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Optimization of Papaya Callina Soft Candy Formulation (*Carica papaya* L.) Using The Response Surface Method

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Abstract

Papaya has perishable properties such as easily rot and weight loss. The making of papaya soft candy is an alternative to developing food products. The purpose of this study was to obtain the right formulation using the surface response method to evaluate the effect of sucrose and agar concentrations on soft candy quality. The soft candy quality parameters observed were color, water content, vitamin C, TDS (total dissolved solids), hedonic values (color, aroma, texture, and taste). The sucrose concentrations used were 10.9%, 15%, 25%, 35%, 39.1%, and the concentration of agar was 0.8%, 1%, 1.4%, 1.8%, 2%. Soft candy papaya will reach the optimum response on a combination of 25.99% sucrose concentration and 1.08% agar, which is expected to produce orange with Chroma 19.85, L 35.56, a * 10.87, b * 14.57 and Å ° Hue 51.94, pH 4, total dissolved solids 49.37 Orix, water content 14.57%, vitamin C 36.58 mg / 100 g. The hedonic color value is 4.66 (rather like), aroma 4.20 (neutral), taste 4.78 (rather like), texture 4.43 (neutral).

Keywords: agar-agar, papaya callina, response surface method, soft candy, sucrose

1. Introduction

Indonesia is one of the tropical countries who have a wealth of diversity of plants that are beneficial for health. One of the most popular fruit is Papaya fruit. Papaya is one of the fruit commodities that has many functions and benefits.

Papaya is widely consumed because in addition to containing good nutrients, the price is also relatively affordable compared to other fruits. Besides being consumed as fresh fruit, papaya can also be processed into various food and beverage ingredients which is have a good value in foreign markets such as processed puree, papaya paste, dried sweets, wet sweets, papaya sauce and others.

Candy is one of the foods that is very easy to obtain, starting from a complete supermarket, small stalls, even hawkers on the streets that provide various shapes, colors and flavors. Making papaya fruit soft candy is one alternative product development, especially in the food sector. Soft candy are a type of brightly colored

or fruit-based pectin, shaped like a cone cut and coated with sugar. This makes soft candy feel very sweet. Making soft candy is almost the same as jelly candy, made from a mixture of fruit juice, gelling material or by adding flavor to produce a variety of flavors, with a clear transparent physical form. Besides soft candy are given coating materials in the form of granulated sugar after the drying process is done. It is expected that a better production process will increase the selling value of papaya-based products

The purpose of this study was to obtain an appropriate formulation of the effect of sucrose and agar concentration on the quality of papaya soft candy

2. Materials and Method

The materials used in the study are grouped as raw materials and additional ingredients. The raw materials used are papaya fruit, sucrose and agar. Whereas additional ingredients consist of citric acid, and coating materials, namely sugar. The equipment used consists of digital scales, pans, stoves, stirrers, juicers, baking pans, knives, plastic gloves, stopwatches, color reader Konica Minolta CR-10 type, hand refractometer, tunnel dehydrator dryer, 0.8 PP plastic, sealer chemical analysis equipment and organoleptic tests.

Experimental Design

This experiment design consists of 2 factors, namely the concentration of sugar (X1) and agar-agar (X2). The research design used was Surface Methodology Response with 2 replications, by entering the value into the Minitab 16 program, it will produce 13 units of experimental combinations. The data obtained was processed using Minitab 16 statistical tools for treatment that showed real differences more specifically.

Product Analysis

The analysis performed was physical test, chemical test and hedonic organoleptic test. Physical testing of soft candy products includes color determination using Color Reader CR-10. chemical tests consist of water content (AOAC, 1984), vitamin C (Sudarmadji, et. al., 1984), pH Test (Muchtadi, 1989), determination of total dissolved solids. The next analysis was the organoleptic test of the hedonic method with color, aroma, texture and taste of soft candy using 25 trained panelists. Organoleptic tests were conducted to obtain selected formulations based on the level of preference of the panelists.

3. Results and Discussion

Color

Color is one of the important parameters in determining the level of consumer preference for a product. Winarno (1997), states that the determination of the quality of a food product is influenced by several factors such as color, taste, texture and nutritional value.

Value a * Color

A value is reflected light which produces a red green chromatic color mixture (Saputra, 2005). The average value of a * is 10.9 which shows red. In figure 1 shows

that the concentration of sucrose and agar does not have a significant effect on the value of a * papaya soft candy color. This shows no contribution to the addition of sucrose concentration and agar concentration in the red color produced. The normal picture of a plot of red papaya soft candy can be seen in Figure 1.

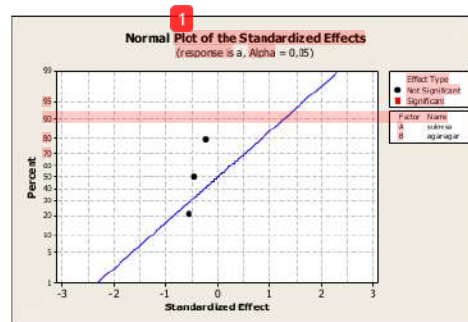


Figure 1. Normal Value Plot a * Color

A residual normality plot if the residual points produced are appropriate or close to a straight line determined based on data (residual), then the residuals can be said to have met or followed a normal distribution

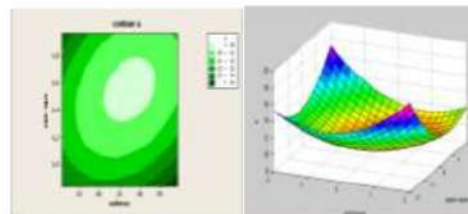


Figure 2. Contour Plot and Surface Value Plot a * Papaya Gumdrops Color

Figure 2 shows the contour plot and the plot surface of the papaya soft candy. The resulting image forms a saddle point with a regression function $Y = 23,8660 - 0,2334X1 - 14,1516X2 + 0,0079X1^2 + 5,70703X2^2 - 0,129688X1X2$. The saddle point shows that the data obtained for the a * color of papaya soft candy obtained on optimal conditions. The widest area of contour plot images is shown by the a * limit of 10 to 11 with sucrose concentrations of 15% to 35% in all distributions of sucrose concentrations, and agar-agar from 1.2 to 1.8. On the surface of the purple part of the plot in the figure shows the value of a * for the color of soft candy getting a value above 16.

Value b * Color

The value of b is reflected light which produces a mixture of blue and green chromatic colors (Saputra, 2005). The average value of b * which is 14.4 shows yellow. Figure 3 shows that the concentration of sucrose and agar did not have a significant effect on the value of b * papaya soft candy. The normal picture of the yellow plots of papaya soft candy can be seen in Figure 3.

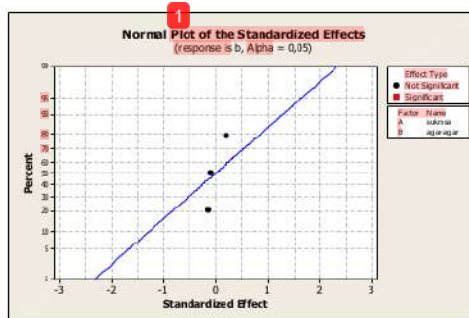


Figure 3. Normal plot of the value of b papaya soft candy

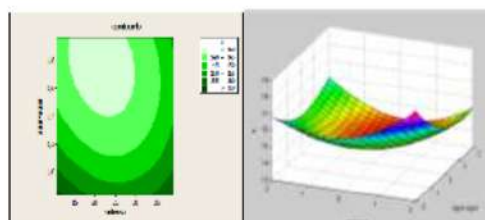


Figure 4. Contour plot and Value b * surface plots of Papaya Soft candy

Figure 4 shows the contour plot and the plot surface of the value of b * papaya soft candy. The image shows that from the data of the value of b * the papaya soft candy color is in optimal. The widest area of contour plot images is shown by the value of b * boundaries 14.0 to 14.5 with sucrose concentrations of 15% to 35% in all distributions of sucrose concentrations, and agar 1.6 to 1.8. The surface of the pink part plot in the figure shows the value of b * for the color of the soft candy getting a value above 16.

Hue Color Value

In Figure 5 shows that the concentration of sucrose and agar do not have a significant effect on $^{\circ}$ Hue color, so that the resulting papaya soft candy color is not different. This is presumably because there is no contribution of sucrose and agar because the two ingredients are colorless.

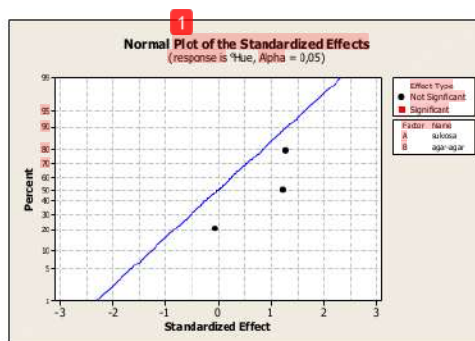


Figure 5. Normal plot of $^{\circ}$ Hue Value for Papaya Soft Candy

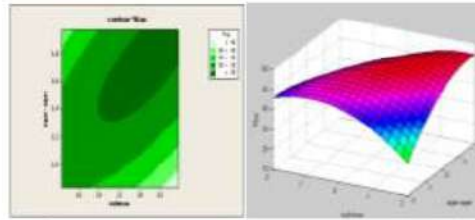


Figure 6. Contour plot and surface plot of °Hue Value Color of Papaya Soft candy

Figure 6 shows the contour plot and the plot surface of the color values of papaya soft candy. The figure shows that from the data of the value of Hue the optimal papaya soft candy color can be determined. The widest area of the contour plot image is indicated by the Hue value of the limit of 50 to 55 with a sucrose concentration of 15% to 35% in all distributions of sucrose concentration, and agar 1.0 to 1.4. On the surface of the red part of the plot in the figure shows the value of ° Hue to the intensity of the brightness of the soft candy color getting a value above 50.

Chroma Color (Color Intensity)

The average value of the papaya soft candy color is 18.9, meaning that the chroma color of soft candy shows results with a strong red color intensity. Viewed from the initial characteristics of papaya raw material, the resulting color is exactly red with strong intensity.

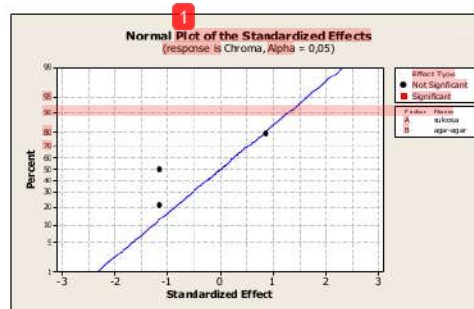


Figure 7. Normal plot of the value of the papaya soft candy color Chroma

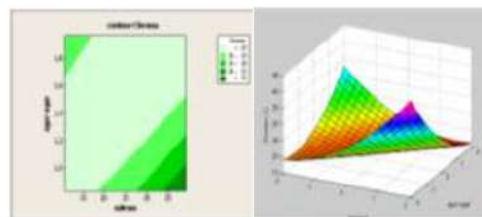


Figure 8. Contour plots and surface plots of the Chroma Color of Papaya Soft Candy

Figure 8 shows the contour plot and the plot surface of the papaya soft candy. The form of the saddle point on the contour plot and the surface plot shows that the color chroma data obtained does not get the optimum condition. The widest area of

contour plot images is shown by the color limit value < 20 with 15% to 35% sucrose concentration in all distributions of sucrose concentration, while the color analysis with the highest chroma value (> 32) is obtained at sugar concentrations above 35%. The blue surface plots indicate that the chroma color soft candy get a chroma value above 35.

L Color Value (Brightness)

Figure 9 shows that the concentration of sucrose and agar did not significantly influence the L value of the papaya soft candy. The attribute L is a brightness value from 0 to 100 (saputra, 2005). The L value is getting higher, showing the color of the soft candy getting brighter.

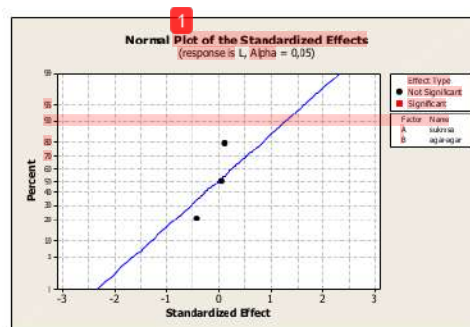


Figure 9. Normal plots the value of L papaya soft candy

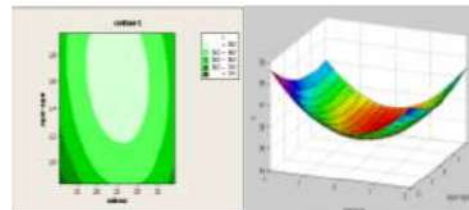


Figure 10. Contour plots and surface plots of L Value of Papaya Soft candy

Figure 10 shows the contour plot and surface plots of papaya soft candy. The L value (brightness) of papaya soft candy obtained optimal conditions. The widest area of contour plot images is shown by the L limit of 35.5 to 36.0 with 15% to 35% sucrose concentration in all distributions of sucrose concentrations, and 1.0 to 1.8 in order. On the surface of the red part of the plot in the image shows the L value of the color of the soft candy getting a value above 38

pH

Figure 11 shows that agar concentration factor (B) has a significant effect on the pH level of the papaya soft candy produced. This shows that agar concentration affects the pH of soft candy. While the interaction between the factors of sucrose concentration and agar concentration (AB) did not have a significant effect.

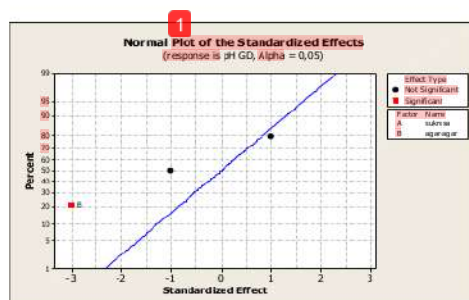


Figure 11. Normal plot of pH of papaya soft candy

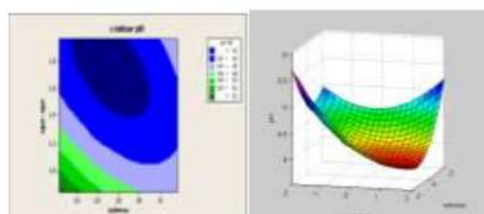


Figure 12. Contour plot and plot surface pH of Papaya Soft candy

Figure 12 forms of contour plots and surface plots showing pH data obtained optimum conditions. The widest area of the contour plot image is indicated by a pH value of 4.2 to 4.4 with a sucrose concentration of 15% to 35% in all distributions of sucrose concentration, and agar 1.2 to 1.8. while the pH analysis with the highest value (> 5.2) was obtained at below sucrose concentration of 15% and so it was below 1.0. The pink surface plots show pH analysis of soft candy getting a pH value above 5.5

Total Dissolved Solids (TDS)

The results of the analysis on soft candy averaged total dissolved solids of 43.3° Brix. It is expected that the total dissolved solids in soft candy are not only sucrose and agar, but also organic acids and water-soluble proteins. According to Pomeranz and Clifton (1978), dissolved solids measured by refractometers are components containing F, Cl, Br, I, carbohydrates, esters, compounds containing sulfur, amine, amide, which are soluble in water. Therefore, the results of the analysis of the test of total dissolved solids on soft candy did not experience a significant difference.

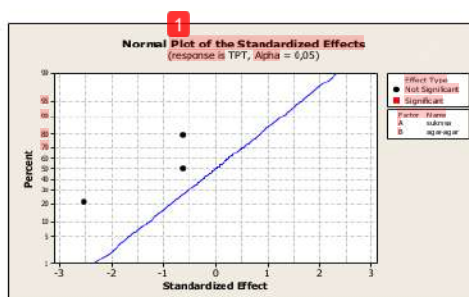


Figure 13. Normal plot of Total Dissolved Solids of Papaya Soft candy

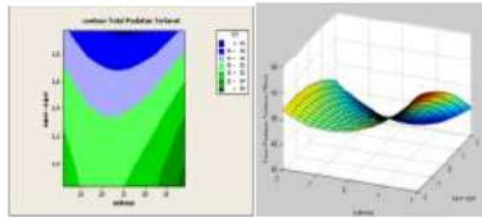


Figure 14. Contour plot and plot surface Total Dissolved Solids Papaya Soft candy

Figure 14 contour plot and surface plot Total Solid Dissolved papaya soft candy analysis can be seen in Figure 8. The shape of the saddle point on the contour plot and surface plot shows the Total Dissolved Solids obtained did not get the optimum condition. The widest area of the contour plot image is shown by the total dissolved solids limit of 48 to 50 with sucrose concentrations of 15% to 35% in all distributions of sucrose concentration, and agar-agar 1.0% to 1.6% while analysis of Total Dissolved Solids with the highest score (> 54) was obtained at sucrose concentrations above 35% and agar below 1.0%. The yellow surface plots show an analysis of the total dissolved solids with soft candy getting values above 50.

Water Content

Seen in figure 15, the normal plot shows that the sucrose and agar concentration factors in the papaya soft candy produced did not have a significant effect. This can be caused by water being analyzed is free water, water that forms hydrogen bonds with other molecules in small quantities. In this case also physically bound water, which is confirmed water between sucrose and agar gel. The average value of water content is 16.2%.

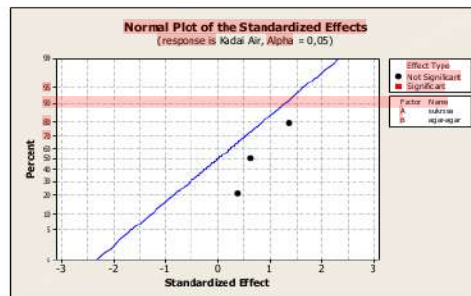


Figure 15. Normal plots of papaya soft candy

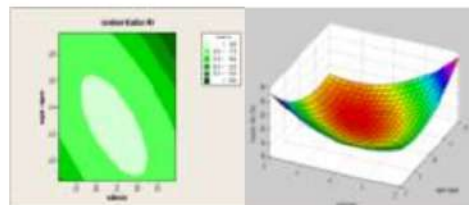


Figure 16. Contour plot and plot surface of Papaya Soft candy Moisture

Contour plot and surface plots analysis of papaya soft candy soft candy can be seen in Figure 16. The form contour plot and surface plot shows that the water

content data obtained get the optimum condition. The widest area of the contour plot image is indicated by the value of the boundary water content of 15.0 to 17.5 with sucrose concentration of 15% to 35% in all distributions of sucrose and agar concentration 1.0 to 1.8, while the water content analysis the highest score (> 25.0) was obtained at sucrose concentrations above 35%. The pink surface plot shows that the analysis of moisture content against soft candy gets a value above 30.

Vitamin C

The tendency of vitamin C levels to decrease can be seen with the higher sugar solution used. According to Buntaran et al. (2011), the higher the sugar solution used, the lower the vitamin C content. Vitamin C levels in puree were 54.7 mg / 100g, while after processing with the addition of sucrose concentration and agar concentration, vitamin C levels produced in soft candy ranged from 30.3 mg / 100g to 45.0 mg / 100g. The cause of the loss of vitamin C is thought to be due to the high sugar solution which causes more water molecules to come out of the material and dissolve vitamin C. The tendency of vitamin C levels to decrease is seen with the higher sugar solution used. The average value of vitamin C levels is 36.0 mg / 100 g. based on the results of research conducted by Nurhasanah (2011) the decrease in vitamin C levels with the addition of sucrose concentrations caused by sucrose and vitamin C binding to each other, so that the higher the concentration of sucrose the lower the vitamin C level in the material. So that the sucrose concentration has a significant effect on the levels of papaya Vitamin C soft candy (Figure 17).

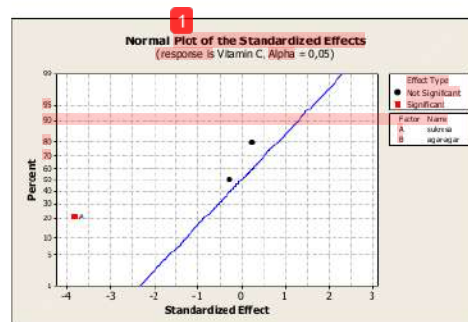


Figure 17. Normal plot of Vitamin C levels in papaya Soft Candy

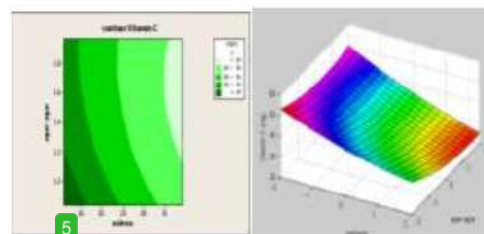


Figure 18. Contour plots and surface plots of Vitamin C Levels of Papaya Soft candy

Contour plots and surface plots of analysis of vitamin C levels of papaya soft candy can be seen in Figure 18. Forms of saddle points on contour plots and surface plots show that data on vitamin C levels obtained did not optimum conditions. The

largest area of contour plot images is shown by the vitamin C value of 30 to 35 limits with sucrose concentrations of 25% to 35% in all distributions of sucrose and agar concentration 1.0% to 1.8%, while the analysis of vitamin C with the highest value (> 45) obtained at 1.5% sucrose concentration and 1.0% agar-agar. The surface plots show an analysis of vitamin C against soft candy that scores 50.

Organoleptic Test

Color Hedonic

In figure 19 shows that the concentration of sucrose and agar does not have a significant effect on hedonic color, so the panelists stated that the hedonic papaya soft candy produced were not different. This is supported by the results of color analysis using a refractometer, that there is no significant difference in color even though the concentration of sucrose and agar-agar used is different.

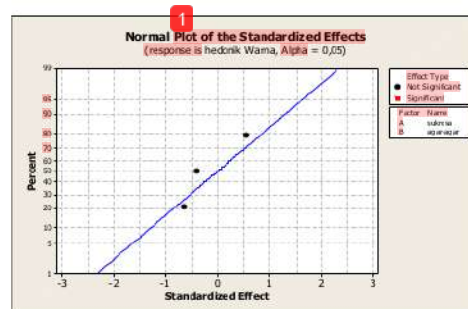


Figure 19. Normal Papaya Color Soft candy Hedonic Organoleptic plot

Hedonic Aroma

In figure 20 shows that the concentration of sucrose and agar does not have a significant effect on hedonic aroma, so the panelists stated that the hedonic papaya soft candy produced were not different. This is presumably because there is no contribution of sucrose and agar because the two ingredients are odorless (neutral).

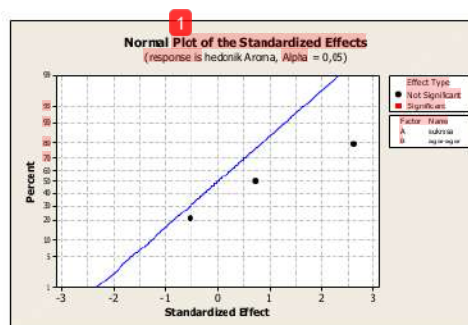


Figure 20. Normal Organoleptic Hedonic Aroma Soft candy Papaya plot

Hedonic Taste

Based on the data from the results of hedonic organoleptic taste in the normal plot, it was shown that agar concentration factor (B) had a significant effect on the hedonic papaya soft candy produced. According to Charalombous (1981) in Hasniarti (2012), the thicker a substance is, the less intense the acceptance of taste

intensity, so that the higher the concentration of agar used, the taste produced will decrease.

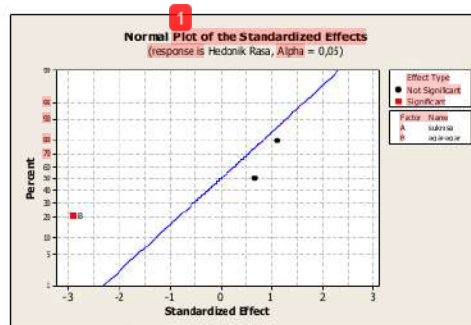


Figure 21. Normal plots of Organoleptic Hedonic Flavors of Papaya Soft candy

Hedonic Texture

Agar concentration is very influential in determining the texture of soft candy. According to Rasyid (2004) the nature of agar is the ability to form a gel, even though the concentration of the solution is very runny, for example 0.04%, but if agar with a concentration greater than 0.5%, it will form a rigid gel. Figure 22 shows that agar concentration factor (B) has a significant influence on the hedonic papaya soft candy texture produced.

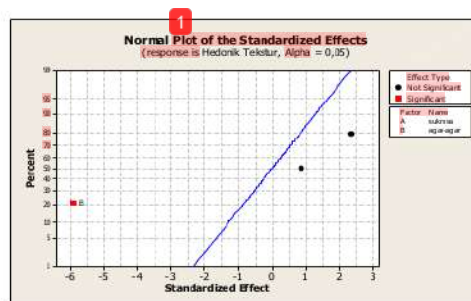


Figure 25. Normal plot of Hedonic Texture Soft candy Papaya

Optimal Formulation

From the analysis of papaya soft candy, it can be seen that there are no optimal conditions for each parameter. In order to obtain the expected optimal value for each test parameter, it is necessary to analyze the data using the surface response method by inputting data from the analysis of papaya soft candy and determining the target results to be achieved so that the resulting product gets the analysis value as expected.

The results of the analysis of the parameters optimized using the surface response method by determining the maximum and minimum value limits, as well as the targets to be achieved on papaya soft candy, it is expected to produce color chroma 19.85, L 35.56 for a* 10.87, b* 14.57 and °Hue 51.94, pH 4, total dissolved solids 49.37 (°Brix), moisture content soft candy 14.57 (%), vitamin C 36.58 (mg / 100 g). Organoleptic test values in color hedonic parameters 4.66 (rather like), hedonic aroma 4.20 (neutral), hedonic taste 4.78 (somewhat like), hedonic texture 4.43 (neutral). And it can be seen to achieve that response, the concentration that

must be used is sucrose 25.99% and agar concentration 1.08% of the response you want to know.

Based on the results of the analysis using the Surface Response Method, papaya soft candy will achieve its optimum response on a combination of 25.99% sucrose concentration and 1.08% agar concentration with a combined value expected to reach 0.62.

4. Conclusion

The results of the research formula to make soft candy and parameters observed can be concluded that based on the analysis results to obtain optimal conditions in the process of making papaya soft candy. Combination of sucrose concentration of 25.99% and agar concentration is 1.08% with a combined value is expected to reach 0.62. In this condition, the value of brightness (L) 35.56, value a * 10.87, value b * 14.57, color chroma 19.85 and ° Hue 51.94 produce red color with a good red intensity, with pH 4, total dissolved solids 49, 37 ° Brix, water content of soft candy 14.57%, vitamin C 36.58 mg / 100 g ingredients. Organoleptic test values in color hedonic parameters 4.66 (rather like), hedonic aroma 4.81 (neutral), hedonic taste 4.78 (somewhat like), hedonic texture 4.43 (neutral). Further research is needed to determine the type of packaging and the shelf life of soft candy with sucrose concentrations of 25.99% and agar-agar 1.08%.

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