducks meat. “Dendeng” can not only be made from animal meat but also with the addition of plant foods such as seaweed. One example way to use seaweed is used as an additive in making “dendeng”. Making beef “dendeng” with the addition of seaweed can increase the value of consumption of seaweed products, increase the economic value of seaweed, and add nutritional value to beef “dendeng” products.

Seaweed contains hydrocolloid and pharmaceutical compounds, so seaweed has been used by fishermen and the community as daily food. Several studies have shown that seaweed contains
gelatine, carrageenan and alginate components that have the potential to reduce plasma cholesterol. Gelatine components are known to reduce blood cholesterol by up to 39% (Ren et al., 1994), while alginate has potential to reduce blood cholesterol through inhibition of cholesterol absorption in the intestine (Suzuki et al., 1993).

Seaweed has been utilized as a food, food supplements, pharmaceuticals, cosmetics, textiles, and alternative energy materials which have been widely researched and developed. Each seaweed contains a large nutritional value, such as a source of protein, fat, and carbohydrate (Marinbo Soriano et al. 2006).

Compared to those food from land plants (tubers, fruit, cereals, and beans), total fiber content of seaweed is relatively higher than them. On other hand, fiber that contains in the land food are usually contained more insoluble fiber, whereas some seaweed has higher soluble fiber than the insoluble fiber, such as E. cottonii and S. polycystum. Several studies shown that dietary fiber has important health values, especially in reducing the accumulation of cholesterol in the blood (Alyssa, 2015). “Dendeng” is one of the foods categorized as "Intermediate Moisture Food" which has water activity at 0.6-0.7 as its characteristic which only a small percentage of microbes can grow on the product, so the product has a higher level of durability than other food products in general. One of the most important things in making “dendeng” is drying. Drying aims some water content from a material so that the activity of microorganisms decreases (Winarno et al., 1984). According to Gaman and Sherington (1992), the problem that arises in the drying process is the occurrence of case hardening, which is a condition where the surface of the food becomes wrinkled and hard, and in meanwhile the water is trapped inside.

2 RESEARCH METHODS

The main ingredients that used in this research are african catfish meat (Clarias gariepinus) which obtained from the Gumilang Farm in Sukabumi and seaweed obtained from its cultivation in the Pontang area of Serang Regency in Banten Province. The ingredients used for chemical analysis are alcohol, toluene, aquadest, kjedahl salt, selenium, concentrated H₂SO₄, KI, HCl, NaOH, N-hexane, luff school solution, Na₂S₂O₃, Na₂SO₃, 2 granules of Zink, and indicator phenolphthalein.

The tools that used in African catfish ground dendeng making are cabinet dryer, digital scale, food processor brand Phillips, rubber, knife, cutting board, trays, oven, desiccator, volumetric flask, drop pipette, bunsen, burette, erlenmeyer 250 ml brand Pyrex, condenser, boiling stones, a set of distillation devices, and a texture analyzer.

The preliminary research was carried out by analyzing protein content with kjedahl method, fat content with sohxlet method, and water content with gravimetric method on a raw materials, and determine the formulation of the good African catfish ground dendeng by using the organoleptic test with hedonic method for 30 panelists.

The main research is a further study from preliminary research, which determinates the best drying temperature among 55°C, 60°C, and 65°C and the substitution of seaweed among 15%, 20%, and 25%. The experimental design used in this study was a randomized block design (RBD) with 3 replications.

The design of the responses carried out in the main study of African catfish ground dendeng making are chemical, microbiological, organolepticals, and physical tests that were conducted for selected samples. Chemical analysis are the determination of carbohydrate levels with the Luff-Schoorl method (AOAC, 2010), protein content with the Kjeldahl method (AOAC, 2010), fat content with the Sohxlet method (AOAC, 2010), water content with the gravimetric method (AOAC, 2010), and calculation of RDA (Nutrition Adequacy Rate). The microbiological response is the determination of the number of microbes with total plate count (TPC) method (Fardiaz, 1992). Organoleptical responses carried out with hedonic methods based on the level of preference of panelists, which tested included the color, scent, texture, and flavor responses of African catfish ground dendeng mixed with seaweed. The panelists that have to test the milled “dendeng” of African catfish are 30 panelists on a numerical scale as follows: (1) very dislike, (2) dislike, (3) somewhat dislike, (4) rather like, (5) like,
(6) really like. Physical response are hardness and elasticity test with texture analyzer method on selected samples.

3 RESULTS AND DISCUSSION

3.1. Proximate Result

Preliminary research results aim to determine the composition (protein, fat, and water) of the raw material where the results can be seen in Table 1, and to determine the selected formulation where the results can be seen in Table 2.

Table 1. Results of raw material analysis

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Protein</th>
<th>Analysis Result*</th>
<th>Fat</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Catfish meat</td>
<td>16.63</td>
<td></td>
<td>4.70</td>
<td>78.03</td>
</tr>
</tbody>
</table>

Note: *in %

The preliminary study with 3 (three) different formulations, by performing an organoleptic response with the hedonic method, the treatment formulation number 1 (one) was selected.

The organoleptic results value (Table 2) showed that the taste attribute in each formula was significantly different. This difference formulations produced significantly differences product, that caused by the difference in the amount of palm sugar added to the different formulations.

The more palm sugar added, the more the African catfish ground dendebergrown. The less palm sugar added, the color of the African catfish ground dendeberg was rather brown. The organoleptic results show that the variation of the formula is significantly different from the scent of African catfish ground dendeberg. The scent of dendeberg generally smelled of strong spices. According to Fitriasari (2010), the formation of scents in end product was determined by one of the raw materials.

The gas molecules that stimulated aroma were contained in small number. The organoleptic results showed that the taste attribute in each formula was not significantly different. It was because African catfish ground dendeberg was using the same type of material, so that the flavor of dendeberg did not specifically affect the response of the panelists.

The organoleptic results showed that texture attribute in each formula was not significantly different, because African catfish ground dendeberg was using the same type of material and the addition of seaweed was the same, so the texture of the dendeberg did not specifically affect response of the panelists.

Table 2. Organoleptic result of hedonic method

<table>
<thead>
<tr>
<th>Sample</th>
<th>Color</th>
<th>Aroma</th>
<th>Texture</th>
<th>Flavor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4,50</td>
<td>4,50</td>
<td>4,70</td>
<td>4,10</td>
<td>17,80</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>C</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>2</td>
<td>3,90</td>
<td>3,70</td>
<td>4,33</td>
<td>4,33</td>
<td>16,26</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>A</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>3,93</td>
<td>4,30</td>
<td>4,57</td>
<td>4,33</td>
<td>17,13</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>B</td>
<td>a</td>
<td>a</td>
<td>a</td>
</tr>
</tbody>
</table>

Note: The average value followed by different letters, was significantly different according to Duncan's advanced test at the 5% level.

3.2. Main Research Results

The main research was a continuation of the preliminary research which aimed to determine the drying temperature among 55 °C for 8 hours, 60 °C for 7 hours, and 65 °C for 6 hours and substitution of seaweed additions: 15%, 20%, and 25% the right to the characteristics of African catfish ground dendeberg. In the main research organoleptic test was carried out by using hedonic test on the value of the color, aroma, texture of dendeberg before fried, and the taste of dendeberg after it was frying. In addition, in the main research chemical analysis were carried out, protein, water, fat, carbohydrate content, and microbiological analysis using the total plate count (TPC) method.
3.2.1. Organoleptic Response

1. Color

The results were showed that the drying temperature and seaweed substitution and its interaction had a significant effect on the color of african catfish dendeng (Table 3).

<table>
<thead>
<tr>
<th>Drying Temperature</th>
<th>Seaweed Substitution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>55 °C, 8 hours</td>
<td>4.26 A</td>
</tr>
<tr>
<td></td>
<td>c</td>
</tr>
<tr>
<td>60 °C, 7 hours</td>
<td>4.15 A</td>
</tr>
<tr>
<td></td>
<td>b</td>
</tr>
<tr>
<td>65 °C, 6 hours</td>
<td>4.11 A</td>
</tr>
<tr>
<td></td>
<td>b</td>
</tr>
</tbody>
</table>

Note: Lowercase letters were read horizontally and uppercase letters were read vertically. Different letters stated significant differences in the 5% level of Duncan test.

The results of color attribute testing showed that the higher the drying temperature, the brown color that was formed was thicker and stronger, because it was due to the millard reaction when it was drying at high temperatures on the African catfish ground dendeng (Figure 1).

Figure 1. African Catfish Ground Dendeng

2. Aroma

The results of variation analysis were showed (Table 4) that the drying temperature and seaweed substitution and its interaction significantly influenced the aroma of African catfish ground dendeng.
Table 4. Effect of Interaction between drying temperature and seaweed substitution on aroma attributes

<table>
<thead>
<tr>
<th>Drying Temperature</th>
<th>Seaweed Substitution 15%</th>
<th>Seaweed Substitution 20%</th>
<th>Seaweed Substitution 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>55 °C, 8 hours</td>
<td>4.13 C</td>
<td>4.10 B</td>
<td>4.05 B</td>
</tr>
<tr>
<td>65 °C, 7 hours</td>
<td>4.52 B</td>
<td>3.89 A</td>
<td>4.07 B</td>
</tr>
<tr>
<td>65 °C, 6 hours</td>
<td>3.86 A</td>
<td>3.89 A</td>
<td>3.19 A</td>
</tr>
</tbody>
</table>

Note: Lowercase letters were read horizontally and uppercase letters were read vertically. Different letters stated significant differences in the 5% level of Duncan test.

The results of aroma attribute test showed that the higher the level of addition of seaweed, the more aroma will be produced on the meat.

3. Texture

The results of the variance analysis was showed that the substitution of seaweed had a significant effect on the characteristics of the jerky texture of dumbo catfish, so it continued Duncan's further test for concentration of seaweed (Table 5).

Table 5. Effect of seaweed substitution on the texture attributes of African catfish dendeng

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average result</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td>6.15 a</td>
</tr>
<tr>
<td>25%</td>
<td>6.28 b</td>
</tr>
<tr>
<td>20%</td>
<td>6.42 c</td>
</tr>
</tbody>
</table>

Note: The average value marked with the same letter showed no significant difference at the 5% level of Duncan Test.

The results of texture attributes test showed dendeng texture on seaweed substitution had a significant effect on each treatment. It can be seen that the more the concentration of seaweed, the lower reception of panelists because texture of the catfish grind will be getting stronger and harder.

4. Taste

The result of variance analysis calculation was showed that the drying temperature and the substitution of seaweed and the interaction of both did not significantly affect the taste of African catfish ground dendeng. The results of taste attribute test showed that the most preferred treatment by panelists for the taste of African catfish ground dendeng was the combination of drying temperature 60°C for 7 hours and 15% substitution of seaweed. It was because the treatment has a savory, tasty, and balanced flavor so that the distinctive taste of beef dendeng mixed with African catfish was more taste. Because the addition of spices and seaweed in African catfish ground dendeng making process was dried which effected a maillard reaction and flavor, provided various components of the flavor of African catfish ground dendeng.

3.2.2. Chemical responses

1. Protein content

The result of variance analysis was showed that the substitution of seaweed had a significant effect on protein content of African catfish ground dendeng, so it continued Duncan's further test for concentration of seaweed (Table 6).

Table 6. Effect of seaweed substitution on protein content of African catfish dendeng

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average result*</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>35.35 a</td>
</tr>
<tr>
<td>20%</td>
<td>36.58 b</td>
</tr>
<tr>
<td>15%</td>
<td>38.50 c</td>
</tr>
</tbody>
</table>
Note: *in %. The average value marked with the same letter showed no significant difference at 5% level of Duncan Test.

The results of protein content test showed that the substitution of seaweed into the ingredients had an effect on protein content of African catfish ground dendeng. It can be seen that the more addition of seaweed, the lower protein content of African catfish ground dendeng. It was because more addition of seaweed reduced addition of African catfish meat to the production of beef dendeng catfish to adjust the percentage in the formulation.

2. Water content

The results of variance analysis showed that the drying temperature and the substitution of seaweed and its interaction did not significantly affect the moisture content of African catfish dendeng. Selected treatment for African catfish dendeng was the combination of drying temperature 65 °C for 6 hours with 20% substitution seaweed. The treatment which chosen had the lowest water content of 9.76%.

3. Fat Content

The results of the analysis of variance found that the concentration of seaweed had a significant effect on fat content of African catfish ground dendeng, so it continued Duncan's further test for concentration of seaweed (Table 7).

Table 7. Effect of Seaweed Substitution on Levels of African Catfish Dendeng

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average result*</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>2.15 a</td>
</tr>
<tr>
<td>20%</td>
<td>2.41 b</td>
</tr>
<tr>
<td>15%</td>
<td>2.69 c</td>
</tr>
</tbody>
</table>

Note: *In %. The average value marked with the same letter showed no significant difference at 5% level of Duncan Test.

It was known that the average value of seaweed substitution treatment showed significantly different at the level of 5%. It was explained that substitution of seaweed into the ingredients had an effect on the level of fat content of African catfish ground dendeng. The more addition of seaweed, the lower the level of fat in dendeng. It was because the more addition of seaweed will reduced addition of African catfish meat to the production of dendeng to adjust the percentage, in the formulation of African catfish dendeng.

4. Carbohydrate content

The results of variance analysis told that the substitution of seaweed had a significant effect on carbohydrate content of African catfish ground dendeng, so it continued Duncan's further test for concentration of seaweed (Table 8).

Table 8. Effect of seaweed substitution on carbohydrate content of african catfish dendeng

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average result*</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td>37.48 a</td>
</tr>
<tr>
<td>20%</td>
<td>39.32 b</td>
</tr>
<tr>
<td>25%</td>
<td>40.28 c</td>
</tr>
</tbody>
</table>

Note: *In %. The average value marked with the same letter showed no significant difference at 5% level of Duncan Test.

The results of carbohydrate content test showed that the higher the concentration of seaweed added, the higher the carbohydrate content. This was consistent with the statement of Astawan (2008) that the more vegetable ingredients added to processed animal products, the higher the carbohydrate content contained in it.

3.2.3. Microbiological response

Microbiological response of african catfish ground dendeng was analyzed by the total number of microbes of representative samples. It was aimed to determine how the drying temperature and seaweed concentration can be influenced the microbial growth. The results of microbiological test analysis revealed that the lowest number of microbes was found in the treatment of drying at 65 °C for 6 hours with 15% substitutional seaweed. Bacterial growth in general will be influenced by
environmental factors. The influence of these factors will give an illustration that showed an increase in the number of different cells.

3.2.4. Physical response

The results of variance analysis showed that the drying temperature (60 °C, 7 hours) with the substitution of seaweed (15%) was selected by analyzing the physical response of texture analyzer test, because the treatment was preferred by panelists in terms of color, aroma, taste, and texture and has a 38.24% of protein, and 2.69% of fat.

Results of the texture analyzer test with the attributes of hardness and suppleness of selected African catfish ground dendeng products were 3888.0 g force and 2.29%. It was known that the ground dendeng had a high level of hardness and elasticity. The addition of seaweed concentration and drying temperature caused an increase in hardness and suppleness in African catfish ground dendeng.

4 CONCLUSION

The drying temperature had an effect on the color and scent of dendeng catfish, but did not affect the texture, taste, protein, fat, water, and carbohydrate content of African catfish dendeng. Seaweed substitution influenced the color, scent, texture, protein, fat, and carbohydrate content of African catfish dendeng, but did not affect the taste and moisture content of African catfish dendeng. The interaction between drying temperature and seaweed substitution influenced the scent and color, but did not affect the texture, taste, protein, water, fat, and carbohydrate content of African catfish dendeng. Based on the calculation of % AKG according to energy requirements dendeng catfish products was 2000 kcal/day obtained in 100 grams of serving which contained total calories of 326 kcal, where there was 24 kcal fat, 152 kcal protein, 150 kcal carbohydrate.

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Certificate of Completion

This Certificate is Awarded to:

Dr. Hasnelly, Ir., M.S

For the participation in International Joint Seminar:

*Indonesian High Education Institution Strategy in Facing the Industrial Revolution 4.0*.

And for having presented a paper entitled:

*Optimization of Breakfast Cereal Product Using Design Expert Program*

Held in Universitat Internacional de Catalunya (UIC), Barcelona, Spain, on November 11th, 2019

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OPTIMIZATION OF BREAKFAST CEREAL PRODUCT USING DESIGN EXPERT PROGRAM

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ABSTRACT

Current demand for gluten-free products is increasing along with the high demand of consumers for products that have a high health impact. Consumers who need gluten-free products are those who have special needs such as celiac sufferers, diabetics, and obesity. Composite flour formula is one of the main factors that can affect the characteristics of the products produced. Optimization for composite flour needs to be done so that the characteristics of gluten-free cereal flakes products match the attributes of gluten-containing flakes. Optimization of composite flour formula was carried out using the Design-Expert version 11.0 program with the D-optimal method. The results of the composite flour optimization using the Design-Expert version 11 program showed that the optimal formula can meet national and international quality standards for flakes products.

Keywords: Breakfast cereal flakes, Gluten-free, Composite Flour, Design Expert program

1. INTRODUCTION

Breakfast cereal is one type of food that is often consumed in several countries. The consumption level of breakfast cereal in Europe is as much as 2 Kg of breakfast cereal per capita. Ireland is a country with the highest consumption of breakfast cereal. The breakfast cereal industry in Europe produces 1.1 million tons annually. The process of making breakfast cereal includes several stages of the process, namely grinding, boiling, mixing, cooking, extruding, puffing, and cooling. This breakfast cereal consists of several forms such as flakes, puffs, shreds, and granola.

Breakfast cereal has an essential role in the diet and ensures the function of the organism works well as in the digestive tract system. Breakfast cereal, especially flakes, is an important type of breakfast food, especially in western countries [1]

Ready-to-eat cereal is usually consumed with milk. The recommended method of consumption is 30 g of cereal serving added with 125 mL of skim milk [2]. Flakes are processed products that are consumed by soaking in milk [3].
Manufacturers of gluten-containing products must start making gluten-free products that have the same characteristics or not much different from products with gluten. This aimed to satisfy consumer's demand for gluten-free products [8].

The main challenge in developing gluten-free products is ensuring that the product has the desired taste and texture, such as products that contain gluten. Gluten-free cereal food products are made from gluten-free flour or unmodified starch or modified starch, so the product will provide only carbohydrate and fat intake. Mechanical and sensory challenges must be found solutions in preparing gluten-free products because dough without gluten has a weak structure and a different texture from products that contain gluten. The gluten-free products that are produced should be not only gluten-free but also have nutritional content comparable to products that contain gluten [7].

The difficulty in product optimization is the number of parameters that must be optimized at the same time, and not all parameters can be known at the beginning of the optimization phase. Optimizing, some of the objectives carried out together will provide efficient solutions based on goals and not exacerbated in other objectives [9].

Composite flour that will be used to make cereal flakes is taro flour, mung bean flour, and black mulberry leaves. The three components have excellent nutritional content so that they are expected to provide more health value to the products produced. The purpose of composite flour production is to obtain the preference characteristics of raw materials and to obtain specific functional features [10]. Composite flour used as a material in making breakfast cereal flakes consisting of taro flour (Colocasia esculenta), mung beans (Phaseolus radiatus L.), and black mulberry leaves (Morus nigra).

Talas can be a source of local ingredients that can be used as an alternative food. Taro is a source of local food that is high in carbohydrates, in 100 grams of taro contains 145 Kcal of energy, 34.20 grams of carbohydrates, 0.4 grams of fat and 1.2 grams of protein [11].

Tuber processing is an effort to support food diversification programs by utilizing local food sources. Taro is generally processed by boiling, fried, made into chips, and usually, the leaves and stems are used as ingredients for making vegetable soup. Taro can also be processed into flour as a raw material for making various processed foods. Taro flour can be made into cakes, bread, donuts, and others to enrich existing nutritional value [11]. Taro tubers can be transformed into various semi-finished food products such as flour, pasta, etc., or finished products such as snacks, cakes, noodles, and others. Taro flour is processed into baby food in the United States, various cakes in the Philippines and Colombia, bread in Brazil, and different foods such as dodol, cakes, and chips in Indonesia [10]. One of the functions of starch can be to change the texture, thickening material, suspended solids, or facilitate food processing [12].

Mung beans have been considered typical traditional food throughout the world for more than 3500 years. Mung beans are often consumed as sprouts in fresh salads. Mung beans are famous for their detoxifying properties. Mung beans are recognized to have high nutritional value. Mung beans have a protein of around 20-25% of the total dry weight, including 60% globulin and 25% albumin as the primary protein fraction. The current intake of mung beans increases significantly with other cereals. Proteins in mung beans contain a large number of
essential amino acids including phenylalanine, leucine, isoleucine, valine, tryptophan, arginine, methionine, and lysine. Mung beans are considered a substantive dietary protein source [13].

Mung beans contain carbohydrates by 55-65% of their dry weight. Carbohydrates contained in mung beans are easy to digest compared to carbohydrates contained in other nuts. Mung beans produce lower calories compared to other cereals, so they are beneficial for people with obesity and diabetes. Mung beans contain tannin, phytic acid, trypsin inhibitors, hemagglutinin, and other antinutrients that have health benefits and have a detox function [13].

Mulberry leaf is one of the traditional medicines commonly used in China [14]. Mulberry leaves are used in Asia and Europe as food and drinks for sore throats. Some health benefits can be obtained from consuming mulberry leaves. Mulberry has been widely known for having a therapeutic effect on diabetics. Many studies on the hypoglycemic mechanism of mulberry leaves. The main active ingredient in mulberry leaves is flavones, polysaccharides, and alkaloids. Flavonoids in mulberry leaves have benefits like antioxidants, anti-bacterial, anti-inflammatory, anti-viral, lowering blood sugar, lowering blood pressure, and can improve heart and liver function. The polysaccharides contained in mulberry leaves have a significant hypoglycemic effect and inhibit the increase of lipids in the blood [14].

This research aims to optimize the formula of composite flour, which consists taro flour, mung bean flour, and black mulberry leaves. This research aims to obtain the best flakes formula according to the standard that has been determined using the Design-Expert version 11.0 D-optimal method.

2. MATERIAL AND METHODS

2.1. Material

The materials that will be used to make gluten-free cereal flakes are a mixture of flour made from taro tuber flour, mung bean flour, black mulberry leaf flour obtained from the Cibodas Lembang area, then mixed with the skim milk powder, salt, sugar, and water.

2.2. Methods

2.2.1. Preliminary Research

Preliminary research consists of three stages. The first step is making flour from black mulberry leaves. The process used in making the flour is bleaching and without using bleaching. After the powder is finished, then a preference test is performed. Flour with the highest preference value will be used in primary research. The attributes of flour tested are color and aroma. The second stage of the preliminary research is to make flour from taro. The third stage of preliminary research is testing the nutritional content of raw materials. The nutritional content analyzed is carbohydrate content and protein content.
2.2.2. Determination of Composite Cereal Flakes Optimal Formula

The research method that was carried out was the optimization of cereal flakes from composite flour using the Design-Expert program (version 11.0, Licensed by Stat-Ease Co., 2018, Minneapolis MN, USA). Design Expert 11.0 is a program used to process statistical data based on linear programs. One of the functions of the Design-Expert program is to determine the optimal formula for product development or manufacturing of new products.

The first step in finding the optimal formula is to determine in advance the number of independent variable components in the flakes. The optimal formula will be determined the upper and lower limits of the independent variable. Components that are used as an independent variable in making cereal flakes are taro flour, mung bean flour, and black mulberry leaves. The total concentration of the independent variable must be determined in advance so that the program can provide formula design data according to the number of independent variables. The number of replications and responses to be used as test parameters are then determined. The responses tested on the optimization results in this study were protein levels and carbohydrate levels. The Design Expert program will produce several designs of flakes formulations that will be made and tested. The results of laboratory testing of the design of the flakes product formula are inputted into the Design-Expert program to be processed statistically. The effect of each response used as a parameter to the finished product will be known after data processing is complete. The Design Expert program will provide the optimal formula for breakfast meal flakes based on the results of the data processing and the estimated response rate of the optimal formula given. The optimal formula for flakes is then made and tested according to a predetermined response to verify the results provided by the Design Expert program. Its chemical content characterizes the optimal breakfast meal flakes formula.

3. RESULTS AND DISCUSSION

3.1. Preliminary Research

3.1.1. Black Mulberry Leaf Flour

The results of the organoleptic test on black mulberry leaf flour showed that the sample with blanching treatment was preferred by panelists when compared with samples without blanching treatment.

3.1.2. Taro Flour

Taro flour is made using 5 kg taro tubers (Colocasia esculenta) which was dried using a cabinet dryer and sifted using an 80 mesh sieve to produce 1000 g of taro tuber flour.
3.1.3. Testing of Raw Material Nutrition

Testing the nutrient content is done on taro flour and mung bean flour where nutritional testing includes carbohydrate content and protein content. Based on the test results found taro flour contains carbohydrates of 85.27 g.100g-1 and proteins of 6.45 g.100g-1 and mung bean flour contain carbohydrates of 63.9 g.100g-1 and protein of 27.5 g.100g-1.

3.2. Main Research: Optimal Formula for Composite Metal Flakes

3.2.1. Data Analysis Using Design Expert 11.0

Protein Levels

The results of data processing by the Design Expert program on the levels of composite flour flakes based on taro flour (A), mung bean flour (B), and black mulberry leaf flour (C), gave rise to recommendations for linear polynomial models. The results of the variance analysis (Table 1) processed by the Design Expert 11.0 program on protein levels of cereal flakes showed significant results. The description of influence given from each of these relationships can be seen from the estimated coefficients of each relationship. Below is the coefficient of each factor contained in the coded equation as follows:

\[
\text{Protein Content} = -51.66 + (-60.02)A + (-58.86)B + (-60.31)C
\]

The resulting mathematical model shows that protein content is influenced by the addition of mung bean flour (B) because it has the largest coefficient value among the three components.

Different colors on the contour plot graph (Figure 1) show the response value of composite breakfast protein flakes from the lowest (blue), which is 6.85 g.100g-1 to the highest (red), which is 9.78 g.100g-1. The three-dimensional graph (Figure 1) shows the interaction between components where the difference in surface height shows the response values of different protein levels in each formulation.

Carbohydrate Levels

The results of carbohydrate composite flour flakes based on taro (A), mung beans (B), and black mulberry (C) tubers obtained the recommendation of the polynomial model suggested by the Design Expert 11.0 program to be linear. The results of the variance analysis (Table 2) processed by the Design Expert 11.0 program on carbohydrate levels at breakfast meal flakes showed significant results. The influence given from each of these relationships can be seen from the coefficients of each relationship.
Carbohydrate level = 1135.64 + 1072.13A + 1068.91B + 1067.74C

The result of mathematical model showed that the carbohydrate content of breakfast meal flakes is influenced by the addition of taro flour (A) because it has the highest coefficient value among the three components.

Different colors on the contour plot graph (Figure 2) show the response rate of carbohydrate composite breakfast meal flakes from the lowest (blue), which is 63.21 g.100g-1 to the highest (red), which is 74.79 g.100g-1. The three-dimensional graph (Figure 2) shows the relationship of interaction between components where the difference in surface height shows the response values of different carbohydrate levels in each formulation.

3.2.2. Selected Formulation

The optimization process of each independent variable will be given a certain level of importance to achieve the objectives sought (Table 3). This level of importance will determine the formula produced by the program and the quality of the breakfast meal flakes product.

The selected formulation is the optimal solution or formulation predicted by Design Expert 11.0 based on the analysis of the response of protein content and carbohydrate levels. The accuracy of the formulation and the value of each response can be seen in desirability. Desirability is the degree of accuracy of the results of optimal solutions or formulations. The closer to the value of one, the higher the value of the accuracy of the formulation, so it can be concluded in this study with a desirability value of 0.962, that the formulation produced has relatively high accuracy.

The Design Expert 11.0 program provides 100 possible optimal formulations of composite flour flakes based on taro tubers, mung beans, and black mulberry leaves. The formulation chosen is a formula that has the highest desirability value.

The optimal formula chosen is 25.016% taro flour, 20% mung bean flour, and 5.004% black mulberry leaf flour. This optimal formula is estimated by the Design Expert 11.0 program to contain carbohydrates of 69 g.100g-1 and proteins of 9.563 g.100g-1 (Table 4). The contour plot and 3-D desirability graph of gluten-free flakes can be seen in Figure 3.

3.2.3. Verification

The optimal formula selected for cereal flakes products is then analyzed in the laboratory. The results of laboratory analysis are then compared with the levels of carbohydrates and proteins provided by the program. Comparison between the program calculations results and laboratory analysis is intended to measure the degree of accuracy of the program in addition to the desirability factor. Based on the data generated (Table 5), the difference between the two results is relatively not too far away so that the program can be said to have good accuracy in determining product formulation.

According to the Indonesian National Standard (SNI), the nutrient content for flakes products has a minimum protein content of 5 g100g-1 and a minimum carbohydrate content of

66
60 g/100g-1. In this study, the protein and carbohydrate content of cereal flakes products in this study were by SNI requirements, both from the results of program calculations and also the results of laboratory analysis.

3.2.4. Characterization of Selected Formula

Antioxidant Levels

Antioxidants are needed by the body to protect the body from attacks by free radicals. The IC50 value is the concentration of substrate solution or sample that can reduce DPPH activity by 50%, or it can be said that the number shows the concentration of extract (mg/ L) which can inhibit the oxidation process by 50%.

Based on the testing of the content of the antioxidant activity in selected formulation samples, the results were 239,845 mg.kg-1. The results of the study stated that the value of the antioxidant activity of selected formulated composite flour flakes products was categorized as weak.

Fat Level

Fat and oil are essential food substances to maintain the health of the human body; besides fat and oil are also useful energy sources apart from carbohydrates and proteins. Fats and oils are found in almost all foods at varying levels. The heating process can reduce the fat content of food, as well as the fatty acids, both essential and non-essential [15].

Based on the testing of the fat content of composite flour flakes products, the results obtained were 1.78 g.100g-1, these results did not meet the standards set out in SNI where the expected value was above five g.100g-1. Composite breakfast flakes are also below the standard set by the USDA National Standard, which is 3.36 g.100g-1. Fat levels that are below the standard in composite flour flakes products based on taro tubers, mung beans, and black mulberry leaves are due to the low-fat content of the raw materials used, thus affecting the fat content of the finished products. The solution to overcome the low-fat content in composite flour flakes products can be done by replacing skim milk using full cream milk, which is more abundant in fat content so that it is expected to meet established standards. These flakes products will have more value for consumers who are on a diet program.

Water content

Water is an essential component in food ingredients because water can affect the appearance, texture, and taste of food ingredients. Water content in food ingredients will determine the freshness and durability of food [15].

Based on the testing of moisture content in composite flour flakes, a value of 2.95 g.100g-1 was obtained, the amount is still below the maximum limit specified by SNI, which is equal to a maximum of 3 g.100g-1. The water content of composite breakfast flakes is above the USDA National Standard, which is 2.53 g.100g-1, but it can be said that this result is not much different.
Crude Fiber Levels

Crude fiber is a part of carbohydrate which has been separated from extract without nitrogen (BETN) which consists of starch, using simple chemical analysis [18]. Crude fiber consists of cellulose, hemicellulose, and lignin. Van Soest's analysis can measure the crude fiber fraction based on its solubility in detergent solutions [18].

Based on the testing of crude fiber content in composite flour flakes, the results were 3.8 g.100g-1. The standard determined by SNI for crude fiber content is a maximum of 5 g.100g-1; the results of this product analysis are still below the specified maximum limit. The crude fiber content in low flakes is an advantage in itself because the crude fiber content in food products must be minimized.

Ash content

Ash content is a mixture of inorganic or minerals contained in a processed food ingredient. Food consists of 96% organic matter and water, while the rest are mineral elements; these elements are also known as organic matter or ash content. The value of ash can indicate how much minerals in a food ingredient. Organic materials in the combustion process will also burn, but the inorganic substance is not, therefore, it is called ash content. Determination of ash content can be used to determine whether the processing is done correctly or not, to determine the type of materials used, to determine the parameters of the nutritional value of a food ingredient. The ash content can be used to estimate the content and authenticity of the ingredients used [16].

The results of ash content testing on composite flour flakes showed a yield of 2.91 g.100g-1. The standard ash content specified in SNI for flakes products is a maximum of 4 g.100g-1. The result of the ash content analysis shows the flakes product has a lower value than the required amount; this concluded that the product meets the standards in terms of ash content.

4. CONCLUSIONS

The results showed that the Design-Expert version 11.0 program using the D-optimal method could be used in finding the optimal formula for breakfast flakes made from gluten-free composite flour. Optimized composite flour consists of taro flour, mung bean flour, and black mulberry leaves. The optimization process uses multiparameter. The Design-Expert version 11.0 program can design formulas according to consumer demand and adhere to existing product quality standards. The optimal formula produced has characteristics that are not much different from existing flakes products. The nutritional content of composite breakfast flakes has also met the nutritional standards set out in SNI and USDA.
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REFERENCE


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Table 1. ANOVA for Linear Model of Protein Content of Breakfast Flakes Gluten-Free

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<tr>
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<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-value</th>
<th>p-value</th>
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<td>Model</td>
<td>8.79</td>
<td>3</td>
<td>2.93</td>
<td>15.73</td>
<td>0.0004</td>
<td></td>
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<tr>
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<td>1</td>
<td>0.0616</td>
<td>0.3306</td>
<td>0.5780</td>
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<td>C-Black Mulberry Leaf Flour</td>
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Table 2. ANOVA for Linear Model of Carbohydrate Content of Breakfast Flakes Gluten-Free

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Table 3. Optimization Breakfast Flakes Gluten-Free

<table>
<thead>
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<th>Goal</th>
<th>Lower Limit</th>
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<tr>
<td>A: Taro Flour</td>
<td>Is in range</td>
<td>25</td>
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<tr>
<td>B: Mung Bean Flour</td>
<td>Is in range</td>
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<td>3</td>
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<tr>
<td>C: Black Mulberry Leaf</td>
<td>Is in range</td>
<td>5</td>
<td>15</td>
<td>3</td>
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</table>
Flour
Carbohydrate Content  Is target = 69  63.21  74.79  3
Protein Content  Maximize  6.85  9.78  3
Taste  None  3.3  3.73  3
Aroma  None  2.97  3.73  3
Colour  None  2.9  3.67  3
Texture  None  3.17  3.73  3

Table 4. Formula Optimization Breakfast Flakes Gluten-Free

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<tr>
<th>Taro Flour</th>
<th>Mung Bean Flour</th>
<th>Black Mulberry Leaf Flour</th>
<th>Carbohydrate Content</th>
<th>Protein Content</th>
<th>Desirability</th>
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<td>25.016</td>
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<td>5.004</td>
<td>69.000</td>
<td>9.563</td>
<td>0.962</td>
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Figure 1. Contour plot and 3D Graph of Gluten-Free Protein Flakes Response
Figure 2. Contour plot and 3D Graph of Gluten-Free Carbohydrate Flakes Response

Figure 3. Contour plot and 3D Graph of Gluten-Free Desirability Flakes
Figure 4. Capture of Product (Flakes)
5. Lampiran Data Analisis dan Foto Produk yang di Analisis

### FORM HASIL ANALISIS

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**TLP/HP** : 0811 – 215 – 018  
**SAMPEL** : Keripik Jagung  
**KEMASAN** : Plastik

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<th>%AKG/100g</th>
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<tr>
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<td>Serat</td>
<td>%,b/b</td>
<td>2.0217</td>
<td>4.0434</td>
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</tbody>
</table>

**NAMA** : Dr. Ir. Hj. Hasnelly, MSIE  
**ALAMAT** : Teknologi Pangan FT - Unpas  
**TLP/HP** : 0811 – 215 – 018  
**SAMPEL** : Cookies Havermut Chocochip  
**KEMASAN** : Plastik

## HASIL PEMERIKAAN

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<tr>
<th>No.</th>
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</table>

**NAMA** : Dr. Ir. Hj. Hasnelly, MSIE  
**ALAMAT** : Teknologi Pangan FT - Unpas  
**TLP/HP** : 0811 – 215 – 018  
**SAMPEL** : Cookies Havermut Cheese  
**KEMASAN** : Plastik

## HASIL PEMERIKAAN

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FORM HASIL ANALISIS

NAMA : Dr. Ir. Hj. Hasnelly, MSIE
ALAMAT : Teknologi Pangan FT - Unpas
TLP/HP : 0811 – 215 – 018
SAMPEL : Rangginang Beras Putih Organik
KEMASAN : Plastik

HASIL PEMERIKSAAN

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NAMA : Dr. Ir. Hj. Hasnelly, MSIE
ALAMAT : Teknologi Pangan FT - Unpas
TLP/HP : 0811 – 215 – 018
SAMPEL : Rangginang Beras Merah Organik
KEMASAN : Plastik

HASIL PEMERIKSAAN

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NAMA : Dr. Ir. Hj. Hasnelly, MSIE
ALAMAT : Teknologi Pangan FT - Unpas
TLP/HP : 0811 – 215 – 018
SAMPEL : Rangginang Beras Brown Organik
KEMASAN : Plastik

HASIL PEMERIKSAAN

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FORM HASIL ANALISIS

NAMA : Dr. Ir. Hj. Hasnelly, MSIE
ALAMAT : Teknologi Pangan FT - Unpas
TLP/HP : 0811 – 215 – 018
SAMPEL : Rangginang Ketan Putih
KEMASAN : Plastik

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NAMA : Dr. Ir. Hj. Hasnelly, MSIE
ALAMAT : Teknologi Pangan FT - Unpas
TLP/HP : 0811 – 215 – 018
SAMPEL : Rangginang Ketan Hitam
KEMASAN : Plastik

HASIL PEMERIKAAN

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