Durability and Taste of Tofu with “Ie Asam Sunti” Coagulant

Salmyah1, Fachraniah1, Fajri2, Maulizar3
1 Chemical Engineering Department, Lhokseumawe State Polytechnic, Aceh, Indonesia
2 Civil Engineering Department, Lhokseumawe State Polytechnic, Aceh, Indonesia
3 Management Department, Lhokseumawe State Polytechnic, Aceh, Indonesia
Email: salmyah@pnl.ac.id

Abstract. One of the special spices in the Province of Aceh that is not available except “Pliek U” is “Asam Sunti”. “Asam Sunti” is made from star fruit wuluh by means of drying in the sun and fermentation at night until the 4-5 days. Waste “Ie Asam Sunti” which can be used as a coagulating of soy protein and tofu preservatives because it contains some that are not contained in starfruit, among others: acids, citric, calcium citrate, flavonoids and anti-bacterial. The results showed that the “Ie Asam Sunti” can coagulating of soy protein into tofu, based on statistical analysis, Minitab software 14 optimal caking process at 5 hours immersion, 25 minutes coagulating time and volume of 250 ml “Ie Asam Sunti” get 120 - 140 % yield, content protein with the Kjedall tool obtained 6.89 – 10.54 %, the results of the microbial test showed the number of microbes <3APM / Gr and the test of the taste was very delicious.

1. Preliminary
Tofu is one of the foods made from soybeans and is widely known to the public. Like other traditional foods, tofu is generally processed on a small industrial scale, although at present large-scale tofu factories are also found in big cities, but the opportunity to know on a small scale is still there is.

Tofu is the result of the extraction of soybeans that contain high protein. The protein contained in soy has a quantity that has similarities with meat.

In the process of making tofu, usually added tofu (Ca2So4), acetic acid or glokkno delta laktono (GDI) into soybean extracts that serves to precipitate and agglomerate the protein contained in soybean extracts. Ca2So4 coagulating solids and acetic acid are widely used in the tofu industry (Hariyadi, Purnomo, Umaryadi, & Adawiyah, 1999).

2. Literature Review
The people of Aceh are known for their unique flavoring in Aceh which is the result of fermentation from starfruit, Sunti Acid. Tamarind is a spice in cooking with a distinctive taste and aroma. Making Sunti Acid is done in a very simple way that is wuluh starfruit which is ready to harvest soaked overnight, then salting in the afternoon, fermentation at night and drying in the afternoon, done repeatedly for 4-5 days. The next day star fruit extracted a fermentation solution for 4 days (600-700) ml in 5 kg starfruit for the addition of an average of 200 grams of salt (Salmyah, 2016). This solution is very limited in its use by the people of Aceh, namely in a small portion of the Pidie community as a companion to grilled fish and lime substitutes in Aceh's unique Keueng Asam.

According to (Mursito, 2002) and (Thomas, 2007), the content of starfruit is formic acid, citric acid, ascorbic acid (vitamin C), saponins, tannins, glucosides, flavonoids, and some minerals, especially...
calcium and potassium in the form of potassium citrate and calcium oxalate. Starfruit contains quite high levels of vitamin C. The content of vitamin C contained therein is around 25.8 mg / 100 grams. In addition, the presence of citric acid in starfruit has great benefits, citric acid can be used in food preservation, as an antioxidant and which prevents rancidity and retains color and aroma. Citric acid can also function as a sequestrant, a metal-binding chemical compound in the form of complex bonds (Tranggono, n.d.)

In vitro testing of the bacteria E. Coli, S. Aureua, M. Luteus and P. fluorescence shows the active potential as an anti-bacterial. The antibacterial potential contained in starfruit makes the opportunity to be developed as a natural preservative substitute for formaldehyde (Hayati, 2010).

Tofu is a processed soybean product that is very popular in Indonesia and is the most widely produced. As much as 40% of Indonesian soybean consumption is processed into tofu. Tofu has an original white color, compact texture but still soft and soft. The principle of making tofu is generally the extraction of soy protein with water and then agglomerated with coagulating material in the form of tofu stone (CaSO4) or acid (vinegar) and certain salts. Tofu is often called boneless meat because of its high nutritional content, especially the protein quality which is equivalent to animal meat. Even tofu protein is higher than soy protein and tofu has the best quality vegetable protein because it has the most complete amino acid composition and has a high digestibility or by 85% -98% (Widaningrum, 2015).

The addition of tofu stone as a clot has less effect on the preservation of the product so it is necessary to add other ingredients such as salt or even the addition of formalin which is very dangerous for health. Likewise with the addition of vinegar acid which sometimes produces products with a sour taste.

The use of Ie Kuloh Sira coagulating produces solid tofu and good taste because there is still residual salt (NaCl) because Ie Kuloh Sira is a residual water from the salt industry that has not completely crystallized (Salmyah, 2004).

The combination of nutritional content of starfruit fruit such as citric acid and the addition of salt in the process of making syringe opens the opportunity to make Ie Sunti Acid as a healthy clot and has a longer shelf life. In addition, Ie Asam Sunti coagulating is easily obtained because it is a waste from a very simple process.

The use of Ie Sunti Acid as a lump of soy milk and can be a tofu preservative because of the nutritional content contained in starfruit consisting of calcium, oxalic acid, citric acid and some antibacterial which is carried from the residual fermentation of injectable acids. The use of Ie Sunti Acid as a clot is very good because it can reduce the use of formalin as a preservative.

Reducing the effects of environmental pollution, especially in the Province of Aceh, which almost all regions make Sunti Asam sometimes on a large scale, sometimes because some people have starfruit plantations which are then sold as an Acehnese special spice. Increasing community income because the waste that has been thrown away so far, only by continuing the simple sterilization process can be sold to tofu entrepreneurs.

Waste of Sunti Acid can be used as a lump of soy protein as well as tofu preservatives because it contains several elements contained in starfruit, among others: acids, citric, calcium citrate, flavonoids and anti-bacteria. The results showed that Ie Sunti Acid can coagulate soy protein into tofu. Characteristic ie syringe acid based on the results of GCMS containing 2.3-Dihydro 3.5 dihydroxymethyl-4H Pyran-4 one is an anti-oxidant compound, Ethylic acic SS, Vinegar acid, Ethanoic acid and Ethanediamine, N-ethyl-N-methyl SS; Ethylenediamine, N-ethyl-N-methyl which is useful for dealing with iodine disorders, bacterial infections, hourur and protozoa. Based on statistical analysis, Minitab software 14 optimum conditions of coagulating process not at Soaking Time 5 hours, clotting time 25 minutes and volume of 150 ml Sunti Acid obtained yield 121-135%, protein content 20-22.5 mg / l and texture 300-350 mm / det. (Salmyah, 2017)

Ie sunti acid which is a waste of the processing of sunti acid (a typical Aceh spice) that comes from the fermentation and drying process of starfruit with the addition of salt (NaCl). The process of tofu coagulating occurs by heating accompanied by the addition of acidic elements such as acetic acid and salt elements such as CuSO4. The acidic and salt elements contained in the syringe acid can agglomerate tofu, while some elements found in the results of research based on GCMS analysis results containing
2.3-Dihydro 3,5 dihydroxi-6methyl-4H Pyran-4 one is an anti-oxidant compound, Ethylic acic SS, Vinegar acid, Ethanoic acid and Ethanediamine, N-ethyl-N-methyl SS; Ethylenediamine, N-ethyl-N-methyl which is useful for dealing with iodine disorders, bacterial infections, hourur and protozoa.

Tofu is Indonesia's favorite food, especially even the world in general. Tofu which has an excellent vegetable protein content for health is produced by the community both large, medium industries and even household scale. Likewise, the province of Aceh has a number of tofu factories in the medium scale and households that have been using acetic acid and tofu stone as a clot while ie sunti acid which reaches 5 to 10 liters / KK from the Acehnese people has not been touched as an alternative lump which is much tastier he knows. Utilization of waste disposal process of making syringe acid can prevent the disposal of waste into the environment.

The compound as a preservative contained in ie sunti acid
1. 2.3-Dihydro 3,5 dihydroxi-6methyl-4H Pyran-4 one

![Formula](C6H8O4)

2. Ethylic acic SS

3. Vinegar acid

Vinegar or astenoic acid is an organic acid known as a sour taste in food or drinks. Vinegar has the chemical formula C2H4O2, this formula is often written CH3CO2H or CH3COOH or CH3-COOH. Glacial vinegar is a hygroscopic liquid that has no color and has a freezing point of 16.7 ° C. In the vinegar acid contained 3-9% by volume vinegar acid. Vinegar is a monoprotic weak acid with a pKa value of 4.76, but can attack the mill and is corrosive if dissolved in water. Liquid acetic acid is a hydrophilic polar or protic solvent, it is similar or the same as water and ethanol. Vinegar is produced as a precursor for polyvinyl acetate and cellulose acetate, produced for household consumption vinegar and in a variety of fibers and fabrics. (Berita et al., 2019)

![Formula](CH3COOH)

4. Ethanoic acid (acetic acid)

Much of the ethanoic acid produced is converted into ethenyl ethanoate (vinyl acetate). The acid itself is the solvent for the liquid phase oxidation of 1,4-dimethylbenzene (p-xylene), leading to the production of polyesters. (ECI, 2016)

![Formula](CH3COOH)

5. Ethanediamine

![Formula](C2H8N2)
6. N-ethyl-N-methyl SS

7. Ethylenediamine
   Ethylenediamine is an alkane-alpha,omega-diamine in which the alkane is ethane. It has a role as a GABA agonist. It derives from a hydride of an ethane. (PubChem, 2019)

8. N-ethyl-N-methyl

   ![Chemical structure of N-ethyl-N-methyl](image)

   Formula : C9H13N

3. Research Method
   This research method will be located in the Biotechnology and food laboratory majoring in Chemical Engineering at the Lhokseumawe State Polytechnic. Sample analysis will be conducted at the Analytical Chemistry Laboratory, Lhokseumawe State Polytechnic Chemical Engineering Department. The ingredients used are soybeans, Ie Kuloh Sira, water, and 25% acetic acid. 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. The detailed process of making Tofu with “Ie Asam Sunti” coagulant is shown in Figure 1.
Figure 1. Process of Making Tofu with “Ie Asam Sunti” Coagulant

4. Discussion
Calculation Result Table (Minitab 14)

| No | Run Order | Volume of “Ie asam sunti” (ml) | Soaking Time (hour) | Coagulating time (minute) | Yield (%) | Protein Levels (%) | Texture (gr/mm) | Microbial Test |
|----|-----------|-------------------------------|---------------------|---------------------------|-----------|-------------------|-----------------|---------------|
| 1  | 1         | 200,000                       | 4.00000             | 20,0000                   | 63.6       | 8.13              | 300.8           | 1             |
| 2  | 2         | 300,000                       | 4.00000             | 20,0000                   | 70.0       | 8.27              | 310.5           | 0             |
| 3  | 3         | 200,000                       | 6.00000             | 20,0000                   | 61.6       | 8.24              | 292.8           | 2             |
| 4  | 4         | 300,000                       | 6.00000             | 20,0000                   | 73.6       | 10.12             | 350.1           | 0             |
| 5  | 5         | 200,000                       | 4.00000             | 30,0000                   | 64.0       | 6.89              | 320.7           | 1             |
| 6  | 6         | 300,000                       | 4.00000             | 30,0000                   | 75.6       | 10.54             | 340.5           | 1             |
| 7  | 7         | 200,000                       | 6.00000             | 30,0000                   | 72.4       | 8.40              | 310.7           | 2             |
| 8  | 8         | 300,000                       | 6.00000             | 30,0000                   | 72.6       | 7.65              | 315.6           | 1             |
| 9  | 9         | 165,910                       | 5.00000             | 25,0000                   | 50.6       | 6.87              | 225.6           | 3             |
4.1. Yield

Regression Equation in Uncoded Units

\[
\text{Yield} = -0.000135X_1 - 0.53X_2^2 + 0.0410X_3^2 - 0.0145X_1X_2 - 0.0033X_1X_3 + 0.095X_2X_3 + 0.324X_1 + 7.3X_2 - 1.45X_3 + 8.5
\]

Based on the regression model obtained, it is seen that the chosen variable is significant to the model with \( R^2 \) of 65.86% so that only 34.14% is due to other factors. The optimization process is at 250 ml clump volume, 5 hours soaking time and 25 minutes clumping duration. The yield obtained is at the level of 57.11 - 65.66%.
4.2. Protein Levels
Regression Equation in Uncoded Units
Protein Levels (%) = -0.00354X_1^2 - 1.235X_2^2 - 0.0353X_3^2
-0.00665X_1X_2 + 0.000X_1X_3 - 0.0835X_2X_3
+0.2153X_1 + 16.13X_2 + 2.096X_3 - 84.4

For the protein content significantly, the model contributing to the chosen variable was 78.70% with the results at the level of 6.81-11.38%

4.3. Texture
Regression Equation in Uncoded Units
Texture (gr/mm) = -0.00471X_1^2 - 19.74X_2^2 - 0.761X_3^2
+0.082X_1X_2 - 0.0211X_1X_3 - 1.66X_2X_3
+299X_1 + 226X_2 + 51.5X_3

For the texture content significantly, the model contributing to the chosen variable was 81.20% with the results at the level of 6.81-11.38%
The results of the texture test with a limit of 262.7-278.4 gr / mm were also significant for the model with a contribution of 69.33%.

4.4. Response Optimization

4.4.1. Response Optimization (Maximum)

| Response                | Goal     | Lower     | Target  | Upper    | Weight | Importance |
|-------------------------|----------|-----------|---------|----------|--------|------------|
| Texture (gr/mm)         | Maximum  | 225,60    | 380,40  | 1        | 1      | 1          |
| Protein Levels (%)      | Maximum  | 6,87      | 12,21   | 1        | 1      | 1          |
| Yield (%)               | Maximum  | 50,60     | 75,60   | 1        | 1      | 1          |

4.4.2. Response Optimization (Minimum)

| Response                | Goal     | Lower     | Target  | Upper    | Weight | Importance |
|-------------------------|----------|-----------|---------|----------|--------|------------|
| Texture (gr/mm)         | Minimum  | 225,60    | 380,40  | 1        | 1      | 1          |
| Protein Levels (%)      | Minimum  | 6,87      | 12,21   | 1        | 1      | 1          |
| Yield (%)               | Minimum  | 50,60     | 75,60   | 1        | 1      | 1          |

Conclusion

1. Ie sunti acid can coagulate tofu protein
2. Optimization of the tofu coagulation process is in the volume of 250 ml ie acid injections, soaking time 5 hours and 25 minutes’ coagulation
3. The research results obtained are yield of 57.11-65.66% wet basis, 6.81-11.38% protein content using the Kjedall tool and texture 262.7-278.4 gr / mm using a texture analyzer.
4. Based on the organanptic test, the taste is very good
5. Microbial test results for 24-hour storage time at room temperature are still in the standard that is <3APM / hour.

References

[1] Berita, S., Online, P., Smp, S. D., Smk, S. M. A., Tinggi, P., Terlengkap, T., … Cuka, R. A. (2019). Situs Berita Pendidikan Pengertian Asam Cuka dan Rumus Kimia Asam Cuka Sifat – Sifat Kimia, 1–5.
[2] ECI. (2016). The Essential Chemical Industry.
[3] Hariyadi, P., Purnomo, E. H., Umaryadi, M. E. W., & Adawiyah, D. R. (1999). Latihan Soal Prinsip Teknik Pangan. Jurusan Teknologi Pangan Dan Gizi, IPB.
[4] Hayati, E. K. (2010). Dibalik Mukzizat Tanaman Belimbing Wuluh (Averrhoa Bilimbi Linn) Sebagai Pengawet Alami.
[5] Mursito, B. (2002). Ramuan tradisional untuk pengobatan jantung. Penebar Swadaya.
[6] PubChem. (2019). PubChem. UK Food Standards Agency.
[7] Thomas, A. N. S. (2007). Tanaman Obat Tradisional (Jilid 2). Kanisinus. Jakarta.
[8] Tranggono, H. (n.d.). LAPORAN PRAKTIKUM PRINSIP TEKNIK PANGAN.
[9] Widaningrum, I. (2015). Teknologi Pembuatan Tahu yang Ramah Lingkungan (Bebas Limbah).
   Jurnal Dedikasi, 12.
Conclusion

1. Ie sunti acid can coagulate tofu protein
2. Optimization of the tofu coagulation process is in the volume of 250 ml ie acid injections, soaking time 5 hours and 25 minutes coagulation
3. The research results obtained are yield of 57.11-65.66% wet basis, 6.81-11.38% protein content using the Kjedall tool and texture 262.7-278.4 gr / mm using a texture analyzer.
4. Based on the organoleptic test, the taste is very good
5. Microbial test results for 24 hour storage time at room temperature are still in the standard that is <3APM / hour.

References

[1] Berita, S., Online, P., Smp, S. D., Smk, S. M. A., Tinggi, P., Terlengkap, T., … Cuka, R. A. (2019). Situs Berita Pendidikan Pengertian Asam Cuka dan Rumus Kimia Asam Cuka Sifat – Sifat Kimia, 1–5.
ECI. (2016). The Essential Chemical Industry.
Hariyadi, P., Purnomo, E. H., Umaryadi, M. E. W., & Adawiyah, D. R. (1999). Latihan Soal Prinsip Teknik Pangan. Jurusan Teknologi Pangan Dan Gizi, IPB.
Hayati, E. K. (2010). Dibalik Mukzizat Tanaman Belimbing Wuluh (Averrhoa Bilimbi Linn) Sebagai Pengawet Alami.
Mursito, B. (2002). Ramuan tradisional untuk pengobatan jantung. Penebar Swadaya.
PubChem. (2019). PubChem. UK Food Standards Agency.
Thomas, A. N. S. (2007). Tanaman Obat Tradisional (Jilid 2). Kanisinus. Jakarta.
Tranggono, H. (n.d.). LAPORAN PRAKTIKUM PRINSIP TEKNIK PANGAN.
Widaningrum, I. (2015). Teknologi Pembuatan Tahu yang Ramah Lingkungan (Bebas Limbah). Jurnal Dedikasi, 12.