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Chemical Composition and Sensory Analysis of Simulated Chips Based Rice Bran Tempe Flour

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Abstract

Indonesia has a diversity of traditional food. One of them is tempe, a fermented food which is generally made from soybean. Currently, the diversity of tempe raw materials and tempe products are widely developed with the aim of increasing the nutritional content of tempe. Processing soybean into various foods is generally a simple process, like chips. Chip is one of the most popular snack food consumed by all ages. The effects of rice bran tempe flour addition as a fortification of wheat flour in the processing of simulated chips was determined. Rice bran tempe has been made through fermentation method using *Rhizopus oligosporus* culture. This study aims to determine the chemical properties and sensory tests of simulated chips with the addition of rice bran tempe flour. The simulated chips were formulated by supplementing rice bran tempe flour at different proportions (10%, 20%, and 30%) with 100% wheat flour as a control. Results have shown protein, fat and ash of the simulated chips to be increased, while carbohydrate content decreased corresponding to the increase in proportion of rice bran tempe flour. The result of hedonic test showed that the addition of 10% rice bran tempe flour is the most favourite compared with others. However, the consumer perception has stated that simulation chips product with added rice bran tempe flour has no resemblance to the commercial product as a whole product.

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Introduction

Tempe is a fermented food by the *Rhizopus* sp. commonly using soybeans as a substrate.[1,2] Microorganisms that are commonly used in tempe fermentation is *Rhizopus oligosporus.*[3] Although the raw material of tempe is generally soybean, but other ingredients such as green beans, mung beans, seeds lamtoro and others can

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be added to improve the nutritional value of tempe and tempe products.[4] Rice bran tempe is a fermented food of soybean raw material (Glycine max (Ld.) Merril) with the addition of rice bran.

Rice bran is a by-product of the rice mill, which has nutritional and phytochemical sources that are good for health.[5,6] With high nutrient content, rice bran is very easily damaged. The higher the nutrient contained in a foodstuff, the more susceptible to damage resulting from enzymatic activity and microorganisms.[7] Longer storage of rice affects the rancidity on rice bran, so it needs the process of stabilizing rice bran to prevent it and extend the shelf life. The action of the enzymes that accelerate the lipid oxidation of the rice bran.

Fermentation is a potential process to prevent damage of rice bran and able to increase the functional value of rice bran.[8] The addition of rice bran and chitosan to tempe makes it to have new functional properties. It can serve as prebiotics.[9] Soybean can be processed into tempe, tempe chips, tofu, milk, and others.

Processing soybean into various food is generally a simple process, like chips. Chip is one of the most popular snack food consumed by all ages, including in Indonesia. Simulated chips are chips that involving flour formulation and kneading process during its preparation.[10] Chips are processed food made by drying and frying.[11]

Snack or snack food is a kind of food that has been known widely to most people. These snacks are usually consumed between the main meal times. For some people, snacks as a part that cannot be left out of everyday life. In Indonesia, snacks have been developed since 1970s. One type of snack that is developed and quite popular is chips. Chips are generally made by using one type of raw materials, such as potatoes, cassava, and other materials that have been thinly sliced and then fried. Limitations of raw materials will produce chips that have a less diverse taste and type of nutrition.[12]

In this research, rice bran tempe fortified with chitosan and GDL were dried and ground into flour. Utilization of rice bran tempe flour was intended to provide the added value to the product and to increase the nutritional value of the resulting chips.

Materials and Methods

Source of Raw Material

The research materials used consist of soybean (Glycine max (Ld.) Merril) which were obtained from Kencar Traditional Market and Raprima molds was produced by PT. Aneka Fermentasi Indonesia (AFI), Bandung, the Rice bran used has a brand called dr. Liem Rice Bran from Bandung, where the chitosan from shrimp was obtained from Faculty of Fisheries and Marine Sciences, Bogor Agricultural University (IPB), Glucono Delta Lactone (GDL). Other ingredients used to produce chips are wheat flour, sago flour, salt, lime betel, margarine, garlic, onion, cooking oil and water.

Rice Bran Tempe Fermentation Using Raprima Culture (*Rhizopus Oligosporus*)

A total of 40 grams of soybean was washed and then soaked for approximately 24 hours in the water. After that, the soybeans are peeled off the shell. Soybeans were boiled for 30 minutes at a temperature of 100^{0}C which then they were drained and aerated. After that, the soybean was added with 0.4% GDL for 2 hours. GDL is used to speed up fermentation time. GDL is a food supplement that is Generally Recognized as Safe (GRAS).[12] The technology of making tempe using GDL acidic substances has been developed. Tempe products are known as "Quick Tempe".[14] Then, soybean were washed and peeled. Soybean that have been peeled then boiled for 30 minutes with a temperature of 100^{0}C. Soybean then drained and aerated. After that, the soybean was added with 2% chitosan solution. Ten grams rice bran was added to the ingredients, stirred and all parts of soybean covered rice bran. Then added Raprima culture tempe was added as much as 0.1 grams and packed in a plastic clip that had been perforated. Incubation was carried out for 30 hours at ambient temperature.

Production of Rice Bran Tempe Flour

The production of rice bran tempe flour started by slicing of rice bran tempe with a thickness of

± 0.5-1 cm. The next stage of rice bran tempe was dried using oven for 1 hour at 130^{0}C until the moisture content reached 3%. Furthermore, rice bran was milled using a grinder.

Preparation of Simulated Chips

The production of simulated chips started by mixing all of the used materials which are wheat flour, sago flour, rice bran tempe flour, margarine, onion, garlic, salt, and water. The used formula is shown in Table 1. Then the dough is stirred unil homogeneous and sheets are formed with noodle roller. The next stage was forming a round with diameter of 3 cm, then fried using oil temperature of 1500C for 15 until 20 seconds.

Proximate Analysis of Fried Chips

Simulated rice bran tempe chips were analyzed for chemical compositions (moisture, crude protein, fat, fiber, ash) by the Indonesian National Standard (SNI) and Association of Official Analytical Chemists (AOAC). The moisture content was analyzed using oven evaporation method.[14] Crude protein content was determined by micro-Kjeldhal method,[16] while fat content was estimated by Soxhlet method using petroleum ether as the extracting solvent.[14] The ash content was determined by incineration at 550^{o}C by using muffle furnace.[14] Available carbohydrate was calculated based on the differences found from the method.[16]

Sensory Evaluation

Simulated rice bran tempe chip samples were analyzed and compared with commercial chips as a control. A seventy-five untrained panelist evaluated the chips using a 9 point hedonic scale ranging from 1 (extremely disliked) to 9 (extremely liked). The panelists were asked to score for texture, taste, color, aroma, aftertaste and overall acceptability.

Statistical Analysis

All of the analysis were reported in this study and was performed in duplicates. The obtained data was reported as a mean ± standard deviation. One-way ANOVA was used to determine the statistical significance of the results. Duncan means the comparison test was applied to determine the differences between the mean values at a significant level of $p<0.05$ using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA).

Results and Discussion

The preparation of the soybean seeds consists of cleaning from physical contamination such as fine pebbles and damaged seeds. Furthermore, soy has been soaked in water then boiled which given the acid compound GDL. Natural acidification can be replaced by chemical acidification. Chemical acidification is the acidification process by adding acidic substances to achieve conditions that is suitable for mold growth.[18] GDL can be used as chemical acid substances and when compared to natural acid which takes 8 until 22 hours and thus the chemical acid substances can shorten the immersion time of 2 until 3 hours. Then, the next process was the immersion that aims to soften the texture of soybean seeds.[14] The texture (crispiness) of chips determines the consumers' preferences.[19] Soybean that have been soaked will also facilitate

Table 1. Composition of Simulated Chips with Substitution of Rice Bran Tempe Flour

Ingredients	Control (%)	RBTC1(%)	RBTC2 (%)	RBTC3 (%)
Wheat Flour	100	90	80	70
Rice Bran Tempe Flour	-	10	20	30
Sago Flour	20	20	20	20
Margarine	4	4	4	4
Onion	4	4	4	4
Garlic	2	2	2	2
Salt	3	3	3	3
Water	45	45	45	45

the stripping of the epidermis. It makes easier for mold to penetrate soybean in the fermentation process boiling of soybean which is done for 30 minutes.[18,20] Boiling on soy can form soybean texture to be softer, so it can produce tempe with a good texture.[7] During the boiling process, soybean seeds will increase weight, volume, and water absorption. Soybean boiling in the process of making tempe has served to inhibit the growth of other microorganisms that are not desirable. Then, the boiled soybean are aerated at ambient temperature for the soybean to dry completely. To prevent microbial contamination, the aeration is carried out with a short period of time. This is done to avoid contamination of bacterial decay which can inhibit the mold growth. The next stage is the inoculation of yeast culture of RAPRIMA tempe. Yeast tempe RAPRIMA has the composition of rice and tempe yeast.[2] Yeast tempe RAPRIMA contains *Rhizopus oligosporus* culture.[10] *R. oligosporus* is a strain derived from the zygomycetes group. The mold is the dominant tempe fungus although some other moulds, such as *R. oryzae* and *Mucor spp,* which may also contribute to the flavor, texture, or nutritive value.[2]

Molds which grow during fermentation will form hyphae, a white thread that covers the surface of soybean seeds and bran as to form a bundle of mycelium that binds soybean seeds to one another, form a compact structure and a dense texture.[3] *R. oligosporus* which grows on tempe produces protease enzymes to break down proteins into peptides and free amino acids. Therefore, tempe contains nutrients that are easily digested, absorbed and utilized by the body.[21] *Rhizopus* sp. growth rate remained stable as long as the pH is at or above 3.5 and was slightly slower when the beans were more acidic.[2] The reshuffle of complex protein compounds into simpler compounds is important in tempe fermentation. It is one of the main factors to determine the quality of tempe, as a source of vegetable protein that has a high digestibility.[18]

Table 2 shows that the moisture content of control simulated chips was significantly lower ($p < 0.05$) compared with all treatments. The prevailing product quality standard in Indonesia, the

(A) **(B)**

Fig. 1: (A) Rice Bran Tempe on the plastic packaging that has been given air holes, (B) Pieces of Rice Bran Tempe for flour preparation

Fig. 2: Rice Bran Tempe Flour

maximum limit of moisture content of simulated chips is 3% .[15] Hence, the moisture content of the sample can be concluded as meeting the quality requirements of SNI. The shelf life of the product will be longer if the moisture content of food product lower. Low moisture content gives the crispy texture to the product.[22]

Protein content is increasing and significantly different ($p < 0.05$) on the simulated chips given a treatment of rice bran tempe added with 10%, 20%, 30%, respectively. High protein content in chips was due to the presence of rice bran tempe flour which was added to the formulation. the protein rice bran (14-18%) is excellent, as well as the protein contained in tempe flour.[23] the content of tempe powder protein fermented with *Rhizopus oligosporus* has a value of 46%. Although these values are significantly different, the protein content of rice bran tempe simulated chips is not too high in value.[24] This is occurred when the protein is denatured as a result of cooking or heating with high temperatures.[25,26]

Ash content is an indication of mineral content of the chips.[27] Ash content is the result of the process of feeding food which can show the mineral content of these foods.[17] Table 2 shows that the controlled ash content of simulated chips is lower than that of RBTC1, RBTC2, and RBTC3 simulated chips. Ash that contained in rice bran tempe simulated chips has an average value of 1.603%, while the control simulated chips have a value of 1.17%. These results indicate that the mineral content of simulated chips with the addition of rice bran tempe flour as more than control chips.

Fat content in the chips given the addition of rice bran tempe flour showed different results significantly and increased by 20 to 30% higher than control. rice bran contains fat content of 17.87%. The high fat content can be derived from rice bran.[28] Heat is received by materials that make water in the material to evaporate and cause oil to enter into the material during the process of frying, thereby increasing the fat content in the material.[26] The maximum limit of fat content in the process of frying snacks is

(A) (B) (C) (D)

Fig. 3: Rice Bran Tempe Chips: (A) Control, (B) RBTC1, (C) RBTC2, (D) RBTC3

Table 2. Result of Proximate Analysis of Simulated Chips with Various Level Substitution of Rice Bran Tempe Flour

Sample	Moisture	Protein	Ash	Fat	Carbohydrate
Control	1.78 ± 017^{a}	7.58 ± 0.37^{a}	1.17 ± 0.19^{a}	27.4 9 ± 2.29^{b}	61.97 ± 1.57^{c}
RBTC1	2.15 ± 0.20^{bc}	10.15 ± 0.14^{b}	1.95 ± 0.54^{b}	24.00 ± 1.50^{a}	62.54 ± 1.56^{c}
RBTC2	2.41 ± 032^{c}	11.26 ± 0.11^{c}	1.28 ± 0.06^{a}	30.56 ± 0.29^{c}	54.49±0.16^{b}
RBTC3	1.97 ± 0.04^{ab}	13.13 ± 0.36^{d}	1.58 ± 0.05^{ab}	32.78 ± 2.35^{c}	50.54±2.01^{a}

38%.[29] Therefore, this can be concluded that the fat content of simulated chips with the addition of rice bran tempe flour produced in the study meets the quality requirements as listed SNI.

Carbohydrate content of rice bran tempe simulated chips have decreased by 10 to 30% and significantly different with control. The greater addition of rice bran tempe flour followed by decreasing of carbohydrate levels. The carbohydrate content of tempe flour is 19.3%,[3] while carbohydrate content contained in wheat flour is 59.4% 30. The carbohydrate content of rice bran tempe chips is lower when compared to the control simulated chips. This is due to the reduced proportion of wheat flour that caused by the substitution of rice bran tempe flour.

Sensory Characteristics of Chip Samples

The sensory evaluation studies that have been reported here were found based on the evaluation by 75 untrained panelists. Overall, the hedonic test has showed that RBTC1 chips as having a higher degree of preference than other formulations. When compared with controls and commercial products, simulated rice bran tempe chips have a lower degree of preference and there were significantly different. This is because the color of rice bran tempe simulated chips RBTC1 is not significantly different from the control product. sensory evaluation which has shown that the color of tempe is light brown.[31] The color and aroma of acceptance of rice bran tempe simulated chips of each formulation have shown significant differences where the more rice bran tempe is added, the less its preference value. Color is a very important parameter in food products. The color visual is the first factor to appear before considering other factors and may affect the selection of food products.[31] These results reveal that consumers tend to prefer chips with a brighter color. Chips with the addition of rice bran tempe flour have a slightly brownish color, thus the consumers tend to choose commercial chips. As for the taste, texture, and aftertaste, RBTC2 and RBTC3 are not significantly different. RBTC 2 and RBTC 3 simulated chips receive lower flavor taste preferences ($p < 0.05$) than control chips. This is because consumers are still not familiar with rather bitter taste caused by rice bran. RBTC1 chips and commercial tempe simulated chips have their yields of 4.95 (slightly like) and 5.81 (like), respectively. These results explain that consumers tend to prefer the taste of tempe chips without the addition of rice bran. Consumers tend to prefer crisp textures. The acceptance level of commercial chips texture is better when compared with simulated chips when the addition of RBTC1 is $p < 0.05$. When the

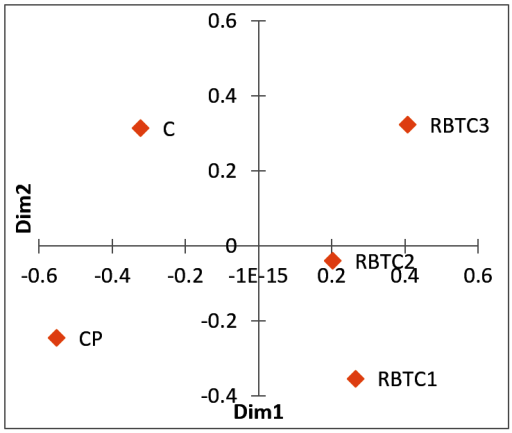

Fig. 4: Two dimensional plots of control and three of formulations of rice bran tempe flour from a classical MDS

Table 3. Result of Hedonic Analysis of Simulated Chips with Various Level Substitution of Rice Bran Tempe Flour

Sample	Color	Aroma	Flavor	Texture	After taste
Control	5,61 ± 1,29^{cd}	5,16 ± 1,21^{c}	5,16 ± 1,21^{b}	5,24 ± 1,20^{b}	5,20 ± 1,08^{bc}
RBTC1	5,25 ± 0,96^{c}	4,97 ± 1,12^{bc}	4,95 ± 1,13^{b}	4,91 ± 1,28^{ab}	4,92 ± 1,21^{b}
RBTC2	4,92 ± 1,21^{b}	4,55 ± 1,05^{a}	4,16 ± 1,44^{a}	4,75 ± 1,10^{a}	4,13 ± 1,49^{a}
RBTC3	3,97 ± 1,56^{a}	4,61 ± 1,15^{ab}	3,77 ± 1,53^{a}	4,72 ± 1,22^{a}	3,76 ± 1,47^{a}
Commercial Product	5,91 ± 0, 84^{d}	5,35 ± 1,56^{c}	5,81 ± 1,34^{c}	5,92 ± 0,89^{c}	5,41 ± 1,35^{c}

texture associated with the level of crispy simulated chips, the congested texture of crispiness is also increasing.

The level of hardness can be caused by the increase in protein content. The existence of protein will form a matrix on the fiber-like product which can increase the hardness of the product.[24, 33] After taste of the simulated chips with addition of rice bran tempe flour feels a little bitter. The more the addition of rice bran tempe flour, the bitter it will be. The main source of bitter taste is the process of damage to lipids, proteins, amino acids, and peptides.

Overall Consumer Preference in Products With Multidimensional Scaling (MDS)

Multidimensional Scaling (MDS) is a statistical analysis to determine the similarities and dissimilarities variables as described in geometric spaces.[34,25] MDS requires a measure of proximity that is similar between two or more products. Fig. 4 shows that the product RBTC1 has similarities or characteristics as similar to that of RBTC2. Due to they are in the same quadrant. RBTC3 is quite distant from the resemblance to RBTC1, but lies closer to RBTC 2 (value of proximity matrix 0.477) even though it is in a different quadrant. The samples residing in the same quadrant also have similarities, while the products contained in different quadrants have different characteristics. Therefore, the commercial products are concluded to have close proximity to RBTC2, this indicates that the formulation has a close resemblance to the commercial product.

Conclusion

The addition of rice bran tempe flour can significantly increase protein and ash content of simulated chips ($p < 0.05$). It has an effect on the decrease of carbohydrate content. The moisture content of simulated chips produced in the study is below 3% so that it complies with SNI 01-2062-1992, Indonesian government regulation. The fat content of simulated chips is below 38%, so that it meets the quality requirements of SNI 01-2886-2015. The hedonic test showed that RBTC1 (the addition of rice bran tempe flour 10%) has obtained the highest favored level when compared with RBTC2 (rice bran tempe flour 20%) and RBTC3 (rice bran tempe flour 30%) in overall results ($p < 0.05$). However, the simulated chips product which was added with the rice bran tempe flour did not have any resemblance to the commercial product as a whole product.

Conflict of Interest

All authors have no conflicts of interest to declare.

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