Sri Atmaja, Novizar Nazir, Adhi Harmoko Saputro, Rahmat Hidayat, Ario Betha Juanssilfero, Slamet Riyadi

International Journal on Advanced Science, Engineering and Information Technology

Vol. 3 (2013) No. 2
ISSN: 2088-5334

INSIGHT Pub.
Preface

It is our great pleasure to present the Vol. 3 of the International Journal on Advanced Science, Engineering and Information Technology (IJASEIT). This volume comprises articles which are presented in the 1st International Conference Sustainable Agriculture, Food and Energy (SAFE2013) held in Padang, West Sumatera, Indonesia, 12-13 May 2013. Article submissions came from different countries that cover varies topics in science, engineering and sustainability. This volume consists of 119 articles classified into six issues based on their field of study.

We would like to take this opportunity to thank all colleagues who had submitted their articles to the IJASEIT through the committee of the 1st SAFE2013. A lot of number of submissions indicates their high trustworthy to us to publish their current findings and spread to wide academic communities. We also send our appreciation to all reviewers who had dedicated their valuable time and comments to ensure articles significantly contribute to science and technology. In addition, we would like to acknowledge the organizing committee of the 1st SAFE 2013 for this great collaboration and the Editorial Board who had worked hard to prepare this volume.

We are pleased to inform you that the editorial boards of the journal have been trying to widen the journal indexing to main databases and to receive regular submissions for publication for the forthcoming issues. We are committed to serve a fast publication and provide quick access to the recent articles for academic communities globally.

Finally, we do hope that articles published in this volume might inspire a state of the art research and new findings for the advancement of science, engineering and information technology.

May 2013

Sri Atmaja
Novizar Nazir
Adhi Harmoko Saputro
Rahmat Hidayat
Ario Berta Juanissilfero
Slamet Riyadi
# Table of Content

**An Organic Certification of Organic Salak Pondoh (Salacca zalacca var.pondoh): South Sumatera Experience**
*Herfiani Rizkia, Wahyu Anisa Sari* ................................................................. 1

**MedLeaf: Mobile Application for Medicinal Plant Identification Based on Leaf Image**
*Desna Sandy Prasvita, Yenti Herdiyeni* ................................................................. 5

**The Integration of Cleaner Production Indicators on the Environmental Performance Measurement System for the Indonesian Natural Rubber Industry**
*Sawarni Hasibuan, E. Gumbira-Sa'id, Eriyatno, Illah Saillah, Sulharto Honggokusumo, M. Romli* ................................................................. 9

**Effect of Dope Solution Temperature on Characteristic and Performance of Cellulose Diacetate Membrane Based on Cellulose of Sengon Wood (Paraserianthes falcatoria sp)**
*Cut Meurah Rosnelly, Darmadi, Sofyana* ................................................................. 15

**The Effect of Substrat Ratio Fish Oil and Milk Fat on Synthesis of Structured Lipid by Enzimatic Transesterification**
*Edy Subroto, Tensiska, Rossi Indarto, & Chusnul Hidayat* ................................................................. 19

**Sustainability Analysis for Gayo Coffee Supply Chain**
*Rachman Jaya, Machfud, Sapta Raharja, Marimin* ................................................................. 24

**Optimization of Business Partners Feasibility for Oil Palm Revitalization Using Fuzzy Approach**
*Jiliza Hidayati, Sukardi, Ani Suryani, Sugiharto, and Anas M.Fauci* ................................................................. 29

**Synthesis, Structural and Antioxidant Properties of C-p-methoxyphenylcalix[4]resorcinarene**
*Aishah Hasbuliah, Hanza,M.Abosadiya, Jumina, M.Ibrahim M.Tahir and Bohari M. Yamin* ................................................................. 36

**Protonated 14-membered 5,5,7,12,12,14-hexamethyl-1,4,8,11-tetrazacyclotetradeca-7,14-diene Salts and Their Biological Activity**
*Siti Fairus M. Yusoff, Wafuuddin Ismail, Nazlina Ibrahim and Bohari M. Yamin* ................................................................. 40

**Consumer Behavior on The Choice of Typical Regional Food Products Based on External and Internal Factors, Perception, Attitude and Consumer Preference**
*Dwi Gemina, Titiek Tjahya Andari, Indra Cahya Kusuma* ................................................................. 43

**Ethylendiammonium-Dicarboxylate Salts and Co-Crystallization for Biological and Pharmaceutical Applications**
*Bohari M. Yamin, Leila Narinani, Nazlina Ibrahim* ................................................................. 47
A Preliminary Study on Gum Arabic as a Binder in Preparation of Starch Based Edible Plastic
N. Ayuni A. Apandi, N. A. Salfarina A. Razak, Mustika Masri, S.F. Yusoff & Azwan Mat Lazim

Plywood Industry by Using Eco-efficiency Approach and LIA- Wood Balance Sheet Program
Yulia Nurendah, E. Gumbira Said, A. Miftah Faizi, Zahrial Coto, M. Romli, Hartrisari

The Characteristic Change of Shallot (Allium ascalonicum L.) During Curing Process
Mohamad Djali, Selly Harnesa Putri

Thermally Activated Palm Kernel Based Carbon as a Support for Edible Oil Hydrogenation Catalyst
Abdulmajid Alshaibani, Zahira Yaakob

Pre-Optimization Conditions for Haematococcus pluvialis Growth
Nurul Asmidar Hanan, Najeeb Kaid Al-Shorgani, Hafiza Shukor, Norliza Abd. Rahman, Mohd Sahaid Kalil

Optimization of Multilevel Ethanol Leaching Process of Porang Flour (Amorphophallus muelleri) Using Response Surface Methodology
Anni Faridah, Simon Bambang Widjanarko

Design of Thermal Conductivity Apparatus Base on Transient-state Radial Cylinder Method
Bambang Dwi Argo, Wahyunanto A. Nugroho, Yoes B. Pristy, Ubaidillah

Case Study of Maize Planting On Marginal Dry Land in The Rainy Season in Lampung
Bariot Haff, Meidaliantisya

Detection of Ethanol Adulteration in Citronellal Oil by using Near Infrared Spectroscopy and Multivariate Data Analysis
Hesti Melina, M. Dani Supardan, Alfiat Putra, Shinichiro Kuroki, Roumiana Tsenkova
Optimization of Multilevel Ethanol Leaching Process of Porang Flour (Amorphophallus muelleri) Using Response Surface Methodology

Anni Faridah¹, Simon Bambang Widjanarko²

¹Faculty of Technology, Padang State University, Padang, Jalan Prof. Dr. Hanka Air TawarPadang - Sumatera Barat, Indonesia
E-mail: faridah.anni@gmail.com

²Faculty of Agricultural Technology, Brawijaya University, Malang, Jalan Veteran, Malang, JavaTimur, Indonesia
E-mail: simonbw@brawijaya.ac.id

Abstract— Porang flour is a processed product derived from porang tuber (Amorphophallus oncophyllus), contains polysaccharide hydrocolloid such as glucomannan and it can be used as gelatinization, viscosity, filming, emulsifier and stabilizer agent. Porang flour has low content of glucomannan, contributing to its dark brown color and contains high level of calcium oxalate which can cause itching, irritation and other health effects. In this study, the multilevel ethanol optimization and maceration method were used to extract the glucomannan content from porang flour by the leaching process. Response surface methodology (RSM), Central Composite Design (CCD) on three independent variables leaching time ($X_1$), stirring speed ($X_2$) and ratio of solvent to flour ($X_3$) with response of glucomannan content and calcium oxalate) were used as a tools to study the optimum responses. Responses model were quadratic with optimal condition as follows: leaching time was 4 h 6 min and 18 sec, stirring speed was at 443.45 rpm and ratio of solvent to flour was 8.92 ml/g. Under these conditions, the experimental yield of glucomannan content and calcium oxalate were 79.19 % and 0.08 %, respectively, which were very close to the predicted values of 79.26 % and 0.07 %, respectively.

Keywords— Response Surface Methodology; Glucomannan; Calcium Oxalate; Optimization; Porang Flour.

I. INTRODUCTION

Porang flour is a processed product from porang tuber (Amorphophallus oncophyllus) produced. Using stamp mill and contains about 67.5% (Faridah, 2011). This is much lower than the normal glucomannan level needed which is about ≥ 90%. Thus, there is a need to conduct studies on how to enhance the recovery rates of glucomannan in porang tuber.

Glucomannan is a soluble dietary fiber that has strong hydrocolloid properties and calorie content. Due to its glucomannan content, porang flour have potential role as a major export commodity in food, non-food and health-purposing manufactured-food (Kohyama et al., 1993). Glucomannan, due its high fiber contents, can be used as a food additive.

In Indonesia, the main problems on the development of porang flour were due to the fact that the after processed flour has low levels of glucomannan and high presence of calcium oxalate. It is a well known facts that calcium oxalate causes itching, skin irritation, crystalization in the kidney and other health’s effects. Therefore, it has not been applied in the manufacturing of food product in Indonesia. So, it is clear that improving the glucomannan and reducing the calcium oxalate in porang flour is very important to enable it to be used in food manufacturing. In this study, recovery of glucomannan was conducted by the addition of porang flour to ethanol solution or leaching by multilevel ethanol using RSM.

Water and organic solvent as media, which have miscible properties, can be use in purifying the porang flour. Ethanol solvent has volatile properties, colorless, and non-toxic to human life (Sugiyama et al., 1971; Widjanarko et al., 2011). Ethanol will not propagate porang flour expansion. To date, there is a dearth of information on the method for the recovery of porang flour with high glucomannan content. The objectives of this research were to optimize the time, the stirring speed and the best ratio between multilevel ethanol to porang flour, in order to producelow level calcium oxalate and high level of glucomannan content.

II. MATERIALS AND METHODS

A. Materials

Porang or local name for conjac bulb, native to Indonesia, with diameter ranged 15-25 cm, height ranged 5-10 cm and...
weight ranged 500-2500 g were obtained from Sumber Bendo Village, Saradan Subdistrict, Madiun Regency, Indonesia. The chemicals with pro analysis (p.a) purity were NaOH, formic acid, concentrated HCI (37%), concentrated H2SO4 (95%), CaCl2, ether, metil red indicator, phenolphetamine (pp) indicator, NH2OH, Kjeldahl tablet, boric acid 30%, sodium sulfate, dinitrosalylicacid (DNS).

B. Extraction methods

Porang flour (25 g) was weighed and transferred into sterile beaker glass. To extract the porang flour, 200 mL of ethanol 40% and 50 mL hydrogen peroxide 0.5% were added to the mixture and stirred using homogenizer based on the design described in Table 2. Porang flour was filtered, and the deposit was rinsed using ethanol 60% and was subjected to the mixture. The solution of porang flour was filtered from deposit and separated from filtrate. The deposit was subjected to the mixture. The solution of porang flour was added to the mixture and stirred using homogenizer based on ethanol 40% and 50 mL hydrogen peroxide 0.5% were sterile beaker glass. To extract the porang flour, 200 mL of ethanol 40% and 50 mL hydrogen peroxide 0.5% were added to the mixture and stirred using homogenizer based on the design described in Table 2. Porang flour was filtered, and the deposit was rinsed using ethanol 60% and was subjected to the mixture. The solution of porang flour was filtered from deposit and separated from filtrate. The deposit was rinsed using ethanol 80%, and then filtered using Whatman paper 41 (length : 35 mm, width : 5mm). The deposit was dehydrated by drying in oven at 40°C for 12 h to produce porang flour from maceration extraction.

C. Analysis methods

Water content was determined by weight difference after drying of samples, following the official method of AOAC (1995). Fat content was determined using a Soxhlet apparatus according to AOAC (1995). Protein content was calculated from the nitrogen content (N% : 6.25) analyzed by Kjeldahl method. Ash was determined gravimetrically (AOAC, 1995). Starch content as described by Zapata et al. (1995). Yield was calculated based on the weight of the crude porang flour to the total weight of porang used. Calcium oxalate was determined as described by Ukpabi and Ejob (1989) and glucomannan assay was conducted as described by Peying et al. (2002). Scanning electron microscope (SEM) (Instruction Manual FEI type InspectS50) was used to observe microscopically on rough porang flour and leaching optimization process of porang flour was carried out using maceration method.

D. Experimental design

The improving of glucomannan content and reducing of calcium oxalate content by multi level ethanol were optimized using RSM, employing the CCD. The range and center point values of three independent variables were as presented in Table 1 were based on the results of preliminary experiments on the extraction of porang flour as described under the extraction method section in this study (Widjanarko et al., 2011). Leaching time (X1), stirring speed (X2), and ratio of solvent ethanol toflour (X3) were chosen for independent variables.

All treatments comprised of 20 proceses of leaching, in which each process condition followed the central composite design. Analysis of the experimental design and calculation of predicted data were carried out using Design expert Software version 7.1 to estimate the responses. The behavior of the system was explained by following quadratic equation:

\[
Y = \beta_0 + \sum_{i=1}^{3} \beta_i X_i + \sum_{i=1}^{3} \beta_{ii} X_i^2 + \sum_{i=1}^{3} \sum_{j=1}^{2} \beta_{ij} X_i X_j + \epsilon
\]

(1)

where \(Y\) is the observation response, \(\beta_0\) is the intercept, \(\beta_{ii}\) is linear coefficients, \(\beta_{ii}\) is quadratic coefficients, \(\beta_{ij}\) is treatment interaction coefficients, \(X_i\) is treatment code for “i” factor and \(X_j\) is treatment code for “j” factor.

| TABLE I |

| Independent variables | Levels | Leaching time (h) | Stirring speed (rpm) | Ratio of solvent to flour (X3) |
|-----------------------|--------|-------------------|----------------------|-------------------------------|
|                      |        | (X1)              | (X2)                 | (X3)                          |
|                      | -1.68  | -1                | 0                    | +1                            |
| Leaching time (h)    | 2.32   | 3                 | 4                    | 5                             |
| Stirring speed (rpm) | 63.64  | 200               | 1:6                  | 1:8                           |
| Ratio of solvent to flour (X3) | 1:6 | 1:8 | 1:10 | 1:11.36 |

E. Statistical analyses

The responses obtained from each set of experimental design (Table 1) were subjected to multiple non-linear...
regressions using the Design Expert software (Version 7.1, Stat-Ease Inc., Minneapolis, MN). The quality of the fit of the polynomial model equation was expressed by the coefficient of determination, R^2 and the significances of the regression coefficient were checked by F-test and p-value.

III. RESULTS AND DISCUSSION

A. Fitting the model

Response surface methodology in this research was used to determine the appropriate model for predicting the responses of glucomannan and calcium oxalate content. Montgomery (2001) noted that model analysis are used to determine the appropriate model in RSM methodology, which are subsequently used to predict the response for independent variable. The evaluated model included linear, 2FI (interaction), quadratic or cubic. The selection of model was conducted based on: P-value model, lack of fit test, and quadratic or cubic. The selection of model was conducted based on sequential model summary statistics (R^2, Adjusted R^2 and std dev. (Table 3) (Bradley, 2007; Bezerra et al., 2008).

| Source     | Sum of squares | d.f | Means square | F-value | p-value | Prob > F |
|------------|----------------|-----|--------------|---------|---------|----------|
| Glucomannan| Model          | 776.83 | 9 | 86.3140 | 21.3394 | < 0.0001 |
| Linier     | 45.59          | 3   | 15.20        | 0.32    | 0.8143  |          |
| 2FI        | 68.08          | 3   | 22.69        | 0.42    | 0.7422  |          |
| Quadratic  | 663.16         | 3   | 221.05       | 54.65   | <0.0001 |          |
| Qubic      | 23.58          | 4   | 5.89         | 2.10    | 0.1995  |          |
| Residual   | 40.4482        | 10  | 4.0448       |         |         |          |
| Lack of Fit| 27.8410        | 5   | 5.5682       | 2.2083  | 0.2025  |          |
| Pure error | 12.6072        | 5   | 2.5214       |         |         |          |
| Cor total  | 817.2746       | 19  |              |         |         |          |

R^2=0.9505, Adjusted R^2=0.9060, std. dev. = 2.01

Ca-Oxalate

| Source     | Sum of squares | d.f | Means square | F-value | p-value | Prob > F |
|------------|----------------|-----|--------------|---------|---------|----------|
| Model      | 41.7075        | 9   | 4.6342       | 52.4315 | <0.0001 |          |
| Linier     | 5.555E-003     | 3   | 1.852E-003   | 2.72    | 0.0791  |          |
| 2FI        | 1.375E-004     | 3   | 4.583E-005   | 0.055   | 0.9821  |          |
| Quadratic  | 8.422E-003     | 3   | 2.807E-003   | 12.00   | 0.0012  |          |
| Qubic      | 7.945E-004     | 4   | 1.986E-004   | 0.77    | 0.5816  |          |
| Residual   | 0.00234        | 10  | 0.000234     |         |         |          |
| Lack of Fit| 0.001607       | 5   | 0.000321     | 2.19134 | 0.2047  |          |
| Pure error | 0.000733       | 5   | 0.000147     |         |         |          |
| Cor total  | 0.016455       | 19  |              |         |         |          |

R^2=0.8578, Adjusted R^2=0.7298, std. dev. = 1.36

The selection of the model based on sequential model sum of square showed that the significant and advised model was quadratic (Table 3). When the p-value is less than 0.05, it shows that this variable is significant. When the p-value is less than 0.001, it shows that the variable is highly significant and that means this variable had a greater influence than other variables (Cai et al., 2007). The other model suggested based on sequential model sum of square was quadratic, P < 0.0001 at glucomannan and P < 0.0012 at calcium oxalate, indicating that the fitness of this model was highly significant. While based on lack of fit tests at glucomannan and calcium oxalate content were P > 0.2025 and P > 0.1056 respectively, which implied an insignificant difference relative to the pure error and a good fitness of the model. Analysis of variance from quadratic response surface showed that quadratic models had a significant effect to response.

Quadratic model has a least standard deviation compared with other models such as the determination coefficient (R^2=0.9505), Adj. R^2 of 0.9060 to improve the glucomannan content and R^2=0.9505, Adj. R^2=0.7298 to reduce the calcium oxalate content. It means that variables of leaching time, stirring speed and ratio of solvent to flour were significantly different to response variance of 90.6% and 72.98%, whilst the rests were 9.4% and 27.02% influenced to other factors which was not variables considered in this research. Widjanarko et al. (2011) noted that leaching time and the level of leaching play role to improve the glucomannan content and reduce the calcium oxalate.

A value R^2 greater than 0.75 indicates aptness of the model is significant. The optimization of the extract of steviosides from stevia rebudiana leaves using RSM have a value R^2=0.98, P-value = 0.0074 and lack of fit (P>0.05) showed that quadratic model was significant (Puri et al., 2012). Silvaet al. (2007) research optimization of extraction of phenolics from Inga edulis leaves using RSM have a value R^2=0.85 for total phenolic, R^2=0.87 for total flavonoid and 0.96 for total flavonoid with lack of fit (P>0.05) showed that this model is significant.

B. Response surface and influence of variables on yield

Quadratic equation can be used to predicted the responses from several levels. Quadratic equation obtained:

\[ Y_1 = -46.64 + 43.22 X_1^2 + 0.06 X_2^2 + 5.75 X_1 X_2 + 0.01 X_1 X_3 - 0.88 X_2 X_3 - 1.30 \times 10^{-5} X_2 X_2 - 5.10 X_1^2 - 1.22 \times 10^{-5} X_2^2 - 0.05 X_3^2 \]

to improve the glucomannan content is:

\[ Y_2 = 0.74 - 0.18 X_1 - 3.15 \times 10^{-4} X_2 + 1.83 \times 10^{-5} X_3 + 1.88 \times 10^{-5} X_2 X_3 - 2.5 \times 10^{-5} X_2 X_2 - 1.25 \times 10^{-5} X_3 X_3 + 0.02 X_1^2 + 2.55 \times 10^{-5} X_2^2 + 4.78 \times 10^{-5} X_3^2 \]

to reduce the calcium oxalate is:

This research has 3 factors of variables, therefore there were 3 responses graph which describe the relationship between leaching time, stirring speed and ratio of solvent to flour. The effect of leaching time, stirring speed and ratio of solvent to flour which quadratic to response of improving the glucomannan and reducing the calcium oxalate were shown in Figure 1.
1) Effect of leaching time to glucomannan content and calcium oxalate of porang flour: Leaching processed was carried out using 3 different ethanol concentrations (40% ethanol for the first stage, 60% ethanol for the second stage and 80% ethanol for the third stage) and the difference in the concentrations of ethanol used may allow a distinctive component to dissolved based on the polarity. At higher concentration of ethanol used, the level of polarity will be decreasing, therefore allowing the non-polar components to be dissolved.

Shimizu and Shimara (2004) reported that 80% ethanol may cause distinctive component from porang flour to be dissolved and such ethanol concentration may reduce content of starch, protein, fat, oxalate, ash and calcium oxalate. While Ramadhan and Phaza (2007) also noted that porang flour leaching using ethanol could separate glucomannan compound as ethanol has a high polarity and is able to dissolve several compounds, such as resin, fat, oil, fatty acid, carbohydrate and others organic compound, preventing the glucomannan granule from expanding and dissolved into the solution.

Maceration method extraction time is appropriately required to ensure the distribution of extracted compounds from solid component to its solvent. Leaching time can play role in the leaching process, therefore the optimal leaching time can be achieved to produce flour which contains high glucomannan content, low calcium oxalate and has light porang flour colour.

Increasing leaching time that exceeds the optimal leaching time can lead to decreasing glucomannan content and improving calcium oxalate content. However, its decreasing and increasing were not the same as the amount obtained using optimal leaching time. Kato (1970) reported that the degraded glucomannan will produce oligosaccharide such as manosa, glucose, mannobiosa, manosil glucose, manotriosa, manobiosil glucose, manotetraosa, manotrisil glucose and manotetraosil glucose. Claver et al. (2010) also reported that leaching time can lead to the degradation of dissolved of glucomannan. The extraction of Chinese sorghum flour produces a low polysaccharide throughout the duration of the leaching time used. Caili et al. (2006) noted that the increase in the optimization of extraction time from xyloglucan produce less oxymethylglucan.

2) Effect of Stirring speed to glucomannan content and calcium oxalate of porang flour: The faster stirring speed of leaching can stimulate loss of distinctive compound, therefore producing porang flour with high glucomannan content and low calcium oxalate. Glucomannan are located inside a cell which envelope the distinctive compound, such astarch, protein and calcium oxalate. The leaching process using stirring can help to increase ethanol ability to dissolve compounds on the cell surface and also to release distinctive component out of the ethanol.

Keil (2007) noted that mechanical effect can increase the penetration from liquid to cell membrane wall, support the release of cell component, and increase the mass transfer. Stirring speed can also accelerate the extraction process or purification of glucomannan as reported by Povey (1988), who found that extraction has mechanical effect to enhance stronger liquid penetration energy into cell tissue and increase penetration of ethanol into the cell, therefore oxalate can be released easily.

Mason et al. (1996) and Paniwnyk et al. (2009) noted that mechanical effect increase the penetration of liquid into the wall of the cell membrane, supporting the release of cell components, and improve mass transfer. Caili et al. (2006) also suggested that the contribution of mechanical effect on the extraction of xyloglucan with physical phenomena, such as diffusion through cell walls and rinsing all broken cell content.

Sarkhosh (2012) noted that stirring or agitation on extraction process can increase the efficiency and shorten the time of extraction. Stirring process can enhance the surface leaching area of extracted material with solvent to increase the efficiency and may lead to increase the temperature of extraction. The increase of extraction temperature may affect the extraction efficiency in several extraction processes. Metz and Ganor (2001) reported that the extraction efficiency increase at stirring speed of 800 rpm, and it will decrease at stirring speed of 1000 rpm. And Sarkhosh (2012) also noted that the increasing of stirring speed may lead intensity pounded between particles in the materials is getting higher.

3) Effect of different ratio of solvent to flour to glucomannan content and calcium oxide of porang flour: Glucomannan response increased and calcium oxide decreased as the ratio of solvent increased. When ethanol
solvent applied increase, the distinctive component and non-glucosan compounds also increase which can be dissolved by ethanol. The increasing of glucosan and the decreasing of calcium oxalate each leaching were directly proportional with the decreasing of distinction compounds such as non-glucosan.

In general, a larger volume of solvent can dissolve constituents more effectively leading to improved extraction of routine and quercetin from *Euonymus alatus* (Thunb.) (Yang and Zhang, 2008). Gamse (2002) also reported that when the number of solvent used increase, the dissolve solid increasing due to the dispersion of the particle, as. higher solvent ratio will increase the mass transfer. Qing et al. (2009) noted that the penetration during mass transfer was affected by concentration gradient between solid and liquid. The higher solvent ratio will produce porang flour which contained high glucosan.

Increase of solvent ratio above optimal response point can lead to decrease in the glucosan content. Susanto (1999) reported that the comparison between number of sample and extracted liquid affected the efficiency of extraction. Yang and Zhang (2008) reported that an increasing in extraction of routine and quercetin with an increasing in the ratio of solvent : sample weight, especially when the ratio increased from 20 to 40 ml/g and will decrease after the ratio increased from 40 to 60 ml/g. There were also similar findings reported by Claver et al. (2010), on the lower recovery polysaccharides extraction from Chinese sorghum powder when solvent ratio and time increased.

4) Response optimal point and verification: Stationary point value obtained from canonical analysis was carried out under optimal conditions: leaching time of 4 h 6 min and 18 sec, stirring speed 443.45 rpm and ratio of solvent to flour 8.92 ml/g (Table 3). The response of glucosan content and calcium oxalate content under optimal conditions were 79.19% and 0.075%, respectively. These condition were optimal to obtained glucosan and the lower of calcium oxalate on porang flour using maceration method.

Verification was performed by comparing response analysis value from the research to response value calculated by Design Expert. Accuracy level of glucosan and calcium oxalate were 99.91% and 97.33%, respectively, whilst the difference value were 0.09% and 2.66%, respectively, obtained from real experiments, demonstrating the validation of the RSM model (Table 4).

The difference of predicted values was significant (p>0.05) obtained from real experiments which was demonstrated in the validation of the RSM model. The result of analysis confirmed that the response model was adequate for reflecting the expected optimization and the model was satisfactory and accurate.

5) Physicochemical analysis of optimal porang flour

Leaching optimization process of maceration method may increase glucosan and decrease calcium oxalate content of porang flour. As mentioned in Table 4, several trends were observed. An increase in glucosan content was found in leaching optimization process of porang flour using maceration method from 67.02% to 79.19% and also a decrease in calcium oxalate was found from 0.28% to 0.07%. This difference was further evidenced as seen in the microstructure using scanning electron microscopy (SEM) at magnification 100 x as shown in Figure 2. Microstructure of non-glucosan from leaching at optimized process of porang flour using maceration method showed that granules surface of non-glucosan decreased compared with rough porang flour due to impurities of glucosan. This phenomenon showed that there were synchronization between data observed visually (Figure 2) and quantitatively (Table 5).

![Fig. 2. Microstructure of porang flour (A) before leaching, (B) leaching optimization process using maceration method at magnification 100x](image)
Leaching at optimized conditions of porang flour using maceration method produced clear glucomannan granule and form of scales as shown in Figure 3. Takigami (2000) reported that the surface of glucomannan granule has a light colour, clean and more visible in the scales after leaching process.

The other components of porang flour were decreased with the increased of glucomannan content such as starch, protein, fat and ash. A similar process was observed for calcium oxalate due to its solubility properties to ethanol solvent. Shimize and Shimahara (2004) reported that ethanol solvent may lead to the decreasing amount of distinctive compounds such as starch, protein, fat, oxalate and ash compared with rough porang flour which produce high glucomannan content.

### IV. CONCLUSION

The response surface methodology was used to estimate and optimize the experimental variables: leaching time (h), stirring speed (rpm) and ratio of solvent to flour (ml/g). All variables were the important factors which affect leaching process, on the response model values (P < 0.0001) for glucomannan content and calcium oxalate content. Response model was quadratic with optimal condition as follows: leaching time of 4 h 6 min and 18 sec, stirring speed of 443.45 rpm and ratio of solvent to flour 8.92 ml/g enhance the experimental yield of glucomannan content and calcium oxalate.

### TABLE IV

| Parameter | Rough porang flour | Optimization of maceration leaching (%) |
|-----------|--------------------|----------------------------------------|
| Moisture  | 12.17              | 12.54                                  |
| Ash content | 2.63               | 0.38                                   |
| Starch content | 2.7                | 1.26                                   |
| Protein content | 2.35              | 0.78                                   |
| Fat content | 1.49               | 0.45                                   |
| Oxalate content | 0.28              | 0.073                                  |
| Glucomannan content | 67.019          | 79.18                                  |
| White degree | 50.75*             | 53.19*                                 |
| Viscosity | 6300**             | 9633.33**                              |
| Yield     | 62.71              | 89.83                                  |

### TABLE 5

**PHYSICOCHEMICAL PROPERTIES OF ROUGH PORANG FLOUR AND OPTIMIZATION OF MACERATION LEACHING OF PORANG FLOUR**

| Parameter               | Actual   | Prediction   |
|-------------------------|----------|--------------|
| Leaching time (h)       | 4.13     | 4.13         |
| Stirring speed (rpm)    | 434.45   | 434.45       |
| Solvent/flour ratio     | 8.92:1   | 8.92:1       |
| Glucomannan (%)         | 79.26    | 79.19        |
| Ca-oxalate (%)          | 0.073    | 0.075        |
| Desirability            | 97.33    | 99.91        |
| Accuracy level (%)      | 2.66     | 0.09         |
| Difference value (%)    |          |              |

### REFERENCES

[1] AOAC, *Official methods of analysis*, Washington DC, USA: Association of official analytical chemists, 1995.
[2] J.P. Claver, H. Zhang, Q. Li, Z. Kexue, and H. Zhou, “Optimization of ultrasound-assisted extraction of polysaccharides from Chinese malted sorghum using response surface methodology,” *Journal of Nutrition*, vol. 9 (4), pp. 336-342, 2010.
[3] W. Cai, X. Gu, and J. Tang, “Extraction and preliminary structure discussion of soluble Opuntia Milpa Alta polysaccharide,” *Food Mach.*, vol. 23, pp. 68-71, 2007.
[4] Caili, T. Hajun, L. Quanhong, C. Tongyi, and D. Wenguan, “Ultrasound-assisted extraction of xyloglucan from apple pomace,” *Ultrasonics Sonochemistry*, vol.13, pp. 511 – 516, 2006.
[5] A.Faridah, S.B. Widjanarko, and A. Sutrisno, “Optimization study of increased content of glucomannan and diminution content of calcium oxalate in porang chip (Amorphophallus oncophyllus) during mechanical grinding process,” in Proc. Indonesia Food Conference, 15-17 September Menado. Indonesia, 2011, paper 3, p. 12-17.
[6] T. Gamse, *Liquid-liquid extraction and solid-liquid extraction. Institute of thermal process and enviromental engineering*, Graz University of Technology, 2002.
[7] K. Kato, T. Watanabe, and K. Matsuda, “Studies on the chemical structure of konjac mannan. Part II. Isolation and characterization of oligosaccharides from the enzymic hydrolysis of the mannan,” *J Agricultural and Biological Chemistry*, vol.3, pp. S253-S260, 1970.
[8] F.J. Keil, Modeling of process intensification, WILEY-VCH Verlag GmbH & Co, KgaA, Weinheim, 2007.
[9] T.J. Mason, L. Paniwnyk, and J.P. Lorimer, “The use of ultrasound in foodtechnology”, *Ultrasonics Sonochemistry*, vol.3, pp. S253-S260, 1996.
[10] V. Metz, and J. Ganor, “Stirring effect on kaolinite dissolution rate,” *Geochemica et Cosmochimica Acta*, vol. 65 (20), pp.3475–3490, 2001.
[11] D.C. Montgomery, *Design and Analysis of Experiment, 5th ed.*, John Willey and Sons, Inc: New York, 2001.
[12] S. Ohashi, G.J. Shelson, A.L. Moirano, and W.L. Drinkwater, (2000). Clarified Konjac Glucomannan. US Patent. [Online] http://www.patentstorm.us.Retrieved:October 23, 2007.
[13] L. Paniwnyk, H. Cai, S. Albu, T.J. Mason, and R. Cole, “The enhancement and scale up of the extraction of anti-oxidants from...
Rosmarinus officinalis using ultrasound,” Ultrasonics Sonochemistry, vol.16, pp. 287–292, 2009.

[14] L. Peiying, Z. Shenglin, Z. Guohua, C. Yan, O. Huaxue, H. Mei, W. Zhongfeng, X. Wei, and P. Hongyi, Professional Standart of The People’s Republic of China for Konjac Flour. NY/T : 494-2002.

[15] M. Puri, D. Sharma, J.C. Barrow, and A.K. Tiwary, “Optimisation of novel method for the extraction of steviosides from Stevia rebaudiana leaves,” Food Chem, vol.132, pp.1113-1120, 2012.

[16] An. Z. Qing, Q.Z. Zhi, F.Y. Xuen, H.F. Xue, L. Tao, and F.C. Shou, “Response surface optimization of ultrasound-assisted oil extraction from autoclaved almond powder,” Food Chem. Vol.116 (2), pp.513 – 518, 2009.

[17] E. Ramadhan and A.H. Phaza, “The effect of ethanol, temperature and stage numberconcentration on ginger oleoresin extraction using batch,” Thesis, Technic Faculty, Diponegoro University. Indonesia, 2007.

[18] M. Sarkhosh, A. Mehedinia, A. Jabbary, and Y. Yamini, “Determination of biphenyl and biphenyloxide in aqueous samples by head space single drop microextract ion coupled to gas chromatography,” J.Braz. Chem. Soc. 00 (00): 1-8, 2012.

[19] M. Shimizu, and H. Shimahara (2004). Method Of selective separation of konjacfluor from the tubers of Amorphophallus konjac., [Online], http://codex.foodnara.go.kr/lib/base_down.jsp?dr=eu&fn=konjac%2gum.pdf.

[20] E.M. Silva, H. Rogez, and Y. Larondelle, “Optimization of extraction of phenolics from Inga edulis leaves using response surface methodology,” Separation and Purification Technology, vol.55, pp.381-387, 2007.

[21] S.B. Sudarmadji, Hayono, and Suhardi, Analayses procedure for food and agriculture product, 4th ed. Liberti. Jogjakarta. Indonesia, 1997.

[22] N. Sugiyama, H. Shimahara, and T. Andoh, “Studies on mannan and related compounds, I. the purification of konjac mannan”, Bulletin of the Chemical Society of Japan, vol.45, pp.561-563, 1972.

[23] T. Susanto, Introduction of agricultural processing, Agriculture Faculty, Brawijaya University, Malang. Indonesia, 1999.

[24] U.J. Ukpabi, and J.I. Ejidoh, “Effect of deep oil frying on the oxalate contentand the degree of itching of cocoyams (Xanthosoma spp and Colocasia spp). Technical Paper presented at the 5th Annual Conference of The Agricultural Society of Nigeria, Federal University of Technology, Owerri, Nigeria, 3-6 Sept 1989.

[25] S.B. Widjanarko, A. Faridah, and A. Sutrisno, “Effect of multi level ethanol leaching on phisico-chemical properties of konjac flour (Amorphophallus oncophyllus). The 12th Asean food conference. 16-18 June 2011, Bangkok, Thailand.

[26] J. Wu, R.E. Aluko, and H. Corke, “Partial least-squares regression study of the effects of wheat flour composition, protein and starch quality characteristics on oil content of steamed-and-fried instant noodles,” Journal of Cereal Science, vol.44, pp.117–126, 2006.

[27] Y. Yang, and F. Zhang, “Ultrasound-assisted extraction of rutin and quercetin from Euonymus alatus (Thunb.) Sieb,” Ultrasonic sonochemistry, vol.15, pp. 308-313, 2008.

[28] C. Zapata, E. Deleens, S. Chaillou, and C. Magne, “Partitioning andmobilization of starch and N reserve in grapevine (Vitis vinifera L.),” Journal of Plant Physiology, vol.161, pp. 1031-1040, 2004.