Development of Non-Soybean Tempeh from Cowpea Bean and Koro Bean

by Angga Pramana

PAPER · OPEN ACCESS

Development of Non-Soybean Tempeh from Cowpea Bean and Koro Bean

To cite this article: H Adhianata *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1059** 012062

Development of Non-Soybean Tempeh from Cowpea Bean and Koro Bean

Adhianata H[1], Pramana A[2], Rochmawati N[3], Ditya Y[4]

[1] Culinary Art Study Program, OTTIMMO International Master Gourmet Academy, Bukit Telaga Golf TC 4 No. 2-3, Citraland-Surabaya

[2] Agricultural Technology Industry Study Program, Riau University, Kampus Bina Widya KM 12.5, Pekanbaru-Riau

Corresponding author's email address: pramana.angga@lecturer.unri.ac.id

Abstract. Tempeh is a fermented food product that is very widely consumed in Indonesia because of it has a low price but high in nutritional value and health benefits. Tempeh made from non-soybean ingredients, can be used as an alternative of local abundant beans in Indonesia and also to reduce the dependence on imported soybeans. So the purpose of this study was to determine the effect of using non-soybeans ingredients, cowpea beans; koro beans; and mix of both beans on the manufacture of tempeh and to evaluate the microbiological characteristic and chemical composition of tempeh products. Non-soybean tempeh was made with the proportion of cowpea bean and koro beans 0:100; 50;50; 100;0 (g/g) then inoculated and incubated at 30 ±2 °C for 36 hours. The microbiological characteristic of non-soybean tempeh was evaluated from the viability of the mold in tempeh. The highest viability comes from koro bean tempeh, which was 7.3 log cfu/gram. The chemical composition of non-soybean tempeh was evaluated from water content, crude protein, fat, carbohydrates, ash, crude fiber and nitrogen content. The highest crude protein content was obtained from koro bean tempeh sample, which was 41.5%. The production of non-soybean tempeh is expected to be an alternative to fermented food products made from local ingredients at affordable prices but with good nutritional quality. So it is hoped that non-soybean tempeh can also be produced from other beans that have not widely used but have a huge nutritional value.

1. Introduction

Tempeh is a fermented food product origin from Indonesia, which is made from soybeans. *Rhizopus* sp was used for the process of fermenting soybeans into tempeh. There have been many studies evaluating the nutrition content and sensory properties of soybean tempeh [1,2,3]. Tempeh has many advantages as a fermented food products because of its good nutritional value for health, including protein, iron, vitamin B_{12}, antioxidant compounds and other bioactive compounds [1,4,5].

Tempeh is an alternative fermented food product with affordable price yet high in nutritional benefit. Since 2015, soybean productivity continues to decline until scarcity as raw material for making tempe, most of which are imported soybeans [6]. For this reason it as necessary to conduct a study to find other materials from non-soybean grains which are Indonesian local products to replace soybeans.

Koro beans (*Canavila ensiformis* DC) is a type of legume that has been widely developed in Indonesia with a productivity up to 4 tons per hectare of land with three times harvests a year. Koro beans have a potential to be developed, as a source of protein because of their protein content is close

with soybeans, which is 28.6% [7]. Another type of bean that is widely produced in Indonesia is cowpea bean (*Vigna unguiculata*) with high productivity value but is still rarely used. Cowpea bean contain 24.4% protein and 56.6% carbohydrates [8]. The high protein content with easy and relatively inexpensive procurement makes the development of beans vary suitable in supporting food diversification while at the same time providing a source of highly nutritious food. The purpose of this study was to determine the effect of using non-soybean ingredient (cowpea bean, koro bean, and mixed of both) on tempeh production and to evaluate the microbiological characteristic and chemical composition of the resulting tempeh products.

2. Material and Methods

2.1 Starter culture

In this study, commercial dried yeast was used as the starter culture for tempeh. There was a visual test of the effectiveness of the yeast was conducted by inoculating it on boiled soybeans prior to the inoculation of the samples.

2.2 Tempe making

The raw materials for making tempeh are soybeans, cowpea beans and koro beans purchased from traditional market in Surabaya, East Java. Each of 1 kg soybeans, cowpea and koro beans were washed and then soaked in water overnight at room temperature. Then the beans washed using clean water and steamed for 10 minutes. After the first steaming, the skin was removed and washed using clean water. Dehulled beans were then steamed again for 15 minutes, and then cooled at room temperature. After that, the tempeh yeast inoculation process was carried out. The variation of tempeh yeast concentration used was 2%; 4%; and 6%. Non-soybean tempeh was made with the proportion of cowpea bean and koro bean 0:100 (K1); 50:50 (K2); 100:0 (K3) (g/g); and 100% of soybean as control sample. Tempeh fermentation process was carried out at room temperature for 32 hours.

2.3 Total mold analysis

Total mold analysis was carried out by counting on PDA media. Mold spores were incubated for 48 hours at 30°C.

2.4 Protein and fat content

Protein content was analyzed using Kjedahl method.

$$\%\ \text{protein} = \frac{(b-a)x\ 0.1\ x\ 14.00}{W}\ x\ 100\ x\ \frac{6.25}{1000}$$

W = weight (gram) of tempeh
a = volume (ml) of 0.1N H_2SO_4 used in blank titration
b = volume (ml) of 0.1N H_2SO_4 used in tempeh titration
14.00 = atomic weight of nitrogen

Fat content was analyzed using Soxhlet extraction method.

$$\%\ \text{crude fat} = (W2 - W1)\ x\ \frac{100}{S}$$

W1 = weight of empty flask (gram)
W2 = weight of extracted fat + flask (gram)
S = weight of tempeh (gram)

2.5 Ash content

Ash content was analyzed using method by AOAC 1984. The result of ash content was expresses as percentage of ash (%).

3. Results and Discussion

3.1 Tempeh microbiological analysis

Tempeh microbiological characteristic was described by the viability of molds in tempeh. The microbiological characteristic of tempeh was indicated by the viability of mold growth after 32 hours of fermentation.

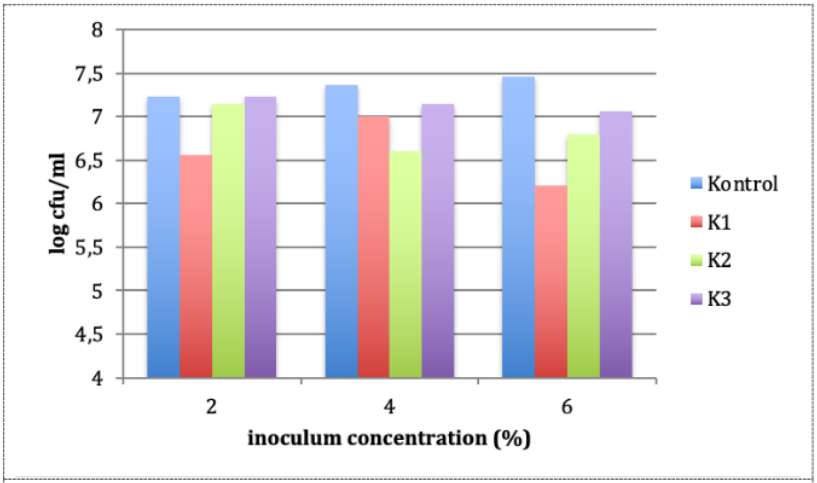

Figure 1. Mold viability of tempeh

The highest mold viability was found in koro bean tempeh compared to mold viability of cowpea bean tempeh and mix-bean tempeh. The difference in inoculum concentration did not give a significant difference in mold viability of koro bean tempeh. The highest viability comes from koro bean tempeh (K3) with 2% of inoculum concentration, which was 7.3 log cfu/gram.

The process of tempeh fermentation involves various microorganisms. The most important microorganism in tempeh fermentation is *Rhizopus* sp. The use of mold spore inoculum (laru tempe) during fermentation inoculation plays an important role in the success of tempeh production. The use of the type and amount of inoculum plays an important role in tempeh fermentation.

Based on the result, increasing of inoculum concentration added also increase the mold concentration for soybean tempeh (K). The addition of excessive inoculum will result in incomplete fermentation. Conversely, if the addition of tempeh inoculum is less, it can cause destructive bacteria to grow. The optimal condition for giving tempeh inoculum during inoculation was when the added inoculum contained 6 log of mold spores/100 grams of boiled grains. Different result were obtained for non-soybean tempeh. Not all of non-soybean materials can be modified with the same manufacturing process depends on their thickness, size and structure. The manufacture of tempeh from several types of materials has different treatment times for soaking, boiling/steaming and the length of fermentation time [6,9].

3.2 Chemical composition of tempeh

Parameters of nutrients assessed from tempeh include protein, carbohydrate, fat, ash and fiber content. The components are the main nutrients contained in tempeh. The highest crude protein content was obtained from koro bean tempeh sample, which was 41.5%.

Based on the chemical composition analysis, koro bean tempeh has a higher protein and crude fiber content, while soybean tempeh has a higher carbohydrate and ash content. The main advantage of tempeh fermentation is its increased nutritional value and organoleptic properties over its preservation

properties. The stages of tempeh making process result in the loss of unpleasant odor (beany flavor) and a reduction in the bitter taste of raw grains. During fermentation, various enzymes such as protease, lipase and carbohydrates enzymes are produced. During fermentation, there is enzymatic degradation of macromolecules into lower molecular weight and partial dissolution of cell wall and intracellular materials, which results in the desired texture and flavor.

Table 1. Chemical composition of koro bean tempeh (per 100 gram)

Chemical parameters	Soybean tempeh	Koro bean tempeh
Water (wb)	55.3 %	51,7 %
Protein (db)	20.8%	41,5 %
Fat (db)	8.8%	8,2 %
Carbohydrate (db)	35.4%	29,3 %
Ash (db)	1.6%	1,3 %
Crude fiber (db)	1.4%	3,1 %

Table 2. Soybean tempeh quality requirements according to Indonesian National Standards 01-3144-1992

Criteria	Requirements
Circumstances:	
- Smell	Normal
- Color	Normal
- Flavor	Normal
Water (% w/w)	Max 65
Ash (% w/w)	Max 1.5
Protein (% w/w) (Nx6.25)	Min 20
Microbial contamination	
- E.coli	Max 10
- Salmonella	Negative

Source: Indonesian National Standards 01-3144-1992 (1992).

Compared to the Indonesian national Standards of soybean tempeh, koro bean tempeh has met the prerequisites, having water content below 65%; ash content below 1.5%; and protein content more than 20%. So that koro bean can be used as an alternative to soybean replacement in tempeh making.

4. Conclusion

The differences in raw materials in making tempeh will produce tempeh with different characteristic both in microbiological and nutritional. Koro bean and cowpea bean can be used as a replacement or mixture of soybean in tempeh making. The nutritional content in the grains will also affect the growth capability of mold that plays an important role during fermentation. The highest mol viability was found in koro bean tempeh with 2% inoculum concentration. Koro bean tempeh also has a higher protein and crude fiber content compared with soybean tempeh. The production of non-soybean tempeh is expected to be an alternative to fermented food products made from local ingredients at affordable prices but with good nutritional quality. So it is hoped that non-soybean tempeh can also be produced from other beans that have not widely used but have a huge nutritional value.

5. References

[1] Astuti, M., Meliala, A., Dalais, F. S., and Wahlqvist, M. L. 2000. Tempe, a nutritious and healthy food from Indonesia. *Asia Pacifis J Clin Nutr*, Vol. 9, No. 4, pp. 322-325

[2] Hartanti, A. T., Wulandari, Y. R. E., Hutagalung, R. A., and Barus, T. 2018. Socialization of tempeh as Organic and Healthy Food for Household Mother in the South Tangerang City. *Jurnal Mitra*, Vol. 2, No.2, pp. 92-103

[3] Nout, M. J. R., and Kiers, J.L. 2005. Tempe fermentation, innovation and functionality: update into third millennium. *Journal of Applied Microbiology*, Vol. 98, pp. 789-805
[4] Hashim, N., Tai, C. w., Wen, H. X., Ismail, A., and Kong, K. W. 2018. Comparative Evaluation of Antioxidant Properties and Isoflavones of Tempeh Fermented in Two Different Wrapping Materials. *Current Research in Nutrition and Food Science*. Vol. 06, No. 2, pp. 307-317
[5] Kustyawati, M. E., Subekti, Murhadi, Rizal, S., and Astuti, P. 2020. Vitamin B12 Production in Soybean Fermentation for Tempeh. *AIMS Agriculture and Food*. Vol. 5, No. 2, pp. 262-271
[6] Sari, I.P., and Mardhiyyah, Y.S. 2020. Literature Review: Potency of Non-Soybean Tempeh Protein. *Jurnal Teknologi Pangan*. Vol. 14, No. 2, pp. 72-87
[7] Susanti, I., Hasanah, F., Siregar, N. C., and Supriatna, D. 2013. Potensi Kacang Koro Pedang (*Canavila ensiformis* DC) sebagai Sumber Protein Produk Pangan. *Jurnal Riset Industri*. Vol. 7, No. 1, pp. 1-13
[8] Tunjungsari, P., and Fathonah, S. 2019. Pengaruh Penggunaan Tepung Kacang Tunggak (*Vigna unguiculata*) terhadap Kualitas Organoleptik dan Kandungan Gizi Biskuit. *Teknobuga*. Vol. 7, No.2, pp. 110-118
[9] Rahayu, N.A., Cahyanto, M.N., and Indrati, R. 2019. Pola Perubahan Protein Koro Benguk (*Mucuna pruriens*) selama Fermentasi Tempe menggunakan Inokulum Raprima. *AGRITECH*. Vol. 32, No. 2, pp. 128-135

Development of Non-Soybean Tempeh from Cowpea Bean and Koro Bean

ORIGINALITY REPORT

18%	%	16%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Neswati, S D Ismanto. "Hydrogen Cyanide (HCN) Detoxification of Crude Rubber Oil Seeds Using Ultrasonic Waves and Neutralization", IOP Conference Series: Earth and Environmental Science, 2020 Publication	4%
2	Submitted to Higher Education Commission Pakistan Student Paper	2%
3	Yu Yu Miller, T F Kiseleva, L V Permyakova, V A Pomozova. "The use of high-protein vegetable raw materials in the production of fermented drinks", IOP Conference Series: Earth and Environmental Science, 2022 Publication	2%
4	A K Dewi, A D Saputro, Z Kusumadevi, F Irmandharu, T Oetama, A D Setiowati, S Rahayoe, J N W Karyadi. "Physical properties of red velvet compound chocolates sweetened with stevia and inulin as	2%

alternative sweeteners", IOP Conference Series: Earth and Environmental Science, 2021
Publication

5	S Marfu'ah, J N W Karyadi, M A Akbar, D I Imaniar, F I P Hati. "Physical quality change of tempeh during freeze drying", IOP Conference Series: Earth and Environmental Science, 2019 Publication	1 %
6	A Pramana, H Adhianata, Y Zamaya, Y Nopiani, P Alvionita. "Acceleration of Sago Food Diversification in Improving the Welfare of Sago Farmers in Riau Province", IOP Conference Series: Earth and Environmental Science, 2021 Publication	1 %
7	B Sultan, K Guan, M Kouressy, M Biasutti, C Piani, G L Hammer, G McLean, D B Lobell. "Robust features of future climate change impacts on sorghum yields in West Africa", Environmental Research Letters, 2014 Publication	1 %
8	Submitted to School of Business and Management ITB Student Paper	1 %
9	Fitri Wijarini, Muhammad Abrar Putra Siregar, Aidil Adhani, Nur Elisia, Susi Yantika Siahaan, Jamardi Sinaga. "Diversity and Habitat Preferences of Orchids in Tarakan Forest", IOP	1 %

	Conference Series: Earth and Environmental Science, 2022 Publication	
10	Submitted to University of Warwick Student Paper	1 %
11	K.A. Khatib. "Characterization and Functional Properties of Soy β-Conglycinin and Glycinin of Selected Genotypes", Journal of Food Science, 10/2002 Publication	1 %
12	A Noviana, F F Dieny, N Rustanti, G Anjani, D N Afifah. " Antimicrobial activity of hydrolyzate ", IOP Conference Series: Earth and Environmental Science, 2018 Publication	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		