Original Article
Food Science and Technology
ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)

DOI: https://doi.org/10.1590/fst.69022

Optimization of herbal tea drink formula based on aloe vera rind (*Aloe barbadensis miller*)

SRIHARTI[1]*, Raden Cecep Erwan ANDRIANSYAH[1], Wawan AGUSTINA[1], Ashri INDRIATI[1]*,
Christina LITAAY[1], Rohmah LUTHFIYANTI[1], Nur Kartika Indah MAYASTI[1], Agus TRIYONO[1],
Raden Ismu TRIBOWO[1], Pradeka Brilyan PURWANDOKO[1]

Abstract

Aloe vera rind contains antioxidant active components that can be used as raw materials for making herbal teas. The purpose of this study was to obtain the optimal formula for making herbal tea drinks made from aloe vera rind with a mixture of mint leaves and cinnamon by using the Expert Design 12 program with the D-optimal Mixture method. The formulations studied were obtained from the upper and lower limits of each raw material, so 16 formulas were obtained. Each quality formula was tested chemically and physically (lightness, antioxidant activity) and organoleptic (taste, color, odor, and overall), then the optimization stage was carried out to obtain the most optimal formula by determining the desired response value criteria. The optimal formula of herbal tea that has been selected by the Design Expert program with the Mixture D-optimal method with component proportions of 65,79% aloe vera rind, 30% mint leaf, and 4,21% cinnamon, has a desirability value of 0.604. Herbal tea has a green color, with a strong odor and a non-bitter taste.

Keywords: aloe vera rind; design expert; herbal tea; mint leaves.

Practical Application: The research results can be applied to the herbal beverage industry, especially the tea industry. a new innovation that is presented by optimizing the antioxidant content, color and acceptance of herbal tea products by utilizing aloe vera rind with mint leaves and cinnamon added.

1 Introduction

Aloe vera (*Aloe vera badensis*) is a tropical agricultural plant that has the potential to be developed as an agro-industry business. According to statistical data on biopharmaceutical production, the production of aloe vera in Indonesia in 2020 amounted to 21.704.984 kg, with the largest production being in the province of West Kalimantan with a total production of 20.307.634 kg (Badan Pusat Statistik, 2021).

Aloe vera leaves are widely developed into various processed food and beverage products, medical/pharmaceutical, cosmetics, and other processing (Mogaddasi & Verma, 2011; Pegu & Sharma, 2019). In the aloe vera processing industry, the gel from aloe vera is used (Hossain et al., 2013), so that it produces solid waste in the form of abundant rind and has not been used optimally.

Aloe vera leaves consist of three layers namely a hard green outer rind, covered with very thick cuticle, inner jelly like parenchym known as aloe vera gel, and a thin layer of latex beneath the rind (Cheng et al., 2014).

The rind section produces carbohydrates, fats, proteins, and vitamins and contains calcium oxalate crystals and magnesium lactate crystals (Sianturi, 2019), anthraquinones/anthrones, chromones, phytosterols and phenolics (Larasati, 2020).

Lakshmi & Rajalakshmi (2011) and López et al. (2013) reported that aloe vera rind has antioxidant activity, it also contains aloin and saponin compounds which are bitter components (Choi et al., 2015). Aloin can act as an antioxidant but can harm health if used excessively (Adushan, 2008). Yanuartono et al. (2017) reported that saponins can cause antinutritional and toxic effects.

The results of phytochemical screening showed that aloe vera rind was rich in alkaloids, tannins, flavonoids, sterols, triterpenes, mucus, oses, holosides, and metabolite reducing compounds (Mahadi, 2019). Benzidia et al. (2019) stated that aloe vera rind contains palmitic acid (11.91%), E-phytol (14.40%), linolenic acid (16.59%), diisooctylphtalate (11.84%). Therefore, aloe vera rind can be used as raw material for herbal tea drinks, but it has a bitter taste, unpleasant smell, and pale color, so it is necessary to add other ingredients such as peppermint leaves and cinnamon.

Peppermint leaves (*Mentha piperita* L.) have a fragrant smell and refreshing cold taste because they contain essential oils in the form of menthol oil (73.7-85.8%), menthone, and methyl acetate, high in resin and tannins which are polyphenol-type antioxidants. prevent or neutralize the effects of free radicals (Apriliyani et al., 2021). Cinnamon (*Cinnamomum burmanii*) contains essential oils, cinnamic, coumarin, cinnamic acid, cinnamaldehyde, anthocyanins, flavonoids, phenolic compounds, tannins, calcium oxalate, aromatic aldehyde compounds (Emilda, 2018).

Formulation development is very important so that it can produce food products that can be accepted by the community. The presence of admixtures used in the formulation of aloe vera

Received 28 May, 2022
Accepted 19 July, 2022
[1] *Research Center for Appropriate Technology, Indonesian Institute of Sciences, Subang, West Java, Indonesia*
*Corresponding author: srihartitriyasa@gmail.com; ashriindriati@gmail.com

rind functional drinks can affect the characteristics of the resulting product. One of the software that can be used in determining the optimal formulation of functional drinks from aloe vera rind is the Design Expert D-optimal mixture method. Design Expert is used for process optimization (Ramadhani et al., 2017). The main response is caused by several variables and the goal is to optimize the response.

2 Materials and methods

2.1 Materials

The raw material used in this research is aloe vera rind (*Aloe barbarensis* Miller) which is a waste from processing aloegin herbal drinks. Additional ingredients used are mint leaves (*Mentha piperita* L) to add flavor to the tea and cinnamon (*Cinnamomum burmanii*) to add to the smell of herbal tea.

2.2 Methods

The process for making aloe vera rind tea drink

Aloe vera rind waste from taking aloe vera gel is sorted, then cut. The pieces were washed with running water to remove the mucus that was still attached, then soaked in a 5% salt solution for 30 min to remove anti-nutrients. The results of the soak are washed with running water until the aloe vera rind does not taste salty, then drained. Slices of aloe vera rind were blanched at 70 °C for 5 min. Aloe vera rind is dried using a cabinet dryer at a temperature of 60 °C, for 16 h, until it reaches a moisture content below 8%, this is based on the results of research by Satriadi et al. (2015) 60 °C is the best temperature that produces the highest antioxidant activity. The dried aloe vera rind is then ground using a blender, then mixed with dried mint leaves and cinnamon powder.

Formulation design and response

The design of the formulation and response was carried out using the Design Expert 12 mixture D-optimal program. The determination of the minimum and maximum percentage of independent variables was obtained from previous research studies using trial error (Table 1).

The response design that was measured and optimized for herbal teas included physical-chemical responses including color, antioxidant activity, and organoleptic responses.

2.3 Color analysis

The color was tested by using Chromameter CSCQ 3 parameters observed Lightness. The analysis was carried out in three replicates of the analysis on spots taken randomly from the sample. The measurement results are expressed in CIE LAB with a value of 0 = black, 100 = white (Sharma et al., 2011).

Table 1. The determination of the minimum and maximum percentages of independent variables.

Component	Minimum Limit (%)	Maximum Limit (%)
Aloe vera rind	62	80
Mint leaves	12	30
Cinnamon	4	8

2.4 Antioxidant activity analysis

Antioxidant activity was analyzed using the DPPH (1,1-diphenyl-2picrylhydrazil) method carried out by Khan et al. (2012). A total of 4 ml of DPPH (0.004% w/v in ethanol) was dissolved with 1 mL of the sample in a test tube. The solution was vortexed and incubated for 30 min in the dark at room temperature, then the absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm. The readings were compared with the standard curve of vitamin C with concentrations of 2, 4, 8, 10, and 25 ppm. The antioxidant activity of the sample was expressed as Vitamin C equivalent in mg Eq.Vit.C/100 g extract.

2.5 Organoleptic quality

Organoleptic quality was determined by performing a scoring test. The assessment was carried out by 30 untrained panelists covering taste, smell, color, and overall with a score ranging from 1 to 6 (dislike very much to like very much).

2.6 Formulation optimization

The results of the analysis of each response are then used to optimize the formula with the Design Expert 12.0 program. The optimization process is carried out to obtain a formula that produces an optimal response according to the desired optimization target. In optimization, the important test components will be determined so that a solution formula will be obtained which will be selected based on the highest degree of desirability. The optimization target value that can be achieved is known as the desirability value which is indicated by a value of 0-1. The higher the desirability value, the higher the suitability of the herbal tea formula obtained to achieve the optimal formula with the desired response variable.

3 Result and discussion

3.1 The result of the formulation of aloe vera rind tea with the addition of mint leaves and cinnamon

The formulation of aloe vera rind herbal tea drink with a mixture of mint leaves and cinnamon based on the Design Expert Program with the Mixture D-optimal method obtained 16 formulas, as can be seen in Table 2.

3.2 Agreement between model prediction to the observed value

Statistical analysis parameters of the Fisher test value (F-value), a p-value of a model, a p-value of lack of fit, coefficient of determination (R^2), the coefficient of determination (Adjusted R^2), predicted R^2, adequate precision of the model parameters and CV% obtained from the analysis of variance (ANOVA) were used for evaluation of the agreement of fit in models. Fitted polynomial models were applied for the optimization of production conditions. Statistical analysis of variance of the model parameters was set at 5% (p-value,0.05). Table 3 shows the parameter estimates and analysis of variance in the response model.

From Table 3, it is obtained that the p-value of almost all responses is lower than 0.05 which indicates the high significance of the regression model and can be used to optimize the variables. The quality of the fittings for the selected models was confirmed by the high values achieved for the coefficient of determination (R2) obtained from differences in lightness, antioxidant activity, color, taste, odor, and overall sensory tests. The lack of fit for all responses is not significant relative to the pure error. The differences between the adjusted coefficient (Adj R2) and predicted coefficient (Pred R2) are less than 0.2 for all responses, except for the water content. It indicates that the prediction R2 is in reasonable agreement with the adjusted R2 and the values of adequate precision for all reactions are higher than 4, demonstrating a proper signal.

3.3 Lightness response analysis

The results of the analysis of variance (ANOVA) conducted by Design Expert 12 at a significance level of 5% indicate that the resulting model is linearly insignificant with a p-value of "prob > F" greater than 0.05, which is 0.7285, which means that the 16 formulations tested do not affect the lightness of herbal tea, because the addition of cinnamon in small amounts does not affect the color of the formulation. The average value of Lightness is 67.55 with a standard deviation of 0.0229.

Table 2. Formulation results of aloe vera rind tea drink with the addition of mint leaves and cinnamon with expert design.

Formulation	Aloe vera rind (%)	Mint leaves (%)	Cinnamon (%)
F1	68.52	24.48	8
F2	70.64	25.36	4
F3	67.10	28.90	4
F4	74.03	17.97	8
F5	72.79	21.46	5.75
F6	72.79	21.46	5.75
F7	72.79	21.46	5.75
F8	80	12.59	7.41
F9	76.79	19.21	4
F10	80	12.50	7.41
F11	63.40	30	6.60
F12	72.79	21.46	5.74
F13	77.36	15.61	7.03
F14	65.55	26.44	8
F15	80	16	4
F16	63.40	30	6.60

The residual plot graph (Figure 1) illustrates the relationship between the combined use of aloe vera rind, mint leaf, and cinnamon with the resulting Lightness response value. The red section of the graph shows the highest response of 67.644 (72.79% on aloe vera rind, 21.46% mint leaf, and 5.75% cinnamon), while the blue graph shows the lowest response of 67.485 (aloe vera rind 63.40%, mint leaves 30%, and cinnamon 6.60%). The points that are located have the same color, have the same response even with different combinations.

3.4 Antioxidant activity response analysis

Antioxidants are compounds that can delay and slow down oxidation reactions by binding or counteracting free radicals (Hęś et al., 2019). Free radicals are the compounds formed in the cell as a result of normal metabolic processes, environmental factors and foods consumed (Guldas et al., 2021). Free radicals, are oxidized to produce ROS (Reactive Oxygen Species) and RNS (Reactive Nitrogen Species) that cause DNA denaturation, lipid peroxidation, protein inactivation, and other cell dysfunction. It causes cancer, diabetes, cardiovascular, atherosclerosis, aging, inflammation, carcinogenesis, and atherosclerosis and Parkinson's disease (Byun et al., 2021; Seon et al., 2021). The antioxidant activity related to flavonoids such as quercetin, flavones, isoflavones, flavonones, anthocyanins, catechins and isocatechins, and the phenolics may participate together with the flavonoids in determining the antioxidant activities (Gregório et al., 2021). Antioxidants are needed to ward off free radicals and prevent various diseases. Antioxidant compounds can bind to other metabolites such as proteins, fats, and carbohydrates to form stable complex compounds, thereby inhibiting mutagenesis and carcinogenesis (Mukhopadiay, 2000 in Kusumaningrum et al., 2013). Antioxidants are very easily oxidized, so free radicals will oxidize antioxidants and protect other molecules in cells from damage due to oxidation by free radicals or reactive oxygen (Wherdasari, 2014). Antioxidants are substances that can neutralize free radicals, so they can protect biological systems from harmful effects arising from processes or reactions that cause excessive oxidation (Satriadi et al., 2015).

The results of the analysis of variance (ANOVA) conducted by the Design Expert 12 program at a significance level of 5% showed that the antioxidant activity of the aloe vera rind tea model produced was significant with a p-value of "prob > F" less than 0.05, which is 0.0014, which means that the 16 formulations used tested to have a significant effect on antioxidant activity. The average value of the antioxidant activity test was 266.11 mg Eq.Vit.C/100 g material, with a standard deviation of 6.69 mg Eq.Vit.C/100 g material.

Table 3. The parameter estimates and analysis of variance the response model.

Response	p-value of model	p-value lack of fit	R^2	Adjusted R^2	Predicted R^2	Adequate precision
Lightness	0.7285	0.2200	0.7424	0.5359	0.3422	4.4485
Antioxidant activity	0.0014	0.4360	0.9372	0.8654	6.7783	9.4917
Color	0.0108	0.9332	0.8984	0.7461	0.6575	9.5065
Odor	0.0186	0.8182	0.8622	0.7047	0.5893	6.3460
Taste	0.0105	0.8096	0.8773	0.7371	0.6006	6.7952
Overall	0.0140	0.3498	0.8740	0.7301	0.5429	9.3913

The residual plot graph (Figure 2) illustrates the relationship between the combination of the use of aloe vera rind, mint leaf, and cinnamon with the resulting antioxidant activity response value.

The red part of the graph shows the highest response of 263.705 mgEq. Vit C/100 g of ingredients (77.36% aloe vera rind, 15.61% mint leaf, and 7.03% cinnamon), while the blue chart shows the lowest response. of 243.58 mg Eq.Vit C/100 g ingredients (72.79% aloe vera rind, 21.46% mint leaves, and 5.74%). Chemical compounds that play a role in antioxidant activity on aloe vera rind are aloin and anthraquinone (Tensiska et al., 2017). The points that are close along the normal line, have the same color, have the same response even with different combinations.

3.5 Color, odor, taste, and overall organoleptic response analysis

The results of the analysis of variance (ANOVA) conducted by the Design Expert 12 program at a significance level of 5% showed that the organoleptic response of the aloe vera rind tea color, odor, taste and overall model produced was linearly significant with a p-value of "prob > F" less than 0.05, each of 0.0108, 0.0186, 0.0105 and 0.0140 which means that the 16 formulations tested have a significant effect on the color, odor, taste, and overall organoleptic response. The average value of the color organoleptic response test is 4.24 with the criteria of slightly liking, the standard deviation of 0.179, the odor organoleptic response test is 3.82 with the criteria of slightly liking, the standard deviation of 0.173, the taste organoleptic response test was 3.54 with the criteria of slightly liking, the standard deviation of 0.2105. The taste organoleptic response test was 3.54 with the criteria of slightly liking, the standard deviation of 0.2105, and the overall organoleptic response test is 3.85 with the criteria of slightly liking, the standard deviation of 0.237.

The residual plot graph (Figures 3-6) illustrates the relationship between the combination of the use of aloe vera rind, mint leaves, and cinnamon with the resulting color response value.

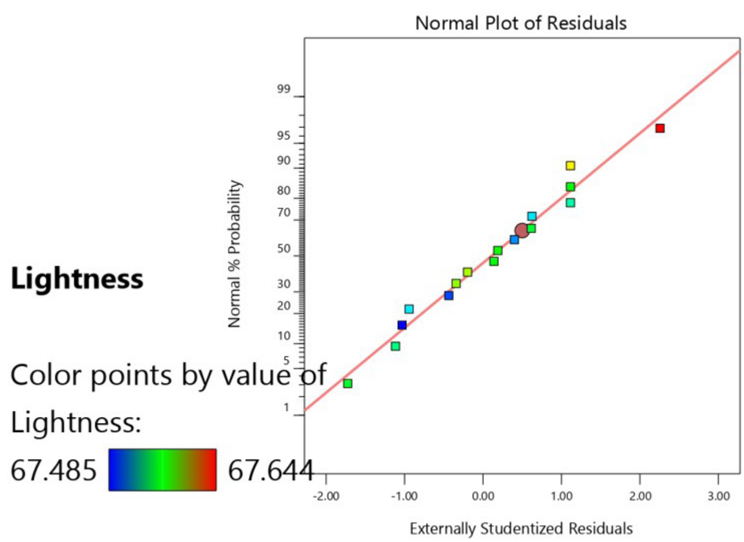

Figure 1. Normal graph plot of residual response Lightness.

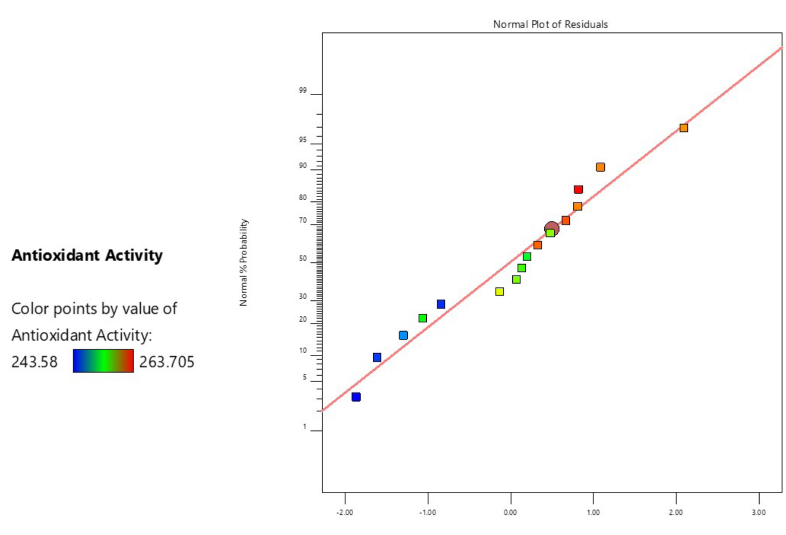

Figure 2. Normal graph plot of residual antioxidant activity response.

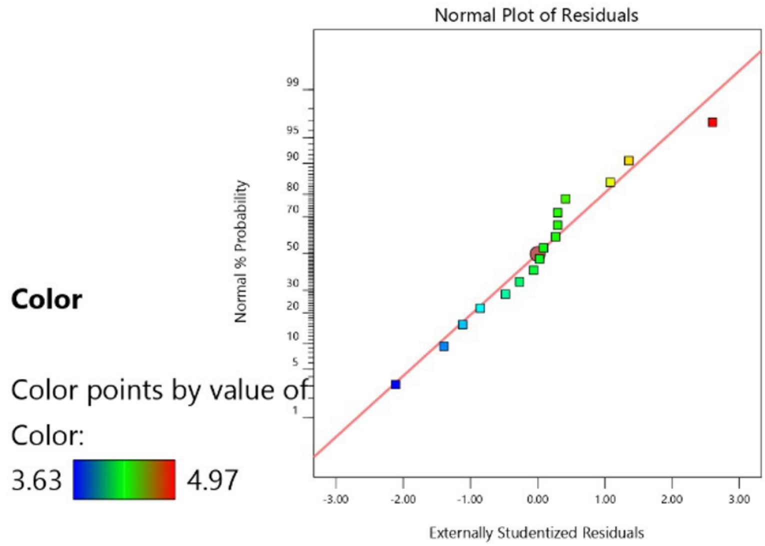

Figure 3. Normal graph plot of residual color organoleptic response.

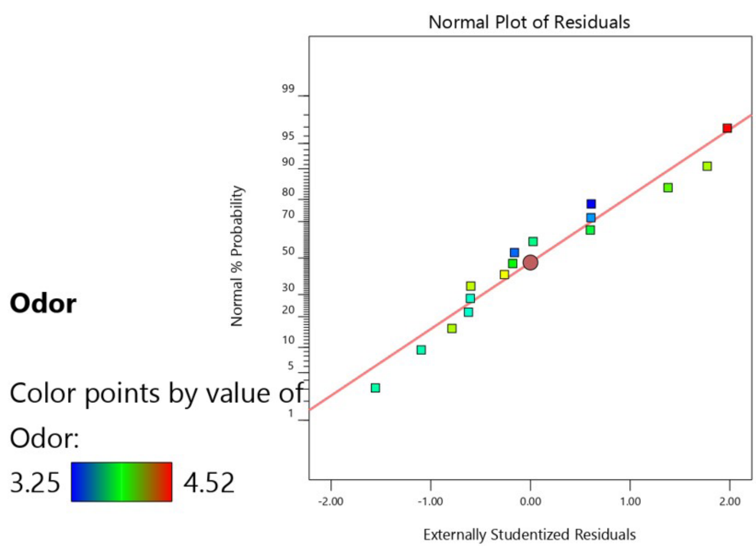

Figure 4. Graph of a normal plot of residual odor organoleptic response.

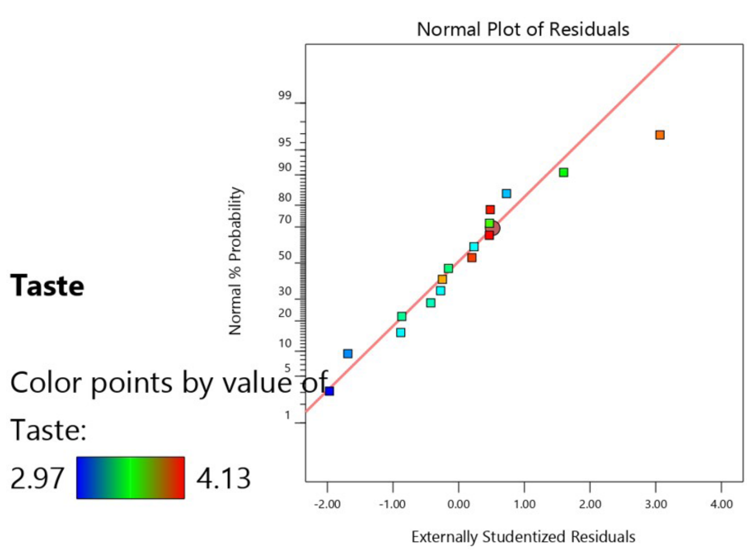

Figure 5. Graph of a normal plot of residual taste organoleptic response.

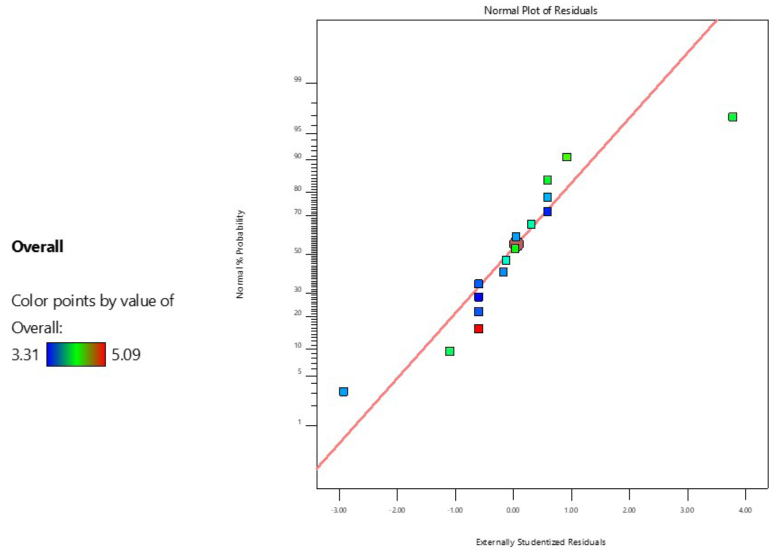

Figure 6. Graph of a normal plot of residual overall organoleptic response.

The red part of the graph (Figure 3) shows the highest response of 4.97 with the criteria of liking (in the combination of aloe vera rind, mint leaves, and cinnamon, respectively 77.36%, 15.61%, and 7.03%), while The blue color indicates the lowest response of 3.63 with the criteria of slightly liking (in the combination of aloe vera rind, mint leaves, and cinnamon, 74.03%, 17.97%, and 8%, respectively). Greenish herbal tea is derived from chlorophyll contained in aloe vera rind and mint leaves.

The points are close along the normal line, so it can be said that the data for the organoleptic response to odor spread normally. The data for the organoleptic response of odors that spread normally indicate that the model fulfills the assumptions of ANOVA on the response of organoleptic odors. The red part of the graph (Figure 4) shows the highest response of 4.52 with the criteria of liking (in the combination of aloe vera rind, mint leaves, and cinnamon, 72.79%, 21.46%, and 5.75%, respectively), while The blue color indicates the lowest response of 3.25 with the criteria of mild dislike (in the combination of aloe vera rind, mint leaf and cinnamon, 76.79%, 19.21%, and 4%). The odor of herbal tea is influenced by 2-pentyl furan which is an aromatic compound formed from 4-keto-nonanoic acid which causes an unpleasant odor on aloe vera rind (Tensiska et al., 2017).

Figure 5 shows that the red part of the graph shows the highest response of 4.13 with the criteria of slightly liking (in the combination of aloe vera rind, mint leaves, and cinnamon 72.79%, 21.46%, and 5.8%), respectively, while the colored graph blue showed the lowest response of 2.97 with the criteria of mild dislike (in the combination of aloe vera rind, mint leaves and cinnamon, 76.79%, 19.21%, and 4%). The taste was included as a response because the change in the number of mint leaves and cinnamon may change the taste due to the bitter taste of aloe vera rind, which is due to the presence of aloin compounds.

The residual plot graph (Figure 6) illustrates the relationship between the combined use of aloe vera rind, mint leaf, and cinnamon with the resulting overall response value. The red part of the graph shows the highest response of 5.09 with the criteria of liking (the combination of aloe vera rind, mint leaves, and cinnamon respectively 68.52%, 23.48%, and 8%), while the blue graph shows the lowest response of 3.31 (76.79%, 19.21% and 4% in the combination of aloe vera rind, mint leaves, and cinnamon, respectively) with the criteria of slightly dislike.

3.6 Selected formulation optimization

The selected formulation is the optimal solution or formulation predicted by Design Expert Method 12.0 the D-optimal method based on the results of the analysis of the chemical response (antioxidant), physical response (lightness), and organoleptic response. (taste, smell, color, and overall attributes). The accuracy of the formulation and the value of each response can be seen in the desirability (Taufik et al., 2017).

The selected formula solution is the most optimum formula with a desirability value of 0.604, which means that the formula will produce a product that has characteristics by the optimization target of 60.4%. The formula consists of 65.79% aloe vera rind, 30% mint leaves, and 4.21% cinnamon. This formula is predicted to have response values including, Lightness 67.589, antioxidant activity 262.355 mg Eq.Vit. C/100 g of material, organoleptic in color attributes 3.63 (slightly like), taste 3.973 (slightly like), smell 3.963 (slightly like), and overall 3.934 (slightly like).

4 Conclusion

Based on the optimization results of herbal tea formulas made from aloe vera rind, mint leaves, and cinnamon using the Design expert 12.0 application, the optimum formula desirability value based on the analysis was 0.604. A desirability value of more than 0.5 was sufficient with the optimum formula consisting of aloe vera rind at 65.79%, mint leaves at 30.0%, and cinnamon at 4.21%. The results of physical and chemical tests show that the formula produces a lightness value of 67,589, contains the antioxidant activity of 262,355 mgEq.Vit.C/100 g of material. The results of the organoleptic test showed the color value was

3.63 (slightly like), the taste was 3.97 (slightly like), the smell was 3.963 (slightly like) and the overall value was 3.934 (slightly like).

References

Adushan, P. (2008). *Synthesis and biological activity of aloin derivates* (Master's thesis). School of Chemistry, University of KwaZulu-Natal, Pietermaritzburg.

Apriliyani, D. A., Prabawa, S., & Yudhistira, B. (2021). Pengaruh variasi formulasi dan waktu pengeringan terhadap karakteristik minuman herbal daun beluntas dan daun mint. *Agrointek*, 15(3), 876-885. http://dx.doi.org/10.21107/agrointek.v15i3.10492.

Badan Pusat Statistik – BPS. (2021). *Production of medicinal plants by province and kind of plant 2021*. Retrieved from https://www.bps.go.id/indikator/indikator/view_data_pub/0000/api_pub/UVMzY2pGV3kyWjhLYm9UTEdtYk52Zz09/da_05/1

Benzidia, B., Barbouchi, M., Hammouch, H., Belahbib, N., Zouarhi, M., Erramli, H., Daoud, N. A., Badrane, N., & Hajjaji, N. (2019). Chemical composition and antioxidant activity of tannins extracted from the green rind of *Aloe vera* (L.) Burm. F. *Journal of King Saud University-Science*, 31(4), 1175-1181. http://dx.doi.org/10.1016/j.jksus.2018.05.022.

Byun, N.-Y., Cho, J.-H., & Yim, S.-H. (2021). Correlation between antioxidant activity and anti-wrinkle effect of ethanol extracts of *Sanguisorba officinalis* L. *Food Science and Technology*, 41(Suppl. 2), 791-798. http://dx.doi.org/10.1590/fst.10921.

Cheng, S., Panthapulakkal, S., Ramezani, N., Asiri, A. M., & Sain, M. (2014). Aloe vera rind nanofiber: effect of isolation process on the tensile properties of nanofibre films. *BioResources*, 9(4), 7653-7665. http://dx.doi.org/10.15376/biores.9.4.7653-7665.

Choi, S., Supeno, D., Byun, J., Kwon, S.-H., Chung, S.-W., Kwon, S.-G., Kwon, D., & Choi, W. (2015). The identification of saponin to obtain the maximum benefit from *Aloe saponaria*. *Advance Science, and Technology Letters*, 120, 558-563. http://dx.doi.org/10.14257/astl.2015.120.112.

Emilda, E. (2018). Efek senyawa bioaktif kayu manis (*Cinnamomum burmanii* NEES EX.BL.) terhadap diabetes melitus: kajian pustaka. *Jurnal Fitofarmaka Indonesia*, 5(1), 246-252. http://dx.doi.org/10.33096/jffi.v5i1.316.

Gregório, A., Galhardo, D., Sereia, M. J., Wielewski, P., Gavazzoni, L., Santos, I. F., Sangaleti, G. S. S. G. M. G., Cardoso, E. C., Bortoti, T. L., Zanatta, L. A., Gonçalves, L. M., Suzin, M. A., Santos, A. A., & Toledo, V. A. A. (2021). Antimicrobial activity, physical-chemical and activity antioxidant of honey samples of *Apis mellifera* from different regions of Paraná, southern Brazil. *Food Science and Technology*, 41(Suppl. 2), 583-590. http://dx.doi.org/10.1590/fst.32820.

Guldas, M., Ziyanok-Demirtas, S., Sahan, Y., Yildiz, E., & Gurbuz, O. (2021). Antioxidant and anti-diabetic propertis of *Sprirulina platensis* produced in Turkey. *Food Science and Technology*, 41(3), 615-625. http://dx.doi.org/10.1590/fst.23920.

Hęś, M., Dziedzic, K., Górecka, D., Jędrusek-Golińska, A., & Gujska, E. (2019). *Aloe vera* (L) Webb.: natural sources of antioxidants – a review. *Plant Foods for Human Nutrition*, 74(3), 255-265. http://dx.doi.org/10.1007/s11130-019-00747-5. PMid:31209704.

Hossain, S., Mamun-Or-Rashid, A. N. M., Towfique, N., & Sen, M. K. (2013). A review on ethnopharmacological potential of *Aloe vera* L. *Journal of Intercultural Ethnopharmacology*, 2(2), 113-120. http://dx.doi.org/10.5455/jice.20130612035300.

Khan, R. A., Khan, M. R., Sahreen, S., & Ahmed, M. (2012). Evaluation of phenolic contents and antioxidant activity of various solvent extracts of *Sonchus asper* (L.) Hill. *Chemistry Central Journal*, 6(1), 12. http://dx.doi.org/10.1186/1752-153X-6-12. PMid:22305477.

Kusumaningrum, R., Supriadi, A., & Hanggita, R. J. S. (2013). Karakteristik dan mutu the bunga lotus (*Nelumbo nucifera*). *Jurnal Fishtech*, 2(1), 9-21.

Lakshmi, P. T. V., & Rajalakshmi, P. (2011). Identification of phyto component and it's biological activities of *Aloe vera* through the gas chromatography-spectrophotometry. *International Research Journal of Pharmacy*, 2(5), 247-249.

Larasati, C. (2020). Efek antidiabetik dari *Aloe vera*. *Jurnal Penelitian Perawat Profesional*, 3(1), 21-30. http://dx.doi.org/10.37287/jppp.v3i1.252.

López, A., Tangil, M. S., Veja-Orellana, O., Ramírez, A. S., & Rico, M. (2013). Phenolic constituents, antioxidant and preliminary antimycoplasmic activities of leaf skin and flowers of *Aloe vera* (L.) Burm. f. (syn. *A. barbadensis* Mill.) from the Canary Islands (Spain). *Molecules*, 18(5), 4942-4954. http://dx.doi.org/10.3390/molecules18054942. PMid:23624648.

Mahadi, S. B. (2019). Antioxidant and anti-tyrosine activities of *Aloe vera* rind and gel extracts. *Global Medical and Health Communication*, 7(3), 170-176.

Mogaddasi, S., & Verma, S. K. (2011). Aloe *vera* their chemical composition and application: a review. *International Journal of Biological and Medical Research*, 2(1), 466-471.

Pegu, A. J., & Sharma, A. (2019). Review on Aloe vera. *International Journal of Trend in Scientific and Development*, 3(4), 35-40. http://dx.doi.org/10.31142/ijtsrd23541.

Ramadhani, R. A., Riyadi, D. H. S., Triwibowo, B., & Kusumaningtyas, R. D. (2017). Review pemanfaatan design expert untuk optimasi komposisi campuran minyak nabati sebagai bahan baku sintesis biodiesel. *Jurnal Teknik Kimia dan Lingkungan*, 1(1), 11-16. http://dx.doi.org/10.33795/jtkl.v1i1.5.

Satriadi, I. W. A., Wrasiati, N. L. P., & Triani, I. G. A. L. (2015). Pengaruh suhu pengeringan dan ukuran potongan terhadap karakteristik teh kulit lidah buaya (*Aloe barbadensis* Milleer). *Jurnal Rekayasa dan Manajemen Agroindustri*, 3(2), 120-129.

Seon, H. Y., Sun, S., & Yim, S. H. (2021). Correlation of the free radical and antioxidant activities of *Eriobotrya japonica* Lind. with phenolic and flavonoid content. *Food Science and Technology*, 41(4), 1025-1032. http://dx.doi.org/10.1590/fst.21720.

Sharma, P. K., Ali, M., & Yadav, D. (2011). Physicochemical and phytochemical evaluation of different black tea brands. *Journal of Applied Pharmaceutical Science*, 1(3), 121-124.

Sianturi, C. Y. (2019). Manfaat lidah buaya sebagai anti penuaan melalui aktifitas antioksidan. *Essence of Scientific Medical Journal*, 17(1), 34-38.

Taufik, Y., Widiantara, T., & Ulfah, S. (2017). Optimization of aloe vera jelly drink formulation (*Aloe vera L.*) and black mulberry (*Morus nigra, L*) leawes using design expert d-optimal mixture method. *Pasundan Food Technology Journal*, 4(3), 176-181.

Tensiska, Sumanti, D. M., & Sari, V. H. (2017). Pemanfaatan kulit lidah buaya (*Aloe vera* Linn.) dan bunga rosela (*Hibiscus sabdariffa* Linn.) dalam pembuatan minuman herbal. *Jurnal Penelitian Pangan*, 2(1), 1-8.

Wherdasari, A. (2014). Peran antioksidan bagi Kesehatan. *Jurnal Biotek Medisiana Indonesia*, 3(2), 59-68.

Yanuartono, Purnamaningsing, H., Nururrozi, A., & Indarjulianto, S. (2017). Saponin: impact on livestock (a review). *Jurnal Peternakan Sriwijaya*, 6(2), 79-90.