Comparison of methods of heating soybean to yield and the characteristics of tofu with a mixture of acetic acid and *Ie Kuloh Sira*

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**Abstract.** Tofu is one of the vegetable proteins made from clumping of soy milk which is accompanied by heating soybean porridge and adding clumps from either acid, organic salt or a mixture of both. For heating soybean porridge can be done without filtering or heating directly with the pulp. This research was carried out by comparing the two methods and the addition of a mixture of acid and organic salts namely acetic acid and *Ie Kuloh Sira* in the amount of 100 ml in (0; 5; 10; 15; 20) ml, clotting time (10; 15; 20; 25; 30 ) men and soybean immersion time (5; 5.5; 6; 6.5; 7) hours. The results showed that the optimization process was in the addition of *Ie Kuloh Sira* 10 ml clumping time 20 minutes and soybean immersion time 6 hours. Process optimization was in the addition of *Ie Kuloh Sira* 10 ml clumping time 20 minutes and soybean immersion time 6 hours. The highest yield was 14.5% with the pulp heating method and no pulp heating, but the protein content test (Lowry method) differed slightly from the method without pulp residue, 24.3381% and 24.941%. Texture Test with higher Texture Analyzer with 480 gr pulp heating/mm².

1. **Introduction**

1.1. **Tofu**

Tofu is one of the foods made from soybeans and has been widely known by the public. Like other traditional foods, tofu is generally processed on a small-scale industry, even though currently large-scale tofu factories are also found in big cities, but there are still many opportunities for tofu on a small scale. Know is the result of extraction of high protein soybeans. The protein contained in soybeans has a quantity that has similarities with meat. Tofu has the original white color, compact but soft and soft texture. The principle of making it is the extraction of soy protein with water and then it is mixed with swirling ingredients in the form of certain acids and salts.
Table 1. Average consumption of processed soybeans in Indonesia per capita/year.

| Number | Type   | Unit | 2013   | 2014 | 2015 | 2016 | 2017   |
|--------|--------|------|--------|------|------|------|--------|
| 1      | Soybeans | kg   | 0,001  | -    | -    | -    | 0,001  |
| 2      | Tofu   | kg   | 0,135  | 0,136| 0,144| 0,151| 0,157  |
| 3      | Tempe  | kg   | 0,136  | 0,133| 0,134| 0,141| 0,147  |

Compiled from the Results of the National Socio-Economic Survey (Susenas) Quarter I-2013 and Quarter I-2014, BPS.
Source: Indonesian Statistical Publications (Statistics Indonesia, 2018)

In the tofu making process, usually tofu stone (Ca2S04), acetic acid or glokno delta lactono (GDI) is added to the soybean extract which serves to precipitate and agglomerate the proteins found in soybean extract. Clumping solids of Ca2S04 and acetic acid are widely used in tofu industry (Widaningrum)

1.2. *Ie kuloh sira*

The people in Nanggroe Aceh Darussalam who live on the beach are generally fishermen and salt craftsmen. Salt is processed by precipitation, evaporation and crystallization. In the crystallization process the salt solution will change color at 290Be viscosity so that it is not crystallized again. The parent solution that is not crystallized in Nanggroe Aceh is called Ie Kuloh Sira.

The use of Ie Kuloh Sira as a feeder in the tofu making process is still rare, both around the salt industry and in other tofu industries. Though Ie Kuloh Sira is very effective to use because the level of pollution to food is relatively small. Moreover, some people have consumed it directly as medicine (Salmyah, 2006)

1.3. *Asam asetat*

Acetic acid (C2H4O2) Acetic acid, ethanoic acid or vinegar is an organic acid chemical compound known as an acid and aroma flavor in food. Vinegar has an empirical formula of C2H4O2. Acetic acid also functions in the food industry. One of the benefits of acetic acid is as an acidity regulating agent in acidity. Acetic acid can also be used to help in making acidic foods or drinks.

1.4. *Protein*

Protein is a polymer of amino acids that binds to peptides. This is called a polypeptide with a large BM. Protein molecules contain CHONPS elements which consist of primary, tertiary and quantener forms. Protein is a macro molecule containing nitrogen with molecular weights ranging from 5000 to 1000,000 more. Protein sources are mainly found in animals and plants which have the following properties:

1.4.1. *Solubility.* Protein can be classified according to its solubility, so it is an important way for protein differences. The two main solubility groups are: (a) Fibrous protein. This is insoluble in saline solution, the overall transformation of protein molecules is generally long (a) fibers, and (b) Ball-shaped protein. Is a protein that dissolves in salt solution.

1.4.2. *Partial colloidal properties of hydrogen.* High protein molecular weight shows the nature of colloid and contains hydrophilic groups (-NH2-OOH-OH), then hydrophilic colloidal proteins.

1.4.3. *The nature of forming foam.* If the protein is shaken it will form foam.
1.4.4. Denaturation and coagulation. Heat can be used to damage nitrogen bonds and non-polar hydrophobic interactions found in proteins. This happens because high temperatures can increase kinetic energy and cause the molecules that make up the protein to move or vibrate so fast that it disrupts the molecular bond. Protein is denatured and coagulated during pamanasan / cooking. Some foods are cooked to denature proteins that are contained in order to facilitate digestive enzymes to digest the protein. Warming will make protein material denatured so that the ability to bind water decreases. This happens because heat energy will result in the interruption of non-covalent interactions in the natural structure of the protein but not break the covalent bond in the form of a peptide bond. This process usually takes place in a narrow temperature range. In general, the higher the solvent temperature, the higher the interaction between solvent molecules and solutes. As a result, the dissolved components will become more numerous. This situation will cause the soybean juice produced will be even thicker. The more concentrated the soybean juice produced, the more it will produce it. This is because the tofu is made by adding thickening agents in the form of tofu or salt or acid in soybean juice. Therefore, if more soybean juice is produced, it means that the amount of protein in the tofu produced will increase. This statement is supported by Sutrisno Kuswara in his book processing soybeans into good quality food, saying that the addition of water when grinding soybeans should be at a temperature of 80-100 °C to produce tofu with a high amount of protein. The process of making a good tofu is to produce a lot of tofu which is good and has good tofu quality. One indicator used to determine the quality or quality of tofu is the high protein content. The protein content in 100 grams is 7.9 grams. The protein content in a substance is very determined from the manufacturing process, where one of the properties of the protein is not resistant to heat. The presence of high heat will cause the protein to break down so that the level will decrease. (uyukakop garden, 2009)

1.4.5. Hydrolysis. This hydrolysis process occurs with acids, bases, or enzymes (Sudarmadji, Slamet, 1984).

1.5. Protein denaturation due to heat

Denaturation is a change in the structure of a protein where in a fully denatured state, only the primary protein structure is left, the protein no longer has secondary, tertiary and quaternary structures. However, there has not been a break in the peptide bond in this fully denatured condition. Excessive protein denaturation can cause insolubilization which can affect the functional properties of proteins and depend on their solubility.

In terms of nutrition, partial denaturation of proteins often increases digestibility and biological availability. Moderate heating can thus increase protein digestibility without producing toxic compounds. In addition, moderate warming can inactivate several enzymes such as protease, lipase, lipoygenase, amylase, polyphenoloxidase and other oxidative and hydrolytic enzymes. If it fails to inactivate these enzymes it will result in off-flavor, rancidity, changes in texture, and changes in the color of the food during storage. For example, nuts are rich in lipoygenase enzymes. During the destruction of the material, to isolate the protein or lipid, in the presence of oxygen this enzyme works so as to produce the compound resulting from lipid oxidation which causes off-flavor. Therefore, enzyme inactivation is often carried out using heating before destruction. In addition, moderate heat treatment is also useful for inactivating several antigenic factors such as antitrypsin and leptin enzymes.

Factors The causes of protein denaturation include heating, extreme acid or alkaline atmosphere, heavy metal cations and addition of saturated salt. Protein denaturation occurs when the composition of the polypeptide space or chain of a protein molecule changes. If the bonds that make up the molecular configuration are damaged, the molecule will expand.
Heat denaturation causes the molecules that make up proteins to move very quickly, so the nature of the protein is hydrophobicity to be open. As a result, the more heat, the molecule will move faster and break the hydrogen bond in it. Second Denaturation due to acid / base occurs when there is an addition of acid or base levels in protein salts which can break the structural content of the protein because there is a substitution of negative and positive ions in the salt with positive and negative ions in acids or bases. Denaturation due to a mixture of heavy metals in proteins, this happens because the sulfur bond in the protein is attracted by heavy metal bonds so that the denaturation process occurs with a change in the structure of the compound content in the protein when the ion in the protein reacts with heavy metal ions mixed in it. Denaturation with heat temperatures carried out on fruits will result in reduced water content and increased viscosity or viscosity of protein levels embedded in fruits that are denatured due to heat. In addition to protein denaturation, it also undergoes coagulation which results in a decrease in protein content to impact on the amount of rendement weight. Coagulation is an advanced process that occurs when denatured protein molecules form a solid mass. Egg fluid (sol) is converted into solid or semi-solid (gel) with the process of water coming out of the structure to form spirals that open and attach to one another. This coagulation occurs over a long time temperature range and is obtained by the previously mentioned factors such as heat, shaking, pH, and also using acids and salt. The results of the protein coagulation process are usually able to form the desired characteristics. That is thickening which might occur in the subsequent process after denaturation and coagulation. proses pembuatan tahu

2. Research Method
This research method will take place in the Biotechnology and Food Laboratory of the Chemical Engineering Department of the Lhokseumawe State Polytechnic. Sample analysis will be carried out at the Analytical Chemistry Laboratory of the Chemical Engineering Department of Lhokseumawe State Polytechnic. The ingredients used are soybeans, Ie Kuloh Sira, water and acetic acid 25%. While the equipment used is a stove, blender, glass beaker, measuring cup, stirrer, thermometer, erlenmeyer, wood mold, UV-VIS spectrophotometer Shimadzu type UV-1800 j and texture analyzer.

Figure 1. The process of making tofu
3. Discussion

3.1. The effect of adding Ie Kuloh Sira to the yield with and without heating the pulp

From Figure 2 it can be seen that the effect of adding Ie Kuloh Sira to the yield with the pulp heating method can be the highest yield at a volume of 3 ml with a yield weight of 14.5%, while for the method without heating the highest yield of pulp is obtained at volumes 1 and 4 ml that is 15%, from this result the researcher found no linearity between the addition of the volume of Ie Kuloh Sira to yield, for the best addition which is at 3 ml because the taste and protein content were also high.

From Figure 2 it can also be seen that the high yield obtained in the process without heating this pulp because the protein will be damaged due to heating, this is because the protein will denature, most proteins in food are denatured when heated at moderate temperatures (60-90°C) during one hour or less.

3.2. The effect of adding Ie Kuloh Sira to the protein content with and without heating the pulp

From Figure 3 it can be seen as a whole that the more volume of Ie Kuloh Sira is added, the higher the protein content, the highest level is in the process without heating the pulp at 4 ml volume, while for the highest method of heating the protein content at 3 ml volume, from these two methods can be seen the difference in protein content, for the heating of the pulp content of the protein tends to be less than those that do not heat the pulp because the protein is denatured and coagulated due to the effect of heating and adding acid and salt as described above (Widaningrum, 2015).
3.3. The effect of adding Ie Kuloh Sira to the texture with and without heating the pulp

Product texture is an important parameter for various types of products. Texture is one of the factors that determine the quality of food products. The range of quality in food products is very broad, and originates from poor food quality. For tofu products, it must be supple and soft. Based on the marketing standard of the texture of tofu, for bulk tofu of 383.50 gr / mm² while the tofu is branded 566.50 gr / mm². Texture analysis in this study uses a texture analyzer. From figure 4 it can be seen that the texture of tofu that meets the marketing standards can be obtained at a volume of 1 and 3 ml addition with the pulp heating process. Whereas for the process of not heating the best texture pulp can be added at a volume of 2 ml.

![Surface Plot of TEKSTUR vs Coagulant Time (minute); Soaked Time (hour)](image1)

![Surface Plot of TEKSTUR vs Coagulant Time (second); Soaked Time (hour)](image2)

Methods of Warming Figure

Non-Heating Methods

Figure 4. Texture graph of the volume of Ie Kuloh Sira

4. Conclusion

Process optimization is in the addition of Ie Kuloh Sira 10 ml clumping time of 20 minutes and 6 hours of soybean soaking time. The highest yield was 14.5% with the pulp heating method and no pulp heating, but the protein content test (Lowry method) differed slightly from the method without pulp residue, 24.3381% and 24.941%. Texture Test with higher Textur Analyzer with 480 gr pulp heating / mm².

References

[1] Salmyah. (2006). Penggunaan Ie Kuloh Sira Sebagai Bahan Penggumpal Dan Pengendap Susu Kedelai. Jurnal Reaksi (Journal of Science and Technology), 26–30.

[2] Statistics Indonesia, B. (2018). Badan Pusat Statistik. Retrieved September 30, 2018, from https://www.bps.go.id/statistic/2014/09/08/950/rata-rata-konsumsi-per-kapita-seminggu-beberapa-macam-bahan-makanan-penting-2007-2017.html

[3] Sudarmadji, Slamet dkk. 1996. Analisa Bahan Makanan dan Pertanian. Yogyakarta: Liberty Yogyakarta.

[4] Uyukakop garden. (2009). Sebuah Catatan Kecil: Pembuatan Tahu dan Pengujian Kadar Protein. Retrieved September 29, 2018, from http://ekosistemguna.blogspot.com/2009/09/pembuatan-tahu-dan-pengujian-kadar.html

[5] Widyaningrum, H., dan Rahmad, A., 2011, Kitab Tanaman Obat Nusantara, MedPress, Yogyakarta.