Available online at
http://journal.ugm.ac.id/jifnp
DOI: http://doi.org/10.22146/ifnp.33349

INDONESIAN FOOD AND NUTRITION PROGRESS

Indonesian Food and Nutrition Progress, 2018, Vol. 15, Issue 2

Comparative Study of $CaSO_4$ and Papain Enzyme as Coagulants in The Tofu Production

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R Received 01 March 2018; Accepted 29 November 2018; Published Online 30 November 2018

Abstract

Tofu is a high protein food which is widely consumed in Indonesia. In this study, we used the variety of coagulant which is CaSO4 and papain enzymes. The extraction of soybean protein was conducted using selected ratio (1:2), then coagulated using two different coagulant which are $CaSO_4$ (1 and 2 gram) and papain enzyme (3 and 6 gram). The highest yield of tofu used $CaSO_4$ 2 gram with 66% yield and papain enzyme 6 gram with 65% yield. This indicates that more of coagulant are used so more yield of tofu. Based on the proximate test, especially proteins showed the making of tofu with papain enzyme (9.29%) gave higher protein content than $CaSO_4$ (6.50%) as coagulant.

Keywords: Tofu, soybean, $CaSO_4$, papain enzyme

Introduction

Tofu has long been consumed by Indonesians where it has a high protein content and the best quality of vegetable protein because it has the complete amino acid composition. It is made from soybeans by soybean protein coagulation to be thick (curd), then formed and pressed. Unlike tempeh which is from Indonesia, tofu comes from China as soy sauce, *tauco, bakpau*, and meatballs.

Coagulation causes a denatured protein and produces curd. Coagulation process at making of tofu use coagulant. There are variety of coagulant used, which are chloride salt ($MgCl_2.6H_2O$, $CaCl_2$, and $CaCl_2.2H_2O$), sulphate salt ($CaSO_4.2H_2O$ and $MgSO_4.7H_2O$), Lactone ($C_6H_{10}O_6$/Glukono-δ-lakton)/GDL), and acid (lactate acid, orange juice, acetate acid) (Sarwono & Saranggih, 2006; Zhang, Q., Li, W., Dong, M., & Feng, M., 2013). Coagulant sulphate is a coagulant that has been widely used in the world, such as calcium sulfate and magnesium sulphate, because the use of coagulant is quite easy. However, these coagulants dispersed slowly in water to form a colloidal solution in slow time (Shurtleff, et.al., 2001). In addition, these coagulants also produce side effect for healthy if has a lot of calcium levels causing the accumulation of calcium in the blood that causes the function of nerves worsen, body performance decreases, kidney damage, occurrence coagulation in the bloodstream and fluid in the

body, and for environment produce waste that contains the residual of coagulation used (Yudhistira, B., et.al., 2016).

The making of tofu can use natural coagulation such as papaya and pineapple extract. This is because pineapple extract contains bromelin enzyme and papaya extract contains papain enzyme. The two enzymes are highly proteolytic in that they have a high ability to break the peptide bond so that it can agglomerate milk proteins (Daulay, 1992 and Yamamoto, 1995). In addition, bromeline and papain enzymes include heat-resistant and high activity enzymes (Reed, 1995), more economical and safer in terms of health and environment (Hou et al., 1997). The quality of tofu is also influenced by the use of coagulant, the type of coagulant, coagulant concentration and temperature addition of coagulant. The addition of different coagulants will produce tofu with different textures and flavors.

In this study, we compared the use of of $CaSO_4$ and papain enzyme in coagulation protein from soybean. $CaSO_4$ is a coagulant that is used in the manufacture of tofu. Papain enzyme is a protease enzyme that can be coagulant and safer for health in food processing because it is produced from papaya. Using of variety coagulation was known to give the best quantity and quality in the making of tofu based on protein content, moisture content, carbohydrate content, and yield.

Materials and Methods

Materials and Chemicals

Soybean was collected from Depok Market, West Java. Batu tahu ($CaSO_4$) food grade was obtained from Pharmacy Laboratorium in Pancasila University and papain enzyme commercial with “Paya” brand was obtained from supermarket, as coagulant at the making of tofu.

Extraction Soybean

Soybean was washed and immersed in clean water for 8 hours. Soybeans were heated in hot water at 50^oC and peeled the skin of soybeans followed by washing. Water was added according to the variation of water ratio (1:2 and 1:3) then crushed. After that, the extract was filtered from the pulp by a filter cloth (Figure 1). The extract was subjected to the protein content analysis.

Coagulation of Protein Extract Soybean

200 gram of extract soybean were heated until the temperature reaches 70^oC - 80^oC and added with $CaSO_4$ (1 and 2 gram) and commercial papain enzymes (3 and 6 gram). The mixture were stirred evenly, put into plastic container and closed tightly. After curd formed, the liquid extract was separated from the precipitate using a filter cloth and was then pressurized to accelerate the separation of water from the sediment. The precipitate is molded by inserting it into the mold and calculated the yield of tofu. The highest yield of tofu was subjected to proximate analysis. (Figure 1).

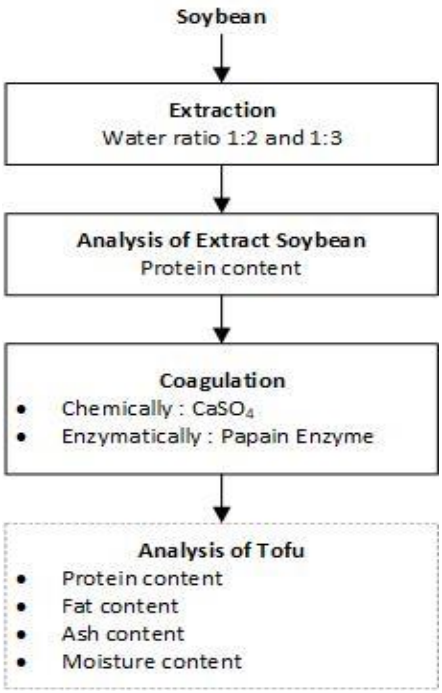

Figure 1. Schematic diagram of making tofu

Analytical Method

The analysis was done with measurement the proximate of tofu which contains of protein, fat, water, ash, and carbohydrate content. Measurement of protein content soybean extract was done by Lowry method. Measurement of total protein content was done by Kjehdahl method, total fat content (%fat) was done by the Soxhletasi method, total ash content (%ash) was done by gravimetric method, total water content (%water) was done by thermogravimetric method (oven method) from tofu (SNI 01-2892-1992). The measurement of total carbohydrate (carbohydrate) levels in the sample was calculated from different of protein content, fat content, ash content, and water on all content of tofu. The tofu yield is calculated based on the weight of the tofu produced from one liter of extract soybean in grams. Measurement of pH of the sample using pH meter were done triplicate.

Results and Discussion

Protein Content Analysis

Extraction of soybean were conducted using two different ratios of water. From the extraction process it was clearly seen that the higher protein content of extracts was obtained when the soybean was extracted with 1:2 ratio of soybean to water. It gives 695.48 mg/ml protein content or an increase around 16% more than another ratio (1:3) (596.12 mg/ml). This was due to the less water used, the protein content in the solution will be concentrated. Therefore, extraction using 1:2 ratio was selected and continued to tofu production.

Yield of Coagulated Soybean Protein

The coagulation process was done using two variation of chemical coagulant i.e. CaSO4 and papain enzyme with two different concentration respectively. It can be seen that both of chemicals performed well in coagulation process, showing more than 45% of protein was coagulated during the process (Table 2). Furthermore, the higher concentration of coagulant resulting the higher yield of protein. $CaSO_4$ concentration used was 1 and 2 gram that produced a yield tofu 93.33 gram (47%) and 131.07 gram (66%), respectively. Meanwhile, papain enzyme concentration used was 3 and 6 gram that produced a yield of tofu 90.346 grams (45%) and 130.74 grams (65%), severely. It also clearly seen that the papain enzyme has less efficiency (nearly a third) compared to $CaSO_4$. This suggest that papain enzymes can coagulation protein extract soybean as like as $CaSO_4$ which are hydrolyzing the soybean peptide chains, so the hydrophobic amino acid come out to form a flock interconnecting to form larger ones. So, papain enzyme can use as substitution of coagulant because can produce high yield of tofu too (approximately 65%). Although amount of papain enzyme was used more than that of $CaSO_4$, but it is cheaper and safer.

Proximate Analysis of Coagulated Soybean Protein

The proximate analysis was conducted for coagulated soybean protein using sample those gave more than 65% of yield. Making of tofu with $CaSO_4$ as coagulant produce tofu with protein content 6.50%, moisture content 88.1%, ash content 0.57%, fat content 3.70%, and carbohydrate content 1.13%. While, papain enzyme produced tofu with protein content 9.29%, moisture content 82.2%, ash content 0.63%, fat content 6.04%, and carbohydrate content 1.84%. Based on protein content, using papain enzyme as a coagulant in making of tofu has high protein content than using $CaSO_4$ that was 6.50% and 9.29%, respectively (Table 3).

Table 2. The yield of tofu using $CaSO_4$ and papain enzyme as coagulant

Sample		Extract Soybean (gram)	Yield of Tofu (gram)	Yield of Tofu (%)
CaSO4 (grams)	1	200	93.33	47%
	2	200	131.07	66%
Papain enzyme (grams)	3	200	90.346	45%
	6	200	130.74	65%

Table 3. Analysis proximate of tofu

Analysis Proximate	$CaSO_4$	Papain Enzyme
Protein Content (%)	6.50	9.29
Moisture Content (%)	88.1	82.2
Ash Content (%)	0.57	0.63
Fat Content (%)	3.70	6.04
Carbohydrate Content (%)	1.13	1.84

Conclusion

The high protein content of tofu is obtained by using water ratio of 1: 2 in the soybean extract that was used as raw material in coagulation process. Tofu production was successfully conducted using two coagulant i.e. $CaSO_4$ and papain enzyme. The yield of coagulated soybean could reach 66% using $CaSO_4$ 2 gram and 65% using papain enzyme 6 gram. However, tofu produced from papain enzyme coagulant has less water content thus resulted in the higher protein intake, when consumed, compared the $CaSO_4$ coagulated protein in the same basis.

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