

# Optimization of Formulation and Mass Balance of Aloe Vera Herbal Drink (*Aloe vera barbadensis* Miller) Using the D-Optimal Mixture Method

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**Abstract.** Aloe vera and empon-empon contain bioactive compounds that are good for health and have a role as an antioxidant. This research aims to produce herbal drinks based on aloe vera and empon-empon, which have high antioxidant levels that can improve the immune system and have acceptable and preferred characteristics. This study uses Design Expert Mixture D-optimal method. This method is used to determine the proportion of aloe vera and empon-empon by predetermined limits to produce an optimum response value. Based on the results of the study, it was found that the optimum formulation in the manufacture of herbal drinks based on aloe vera and empon-empon with the proportions of aloe vera 52.92%, ginger extract 11.58%, white turmeric extract 1.50%, and galangal extract 2.00%, with a value of precision (desirability) of 58.50%. With this formulation, a viscosity value is 161 cP, a total dissolved solids value is 16.80%, a density value is 1.0658 g/cm<sup>3</sup>, a pH value is 4.502, and an antioxidant capacity value (as vitamin C) is 7.4638 mg ascorbic acid equivalent/100 g, the value of total phenolic contents is 0.1314 mg GAE/g, and total flavonoid contents is 0.3315 mg QE/g. Keywords : herbal drinks, aloe vera, formula optimization, design expert.

## INTRODUCTION

Herbal drinks are drinks that come from natural ingredients and have benefits for the body. Herbal drinks are usually made from spices or parts of plants, such as roots, stems, leaves, flowers, or tubers. Herbal drinks have properties that are useful for healing various diseases. These properties come from the active ingredients contained in plants (Ismiati, 2015). Herbal drinks can be categorized as functional drinks, which contain nutrients or non-nutrients that can have a positive effect on body health when consumed.

This research formulates aloe vera and empon empon into ready-to-drink herbal drinks that have high antioxidants. The antioxidants contained in aloe vera herbal drinks and empon-empon are expected to be able to increase body immunity during the COVID-19 pandemic. According to Wiedosari (2007) aloe vera extract in the form of a gel contains active substances monosaccharides and polysaccharides (especially in the form of mannose) called acemannan (acetylated). mannose) and has an effect on the immune system. Aloe vera plants also contain flavonoid compounds that have functional properties as antioxidants and function as an antidote to free radicals in the body (Werdhasari, 2014). According to Sultana and Anwar (2008), aloe vera contains flavonol compounds, such as kaempferol, quercetin and myricetin each as much as 257.7; 94.80, and 1283.50 mg/kg. These compounds are included in the polyphenol group which is believed to have antioxidant properties. According to Miranda et al., (2009) aloe vera also contains nutrients such as vitamins C, E and A and is rich in fiber. Antioxidants in plants can keep immune cells protected from damage caused by free radicals (Siswanto et al, 2013).

The use of aloe vera in the form of extracts is less practical, easily damaged and has low acceptability. Therefore, aloe vera gel is processed into aloe vera drink. However, the antioxidants in aloe vera can decrease in levels during the processing. To overcome this, it is necessary to add other medicinal plants that also have high levels of antioxidants. (Riyanto and Wariyah, 2012)

Optimization process is a normative approach to identify the best solution in making a decision on a problem. Through optimization, problems will be solved to get the best results in accordance with the given constraints. Optimization aims to minimize the effort required or operational costs and maximize the desired results (Ma'arif et al. 1989). According to Nugroho, (2012) Design expert is software for optimizing a process or formula for a product. This program can process 4 different research designs, namely: factorial design, combined design, mixture design, and response surface method design. For the optimization of the formula from a series of mixtures of components used, a mixture design can be selected.

According to Hidayat et al (2021) and Zen et al (2015) formula optimization using the mixture design method has the advantage that the number of run formulas is less than the factorial and RSM methods. A smaller number of runs means that it takes less time for experiments in the laboratory, so it will be more efficient in terms of time and materials. The selected optimal formulation has a degree of accuracy or desirability. The closer the value to one, the higher the value of optimization accuracy (Nugroho, 2012). The D-Optimal Mixture Design method has advantages compared to other optimization programs, namely it can automatically display the number of formulations in accordance with predetermined limits. D-Optimal Mixture Design will provide variations in the concentration of each ingredient with a predetermined number of formulas making it easier for researchers to make formulas (Borhan et al, 2014)

The functional drink formulation using the Design Expert Mixture D-Optimal method resulted in the best combination of turmeric extract at 5.0%(v/v), tamarind extract at 9.9%(v/v), and ginger extract at 15.1%(v/v). desirability value of 0.913. And has an antioxidant capacity of 0.1741mgAEq/ml. (Susilo, 2011). The optimum formula for an integrated drink of Moringa leaves, pandan leaves, and red ginger based on the Design Expert Mixture D-Optimal method is with the proportion of moringa 72.45%, pandan fragrant 20.17% and red ginger 7.38% with an IC50 value of 130, 55 ppm, total phenol 750.3 mg GAE/kg and total flavonoids 44.96 mg QE/kg (January, 2017)

The mass balance is a calculation of all incoming, accumulated and outgoing materials within a certain time. The mass balance is used to see the amount of incoming and outgoing materials in a process. The basic principle used is that if in a process there is no accumulation in the processing equipment, then the amount of incoming material will be equal to the amount of output material (Maflahah, 2010). According to Wirakartakusumah (1989), any system, the amount of matter will remain even though there is a change in shape or physical state. Therefore, in a processing process, the amount of incoming material will be equal to the amount of material that comes out as the desired product plus the amount lost or by-products. Determination of the mass balance in this study aims to determine the amount of incoming and outgoing materials and to determine the efficiency in the process of making the herbal drink. The purpose of this study was to produce herbal drinks based on aloe vera and empon-empon which have high antioxidant levels so as to improve the immune system and have acceptable and preferred characteristics by using the Design Expert application with the Mixture D-optimal method and to obtain a mass balance flow. from herbal drinks aloe vera and empon empon.

## MATERIALS AND METHODS

### Materials

The ingredients used in making herbal drink are aloe vera (*Barbadensis Miller*), red ginger, local varieties of white turmeric, local varieties of turmeric, white galangal varieties, honey, sugar, CMC, citric acid, Na-benzoate, salt, and plastic bottle packaging. Materials for analysis consisted of gallic acid p.a, methanol p.a, ethanol p.a, Folin-Ciocalteu rectifier, Na<sub>2</sub>CO<sub>3</sub> 7%, aquadest, quercetin standard standard, AlCl<sub>3</sub> 10%, NaOH 1 M DPPH p.a powder, buffer solution 4 and 7. used are basins, knives, glasses, blenders, pans, stoves, spoons, digital balances, bowls, plates, funnels, sealers, and wooden spatulas. The analytical tools used are measuring flask, Erlenmeyer flask, beaker, dropper, measuring pipette, measuring pipette, micron pipette, ball filler, digital balance, spatula, weighing bottle, pH meter (SI Analytics Lab 865), Chromameter (3nh\_NH310) , Viscometer (Brookfield DV-E), Pocket Refractometer PAL 1 brix 0-53% (Atago), pycnometer, cuvette and UV-Vis spectrophotometer

### Methods

There are two stages of research, namely preliminary research and main research. Preliminary research is conducted to verify the formula that will be used to make herbal drinks based on aloe vera and empon-empon, as well as determine the mass balance for the flow of the production process for making these herbal drinks. The results of the preliminary research will be used as a reference for the main research. The formulation of aloe vera and empon-empon herbal drinks that will be verified in the preliminary study can be seen in table 1.

**TABLE 1.** Formulasi Minuman Herbal Berbasis Lidah Buaya dan Empon-Empon

| Bahan            | Jumlah (%) |
|------------------|------------|
| Aloe vera        | 55,0       |
| Water            | 14,9       |
| Ginger extrct    | 10,0       |
| Sari Kunir Putih | 2,0        |
| Sari Kunyit      | 2,0        |
| Sari Lengkuas    | 1,0        |
| Gula Pasir       | 10,0       |
| Garam dapur      | 0,03       |
| CMC              | 0,02       |
| Asam Sitrat      | 0,03       |
| Na-Benzoot       | 0,02       |
| Madu             | 5,0        |

Source : P2TTG-LIPI (2021).

In the main study, the Design Expert software 13 Mixture D-Optimal method was used to determine the formulation of the ingredients to be optimized, namely aloe vera, ginger, white turmeric, and galangal. The responses to be tested include analysis of bioactive components (phenolic and flavonoids), antioxidant capacity test (as vitamin C), physical analysis such as color, pH, viscosity, total dissolved solids and density. Determination of the optimum formula consists of four stages, namely the formula planning stage, the formulation stage, the analysis stage, and the optimization stage. The first stage is to determine the formula/variable to be optimized, usually referring to the formula based on the existing research literature or based on the results of trial and error. Then determine the response to be tested, then each response will be analyzed by Design Expert 13 to produce the D-Optimal equation. Furthermore, Design Expert 13 will display the selected formulation according to the program which is summarized based on the conclusions of all responses. The number of runs or formulations given by the Design Expert 13 program is 15

formulations. The number of runs is obtained automatically by the program. The formulation of aloe vera and empon-empon herbal drinks can be seen in table 2

**TABLE 2.** Formulation of Raw Materials for Making Herbal Drinks Based on Aloe Vera and Empon-Empon

| Formula | Aloe vera (%) | Ginger extract (%) | White tumeric extract (%) | Galangal extract (%) |
|---------|---------------|--------------------|---------------------------|----------------------|
| 1       | 53.63         | 12.62              | 0.79                      | 0.96                 |
| 2       | 57.62         | 8.13               | 1.29                      | 0.96                 |
| 3       | 50.00         | 14.50              | 1.50                      | 2.00                 |
| 4       | 60.00         | 7.00               | 0.50                      | 0.50                 |
| 5       | 60.00         | 6.00               | 1.50                      | 0.50                 |
| 6       | 60.00         | 5.00               | 1.00                      | 2.00                 |
| 7       | 60.00         | 6.25               | 0.50                      | 1.25                 |
| 8       | 52.00         | 15.00              | 0.50                      | 0.50                 |
| 9       | 51.00         | 15.00              | 1.50                      | 0.50                 |
| 10      | 55.75         | 10.75              | 1.00                      | 0.50                 |
| 11      | 55.25         | 10.25              | 0.50                      | 2.00                 |
| 12      | 52.62         | 12.38              | 1.29                      | 1.71                 |
| 13      | 50.70         | 15.00              | 1.00                      | 1.30                 |
| 14      | 50.50         | 15.00              | 0.50                      | 2.00                 |
| 15      | 55.08         | 10.08              | 1.50                      | 1.33                 |

TABLE 3. Variable Constraints Change

| No | Nama Bahan            | Lower (%) | Upper (%) |
|----|-----------------------|-----------|-----------|
| 1  | Aloe vera             | 50        | 60        |
| 2  | Ginger extract        | 5         | 15        |
| 3  | White tumeric extract | 0,5       | 1,5       |
| 4  | Galangal extract      | 0,5       | 2         |

## RESULT AND DISCUSSION

### Preliminary

The verification process in the preliminary study aims to determine the characteristics of the product produced from the formula and procedures that have been made by the LIPI P2TTG Team, with the responses being considered, namely the antioxidant capacity test (as vitamin C), total phenolic content, total flavonoid content, pH, viscosity, color, total dissolved solids and density. The results of the verification process for aloe vera herbal drinks and empon empon can be seen in Table 4.

**TABLE 4.** Hasil Analisis Verifikasi Produk Minuman Herbal Lidah Buaya dan Empon-Empon

| Parameter                 | Hasil                          |
|---------------------------|--------------------------------|
| Uji kapasitas antioksidan | 7,0482 mg Ek.Vit C/100 g bahan |
| Kadar total fenolik       | 0,1073 mg GAE/g bahan          |
| Kadar total flavonoid     | 0,1338 mg QE/g bahan           |
| pH                        | 4,499                          |

|                        |         |                          |
|------------------------|---------|--------------------------|
| Viskositas             |         | 182 cP                   |
| Total padatan terlarut |         | 15,7% brix               |
| Densitas               |         | 1,0674 g/cm <sup>3</sup> |
|                        | Nilai L | 61,237                   |
| Warna                  | Nilai a | -1,871                   |
|                        | Nilai b | -2,363                   |

## Main Research

The main research aims to determine the optimal formulation of aloe herbal drink products using Design Expert 13 software. The desired response is a physical response and a chemical response. Physical responses in this study include viscosity, total dissolved solids, density and color. Chemical responses include pH, antioxidant capacity (as vitamin C), total phenolic content, and total flavonoid content.

## Physical Responses

The results of the physical response analysis can be seen in table 5, the physical responses in this study included viscosity, total dissolved solids, density and color (values of L\*, a\*, and b\*).

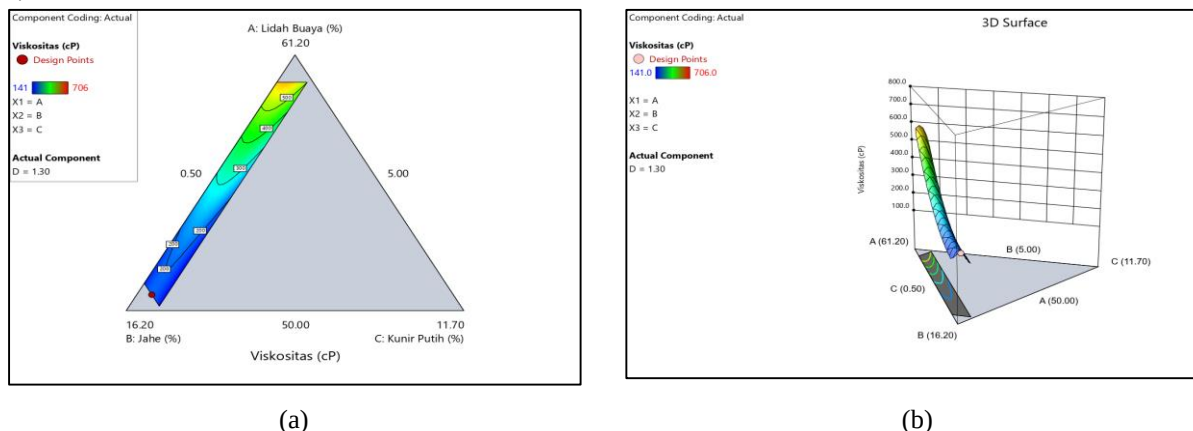
**TABLE 5.** Hasil Analisis Respon Fisik Dari Minuman Herbal Lidah Buaya dan Empon-Empon

| Formula | Viskositas (cP) | Total Padatan Terlarut (%brix) | Densitas (g/cm <sup>3</sup> ) | Warna  |        |        |
|---------|-----------------|--------------------------------|-------------------------------|--------|--------|--------|
|         |                 |                                |                               | L*     | a*     | b*     |
| 1       | 217             | 15,25                          | 1,0682                        | 61,038 | -1,775 | -1,496 |
| 2       | 348             | 15,60                          | 1,0718                        | 60,959 | -1,859 | -1,883 |
| 3       | 141             | 14,60                          | 1,0630                        | 61,057 | -1,735 | -1,506 |
| 4       | 558             | 15,80                          | 1,0739                        | 61,196 | -1,840 | -2,014 |
| 5       | 441             | 15,90                          | 1,0725                        | 61,048 | -1,862 | -2,042 |
| 6       | 706             | 16,10                          | 1,0743                        | 61,252 | -1,848 | -2,207 |
| 7       | 582             | 17,35                          | 1,0740                        | 61,112 | -1,799 | -2,144 |
| 8       | 200             | 14,90                          | 1,0672                        | 61,440 | -1,532 | -1,290 |
| 9       | 196             | 14,90                          | 1,0636                        | 62,016 | -1,670 | -1,630 |
| 10      | 315             | 15,45                          | 1,0695                        | 61,700 | -1,751 | -1,944 |
| 11      | 299,9           | 15,35                          | 1,0688                        | 61,953 | -1,733 | -1,672 |
| 12      | 205             | 15,20                          | 1,0679                        | 62,039 | -1,669 | -1,584 |
| 13      | 195             | 14,85                          | 1,0632                        | 61,992 | -1,668 | -1,681 |
| 14      | 187             | 14,80                          | 1,0630                        | 62,018 | -1,547 | -1,376 |
| 15      | 230             | 15,35                          | 1,0686                        | 61,669 | -1,756 | -1,986 |

## Viscosity

Viscosity is a property of a fluid that describes the resistance of the fluid when it flows. The greater the value of the viscosity coefficient, the greater the resistance of the fluid to flow (Yusibani et al, 2017). Based on the test results contained in table 6, it can be seen that the viscosity of the 15 aloe vera herbal drink formulas ranged from 141-706 cP. The highest viscosity value was obtained from the 6th formulation with the highest composition of aloe vera as

much as 60%, ginger juice 5%, white turmeric extract 1% and galangal juice 2%. The polynomial model recommended by Design Expert 13 for the viscosity response is quadratic. The ANOVA results show that at the 5% level, the recommended model has a significant value, with a p value of "prob<F" less than 0.05, which is 0.0001. The viscosity response contour plot obtained from the results of the research using the Mixture Design method can be seen in Figure 1.



**FIGURE 1.** Grafik *Countour Plot* dan Gambar Tiga Dimensi Uji Respon Viskositas

The blue color on the contour plot shows the lowest viscosity response value, which is 141 cP. While the red color shows the highest viscosity response, which is 706 cP. According to Reddy et al. (2013), acetylated mannan contained in aloe vera gel is a primary polysaccharide that can be used as a gelling agent, such as polysaccharides that have been found in guar gum and gum. These polysaccharides are mostly composed of linear bonds 1-4 glucose and mannose forming glucomannan as the most dominant molecule.

The difference in viscosity values in each formulation was influenced by the addition of aloe vera and CMC. The more aloe vera is added, the more the molecular weight of the aloe vera herbal drink and the empon-empon will increase, so as to increase the viscosity value of the herbal drink. And vice versa, the less aloe is added, the lower the viscosity value of the aloe vera herbal drink and the empon-empon. This is in accordance with the statement of Belizt, Grosch and Schierberle (2009), which states that the viscosity is influenced by the concentration and molecular weight of the stabilizer. The higher the value of molecular weight and concentration of stabilizer, the viscosity of the product will increase.

### *Total Dissolved Solids*

Total dissolved solids is the content of water-soluble materials such as glucose, sucrose, fructose, and pectin. Based on the test results contained in table 6, it can be seen that the total soluble solids of the 15 aloe vera herbal drink formulas ranged from 14.60-17.35% brix. The highest total dissolved solids value was obtained from the 7th formulation with the highest composition of aloe vera, namely 60%, ginger extract 6.25%, white turmeric extract 0.5% and galangal extract 1.25%. The polynomial model recommended by Design Expert for the total dissolved solids response is special cubic. The ANOVA results show that at the 5% level, the recommended model has a significant value, with a p value of "prob<F" less than 0.05, which is 0.0101. The contour plot graph of the total dissolved solids response obtained from the results of research using the Mixture Design method can be seen in Figure 2.

The blue color on the contour plot shows the lowest total response value of dissolved solids, which is 14.60% brix. While the red color shows the highest total dissolved solids response, which is 17.30% brix. According to Farikha et al (2013), the total value of dissolved solids can increase because the amount of free water is bound by the stabilizer so that the concentration of the soluble material increases. The more particles bound to the stabilizer, the total dissolved solids will also increase and reduce the precipitate formed. In the presence of a stabilizer, the suspended particles will be trapped in the system and will not settle under the influence of gravity. Wang and Johnson (2006) stated that, the polysaccharides in aloe vera gel consist of glucomannan and small amounts of arabinan and galactan. In the food industry, glucomannan can be used as a stabilizer and emulsifier

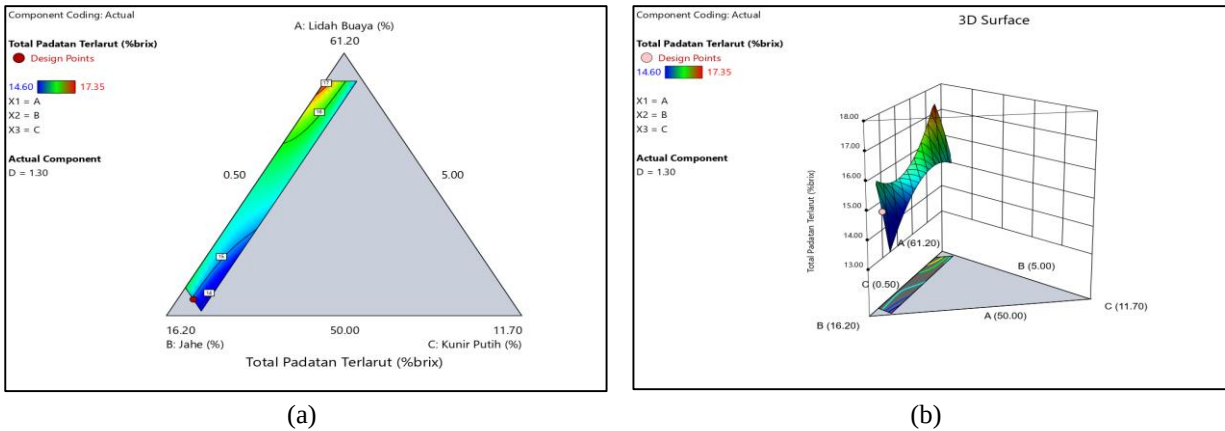


FIGURE 2. Grafik Countour Plot dan Gambar Tiga Dimensi Uji Respon Total Padatan Terlarut

### Density

Density or density or also called density is a measurement of the mass of each unit volume of an object. Density depends on the mass and volume of the object. Based on the results of the analysis in table 6, it can be seen that the density of the 15 formulas of aloe vera herbal drink ranged from 1.0630-1.0743 g/cm<sup>3</sup>. The highest density value was obtained from the 6th formulation with the highest composition of aloe vera as much as 60%, ginger juice 5%, white turmeric extract 1% and galangal extract 2%. The polynomial model recommended by Design Expert for density response is linear. The ANOVA results show that at the 5% level, the recommended model has a significant value, with a p value of "prob<F" less than 0.05, which is 0.0001. The density response contour plot graph obtained from the results of the research using the Mixture Design method can be seen in Figure 3. The blue color on the contour plot graph shows the lowest density response value, which is 1.0630 g/cm<sup>3</sup>. While the red color indicates the density response, which is 1.0743 g/cm<sup>3</sup>.

Based on the analysis data, the concentration level of aloe vera gel has a significant effect on the specific gravity or density of aloe vera herbal drinks and empon-empon. The more aloe vera gel added will increase the density value. This is because aloe vera gel has a higher density than water. In addition, from the results of the analysis, it can be seen that the density value of aloe vera herbal drinks and empon-empon is directly proportional to the viscosity value.

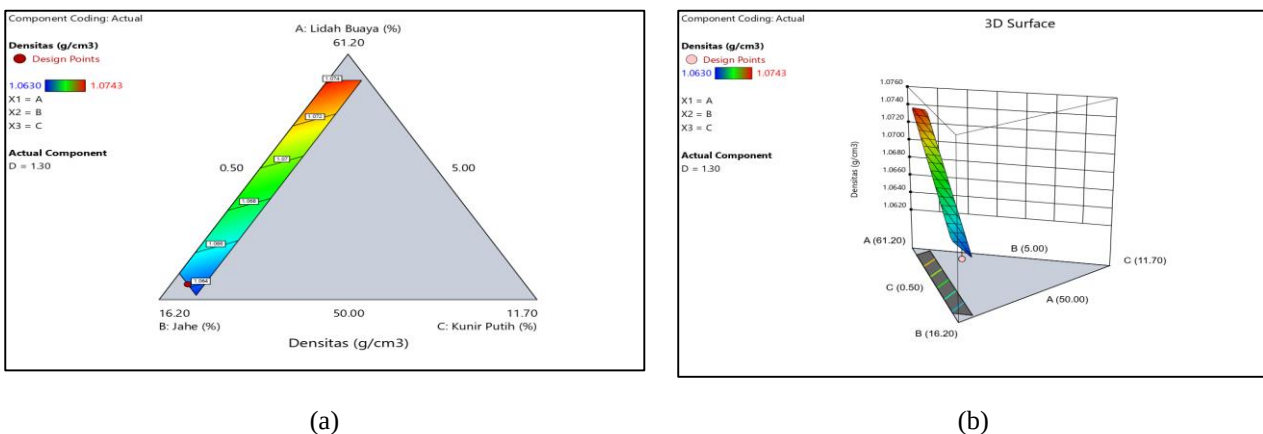


FIGURE 3. Grafik Countour Plot dan Gambar Tiga Dimensi Uji Respon Densitas

## Color

The results of the color response test are not included in the Design Expert 13 application. The measurement of color intensity in aloe vera and empon-empon herbal drinks is carried out using a chromameter. This color meter works based on the Lambert-Beer law which states that the absorption of light transmitted through a medium is directly proportional to the concentration of the medium. Measurements produce values of L, a and b. The L value represents the brightness parameter (achromatic color, 0: black to 100: white). The chromatic color of the red-green mixture is indicated by the value of a ( $a^+ = 0-100$  for red and  $a^- = 0-(-80)$  for the green color). The chromatic color of the blue-yellow mixture is indicated by the value of b ( $b^+ = 0-70$  for yellow, and  $b^- = 0-(-70)$  for blue (Engelen, 2018)).

The results of the measurement of the L value ranged from 60.959 to 62.039. The lowest L value, which is 60.959, comes from the 2nd formula, while the highest L value is 62.03, which comes from the 12th formula. The L value obtained is thought to be influenced by the addition of turmeric extract and the amount of galangal juice added. The increase in added galangal juice tends to cause an increase in the L value obtained. The results of the measurement of the value of a ranged from -1.862 to -1.532. The lowest a value of -1.862 comes from the 5th formula, while the highest a value of -1.532 comes from the 8th formula. The color produced from all formulas tends to be more green, this is because the a value obtained is in the 0-(-80) range. The measurement results of b values ranged from -2.207 to -1.290. The lowest b value is -2.207 from the 6th formula, while the highest b value is -1.290 from the 8th formula. The color produced from all formulas tends to be more blue, this is because the b value obtained is in the 0-(-70) range.

The color response can be influenced by the interaction between the color pigments contained in the material. According to Pan et al (1999) in Puspitasari (2015), the yellow pigment in turmeric is produced from a compound called curcumin. Curcumin is one of the substances contained in a color pigment in turmeric, namely curcuminoids (Sari et al, 2013 in Puspitasari, 2015). The color pigment in ginger is thought to come from oleoresin compounds. The oleoresin compounds in ginger are bright yellow, yellow to dark brown (Oktora et al, 2007 in Ibrahim et al, 2015).

## Respon Kimia

Chemical responses in this study included analysis of pH, antioxidant capacity (as vitamin C), total phenolic content, and total flavonoid content. The results of chemical analysis of herbal drinks based on aloe vera can be seen in table 6.

**TABLE 6.** Hasil Analisis Respon Kimia Dari Minuman Herbal Lidah Buaya dan Empon-Empon

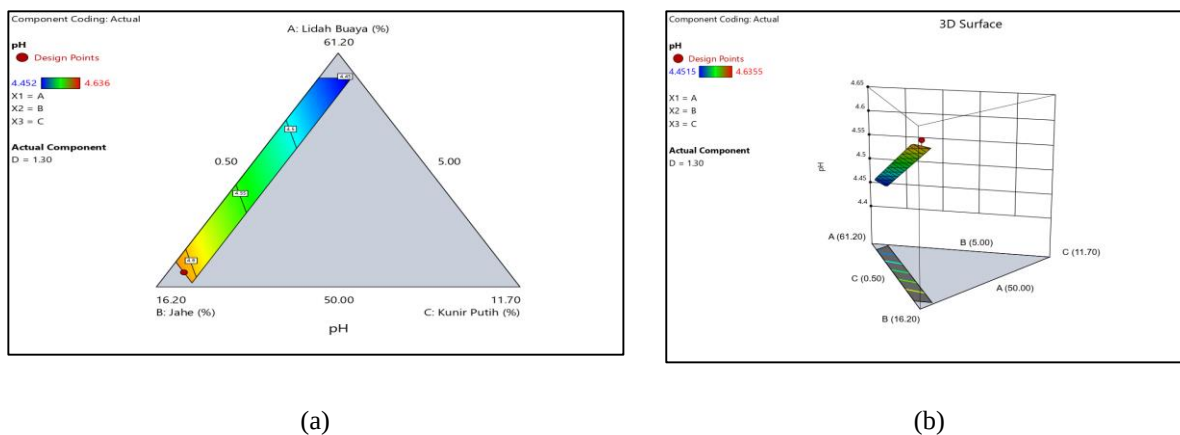
| Formula | pH    | Kapasitas Antioksidan<br>(mg Ek.vit C/100 g bahan) | Kadar Total Fenol<br>(mg GAE/g bahan) | Kadar Total Flavonoid<br>(mg QE/g bahan) |
|---------|-------|----------------------------------------------------|---------------------------------------|------------------------------------------|
| 1       | 4,552 | 8,0479                                             | 0,1310                                | 0,2222                                   |
| 2       | 4,524 | 10,2892                                            | 0,1159                                | 0,2332                                   |
| 3       | 4,601 | 2,4796                                             | 0,1389                                | 0,3114                                   |
| 4       | 4,462 | 11,4514                                            | 0,1131                                | 0,2003                                   |
| 5       | 4,452 | 10,7104                                            | 0,1043                                | 0,1899                                   |
| 6       | 4,452 | 12,5697                                            | 0,0871                                | 0,4210                                   |
| 7       | 4,477 | 12,4728                                            | 0,1103                                | 0,2334                                   |
| 8       | 4,636 | 7,3101                                             | 0,1389                                | 0,1671                                   |
| 9       | 4,598 | 7,2488                                             | 0,1425                                | 0,1451                                   |
| 10      | 4,588 | 8,4042                                             | 0,1276                                | 0,1889                                   |
| 11      | 4,521 | 8,1973                                             | 0,1275                                | 0,3560                                   |
| 12      | 4,557 | 7,3811                                             | 0,1276                                | 0,2996                                   |
| 13      | 4,617 | 7,0104                                             | 0,1625                                | 0,2334                                   |
| 14      | 4,587 | 6,1586                                             | 0,1883                                | 0,3234                                   |
| 15      | 4,497 | 8,1414                                             | 0,1250                                | 0,2551                                   |



## pH

The pH value indicates the concentration of dissolved H<sup>+</sup> (hydrogen) ions in a solution. The pH value is the log of the H<sup>+</sup> ion and the magnitude ranges from 1 to 14. A value of 7 means the pH of the food is neutral, a value <7 means the pH is acidic, and >7 means the pH is alkaline. An increase in the content of H<sup>+</sup> ions will lower the pH so as to create an acidic environment (Pudjirahaju, 2017). Based on the test results contained in table 7, it can be seen that the pH value of the 15 aloe vera herbal drink formulas ranged from 4.452 to 4.636. The highest pH value was obtained from the 8th formulation with the highest composition of ginger juice at 15%, aloe vera 52%, white turmeric extract 0.5% and galangal extract 0.5%.

The polynomial model recommended by Design Expert for the pH response is linear. The ANOVA results show that at the 5% level, the recommended model has a significant value, with a p value of "prob<F" less than 0.05, which is 0.0001. The pH response contour plot obtained from the research using the Mixture Design method can be seen in Figure 4.



**FIGURE 4.** Grafik Countour Plot dan Gambar Tiga Dimensi Uji Respon pH

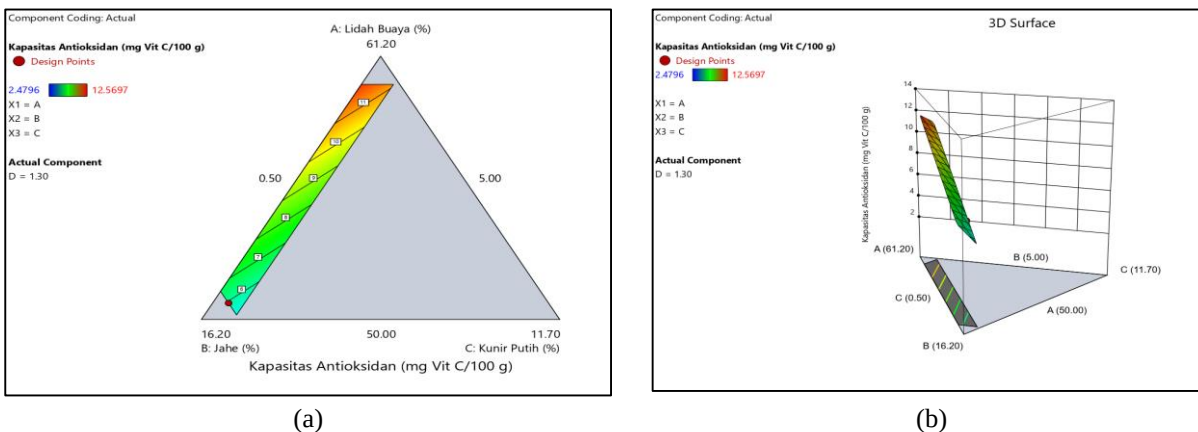
The pH of a food and drink is influenced by the acid content found in natural foodstuffs. In composition, the red ginger component is the second largest component used in the manufacture of aloe vera herbal drinks (Fardiaz, 1992). According to Chasparinda et al (2014), the greater the concentration of ginger extract added to beetroot juice causes the pH of the beet juice to increase, this is because the H<sup>+</sup> ions released are smaller. In addition, the addition of citric acid to aloe herbal drinks can also affect the pH, where the addition of citric acid serves as a regulator of acidity. Winarno (2008) citric acid can function as an acidulant (acidic chemical compound) added to food processing for various purposes, the element that causes a sour taste is H<sup>+</sup> ion or hydrogenium ion H<sub>3</sub>O<sup>+</sup>.

## Kapasitas Antioksidan

Based on the test results contained in table 7, it can be seen that the antioxidant capacity values of the 15 formulas of aloe vera herbal drink ranged from 2.4796-12.5697 mg Ek.vit C/100 g of ingredients. The highest antioxidant capacity value was obtained from the 6th formulation with a composition of 60% aloe vera, 5% ginger extract, 1% white turmeric extract and 2% galangal extract. The polynomial model recommended by Design Expert for the antioxidant capacity response is linear. The ANOVA results show that at the 5% level, the recommended model has a significant value, with a p value of "prob<F" less than 0.05, which is 0.0001. The graph of the contour plot of the antioxidant capacity response obtained from the results of the research using the Mixture Design method can be seen in Figure 5.

The blue color on the contour plot shows the lowest antioxidant capacity response value, which is 2.4796 mg Ek.vit C/100 g. While the red color indicates the highest antioxidant capacity response, which is 12.5697 mg Ek.vit C/100 g. The antioxidant properties of aloe vera herbal drinks and empon-empon can come from the aloe vera and empon-empon used, because each ingredient has compounds that act as antioxidants. Aloe vera contains flavonol compounds, such as kaempferol, quercetin and merycetin, these compounds are included in the polyphenol group which is

believed to have antioxidant properties (Sultana and Anwar, 2008). Ginger contains gingerol and shagaol compounds, these compounds have the ability as primary antioxidants against lipid radicals. While white turmeric and turmeric have curcuminoid compounds, according to Toda et al (1985) the antioxidant activity of curcuminoid components (curcumin, demethoxy curcumin and bisdemethoxy curcumin) is 20, 9 and 8 times higher, respectively than tocopherol. Galangal contains flavanol components such as galangin, kaempferol, quercetin, and mirycetin, where these components act as antioxidants.



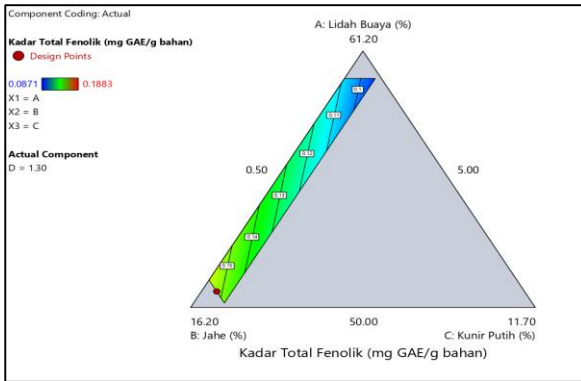
**FIGURE 5.** Grafik Countour Plot dan Gambar Tiga Dimensi Uji Respon Kapasitas Antioksidan (Sebagai Vitamin C)

### Total Phenolic Level

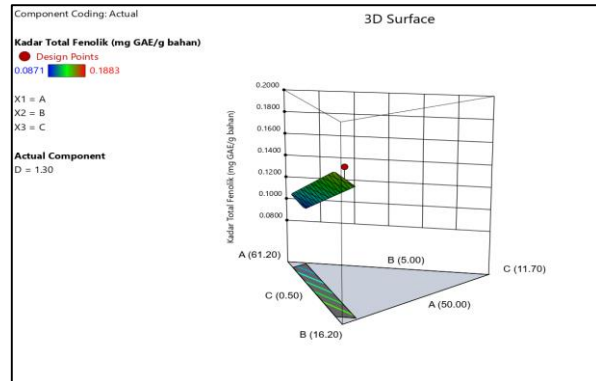
Phenolic compounds are the largest group of compounds that act as natural antioxidants in plants. Phenolic compounds have one (phenol) or more (polyphenol) phenol rings, namely hydroxy groups attached to aromatic rings so that they are easily oxidized by donating hydrogen atoms to free radicals. Its ability to form stable phenoxy radicals in oxidation reactions causes phenolic compounds to be very potential as antioxidants (Dhurhanian and Novianto, 2018). Total phenolic content in this study was assumed to be gallic acid, because the standard solution used for total phenolic response was gallic acid. The total phenolic value in this study was expressed as gallic acid equivalent (GAE) (mg/g).

Based on the test results contained in table 7, it can be seen that the total phenolic content of the 15 aloe vera herbal drink formulas ranged from 0.0871-0.1883 mg GAE/g ingredient. The largest total phenolic value was obtained from the 14th formulation with the largest composition of ginger juice, namely 15%, aloe vera 50.50%, white turmeric extract 0.5% and 2% galangal extract. The polynomial model recommended by Design Expert for total phenolic content response is linear. ANOVA results show that at the 5% level, the recommended model has a significant value, with a p value of "prob<F" less than 0.05, which is 0.0005. The contour plot graph of the response to total phenolic levels obtained from the results of research using the Mixture Design method can be seen in Figure 6.

The blue color on the contour plot shows the lowest response value for total phenolic content, which is 0.0871 mg GAE/g material. While the red color shows the response value of the highest total phenolic content, which is 0.1883 mg GAE/g material. Total phenolic levels are thought to increase with the addition of red ginger. According to Nakatani (1992) in Danthiswara et al. (2016), red ginger, emprit ginger, and elephant ginger contain oleoresin (4.0%-7.5%) and are the active chemical constituents in ginger and are known to have high antioxidant content in the form of phenolic compounds.



(a)



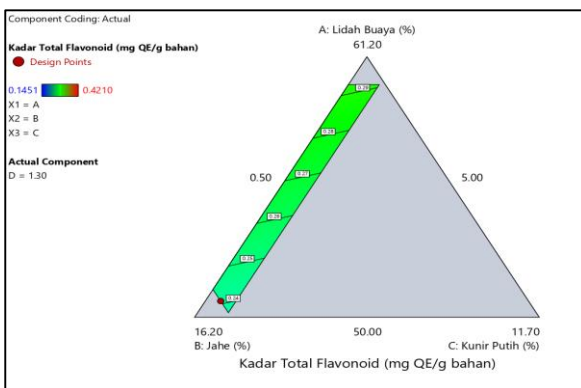
(b)

**FIGURE 6.** Grafik Countour Plot dan Gambar Tiga Dimensi Uji Respon Kadar Total Fenolik

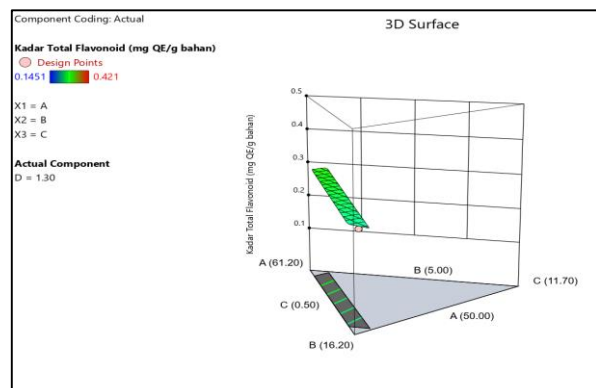
### Kadar Total Flavonoid

Total flavonoid levels are thought to increase due to the use of galangal and aloe vera. According to research by Hemzela (2006) in Rosihan (2015), the most bioactive components contained in spices, especially from the Zingiberaceae family, are flavonoids, which are the largest phenolic group. The flavonoid group is known as the flavanol group. Flavanol components that are widely distributed in plants, for example those found in galangal are galangin, kaempferol, quercetin, and myrisetin. These components are also found in aloe vera.

Based on the test results contained in table 7, it can be seen that the total flavonoid content of the 15 aloe vera herbal drink formulas ranged from 0.1451-0.4210 mg QE/g of ingredients. The highest total flavonoid value was obtained from the 6th formulation with a composition of 60% aloe vera, 5% ginger extract, 1% white turmeric extract and 2% galangal extract. The polynomial model recommended by Design Experts for the response to total flavonoid levels is quadratic. The ANOVA results show that at the 5% level, the recommended model has a significant value, with a p value of "prob<F" less than 0.05, which is 0.0001. The contour plot graph of the response to total flavonoid levels obtained from the results of research using the Mixture Design method can be seen in Figure 7.



(a)



(b)

**FIGURE 7.** Grafik Countour Plot dan Gambar Tiga Dimensi Uji Respon Kadar Total Flavonoid

### Determination of Optimal Formulation

The formula optimization process is carried out to obtain a formula with the most optimal response using a design expert. The most optimal response is obtained with a desirability value close to one (Wulandhari, 2007). The

desirability value close to one indicates that the product formula has reached the optimal formula according to the desired response variable, whereas if the desirability index is close to zero, it indicates that the formulation is difficult to reach the optimal point based on the response variable (Wahyudi, 2012). The optimized components, target values, limits, and importance at the formula optimization stage using the Design Expert 13 program can be seen in Table 7.

**TABLE 7.** Komponen dan Respon yang Dioptimasi, Target, Batas, dan Importance pada Tahapan Optimasi Formula

| Nama komponen/respon   | Sasaran         | Batas Bawah | Batas Atas | Importance |
|------------------------|-----------------|-------------|------------|------------|
| Lidah Buaya            | <i>In range</i> | 50          | 60         | 3 (+++)    |
| Sari Jahe              | <i>In range</i> | 5           | 15         | 3 (+++)    |
| Sari Kunir Putih       | <i>In range</i> | 0,5         | 1,5        | 3 (+++)    |
| Sari Lengkuas          | <i>In range</i> | 0,5         | 2          | 3 (+++)    |
| Viskositas             | <i>Minimize</i> | 141         | 706        | 3 (+++)    |
| Total padatan terlarut | <i>Maximize</i> | 14,60       | 17,35      | 3 (+++)    |
| Densitas               | <i>Minimize</i> | 1,0630      | 1,0743     | 3 (+++)    |
| pH                     | <i>Maximize</i> | 4,452       | 4,636      | 3 (+++)    |
| Kapasitas Antioksidan  | <i>Maximize</i> | 2,4796      | 12,5697    | 5 (+++++)  |
| Kadar Total Fenol      | <i>Maximize</i> | 0,0871      | 0,1883     | 5 (+++++)  |
| Kadar Total Flavonoid  | <i>Maximize</i> | 0,1451      | 0,4210     | 5 (+++++)  |

The response of antioxidant capacity, total phenolic content and total flavonoid content were given importance 5, this is because vitamin C, phenolic compounds and flavonoid compounds have antioxidant properties, and antioxidant properties are important functional properties of a functional food product, especially herbal drinks. In addition, the high antioxidant content is a characteristic of an empon-empon (spice). From the optimization stage that has been carried out, the Design Expert 13 program recommends an optimum formula solution which can be seen in Table 8

**TABLE 8.** Formula Optimum Hasil Optimasi Program

| Lidah Buaya (%) | Sari Jahe (%) | Sari Kunir Putih (%) | Sari Lengkuas (%) | Desirability |
|-----------------|---------------|----------------------|-------------------|--------------|
| 52,92           | 11,58         | 1,50                 | 2,00              | 0,585        |

The optimum formula solution resulting from the Design Expert program optimization has a desirability value of 0.585, which means that the formula will produce a product that has characteristics in accordance with the optimization target of 58.50%.

## Optimal Formula Verifivation

Verification of the optimal formula is carried out to determine the actual value of the optimum formula so that it can be compared with the predictions given by the Design Expert 13 program. The results of prediction and verification of formulas for making aloe vera herbal drinks and empon-empon can be seen in table 9.

Tabel 9. Hasil Prediksi dan Verifikasi Formula Minuman Herbal Lidah Buaya dan Empon-Empon

| <b>TABLE 9.</b> Hasil Prediksi dan Verifikasi Formula Minuman Herbal Lidah Buaya dan Empon-Empon |          |            |                   |                    |
|--------------------------------------------------------------------------------------------------|----------|------------|-------------------|--------------------|
| Respon                                                                                           | Hasil    |            | 95% <i>PI low</i> | 95% <i>PI high</i> |
|                                                                                                  | Prediksi | Verifikasi |                   |                    |
| Viskositas                                                                                       | 186,6    | 161        | 107,5             | 265,8              |
| Total padatan terlarut                                                                           | 16,64    | 16,80      | 15,98             | 17,30              |
| Densitas                                                                                         | 1,0662   | 1,0658     | 1,0637            | 1,0687             |
| pH                                                                                               | 4,541    | 4,502      | 4,483             | 4,599              |
| Kapasitas antioksidan                                                                            | 6,5495   | 7,4638     | 3,8078            | 9,2912             |
| Kadar total fenolik                                                                              | 0,1309   | 0,1314     | 0,0993            | 0,1624             |
| Kadar total flavonoid                                                                            | 0,3513   | 0,3315     | 0,3087            | 0,3938             |

Based on the results of the formula verification that has been carried out, it can be seen that the data from the verification results are still in accordance with the predictions made by the Design Expert 13 program. This is indicated by the response value of viscosity, total dissolved solids, density, pH, antioxidant capacity (as vitamin C). , total phenolic content and total flavonoid content met the 95% Prediction Interval (PI) predicted by the Design Expert 13 program. The results of the color response analysis in the selected optimum formula obtained an L value of 61.496, a value of -1.778, and a value of -b of - 2,006.

### Mass Balance

In any system, the amount of matter will remain constant even if there is a change in form or physical state. Therefore, in a processing process, the amount of incoming material will be equal to the amount of material that comes out as the desired product plus the amount lost or by-products. Determination of the mass balance in this study aims to determine the amount of incoming and outgoing materials and to determine the efficiency in the process of making the herbal drink (Wirakarkusumah, 1989).

The overall calculation of the mass balance above shows that from 3500 grams of aloe vera, it can produce as much as 1895 grams of aloe vera. The base of the aloe vera herbal drink and the empon-empon to be made is 3000 grams with 55% aloe vera, therefore the aloe vera meat is weighed back as much as 1650 grams. Aloe vera herbal drink and empon-empon produced based on the formula from the verification process (table 1) is as much as 2535 grams.

**TABLE 10.** Neraca Massa Proses Pembuatan Minuman Herbal Lidah Buaya dan Empon-Empon

| Proses                       | Input                             |           |     | Output                                     |           |       | By Product                     |           |       |
|------------------------------|-----------------------------------|-----------|-----|--------------------------------------------|-----------|-------|--------------------------------|-----------|-------|
|                              | Bahan                             | Bobot (g) | %   | Bahan                                      | Bobot (g) | %     | Bahan                          | Bobot (g) | %     |
| Pengupasan                   | Lidah Buaya                       | 3500      | 100 | daging lidah buaya                         | 1890      | 54    | Kulit lidah buaya              | 1610      | 46    |
| Pencucian                    | daging lidah buaya                | 1890      | 100 | daging lidah buaya bersih                  | 1895      | 38,75 | Air kotor                      | 2995      | 61,25 |
| Penimbangan                  | Air Bersih                        | 3000      | 100 |                                            |           |       |                                |           |       |
|                              | daging lidah buaya bersih         | 1895      | 100 | daging lidah buaya bersih timbang          | 1650      | 87,07 | daging lidah buaya bersih sisa | 245       | 12,93 |
| Penghancuran                 | daging lidah buaya bersih timbang | 1650      | 100 | Bubur lidah buaya                          | 2097,6    | 100   | -                              | -         | -     |
| Pencampuran dan pasteurisasi | Air bersih                        | 447       |     |                                            |           |       |                                |           |       |
|                              | CMC                               | 0,6       |     |                                            |           |       |                                |           |       |
|                              | bubur lidah buaya                 | 2097,6    | 100 | minuman herbal lidah buaya dan empon-empon | 2500      | 83,33 | Uap air                        | 500       | 16,67 |
|                              | Gula pasir                        | 300       |     |                                            |           |       |                                |           |       |
|                              | sari kunyit                       | 60        |     |                                            |           |       |                                |           |       |
|                              | sari jahe                         | 300       |     |                                            |           |       |                                |           |       |
|                              | sari kunir putih                  | 60        |     |                                            |           |       |                                |           |       |
|                              | sari lengkuas                     | 30        |     |                                            |           |       |                                |           |       |
|                              | Madu                              | 150       |     |                                            |           |       |                                |           |       |
|                              | asam sitrat                       | 0,9       |     |                                            |           |       |                                |           |       |

|            |                                            |      |     |                                                  |      |     |   |   |   |
|------------|--------------------------------------------|------|-----|--------------------------------------------------|------|-----|---|---|---|
|            | garam                                      | 0,9  |     |                                                  |      |     |   |   |   |
|            | Na-benzoat                                 | 0,6  |     |                                                  |      |     |   |   |   |
| Pengemasan | minuman herbal lidah buaya dan empon-empon | 2500 | 100 | minuman herbal lidah buaya dan empon-empon kemas | 2500 | 100 | - | - | - |

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## CONCLUSION

The results of the optimization of the formula of aloe vera and empon-empon herbal drinks using the Design Expert 13 program obtained a desirability value of 0.585 consisting of 52.92% aloe vera, 11.58% ginger juice, 1.50% white turmeric extract, and galangal juice. 2.00%. The results of the main verification analysis of the optimal formulation predicted by the Design Expert 13 program, namely the viscosity value of 161 cP, the total dissolved solids value of 16.80%, the density value of 1.0658 g/cm<sup>3</sup>, the pH value of 4.502, the antioxidant capacity value of 7.4638 mg of Vitamin C/100 g of ingredients, total phenolic content of 0.1314 mg GAE/g of ingredients, and total flavonoid content of 0.3315 mg QE/g of ingredients. For all responses meet 95% PI low and 95% PI high. The results of the color response analysis in the selected optimal formulation obtained an L value of 61,496, a value of -1,778, and a value of -2,006 b.

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## REFERENCES

1. Astutik Pudjirahaju. 2017. **Pengawasan Mutu Pangan**. Pusat Pendidikan Sumber Daya Manusia Kesehatan. Kementerian Kesehatan Republik Indonesia
2. Azizah, D.N. dan Faramayuda, F., 2014. Penetapan Kadar Flavonoid Metode AlCl<sub>3</sub> Pada Ekstrak Metanol Kulit Buah Kakao (*Theobroma Cacao L.*). *Kartika Jurnal Ilmiah Farmasi*, 2(2).
3. Baratawidjaja, K. 1996. **Imunologi Dasar**. Edisi ke 3. Balai Penerbit Fakultas Kedokteran Universitas Indonesia. Jakarta.
4. Belitz, H.D.W. Grosch, and P. Schieberle. 2009. **Food Chemistry 4th revised and extended Edition**. Verlag Berlin Heidelberg : Springer
5. Bruice, P. Y. 2003. Organic Chemistry. Prentice Hall, New York.
6. Chasparinda, M., E., Andriani, M., A., M., dan Kawiji. 2014. Pengaruh Penambahan Jahe (*Zingiber Officinale. R*) Terhadap Karakteristik Fisikokimia dan Organoleptik Sari Buah Bit (*B Vulgaris L.*). *Jurnal Teknosains Pangan*. 3 (2).
7. Danthiswara Gelgel, Kadek., Yusa, Ni Made., Mayun Permana, I Dewa Gede. Kajian Pengaruh Jenis Jahe (*Zingiber Officinale Rosc.*) Dan Waktu Pengeringan Daun Terhadap Kapasitas Antioksidan Serta Sensoris Wedang Uwuh. **Jurnal Ilmu Dan Teknologi Pangan (ITEPA)**, [S.L.]. 5(2). p. 11-19.
8. Dhurhanian, E dan Novianto, A. 2018. Uji Kandungan Fenolik Total dan Pengaruhnya terhadap Aktivitas Antioksidan dari Berbagai Bentuk Sediaan Sarang Semut (*Myrmecodia pendens*). *Jurnal Farmasi dan Ilmu Kefarmasian Indonesia*. 5 (2): 62-68.
9. Engelen, Adnan. 2018. Analisis Kekerasan, Kadar Air, Warna Dan Sifat Sensori Padapembuatan Keripik Daun Kelor. *Journal Of Agritech Science*. 2(1). p. 10-15.

10. Fardiaz D. 1997. **Makanan fungsional dan pengembangannya melalui makanan tradisional**. Prosiding pada Seminar Nasional Teknologi Pangan, Denpasar, Bali, 16 – 17 Juli.
11. Farikha, IN, Anam, C dan Widowati, E. 2013. Pengaruh jenis dan konsentrasi bahan penstabil alami terhadap karakteristik fisikokimia sari buah naga merah (*Hylocereus polyrhizus*) selama penyimpanan.. J. Teknosains Pangan, vol 2, no. 1, hlm. 30-8.
12. Hidayah, I.N., dan Indradi, R.B. 2020. **Aktivitas Imunomodulator Beberapa Tanaman Dari Suku Zingiberaceae**. *Jurnal Kesehatan Bakti Tunas Husada : Jurnal Ilmu Keperawatan, Analis Kesehatan Dan Farmasi*. 20(2). p 181-193.
13. IB. Ketut Widnyana Yoga. 2015. Penentuan Konsentrasi Optimum Kurva Standar Antioksidan; Asam Galat, Asam Askorbat dan Trolox terhadap Radikal Bebas DPPH (2,2-diphenyl-1-picrylhydrazyl) 0,1 mM. Prosiding Seminar Nasional FMIPA. Bali : Universitas Udayana
14. Ibrahim, A.M., Yuniarta., Sriherfyna, F.H. 2015. Pengaruh Suhu Dan Lama Waktu Ekstraksi Terhadap Sifat Kimia Dan Fisik Pada Pembuatan Minuman Sari Jahe Merah (*Zingiber officinale var. Rubrum*) Dengan Kombinasi Penambahan Madu Sebagai Pemanis. *Jurnal Pangan dan Agroindustri*. 3(2). p.530-541
15. Indriati, I.L, Cahyani, A, dan Harismah, K. 2019. Formulasi Gel Lidah Buaya Dengan Bahan Tambahan Minyak Cengkeh Sebagai *Hand Sanitizer*. *Edusaintek*. 3 : 359-364
16. Kementerian Kesehatan. 2020. **Pusat Data dan Informasi Covid-19**. Diambil dari <https://www.kemkes.go.id/folder/view/full-content/structure-faq.html>. (Diakses 8 Juni 2021).
17. Kikuzaki, H., Nakatani, N. 1993. **Antioxidant Effect Of Some Ginger Constituents**. *Journal of food*. 58(6).
18. Molyneux, P. 2004, The Use of The Stable Free Radical Diphenylpicryl-hydrazyl (DPPH) for Estimating Antioxidant Activity. *Songklanakarin J. Sci. Technol*. 26(2), 211-219
19. Njoya, E.M. Medicinal Plants, Antioxidant Potential, and Cancer. In book: Cancer (pp.349-357)
20. Parwata, I Made Oka Adi. 2016. **Diktat/ Bahan Ajar Kimia Organik Bahan Alam**. Fakultas Matematika dan Ilmu Pengetahuan Alam Universita Udayana Denpasar.
21. Pujimulyani, D. dan Sutardi. 2003. **Curcuminoid Content And Antioxidative Properties On White Saffron Extract (*Curcuma manga Val.*)**. Proceeding International Conference on Redesigning Sustainable Development on Food and Agricultural System for Developing Countries, September 17-18. 2003. Yogyakarta-Indonesia
22. Puspitasari, D. 2015. Kunyit Sebagai Pewarna Alternatif Pewarnaan Tulang Embrio Ayam (*Gallus-gallus*). <http://ejurnalunesa.ac.id/index.php/bioedu>. 4(1).
23. Rauf *et al.* 2006. Efek Imunostimulan Fraksi Daun Katuk (*Sauropus androgynus* L. Merr.) Terhadap Aktivitas Dan Kapasitas Fagositosis Makrofag Pada Mencit Jantan (*Mus Musculus*). *Jurnal Farmasi*. 4(1). P. 9-15.
24. Reddy, D. Mahidhar, Sk. Razia Begum, K.Jyothirmmai, G.V. Dileep Kumar, S. Jayasree, J. Jeevankumar, A.V.S. Gita Samira. 2013. **A Novel Review on Natural Polymers Used In Formulation of Pharmaceutical Dosage Forms**. *Int. J. Pharm Natural. Med*. 1(1). 71-78.
25. Rosihan, R. 2015. **Efikasi Ekstrak Lengkuas Pada Mikroba Indigenous Buah Salak (*Salacca edulis* Reinw.)**. Skripsi. Fakultas Sains dan Teknologi. Universitas Islam Negeri Syarif Hidayatullah, Jakarta
26. Sultana, B., dan Anwar, F. 2008. Flavonol (*kaempferol*, *quercetin*, *merycetin*) Contents Of Selected Fruits, Vegetables And Medicinal Plants. *Food Chemistry*. 108:879 – 884.
27. Supriati, Y. 2016. Keanekaragaman Iles-Iles (*Amorphophallus* spp.) dan Potensinya untuk Industri Pangan Fungsional, Kosmetik, dan Bioetanol. *Jurnal Litbang Pertanian*. 35 (2): 69-80.
28. Susmawati. 2019. **Jenis Empon-Empon Dan Khasiatnya Untuk Meningkatkan Imun Tubuh**. Diambil dari <http://bbppbinuang.bppsdp.pertanian.go.id/blog/post/jenis-empon-empon-dan-khasiatnya-untuk-meningkatkan-imun-tubuh>. (Diakses 8 Juni 2021).
29. Wang, W and A. Johnson. 2006. Konjac Introduction. Textural and rheological properties of hydrolyzed Konjac Glucomannan and Kappa- Carrageenan: Effect of molecular weight, total content, pH and temperature on the mixed system gels. *Journal of Food Science and Technology*. School of Food Science and Technology, Jiangnan University, Wuxi. China
30. Wiedosari E. 2007. Peranan Imunomodulator Alami (*Aloe vera*) Dalam Imunitas Seluler dan Humoral. *ARTAZOA*.17(4);165-171
31. Winarno, F.G. 2008. **Kimia Pangan dan Gizi**. Gramedia Pustaka Utama. Jakarta
32. Yusibani, E *et al.* 2017. **Pengukuran Viskositas Beberapa Produk Minyak Goreng Kelapa Sawit Setelah Pemanasan**. *Jurnal Teknologi dan Industri Pertanian Indonesia*. 9(1).