Journal of Vocational Studies on Applied Research

Implementation of Ambon Banana Peel *(Musa Paradisiaca)* as Foaming Agent of Banana Fruitghurt using Foam Mat Drying Method

Cindyana Putry[1*)], Vita Paramita[1)], Indah Hartati[2)]

[1)]Department of Technology and Industry, Vocational College, Diponegoro University, Jl Prof Soedarto. SH, Tembalang, Semarang, 50275, Indonesia
[2)]Chemical Engineering, Faculty of Engineering, Wahid Hasyim University, Jl. Menoreh Tengah X/22 Sampangan Semarang, 50236, Indonesia

[*)]Corresponding Author: cindyanaputri99@gmail.com

Abstract - *Fruitghurt is a product of lactic acid fermentation, namely L. bulgaricus and S. Thermopillus in an acidic state enriched by nutrients from fruit such as Ambon banana but has a short shelf life. Bananas have a role as an additional nutrient in the form of glucose which then becomes a nutrient for lactic acid bacteria. Foam mat drying itself is a drying method that is better than other types of drying because it does not require large production costs and protects the structure of the material through the formation of foam. Application of foam mat drying on fruitghurt using Ambon banana peel extract as a foaming agent is expected to increase the shelf life of fruitghurt as well as an alternative foaming agent derived from vegetable protein Ambon banana peel contains a protein content of about 0.64% when bananas experience a good level of maturity.In the manufacture of fruitghurt powder, the research method used is Response Surface Methodology (RSM) with variables changing the concentration of banana peel extract as a foaming agent, the concentration of maltodextrin as a binder and mixing time. The resulting fruitghurt powder will be analyzed for water content, total acid analysis and pH analysis. The research data were processed using minitab 19 software. Thebest fruitghurt powder results were found in the 9th variable with the optimum conditions (banana peel extract concentration of 2.38 ml, maltodextrin concentration of 30 grams and stirring time of 20 minutes). Fruitghurt variable 9 has a pH of 5 after drying which is in accordance with SNI 01-2981-2009, water content is 0.64% and total acid is 1.08%*

Keywords: *foam mat drying; fruitghurt; foaming agents; ambon banana peel*
Received: September 14, 2022 Revised: November 3, 2022 Accepted: December 20, 2022

Doi: http://dx.doi.org/10.14710/jvsar.v4i2.15821
[How to cite this article: Putry, C., Paramita, V., and Hartati, I. (2022). Implementation of Ambon Banana Peel (Musa Paradisiaca) as Foaming Agent of Banana Fruitghurt using Foam Mat Drying Method. *Journal of Vocational Studies on Applied Research, 4*(2), 40-46. doi: http://dx.doi.org/10.14710/jvsar.v4i2.15821]

INTRODUCTION

The Covid 19 outbreak that began in March 2020 caused Indonesian people to compete to buy and consume various types of food that contain certain nutritional intakes that are useful for strengthening the body's immune system. One example is bear milk with certain trademarks or vitamin-rich drinks (Arnomo, et. al, 2021.) In fact, foods or drinks that can provide additional vitamins to the body are not only obtained from bear milk or drinks rich in vitamin C. Examples of drinks no less nutritious is yogurt enriched with fruit extracts (Sopiani, 2021)

Fruit yoghurt is yoghurt which in the process of making fruit juice is added to increase the organoleptic properties of yogurt (Tamime & Robinson, 2007). The selection of bananas as an additional ingredient in fruitghurt because it contains flavonoids, glucose, fructose, sucrose, flour, protein, fat, oil, is rich in vitamins (A, B, C, and E), minerals (potassium, calcium, phosphorus, Fe), high levels of pectin, serotonin, dopamine, and noradrenaline as well as potassium with varying levels (Ramadhan et al., 2021).

Banana is a fruit that contains flavonoids, glucose, fructose, sucrose, flour, protein, fat, oil, rich in vitamins (A, B, C, and E), minerals (potassium, calcium, phosphorus, Fe), pectin, serotonin, dopamine, and noradrenaline as well as potassium which is quite high with varying levels (Ramadhan et al., 2021).

The type of glucose contained in Ambon banana can provide additional nutrition for lactic acid bacteria in addition to lactose which is only obtained from milk (Toledo,2012). However, the shelf life of fruitghurt tends to be short, so it is necessary to use a drying method on fruitghurt products that have gone through a fermentation process, for example foam mat drying. The foam mat dying method was choosen because the production cost is small and it uses an easy tool by making the material into foam first. Water content in the sample without foam decreases slowly compared to the sample with addition maltodextrin (Kurniasari, 2019).

The most widely used foaming agent is egg white. This is because egg whites are easy to obtain and can produce large amounts of foam (Haryanto,2016). However, the addition of egg whites as a yogurt foaming agent can be a problem for some people who do not like the fishy smell of egg whites. Therefore, banana peels are used as a foaming agent from vegetable protein containing a protein content of about 0.64% when bananas experience a good level of maturity (Wakano et al., 2020).

In principle, this drying method uses the help of foam which aims to speed up drying, maintain the content of food ingredients, especially those that are easily damaged, so that they remain in good condition (Hidayat, 2021). Drying is an intensive process that can consume a huge amount of energy when it is not applied well; acquiring the fundamental behavior of the tested material and modeling the drying system are two necessary steps for an adequate and efficient accomplishment of the process (Bennamon, 2018)

According to research conducted by (Li et al., 2020) protein is a foaming agent that is commonly used in various food applications. Examples are whipped cream and bread making. Likewise, research conducted by (Jiangping Ye et al., 2021) in which the use of a foaming agent obtained from soy protein can produce foam with good emulsion ability. Ambon banana peel contains a protein about 0.64% when bananas in a good level of maturity (Wakano et al., 2020). The presence of protein content in Ambon banana peel proves that there is potential for banana peel extract to become a good foaming agent from the vegetable protein

METHODS

Determination of the best solution variable fruitghurt powder with the lowest water content using Minitab 19 software and falls on the 9th variable, namely the minimase variable, where the concentration of banana peel extract is 2.38 ml, maltodextrin concentration is 30 grams and mixing time is 20 minutes. Fruitghurt variable 9 has a pH of 5 after drying, a water content of 0.64% and a total acid content of 1.08%.

In the independent variable analysis, it was found that the higher the concentration of maltodextrin, the concentration of banana peel extract and mixing time resulted in lower water content. The pH analysis carried out on each sample of fruitghurt powder after drying resulted in an acidic pH ranging from 4-5.

The main raw materials used are bananas and their skins, skim milk, sugar, biocultivar as a starter, agar powder, maltodextrin, aquadest, PP indicator, NaOH.

The tools used are: measuring cup, porcelain cup, watch glass, analytical balance, stove, burette, clamps and stabilizers, beaker glass, funnel, spoon, mixer, thermometer, mortar and pestle, incubator, blender, oven, sieve. 50 mesh, erlenmeyer, sieve, universal indicator.

Table 1 Experimental Independent Variables

Independent Variables	Star Low	Low Point	Center Point	High Point	Star High
Banana Peel Extract (mL)	2,38	7,5	15	22,5	27,62
Maltodextrin (gr)	17,38	22,5	30	37,5	42,61
Mixing time (Minutes)	11,59	15	20	25	28,40

Table 2 Experimental Design Using RSM

No	Banana Peel Extract (mL)	Maltodextrin (gr)	Mixing Time (Minutes)
1	7.5	22.5	15
2	7.5	22.5	25
3	7.5	37.5	15
4	7.5	37.5	25
5	22.5	22.5	15
6	22.5	22.5	25
7	22.5	37.5	15
8	22.5	37.5	25
9	2.4	30	20
10	27.6	30	20
11	15	17.4	20
12	15	42.6	20
13	15	30	11.6
14	15	30	28.4
15	15	30	20
16	15	30	20

Foam mat drying process using an experimental design using Respond Surface Methodology (RSM) to determine the variables involved most influential which can be seen in Table 1. In this study, the variable banana peel extract of the solution, concentration of maltodextrin, and mixing time were used.

RESULTS AND DISCUSSION

Result of Fruitghurt Powder Analysis

Table 2. Fruitghurt Powder Test Results

Run	Banana Peel Extract (mL)	Concentration of Maltodextrin (gr)	Mixing Time (minutes)	pH		Total Acid (%)	Water Content (%)
				Before	After		
1	7.5	22.5	15	4	5	1.08096	0.63253
2	7.5	22.5	25	4	4	1.3512	0.615854
3	7.5	37.5	15	5	5	1.17104	0.71123
4	7.5	37.5	25	4	5	1.44128	0.724868
5	22.5	22.5	15	5	4	1.89168	0.552941
6	22.5	22.5	25	5	5	1.98176	0.574713
7	22.5	37.5	15	5	5	1.8016	0.727749
8	22.5	37.5	25	4	5	1.89168	0.703704
9	2.4	30	20	5	5	1.08096	0.641975
10	27.6	30	20	5	5	1.98176	0.618557
11	15	17.4	20	4	5	1.53136	0.613497
12	15	42.6	20	4	5	1.71152	0.705882
13	15	30	11.6	4	5	1.53136	0.606742
14	15	30	28.4	5	5	1.62144	0.620112
15	15	30	20	4	5	1.44128	0.621469
16	15	30	20	5	5	1.44128	0.621469

Determination of water content in banana extract fruitghurt using foam mat drying method with various variations of banana peel extract, maltodextrin and mixing time. Of the 16 runs that have been carried out, the water content obtained ranged from 0.5 to 0.7%. The decrease in water content is due to the heat from the drying air received by the material to meet the latent heat of evaporation of water, the water content of the material is in the free water status. In line with the increase in drying time, the rate of decrease in water content is getting faster (Nusa, 2020).

The addition of banana peel extract as a foaming agent and maltodextrin produces foam from vegetable protein so that air bubbles accelerate the drying rate. In addition, the addition of maltodextrin is useful for binding water and expanding the surface area so that the higher the concentration of maltodextrin, the faster the drying rate. which was explained in previous studies that the addition of the concentration of the foaming agent will trigger foaming so that the concentration of the water will get bigger (Nusa, 2020). It can be seen in the table that mixing time with a relatively longer time of 15 to 25 minutes produces a smaller water content. The water content obtained is in accordance with the needs of SNI for instant drinks, namely SNI 01-4320-1996 with a maximum condition of 3%. Variations in time affect the water content where. The longer the fruitghurt stirring time, the more foam or foam produced so that the surface area of the field increases. From the results of the study, it can be seen that the samples of powdered fruitghurt that meet the criteria of SNI 01-4320-1996 are samples 1-16.

The results of the pH test of fruitghurt powder were carried out in various samples before drying using the foam mat drying method and after drying. From the 16 samples that have been carried out, it can be seen that all of them meet the pH of the yogurt, which is acidic both before and after drying. According to SNI (2009), good yogurt has a pH ranging from 4-5. The acidic state of yogurt is caused by the activity of lactic acid bacteria. During the fermentation process Lactoabcillus bulgaricus gives a sour taste while Streptococcus thermophilus gives acidity and flavor (Nurjannah,2019). Lactic acid is the main acid formed in various fermented food products lactic acid bacteria. The amount of acid formed may be so high that it inhibits growth of acid-fast bacteria (Triyono,2010).

The results of the total acid test on fruitghurt banana extract powder using the foam mat drying method in which banana peel is the foaming agent. The test was carried out using 0.1 N NaOH with a sample volume of 10 ml. Of the 16 runs that have been carried out the volume of NaOH required during the titration process ranged from 12-22 ml while the total acid produced ranged from 1.0 to 1.98%. The higher concentration of foaming agent added causes an increase in pH but causes a decrease in lactic acid levels (Prabandari, 2011).
This total acidity was carried out as an indication that the resulting powdered fruitghurt had the same characteristics as yogurt before drying. Based on the quality requirements of yogurt in SNI 01-2981-

1992, the total acid found in yogurt ranged from 0.5 to 2.0%. If seen from the table above, the variables of powdered fruitghurt that meet SNI are samples 1 to 16.

Response Surface Design Analysis between Water Content (%) With Independent Variables using Minitab

Table 3 Model Summary from Response Surface Regression for Water Content (%)

S	R-sq	R-sq(adj)	R-sq(pred)
0.030255	74.8 %	68.53%	53.32%

Table 3 shows the model summary of the response surface regression, the interpretation of the data should be done by referring to the value of R-square adjust (R-aq(adj)) because the values tend to be constant and sensitive to changes in the independent variables. R square has a value between 0 – 1 with the provision that the closer to the number one, the better. But the R-square will change up if you add another variable. The more independent variables used, the more bias or "noise" in the model, and this cannot be explained by R-square and is a weakness of R-square itself. Value of R square Adjusted it is more suitable to know how the independent variable explains the dependent variable, if the researcher uses more than 2 independent variables.

This R squared adjusted has taken into account the number of sample data and the number of variables used, so that the R squared adjusted value does not always increase when additional variables are added. From the table, it is found that the R square adjust is 68.53%, which means 68.53% of the value of the dependent variable (water content of powdered fruitghurt) which is influenced by the independent variables in the study (banana peel extract concentration, maltodextrin concentration and mixing time).

Table 4 Analysis of Variance from Response Surface Regression of Water Content (%)

Source	**DF**	**Adj SS**	**Adj MS**	**F-Value**	**P-Value**
Regression	3	0.032545	0.010848	11.89	0.001
Banana Peel Extract (%)	1	0.002384	0.002384	2.61	0.132
Maltodextrin Concentrations (gr)	1	0.030120	0.030120	33.01	0.000
Mixing Time (minutes)	1	0.000041	0.000041	0.04	0.836
Error	12	0.010948	0.000912		
Lack-of-Fit	11	0.010948	0.000995	*	*
Pure Error	1	0.00000	0.000000		
Total	15	0.043494			

In table 4, the analysis of variance shows that the P-value for the overall regression model is 0.001 where the P-value is <0.05. This means that the response surface regression test is considered to have represented all of the existing data. From the analysis of variance table, it can be seen in the linear part that the P-value of the banana peel extract concentration is 0.132 where this value is greater than (α = 0.05), which means that the banana peel extract concentration variable does not have a significant effect on amount of water produced. Then the maltodextrin concentration variable shows a P-value of 0.000 where this value is smaller than (α = 0.05) which means that the maltodextrin concentration variable has a significant effect on the amount of water content produced. Then the last is the mixing time variable which has a P- value of 0.836 where this value is greater than (α = 0.05) which means that the mixing time variable does not have a significant effect on the amount of water content produced.

The regression equation can be written as:
% Water Content = 0.4710 – 0.00176 Banana Peel Extract Concentration (ml) + 0.00626 Maltodextrin Concentration (gr) + 0.00035 mixing Time (min)

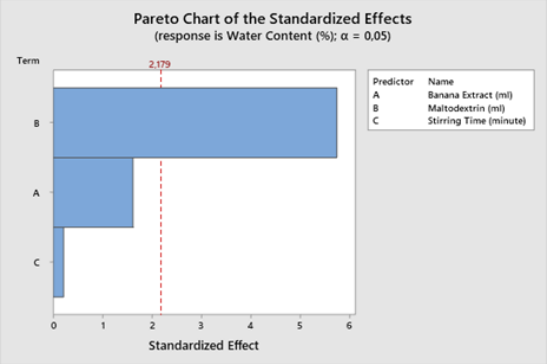


Figure 1 Pareto Diagram of Standard Effects to Determine Effect of Independent Variables on Water Content (%)

The Pareto chart was created to help identify the significant factors that have an effect on the water content resulting from the experiment. From Figure 1 it can be seen that the variable factor of maltodextrin concentration has the most significant effect on the amount of water content produced. This is in accordance with the research conducted by Nusa (2020) that the addition of foam triggers and increasing mixing time will increase the foaming power of the material so as to facilitate the

process drying. This is due to the heat received the material will be better accumulated, materials that have been foaming will enlarge the area drying air contact surface with material, and area evaporation of water in the material, so that the decrease in water content occurs more quickly. Then after that there is a variable concentration of banana extract which has an effect on the amount of water content, and a variable mixing time which gives the smallest effect on the amount of water content produced.

After performing a regression analysis on the response surface design, it is also necessary to look at the residual plot of the resulting water content. Residual is the difference between the dependent variable or Y with Y prediction. Y prediction is the value of Y based on the results of the regression equation. The residual plot can be observed in Figure 2.

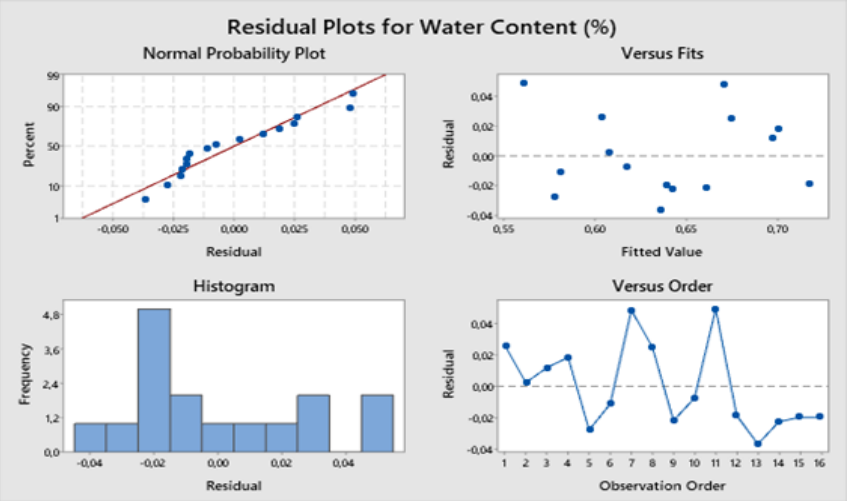


Figure 2. Residual Plots Graph from Analysis of Independent Variable on Water Content (%)

In the histogram graph in Figure 2, it can be seen that the histogram resembles a bell facing upwards and means that the residuals are said to contribute normally. A bell shaped curve, also called a standard curve or normal curve, is a curve that represents the normal distribution of test numbers or values. The normal distribution has a normal/directed pattern distribution, has a mean of zero, and a standard deviation of one. This distribution is called the bell curve because the graph of the probability density function is similar to the shape of a bell. Data that is normally distributed will minimize the occurrence of bias.

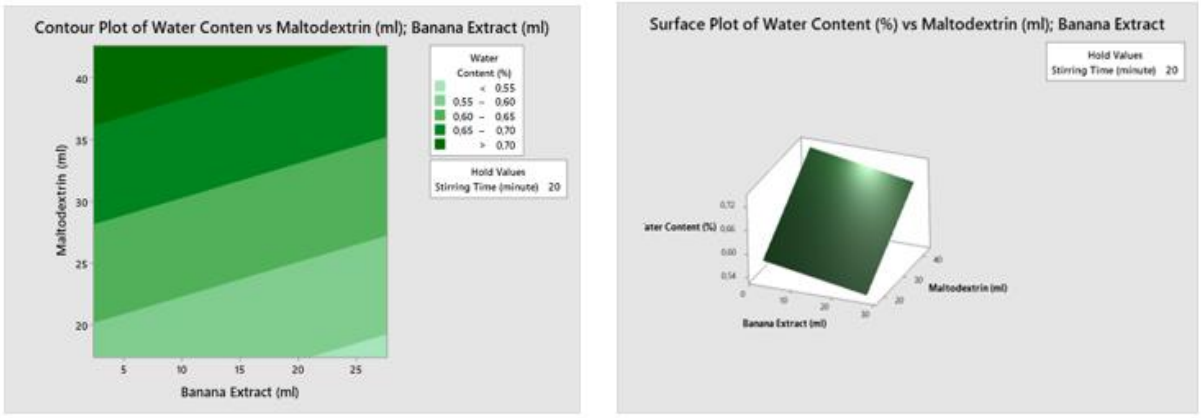
In the Normal Probability Plot graph, the plot results are not randomly distributed but follow a straight line or the dots follow and approach the diagonal line so that it can be concluded that the regression model meets the assumption of normality and the residuals are normally distributed.

The normality assumption test is a test conducted with the aim of assessing the distribution of data in a group of data or variables, whether the distribution of the data is normally distributed or not.

A good regression model is one that has a normal or close to normal data distribution. In the versus fit and versus order graphs, it can be concluded that there are no symptoms of heteroscedasticity because the plots spread evenly above and below the 0 axis without forming a particular pattern.

Furthermore, to analyze the relationship between variables, contour plots and surface plots can be used to analyze the variables of mixing time and the concentration of banana peel extract on water content with the variable concentration of maltodextrin and banana peel extract concentration on water content. To analyze the effect of variable banana peel extract and maltodextrin concentration on water content, it can be seen in Figure 3.

In Figure 3 in the contour plot, it can be seen that the most optimum part (which produces a small water content) is marked with a light green color, and is present at a concentration of 15-20 grams of maltodextrin and a concentration of 20-25 ml banana peel extract. Then on the surface plot, the most optimum water content is shown at the top end of the curve which is also at a concentration of 15 gram maltodextrin and 25 ml banana peel extract concentration. The greater the concentration of maltodextrin, the smaller the water content produced, while the smaller the concentration of maltodextrin, the greater the water content.

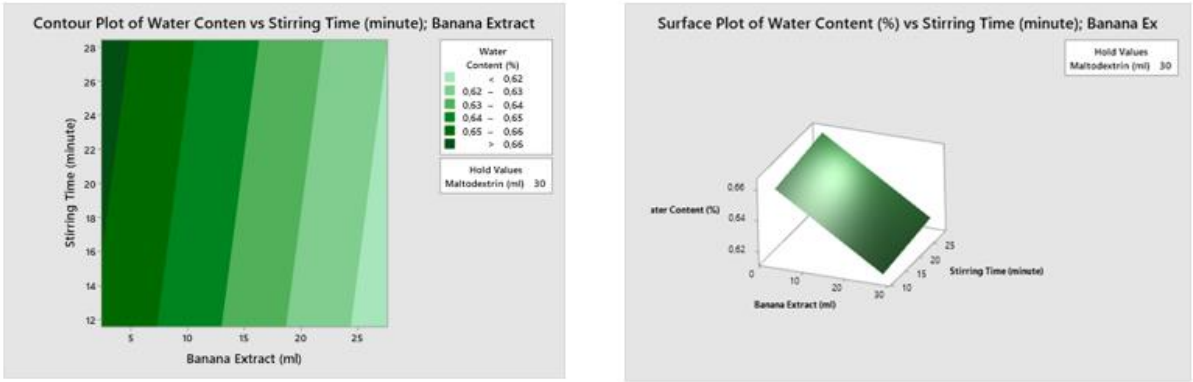


(a) Contour Plot (b) Surface Plot

Figure 3. Analysis of Water Content (%) vs Maltodextrin (gr); Banana Extract (mL)

Then for the concentration of banana peel extract, the greater the concentration of banana peel extract added, the smaller the water content formed and vice versa, the smaller the concentration of banana peel extract, the greater the water content.

Then to analyze the effect of variable concentration of maltodextrin and concentration of banana peel extract on water content with variable stirring time and concentration of banana peel extract on water content can be seen in Figure 4.



(a) Contour Plot (b) Surface Plot

Figure 4. Analysis Effect of Water Content (%) vs Stirring Time (minutes); Banana Extract (mL)

In Figure 4 in the contour plot, it can be seen that the most optimum part (producing a small water content) is marked with a light green color, and is present at a mixing time of 14 minutes and a concentration of 25 ml Banana peel extract. Then on the surface plot, the most optimum water content is shown at the top end of the curve which is also at a mixing time of 14 minutes and a banana peel extract concentration of 25 ml.

The longer the mixing time, the smaller the water content produced, while the smaller the mixing time, the greater the water content.Then for the concentration of banana peel extract, the greater the concentration of banana peel extract added, the smaller the water content formed and vice versa, the smaller the concentration of banana peel extract, the greater the water content.

This is in accordance with the research conducted by Nusa (2020) that the addition of foam triggers and increasing mixing time will increase the foaming power of the material so as to facilitate the process drying. This is due to the heat received the material will be better accumulated, materials that have been foaming will enlarge the area drying air contact surface with material, and area evaporation of water in the material, so that the decrease in water content occurs more quickly.

Based on the results obtained, the optimum water content (yielding small moisture content) was obtained with the minimum variable conditions, which are listed in Table 5 using a banana peel extract concentration of 2.39 ml, a maltodextrin concentration of 42.6 g, and a mixing time of 28 ,40 minutes. The program found the optimum value with composite desirability 1.

Table 5. Solutions of Independent Variable Water Content in Fruitghurt Powder

Solutions	Banana Peel Extract (mL)	Maltodextrin Concentrations (gr)	Mixing Time (minutes)	Water Content (%) Fit	Composite Desirability
1	2.38655	42.6135	28.4090	0.743489	1

The desirability value is the value of the optimization objective function which indicates the program's ability to fulfill the wishes based on the specified criteria. The range of desirability values is 0-1.0. This shows that the closer the value to 1.0, the more perfect (Nurul et al., 2019).

CONCLUSION

Determination of the best solution variable fruitghurt powder with the lowest water content using Minitab 19 software and falls on the 9th variable, namely the minimase variable, where the concentration of banana peel extract is 2.38 ml, maltodextrin concentration is 30 grams and mixing time is 20 minutes. Fruitghurt variable 9 has a pH of 5 after drying, a water content of 0.64% and a total acid content of 1.08%.

In the independent variable analysis, it was found that the higher the concentration of maltodextrin, the concentration of banana peel extract and mixing time resulted in lower water content. The pH analysis carried out on each sample of fruitghurt powder after drying resulted in an acidic pH ranging from 4-5.

REFERENCES

Arnomo, S. A. (n.d.). Market Basket Analysis pada Barang Minimarket dimasa Pandemi Covid-19. JUSTIN (Jurnal Sistem Dan Teknologi Informasi), 9(2), 127–131.

Bennamoun, L., & Li, J. (2018). Drying process of food: fundamental aspects and mathematical modeling. In Natural and artificial flavoring agents and food dyes (pp. 29–82). Elsevier.

Fardiaz, S. (2019). mikrobiologi pengolahan Pangan.

Haryanto, B. (2016). Pengaruh konsentrasi putih telur terhadap sifat fisik, kadar antosianin dan aktivitas antioksidan bubuk instan ekstrak kulit manggis (Garcinia mangostana L.) dengan metode foam mat drying. Jurnal Kesehatan, 7(1), 1–8.

Kurniasari, F., Hartati, I., & Kurniasari, L. (2019). Aplikasi Metode Foam Mat Drying Pada Pembuatan Bubuk Jahe (Zingiber Officinale). Jurnal Inovasi Teknik Kimia, 4(1).

Li, X., Murray, B. S., Yang, Y., & Sarkar, A. (2020). Egg white protein microgels as aqueous Pickering foam stabilizers: Bubble stability and interfacial properties. Food Hydrocolloids, 98, 105292.

Nasional, B. S. (2009). SNI Yoghurt (SNI 01-2981-2009). Dewan Standar Indonesia: Jakarta.

Nurjanah, S., Muchayani, D., Afrianto, A., & Syamsiary, E. (n.d.). Penggunaan "Pre-Kupis"(Prebiotik Kulit Pisang) Sebagai Pengganti Antibiotik Untuk Peternakan Organik Masa Depan.

Nusa, M. I. (2020). KINETIKA PENGERINGAN SARI BUAH MENGKUDU DENGAN METODE FOAM MATE DRYING.Agrintech: Jurnal Teknologi Pangan Dan Hasil Pertanian, 3(1), 28–36.

Prabandari, W. (2011). Pengaruh penambahan berbagai jenis bahan penstabil terhadap karakteristik fisikokimia dan organoleptik yoghurt jagung.

Ramadhan, M. R., Retnaningrum, Y. R., Riastiti, Y., Yadi, Y., & Irawiraman, H. (2021). Pengaruh Konsumsi Pisang Ambon (Musa paradisiaca) terhadap Penurunan Tekanan Darah Penderita Hipertensi di Puskesmas Bontang Selatan. Jurnal Sains Dan Kesehatan, 3(2), 290–295.

Sopiani, R. A. (2021). Perilaku Gizi Konsumen pada Produk Minuman Yoghurt Kemasan di Kota Bekasi.

Tamime, A. Y., & Robinson, R. K. (2007). Tamime and Robinson's yoghurt: science and technology. Elsevier.

Toledo, T. T., Nogueira, S. B., Cordenunsi, B. R., Gozzo, F. C., Pilau, E. J., Lajolo, F. M., & do Nascimento, J. R. O. (2012). Proteomic analysis of banana fruit reveals proteins that are differentially accumulated during ripening. Postharvest Biology and Technology, 70, 51–58.

Triyono, A. (2010). Mempelajari pengaruh maltodekstrin dan susu skim terhadap karakteristik yoghurt kacang hijau (Phaseolus radiatus L.).

Wakano, D., Sahertian, D. E., & Telussa, T. (2020). Analisis Nilai Proksimat Kulit Buah Pisang Tongka Langit (Musa troglodytarum L.) Pada Beberapa Tingkat Kematangan Buah. AGRITEKNO: Jurnal Teknologi Pertanian, 9(2), 58–63.