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Optimization of Red Ginger, Alginate and Drying Time on the Characteristics of Antidiabetic Effervescent Powder Drink with Combination Design

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ABSTRACT

Red ginger and alginate contain antidiabetic compounds such as flavonoids. The purpose of this study was the optimization of red ginger, alginate, and drying time on the characteristics of antidiabetic effervescent powder drinks with a combined design. The tests were physical quality (flow time, dissolving time, angle of repose, and total soluble solids) and chemical quality (water content, antioxidant activity, total sugar, and pH value). Data were analyzed with ANOVA on Design Expert 13®. The optimal formulation consists of a red ginger concentration of 6.497%, alginate at 1.007%, and a drying time of 1.987 hours. The resulting product exhibited a repose angle of 37.89°, dissolution time of 75.65 seconds, bulk density of 0.58 g/mL, total soluble solids at 2.4°Brix, flow time of 0.8 seconds, moisture content of 4.75%, pH of 5.1, antioxidant activity (IC_{50}) of 172.79 ppm (classified as weak), and total sugar content of 29.59%.
Keywords: Red Ginger, Alginate, Drying Time

INTRODUCTION

Nowadays, people prefer food and drink that not only taste good, but also have health benefits. Drinks that are known to have health benefits and are favored by the public are spice drinks. Spices that are known to have health benefits are red ginger (Zingiber officinale Rosc.). Red ginger (Zingiber officinale Rosc.) is one such spice with great potential for product development (Diana and Darmawan, 2023). This is because red ginger rhizomes contain flavonoid, which are antioxidants that can reduce free radicals and lower blood sugar levels in people with diabetics (Luthfiani and Setyowati, 2023). The number of people with diabetes in Indonesia is large and projected to increase from 19.5 million people in 2021 to 28.6 million people in 2045 (Nugraha *et al.,* 2024), making diabetes a significant concern.

Taking antioxidants can help to neutralise free radicals and reduce oxidative stress in people with diabetes (Addina *et al.,* 2020). Research by Vifta *et al.* (2019) showed that red ginger has a very strong IC_{50} antioxidant activity of 25.27 ppm, making it

beneficial for diabetics. However, red ginger needs to be combined with other ingredients to make it more useful and attractive to the public as a product for diabetics. Another ingredient with high antioxidant content is alginate, which contains flavonoid compounds (Ndahawali *et al.*, 2021). Addina *et al.* (2020) found that alginate has an IC_{50} antioxidant activity of 32.69 ppm (very strong). In order for the two ingredients to be accepted by the public, they need to be used to make trending products.

Currently, carbonated drinks are trending because they are refreshing and provide a pleasant fizz. A practical way to produce a carbonated drink is in powder form, known as an effervescent powder drink. This type of soft drink comes in the form of a coarse dry powder containing CO_2 (Mamatha *et al.*, 2023), and is refreshing, practical, and easy to carry. It also dissolves quickly in water (Arisanty and Daswi, 2021). The length of drying affects the quality of the final effervescent powder drink product. Drying is the process of reducing the moisture content of materials to a level at which their biological and chemical activities are slowed down. This improves quality and extends product shelf life (Rifman *et al.*, 2023). Based on the results of research by Septianingrum *et al* (2019), the optimal temperature for making effervescent powder is 50°C, therefore, the research used this temperature.

In order for the effervescent powder formula to be popular with the public, it needs to be optimised. The optimization process was carried out using the Combined Design method in the Design Expert 13® application. Combined design is a combination of Design of Experiment (DOE), Response Surface Methodology (RSM), and mixture Design. This design is used to study the optimization of mixed variables between materials and processes within a single DOE (Hidayat *et al.,* 2020). The aims of the research is to determine the optimal formula of red ginger, alginate, and drying time in order to produce effervescent powdered drinks that are suitable for diabetics.

MATERIALS AND METHODS

Tools and Materials

The materials for effervescent powder production were sourced online, including red ginger powder (Traditional Herbal Medicine brand), alginate, mannitol, PEG 6000, sodium bicarbonate, citric acid (Merck), and stevia (Forestry Care). Materials used for chemical analysis are distilled water, DPPH and methanol (SMARTLAB), 150 ppm glucose solution (MI Glory), anthrone reagent, calcium carbonate, sodium oxalate, sulfuric acid, and Pb acetate (Merck). The tools used are a refractometer (Atago ATC-1 capacity 32 ºBrix), UV-Vis spectrophotometer (Cecil 1021), pH meter (JENWAI 3510), oven blower (WTC Binder), and glassware brand "Pyrex.".

Methods for Determining Variables, Experimental Design and Responses

Variables were determined based on the results of preliminary tests and obtained the concentration of independent variables as upper and lower limits, namely red ginger concentration (2-6.5%), alginate (1-5.5%), and drying time (1.5-2 hours). Determination of the formula for each variable was determined with the Design Expert 13® application Combined Design method. In Table 1, 16 experimental designs were obtained to be tested. The responses tested were physical quality parameters (angle of repose and dissolving time (Januarti *et al.*, 2020), bulk density (Elisabeth *et al.,* 2018), total soluble solids (TPT) (Tampubolon & Yunianta, 2017), flow time (Oktavina and Imtihani, 2023)). Chemical quality (moisture content (Arifin *et al.*, 2023), pH value

(Januarti *et al.*, 2020), antioxidant activity test (Addina *et al.,* 2020) and total sugar (Prasetyo and Anwar, 2024)).

Effervescent Powder Drink Manufacturing

The process of making effervescent powder refers to the modified research of Septianingrum *et al* (2019), starting with weighing each ingredient used. Mixture 1 is red ginger powder, alginate, stevia sugar, mannitol and sodium bicarbonate weighed according to the formula then sieved mesh 16 and mixed until homogeneous, while mixture 2 is citric acid crushed until smooth then sieved mesh 16 and weighed according to the formula. Mixtures 1 and 2 were dried in separate containers using a blower oven at ± 50°C for 1.5-2 hours. Then mixtures 1, 2 and PEG were mixed and stirred until homogeneous, then sieved mesh 20 so that effervescent powder was obtained.

Data Analysis

The data that has been obtained is then processed using the Design Expert 13® program Combined Design method. The results obtained will be translated based on the lack of fit ANOVA response to the selected independent variables. In the final stage of optimization, the program will recommend the optimal process combination. The optimal condition is selected by comparing the desirability values of each solution. The combination selected is the one with the highest desirability value.

RESULTS AND DISCUSSION

The Angle of Repose

The angle of repose is the fixed angle formed between the conical pile of particles and the horizontal plane when a certain amount of powder is introduced into the measuring device (Al-Hashemi and Al-Amoudi, 2018). In Table 2, the average results of the stationary angle test ranged from 24.22° to 41.35°. The powder will flow well if it has a stationary angle of 25º-45º (Nining *et al.,* 2019). It means the 16 formulas show good flow. The highest angle of repose result is owned by run 4, while the lowest result is in run 2. A longer drying time generally results in a lower angle of repose in the effervescent powder.

The results of the ANOVA test ($\alpha = 0.05$) showed that red ginger, alginate, and drying time significantly influenced the response of angle of repose with an insignificant lack of fit value, which is a p value > 0.0500 (0.2134). The angle of repose is related to changes in the physical properties of the powder during the drying process. The longer the drying time, the water content in the powder will decrease, which can cause changes in the size, texture, and compactness of the powder (Oktavina and Imtihani, 2023).

Alginate is often used as a thickener or gelling agent (Abka-khajouei *et al*., 2022). The sticky nature of alginate can cause powder particles to stick to each other, resulting in a larger angle of repose. While red ginger in powder form has particles that tend to be non-uniform and rather coarse. Syukri (2018), stated that non-uniform and coarse particles tend to have higher cohesion with increasing particle diameter, so that the angle of repose can increase, indicating that the powder has a slower flow. According to the results of research by Giyatmi and Lingga (2019), the angle of repose of red ginger extract effervescent powder drinks ranged from 42.30 to 42.36 º while the results of Julianti *et al.* (2024), research showed that the angle of repose of 'Kencur' (also known as aromatic ginger) effervescent tablets ranged from 25-30°, this was the same as the results of research on red ginger, ginger and cinnamon effervescent granules (Sidoretno *et al.*, 2022)

Dissolving Time

Dissolving time is the time required by effervescent powder to dissolve completely in water. In Table 2, the average results of the dissolving time test ranged from 73.16 to 84.96 seconds. The requirement for a good effervescent powder dissolving time according to BPOM Regulation Number 12 of 2014 is <300 second. The 16 formulas show that the effervescent powder meets the dissolving time requirements. The highest dissolving time result is owned by run 3, while the lowest is in run 8. The higher the concentration of alginate tends to increase the dissolving time of effervescent powder. The results of the ANOVA test ($\alpha = 0.05$) show that the 16 formulas do not significantly affect the response of dissolving time, and the resulting lack of fit value is not significant, namely the p value >0.0500 (0.1366).

The increase in dissolving time is due to the high use of alginate concentration. Abka-khajouei *et al.,* (2022), stated that alginate can form a gel by being absorbed by the liquid, so that the resulting liquid will be retained and form a gel mass. This happens because alginate is a natural polymer that can bind water molecules and form a stable network, while increasing the concentration of red ginger in the formulation tends to slow down the dissolution process because high fiber content can make particles denser and accelerate dissolution in water. According to the results of research by Nasution *et al* (2023), red ginger contains crude fiber ranging from 1.86 ± 0.10% at 50°C.

The dissolution time results are different from those reported by Giyatmi and Lingga (2019). The dissolution time of the red ginger extract effervescent powder ranged from 116-145 seconds, while the turmeric effervescent granules took 187 seconds *(*Arifuddin *et al.,* 2022). However, these results are similar to those reported by Hamsinah and Ririn (2020), who found that the dissolution time of effervescent granules containing binders ranged from 101 to 107 seconds..

Bulk Density

Bulk density is weight divided by bulk volume and is expressed as g/mL. Bulk density parameters play an important role in determining the size of product storage containers. In Table 2, the average results of the response test ranged from 0.54 to 0.60 g/mL. The highest bulk density result is owned by run 11 at 0.60 g/mL, while the lowest result is in run 7 at 0.54 g/mL. The longer the drying time, the lower the bulk density value. The ANOVA test results ($\alpha = 0.05$) showed 16 formulas didn't significantly affect the bulk density response, with the resulting lack of fit value significant <0.0500 (0.0089).

According to Putri e*t al* (2021), longer drying time the moisture content in the powder, so the powder particles become drier and fill less space because they do not stick together as much as more moist powders. The bulk density values in the 16 formulas tend not to be too different from each other, which is low and can be assumed to require a small container. In line with the results of research by Hamsinah and Ririn (2020), the bulk density of pepino fruit ethanol extract effervescent powders ranges from 0.53 to 0.65 g/mL, while the bulk density of turmeric and tamarind effervescent granules ranges from 0.58 to 0.64 g/mL *(*Arifuddin *et al.,* 2022). Meanwhile, Giyatmi and Lingga (2019) found that the bulk density of red ginger extract effervescent powder drinks was between 13.00 and 13.66 g/mL.

Total Dissolved Solids

In Table 2, the results of the total dissolved solids (TDS) test obtained the average value of the response test ranged from 2.4-3°Brix. The highest TDS result was found in run 16, while the lowest result was

found in run 14. The higher the alginate concentration and red ginger concentration, the higher the TDS. The ANOVA test results ($\alpha = 0.05$) showed that red ginger, alginate, and different drying times had a significant effect on the TDS response, with the resulting lack of fit value being insignificant at $p > 0.0500$ (0.0905).

The increase in TDS value is due to the presence of dissolved compounds such as carbohydrates and sugars in red ginger and alginate, which, when dried, do not evaporate and remain in the material. This is in line with the research of Tampubolon & Yunianta (2017), that the increase in TDS occurs due to the breaking of the long chain of carbohydrate compounds that produce dissolved sugar compounds. The results of research by Nasution *et al* (2023), on red ginger have a carbohydrate content of 50–70%, while the results of research by Fransiska *et al* (2020), on alginate have a carbohydrate content of 5.94% ± 2.35%.

The TDS results differ from those of Murdinah (2015), who found a TDS of 48.57 ± 3.11° Brix when alginate was added to selected effervescent drinks. However, they are in line with the TDS values of red guava effervescents, which range from 3.60 to 5.27 °Brix (Tampubolon and Yunianta, 2017) and the TDS values when turmeric emulsion carrageenan was added, which range from 1.71 to 2.17 ppm (Arganis *et al.*, 2020).

Flow Time

Flow time is the time required for powder to flow into a container, which is influenced by form factors, surface area, density, and powder moisture (Syukri, 2018). In Table 2, the average results of the flow time test ranged from 0.15 to 1.24 seconds. The highest result was owned by run 6, while the lowest result was in run 14. The longer the drying time tends to be, the faster the flow time. The ANOVA test results ($\alpha = 0.05$) show the16 formulas did'nt significantly affect the flow time response, with the resulting lack of fit value significant <0.0500 (0.0001).

An increase in flow velocity is influenced by the lower moisture content of the powder. Conversely, high moisture content can cause the flow velocity to slow down (Syukri, 2018). The high concentration of alginate can increase the viscosity of the powder mixture when interacting with air moisture. This can cause the powder to become more sticky and difficult to flow, thus increasing the flow time Alginate has a viscosity of 50 cP (Mokoginta *et al.*, 2019). The results of the flow time study differ from those of Giyatmi and Lingga (2019). The flow time of the red ginger extract effervescent powder drink is 9.35-9.45 seconds, whereas the results of Sidoretno *et al.* (2022) research show that the flow time of red ginger, ginger, and cinnamon effervescent granules ranges from 4.95–8.05 g/s and 0.517–0.615 seconds for turmeric effervescent tablets (Julianti *et al.,* 2024).

Water Content

Moisture content is the water content in effervescent powder products. In Table 2, the average results of the response test ranged from 4.2 to 4.9%. According to BPOM Regulation Number 12 of 2014, the quality requirements for effervescent powder water content are >5%, which means that 16 formulas are in accordance with the standards. The highest water content result is owned by run 11, while the lowest water content is in run 8. The longer the drying time tends to be, the lower the water content results. The ANOVA test results ($\alpha = 0.05$) showed that the 16 formulas did'nt significantly affect the moisture content response with a significant lack of fit value, namely p value <0.0500 (0.0456).

Wirzan, *et al.* (2018), stated that the role of water in food is one of the factors that

greatly affects shelf life. The moisture content is influenced by the drying process because the longer the drying process takes place, the more water evaporates and the lower the moisture content (Yunita and Rahmawati, 2015). Alginate is a hygroscopic polysaccharide that can form a gel, thereby increasing the moisture content in the effervescent powder. This statement is reinforced by the opinion of Guo, *et al.* (2019), which states that mineral salts are hygroscopic, so they can cause high water content in sodium alginate.

The results of the water content research are consistent with those of Giyatmi and Lingga (2019): the water content of red ginger extract effervescent powder drinks ranged from 0.41-0.47%, which is below the required level of 5%. However, the results of research by Murdinah (2015) indicate that the water content was 11%.07% with the addition of alginate to effervescent drinks. The results of the research by Sidoretno, *et al.* (2022) showed that the moisture content of red ginger effervescent granules, temulawak and cinnamon ranged from 2.54-6.51%. This did not meet the requirement of less than 5%.

pH Value

The pH value testing is very important because if the pH value is too acidic or alkaline, it can cause stomach irritation and a bitter taste. In Table 2, the average pH test results ranged from 4.26 to 4.98. The highest pH value is owned by run 8, while the lowest pH level is found in run 16. The higher the concentration of red ginger tends to be the lower the pH value. ANOVA test results ($\alpha = 0.05$) showed 16 formulas did'nt significantly affect the pH value response with a significant lack of fit value of <0.0500 (<0.0001).

This decrease in pH is due to the content of active compounds in red ginger rhizomes such as gingerol, shogaol, and ascorbic acid (Siregar *et al.*, 2022), while alginate tends to reduce pH presumably due to several factors such as the type of seaweed used to make sodium alginate. The sodium alginate pH will stabilize at pH 5–10 (Mokoginta *et al.*, 2019). According to research Murdniah (2015), the pH value of lemon juice effervescent powder with the addition of alginate ranged from 5.17 to 5.32. Meanwhile, the results of research by Giyatmi and Lingga. (2019) showed that the pH of red ginger extract effervescent powder ranged from 7.3–7.5, while the pH of red ginger, ginger and cinnamon effervescent granules was found to range from 6.72–8.76 (Sidoretno et al., 2022).

Antioxidant Activity

Antioxidant activity is a parameter used to determine free radical-inhibiting samples. This parameter is very important for antidiabetic effervescent powder drinks. Excess free radicals can damage cells, including pancreatic beta cells responsible for insulin production (Sinaga, 2016). Antioxidant activity helps neutralize free radicals and reduce oxidative stress. In Table 2, the average results of the antioxidant activity test ranged from IC_{50} values of 96.15 to 272.07 ppm (strong-very-weak). The results of the weakest antioxidant levels are owned by run 15, which has an IC_{50} value of 272.07 ppm (very weak), while the strongest antioxidant levels are found in run 5, with an IC_{50} value of 96.15 ppm (strong). The longer the drying time, the weaker the antioxidant activity. ANOVA test results ($\alpha = 0.05$) showed 16 formulas did'nt significantly affect the antioxidant activity response with a significant lack of fit value of <0.0500 (<0.0001).

Antioxidant activity in effervescent powder drinks is due to phytochemical compounds contained in red ginger powder, which contains an IC_{50} of 60.52 ppm (strong). Phytochemical compounds found in red ginger are flavonoids, phenols, and

terpenoids (Amalia and Sabila, 2021). The main flavonoid compounds in red ginger are gingerol and shogaol, which have antioxidant activity (Verenzia *et al*., 2022), while the content of phytochemical compounds found in alginate is flavonoids (Ndahawali *et al.*, 2021). Alginate contains an IC50 of 32.29 ppm (very strong) in effervescent powder raw materials. The weak antioxidant activity in effervescent powders is thought to be the process of heat contact with high temperatures and long drying times that reduce antioxidant levels because antioxidant compounds are very easy to change, sensitive, unstable, and susceptible to degradation (Fauzi *et al.*, 2022).

The results of the research into antioxidant activity differ from those of Suena *et al.* (2021). The IC50 of the white turmeric effervescent granule preparation was 13,056 ppm, while the results of the research by Belgis *et al.* (2023) found that the antioxidant activity of turmeric effervescent tablets with stevia ranged from 46.36% to 55.94%. Aulifa *et al.* (2022) found that the IC50 of ginger extract effervescent granules was 283.28 ppm.

Total Sugar

Total sugar is the amount of sugar in effervescent powder measured in percentage units per 100 grams. In Table 2, the average results of the total sugar test ranged from 11.86 to 29.86%. The highest total sugar result is owned by run 1 at 29.86%, while the lowest result is in run 3 at 11.86%. The longer the drying time tends to increase the total sugar content. ANOVA test results ($\alpha = 0.05$) showed that 16 formulas did'nt significantly affect the total sugar response with a significant lack of fit value of <0.0500 (0.0031).

Erickson and Slavin (2015), stated that the total sugar content is affected by the amount of sugar added. The increase in total sugar is inversely proportional to the water content. The lower the moisture content, the more the total sugar increases. This increase is thought to be due to the drying process that is too long, resulting in higher evaporated moisture content and the total sugar content in red ginger powder becoming more concentrated (Nuramalia and Sari, 2024). Heat application is also a concern because sucrose is easily caramelized when the red ginger extract thickens and shrinks (Saraswati *et al.*, 2019). The phenomenon of caramelization occurs when sucrose interacts at temperatures close to its melting point (Siskawardani *et al.*, 2021), while alginate has gel-forming properties that can slow the release of sugar in effervescent powders.

The results of Harahap, *et al.* (2017), research on the total sugar content of mangosteen fruit peel effervescent powder ranged from 6.17-6.67%, while Murdinah, 2015) found that the total sugar content of lemon juice alginate effervescent powder was 3.74%. Mutiarahma *et al.* (2019) found that the sugar content of jackfruit effervescent tablets ranged from 11.83-14.99%.

Optimization

Figure 1 shows the desirability number of 0.658 with the optimal formula. The selected formula is based on the desirability value closest to one because the value of one indicates the accuracy of the optimization results. Table 3 shows that the actual values of 9 responses are still in the range of 95% confidence prediction interval (PI). The conformity between predictions and measurement results indicates that the model used is verified and quite consistent (Rahmawati *et al.*, 2020).

CONCLUSION

Various formulations of red ginger, alginate, and drying durations were tested, and the optimal effervescent powder drink was identified as safe for diabetic consumption. The best optimum formula is

the use of red ginger concentration of 6.497%, alginate 1.007%, and drying time 1,987 hours with a desirability value of 0.658. Response values include physical quality (angle of repose 37.89°, dissolving time 75.65 seconds, bulk density 0.58 g/mL, total soluble solids 2.4°Brix, and flow time 0.8 seconds) and chemical quality (water content 4.75%, pH value 5.1, antioxidant activity (IC_{50}) 172.79 ppm (weak), and total sugar 29.59%).

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REFERENCES

Abka-khajouei, R., Tounsi, L., Shahabi, N., Patel, A.K., Abdelkaf, S and Michaud, P. (2022) 'Properties and applications of alginate', *Properties and Applications of Alginate*, 20, p. 364. https://doi.org/10.5772/intechopen.94635.

Addina, S., Subaryono, S. and Sukarno, S. (2020) 'Aktivitas Oligosakarida Alginat Sebagai Antioksidan dan Inhibitor Alfa glukosidase', *Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan*, 15(1), p. 47. https://doi.org/10.15578/jpbkp.v15i1.646.

Amalia, R.T. and Sabila, F.I. (2021) 'Phytochemical Screening and Total Phenolic Compounds of Red Ginger (Zingiber officinale) and Secang Wood (Caesalpinia sappan) As Preliminary Test of Antiarthritis', *Chimica et Natura Acta*, 9(1). https://doi.org/10.24198/cna.v9.n1.34230.

Antioksidan, A., Beras, T. and Suhu, V. (2023) 'Antioxidant Activity of Colored Rice Flour with Drying Temperature Variations Nasional , 2015). Di Indonesia terdapat beberapa sativa L .), beras merah (Oryza nirvara), beras sehingga perlu melakukan proses pengolahan untuk memaksimalkan nilai beras te', 8(2), pp. 195–202.

Anwar Fauzi, R. *et al.* (2022) 'Optimasi Proses Pengeringan Terhadap Aktivitas Antioksidan Bunga Telang (Clitoria Ternatea) Menggunakan Metode Respon Permukaan', *Jurnal Teknologi Pertanian*, 23(1), pp. 9–22. https://doi.org/10.21776/ub.jtp.2022.023.01.2.

Arifuddin, A., Al Akram, M.F. and Ibrahim, I. (2022) 'Formulasi Granul Effervescent Dari Kunyit (curcumae domestica) Dan Asam Jawa (tamarindus indica)', *Jurnal Kefarmasian Akfarindo*, 7(2), pp. 15–19. https://doi.org/10.37089/jofar.vi0.134.

Arisanty and Daswi, D.R. (2021) 'Formulation And Physical Quality Of Effervescent Granules Containing Rambutan (Nephelium lappaceum L) Peel Dried Extract', *The 3rd International Conference on Urban Health, The Covid-19 Pandemic and Urban Health Issues*, 3(1), pp. 200–206.

Aulifa, D.L. *et al.* (2022) 'Formulation of Effervescent Granules From Red Ginger (Zingiberis Officinale Roscoe Var. Rubrum) Extract and Its Antioxidant Activity', *International Journal of Applied Pharmaceutics*, 14(1), pp. 112–115. https://doi.org/10.22159/ijap.2022v14i1.43377.

Ayu, D.F., Wirzan, A. and Hamzah, F. (2018) 'Addition of Red Ginger Powder (Zingiber officinale Rosc.) in Making

Herbal Tea of Avocado Leaf (Persea americana Mill.)', *Jurnal Agroindustri Halal*, 4(2), pp. 117–129. https://doi.org/10.30997/jah.v4i2.1200.

Beakawi Al-Hashemi, H.M. and Baghabra Al-Amoudi, O.S. (2018) 'A review on the angle of repose of granular materials', *Powder Technology*, 330(May), pp. 397–417. https://doi.org/10.1016/j.powtec.2018.02.003.

Belgis, M. *et al.* (2023) 'Antioxidant, Anti-microbial, and Physical Properties Improvement of Turmeric (Curcuma domestica Val.) Effervescent Tablets with Stevia (Stevia rebaudiana) Leaf Powder', *AIP Conference Proceedings*, 2583(January). https://doi.org/10.1063/5.0116410.

Diana, R. and Darmawan, I.P.A. (2023) 'Jahe+Khaliya+Onomiea+(Ruat+Diana).docx', 1(1), pp. 19–27.

Elisabeth, V., Yamlean, P.V.Y. and Supriati, H.S. (2018) 'Formulasi sediaan granul dengan bahan pengikat pati kulit pisang goroho (musa acuminafe l.) dan pengaruhnya Pada sifar fisik granul', *PHARMACON Jurnal Ilmiah Farmasi*, 7(4), pp. 1–11.

Erickson, J. and Slavin, J. (2015) 'Total, added, and free sugars: Are restrictive guidelines science - Based or achievable?', *Nutrients*, 7(4), pp. 2866–2878. https://doi.org/10.3390/nu7042866.

Fransiska, D. *et al.* (2020) 'Karakterisasi Natrium Alginat Dari Banten, Lampung Dan Yogyakarta', *Jurnal Teknologi Pangan dan Kesehatan (The Journal of Food Technology and Health)*, 2(2), pp. 97–104. https://doi.org/10.36441/jtepakes.v2i2.521.

Giyatmi and Lingga, D.K. (2019) 'The effect of citric acid and sodium bicarbonate concentration on the quality of effervescent of red ginger extract', *IOP Conference Series: Earth and Environmental Science*, 383(1). https://doi.org/10.1088/1755-1315/383/1/012022.

Guo, L. *et al.* (2019) 'A comprehensive study of hygroscopic properties of calcium- and magnesium-containing salts: Implication for hygroscopicity of mineral dust and sea salt aerosols', *Atmospheric Chemistry and Physics*, 19(4), pp. 2115–2133. https://doi.org/10.5194/acp-19-2115-2019.

Hamsinah, H. and Ririn, R. (2020) 'Pengembangan Ekstrak Etanol Buah Pepino (Solanum Muricatum Aiton) dalam Bentuk Granul Effervescent dengan Variasi Bahan Pengikat', *Jurnal Farmasi Galenika (Galenika Journal of Pharmacy) (e-Journal)*, 6(1), pp. 124–131. https://doi.org/10.22487/j24428744.2020.v6.i1.12037.

Harahap, R.A., Efendi, R. and Ayu, D.F. (2017) 'Effervescent Mix Concentration in Making Skin Extract Effervescent Powder Mangosteen (Garcinia mangostana L.)', *Jom FAPERTA UR*, 4(1), pp. 1–14.

Hidayat, I.R., Zuhrotun, A. and Sopyan, I. (2020) 'Design-Expert Software sebagai Alat Optimasi Formulasi Sediaan Farmasi', *Majalah Farmasetika*, 6(1), pp. 99–120. https://doi.org/10.24198/mfarmasetika.v6i1.27842.

Januarti, I.B. *et al.* (2020) 'Aktivitas Antidiabetes Tablet Effervescent Ekstrak Daun Putri Malu (Mimosa pudica Linn.)', *Jurnal Farmasi Sains dan Praktis (JFSP)*, 6(2), pp. 99–107. Available at:

https://journal.unimma.ac.id/index.php/pharmacy/article/download/3008/2070/.

Julianti, T.B., Bakar, F.A. and Wikantyasning, E.R. (2024) 'Formulation and Optimization of Effervescent Tablet Containing Kaempferia Galanga', *International Journal of Applied Pharmaceutics*, 16(spl5), pp. 133–139. https://doi.org/10.22159/ijap.2024v16s5.52464.

Luthfiani, F. and Setyowati, D. (2023) 'Penerapan Intervensi Pemberian Jahe Merah Terhadap Kadar Glikemik Indeks Pada Lansia Dengan Diabetes Mellitus', *Ners Muda*, 4(3), p. 257. https://doi.org/10.26714/nm.v4i3.10603.

Mamatha, A. *et al.* (2023) 'Herbal Effervescent Powder For Gastritis Using Shankabhasma, Yashadbhasma, Triphala And Others', *Journal of Survey in Fisheries Sciences*, 10(2), pp. 547–558.

Mokoginta, M.K. *et al.* (2019) 'Extraction and characterization of sodium alginates from Sargassum polycystum for manufacturing of tuna (Thunnus sp.) meatballs', *IOP Conference Series: Earth and Environmental Science*, 278(1). https://doi.org/10.1088/1755-1315/278/1/012047.

Mulia Arganis, L. *et al.* (2020) 'Nilai Total Padatan Terlarut pada Emulsi Kunyit (Curcuma longa L.) yang Dipengaruhi oleh Iota dan Kappa Karagenan The Value of Total Dissolved Solids on Turmeric Emulsion (Curcuma longa L.) Affected by Iota and Kappa Carrageenan', *Jurnal Teknologi Pangan*, 4(1), pp. 1–3. Available at: www.ejournal-s1.undip.ac.id/index.php/tekpangan.

Murdinah (2015) 'The Use of Alginate in Lemon Extract Effervescent Powder Production', *Jurnal Pengolahan Hasil Perikanan Indonesia*, 18(2), pp. 177–189. https://doi.org/10.17844/jphpi.2015.18.2.177.

Nasution, A.S., Hasbullah, R. and Hartulistiyoso, E. (2023) 'Effect of Drying Temperature on Quality of Dried Red Ginger (Zingiber Officinale Var. Rubrum)', *Jurnal Teknik Pertanian Lampung (Journal of Agricultural Engineering)*, 12(1), p. 107. https://doi.org/10.23960/jtep-l.v12i1.107-117.

Ndahawali, S. *et al.* (2021) 'Analisis Kandungan Fitokimia Beberapa Jenis Makroalga Dari Perairan Pantai Londalima Kabupaten Sumba Timur', *Jambura Fish Processing Journal*, 3(2), pp. 46–50. https://doi.org/10.37905/jfpj.v3i2.10234.

Nining, Gusmayadi, I., Widayanti, A., Lestari, P.M., Prisiska, F., & Amalia, A. (2019) *Teknologi Sediaan Farmasi Solid*, *UHAMKA*. Available at: http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI.

Nugraha, E.C. and Permanasari, V.Y. (2024) 'Utilisation of Hospital Outpatient Services by Diabetes Mellitus Sufferers , Analysis of BPJS Kesehatan Sample Data', 4(2), pp. 144–159.

Nuramalia, R.N. and Sari, D.A. (2024)

'Analisis Karotenoid dan Glukosa pada Produksi Serbuk Jahe Merah (Zingiber officinale Rosc. var Rubrum) terhadap Variasi Suhu dan Kadar Gula', *JiTEKH*, 12(1), pp. 1–7. https://doi.org/10.35447/jitekh.v12i1.829.

Oktavina, W.R. and Imtihani, H.N. (2023) 'Formulasi dan Evaluasi Suspensi Granul Effervescent Ekstrak Kitosan Cangkang Kepiting Bakau (Scylla serrata) Dengan Perbandingan Natrium Bikarbonat', *Journal of Islamic Pharmacy*, 8(2), pp. 62–67. https://doi.org/10.18860/jip.v8i2.23533.

Pramono, Y.B. and Nurwantoro, N. (2019) 'Evaluasi Kadar Gula, Kadar Air, Kadar Asam dan pH pada Pembuatan Tablet Effervescent Buah Nangka', *Jurnal Teknologi Pangan*, 3(1), pp. 36–41. https://doi.org/10.14710/jtp.2019.20519.

Prasetyo, I.N. and Anwar, K. (2024) 'Analisis Kadar Gula Total, Flavonoid, Dan Uji Aktivitas Antioksidan Dari Formulasi Brotowali Dengan Apel Manalagi Sebagai Minuman Fungsional', *Jurnal Gizi dan Pangan Soedirman*, 8(1), p. 66. https://doi.org/10.20884/1.jgipas.2024.8.1.11877.

Putri, W.D., Luliana, S. and Isnindar (2021) 'Pengaruh Lama Pemanasan terhadap Kadar Air Serbuk Instant Kombinasi Ekstrak Air Meniran (Phyllanthus niruri L) dan Jahe (Zingiber officinale Roscoe.)', *Jurnal Farmasi Kalbar*, 5(1), pp. 6–8.

Rahmawati, R. *et al.* (2020) 'Optimization of temperature and drying time of indigenous cocktail yeast mold culture using response surface methodology (RSM)', *Food Research*, 4(2), pp. 389–395. https://doi.org/10.26656/fr.2017.4(2).247.

Rebecca Tampubolon, T. (2017) 'Sifat Fisik Kimia dan Organoleptik Effervescent Jambu Biji Merah-Tampubolon, dkk', *Jurnal Pangan dan Agroindustri*, 5(3), pp. 27–37.

Rifman, A.A. *et al.* (2023) 'Drying carrots', pp. 1–8.

Saraswati, Desnita, R. and Luliana, S. (2019) 'Optimasi Proses Pembuatan Minuman Serbuk Instan Kombinasi Jahe (Zingiber officinale Rosc) dan Kencur (Kaempferia galanga L .)', *Jurnal Mahasiswa Farmasi Fakultas Kedokteran UNTAN*, 4(1), pp. 1–4.

Septiana, nila ayu made ni, Santi Hapsari, W. and Khoirul Amin, M. (2019) 'Formulasi Dan Uji Sediaan Serbuk Effervescent Ekstrak Okra (Abelmoschus Esculentus) Sebagai Nutridrink Pada Penderita Diabetes', *Media Farmasi*, 16(1), pp. 11–20.

Sidoretno, W.M. (2022) 'Formulasi Dan Evaluasi Granul Effervescent Kombinasi Ekstrak Kering Rimpang Jahe Merah, Temulawak Dan Kayu Manis', *JOPS (Journal Of Pharmacy and Science)*, 5(2), pp. 21–35. https://doi.org/10.36341/jops.v5i2.2461.

Sinaga, W. (2016) 'Peran Tunas Brokoli pada Stres Oksidatif Penyandang Diabetes', *Jurnal Cermin Dunia Kedokteran*, 43(10), pp. 792–795.

Siregar, P.N.B. *et al.* (2022) 'Review: Kandungan Kimia Jahe Merah (Zingiber officinale var. Rubrum) dan Pembuktian In Silico sebagai Inhibitor SARS-CoV-2', *Jurnal Pharmascience*, 9(2), p. 185. https://doi.org/10.20527/jps.v9i2.13149.

Siskawardani, D.D., Warkoyo, W. and Onthong, J. (2021) 'Sweet bread

chemical properties optimalization based on baking temperature and duration', *Canrea Journal: Food Technology, Nutritions, and Culinary Journal*, 4(1), pp. 1–7. https://doi.org/10.20956/canrea.v4i1.416.

Suena, N.M.D.S., Suradnyana, I.G.M. and Juanita, R.A. (2021) 'Formulasi Dan Uji Aktivitas Antioksidan Granul Effervescent Dari Kombinasi Ekstrak Kunyit Putih (Curcuma zedoaria) Dan Kunyit Kuning (Curcuma longa L.)', *Jurnal Ilmiah Medicamento*, 7(1), pp. 32–40. https://doi.org/10.36733/medicamento.v7i1.1498.

Syukri, Y. (2018) *Teknologi sediaan obat dalam solida*, *Angewandte Chemie International Edition, 6(11), 951–952.*

Verenzia, N.A., Sukardi, S. and Wachid, M. (2022) 'Karakterisasi Fisikokimia dan Organoleptik Stik dengan Formulasi Tepung Lemon (Citrus limon L) dan Pati Jahe Merah (Zingiber officinale var Rubrum)', *Food Technology and Halal Science Journal*, 5(1), pp. 93–108.https://doi.org/10.22219/fths.v5i1.18979.

Vifta, R.L., Rahayu, R.T. and Luhurningtyas, F.P. (2019) 'Uji Aktivitas Antioksidan Kombinasi Ekstrak Buah Parijoto (Medinilla Speciosa) dan Rimpang Jahe Merah (Zingiber Oficinalle) dengan Metode ABTS (2,2-Azinobis (3-Etilbenzotiazolin)-6-Asam Sulfonat)', *Indonesian Journal of Chemical Science*, 8(3), pp. 197–201.

Yunita, M. and Rahmawati (2015) 'Uji Rangking Berdasarkan Tekstur) .', *Konversi*, Volume 4 N, pp. 17–28.

Table 1. Experimental design for effervescent powdered drink research

Run	Drying Time (hours)	Alginate (%)	Red Ginger Powder (%)
1	2.00	3.25	4.25
2	1.87	2.12	5.37
3	1.50	1.00	6.50
4	1.75	1.00	6.50
5	1.87	5.50	2.00
6	1.62	2.12	5.37
7	1.75	4.37	3.12
8	2.00	5.50	2.00
9	1.50	5.50	2.00
10	1.50	3.25	4.25
11	1.50	3.25	4.25
12	2.00	1.00	6.50
13	2.00	1.00	6.50
14	1.50	5.50	2.00
15	1.50	1.00	6.50
16	2.00	3.25	4.25

Source: Design-Expert 13 Processing Results

Table 2. Results of physical and chemical response test parameters

Formula	Angle Of Repose (°)	Dissolving Time (second)	Bulk Density (g/mL)	Total Dissolved Solids (°Brix)	Flow Time (second)	Moisture Content (%)	pH Value	Antioxidant Activity (ppm)	Total Sugar (%)
1	39.97^{k}	74.94^{b}	0.56^{b}	3.00^{i}	0.20^{c}	4.81^{l}	4.26^{a}	186.02^{g}	29.86^{p}
2	24.22^{a}	74.78^{bc}	0.56^{b}	3.00^{i}	0.28^{f}	4.71^{h}	4.40^{b}	181.45^{e}	21.57^{e}
3	39.39^{i}	84.96^{j}	0.60^{e}	2.57^{d}	0.17^{b}	4.70^{g}	4.77^{h}	265.15^{m}	11.86^{a}
4	41.35^{p}	80.48^{h}	0.58^{d}	2.70^{e}	0.28^{f}	4.89^{m}	4.88^{k}	265.44^{n}	24.20^{m}
5	31.63^{b}	75.36^{e}	0.60^{e}	2.53^{c}	0.30^{g}	4.58^{f}	4.54^{c}	96.15^{a}	18.09^{d}
6	40.72^{n}	77.84^{g}	0.58^{d}	3.00^{i}	1.24^{i}	4.24^{c}	4.60^{d}	173.05^{d}	21.65^{f}
7	40.58^{l}	78.00^{g}	0.54^{a}	2.50^{b}	1.09^{h}	4.48^{e}	4.68^{f}	271.61^{o}	23.43^{i}
8	35.06^{d}	73.16^{a}	0.57^{c}	3.00^{i}	0.28^{f}	4.20^{a}	4.98^{n}	185.50^{f}	17.93^{c}
9	37.89^{f}	75.20^{de}	0.60^{e}	2.57^{d}	0.15^{a}	4.21^{b}	4.67^{e}	234.25^{k}	24.14^{l}
10	39.24^{h}	77.04^{f}	0.60^{e}	2.80^{g}	0.23^{e}	4.89^{m}	4.95^{m}	190.54^{i}	23.73^{k}
11	40.65^{m}	77.04^{f}	0.60^{e}	2.77^{i}	0.22^{d}	4.90^{n}	4.92^{l}	198.93^{j}	23.05^{g}
12	38.43^{g}	75.20^{de}	0.60^{e}	2.80^{g}	1.09^{h}	4.72^{i}	4.87^{j}	159.14^{b}	23.49^{j}
13	37.23^{e}	74.90^{bcd}	0.60^{e}	2.73^{f}	1.09^{h}	4.75^{k}	4.86^{i}	159.51^{c}	25.29^{n}
14	39.84^{j}	73.30^{a}	0.58^{d}	2.40^{a}	0.15^{a}	4.29^{d}	4.67^{e}	236.76^{l}	23.26^{h}
15	41.08^{o}	83.90^{i}	0.60^{e}	2.83^{h}	0.17^{b}	4.74^{j}	4.76^{g}	272.07^{p}	13.61^{b}
16	34.87^{c}	74.98^{cd}	0.56^{b}	3.00^{i}	0.20^{c}	4.48^{e}	4.26^{a}	187.56^{h}	28.38^{o}

*Samples means with same superscripts in the same column are not significantly at $\alpha = 0.05$

Table 3. Verification of optimum formula results

Respon	Actual	Prediction	Std Dev	SE Mean	P1 Prediction Range 95%	
					Low	High
Angle Of Repose	37.89	37.97	2.27	1.46	31.72	44.19
Dissolving Time	75.65	75.45	0.91	0.59	72.94	77.96
Bulk Density	0.58	0.59	0.02	0.01	0.55	0.64
Total Dissolved Solids	2.40	2.73	0.16	0.07	2.34	3.12
Flow Time	0.80	0.78	0.21	0.13	0.22	1.34
Moisture Content	4.75	4.77	0.21	0.08	4.30	5.25
pH Value	5.10	4.85	0.12	0.07	4.54	5.16
Antioxidant Activity	172.79	162.88	46.12	30.12	32.61	293.15
Total Sugar	29.59	21.72	3.21	1.84	13.65	29.79

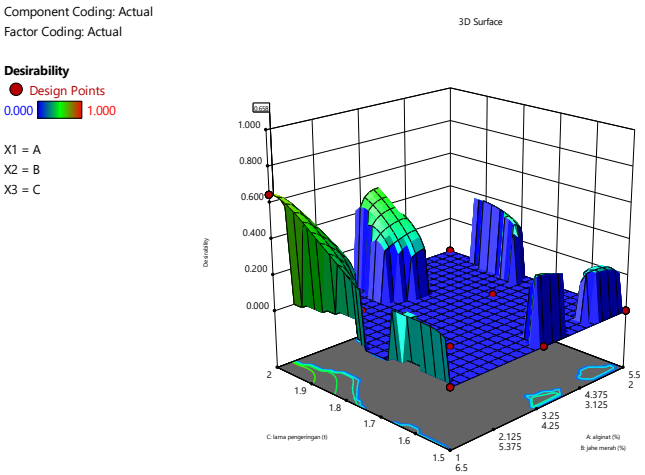

Figure 1. *Desirability* of effervescent powdered beverage