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The Effect of Mixing Time and Rotation Speed on the Consistency of Dough Viscosity in a Horizontal Mixer

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ABSTRACT

Cassava must go through several manufacturing processes before it becomes chips on the market, including the process of stirring the dough. The stirring process is an important stage in various food industries. In the stirring process, the viscosity change in the dough is influenced by various factors, including the stirring process time and speed in stirring. Research on dough viscosity is important because it is directly related to the quality of the final product. The purpose of this study is to provide recommendations to users, both in the context of using horizontal mixers and the process of making similar products. The type of research used is quantitative research based on experimental methods that aim to test a hypothesis by collecting data that can be measured using statistics, mathematics, and computing. The independent variables in this study are rotation speed (20, 40, and 80 rpm) and stirring time (5 minutes, 10 minutes, and 15 minutes). From these independent variables calculations and data analysis, the optimal setting was obtained using a rotation speed of 80 rpm and a stirring time of 15 minutes with a dough viscosity of 1411.12 PaS. The rotation speed of 80 rpm has more even data or more consistent data compared to the rotation speed values of 20 rpm and 40 rpm.

Keywords: *Dough, quantitative, stirring, viscosity*

I. Introduction

Micro, Small, and Medium Enterprises (MSMEs) are the driving force of Indonesia's economy, playing a crucial role in increasing employment opportunities and promoting a more equitable national economy for all citizens of Indonesia. One of the staple commodities abundantly produced in Indonesia is cassava. The diversity of cassava-based products results in varied production systems. Fundamental aspects need to be considered in this process, including how to process cassava into a high-quality product. Ensuring proper control of the quality and quantity produced in cassava processing can be seen from the technical procedures involved. Efficient production techniques and timing can optimize the cassava production process [1].

Cassava is a significant crop in Indonesia, ranking fourth globally in production. However, despite surplus production, Indonesia remains a major importer to meet industrial demands. Climate change impacts cassava production, with temperature, humidity, and rainy days negatively affecting yields [2]. Researchers have employed various methods to

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analyze and predict cassava production, including artificial neural networks achieving 94% accuracy and double exponential smoothing for long-term projections [3], [4]. Farmers continue cultivating cassava due to its role as a savings crop during dry seasons, ease of planting, and minimal capital requirements [5].

Micro, Small, and Medium Enterprises (MSMEs) play a crucial role in economic development, particularly in developing countries. Studies have shown that MSMEs contribute to poverty reduction, employment creation, and economic [6]. In Nigeria, research indicates that MSME output has a positive impact on GDP (Gross Domestic Product) while lending rates negatively affect economic growth [6]. Similarly, in the Philippines, MSMEs are vital development agents in rural communities, offering income opportunities and employment [7]. In Indonesia, a study on chip production by MSMEs found that raw materials, equipment, and labor significantly influence production, with labor having the most substantial impact at 55.3% [8].

Rheological properties play a crucial role in cassava starch processing and its applications in food products. Cassava starch solutions exhibit gel-like behavior, with storage modulus (G') exceeding loss modulus (G"), indicating elastic and recoverable deformations [9]. These gels demonstrate non-Newtonian, pseudoplastic fluid behavior and are classified as weak gels due to their temperature-dependent properties [10]. Processing parameters significantly influence cassava starch's physicochemical characteristics. Higher drying temperatures decrease swelling power, paste viscosity, and gel strength while increasing solubility [11]. Conversely, larger milling sizes enhance these properties. The use of mineral water in processing yields higher paste viscosity compared to other water types [11]. Understanding these rheological and processing factors is essential for optimizing cassava starch's functionality as a thickening agent, texture enhancer, and binder in various food applications.

One of the tools commonly used for mixing is the horizontal mixer. The horizontal box mixer is a component of the horizontal mixer that serves as the chamber where various ingredients mix to form cassava cracker dough. The machine’s rotational speed during the mixing process affects several physical properties of the dough, including expansion, dough mass, pore size, and water content [12]. In this context, viscosity can be observed from the water absorption rate of the dough during the mixing process in the horizontal mixer. Dough viscosity consistency is a key parameter that significantly affects the quality of the final product [13].

Research on the rheology of cassava dough is crucial for understanding its behavior during processing and improving product quality. Cassava dough exhibits viscoelastic properties, showing shear-thinning and thixotropic behavior [14]. For cassava-based products like lafun, rheological and textural properties vary among varieties and storage time, with some doughs stiffening, softening, or remaining unchanged [15]. Understanding dough rheology is crucial for ingredient specifications, quality control, product design, and adapting new processing technologies [16]. Further research in this area could support the transformation of cassava into value-added products like bread, potentially improving food security and reducing import dependence in African countries [17].

Therefore, understanding the impact of process variables, such as mixing time and rotation speed, is crucial for achieving positive effects not only on the dough produced but also on the productivity and profitability of MSMEs, as well as the entire production chain that plays an important role [18]. Observations were made to analyze the influence of mixing time and rotation speed on dough viscosity consistency using a horizontal mixer. In the dough-making stage, settings were typically estimated without clear control over the machine or dough consistency. Thus, this research aims to help producers optimize the cassava cracker production process, making it more effective, efficient, and capable of increasing revenue.

II. Material and Methods

Research Design

The research used experimental research and quantitative methods. There were four replications for every interaction between the two variables in the study, which included multiple changes in speed (rpm) and mixing duration (minutes). This study used 4 replications because using 4 sample replications can improve the statistics and reliability of the results [19]. Quantitative regression-based research, in this context, aims to investigate a hypothesis by collecting measurable data using statistical, mathematical, and computational methods [20]. After obtaining the desired data, the next step is to process the data using Minitab 20 software. The method used in Minitab 20 software is the DOE factorial method with simple regression analysis, Tukey test, and Shapiro-Wilk test to ensure the suitability of analysis quality [21].

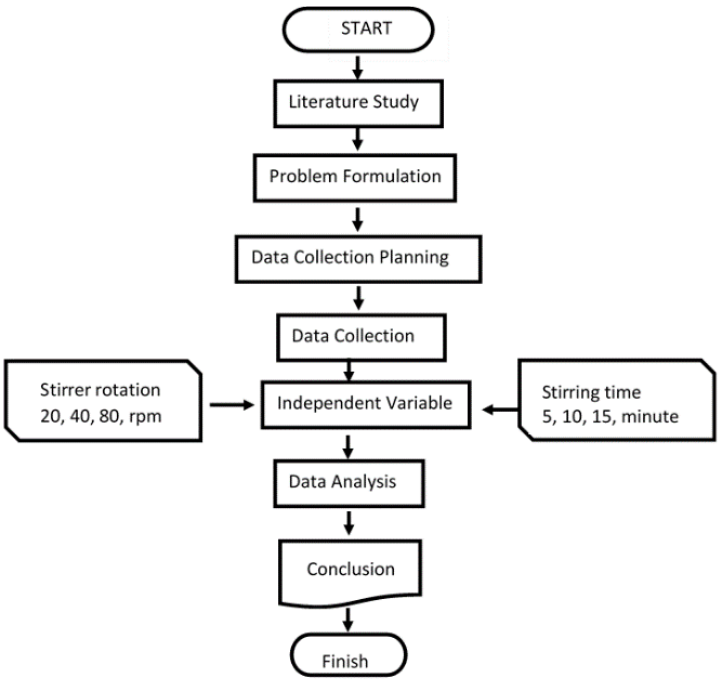

Fig. 1. Research flow diagram

Based on Figure 1, the explanation of the research flow diagram is based on the steps provided; First, this is the initial phase where the researcher understands the research concept to be conducted. After that, the literature review involves studying all necessary aspects of the research. The data collected comes from sources such as journals and books relevant to the research topic. Meanwhile, the field study involves observing real-world problems. Then, the problem statement in this research relates to the influence of mixing time and rotation speed on the consistency of dough viscosity in a horizontal mixer and determining the optimal speed to achieve the desired dough viscosity. Then, in this stage, secondary data from reliable literature (books and journals) are collected, and a plan is made for data collection involving the treatment of independent variables. After that, this research involves independent variables such as mixing speed (20 rpm, 40 rpm, and 80 rpm) and mixing time (5 minutes, 10 minutes, and 15 minutes). The dependent variable affected by these factors is the dough's viscosity consistency. Then, raw data is collected and processed by using Microsoft Excel for calculations. Then. the data is further processed using Minitab 20 software for data analysis and quality testing. This step involves three phases: data reduction or summarization, data presentation, and conclusions. The final section includes the results from the data collection process. Numerical data is interpreted into a summary of the overall findings, along with the implications or impact of the research results.

Research Location

The research was conducted at MSMEs Kripik Singkong owned by Mr. Junaidi in Tumpang District, Malang.

Tools and Materials

In this experiment analysis, we are using the main ingredients, which are cassava and tapioca flour; using tools such as horizontal mixing (Specification box dimensions of 800 mm x 450 mm x 400 mm with a power of about 1,320W, and a maximum production capacity of 110 kg/hour) this mixer is one of the krupuk processing machines that functions to mix the ingredients in the process of making krupuk so that the resulting product is more uniform or homogeneous and the shape of this mixing machine is designed to be horizontal. Steel balls, rotation reduction pulleys (v-belt), 300 kg LS series digital sitting scales to measure the weight of cassava, 1000 ml plastic measuring cups, digital stopwatches, measuring cups, rulers, and scales. All equipment and materials used in this study are locally produced.

Data Collection Method

The method used is quantitative experimental observation. This experiment provides control over the desired conditions, with the following calculations :

1. Ball density calculation

$$d = \frac{m}{v} \quad (1)$$

Where :
d : density of the ball(g/cm^3)
m : mass of the ball (g)
v : volume of the ball (cm^3) = $(4/3)$ x π x r^3

2. Viscosity measurement from recording the time it takes for a ball to fall from the top mark to the bottom mark of a filled cylinder.

3. Speed Calculation

$$v = \frac{d}{t} \quad (2)$$

Where :
v : velocity (cm/s)
d : measured distance (cm)
t : time (s)

4. Viscosity calculation

$$Viscocity : \frac{[2(d\ ball - d\ liq) g r^2]}{9v} \quad (3)$$

Where :
$d\ ball$: density of the ball (g/cm³)
$d\ liq$: density of the liquid (g/ml)
g : gravitational acceleration (9.8 m/s²)
r : radius of the ball (cm)
v : velocity of the ball (cm/s)

Statistical Analysis

Statistic analysis was conducted using 2-ways ANOVA, followed by simple regression analysis, Tukey, and Shapiro-Wilk test. The data collection table, which shows the results of viscosity calculations between the independent and dependent variables, is shown in Table 1.

Table 1. Table collection data

Speed (rpm)	Time (Minute)	Results			
		Rep 1	Rep 2	Rep 3	Rep 4
20	5				
	10				
	15				
40	5				
	10				
	15				
80	5				
	10				
	15				

III. Results and Discussion

1. Research Data

The results of the dough mixing process for cassava crackers show various viscosity outcomes in the raw data, which will later be processed using Microsoft Excel. The observations on dough viscosity highlight two key factors that significantly affect the viscosity: mixing speed (rpm) and mixing time (minutes). The research involved several variations in speed (rpm) and mixing time (minutes), with 4 replications for each interaction between the two variables. The processed data using Microsoft Excel is shown in Table 2.

Table 2 contains data on the mixing speed at levels of 20 rpm, 40 rpm, and 80 rpm, along with different mixing times (5 minutes, 10 minutes, and 15 minutes), resulting in different dough viscosity values. Table 2 indicates that increasing the replication at specific times and speeds generally increases the thickness or viscosity of the dough. However, at a certain peak, the viscosity begins to decline after reaching its maximum point.

This phenomenon supports the statement by Pastukhov and Dogan, starch particles that break down at maximum mixing speeds result in a peak viscosity, followed by a decrease due to the breakdown of starch and the reduction of protein content in the dough [22]. The data show that by the third replication at 5 minutes with the same speed, viscosity decreases, while at the second replication with 10 minutes, the same decline starts to appear. At the highest speed with a mixing time of 15 minutes, a more consistent change in viscosity is observed. This demonstrates good consistency in the results, reinforcing the validity of the data for the subsequent stages of the study.

Table 1. Result processed data from Microsoft Excel

Speed (rpm)	Time (Minute)	Results			
		Rep 1	Rep 2	Rep 3	Rep 4
20	5	1074.8	1152.13	1132.77	1113.41
	10	1161.82	1200.54	1229.59	1200.54
	15	1278.00	1307.04	1297.36	1326.41
40	5	1171.50	1200.54	1219.91	1190.86
	10	1210.22	1229.59	1268.31	1229.59
	15	1297.36	1316.72	1336.09	1365.13
80	5	1403.86	1374.81	1423.22	1403.86
	10	1384.50	1413.54	1423.22	1374.81
	15	1413.54	1403.86	1384.50	1442.59

2. Shapiro-Wilk Test

The Shapiro-Wilk test is a statistical method used to verify the normal distribution of experimental data [23]. These tools and methods are crucial for researchers and practitioners in various fields to ensure the validity of their statistical analyses and draw accurate conclusions from their data. In Shapiro-Wilk, if the P-value is less than 0.05, the results are considered "not normally distributed", indicating that the normality test is not met. If the p-value is more than 0.05, the results are considered "normally distributed", indicating that the data normality test is met [24]. Shapiro-Wilk test result of this study is shown in Figure 2.

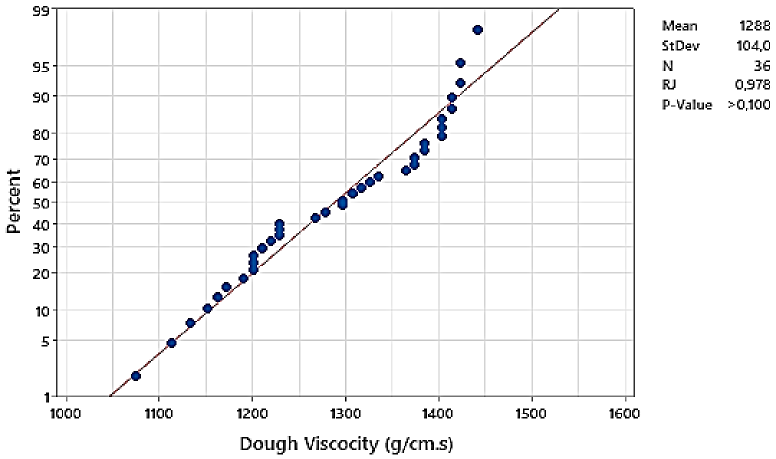

Fig. 2. Chart of the Shapiro-Wilk normality test

As shown in Figure 2, on the right side of the graph, there are the following descriptive statistics: Mean = 1288, StDev = 104.0, N = 36, RJ = 0.978. P-value >0.100. The data points are mostly around the normal line, indicating that the dough viscosity data is close to the normal distribution.

3. Analysis of Variance

Analysis of variance is a process of analyzing data obtained from experiments with multiple factor levels, usually more than two-factor levels. This analysis intends to identify the important independent variables and the way they may affect the response [25]. In this context, partial significance testing is employed to determine whether the independent variables individually have an effect on the dough. A significance level of 5% is used, and decisions are based on comparing the calculated t-value with the critical t-value or comparing the p-value with α (alpha). The decision-making criteria are as follows: If $t_{calc} < t_{table}$ or P-value > α (0.05) accept H_0 or not significant and if $t_{calc} > t_{table}$ or P-value < α (0.05), reject H_0 or significant [15]. The analysis of variance for this study can be seen in Table 3.

Table 3. Analysis of variance (ANOVA)

Source	DF	Adj SS	Adj MS	F-value	P-value
Modal	8	362013	45252	72.41	0.00
Linear	4	329267	82317	131.73	0.00
Rotation speed (rpm)	2	256105	128053	204.91	0.00
Stirring time (minute)	2	73162	36581	58.54	0.00
2-way interactions	4	32745	8186	13.10	0.00
Rotation speed*Stirring time	4	32745	8186	13.10	0.00
Error	27	16873	625		
Total	35	378885			

Table 3 shows sufficient statistical evidence to conclude that the variable or interaction has a significant effect on the response and influences the results in the various tests or models conducted (rotation speed, stirring time, and the interaction between speed and stirring time). It can be concluded that the results of this study are considered significant, meaning that the null hypothesis is rejected because the P-value is less than 0.05 according to the test conducted. Based on all the factors that have been tested (rotation speed, stirring time, and their interaction), have P-value of 0.000, which means that all these factors have a significant effect on the results of the study.

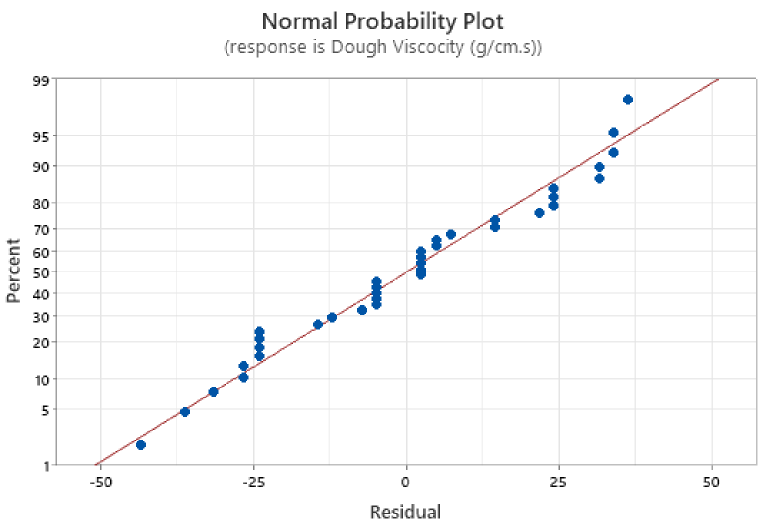

Fig. 3. Graphic normal probability test

After testing ANOVA, data validation is needed to be able to determine the quality of the model used. Normal probability plot or normality test is aimed to test whether in the regression model, the disturbing or residual variables have a normal distribution or not. If the distribution is not normal, then the ANOVA results cannot be a reference in the normality assumption used and the test results cannot be interpreted. The average error value in regression is expected to be close to zero so that errors that have a normal distribution are needed in estimating regression parameters [26]. From Figure 3, it can be concluded that the data from this study follow a normal distribution. This is evident from the points that lie close to the diagonal line or the line of best fit.

4. Factorial Plot

Factorial plot is a type of graph or diagram used to display the results of experiments involving multiple factors or variables that may influence the outcome. This type of plot helps in understanding whether there are interaction effects between the independent variables, specifically whether the effect of one variable on viscosity depends on the levels of the other variable [27]. The Factorial Plot illustrating the impact of rotation speed and mixing time on the consistency of dough viscosity can be seen in Figures 4 and 5.

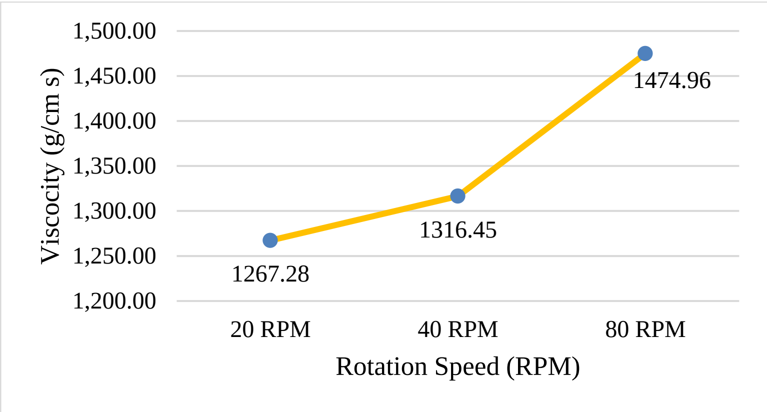

Fig. 4. Factorial plot graph of the effect of rotation speed on dough viscosity consistency

From Figure 4, it can be interpreted that the higher the rotation speed, the better the stirring, so it can be interpreted in this case that the viscosity of the dough is higher. Increasing the rotation speed has a more significant effect on increasing the stirring time, based on the optimization of changes seen in the graph. Cassava dough will tend to absorb water at high rotational speeds can cause the dough to have sufficient water content at optimal water usage. During stirring, homogenization occurs, the components in the dough are evenly mixed, including water with the dough which will conjugate to form a strong bond that can increase the viscosity of the dough [28]. The mixing process in dough preparation involves complex physicochemical interactions that contribute to the formation of a homogeneous structure [29]. During stirring, components like flour and water interact, leading to processes such as swelling and dissolution of flour polymers. In cassava starch, high-pressure homogenization can partially gelatinize the starch, increasing granule swelling and particle size [30]. Agitation methods, such as stirring and homogenization, significantly affect the characteristics of modified starches, including their degree of substitution and functional properties [31]. In gluten-free doughs, hydrocolloids like xanthan gum and hydroxypropyl methylcellulose (HPMC) influence water distribution and rheological properties. These additives can alter the elastic and viscous moduli of the dough, affecting gas cell expansion and ultimately impacting bread quality, such as loaf volume and crumb hardness [32].

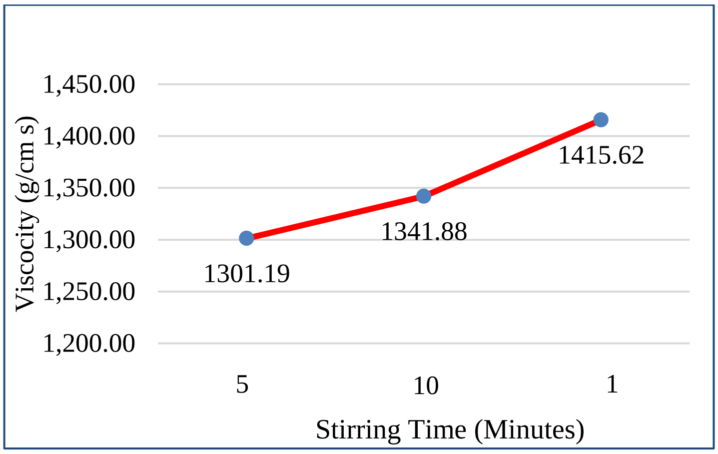

Fig. 5. Factorial plot graph of the effect of stirring time on dough viscosity consistency

The efficiency of the results obtained from the stirring time depends on the mass of the dough obtained, when the dough is chewier and more fluffy, the mass obtained from the dough will be greater. The longer the stirring time, the efficiency of the results obtained on the viscosity of a dough increases. In addition, the long stirring time can damage the starch in the dough which can cause water to easily enter the pores in the dough which will absorb the water in it, the open starch structure will be easily entered by water which will fill the starch granules so that swelling of the starch will be characterized by an increase in viscosity [33].

The effect of mixing time on dough properties varies depending on flour type and composition. Longer mixing times can lead to gluten network depolymerization in some flours [34], while for whole wheat flour, extended mixing may result in water agglomeration and harder cookies [35]. The addition of flaxseed flour increases mixing time and water absorption capacity but decreases viscosity and amylolytic activity [36]. Glutenin macropolymer (GMP) content decreases with increased mixing time, causing depolymerization and formation of smaller particles. However, resting can partially restore GMP content and promote larger particle formation [37]. Optimal mixing and resting times are crucial for achieving desired dough properties and final product quality. Excessive mixing or resting can lead to negative effects on dough structure and rheological properties [34], [37].

Based on Figures 4 and 5, the optimization of stirring can be seen from the effect of a certain stirring speed with a certain time variation to get the optimal viscosity with constant changes. From Figure 6, both factors can play an active role in thickening or increasing the viscosity of a dough. The speed of rotation will greatly affect the tendency of the dough to absorb water and cause physical and structural changes in the dough. The dough time will increase and be needed as long as the viscosity of the dough has not been reached. The time factor in the stirring speed itself includes a process that can take time, so it is mutually influential in optimizing the viscosity of the dough.

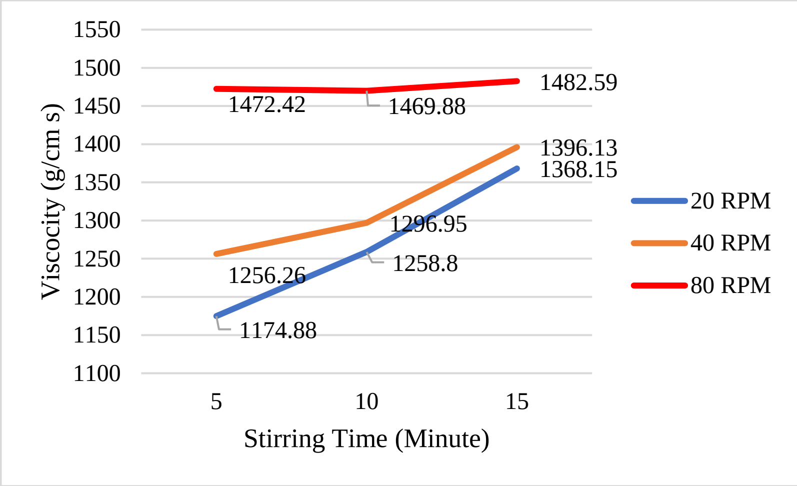

Fig. 6. Factorial plot of the effect of interaction between stirring time and mixer rotation speed on dough viscosity

The effect of higher speed on the dough is the shifting of forces that affect the alignment of the interaction between starch or protein in the dough with water causing pores that cause water to easily enter the dough to cause more optimal dough viscosity and elasticity [38]. In addition, the important role of the accuracy of stirring time will determine how long the dough becomes perfect with a certain stirring speed, too long the dough is stirred the possibility of damaged starch because the hydrophilicity of the dough to water is getting stronger, it will make it easier for more water to get into between the pores which can cause swelling of the starch from full starch granules [28].

The accuracy of mixing speed and time is crucial for achieving optimal dough quality. Studies have shown that increasing mixing time and speed generally improves mixing effectiveness and efficiency [39]. However, over-mixing can lead to dough deterioration, as evidenced by changes in gluten network structure [40]. Real-time monitoring of dough quality using current sensors can help identify the peak point of dough consistency, optimizing the kneading process [41]. During mixing, various physicochemical processes occur, including swelling, dissolution, and heat generation, which influence dough structure formation [42]. The optimal ratio of ingredients, particularly flour and water, is essential for these processes to develop properly. By understanding and regulating these factors, bakers can achieve dough with predetermined physical properties and produce bread of the desired quality [39], [42].

The starch in cassava dough shows a tendency to interact with water thoroughly, indicating the hydrophilicity or stronger water absorption dominance of cassava dough. In other words, cassava starch is highly hydrophilic to water. The tendency of the starch content to absorb water will cause the starch granules to swell in the dough which can affect the viscosity of the dough [33]. This can be influenced by different characteristics in terms of surface properties, hydrophilicity, as well as mechanical properties and structure of dough components.

6. Standard Deviation

Standard deviation is identical to the degree of group variation from the existing data distribution, by definition this standard deviation or standard deviation is a standardized measure of data from its mean deviation [43]. The standard deviation in this case shows a value that shows the consistency data of the treatment effect on the consistency of the dough viscosity, with a variety of variations in the effect of the dough given the treatment. In order to speed up the calculation, Microsoft Excel software is used to calculate the standard deviation of this viscosity value data. The value of the calculation of the standard deviation for the viscosity of the dough can be seen in Table 4.

Table 4. Standard deviation dough viscosity

Speed (rpm)	Time (Minute)	Average of standard deviation
20	5 10 15	86.69
40	5 10 15	65.70
80	5 10 15	22.12

From Table 4, it can be seen that the standard deviation value for the rotation speed of 80 rpm is 22.12 this value is smaller than the standard deviation value at the rotation speed of 20 rpm (86.69) and 40 rpm (65.70). From the values, it can be concluded that the 80 rpm rotation speed has very consistent viscosity results than other speed variations and has a more even distribution of data with real consistency compared to the rotation speeds of 20 rpm and 40 rpm. This 80 rpm also shows a stable dough viscosity in the range of 1,328.34 Pa-s which defines the meaning that increasing rotation speed tends to give more consistent results in terms of dough viscosity.

In addition, through Table 4, a new statement is obtained regarding the tendency to increase the consistency of dough viscosity results can be seen from the increase in rotation speed shown by the data of the decrease in standard deviation. At lower rotation speeds (20 rpm), the viscosity measurement results are more variable, which is due to the lack of sufficient energy to mix the dough evenly within the specified time. In addition, at the minimum stirring speed, indications are that the components in the dough are not evenly mixed, resulting in a less fluffy dough. Therefore, in determining the optimal parameters in the dough mixing process to achieve the desired viscosity consistency with high consistency, it is necessary to pay attention to the measurement consistency with different variations in conditions.

7. Tukey Test

The Tukey test is a widely used statistical method for comparing multiple groups in various fields, including agriculture and environmental studies [44]. It is particularly effective for pairwise comparisons, offering shorter confidence intervals compared to Scheffé's method for low-order comparisons [45]. The Tukey method is as robust as Scheffé's method under certain assumption violations, with its performance related to both the type of violation and the number of contrasts being analyzed [46]. While Tukey's test is primarily a parametric method, nonparametric alternatives exist for comparing independent populations, such as the Mann-Whitney and Kruskal-Wallis tests, which can be implemented using statistical software like Minitab [47]. These methods provide researchers with a range of tools to conduct multiple comparisons and analyze experimental data across various disciplines. In the Tukey test, if the P-value value is less than 0.05, the result is considered "significant", indicating that the null hypothesis is rejected. If the p-value is greater than 0.05, the result is considered "insignificant" [48]. The Tukey test for this study can be seen in Tables 5 and 6.

Table 5. Tukey simultaneously tests the relationship between the interaction of the influence of rotation speed (rpm) on dough viscosity (g/cm.s)

Difference of levels	Difference of means	SE of difference	95% CI	T-value	Adjusted P-value
40 - 20	46.8	24.9	(-14.3; 107.9)	1.88	0.161
80 - 20	197.7	24.9	(136.6; 258.8)	7.94	0
80 - 40	150.9	24.9	(89.8; 212.0)	6.06	0
Individual confidence level = 98.04%					

As shown in Table 5, it can be seen that rotation speed of 40 - 20 rpm has a P-value of 0.161, then it can be said that there is no significant difference in dough viscosity (g/cm.s), then at rotation speed 80 - 20 rpm and 80 - 40 rpm has a P-value of 0 then it can be said that there is a significant difference in dough viscosity (g/cm.s).

Table 6. Tukey simultaneously tests the relationship between the interaction of the influence of stirring time (minute) on dough viscosity (g/cm.s)

Difference of levels	Difference of means	SE of difference	95% CI	T-value	Adjusted P-value
10-5	38.7	39.3	(-57.7; 135.1)	0.99	0.591
15-5	108.9	39.3	(12.5; 205.3)	2.77	0.024
15-10	70.2	39.3	(-26.2; 166.6)	1.79	0.19
Individual confidence level = 98.04%					

As shown in Table 6, it can be seen that the stirring time of 10 - 5 minutes has a P-value of 0.591, then it can be said that there is no significant difference in dough viscosity (g/cm.s), then at stirring time of 10 - 5 minutes has a P-value of 0.024, then it can be said that there is a significant difference in dough viscosity (g/cm.s), then in stirring time of 15 - 10 minutes has a P-value of 0.19, so it can be said that there is no significant difference in dough viscosity (g/cm.s).

IV. Conclusions

The research conducted showed a significant effect between mixing time and dough viscosity. The longer the mixing time, the better the dough viscosity value obtained. Therefore, in the research that has been conducted, the time needed to obtain optimal viscosity is 15 minutes using a horizontal mixer. Based on ANOVA, there is a significant effect on the speed of the mixer rotation on the dough viscosity. The faster the rotation of the mixer, the higher the value of the dough viscosity obtained. Therefore, in the research that has been conducted, the stirring speed setting required to obtain optimal viscosity is 80 rpm using a horizontal mixer. The research viscosity standard is taken from the dough viscosity in MSMEs, which is 1,171.50 PaS, while the best viscosity value in the horizontal mixer obtained has an average of 1,411.12 PaS. For a rotation speed of 80 rpm, the data distribution is more even, namely with a standard deviation value of 22.12 compared to rotation speeds of 20 rpm and 40 rpm, so that the viscosity value with a rotation speed of 80 rpm has more even data or has more consistent data compared to the speed value at rotation variations of 20 rpm and 40 rpm. The right tool settings at a speed of 80 rpm with a stirring time of 15 minutes provide good optimization results. Mass production can be done at a constant speed of 80 rpm. Based on this study, the maximum rotation speed will tend to provide more consistent results in terms of dough viscosity consistency in the stirring process using a horizontal mixer. In the future, the results of this study can be used to produce flour dough to obtain the expected results.

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