
Identify the Effect of the Different Ingredients for Wet Noodles Based on Water Absorption Using Design of Experiment

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To cite this article:

Anis Siti Nurrohkayati, Binyamin, Muhammad Khairul. Identify the Effect of the Different Ingredients for Wet Noodles Based on Water Absorption Using Design of Experiment. *American Journal of Software Engineering and Applications*. Vol. 9, No. 2, 2019, pp. 35-39. doi: 10.11648/j.ajsea.20200902.11

Received: December 12, 2019; **Accepted:** December 30, 2019; **Published:** August 25, 2020

Abstract: Wet noodles are one of the foods that are favored by all people, especially in Indonesia. Wet noodles are made from basic ingredients of wheat flour or wheat flour. So far there have been many innovations of wet noodles with basic ingredients apart from wheat flour. The difference in the basic ingredients and additional ingredients can affect the quality of the noodles. However, it is not yet known whether the effect of the quality of the wet noodles is influenced by the type of flour used, the amount of the basic ingredients, or whether there is an effect of the extracts of other ingredients on the quality of the wet noodles. This is the reason for this research. Thus, this study aims to determine the types and differences in the use of basic ingredients in making wet noodles that can affect the quality of wet noodles. Measurement parameters used are by calculating the level of water absorption. The combination of wheat flour, cassava flour, and seaweed were used in this study. Calculation analysis is performed using the Taguchi method. The Taguchi method is the methodology in the world of Engineering which can be used as a method to measure or improve the quality of a product, as well as minimize costs. Wet noodle making experiments were conducted according to the Taguchi Design of Experiments (DOE) method. The repetition of the experiment was carried out eight times according to the orthogonal array (OA) matrix used. There are 5 control factors and 3 noise factors that are used in this study. Control factors are wheat flour, cassava flour, eggs, salt, and seaweed. Meanwhile, the noise factor is a lot of water, a long time to rest dough, and a long time to steam. ANOVA analysis and mean effect were carried out to find out which factors had the most significant influence on the quality of the noodles.

Keywords: DOE, ANOVA, Water Absorption, Wet Noodles

1. Introduction

Noodle is one of food type that can be used as a main food instead of rice. The carbohydrate content in noodles and rice is the same. This is the reason why noodles are often consumed, especially for Indonesian people. The large number of consumers who love noodles causes noodle makers to innovate the taste and quality of noodles. This innovation for example by adding fruit or vegetable flavors to the noodles, in addition to that or by making a substitution of the basic ingredients in making noodles. These innovations include improving the quality of dried noodles

by adding monoglycerides [13], dry noodles with mango leaf flour substitution [12], dry noodles with orange sweet potato flour with mocaf flour [6] etc. The quality of the noodles can be influenced by several things such as mixing ingredients, types of basic ingredients used, the amount of ingredients used, and others. Mixing of ingredients is done to get the perfect gluten formation. Gluten on noodles can affect the smoothness of noodles. The smooth nature of noodles has an impact on the quality of the noodles breaking off. In addition to breaking power, the physical properties of noodles can also be seen from the water content of noodles, water absorption, development power, and color [13].

Substitution of basic ingredients and addition of quantities or proportions of ingredients made in the process of making noodles aims to get the best quality of noodles. Studies on the physical properties of noodles state that the addition of the proportion of potato starch has a significant effect on the value of the strain index, water absorption index, and water content [4]. The addition of tapioca flour as a substitute for flour causes a decrease in the value of solid loss due to boiling, water absorption, and development power, but is able to increase the value of water content and tensile strength in noodles [8]. Sweet potato flour can be used in making noodles due to high levels of gluten content [14]. The levels of gluten in noodles have an effect on the quality of the elasticity of the noodles. The addition of seaweed basic ingredients causes the breaking power of wet noodles to be low [3]. The addition of rice bran flour can improve the quality of noodles in terms of physical, chemical and organoleptic properties. This is because the fiber content in rice bran is able to absorb and evaporate high water [10].

Based on the results of these studies it can be seen that the use of tubers flour can improve the quality of noodles. However, from the research that has been done by literature study, no research has been done to find out what type of substitution is the most influential on the quality of noodles. In addition, it has also not been discussed whether the addition of fruit or vegetable extracts in the manufacture of noodles can affect the quality of the noodles. This study aims to determine what basic ingredients are very influential on the quality of the noodles. In this study an experiment in making noodles which will then be calculated by the Taguchi Design of Experiments method in which there is ANOVA analysis, mean effect, and S / N-ratio.

In this study eight experiments will be repeated making wet noodles according to the standard array rules in the Taguchi method. Next, an analysis was carried out according to the Taguchi method to find out what factors most influenced the quality of the noodles. The factors used are control and noise factors. Cassava flour and seaweed substitution were used to make noodles in this study.

2. Methodology

This research was conducted by conducting an experimental design or by conducting an experiment in making wet noodles based on the Taguchi method (design of experiments). Furthermore, after an experiment, ANOVA calculation and analysis, mean effect analysis, and S / N-ratio analysis are performed to find out which factors influence the quality of noodles based on the measurement of cooking loss level. The factors used in this study are divided into 2 types of factors, namely control factors and noise factors. Control factors are factors that are considered very influential on the quality of the noodles, while the noise factor is a factor that is considered less influential on the quality of the noodles. In this study 2 levels were applied for each factor used. Control and noise factors are presented in Table 1 and Table 2 below:

Table 1. Control factor.

Control Factors	Level 1	Level 2
Wheat Flour (gr)	25	35
Cassava Flour (gr)	50	60
Egg (item)	1	2
Salt (tsp)	1	2
Seaweed (gr)	4	2

Table 2. Noise factor.

Noise Factors	Level 1	Level 2
Water (cc)	30	40
Dough Resting time (minute)	2	4
Steaming (minute)	5	7

3. Water Absorption

The absorption of water in noodles is related to the water content of the material. Water content is one of the important factors in noodle products. Water content can determine the age of the noodles, the more water content there is in the noodles then the storage capacity will be relatively short and vice versa. In the making of noodles, water is used during boiling or wet noodles. The process of boiling the noodles takes about ± 15 minutes. The resulting water absorption (DSA) values are calculated using equation (1) as follows [1].

$$\text{Water absorption (\%)} = \frac{(W_b - W_a)}{W_a} \times 100\% \quad (1)$$

with:

Wa = weight after steam (gr)

Wb = weight before steam (gr)

4. Taguchi Method

The Taguchi method is a method that can be used to measure the quality of an ingredient. In the Taguchi method an experimental design is applied where experiments are carried out with different repetitions. The Taguchi method uses ANOVA analysis, S / N-ratio, and mean-effect analysis.

Taguchi, 1949 states that the Taguchi method is a new methodology in the field of Engineering which aims to improve the quality of a product and process and can minimize costs. The Taguchi method uses a special matrix called the orthogonal array (OA) matrix. Orthogonal array is a step to determine the minimum number of experiments to be performed. Orthogonal array lies in choosing the combination of levels on the input variables used in the experiment [2].

In this research the following analyzes will be carried out:

Analysis of Variance, aims to determine the level of variance in the distribution of data on the cooking loss measurement results.

Mean-effect analysis, aims to see the average value of the biggest factors that most influence the quality of wet noodles.

These analyzes are used to calculate the value of factors in accordance with the control factors and noise factors that most influence the best quality of noodles. The measurement parameter used is cooking loss. The cooking loss value is

then calculated using the analysis above. Given a ranking or ranking based on the greater the value the better. The factor that has the highest rank is the most influential factor. On the contrary, the lowest ranking factor did not affect the quality of the wet noodles.

5. Result and Analysis

5.1. Water Absorption

In this study, the experiment of making wet noodles was done four times. The repetition is in accordance with the rules of the Design of Experiment (DOE) method. The data from the experimental results are as follows.

Table 3. Experiment Replication 1.

TRIAL NO	WA	WB	WATER ABS
1	246	460	0.8699
2	252	539	1.1389
3	337	533	0.5816
4	340	535	0.5735
5	297	406	0.3670
6	308	414	0.3442
7	310	0	-1.0000
8	319	0	-1.0000

Table 4. Experiment Replication 2.

TRIAL NO	WA	WB	WATER ABS
1	245	456	0.8612
2	250	539	1.1560
3	333	536	0.6096
4	342	535	0.5643
5	296	408	0.3784
6	303	420	0.3861
7	314	0	-1.0000
8	311	0	-1.0000

Table 5. Experiment Replication 3.

TRIAL NO	WA	WB	WATER ABS
1	243	464	0.9095
2	252	532	1.1111
3	334	535	0.6018
4	348	532	0.5287
5	294	408	0.3878
6	309	414	0.3398
7	314	0	-1.0000
8	320	0	-1.0000

Table 6. Experiment Replication 4.

TRIAL NO	WA	WB	WATER ABS
1	247	461	0.8664
2	256	533	1.0820
3	335	540	0.6119
4	348	530	0.5230
5	297	402	0.3535
6	304	412	0.3553
7	312	0	-1.0000
8	311	0	-1.0000

Changes in the shape of noodles after boiling can also be shown based on the value of water absorption. Based on Aisya (2013), the level of protein content affects the water absorption of noodles. The higher the protein content of the noodles, the longer the boiling process will take. Noodles that can expand are noodles with a high water absorption value.

Based on the results of experiments and calculations, it was found that the noodle sample in experiment number 2 had the highest DSA value of 1.1389. These results are in accordance with the results of the noodles after boiling. Experiment number 2 is the best noodle product from all sample experiments. The results of boiling noodles number 2 are given in Figure 1 as follows:



Figure 1. Sample 2 of Wet Noodles Experiments.

5.2. ANOVA and Mean Effect Results

Furthermore, in this study calculations were performed using the design of experiment (DOE) method. Calculation by DOE method aims to find out what factors affect the quality level of noodles. The factors seen are a combination of raw materials used in noodles. Analysis was carried out on Anova's results for the main factors (control factors). Anova calculation results are given in Table 7. as follows.

Table 7. ANOVA.

SUMMARY	Count	Sum	Average	Variance
Row 1	4	3.507005	0.876751	0.000488
Row 2	4	4.488031	1.122008	0.001052
Row 3	4	2.404949	0.601237	0.00019
Row 4	4	2.189581	0.547395	0.000638
Row 5	4	1.486672	0.371668	0.000218
Row 6	4	1.425363	0.356341	0.000437
Row 7	4	-4	-1	0
Row 8	4	-4	-1	0
Column 1	8	1.875099	0.234387	0.647808
Column 2	8	1.955679	0.24446	0.654617
Column 3	8	1.878669	0.234834	0.646866
Column 4	8	1.792155	0.224019	0.631306

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Rows	18.05679	7	2.579541	7321.587	4.23E-34	2.487578
Columns	0.001673	3	0.000558	1.582972	0.223293	3.072467
Error	0.007399	21	0.000352			
Total	18.06586	31				

Table 8. Sum of Square Total.

yi ²	0.76	0.74	0.83	0.75
	1.30	1.34	1.23	1.17
	0.34	0.37	0.36	0.37
	0.33	0.32	0.28	0.27
	0.13	0.14	0.15	0.12
	0.12	0.15	0.12	0.13
	1.00	1.00	1.00	1.00
	1.00	1.00	1.00	1.00
TOTAL				19.82
SST				18.07

Table 9. ANOVA (Manual).

Source	SS	v	V	F	P
A	9.77	1	9.77	17740	
B	6.40	1	6.40	11629	
E	1.76	1	1.76	3203	9.76
C	0.02	1	0.02	28	0.09
A x C	0.02	1	0.02	39	0.12
A x D	0.04	1	0.04	73	0.22
D	0.05	1	0.05	90	0.27
e	0.01	24	0.00		0.00
T	18.07	31			100

In this study using a high value or calculation results is the most influential factor on the quality of wet noodles. Based on the ANOVA calculation results, it was found that the most influential ingredients on the quality of the noodles were A (wheat flour), B (cassava flour), and C (eggs).

Next, the mean effect is calculated. The results of the mean effect calculation are used to find out which level has the highest value for each factor. The highest level value is the best value to use for quality recipes for wet noodles. The results of the mean effect calculation are given in Table 10 below.

Table 10. Mean Effect.

	A	B	$\frac{E}{C \times D}$	C	A x C	A x D	D
Level 1	0.79	0.68	0.00	0.21	0.21	0.20	0.20
Level 2	-0.32	-0.21	0.47	0.26	0.26	0.27	0.27
Effect	1.10	0.89	0.47	0.04	0.05	0.07	0.08
Rank	1	2	3	7	6	5	4
Optimum	A1	B1	E2	C2	A x C (2)	A x D (2)	D2

Based on the calculation results, it was found that for factor A (wheat flour) the optimum value was found at level 1, factor B (cassava flour) the optimum value at level 1, and so on.

6. Conclusion

The best quality noodles are noodles in trial number two. Trial trial noodles number two have a good combination and dose of raw materials. The difference in the dose of raw materials in the noodle dough affects the quality of the

noodles. Bad quantities cause sticky noodles and the dough cannot clot, so the noodles cannot be printed. The right combination of wheat flour and cassava flour gives good results. Besides flour, eggs also play an important role in the process of making noodle dough. Dough with an inappropriate quantity of eggs causes the dough not to be finished. The factors that influence the quality of wet noodles are factor A (white flour), B (cassava flour), and C (eggs).

Acknowledgements

The authors wish to thank RISTEKDIKTI of Indonesia and all co-workers for the comment, suggestions, and support throughout the course of the experiments. Also, authors like to thank the students for his help during the preparation of the experiments.

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