The optimal prediction the best quality of tempe gembus by using taguchi method

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Abstract. The purpose of the study is to predict the best quality of tempeh gembus from the amount of tofu waste, whey, duration of immersion, and total of yeast for fermentation process. The design of experiment in Taguchi method with 4 factors and 3 levels are used in experimental process. Thus, 9 total of experimental procedure is performed in this process. To assess the quality of the tempeh gembus, the sensory evaluation are introduced in sharp, taste, and the color. Then, the best result of tempe gembus is 2 kg of tofu waste soaked in 3 liters of whey water, for 72 hours, and the amount of yeast is 15 gr. Moreover, for continuation of this research process is the test of tempe gembus with the best quality as an effort in cholesterol reducing level in blood.

1. Introduction
The most important compounds contained in tempe gembus is isoflavones. [5] revealed that isoflavone compounds can reducing cholesterol levels in blood. Food fermentation processes or the results of soybean processing can increase levels of isoflavones [1]. Thus a study on how to increase isoflavone compounds in processed or fermented soybeans, especially into tempe is very important.

The content of isoflavones in fermented tempe was carried out by Wang. C [13]. The result is the best fermentation process to get isoflavone levels is for 24 hours, meaning that the pulp that has undergone the fermentation process in 24 hours produces the best isoflavone levels. Furthermore, [14] concluded in his study that the highest content of isoflavones in the form of daidzein and genistein in tempe was fermentation on the first day (24) and would change to lower isoflavone levels based on the length of fermentation. In other words, the color produced in the next fermentation will affect the decrease in isoflavone levels. This is in line with the results of the study of Wang.C [13] and Restuhadi [9]. As far as the observations made by the research team and the references that have been studied, the Indonesian people in general and the communities around the Padang city in particular make tempe gembus naturally fermented [2,9,12,14], it meansthis fermentation process only allows the pulp to ferment naturally in the bucket or soaked using pure water. In essence, fermentation is an effort made to grow microbes in the pulp as known as a forerunner to fermentation with tempe yeast, it is hoped that the results can increase the isoflavone content in the tempe. In the previous study, the research team had conducted research with artificial fermentation processes, namely by soaking the tofu pulp with Whey water. As a result, this method produces a better tempe gembus with color, taste, texture and aroma. To produce the best quality with the composition of the amount of tofu, the amount
of water to soak, soaking time, and the amount of yeast that is required for final fermentation needs to be done. For that reason, in this study the researcher will do an optimization to determine the best composition using the Taguchi method. Some studies show the Taguchi method is successful in predicting certain parameters and levels to produce a parameter combination that is as expected [7,8]. For this reason, in this research phase researchers will conduct research by using the Taguchi method. To predict the best comparison between the amount of tofu dregs, the amount of whey water to soak the tofu dregs, the length of the soaking time, and the amount of yeast that must be given in the tempe gembus fermentation process

2. Literature review

2.1. An Efforts to Increase Isoflavones in Tempe Gembus

Tofu dregs are a part of processed from soybeans. As a processed ingredient in tofu waste there are about 19% of isoflavones [10]. The content of isoflavones contained in soybeans are glucoside and isoflavone agluikan. During the processing and fermentation of soybeans into tempe occurs bioconversion of isoflavones from isoflavone glucoside to isoflavone agluikan. Isoflavones which are bioactive (especially genistein and daidzein) which are potential to be used in the health sector, because they have activities such as antioxidants and antihemolytic, anticholesterol and anticancer [11].

The content of isoflavones found in soybeans is also influenced by farming patterns, rainfall, and nutrients during the planting process [3,4,6]. In the process of planting the rainy season produces better soybean seeds with the highest isoflavone content [4]. In maintaining the content of isoflavones contained in soybeans, the treatment process must be maintained properly [5]. In addition, the amount of isoflavones contained in processed tofu also has good isoflavones [6]. [9] revealed the nutrient content and isoflavones contained in tofu dregs. Based on the processing [1] and isoflavone content in the processing of processed food types [6] and [14] that the best fermentation process is 48 hours with isoflavones in the form of daidzein 0.78 and genistein 0.82. Furthermore, the longer the fermentation process will produce the lower isoflavone content. Based on this reason, we see the opportunity to produce the best isoflavones by doing optimization design in the fermentation process, especially in the immersion process, fermentation with artificial fermentation methods to produce the best quality tempe gembus.

3. Research methodology

The method which is used in this research is taguchi method. This method has succeeded in simplifying the process of experimentation in research activities by applying the analysis of variables and the most influential levels so as to increase the desired results [8]. The Taguchi method helps designers with a systematic goal system by applying a mathematical calculation system in the experiment [7]. In the research method taguchi is used in determining the amount of tofu dregs that will be soaked in a certain amount of water with the time of soaking and the amount of yeast that should be given. This is explained in terms of variables and levels as shown in Table 1 and described in the experimental process with 9 times of experimentation as shown in Table 2. Sensory evaluation is used to assess the number of respondents of 13 people who have experience in making tempe gembus and in consuming tempe gembus minimum 5 years.

| Table 1. Variabel and level in experimental design |
|-----------------------------------------------|
| Factor | Definition | Level |
| A | Number of dregs (Kg) | 1 | 2 | 3 |
| B | amount of water (L) | 2 | 3 | 4 |
| C | soaking time (J) | 48 | 72 | 96 |
| D | Amount of yeast (g) | 10 | 15 | 20 |
Table 2. Experimental design with 9 experiments

| No. Exp | A | B | C | D |
|---------|---|---|---|---|
| 1       | 1 | 1 | 1 | 1 |
| 2       | 1 | 2 | 2 | 2 |
| 3       | 1 | 3 | 3 | 3 |
| 4       | 2 | 1 | 2 | 3 |
| 5       | 2 | 2 | 3 | 1 |
| 6       | 2 | 3 | 1 | 2 |
| 7       | 3 | 1 | 3 | 2 |
| 8       | 3 | 2 | 1 | 3 |
| 9       | 3 | 3 | 2 | 1 |

4. Experimental result and discussion

In the experiment factor process and the levels located in Table 1 are then described for research in Table 2, the results are shown in Table 3. All of these experiments are then carried out and each result is given to respondents to provide an assessment. This value will be a parameter as a result of the experiment.

Table 3. The Experimental that have done

| No. Exp | A | B | C | D | Exp Results |
|---------|---|---|---|---|-------------|
| 1       | 1 | 2 | 48| 10| 8.3         |
| 2       | 1 | 3 | 72| 15| 9.2         |
| 3       | 1 | 4 | 96| 20| 7           |
| 4       | 2 | 2 | 72| 20| 7.5         |
| 5       | 2 | 3 | 96| 10| 8.9         |
| 6       | 2 | 4 | 48| 15| 9.3         |
| 7       | 3 | 2 | 96| 15| 8.5         |
| 8       | 3 | 3 | 48| 20| 8.7         |
| 9       | 3 | 4 | 72| 10| 6           |

Figure 1. Effect plot from each experimental

Table 4. The Result of ANOVA

| Parameter | SS  | DOF | MS  | % Effect |
|-----------|-----|-----|-----|----------|
| A         | 0.68| 2   | 0.343| 6.995    |
Based on good observations of texture and color during the experiment process which is the more yeast is given, the faster the fungus will grow on the fermentation, on the contrary, if too little yeast is given, the fungus will grow late and tend not to be finished. This is confirmed from Table 3 in experiment 9 for the taste and color and texture produced by the tempe gembus are not very good, so that the respondent gives a value of 6. From the experimental process that has been carried out and the processing of each effect of the variables and levels has been obtained as shown in figure 1. From Figure 1 it is obtained that the variations of A2, B2, C1, D2 produced the best tempeh gembus.

Furthermore, to find out the presentation of the influence of each parameter, it was tested by analysis of variance (ANOVA) as seen in Table 4. It turned out that the amount of water used in soaking and the amount of yeast had an effect of 34% and 32% on the yield of tempeh gembus. Based on observations, if the amount of water used during soaking is a little while the dregs soak a lot then there will be a top not submerged tone. This non-submerged part will be fermented with air and decay. This will cause the tempe gembus to produce brownish yellow. From the results of the best variations A2, B2, C1, and D2, then the research team conducted a follow-up experiment to ensure that this combination produced the best tempe gembus products. The results are as shown in Figure 2.

![Figure 2. The type of the best tempe gembus](image)

| Table 5. The last result of sensory evaluation |
| No | Indicator | Value |
|----|-----------|-------|
| 1  | Color     | 9     |
| 2  | Texture   | 9.5   |
| 3  | Taste     | 9.2   |
| 4  | Aroma     | 9     |

In figure 2, it is seen the pure white color produced which is indicates that the tempe mushroom is developing well. Astuti [14] explained that pure white color produces high levels of isoflavones. In addition to being seen from its physical form, sensory evaluation is also applied to see the quality of the tempe gembus. The results are shown in Table 5. From the table, it can be seen that the color, texture, taste, and aroma get a value above 9. This indicates that the results of the research team resulted in getting the best appreciation from people who had been making and consuming tempe gembus.

5. Conclusion
   This research used Taguchi method with 4 factors and 3 levels with 9 experiments. From the 9 experiments, the assessment of the quality of tempe gembus was carried out using sensory evaluation
techniques. This technique involves 13 respondents in the city of Padang. Companies to be respondents are people who make and consume tempe gembus more than 5 years. From the results of the combination of 2 kg of Tofu Taguchi method soaked in 3 liters of water for 48 hours, after the process is continued mixed with 15 grams of yeast produces tempe gembus with color, texture, taste and aroma get an average value of nine of the respondents.

References
[1] Chung, Ill Min, et. al. “Changes in isoflavone composition of soya seeds, soya curd and soya paste at different processing conditions”. Journal of Food and Nutrition Research, Vol. 51, 2012, No. 1, pp. 40–51
[2] Eliyana. 2017. “Evaluasi Sifat Kimia dan Sensori Tempe Kedelai-Jagung dengan berbagai Konsentrasir Ragi Raprima dan Berbagai Formulasi”. Skripsi Universitas Lampung.
[3] Han-Sul Yang, Sung-Gil Choi, Jin-Tae Jeon, Gu-Boo Park, Seon-Tea Joo, “Textural and sensory properties of low fat pork sausages with added hydrated oatmeal and tofu as texture-modifying agents”, Meat Science Journal, vol. 75, pp. 283–289, 2007.
[4] Hasanah, Y., Nisa, T. C. Armidin, H. and Hanum, H. 2015. “Isoflavone content of soybean [Glycine max (L). Merr.] cultivars with different nitrogen sources and growing season under dry land conditions”, Journal of Agriculture and Environment for International Development – JAEID. Vol. 109 (1): 5 – 17.
[5] Jackson C.-J.C, J.P. Dini, C. Lavandier, H.P.V. Rupasinghe, H. Faulkner, V. Poysa, D. Buzzell, S. DeGrandis, “Effects of processing on the content and composition of isoflavones during manufacturing of soy beverage and tofu”, Process Biochemistry, vol. 37, 1117-1123, 2002.
[6] Mercedes, C. Panizzi, C. Favoni, S.P.G. Kikuci, A. 2002. “Extraction time for soybean isoflavone determination”. An international journal of Brazilian achieves of Biology and technology. Vol. 45(4):515-518
[7] Purwanto, W., Risfendra, Fernandez, D. Putra, D.S and Sugiarito, T. 2017. Design and comparison of five topologies rotor permanent magnet synchronous motor for highspeed spindle applications. vol.13(40):148-154
[8] Purwanto, W., Risfendra. and Putra, D.S. 2018. “Effect of Stator Slot Geometry on High Speed Spindle Motor Performance”. 2018 International Conference on Information and Communications Technology (ICOIACT), Yogyakarta, Indonesia: 560-565
[9] Restuhadi, F. Studi Pendahuluan Biokonversi Isoflavon pada Proses Fermentasi Kedelai Menggunakan Rhizopus spp. L. 41, Tesis. Magister Kimia ITB. Bandung.1993.
[10] Sidiq M, Mappiratu, Nurhaeni. 2016. “Kajian Kandungan Fenolat dan Aktivitas Antioksidan Ekstrak Etanol Tempe Gembus dari Berbagai Waktu Inkubasi”. Kovalen Journal 2(3):1-9
[11] Sulchan Mohammad and W. Endang Nur, “Nilai Gizi dan Komposisi Asam Amino Tempe Gembus serta Pengaruhnya terhadap Pertumbuhan Tikus”, Maj Kedokt Indon, Volum: 57, Nomor: 3, Marat 2007
[12] Sulchan Mohammad and Rukmi Isworo, “Effect of tempe gembus on cholesterol profile in hyperlipidemic rats”, Med J Indones, Vol 16, No 4,October – December 2007
[13] Wang. C, Q. Ma, S. Padagala, M. S. Sherrand, dan P. G. Khrishnan. "Changes of Isoflavones During Processing of Soy Protein Isolates". JAACS, vol. 75 no.3, 1998.
[14] Widiastuti Agustina, “Profil kandungan daidzein dan genistein pada tempe gembus selama proses fermentasi”, Skripsi. Universitas Negeri Sebelas Maret, 2004.