Quality Control on Flour Rice with Statistical Quality Control (SQC) Method and Taguchi Method

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Abstract: This research was conducted on manufacturing companies engaged in the food industry. The production process in the company applies the make to stock system. It produces rice flour dan sticky rice flour. Rice flour is the most popular according to the market. Many defective products that arise during the flour production process are due to product quality not meeting company standards. The company's daily rice flour target can be reduced due to the high number of defective products produced. Company standard determines the quality of rice flour where the product does not meet the perceived quality is not good. The purpose of this research is to control the quality of rice flour and reduce the number of defects in rice flour. Taguchi method is one methods that can be used to make improvements. The results of the Taguchi method show that the optimum level of ash defects of more than 1% is 192 rpm milling spindle speed, 2.5 hours of rice immersion duration and 197 ° C temperature. Optimum level for crude fiber defects consists of spindle speed of milling machine is 179 rpm , the duration of soaking rice is 2.5 hours and the counting process for 1 hour. Application of the Taguchi method, the amount of rice flour that is not suitable also decreases because ash content reduces the average defect from 5.3 kg / day to 4.89 kg and for crude fiber from 5kg / day to 4.61 kg.

1 INTRODUCTION

Statistical Quality Control (SQC) and Taguchi method have been recognized as an effective approach to process monitoring and diagnosis to control the quality characteristics of methods, machines, products, equipment for both companies and operators (Srinivasan, 2011).

Statistical quality control (SQC) is divided into product and process control. The quality of the product can be control through the product and process control in any manufacturing industry and the product control has to perform when the product is in finished mode.

Product control is a technique that is just as important as process control in the field of statistical quality control to maintain product quality. However, in product control, sampling plan for attributes and variables are available but sampling plan for attribute is easy to perform in any industry or manufacturing unit (Kumar, 2018).

Taguchi uses the delineation of experiments to determine an ideal configuration for the parameters of the process, as well as, to analyze the existing interactions between the controllable factors (Souza, 2018).

SPC is an optimization philosophy concerned with continuous process improvements, using a collection of (statistical) tools for data and process analysis making inferences about process behavior (Chede, 2016).

The process of producing rice flour consists of eight work stations namely, the outpouring, storage, washing, grated, refinement, drying, filtering and packaging. In many companies there is rice flour whose quality does not meet company quality standards.

Disability that occurs in rice flour is moisture content of more than 1%, fiber is still rough and ash content more than 1%. During the period January 2016 to January 2017 has an average of 22.72% / month, so the company needs to do the control quality so that the future will not harm the company either materially or non-material.

Research focuses on the quality of rice flour to reduce the number of rejects in the company. The

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research was conducted quality control by using statistical quality control (sic) method and Taguchi method.

The result of this research is to know the number of rejects that accumulate on the production floor and to know the main cause of the rejects. And if occurred, a plan must be devised to improve the production then that plan must be put into action (Qasim, 2014).

2 RESEARCH METHODS

The type of research is a type of experimental research, i.e. which is a study that aims to investigate the causal relationship and how many relationships are by imposing treatment on one or more experimental groups and comparing the results with one or more control groups or groups that are not subject to treatment (Paradis, 2016).

The results of this study are expected to minimize defects in rice flour products. The object of research observed is rice flour, which is about the quality of rice flour that does not meet the specification or standard and categorized a defect product.

Data collection methods used in this study are through direct observation and interviews with companies (Johnston, 2014). The Data processing methods used in this study is (Besterfield, 1998):

1. Identification of factors that cause the deviation of rice flour quality,

2. Determination of the number of levels and factor level values for the accuracy of the experiment

3. Calculating the number of degrees of freedom, to know how many minimum experiments performed.

4. Selection of appropriate orthogonal matrices depended on the value of factor and expected interaction and the level value of each factor.

5. Implementation the Taguchi Method

This research stage can be explained briefly through block diagrams. The Block diagram of this research can be seen in Figure 1.

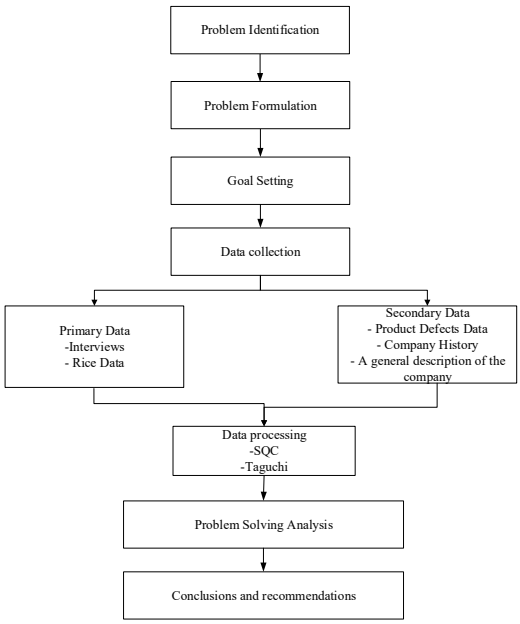

Figure 1. Block Diagram of Research.

3 RESULTS AND DISCUSSION

3.1 Quality Control Tools

The Method used to maintain standards in manufacturing products is by testing sample from output to specification (Neuburger, 2017). This quality control tool is in charge of controlling the quality of statistical to find out the quality data of rice flour that is still within the control limits. The results of the quality control tools produced are as follows:

1. Map Control

   Control charts are used to see if the proportion of ash defects in homogenized rice flour or not (Blitzkow,2013). In this study map, c is used because the disability that occurs in rice flour is in the form of attribute data (Ahme, 2011). The result of the control chart on the type of ash disability (> 1%) and fiber are still rough is that all data is in control.

2. The Cause and Effect Diagram

   This diagram is used to determine the causes of rice flour in detail (Liliana, 2016). The result of causes and effect diagrams for ash disability are some factors causing disability such as human factors, machinery, methods, materials and environment (Belouafa, 2017). And the main factor is the speed the rotary grinding machine, drying temperature and long immersion of rice. The cause and effect diagram for fiber defects is

still rough due to several factors such as humans, machine, materials, and methods. The main factors that cause are the speed of rotary grinding machine, the process of dissolution and the long immersion of rice.

3.2 Identification of Causes of Rice Quality Diversity

The cause of rice quality drift irregularities can be seen in the following figure 2.

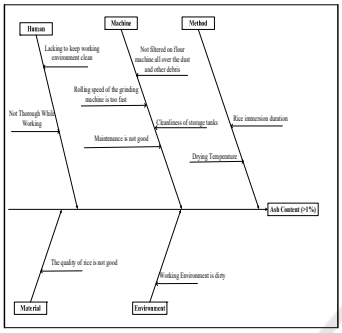

Figure 2. Diagram of cause as a result of Ash Content (> 1%).

Figure 2 shows that the cause of ash disability (> 1%) is the human, machine, method, environment, and material factor.

Based on the results of the way with that the main factor is the machine, namely the rotational speed of the milling machine, the duration of rice immersion and the drying temperature. For the factors causing irregularities in the fiber is still rough can be seen in Figure 3.

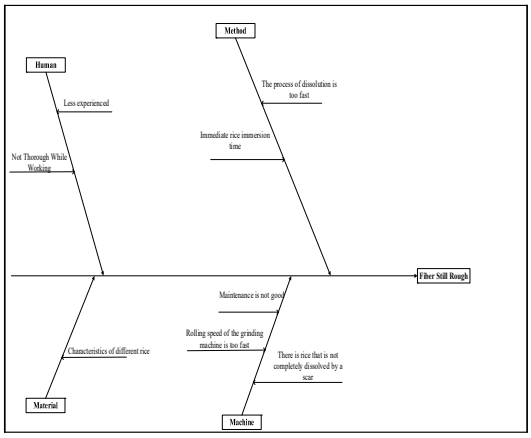

Figure 3. Diagram of Causes of Fiber Still Rough.

Figure 3 shows that the cause of fiber defects is still rough is the human factor, machine, method, and material.

Based on the results of the interview with the company that the main factor is the machine, the rotational speed of the milling machine, the duration of rice immersion and the dissolution process.

3.3 Determining the Number of Levels and Level Values

Determining the number of important levels means for the accuracy of the experimental results (Lamont, 2015). The more levels that are studied the experimental results will be more researched because the data obtained more. Determination of this level is done on the following considerations:

1. The value of each level is within the range set by the company.
2. Point levels are indicating extreme values.
3. The level can still be handled by the existing process technology.

Level determination for ash content (>1%) can be seen in Table 1. The level determination for fiber is still rough can be seen in Table 2.

Table 1. Determining the Number of Levels and Ash Levels (> 1%).

Num	Control Factor	Level 1	Level 2
A	Machine Play Speed Milling	179 rpm	192 rpm
B	Old Immersion of Rice	2 hours	2,5 hours
C	The process of dissolution	187°C	197 °C

Table 2. Determination of Number Level and Fiber Level Levels Still Rough.

Num	Control Factor	Level 1	Level 2
A	Machine Play Speed Milling	179 rpm	192 rpm
B	Old Immersion of Rice	2 hours	2,5 hours
C	The process of dissolution	1 hours	2 hours

3.4 Calculation of the Number of Degrees of Freedom

The calculation of degrees of freedom is done to calculate the minimum amount of research that must be done to investigate the observed factors (Krishankant, 2012).

The computation of degrees of freedom and the proposed combination will later affect the selection in the orthogonal matrix table.

V = Number of Levels – 1

In this study, the degrees of freedom for each type of disability is the same:

1. Factor A = 2 levels
2. Factor B = 2 levels
3. Factor C = 2 levels

Calculation of degrees of freedom can be seen in Table 3.

Table 3. Calculation of Degrees of Freedom.

Control Factor	Degrees Free (DB)	Total
A	2-1	1
B	2-1	1
C	2-1	1
TOTAL		3

3.5 Selection of Orthogonal Matrices

In selecting an appropriate orthogonal matrix, an equation of orthogonal matrices is required which presents the number of factors, the number of levels and the number of observations made. The general form of the orthogonal matrix is La (bc).

The orthogonal matrix used in this study was L8 (23). The arrangement of orthogonal matrix L8 (23) can be seen in Table 4.

Table 4. Orthogonal Array Matrices.

Experiments	Column / Factor		
	1	2	3
1	1	1	1
2	1	1	2
3	1	2	1
4	1	2	2
5	2	1	1
6	2	1	2
7	2	2	1
8	2	2	2

3.6 Implementation of Taguchi Method

The Taguchi method is used to investigate the interaction between factor and factor level in the quality of rice flour. Characteristics used are smaller the better (Cheng, 2016).

Calculation of confirmatory experiments using factor and factor level that has been determined to produce optimal condition and done as many as 6 times experiment by calculating the average value of flour and the variability of rice flour. (Amirul 2016) The results of the Taguchi experiment can be seen in Table 4.

Table 4. Optimal Level Result of Taguchi Experiment.

Ash Content (>1%)			
Factor	**Percent Contribution (%)**	**Optimum Level**	**Value of Optimum Level**
Rotating Speed of Milling Machine (A)	36,30	2	192 rpm
Lama Old Immersion of Rice (B)	-	2	2,5 jam
Drying Temperature (C)	11,85	2	197°C

Fiber Still Rough			
Factor	**Percent Contribution (%)**	**Optimum Level**	**Value of Optimum Level**
Rotating Speed of Milling Machine (A)	-	1	179 rpm
Lama Old Immersion of Rice (B)	16,17	2	2,5 jam
Drying Temperature (C)	26,73	1	1 jam

The interpretation results for the calculation of the amount of flour defect can be seen in Table 5.

Table 5. Interpretation Result of Calculation of Total Flour.

Response (Afkir Flour Rice)		**Prediction**	**Optimization**
Type of Disability Ash Level (> 1%)			
Experiments Taguchi	**Average (μ)**	5,08	$4,48 \leq \mu_{prediction} \leq 5,68$
	Variability (SNR)	-13,78	$-14,38 \leq \mu_{prediction} \leq -13,18$
Confirmation Experiment	**Average (μ)**	4,89	$4,16 \leq \mu_{confirmation} \leq 5,62$
	Variability (SNR)	-13,84	$-14,57 \leq \mu_{confirmation} \leq -8,22$
Types of Fiber Defects Still Rough			
Experiments Taguchi	**Average (μ)**	4,67	$4,90 \leq \mu_{prediction} \leq 5,26$
	Variability (SNR)	-12,85	$-13,35 \leq \mu_{prediction} \leq -12,35$
Confirmation Experiment	**Average (μ)**	4,61	$3,86 \leq \mu_{confirmation} \leq 5,36$
	Variability (SNR)	-13,67	$-14,27 \leq \mu_{confirmation} \leq -12,77$

The result of experiment from table above can be seen that by Taguchi method (Mitreva, 2016) to confirmation experiment decrease at mean value (μ) flour of defect rice and decrease of defect variation that happened compared to average value of defect of rice flour per day, where for type disability ash content (> 1%) suffered a defect per day of 5.33kg / day, after the experiment Taguchi decreased to 5.08 and through confirmation experiments of 4.89. The same is true for fiber defects still rough, where the average defect per day is 5kg / day. After the experiment Taguchi decreased to 4.67, and through confirmation experiments of 4.61.

4 CONCLUSION

Based on the research that has been done, the following conclusions are obtained:

1. The cause of the number of reed rice flour to the type of disability ash content, the cause effect diagram caused by the terms of machine, material, human, method and environment, with the main factor is the rotational speed of grinding machine, rice immersion duration and drying temperature Cause the number of reed rice flour the type of defect is still rough, the cause effect diagram is caused in terms of machine, material, human and method, with the main cause is the process of dissolution, the speed of rotary grinding machine and the duration of rice immersion.

2. After the Taguchi experiment and confirmation experiment, it can be seen that the average number of rejects decreased after the Taguchi experiment and the confirmation experiment.

3. Combination of optimum factor level which has significant influence with Taguchi experimental design as the basis of quality improvement of rice flour on ash disability type is Rolling Speed of 192 rpm Milling Machine, 2.5 hours Rice Soaking, 2.57C Drying Time and Temperature. The combination of optimum factor level which the significant effect on fiber type of defect is still rough is Rolling Speed of 192 rpm Milling Machine, 2.5 Hours Soaking Rice, and Drying Temperature 197oC. Rotary Speed of Grinding Machine 179 rpm, Length of Immersion of Rice 2.5 hours, and 1- hour Dissolution Process.

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