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WELCOMING REMARK

Universitat Internacional de Catalunya

First of all, I would like to express my most warm welcome to all authors

for their valuable work, time and dedication so we can have one full proceeding that is so rich of research contributions. I myself would like to see the proceeding as an interesting window to see research works from Asia, especially from Indonesia. Hopefully this proceeding book can serve as a memento and encouragement for the advancement of further research in the future and enhance and foster collaborations among scientific at international scale.

I wish all participants good luck and have a nice and fruitful conference. Last but not least, welcome and enjoy Barcelona!

Frederic Marimon

Full Professor in Business Administration

Vice-Rector of Planning and Quality

Universitat Internacional de Catalunya

OPENING REMARK
HEAD OF LL-DIKTI REGION IV

Thanks to the grace of God Almighty (Allah SWT), alhamdulillah, the International Proceedings at the Universitat Internacional de Catalunya (UIC), Barcelona, Catalunya, Spain, is complete. We organize this seminar on November 11, 2019 with participants and speakers from Indonesia, Spain, Switzerland, India, Palestine and United Kingdom. With the theme: "The Role of Higher Education in Facing the 4.0 Industrial Revolution in Indonesia", we aim that the seminar participants gain and share knowledge and experience among the participants and speakers present at the event.

Most of the Human Resources (HR) in Indonesia do not fully understand how the 4.0 industry has started to appear rapidly at this time, in the joints of the Indonesian economy. The low understanding of human resources in Indonesia goes straight with the emergence of inequality between the capabilities of local human resources and foreign human resources that began to participate in the current 4.0 industrial revolution in Indonesia. In addition, there are not many formal educations specifically preparing human resources in this field. Efforts that can be made by tertiary institutions to enhance their role are that special courses need to be made on Information and Communication Technology (ICT). If it already exists, then it needs to be deepened to be able to better understand the development of new technologies such as the Internet of Things (IoT), artificial intelligence machines or artificial intelligence (AI), physical-cyber systems and cloud computing.

With the issuance of international proceedings, I would especially like to thank Mr. Mahir Pradana who has worked hard to facilitate seminar activities with UIC Barcelona. Our deepest gratitude also goes to UIC vice rector of Planning and Quality, Prof. Frederic Marimon, for having our participants in his remarkable university. Hopefully these activities can provide us motivation to always work and innovate in developing professionalism as lecturers.

Bandung, 5 November 2019

Head of LLDIKTI Region IV,

Prof. DR. Uman Suherman AS, M.Pd.

OPENING REMARK
CHAIRMAN OF KORPRI LLDIKTI REGION IV

Thanks to the grace and sanctity of God Almighty, the international proceedings published by the Universitat Internacional de Catalunya (UIC), Barcelona, Catalunya, Spain, can be resolved in a timely manner. Also, with good cooperation between our personnel Mr. Mahir Pradana, UIC, the speakers, and participants from Indonesia, and several countries in Asia and Europe. Hopefully this proceeding can provide motivation for lecturers to develop Higher Education 'Tridharma', especially aspects in lecturer research.

The development of technology in the industrial revolution era 4.0 is very influential on the characteristics of jobs that exist today, where skills and competencies are the main things that need attention. Because in the era of the industrial revolution 4.0 the integration of the use of technology and the internet is so sophisticated and massive that it also greatly influences changes in the behavior of the business and industrial world, the behavior of society and consumers in general. Characteristics in the industrial revolution era include digitalization, optimization and customization of production, automation and adaptation, interaction between humans and machines, value added services and business, automatic data exchange and communication of information technology. Therefore, education and industry must be able to develop industrial transformation strategies by considering the human resource sector that has competence in their fields.

In facing the era of the industrial revolution 4.0, students are expected to have 4 (four) competencies in themselves, including: competence to interact with various cultures, social skills, new literacy (data, human technology) and lifelong learning (lifelong education)

Hopefully the international proceedings issued by the University of Internationale de Catalunya (UIC) Barcelona can make useful contributions, especially for lecturers in developing the Tridharma of Higher Education.

Bandung, 5 November 2019

Prof. DR. Endang Komara, M.Sc

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OPTIMATION 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, diabetes, 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].

Breakfast using cereal can provide valuable nutrients. Ready to eat breakfast cereal contains low-fat content, good complex carbohydrates, fortified by vitamins and minerals, and provides dietary fiber intake. Nutrition from ready-to-eat breakfast cereal is beneficial, and like other breakfast meals, it contains high micronutrients, fiber, CHO, protein, and low fat and cholesterol content. The composition and quality of breakfast provide essential benefits for health. Regularly consuming ready-to-eat breakfast cereal will increase immunity to chronic diseases for children, and reduce blood sugar and cholesterol levels in the blood [4].

From the USDA National, Nutrient Database stated that the reformulation of ready-to-eat cereals conducted by the company is very oriented to consumer demand. The nutrition data is updated to illustrate the formulation and fortification changes that have been made. Data from the company showed a change in the breakfast cereal formulation. Changes in formulas can be caused by several reasons, such as health reasons and consumer demand for more healthy cereals.

Consumer demand for healthy cereal is a factor affecting trends in breakfast cereals. Wheat, fiber, and sugar levels are considered by consumers when choosing cereal products. The Diet Guidelines Advisory Committee in 2010 concluded that there is some evidence that a high fiber content diet is essential for digestive health and lowers the risk of cardiovascular disease, obesity, and diabetes. Fiber intake for adults is still 40-50% below recommended levels [5]

Today, people who are busy working choose to consume products that contain essential nutrients and fiber [3]. Consumers pay more attention to their health. This is the reason why proper fiber intake is not only important to get proper quality nutrition, but also has a taste that is liked by consumers. A delicious cereal flavor is caused by a microstructure that will absorb milk by diffusion when it is consumed [6].

Healthy food does not have a specific definition, but generally is a term for foods that provide nutritional intake and provide benefits for health. Healthy food is a group of foods that include functional food, high nutritional food, natural food, organic food, and some food supplements. Consuming gluten-free products can also reduce the risk of serious long-term complications such as celiac disease that is difficult to treat. Some foods can be an alternative substitute because they have high gluten-free proteins such as beans, cereals, grains, tubers such as potatoes, tapioca, taro, and arrowroot. Until now, various studies have been conducted to design and develop gluten-free foods for consumers with special needs using these alternative sources [7].

Today, consumption of gluten-free products continues to increase, and consumers demand more gluten-free products that they can consume. Consumers are also looking for alternative products that are conventionally processed. Other ingredients containing gluten are stapled foods that globally consume. This trait can be associated with complex gluten structures [8]. Gluten is a protein that forms the main structure in flour and forms the desired crumb structure of many food products, especially baked products [7]. Gluten is formed from the fraction of gliadin and glutenin. Gluten is an important factor in shaping crumbs in the manufacture of bread. The market for gluten-free products is increasing beyond the demands of gluten intolerance sufferers. This increase in demand for gluten-free products is mainly due to the latest claims of gluten-free products that provide health benefits to the general public. Manufacturers of gluten-containing products must start making gluten-free products that have 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:

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 60 g100g-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 [16]. 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 [16].

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

1. Wójtowicz, A., Mitrus, M., Oniszczuk, T., & Mo, L. (2015). *Selected physical properties, texture, and sensory characteristics of extruded breakfast cereals based on wholegrain wheat flour*. *7*, 301–308. https://doi.org/10.1016/j.aaspro.2015.12.051
2. Kumar, H., Burkinshaw, R., & Azapagic, A. (2015). Environmental sustainability issues in the food – energy-waterer nexus : Breakfast cereals and snacks. *Sustainable Production and Consumption*, *2*(August), 17–28. https://doi.org/10.1016/j.spc.2015.08.001
3. Kumar, S., Haq, R., & Prasad, K. (2018). Studies on Physico-chemical, functional, pasting, and morphological characteristics of developed extra thin flaked rice. *Journal of the Saudi Society of Agricultural Sciences*, *17*(3), 259–267. https://doi.org/10.1016/j.jssas.2016.05.004
4. Tolfrey, K., & Zakrzewski, J. K. (2012). Breakfast, glycaemic index, and health in young people. *Journal of Sport and Health Science*, *1*(3), 149–159. https://doi.org/10.1016/j.jshs.2012.09.001
5. Thomas, R. G., Pehrsson, R., Kc, J., Smieja, E., & Miller, K. B. (2013). Recent trends in ready-to-eat breakfast cereals in the U. S. *Procedia – Food Science*, *2*, 20–26. https://doi.org/10.1016/j.profoo.2013.04.005
6. Melado, A., Barreiro, P., & Rodríguez-sinobas, L. (2011). MRI texture analysis as means for addressing rehydration and milk diffusion in cereals. *Italian Oral Surgery*, *1*, 625–631. https://doi.org/10.1016/j.profoo.2011.09.094
7. Jnawali, P., Kumar, V., & Tanwar, B. (2016). Celiac disease : Overview and considerations for development of gluten-free foods. *Food Science and Human Wellness*, *5*(4), 169–176. https://doi.org/10.1016/j.fshw.2016.09.003
8. Muggah, E. M., Duizer, L. M., & Mcsweeney, M. B. (2016). A comparison of sensory properties of artisanal style and industrially processed gluten-free breads. *International Journal of Gastronomy and Food Science*, *3*, 38–46. https://doi.org/10.1016/j.ijgfs.2016.01.001
9. Schmidt, M., Schöbel, A., & Thom, L. (2019). Min-ordering and max-ordering scalarization methods for multi-objective robust optimization. *European Journal of Operational Research*, *275*(2), 446–459. https://doi.org/10.1016/j.ejor.2018.11.048
10. Elisabeth, D. A. A. (2015). Added Value Improvement of Taro and Sweet Potato Commodities by Doing Snack Processing Activity. *Procedia Food Science*, *3*, 262–273. https://doi.org/10.1016/j.profoo.2015.01.029
11. Budaraga, I. K. (2017). Processing Taro Tubers (Colocasia esculenta (L) Schott) Become Flour as Efforts to Increase Community Revenues in Mentawai Region. *ISSNPrint) International Journal of Life Sciences Research ISSN*, *5*(2), 2348–313. https://doi.org/10.17632/6zzggr6h96.1
12. Soares, M., Júnior, S., Del, A., & Beleia, P. (2014). *LWT - Food Science and Technology Infant dairy-cereal mixture for the preparation of a gluten-free cream using enzymatically modified rice fl our*. *59*, 1033–1040. https://doi.org/10.1016/j.lwt.2014.06.047

13. Ganesan, K., & Xu, B. (2017). A critical review on phytochemical profile and health-promoting effects of mung bean (Vigna radiata). *Food Science and Human Wellness*, *7*(1), 11–33. https://doi.org/10.1016/j.fshw.2017.11.002
14. Zhang, Su, Zhu, Guo J., Guo S., Qian, Ouyang, Duan. 2019. Mulberry leaf active components alleviate type 2 diabetes and its liver and kidney injury in dB/DB mice through insulin receptor and TGF-β/Smads signaling pathway. Biomedicine and Pharmacotherapy 112: 1-13.
15. Winarno F.G. 2002. Kimia Pangan dan Gizi. PT Gramedia, Jakarta.
16. Balai Penelitian Lahan Rawa. 2015. Arti Penting Kadar Abu Pada Bahan Pangan. http://balittra.litbang.pertanian.go.id/index.php?option=com_content&view=article&id=1676&Itemid=10

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

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	8.79	3	2.93	15.73	0.0004	Significant
A-Taro Flour	0.0616	1	0.0616	0.3306	0.5780	
B-Mung Bean Flour	0.0593	1	0.0593	0.3182	0.5851	
C-Black Mulberry Leaf Flour	0.0622	1	0.0622	0.3338	0.5762	
Residual	1.86	10				
Cor Total	10.65	13				

Table 2. ANOVA for Linear Model of Carbohydrate Content of Breakfast Flakes Free Gluten

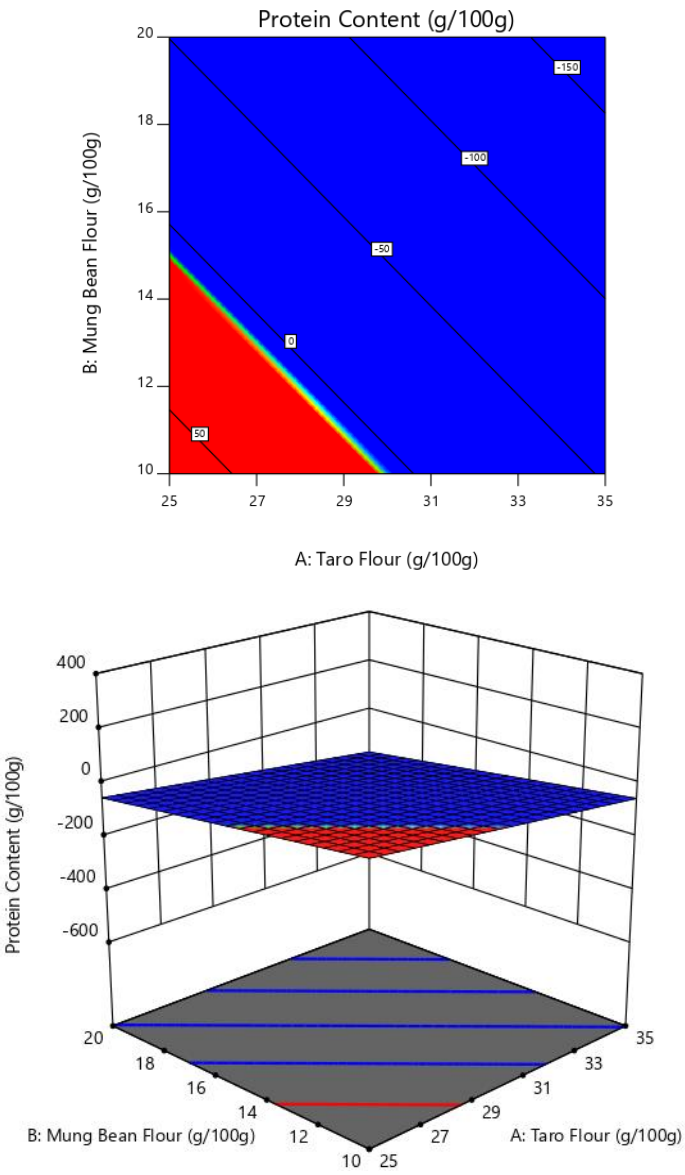
Source	Sum of Squares	df	Mean Squares	F-value	p-value	
Model	101.72	3	33.91	6.26	0.0116	Significant
A-Taro Flour	19.65	1	19.65	3.62	0.0861	
B-Mung Bean Flour	19.54	1	19.54	3.60	0.0868	
C-Black Mulberry Leaf Flour	19.49	1	19.49	3.60	0.0872	
Residual	54.20	10	5.420			
Cor Total	155.92	13				

Table 3. Optimation Breakfast Free Gluten

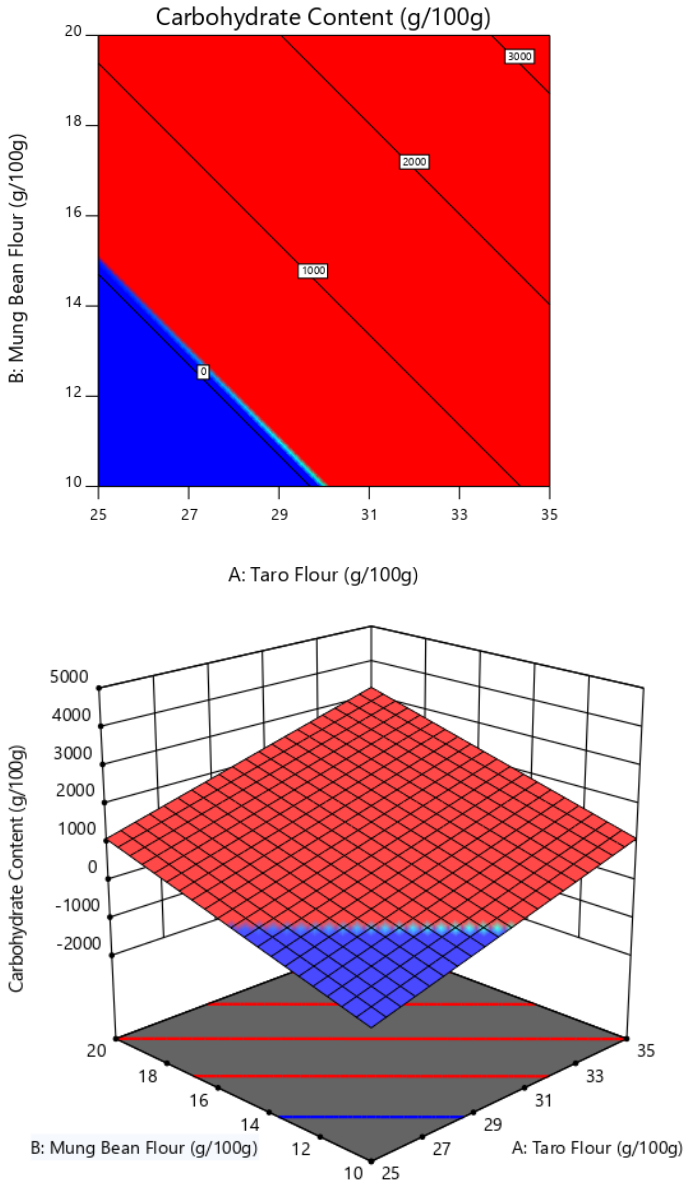
Name	Goal	Lower Limit	Upper Limit	Importance
A: Taro Flour	Is in range	25	35	3
B: Mung Bean Flour	Is in range	10	20	3
C: Black Mulberrry Leaf Flour	Is in range	5	15	3
Carbohydrate Content	Is target = 69	63..21	74.79	3
Protein Content	Maximize	6.85	9.78	3
Taste	None	3.3	3.73	3
Aroma	None	2.97	3.73	3
Colour	None	2.9	3.67	3
Texture	None	3.17	3.73	3

Table 4. Optimition Flakes Free Gluten

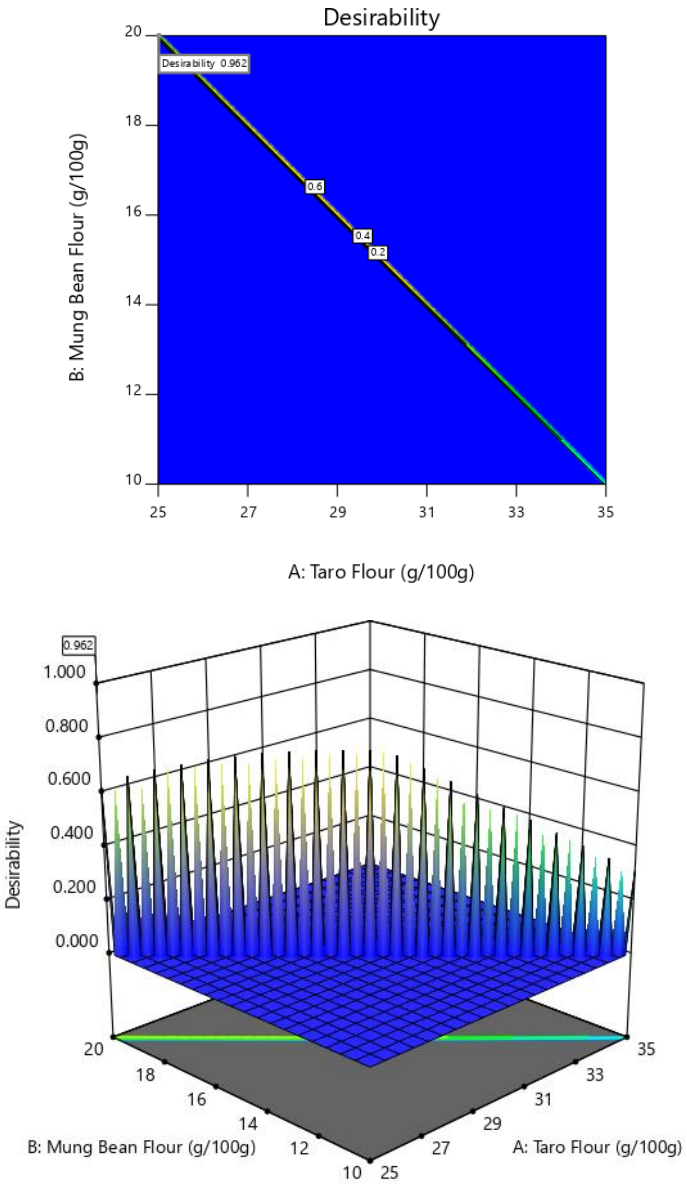
Taro Flour	Mung Bean Flour	Black Mulberry Leaf Flour	Carbohydrate Content	Protein Content	Desirability	
25.016	**20.000**	**5.004**	**69.000**	**9.563**	**0.962**	**Selected**



Picture 1. Contout plot and Grafic 3-D Response Protein Flakes Free Gluten



Picture 2. Contout plot and Grafic 3-D Response Carbohidrate Flakes Free Gluten



Picture 3. Contout plot and Grafic 3-D Deserability Flakes Free Gluten