Chemical characteristic and sensory of tempeh sausage on different soybean varieties and cooking methods variation

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Abstract. Tempeh sausage is the one of variative and interesting processed provide added value and extend the shelf life of tempeh. The purpose of the research is to determine the quality of tempeh sausages, especially chemical and sensory content produced from various soybean varieties and variation of cooking methods. The research had a Complete Random Design of the factorial pattern with 3 repeats. The first factor is tempeh from various soybean varieties (Import, Anjasmoro, Argomulyo, Burangrang, and Grobogan), the second factor is the cooking method (steamed, boiled and oven). The observation parameters include: moisture content, ash content, fat level, protein level, and sensory/organoleptic test. The result was showed that varieties of treatment and cooking methods gave a real interaction effect on ash content, fat content and protein of tempeh sausage. Tempeh sausage was produced from imported soybean, has the lowest water content for the oven cooking method and sausage tempeh of soybean Anjasmoro with steamed method has the lowest ash content. Tempeh sausage produced from soybean Argomulyo has the highest fat content for steamed cooking methods and the highest protein for the oven cooking method. Based on sensory analysis, it is known that having the highest level of preference is tempeh sausage from Grobogan and steamed treatment with a moisture content of 56.25%, ash content is 0.97%, fat 17.38%, and protein 12.91%.

1. Introduction
Soybean is a famous plant that has a higher economic value. Many innovations manage soybean in traditional fermented food in worldwide such as miso and natto from Japan then tempeh from Indonesia. Since a long time ago, tempeh is a famous traditional Indonesian food producing from fermented soybean by working of the fungal Rhizopus sp [1,2].

Tempeh is a traditional fermentation food containing high protein, cheaper, and famous food in the community. Tempeh has many benefits for the human body when routinely consumed. Karyadi (2001) state that tempeh is very useful in increasing nutrition where it has been consumed by vegetarians and non-vegetarians to reduce meat consumption [3]. In the similar fact, Kao and Chen (2006); Cederroth and Nef (2009); and Wang et al. (2013) state that the high content of protein and amino acids in tempeh reducing levels of harmful cholesterol in the body and avoid the risk of heart attack [4–6]. High isoflavones in tempeh function as antioxidants and anti-cancer. In addition, tempeh also contains
magnesium, fiber and various other minerals that play an active role in the metabolic and digestive systems of the human body. According to File et al. (2001); Kao et al. (2007); and Messina (2010) reported that isoflavones is very important as active biological compound contain more antioxidant activity in soybean with health benefits for human [7–9].

During tempeh fermentation, there are nutritional and chemical changes improving many changes in taste, flavor, and functional properties of the products. Enzymes produced during fermentation affect protein, fat, and carbohydrates. The complex sugars stachyose and raffinose cause flatulence will break down into digestible sugar. During fermentation, the fungal produce the enzyme phytase that mobilizes the phytic acid, improving the bioavailability of minerals. Fermentation also promotes the synthesis of B group vitamins (Karyadi, 2001), improving flavor, nutritional, chemical and functional properties of the products [2,3]. Few enzymes result in fermentation process such as : β-glycosidase hydrolyzes the β-glycosides forming the aglycones, which is the readily available form. Carrão-Panizzi and Bordignon (2000); Lima and Ida (2014); Kim et al. (2014) reported that soybean cultivars show a significant genetic variability for β-glucosidase activity [10–12].

The relatively short shelf life of tempeh is often an obstacle in the processing of them. When tempeh is stored at room temperature for one to two days, there are decreasing in quality and shelf life. Some opinion state tempeh as food for low class people. However, tempeh can provide added value while extending the tempeh shelf life. The one innovation to tempeh shelf life is to process tempeh into sausage.

Commonly salty food is ancient technology preserving food storage. Unfortunately this technology contain high-salt intake has been identified as a public health risk for most individual [13]. Beside salty food, sausage is another technique for preserving food. Sausage derived from the word "salsus" means salting or preserving. In the first time, the main ingredient of sausages was meat mixed with lots of spices, then put into a specific chasing (commonly from animal intestines), boiled, smoked and dried. Along with the development of processing technology, sausages also experience changes in basic ingredients. One of them is sausages made from vegetable ingredients such as : black soybean (Glycine soja) and tempeh [14].

Tempeh sausage contain many soy protein, because their raw material of tempeh. There is hydropholic in absorb and hold water, help more the formation of emulsions, has the ability to form membranes or films, form a gel, has the high adhesion and thick.

In general, commercial soybeans still rely on imported varieties. For this reason, it is necessary to find alternative raw materials from domestic varieties of soybeans. It can be used as substitutes reduce imported soybeans. Also, the use of local soybean varieties is expected to be able to produce processed products of good quality sausage and the taste is preferred by consumers.

One of the food processing processes is using heating. Food processing by heating is known as the cooking process which is the heating process of food with a temperature of 100°C or more with the purpose of obtaining a better taste, better aroma, softer texture, killing microbes and activating all of the enzymes [15]. The various methods of cooking sausages through by smoking, boiling, steaming and roasting. Each type of cooking has advantages and disadvantages. It needs to be study how to produce tempeh sausage with a good cooking methods, because the use of heat in the cooking process is very influential on the nutritional value of these foodstuffs [16]. Based on the assumptions previously described, the research purpose is to determine the quality of tempeh sausages, especially chemical and sensory content produced from various soybean varieties and variation of cooking methods.

2. Methodology

2.1. Materials and Tools

The ingredients was used in this study are tempeh derived from several soybean varieties (imported, Anjasmoro, Argomulyo, Burangrang and Grobogan), ice water, egg whites, tapioca flour, corn oil and seasonings (garlic, salt, white sugar and pepper). The equipment used : scales, knifes, cutting boards, grinders, wood stirrers, chasing machines, threads, steamer pan, large pan and gas stove.
2.2. Research Procedures
Tempeh with the basic ingredients derived from several soybean varieties (Import, Anjasmoro, Argomulyo, Burangrang and Grobogan) are weighed then cut into small pieces, mashed using a blender. A mixture of egg white, seasoning, ice water and tapioca flour was added and blended tempeh mixture. Pour the corn oil into the mixture while stirring evenly until it forms a paste-like mixture. The mixture then poured into a chasing machine to produce sausages with length 10 cm, then in the ends are tightly bound using a string. After the processing, tempeh sausages are cooked according to various cooking method treatments (steamed, boiled and oven).

2.3. Experimental Design
The research used factorial Completely Randomized Design with three replications. The first factor is soybean variety consisting of 5 levels (Import, Anjasmoro, Argomulyo, Burangrang, and Grobogan), the second factor is the cooking method consisting of 3 levels (steamed, boiled and oven). The experimental model is a Completely Randomized Design (CRD) 5 x 3 factorial pattern with 3 replications, respectively.

The parameters tested of tempeh sausage were: chemical content analysis and sensory analysis of the tempeh sausages produced. Chemical content analysis includes: analysis of water content, ashes content, fat content and protein using procedures Sudarmadji et al., (1997) [17], whereas sensory analysis or organoleptic testing uses the Lawless and Heymann (2010) methods, in the form of a hedonic test involving 20 semi-trained panelists from staff at South Sulawesi Agricultural Technology Assessment Office in the Postharvest Laboratory [18]. The organoleptic attributes assessed are: color, taste, texture, aroma, and favourite/hobby. The hedonic test used a scale of 1 to 5, namely: scale 1 = very dislike, 2 = dislike, 3 = rather like, 4 = like, and scale 5 = really like.

The collected data then tabulated and analyzed with ANOVA (Analysis of Variance). If the F test is significantly different, forwarded to the Duncan Multiple Range Test.

3. Results and Discussion
3.1. Water content
The water content in the food is very important to know because the water content can determine the freshness, durability, and the special characteristics of the foodstuffs. Water content is also an important component that can affect the performance, texture and taste of food [19]. Water content in tempeh sausages produced in the study can be seen in table 1.

Table 1. Results of the analysis of water content of tempeh sausages in various soybean varieties and variations in cooking methods.

| Varieties      | Cooking Methods |
|----------------|-----------------|
|                | Steamed | Boiled | Oven  | Average |
| Import         | 53.30 a   | 52.74 a | 35.66 a | 47.23 a |
| Anjasmoro      | 51.87 a   | 53.95 a | 42.21 a | 49.34 a |
| Argomulyo      | 50.92 a   | 55.74 a | 44.68 a | 50.44 a |
| Burangrang     | 45.73 a   | 50.21 a | 42.25 a | 46.06 a |
| Grobogan       | 51.15 a   | 56.25 a | 44.21 a | 50.53 a |
| Average        | 50.59 b   | 53.77 a | 41.80 b |         |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan's Multiple Range Test α = 0.05

The tempeh sausage water content according to the results presented in table 1 ranged from 35.66% - 55.74%. The results of variance showed that the factor from soybean variety and the method of delivery had not significant effect (P≥0.05) on the water content of tempeh sausage. The lowest water content was produced in the treatment of imported varieties using the oven cooking method by 35.66%. The highest water content was produced in tempeh sausage from Grobogan.
variety soybeans by boiling method about 56.25%. This result showed that the water content produced by various treatments suitable with the SNI requirements (01-3820-1995) which is a maximum of 67.0%. This result is suitable and allowed based criteria of sausage quality. According to Astawan et al. (2013), the soybean varieties affect the water content of tempeh produced due to differences in water penetration into the soybean matrix and the presence of fungal growth activity when making tempeh [20]. Tempeh made from Grobogan variety has the higher water content compared to Anjasmaro and Argomulyo varieties.

The method of cooking by boiling is significantly different from the treatment of steaming and oven methods. Boiling will cause water enter to the sausage. According to Anjarsari et al. (2009), the high water content of tempeh sausages is influenced by the length of boiling time because during the boiling takes place, the product will absorb water according to their ability determined by the amount of protein contained in tempeh [21]. According to the result, Falisnur et al. (2015) state that the boiling treatment will absorb many water during the treatment [22].

Research result by Widjanarko et al. (2012) showed that that sausages with a cooking method with boiling without fumigation techniques have a higher water content compared to another cooking methods, namely boiling without fuming, steaming with fuming and steaming without fuming [23]. This is also supported by Sundari et al. (2015) which states that boiling on tempeh will increase the water content of fresh form because fermented soybean seeds absorb boiled water, where the space in the cells absorbs boiled water [15]. According to Salma et al. (2020) state that the boiling process using water and high temperatures can increase water content inside the food [24].

### 3.2. Ash Levels

Ashes content in the food ingredient indicates the presence of inorganic mineral content in the food which expressed in percent, and the composition which is not evaporated during the ashing process. The ash content of foodstuffs and their composition depends on the type of material and how they are burned (AOAC, 1995; Winarno, 2004). The ash level of tempeh sausage produced was showed in Table 2.

Table 2. The results of the analysis of the tempeh ash content of various soybean varieties and variations in the cooking methods.

| Varieties | Cooking Methods |
|-----------|-----------------|
|           | Steamed | Boiled | Oven | Average |
| Import    | 1.66 ay   | 1.31 az  | 2.0 ax | 1.65 a  |
| Anjasmaro | 0.04 dz   | 0.76 dy  | 1.09 dx | 0.63 e  |
| Argomulyo | 1.19 cx   | 0.81 dy  | 0.50 ez | 0.83 d  |
| Burangrang| 1.59 ax   | 1.65 cx  | 1.65 cx | 1.48 b  |
| Grobogan  | 1.30 by   | 0.97 cz  | 1.82 bx | 1.36 c  |
| Average   | 1.15 b    | 1.01 c   | 1.41 a  |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan's multiple range test $\alpha = 0.05$

In Table 2, it is known that ash content range from tempeh sausage about 0.50% - 2.00%. This is show that the tempeh sausage ash content is still below of sausage quality criteria, which is a maximum ash about 3% based on SNI 01-3820-1995. The results of the analysis of variance showed that soybean varieties, cooking methods and interactions between the two giving a significant effect ($P <0.05$) on the ash levels of tempeh sausage. The lowest ash content was produced in the tempeh sausage from Anjasmaro variety with steamed treatment that is equal to 0.04%. The highest ash content from tempeh sausage in imported varieties with oven treatment about 2.0%.

The results showed that the average of tempeh sausage produced from the cooking method by oven had higher ash content than the steamed and boiled method. According to Ginting and Antarlina (2002) this is closely related to the mineral content of the protein produced [25]. Protein levels of soy
milk processed in the dry methods are higher than in the wet methods. As a consequence, the level of soy milk ash which is processed by wet method is relatively lower than dry method. Similar results were generated in this study where the levels of tempeh sausage protein cooked by oven were higher than other methods (Table 4). Thus, phosphorus that bound to proteins also more in number, and the ash content will also be higher. According to Nzewi and Anthony (2011) the decrease in ash content when boiling occurs due to the dissolution of minerals into the immersion media which is accelerated by the heating [26].

According to Sulthoniyah et al. (2013) state that the effect of processing on the material can affect the availability of minerals for the body [27]. The use of water in the washing, soaking and boiling process can reduce the availability of minerals because mineral such as salt will dissolve by the water used. According to Sipayung et al., (2015) states that the temperature in the steaming process can affect the ash content [28]. As the temperature of steaming increases and the drying process results in decreasing water content, more residue is left in the material.

3.3. Fat Content

Commonly fat is found in almost all foodstuffs with different contents. Animal fats contain more sterols called cholesterol, while vegetable fat contain phytosterols and more unsaturated fatty acids in the form generally liquid. Fat content derived from sausages was determined by the ability of muscle protein or protein extraction in binding fat which is an important factor in determining the stability of the emulsion and fat content of tempeh sausages. The results of the analysis of tempeh sausage fat levels can be seen in Table 3.

| Varieties       | Cooking Methods | Varieties       | Cooking Methods |
|-----------------|-----------------|-----------------|-----------------|
|                 | Steamed         | Boiled         | Oven           | Average   |
| Import          | 8.41 bx         | 13.86 by        | 21.28 bx       | 14.5 e    |
| Anjasmoro       | 20.27 bx        | 18.85 ax        | 20.37 cdx      | 19.83 b   |
| Argomulyo       | 26.87 ax        | 16.37 abz       | 23.36 aby      | 22.20 a   |
| Burangrang      | 17.44 cx        | 18.95 ax        | 18.25 dx       | 18.21 d   |
| Grobogan        | 21.30 by        | 17.38 ay        | 25.16 ax       | 21.28 ab  |
| Average         | 18.85 b         | 17.08 c         | 21.68 a        |           |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan's multiple range test $\alpha = 0.05$

Tempeh sausage fat content produced ranged from 8.41% -26.87% (Table 3). The results of variance showed that the variety factor, the cooking method and the interaction between the two showed in the significant effect ($P <0.05$) on the levels of fat tempeh sausage. The highest fat content was found in the tempeh sausage from Argomulyo variety by the steaming cooking method that is equal to 26.87% and was not significantly different from tempeh sausage from Anjasmoro variety by boiled treatment and Grobogan variety by oven treatment. The lowest fat content was produced in imported varieties of tempeh sausage by steaming method about 8.41%. According to Antarlina et al. (2003) state that the protein content, fat content, ash content and total tempeh acid from local varieties soybeans are relatively higher than imported soybeans [29].

Research result by Risnawanti et al. (2015) which showed tempeh fat content in local soybeans is higher than tempeh fat from imported soybean [30]. The average fat of tempeh sausage produced is quite high, different from the results of the study Wulandari et al. (2013) showed that the fat content of tempeh sausages with the best treatment (addition of 8% egg white and 25% tapioca flour) was obtained at 13.19% [31]. The results study of Sabudi (2016) obtain tempeh sausage fat content about 11.54% [32]. Ginting and Antarlina (2002) states that the difference occur due to differences in soybean varieties and processing methods used in each study [25].
The cooking methods such as steamed, boiled and oven will affect the fat content of tempeh sausages. The cooking method by boiling resulted the lowest fat content is 17.08%. It assumed that the boiling process used water as a heat-conducting medium, then fat removed due to heating. This is in accordance with the opinion Persson et al. (2003) state that cooking food by boiling caused a decrease in fat content due to high temperatures and fat dissolution in water [33]. The decrease in fat content is due to the nature of the fat that cannot stand the heat, during the cooking process the fat melting and even evaporates (volatile) into other components such as flavor [34]. Cooking accelerates the movement of fat molecules, then create distance between the molecules becomes large and simplifies the process of fat removal [35].

According to Sulthoniyah et al. (2013) and Jacob et al., (2008) state that the one of the factors that influence the fat content of food products is the temperature during steaming [27,36]. High temperatures in steaming will damage the fat content in shredded products. The process of fat oxidation will cause inactivation of biological functions and is potentially toxic. Besides being damaged by oxidation, fat can also be damaged due to hydrolysis. In general, after processing food, fat damage will occur. The degree of damage varies greatly depending on the temperature used and the length of processing time. The higher the temperature used, the more intense the damage to fat.

3.4. Protein Content
Protein is a food substance that is important for the body because it has a function as a builder and regulator of the body. Protein in food consumed by humans will be absorbed by the intestine in the form of amino acids. In addition to making food taste better, the use of heat in food processing such as boiling, steaming and frying can also affect the nutritional value of the used foodstuffs [15]. The results of the analysis of tempeh sausage protein levels was showed in table 4.

Table 4. Results of analysis from tempeh sausage protein content in various soybean varieties and variations in cooking methods.

| Varieties     | Steamed | Boiled | Oven | Average |
|---------------|---------|--------|------|---------|
| Import        | 10.64   | 9.11   | 15.41| 11.72   |
| Anjasmoro     | 13.40   | 12.64  | 15.33| 13.79   |
| Argomulyo     | 12.68   | 13.37  | 17.63| 14.56   |
| Burangrang    | 13.98   | 15.77  | 15.83| 15.19   |
| Grobogan      | 14.06   | 12.91  | 15.34| 14.10   |
| Average       | 12.95   | 12.76  | 15.90|         |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan's multiple range test α = 0.05

Tempeh sausage protein produced in this study ranged from 9.11% -17.63%. The results of variance showed that the variety factor, the cooking method and the interaction had a very significant effect (P <0.01) on the protein levels of tempeh sausage. The lowest protein was produced in the treatment tempeh sausage from imported varieties with boiled method that is equal to 9.11%. The highest protein was obtained from tempeh sausage from Argomulyo varieties with oven treatment about 17.63%. According to Antarlina et al., (2003) state that protein content from local soybean varieties is relatively higher than imported soybean [29]. The protein content of tempeh sausage was obtained from soybean of tempeh used. Research conducted by Ambari et al., (2014) showed that content of the tempeh sausage coming from the main ingredient such as the type of tempeh and egg as an additional ingredient in making the sausages.

The result of research Elizabeth et al., (2018) was showed that tempeh derived from soybean varieties such as : Argomulyo, Anjasmoro, and Burangrang has higher protein content than tempeh from imported soybean [37]. Then research result of Hidayah et al. (2012) was showed that protein content of tempeh using Anjasmoro variety soybean was greater than tempeh from imported varieties
According to Ginting et al., (2009) state that new local soybean varieties such as: Burangrang, Bromo and Argomulyo can produce tempeh with the same quality as imported soybeans and contain higher protein content [39]. According to Santosa and Suliana (2009) states that tofu made used Kaba soybean varieties has a higher protein content when compared to tofu produced by Wilis and imported varieties [40].

The cooking methods (steamed, boiled and oven) affect the protein content of tempeh sausages. The lowest protein content in boiling method is 12.76% due to the fact that the protein will destroy at hot temperatures and easily soluble in water. The boiling treatment can reduce protein levels in the food ingredients. Decrease in protein content caused by high temperatures makes that amino acids more dissolve in water [41].

The higher the temperature used causes the protein content in food decreases. In general, protein molecules are very fragile and immediately damaged when exposed to heat. Warming has a very significant effect on the protein content contained in food ingredients. The boiling treatment will also reduce protein levels in food. This happens because processing using high temperatures causes denaturation of proteins. Denaturation makes the bonds between amino acids break and lost. The breakdown of amino acid bonds causes coagulation and decreases solubility [11,15].

3.5. Sensory Characteristics of Tempeh Sausage

The tempeh sausage was produced were then sensory tested to determine panelist preferences for the tempeh sausages production. The recapitulation and processing of hedonic ranking test data was presented in table 5. From the results of statistical analysis it is known that there are real interactions between soybean varieties and variations of cooking methods on the sensory characteristics of tempeh sausages such as: aroma, taste, texture and favorite/hobby.

| Soybean Varieties | Cooking Methods | Color | Aroma | Taste | Texture | Hobby |
|------------------|----------------|-------|-------|-------|---------|-------|
| Import           | Oven           | 3.26  | 2.45  | 2.29  | 2.60    | 2.47  |
|                  | Steamed        | 3.26  | 3.00  | 2.74  | 2.69    | 3.14  |
|                  | Boiled         | 3.38  | 3.05  | 3.00  | 3.05    | 3.17  |
| Anjasmoro        | Oven           | 3.12  | 2.98  | 2.95  | 2.95    | 3.24  |
|                  | Steamed        | 3.48  | 2.93  | 2.88  | 2.86    | 2.91  |
|                  | Boiled         | 3.26  | 3.00  | 2.83  | 2.83    | 2.91  |
| Argomulyo        | Oven           | 3.38  | 2.83  | 3.29  | 3.31    | 3.38  |
|                  | Steamed        | 3.60  | 3.14  | 3.09  | 3.14    | 3.43  |
|                  | Boiled         | 3.38  | 3.21  | 3.07  | 3.19    | 3.40  |
| Burangrang       | Oven           | 3.00  | 3.19  | 3.29  | 3.38    | 3.12  |
|                  | Steamed        | 3.19  | 3.21  | 3.02  | 3.09    | 3.12  |
|                  | Boiled         | 3.24  | 3.00  | 3.31  | 3.07    | 3.45  |
| Grobogan         | Oven           | 3.62  | 3.50  | 3.48  | 3.26    | 3.48  |
|                  | Steamed        | 3.36  | 3.57  | 3.21  | 3.05    | 3.10  |
|                  | Boiled         | 3.81  | 3.57  | 3.67  | 3.64    | 3.50  |

Notes: The numbers followed by the same letters in the same column are not significantly different in Duncan's multiple range test $\alpha = 0.05$

Color is one of the main attributes in sensory evaluation because it is the fastest and easiest way to give an impression of a product. The average organoleptic color of tempeh sausage ranges from 3.00 - 3.81 (rather like). The color tempeh sausage from Grobogan variety with boiled treatment has the highest value (3.81). The difference in color at tempeh sausages was influenced by the color of tempeh and the cooking process. The color of tempeh sausage cooked in the oven has a more
attractive color (brownish white). It seems the panelists prefer the color of them. The brown color is the result of the reaction of carbonyl compounds with amino acids from protein in high temperatures (100°C or more). The existence of a brown color on fat will cause tempeh sausages produced brownish white [21]. Ratnaningsih et al. (2017) state that commonly raw soybean has interesting color such as greenish-yellow seed color [42]. It was performed by local soybean such as Anjasmoro. The other benefit they had a large size seed (17.84 g/100 seeds) and source of important dietary fiber.

The aroma of tempeh sausage produced comes from raw materials used as soybean and additives in the form of spices. The more used tempeh in sausage, the product will be flavorful. The distinctive aroma of tempeh is caused by the fermentation process [43]. The aroma of Grobogan variety in tempeh sausage with steamed and boiled treatment has the highest value, which is rather like (3.57%). The lowest score was showed in imported varieties of tempeh sausages using the oven cooking method. Different varieties and ways of processing caused many differences in aroma scores [25]. Cooking variations also affect the aroma of tempeh sausage. According to Anjarsari et al. (2009) states that boiling sausages will affect the aroma [21]. The longer of the boiling time is affected the aroma of the dough, especially the aroma of tempeh and tilapia will be smaller. Kouba et al., (2012) states that during the cooking process takes place, various chemical and physical reactions occur then increasing the nutritional and sensory value of odor by inactivating pathogenic microorganisms and the formation of aroma compounds [44]. The aroma of tempeh sausage also influenced by the presence of other ingredients such as herbs or spices that can improve the aroma of tempeh sausages. Nurhikma et al., (2019) added that the existence of the aroma in tempeh sausages is strongly influenced by the spices added when making sausages [45]. The spices can improve the aroma of sausages or other food production.

Taste is the most important factor in determining the decision to accept or reject a food product. The taste of tempeh sausage ranges from 2.29 (dislike) to 3.67 (rather like). The taste of tempeh sausage from Grobogan variety with boiled treatment has the highest value (3.67). Soybean tempeh nuggets are made from soybeans and have a distinctive aroma of tempeh, then the nuggets will also taste such as typical tempeh. The taste of tempeh sausage is very much influenced by the tempeh and spices used. In addition, boiling sausage tempeh also affects the taste. Based perfect mixing and cooking, the spices will spread throughout the sausage mixture, and more water content in the sausage, the spices will spread easier to all parts of the tempeh sausage. This happens because water is an important component in food. Water can affect more in the performance, texture, and taste of food [21].

The tempeh sausage texture derived from soybean varieties Grobogan with boiled treatment has the highest value (3.64). The texture of tempeh sausage produced is chewy because it is influenced by the water content of tempeh sausage and tapioca flour which is able to bind water to the high stickiness. Also, boiling treatment possible form a compact texture. More soybean tempeh added will produce a sausage texture which is preferred, because soy protein is in the raw material of tempeh is hydropholic. The material has the ability to absorb and hold water, help more in the formation of an emulsion responsible for forming a gel, has a high adhesion because it is a thickener [46]. This is supported by research results Anjarsari et al. (2009), which state that the length of boiling will form a compact texture, resulting in tempeh sausages with a chewy and compact texture [21]. The tempeh sausage texture is influenced by additional ingredients given in the form of tapioca flour [47]. Commonly tapioca flour bind to water, including another material when heated. This is a benefit in food processing. In addition, materials with a moisture content of more than 10% still have the potential to be rubbery and still soft.

Related to the holistic approach of tempeh sausage, Andrade et al. (2011) state that the moisture sorption isotherms describe the relationship between moisture content and water activity in food [48]. It is the basic concepts related to the sorption thermodynamics of water and the measurement of sorption isotherms for food materials. The most commonly used models in food are Brunauer-Emmett-Teller. The model of processing food success of the Brunauer-Emmett-Teller model. There is rather qualitative, considering that almost all cases are linear only in a limited rank of water activity.
from 0.05 to 0.45, as its main applicability is the estimation of surface areas. This is only a predictable model of water activities in the future of tempeh sausage production.

The favorite food is the overall and subjective acceptance of the tempeh sausage produced. Based on Table 5 was showed that the panelists' rating has a score of 2.47 - 3.50 (dislike to rather like). The most preferred treatment is the tempeh sausage from Grobogan variety with boiled treatment, which has the highest value (3.50), because they had a compact and chewy texture, attractive color (brownish white), and good taste. The quality of protein derived from vegetables when compared to animals is still relatively low. However, combining vegetable sources are able to provide complementary effects of essential amino acids [49].

4. Conclusion
1. There is no real interaction between varieties and cooking methods on water content, but on ash, fat and protein content, there is a real interaction between soybean varieties and variety of cooking methods (steamed, boiled and oven).
2. Based on the sensory test results, it is known that the most popular tempeh sausage derived from soybean Grobogan varieties and boiled treatment with a water content of 56.25%, ash content of 0.97%, fat 17.38% and protein 12.91%.

References
[1] Egounlety M and Aworh O C 2003 Effect of soaking, dehulling, cooking and fermentation with Rhizopus oligosporus on the oligosaccharides, trypsin inhibitor, phytic acid and tannins of soybean (Glycine max Merr.), cowpea (Vigna unguiculata L. Walp) and groundbean (Macrotyloma unguiculata L) J. Food Eng. 56 249–54
[2] Bavia A C F, Silva C E da, Ferreira M P, Leite R S, Mandarin J M G and Carrão-panizzi M C 2012 Chemical composition of tempeh from soybean cultivars specially developed for human consumption Food Sci. Technol. 32 613–20
[3] Karyadi D 2001 The development of tempeh across five continents (American Soybean Association, Liat Towers Singapure)
[4] Kao T-H and Chen B-H 2006 Functional components in soybean cake and their effects on antioxidant activity J. Agric. Food Chem. 54 7544–55
[5] Cederroth C R and Nef S 2009 Soy, phytoestrogens and metabolism: A review Mol. Cell. Endocrinol. 304 30–42
[6] Wang Q, Ge X, Tian X, Zhang Y, Zhang J and Zhang P 2013 Soy isoflavone: The multipurpose phytochemical Biomed. reports 1 697–701
[7] File S E, Jarrett N, Fluck E, Duffy R, Casey K and Wiseman H 2001 Eating soya improves human memory Psychopharmacology (Berl). 157 430–6
[8] Kao T H, Wu W M, Hung C F, Wu W B and Chen B H 2007 Anti-inflammatory effects of isoflavone powder produced from soybean cake J. Agric. Food Chem. 55 11068–79
[9] Messina M 2010 A brief historical overview of the past two decades of soy and isoflavone research J. Nutr. 140 1350S-1354S
[10] Carrão-panizzi, Concórdia M, Bordingnon and Renato J 2000 Activity of beta-glucosidase and levels of isoflavone glucosides in soybean cultivars affected by the environment Pesqui. Agropecuária Bras. 35 873–8
[11] de Lima F S and Ida E I 2014 Optimisation of soybean hydrothermal treatment for the conversion of β-glucoside isoflavones to aglycones LWT-Food Sci. Technol. 56 232–9
[12] Kim E-H, Lee O-K, Kim J K, Kim S-L, Lee J, Kim S-H and Chung I-M 2014 Isoflavones and anthocyanins analysis in soybean (Glycine max (L.) Merill) from three different planting locations in Korea F. Crop. Res. 156 76–83
[13] Sikes A L, Tobin A B and Tume R K 2009 Use of high pressure to reduce cook loss and improve texture of low-salt beef sausage batters Innov. Food Sci. Emerg. Technol. 10 405–12
[14] Rahma P and Sutrisno A 2017 Sosis Analog Berbasis Tempe Kedelai Hitam (Glysine soja)
(Perbedaan Persentase Gel Glukomanan dan Jenis Pati J. Pangan dan Agroindustri 5

[15] Lamid A, Almasyhuri A dan Sundari D 2015 Pengaruh proses pemasakan terhadap komposisi zat gizi bahan pangan sumber protein Media Penelit. dan Pengemb. Kesehat. 25 20747

[16] Winarno F G 2004 Kimia Pangan dan Gizi (Jakarta: PT Gramedia)

[17] Sudarmadji S, Suhardi dan Haryono B 1997 Analisa bahan makanan dan pertanian (Yogyakarta: Liberty dan Pusat Antar Fakultas Pangan dan Gizi UGM)

[18] Lawless H T dan Heymann H 2010 Sensory evaluation of food: principles and practices (New York: Springer Science & Business Media)

[19] Sudarmaji, Haryono dan Suhardi 1997 Analisis Bahan Makanan dan Pertanian (Yogyakarta: Penerbit Liberty)

[20] Astawan M, Wresdiyati T, Widowati S, Bintari S H dan Ichani N 2013 Physochemical Characteristics and Functional Properties of Tempe Made from Different Soybeans Varieties Pangan 22 241–52

[21] Anjarsari B dan Agustini S M 2009 Perbandingan tempe kedele dengan ikan nila (Oreocromis niloticus) dan lama waktu perebusan terhadap karakteristik sosis tempe kedele Infomatek 11 33–46

[22] Failisnur F, Firdausni F dan Silfia S 2015 Pengaruh Proses Pengolahan Terhadap Sifat Fisika dan Kimia Bubuk Kedelai J. Litbang Ind. 5 37–43

[23] Widjanarko S B, Zubaidah E dan Kusuma A M 2012 Studi kualitas fisik-kimiawi dan organoleptik sosis ikan lele dumbo (Clarias gariepinus) akibat pengaruh perebusan, pengukusan dan kombinasinya dengan pengasapan J. Teknol. Pertan. 4

[24] Salmatia S, Isamu K T dan Sartinah A 2020 The effect of the boiling and steaming process on the content of albumin and proximate Snakehead fish (Channa striata) J. Fish Protech 3

[25] Ginting, E. dan Antarlina S S 2002 The effect of varieties and processing methods on the quality of soymilk J. Penelit. Pangan. Tanam. Pangan 21 48–57

[26] Nzewi D dan Egboonu A C C 2011 Effect of boiling and roasting on the proximate properties of asparagus bean (Vigna Sesquipedalis) African J. Biotechnol. 10 11239–44

[27] Miratis S T, Sulistiyati T D dan Suprayitno H E 2013 Pengaruh Suhu Pengukusan Terhadap Kandungan Gizi Dan Organoleptik Abon Ikan Gabus (Ophiocephalus striatus) J. Mhs. Teknol. Has. Perikan. 1 33–45

[28] Sipayung M Y, Suparmi S dan Dahlia D 2015 Pengaruh Suhu Pengukusan Terhadap Sifat Fisika Kimia Tepung Ikan Rucah J. Penelit. Pertan. Tanam. Pangan 22 106–13

[29] Antarnista S, Ginting E dan Utomo J S 2003 The quality of tempe prepared from selected improved varieties of soybean during frozen storage J. Penelit. Pangan. Tanam. Pangan 21 106–13

[30] Risnawanti Y 2015 Komposisi Proksimat Tempe yang dibuat dari Kedelai Lokal dan Kedelai Impor (Surakarta: Universitas Muhammadiyah Surakarta)

[31] Wulandari D 2013 Perekayasaan Pangan Berbasis Produk Lokal Indonesia (Studi Kasus Sosis Berbahan Baku Tempe). J. Biopres Komod. Trop. 1 73–82

[32] Sabudi I N S 2016 Sosis berbahan dasar tempe kedelai J. Gastron. Indones. 4 56–69

[33] Persson E, Sjöholm I dan Skog K 2003 Effect of high water-holding capacity on the formation of heterocyclic amines in fried beefburgers J. Agric. Food Chem. 51 4472–7

[34] Nurhidajah N, Anwar S dan Nurrahman N 2009 Daya terima dan kualitas protein in vitro tempe kedelai hitam (Glycine soja) yang dialah pada suhu tinggi J. Gizi Indones. 4 1–11

[35] Dhanapal K, Reddy G V S, Naik B B, Venkateswarlu G, Reddy A D dan Basu S 2012 Effect of cooking on physical, biochemical, bacteriological characteristics and fatty acid profile of tilapia (Oreochromis mossambicus) fish steaks Arch. Appl. Sci. Res. 4 1142–9

[36] Jacob A M dan Hamdani M 2010 Composition Changes of Chemical And Vitamin of Ronggeng Shrimp (Harpiosquilla raphidea) Meat by Boiling J. Pengolah. Has. Perikan. Indones. 11

[37] Elisabeth D A A, Ginting E dan Yulifianti R 2018 Respon Pengrajin Tempe Terhadap Introduksi
Varietas Unggul Kedelai Untuk Produksi Tempe. *J. Pengkaj. dan Pengemb. Teknol. Pertan.* 20 183–96

[38] Hidayah N, Adiandra R S and Astuti M 2012 Evaluasi sifat fisikokimiawi dan organoleptik tempe dari berbagai varietas kedelai *Widyariset* 15 357–64

[39] Ginting E, Antarlina S S and Widowati S 2009 Varietas unggul kedelai untuk bahan baku industri pangan *J. Litbang Pertan.* 28 79–87

[40] Santosa B and Suliana G 2009 Pengaruh varietas kedelai terhadap mutu tahu yang dihasilkan *Buana Sains* 9 137–40

[41] Aberoumand A 2014 Preliminary studies on nutritive and organoleptic properties in processed fish fillets obtained from Iran *Food Sci. Technol.* 34 287–91

[42] Ratnaningsih E G, Adie M M and Harnowo D 2017 Physico-chemical properties and dietary fiber content of selected soybean promising lines *J. Penelit. Pascapanen Pertanian* Vol. 14 35–45

[43] Pranata L D 2016 Kajian Penilaian Sensori Sosis Berbasis Jamur Merang (Volvariella Volvaceae) dan Tempe *J. Online Mhs. Fak. Pertan.* 3 1–12

[44] Koubaa A, Mihoubi N B, Abdelmouleh A and Bouain A 2012 Comparison of the effects of four cooking methods on fatty acid profiles and nutritional composition of red mullet (Mullus barbatus) muscle *Food Sci. Biotechnol.* 21 1243–50

[45] Nurhikma N, Luthfiyana N, Maulianawati D and Fitriani A 2019 Karakteristik nilai gizi dan mutu sensori ikan gulamah (Nibea albifora) dengan penambahan daging ayam *J. IPTEKS Pemanfaat. Sumberd. Perikan.* 6

[46] Nishinari K, Fang Y, Guo S and Phillips G O 2014 Soy proteins: A review on composition, aggregation and emulsification *Food Hydrocoll.* 39 301–18

[47] Soegiarto R A, Purwijantiningsih L M E and Pranata S 2013 Aplikasi Kitosan Sebagai Pengawet Alami dari Kulit Udang Dogol (Metapenaeus monoceros Fab.) pada Sosis Daging Sapi (Universitas Atma Jaya Yogyakarta)

[48] Andrade R D, Lemus R and Perez C E 2011 Models of sorption isotherms for food: uses and limitations *Vitae* 18 325–34

[49] Estiningtyas D and Rustanti N 2014 Kandungan Gizi Sosis Substitusi Tepung Tempe Dengan Bahan Pengisi Tepung Ubi Jalar Kuning (Ipomoea Batatas) Dan Bahan Penstabil Ekstrak Rumput Laut (Eucheuma Cottonii) Untuk Pmt Ibu Hamil *J. Nutr. Coll.* 3 8–15