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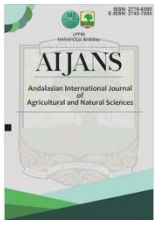

Article

EFFECT OF TYPES AND CONCENTRATIONS OF STABILIZERS ON THE CHARACTERISTICS OF EMPRIT GINGER (Zingiber officinale var. amarum) EXTRACT TEMPE BEVERAGE

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Abstract

In the making of emprit ginger extract tempe beverage requires the addition of a stabilizer to increase the stability and viscosity of the product and each stabilizer has a different effect from one another. This study aims to determine the characteristics of gum arabic stabilizer, Carboxymethyl Cellulose (CMC) and soy lecithin in emprit ginger extract tempe beverage used 0%, 0.3%, 0.5%, 0.7%, and 0.9% of each stabilizer. The observations were physical properties such as stability and viscosity and chemical analysis includes protein content, and pH value. This study used completely randomized design (CRD) with two factors (F1 is the type of stabilizer and F2 is the concentration of the stabilizer) and carried out with 3 replications. The obtained data was analyzed with ANOVA followed by Duncan's test. Decision system analysis was performed using the MADM-SAW method to obtain the best type and concentration of stabilizer. CMC was found out in the first rank of used stabilizers in 0.5% concentration with stability in 21%, viscosity was 2.17 poise, an ash content was 0.26%, protein content was 12.77%, and pH value was 6.2.

INTRODUCTION

Tempe juice beverage is one of the products that can be produced in diversifying tempe processed products. Tempe juice is made by extracting tempe in water. Thus, the nutritional value and components contained in tempe can be maintained. Tempe juice is more practical to consume than fresh tempe [1].

Tempe juice beverages are more valuable than soy milk beverages. Tempe is more considered due to its nutritional content and active substance than soybean. The protein content of soybean and tempe is 46.2 g and 46.5 g, carbohydrates content of soybean and tempeh is 28.2 g with 30.2 g, and fiber content of soybean and tempe is 3.7 g with 7.2 g [2]. Tempe is easily available and easy to make in the form of innovative processed food products.

Reported that the tempe juice beverage with the addition of emprit ginger extract had a preference for neutral color, aroma, and taste with score 3 out of 5, which means tempe juice beverage with the addition of emprit ginger extract are preferred by the panelists and acceptable [3]. The quality of this beverage needs to be improved so that it is preferred by consumers for the stability of the beverage. So the researcher wanted to add and look for the

right type and concentration of the stabilizer for emprit ginger extract tempe beverage. In this study, the used stabilizers were gum arabic, CMC and lecithin.

In Christiana's previous research stated that honey extract beverage products with the addition of 0.15% arabic gum was the best concentration [4]. Reported in ketapang milk beverage products with the addition of 0.4% of CMC was found out as the best concentration [5]. In addition, reported that chocolate candy products with the addition of 0.7% lecithin was known as the best concentration [6]. In this study, five concentrations were used (0%, 0.3%, 0.5%, 0.7%, and 0.9%).

The application of tempe in emprit ginger extract tempe beverage is expected to provide benefits to the industry of tempe in Indonesia. Therefore, economic analysis is needed regarding the feasibility of applying tempeh juice in the tempe industry.

The purpose of this study was first to determine the characteristics of emprit ginger extract tempe beverage which was treated with 3 different stabilizers and 5 different concentrations, second to determine the optimum concentration of the stabilizer to produce the emprit ginger extract tempe beverage which was preferred by the panelists.

EXPERIMENTAL SECTION

Materials and tools

The used raw materials were tempeh and obtained from the Tempe Beans factory in the district of East Padang, Padang City and emprit ginger was obtained at the Lubuk Begalung market. The used stabilizers were gum arabic, Carboxymethyl Cellulose (CMC), and lecithin obtained at PT. Jaya Maimi Medical Jalan Andalas Raya No. 84. The chemicals reagent used were selenium reagent mixture, aquades, H2SO4, NaOH, HCL, boric acid, and MM MB indicator,

The used tools in this study include measuring devices (analytical scales, thermometers, and measuring cups) and supporting tools (dough containers/washbasins, mixers, juicers, pans, spatulas, knives). The used tools for analysis consisted of Ostwald viscometer, pycnometer refractometer, electric furnace, 30 ml Kjeldahl flask, test tube, measuring cup, dropper, burette, funnel, Erlenmeyer, baker glass, distillation tube, porcelain dish, petri dish, oven, desiccator, analytical balance, and pH meter.

Research methods

The study was conducted to determine the causal relationship, the effect of stabilizers on the characteristics of emprit ginger extract tempe beverage and the effect of the concentration of the stabilizer on the emprit ginger extract tempe beverage. The method in this study was an experimental method. The experimental design used was a factorial completely randomized design. The use of the factorial RAL method has two factors (F1 as the type of stabilizer gum arabic, CMC and lecithin and the second factor and F2 as the concentration of the stabilizer, using 5 levels 0%, 0.3%, 0.5%, 0.7% , 0.9%), each of treatments carried out with 3 replications.

The analysis technique was a single factor variance (ANOVA) with five levels and 3 replications, if there was effect from each treatment, then a DMRT (Duncan Multiple Range Test) further test was carried out. The DMRT test was carried out to see which level resulted in different characteristics. Observations were made including physical observations, namely stability tests and viscosity tests. Chemical analysis includes testing of protein content, and pH value.

Procedures

1. Tempe Juice Beverage [7].

Initially, tempe was washed, then drained and then sliced in 5 x 5 cm into cubes. Tempe was soaked with 2% $NaHCO_3$ of the total ingredients for 2 hours. After that, the tempe was mashed with the addition of water. The ratio of tempe with water is 1:2. Next, mashed using a blender. The obtained tempe slurry was filtered using a filter cloth to take the tempe juice beverage, then heated at 70^{o}C for 15 minutes. While heating, the tempe juice beverage was stirred continuously. Furthermore, added 8% of sugar from the total solution when filtering.

2. Emprit Ginger Extract [8].

Weighed and washed all the required emprit ginger using a brush under running water, so that the material obtained was clean. Then, reduced to get a small size to make it easier to take out the extract and blended. Next, it was filtered to obtain ginger extract.

3. Adding Emprit Ginger Extract to Beverage

After making the tempe juice beverage and making the ginger extract, the two stages of the mixing process were carried out after which it was heated at a temperature of 70^{o}C for 15 minutes.

4. The process of adding stabilizers to drinks

The addition of a stabilizer was when the pasteurization has completed. Then, added stabilizers as the treatments (required) to product. After that, the homogenization step was carried out so that the product with the stabilizer was well mixed. The following were the stages of making emprit ginger extract tempeh beverage, as shown in Figure 1.

Table 1 shows the formulation of emprit ginger extract tempeh beverage with the addition of CMC stabilizer, gum arabic and lecithin. Other ingredients such as water, granulated sugar, baking soda and emprit ginger extract were adjusted to the amount of the tempe extract bevarage formulation with the addition of emprit ginger extract as listed in Table 1

Table 1. The formulation of emprit ginger extract tempeh beverage

Ingredient (g)	**Stabilizer Concentration**				
	0%	**0,3%**	**0,5%**	**0,7%**	**0,9%**
Tempe	200	200	200	200	200
Emprit ginger extract	0	7.5	15	22.5	30
Water	400	400	400	400	400
Sugar	40	40	40	40	40
Soda kue	4	4	4	4	4
Baking soda	15	15	15	15	15
CMC/ Gum Arab/ Lesitin	0	1,5	2,5	3,5	4,5

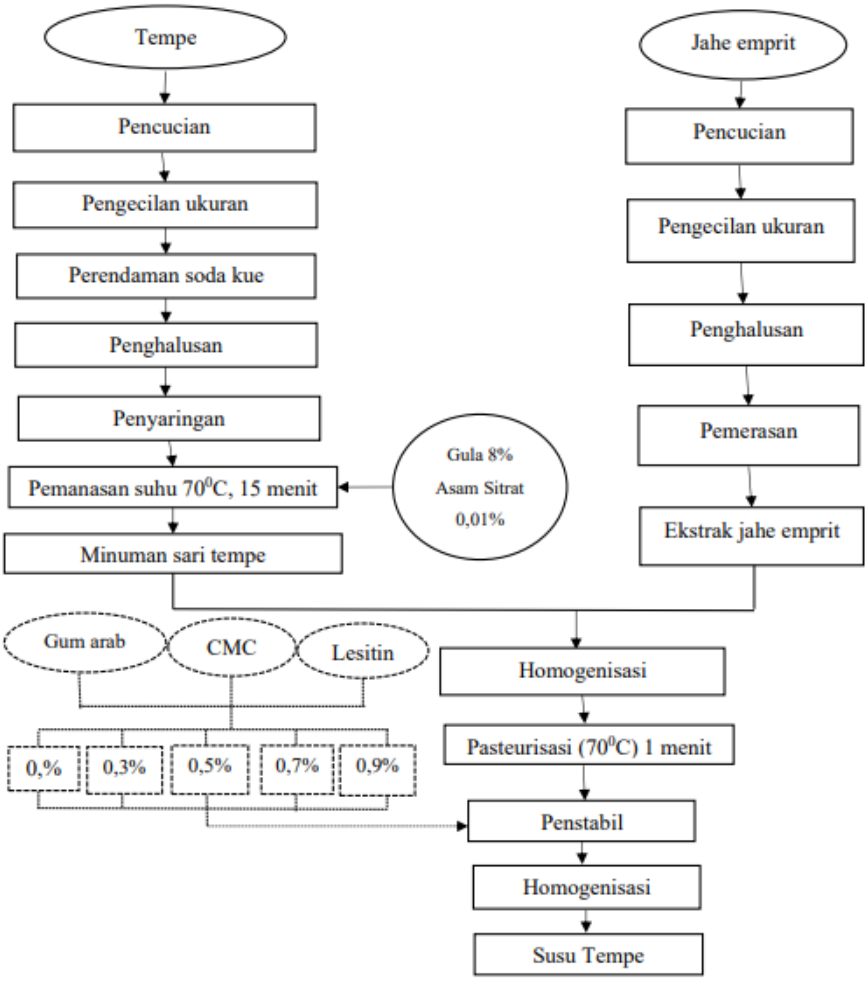

Figure 1. The process of making ginger extract tempeh beverage.

In this study, the stabilizer used was different ginger extract, namely gum arabic, CMC and lecithin using five concentrations, namely 0%, 0.3%, 0.5%, 0.7%, 0.9%.

Observation

a. Stability Test [9].

A suspension was said to be stable if the particles acting as the dispersed phase can be held evenly without changes for a long time, without grouping with each other or dropping to the bottom. The lower the rate of deposition that occurs, the more stable the suspension is. The tempeh juice beverage was put in a 100 ml measuring cup and then observed after 24 hours and the formula was calculated.

b. Viscosity Test [10].

The instrument used to measure viscosity was Stormer viscometer. Viscosity was determined by comparing the time required for one revolution in the sample with the time required in water at the same temperature, and multiplied by the viscosity of the water (cp) at that temperature.

c. Protein Content, Kjeldahl Method [11].

The sample was weighed ± 100 mg and put in a 30 ml Kjeldahl flask then added 1.9 ± 0.1 g K2SO4, 40 ± 10 mg HgO, and 3.8 ± 0.1 ml H2SO4. The sample in the Kjedahl flask was added with boiling stone and destroyed until it became clear.

The destructed sample and the rinsing water were put into a distillation apparatus, then 125 ml Erlenmeyer flask was filled with 5 ml of H_3BO_4 solution and added 4 drops of indicator then placed under the condenser, with the tip of the condenser well submerged in the H_3BO_4 solution. 8-10 ml of NaOH-$Na_2S_2O_3$ solution was added to the distillation apparatus until ± 15 ml of distillate was obtained in Erlenmeyer. The distillate in Erlenmeyer was then titrated with 0.02 N HCl solution until the color changed from green to blue. The calculation of the amount of nitrogen in the sample was carried out after the total volume of the titration blank was obtained.

d. pH Value [12].

The temperature of the sample is measured, the pH-meter temperature controller is set at the measured temperature. The pH meter is turned on, left to stabilize (15-30 minutes). The electrodes were rinsed with sample aliquots or distilled water (if using distilled water, dry the electrodes with tissue paper). The electrode is dipped in the sample solution, adjust the pH measurement. The electrode is left immersed for a while until a stable reading is obtained. The pH of the sample was recorded.

e. Determination of the Best Stabilizer

The resulting emprit ginger extract tempeh beverage was added with different stabilizers, namely CMC, gum arabic and lecithin, then the best stabilizer was selected for physical and chemical characteristics using the Multiple Attribute Decision Making method with the Simple Additive Weighting model (MADM). -SAW).

The basic concept of the MADM-SAW method or the weighted sum method is to find the weighted sum of the performance branches on each alternative of all attributes. The MADM-SAW method requires the process of normalizing the decision matrix (X) to a scale that can be compared with all available alternative branches. The steps for the MADM-SAW method can be detailed as follows [13]:

1. Determine the treatment as an alternative (Xi) and the criteria that will be used as a reference in decision making (characteristics of emprit ginger extract tempe beverage tsuch as the amount of stabilizer, viscosity, stability and color) as Ci.
2. Make a decision matrix X (see equation 1), which is formed from the table of suitability ratings of each alternative on each criterion. The value (Xi) of each alternative on each criterion (Cj) that has been determined, where, i = 1,2,...m and j = 1,2,...n.

$$X = \begin{bmatrix} x11 & x12 & \cdots & xij \\ \vdots & & & \vdots \\ xi1 & xi2 & \cdots & xij \end{bmatrix} \quad \text{..... (1)}$$

3. Give weight to alternatives against criteria
4. Change the values in Table 13 to crisp values for each criterion and arrange them.
5. Then normalize the matrix based on equation 2 which is adjusted to the type of attribute (profit/cost attribute) so that a normalized matrix (R) is obtained as in equation 3.

$$rij = \begin{cases} rij = \frac{xij}{Max\ xij} & \text{if j is benefit} \\ rij = \frac{Min\ xij}{xij} & \text{if j is cost} \end{cases} \quad \text{..... (2)}$$

$$R = \begin{bmatrix} r11 r12 & \cdots & r1j \\ \vdots & & \vdots \\ ri1 ri2 & \cdots & rij \end{bmatrix} \quad \text{..... (3)}$$

6. Give weight and crisp value to each criterion as shown in the table below, so that the crisp value is obtained which will be used as the basis for weighting
7. The final result is obtained from each ranking process, namely the addition of the normalized matrix multiplication R with the weight vector (W) or the crisp value in table 5 so that the largest value is chosen as the best alternative (Ai) as the solution.
   Vi $= \sum_{j=1}^{n}$ wj rij ..... (4).

RESULT AND DISCUSSION

RESULTS AND DISCUSSION

Stability

Analysis of the stability of the ginger extract tempeh drink was carried out by standing for 24 hours so that a precipitate was formed. Data stability analysis of tempe extract drink with ginger extract with CMC, Gum Arab and Lecithin and different concentrations of stabilizers with 0%; 0.3%; 0.5%; 0.7%; and 0.9% as shown in Table 2 and Figure 2.

Table 2. The results of the stability test of emprit ginger extract tempe beverage (% sediment).

Zat Penstabil	**Stabilizer Concentration (%)**				
	0%	0,3%	0,5%	0,70%	0,9%
CMC Average	40±0,58^{c}	23±0,58^{b}	21±1,00^{b}	19±1,15^{a}	21±2,00^{a}
Gum Arab Average	40±0,58^{c}	36±0,58^{b}	34±1,15^{b}	33±0,58^{a}	33±0,58^{a}
Lesitin Average	40±0,58^{c}	35±4,73^{b}	36±2,89^{b}	37±1,15^{a}	34±2,08^{a}

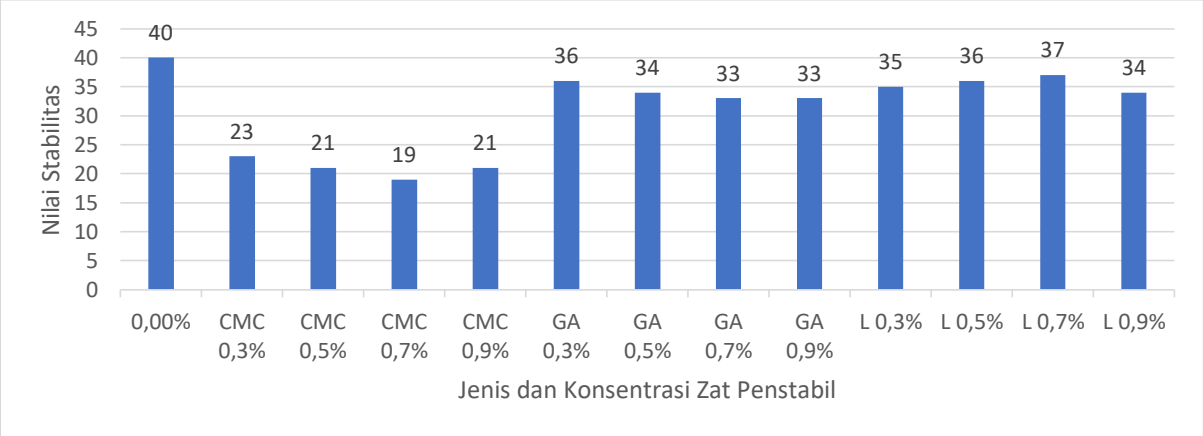

Figure 2. Graph of stability value of each type and concentration of stabilizer

Table 2 shown that the stability of emprit ginger extract tempe beverage with CMC, Gum Arab and Lecithin types and different concentrations of stabilizers 0%; 0.3%; 0.5%; 0.7%; and 0.9% indicates the average value of CMC stabilizer with a predetermined

concentration of 40%, 23%, 21%, 19% and 21%, respectively. In the gum arabic stabilizer the concentrations that have been determined are 40%, 36%, 34%, 33% and 33%, respectively. In the lecithin stabilizer the concentrations that have been determined are 40%, 35%, 36%, 37% and 34%, respectively. The type of stabilizer CMC with a concentration of 0.7% has the highest level of stability, while the type of stabilizer lecithin with a concentration of 0.7% has the lowest level of stability.

The results of variance (ANOVA) for the average value of the stability test for emprit ginger extract tempe beverage showed that there was a significant difference at the level of 0.05. Thus, H_0 is rejected and H*1* is accepted, which means that there was a very significant difference in the stability of the emprit ginger extract. This shown the types of CMC, Gum Arabic and Lecithin and different concentrations of stabilizers 0%; 0.3%; 0.5%; 0.7%; and 0.9% affected the stability of the emprit ginger extract tempe beverage.

Based on the results of stability data according to Kumalasari the percentage of sediment formed during storage ranged from 11.76-54.90% and began to form in the first week of storage [14]. In this study, the percentage of deposits formed during storage ranged from 23-41% and showed that the more Gum Arabic was added, the higher the overall average value, and the less the addition of Gum Arabic, the lower the turbidity value. The higher the viscosity of the drink, the higher the turbidity [15]. Stated that Gum Arabic is a type of natural stabilizer that is colorless, odorless, and has no taste. So therefore, Gum arabic has no effect on the drink [16]. According to Ganz which states that CMC has the ionic nature of Na+ carboxyl methyl cellulose which can attract precipitate particles to form a gel structure and increase viscosity [17]. According to Liu Phospholipids are very unstable when exposed to air and sunlight, so that color aging and oxidation rancidity easily occur, but are stable in oil without water [18]. Lipases may contribute to the reduction of phospholipids during storage. Phospholipids are unstable at high temperatures. It can be concluded that the stabilizer CMC and gum arabic affect the stability of the emprit ginger extract tempe beverage than the stabilizer lecithin. The stability parameter that has the highest value is CMC stabilizer with a concentration of 0.7%.

Viscocity

Analysis of the viscosity of the emprit ginger extract tempe beverage was carried out using the Ostwald Viscometer. The analysis data on the viscosity of emprit ginger extract tempe beverage with different types and concentrations of stabilizers can be seen in Table 3.

Table 3. Viscosity test results for emprit ginger extract tempe beverage (poise).

Zat Penstabil	**Stabilizer Concentration (%)**				
	0%	0,3%	0,5%	0,70%	0,9%
CMC Average	2,07±0,01^{a}	2,12±0,02^{b}	2,17±0,01^{b}	2,22±0,00^{b}	2,27±0,00^{c}
Gum Arab Average	2,07±0,01^{a}	2,53±0,01^{b}	2,55±0,05^{b}	2,53±0,04^{b}	2,67±0,03^{c}
Lesitin Average	2,07±0,01^{a}	1,94±0,04^{b}	1,93±0,01^{b}	1,92±0,01^{b}	1,98±0,01^{c}

In Table 3, it can be seen that the viscosity of the emprit ginger extract tempe beverage with CMC, Guma Arab and Lecithin types and different concentrations of stabilizers 0%; 0.3%; 0.5%; 0.7%; and 0.9% indicatds the average value of CMC stabilizer with a predetermined concentration of 2.07, respectively; 2.12; 2.17; 2.22; and 2.27. In the gum arabic stabilizers were 2.07; 2.53; 2.55; 2.53; and 2.67. In the lecithin stabilizers were 2.07, 1.94; 1.93; 1.92; and 1.98. The type of gum arabic stabilizer with a concentration of 0.9% has the highest viscosity level, while the type of lecithin stabilizer with a concentration of 0.7% has the lowest viscosity.

The results of variance (ANOVA) for the average value of the viscosity test for tempeh extract, ginger extract, showed that there was a significant difference at the level of = 0.05. Thus, H_0 was rejected and H_1 was accepted, which means that there was a very significant difference in the viscosity of the emprit ginger extract tempe beverage. This showed the types of CMC, Gum Arabic and Lecithin and different concentrations of stabilizers 0%; 0.3%; 0.5%; 0.7%; and 0.9% affected the viscosity of emprit ginger extract tempe beverage.

Based on the results of the viscosity data in the research of Farikha showed that the viscosity value was 2.22–2.44 cP using gelatin and chitosan stabilizers in red dragon fruit juice [19]. In this study, the average value of viscosity ranged from 1.92 to 2.67 poise. The type of stabilizer has an effect on the high level of viscosity, the higher the concentration of the stabilizer, the higher the viscosity of the emprit ginger extract tempe beverage. According to Belizt, which states that the viscosity is influenced by the concentration and weight of the stabilizer [20]. The higher the stabilizer weight given, the viscosity will increase. According to Rini, which states that an increase in the concentration of a stabilizer in a solution can result in a large amount of bound water, the greater the increase in viscosity [21]. The viscosity parameter that has the highest value was gum arabic stabilizer with a concentration of 0.9%.

Protein Level

Protein is an important food substance for the body because it has a function as a building block and body regulator. The test results for the protein content of the tempeh extract drink with ginger extract can be seen in Table 4.

Table 4. The results of protein content of emprit ginger extract tempe beverage

Zat Penstabil	**Stabilizer Concentration (%)**				
	0%	0,3%	0,5%	0,70%	0,9%
CMC Average	10,77±0,30[a]	12,05±0,40[b]	12,77±0,40[c]	13,61±0,53[d]	14,53±0,52[e]
Gum Arab Average	10,77±0,30[a]	14,31±0,48[b]	14,75±0,21[c]	16,15±0,37[d]	15,98±0,45[e]
Lesitin Average	10,77±0,30[a]	16,75±0,56[b]	19,88±0,46[c]	21,54±0,84[d]	23,15±0,86[e]

In Table 4, it can be seen that the protein content of emprit ginger extract tempe beverage with CMC, Gum Arab and Lecithin types and different concentrations of stabilizers

0%; 0.3%; 0.5%; 0.7%; and 0.9% indicating the average value of CMC stabilizer with a predetermined concentration of 10.77%, respectively; 12.05%; 12.77%; 13.61%; and 14.53%. The gum arabic stabilizer with a predetermined concentration was 10.77%; 14.31%; 14.75%; 16.15%; and 15.98%. In the lecithin stabilizer the concentration that has been determined was 10.77%; 16.75%; 19.88%; 21.54%; and 23.15%. The type of lecithin stabilizer with a concentration of 0.9% had the highest protein content, while CMC stabilizer with a concentration of 0.3% had the lowest protein content.

The results of the variance (ANOVA) for the average value of the protein content test for emprit ginger extract tempe beverage showed that there was a significant difference at the level of 0.05. Thus, H_0 was rejected and H_1 was accepted, which means that there was a very significant difference in protein content of the tempeh extract of emprit ginger extract. This showed the types of CMC, Gum Arabic and Lecithin and different concentrations of stabilizers 0%; 0.3%; 0.5%; 0.7%; and 0.9% affected the protein content of emprit ginger extract tempe beverage.

Based on the results of the protein content data, it showed that the drink made was in accordance with SNI 01-3830-1995 soy milk, with the addition of gum arabic stabilizer had a higher protein content than drinks with the addition of CMC stabilizer. This was because CMC does not contain protein [22], while according to Stephen, gum arabic contains glycoproteins which acted as emulsifiers and thickeners [23]. According to Kataren the oil in lecithin was relatively lower than that of nuts and the relatively high protein content will cause soybeans to be used as a protein source rather than a fat source [24]. This was because the higher the concentration, the protein content will increase [25]. The protein content parameter that has the highest value was lecithin stabilizer with a concentration of 0.9%.

pH value

The pH value shows the hydrogen ion concentration which describes the level of acidity. The higher the pH value means the lower the acidity level of the product and vice versa, the lower the pH value means the higher the product acidity level. The test results of the pH value of emprit ginger extract tempe beverage can be seen in Table 5.

From Table 5, it can be seen that the pH value of emprit ginger extract tempe beverage with CMC, Gum Arab and Lecithin types and different concentrations of stabilizers 0%; 0.3%; 0.5%; 0.7%; and 0.9% indicated the average value of CMC stabilizer with a predetermined concentration of 5.9, respectively; 6.0; 6.2; 6.3; and 6.3. In the gum arabic stabilizers were 5.9; 6.2; 6,4; 6.5; and 6.4. In the lecithin stabilizers were 5.9; 6.1; 6.2; 6.2; and 6.2. The type of gum arabic stabilizer with a concentration of 0.7% has the highest pH value, while the CMC stabilizer with a concentration of 0.3% has the lowest pH value.

Table 5. Results of the pH value of emprit ginger extract tempe beverage.

Zat Penstabil	Stabilizer Concentration (%)				
	0%	0,3%	0,5%	0,70%	0,9%
CMC Average	5,9±0,06[a]	6,0±0,06[b]	6,2±0,12[c]	6,3±0,10[c]	6,3±0,06[c]
Gum Arab Average	5,9±0,06[a]	6,2±0,12[b]	6,4±0,12[c]	6,5±0,06[c]	6,4±0,12[c]
Lesitin Average	5,9±0,06[a]	6,1±0,06[b]	6,2±0,06[c]	6,2±0,06[c]	6,2±0,06[c]

The results of variance (ANOVA) for the average of pH value of emprit ginger extract tempe beverage showed that there was a significant difference at the level of 0.05. Thus, H_0 is rejected and H_1 was accepted, which means that there was a very significant difference in the pH value of emprit ginger extract tempe beverage. This showed the types of CMC, Gum Arabic and Lecithin and different concentrations of stabilizers 0%; 0.3%; 0.5%; 0.7%; and 0.9% affected the pH value of the emprit ginger extract tempe beverage.

Based on the results of the pH value data, it showed that the drink made was in accordance with SNI 01-3830-1995 soy milk, with the addition of gum arabic stabilizer has a higher pH value than drinks made with the addition of CMC stabilizer and lecithin. This was because the addition of gum arabic can increase the pH of emprit ginger extract tempe beverage. The increase in the average pH value was proportional to the addition of gum arabic emprit ginger extract tempe beverage because gum arabic has a high molecular weight, complex molecular structure, and there was a large amount of starch in it, so it was more hygroscopic and complex, more retained and difficult to evaporate [26]. When the material was dissolved in water, the ratio of hydrogen ions to hydroxyl ions will change. If the number of hydroxyl ions was greater than the number of hydrogen ions, the solution was alkaline so that the pH increase, and vice versa [27]. In addition, gum arabic can form a stable solution at pH 5.0-7.0 conditions [28]. In the pH value parameter which has the highest value was gum arabic stabilizer with a concentration of 0.7%.

Decision Making System Analysis

In this case, there are several assessments that will be carried out by looking at the values against the criteria. The alternative in this case was emprit ginger extract tempe beverage from three stabilizers namely CMC, gum arabic and lecithin and also uses five concentrations, namely 0.3%, 0.5%, 0.7% and 0.9%.

Based on the consideration of the research results, this study used several criteria that were used in the decision-making process, namely, the amount of stabilizer used, observations on the stability of drinks, observations on texture, namely viscosity, and observations of sensory tests on color. Furthermore, each of these indicators was considered as a criterion that must exist in determining the decision to determine the superior product. The weight values of each criterion are shown in Table 6. The following was the calculation process for making decisions using MADM-SAW.

1. Alternative Value

Giving the value of each alternative (Ai) on each criterion (Cj) that has been determined, where the value of each alternative is shown in Table 15 as follows

Table 6. Value of each alternative

Formulasi	Kriteria			
	C1	C2	C3	C4
Formulasi 1	4	3	3	3
Formulasi 2	4	3	3	3
Formulasi 3	4	4	3	3
Formulasi 4	3	3	3	3
Formulasi 5	3	2	3	3
Formulasi 6	2	2	3	3
Formulasi 7	1	2	3	3
Formulasi 8	1	2	2	3
Formulasi 9	4	2	2	3
Formulasi 10	4	5	2	3
Formulasi 11	4	5	2	3
Formulasi 12	3	5	2	3

Giving value to the criteria for each stabilizer ingredient for making emprit ginger extract tempe beverage was based on the costs incurred until the emprit ginger extract tempe beverage was produced, which in C1 shows the criteria for the amount of stabilizer used, the price of the stabilizer is different. Different so that the number of ingredients used in the manufacture of emprit ginger extract tempe beverage will determine the costs incurred, the higher the price of the stabilizer material, the greater the costs incurred, for example the price of CMC Rp. 130,000/kg, the price of gum arabic was Rp.380,000/kg and the price of lecithin was Rp. 150,000/kg. The price of these different stabilizers will certainly affect the cost of the whole process of making emprit ginger extract tempe beverage.

Criterion C2 was the observation of the stability of the drink. In this study, stabilizers were used, namely CMC, gum arabic and lecithin. In this study, the type of stabilizer with different concentrations will provide stability to the beverage product, which has different results. In the tempeh series drinks, the ginger extract has a precipitate in the drink, so that the stabilizer is an important part of the reaction that changes the initial structure that has a precipitate into a stable drink. Stabilizers can increase the viscosity which will prevent the coalescence of some of the dispersed particles into larger particles. Stabilizers are also capable of binding large amounts of free water. So that the price of the stabilizer material, which varies with the number of ingredients used in the manufacture of tempeh extract, emprit ginger extract, will determine the costs incurred.

Criterion C3 was an observation of texture, namely viscosity. The use of different stabilizers gives different finishes as well. In this study, the use of CMC stabilizers, gum arabic and lecithin, the three stabilizers was a measurement of the resistance of the fluid (fluid) which was changed both by pressure and stress. Viscosity describes the internal resistance of a fluid to flow and may be thought of as a measure of the displacement of the fluid. Simply put, the lower the viscosity of a fluid, the greater the movement of the fluid.

Likewise, if the higher the viscosity of a fluid, the smaller the movement of the fluid, therefore the use of a stabilizer required will affect the amount of stabilizer used in the beverage-making process. So the viscosity affects the required cost.

Criterion C4 was a sensory test observation of color. Color was the first sensory that can be seen directly by the panelists. Determination of the characteristics of the stabilizer for drinks generally depends on the color it has, a color that does not deviate from the color that should give the impression of a separate assessment by the panelists. The use of different stabilizers, namely CMC, gum arabic and lecithin, will give different colors to emprit ginger extract tempe beverage. The CMC stabilizer does not add color to the drink because of the colorless nature of CMC. The stabilizer of gum arabic and lecithin will add color to the drink because the stabilizer of gum arabic and lecithin has a color property that is brown, so that the drink of emprit ginger extract tempe beverage will change color from yellowish white to yellow or brownish yellow. The addition of different stabilizers with certain needs will add color to the drink and will also be related to the costs required when making emprit ginger extract tempe beverage.

2. Criteria Weight

Give a weighted value (W) for each criterion in Table 7 as follows.

Table 7. Criteria Weight

	Kriteria	**Bobot**
C1	Bahan zat penstabil	1
C2	Kestabilan	1
C3	Kekentalan	0,75
C4	Warna	0,75

The weight given in Table 7 above was based on the level of criteria that have an important role in the standard process of making a good and profitable emprit ginger extract tempeh drink, from the four criterias, the stabilizer was given a value of 1, this cannot be separated from the importance of calculating the ingredients. stabilizer needed in the manufacture of emprit ginger extract tempe beverage, followed by observation of stability. Observations of texture on viscosity and observations of sensory tests on color were given a weight of 0.75, this was because the role of texture observations on viscosity and sensory test observations on color in making emprit ginger extract tempe beverage was the smallest, but each criterion has its own characteristics. Their respective roles and functions in determining the lowest cost calculation in the manufacture of this emprit ginger extract tempe beverage. The final weighted value of the four criteria must have the highest value.

3. Decision Matrix and Normalized Matrix

Make a decision matrix by calculating the normalized performance rating value (rij) and alternative Ai on the Cj attribute based on equation 1 with the results in Table 8. Then normalize the matrix based on the equation that is adjusted to the type of attribute (cost attribute) in order to obtain a normalized matrix R at Table 9.

Table 8. Decision matrix

Kriteria	C1	C2	C3	C4
Bobot	1	1	0,75	0,75
Formulasi 1	0,75	0,75	0,75	0,75
Formulasi 2	0,75	1	0,75	0,75
Formulasi 3	1	1	1	0,75
Formulasi 4	1	1	1	0,75
Formulasi 5	0,75	0,75	0,75	1
Formulasi 6	0,75	1	0,75	1
Formulasi 7	1	1	1	1
Formulasi 8	1	1	1	1
Formulasi 9	0,75	0,75	0,75	1
Formulasi 10	0,75	1	0,75	1
Formulasi 11	1	1	1	1
Formulasi 12	1	1	1	1

Table 9. Normalized matrix

Kriteria	C1	C2	C3	C4
Formulasi 1	1	0,75	0,5625	0,75
Formulasi 2	1	1	0,5625	0,75
Formulasi 3	0,75	1	0,5625	0,75
Formulasi 4	0,75	1	0,75	0,75
Formulasi 5	1	0,75	0,75	0,75
Formulasi 6	1	1	0,5625	0,5625
Formulasi 7	0,75	1	0,5625	0,5625
Formulasi 8	0,75	1	0,75	0,5625
Formulasi 9	1	0,75	0,75	0,5625
Formulasi 10	1	1	0,5625	0,5625
Formulasi 11	0,75	1	0,5625	0,5625
Formulasi 12	0,75	1	0,75	0,5625

4. Total Value of Each Alternative

Determination of the total value of each alternative. The value of the decision matrix was used to determine the total value of each alternative using equation 2. The best alternative was the alternative that has the highest value that can be seen in Table 10.

Table 10. Total value of each alternative

Alternatif	Nilai Total	Rangking
Formulasi 1	3,0625	6
Formulasi 2	3,3125	1
Formulasi 3	3,0625	7
Formulasi 4	3,25	2
Formulasi 5	3,25	3
Formulasi 6	3,125	4
Formulasi 7	2,875	11
Formulasi 8	3,0625	8
Formulasi 9	3,0625	9
Formulasi 10	3,125	5
Formulasi 11	2,875	12
Formulasi 12	3,0625	10

Based on the value of the calculation of the total value of each alternative in Table 19. Then the total value of the highest alternative was the manufacture of emprit ginger extract tempe beverage using a CMC type stabilizer with a concentration of 0.5% for a total of 3.3125 which can be seen in Table 18. So it can be concluded that the best product of making emprit ginger extract tempe beverage using the smallest cost is using a stabilizer of the type CMC with a concentration of 0.5%, this result is in line with the chemical results obtained at the analysis stage of the emprit ginger extract tempe beverage.

CONCLUSION

Stabilizers in the form of CMC, gum arabic and lecithin at concentrations of 0%, 0.3%, 0.5%, 0.7% and 0.9% to the emprit ginger extract tempe beverage had a significantly different effect on Sig. <0.05 to viscosity (gum arabic 0.9%), stability (CMC 0.7%), protein content (lecithin 0.9%), pH value (gum arabic 0.7%), and total dissolved solids (gum arabic 0.7% but had no significant effect on ash content. In addition, the treatment of tempe extract with ginger extract which produced the best characteristics was seen from the analysis of the decision-making system using MADM.

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