QUALITY IMPROVEMENT IN TOFU PRODUCED BY MADURESE HOME INDUSTRIES

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ABSTRACT

The present study was conducted in several home industries engaged in the manufacture of Madurese tofu. The tofu home industries used soybean as the raw material, which was processed by the use of machines and humans. In the manufacture of tofu, the home industries had a difficulty in maintaining the quality of the tofu. Each operator produced tofu of varying degree in quality. The present study used the DOE method with two factors highly influential to the manufacture of tofu. The two factors were the cooking temperature and water volume. Data processing by the use of the SPSS software showed that the cooking temperature and water volume had significant effects on the quality of tofu.

Keywords: Product quality, processed products, home industry.

INTRODUCTION

The growth of the creative economy in Indonesia is considered able to drive the achievement of the economic growth target of 6.8 percent in the 2013 draft state budget. The available products are not only those of manufacturers, but it has added value and the people’s purchasing power has improved. Products produced by small- and medium industries in Indonesia have creative values and high innovation and they are all part of the creative economy. The future prospects of the industry will be better, especially with the increasing number of middle class in Indonesia. The government has been giving incentives in the form of discounts of up to 40 percent of the purchase price for the purchase of production machines. It is expected to boost the productivity of creative industries. Additionally, the government has been providing training, assistance and experts in order to develop creative industries in Indonesia.(Departemen Perdagangan, 2009)

Tofu constitutes one of the mainstays of the provision of processed products for the people of Indonesia. It is a traditional processed product of Indonesian people, which contain considerable levels of proteins, minerals, and carbohydrates. Tofu companies should be able to transform themselves to produce quality products for the consumers. Tofu is made by coagulating soy milk and pressing them at its isoelectric point (Suprapti, 2005). During the process of making tofu several factors that affect the yield and quality of the resulting tofu are the selection of raw materials, coagulants and grinding methods (Koswara, 2002). There are two types of tofu: white tofu and yellow tofu. Both types are differentiated on the basis of how to make it. In the yellow tofu, turmeric is added, which serves as a dye and also as a preservative. The texture of the yellow tofu is usually denser than the regular tofu.

The quality standards of tofu (Purwanti, 2004) relate to (1) water. Despite the largest component of approximately 80–85%, water is not defined as a determining characteristic of the quality of tofu. (2) The main component relating to the quality of tofu is its protein content. The Quality Standards of tofu define that the minimum content of protein is 9% of the tofu weight. (3) Ashes in tofu are a mineral element contained in soybeans. Excessively high contents of ashes mean that tofu has been contaminated by dirt, such as soils, sands, etc., which may be caused by an improper use of calcium sulfate (locally known as *batu tahu* or "tofu stones"). Salts (NaCl) are included in the group of ashes, but the presence of salts in tofu is "intentional" with the aim to improve the quality, durability and flavor of tofu. Except for salts, the allowed content of ashes in tofu is 1% of tofu weight. (4) Coarse fibers in tofu can be derived from soybean dregs and turmeric (a dye). The permitted maximum level of coarse fibers is 0.1% of tofu weight.

(5) Hazardous metals (As, Pb, Mg, Zn) contained in tofu can be derived from, among others, unqualified water and the equipment used, especially the grinder. (6) Dyes on the market are already appropriated, such as for textiles, leathers, paints, papers, etc. Dyes that are allowed for use are natural dyes and dyes manufactured specially for food. (7) Variations in smell and taste signify the occurrence of damage or contamination by other materials. (8) The presence of slime and fungus in tofu indicates damage or decay. (9) In order to extend shelf life, preservatives in tofu are permitted by the decree of the Minister of Health. In this regard, a lot of tofu producers commit violations, in which they use formaldehyde as a preservative for tofu. This certainly should not be allowed and the relevant agencies should take action. (10) *E. coli* can be present in tofu when the manufacturing process uses unqualified water.

The process of tofu manufacture generally consists of 7 stages: (1) select clean soybeans and then wash them until they are clean; (2) soak them in water (at least 3 liters of water for 1 kg of soybean) for 1 hour. Soybeans will expand when soaked. (3) Wash the soaked soybeans repeatedly. Suboptimal cleaning will make the tofu produced to become sour quickly. (4) Grind the soybeans and add water gradually. (5) Cook the milled soybeans (soymilk) and add water; avoid coagulation at a temperature of 100°C (characterized by the presence of small bubbles). (6) Filter the soymilk and precipitate the water by using acetic acid for 1 liter of soymilk little by little while stirring it slowly. (7) Press the precipitate.

Tofu is produced by utilizing the properties of protein, which will clot when it reacts with the acid. Several factors that lead to variations in the quality of tofu are: (1) density; the manufacture of dense tofu, also known as Kediri tofu, requires a larger amount of raw materials; (2) the sour smell; loosely pressed tofu is generally relatively more easily damaged. Usually, loose tofu is marketed in the water-soaked state in order to preserve and prevent the shrinking of tofu; (3) appearance; the appearance of tofu relates to colors and the varied shapes and sizes. The color usually used is yellow, while the original color is white; (4) flavor; the favlor of tofu can be improved by adding salt or artificial flavors. (Sarwono and Saragih, 2004)

RESEARCH METHODS

Data Collection

In order to collect data that are adjusted to the criteria for good quality of tofu, such as clarity and mold-adjusted volume (Tandian, 2013), data will be grouped:

Table 1. Grouping of data according to tofu quality

Tofu quality criteria	Collecting data
Volume tofu fit the mold	**Tofu weight data**
Volume tofu fit the mold	**Tofu high data**
Tofu Resilience	**temperature**

General Full-Factorial Design

General full-factorial design is a factorial design consisting of k factors, in which each factor is composed of the p level. The number of run required for general full-factorial design is *p*k (Montgomery, 2012). Here is an example of the table of factorial design with 3 factors and 3 levels.

Table 2. Factorial design

Run	Factor			Combination
	A	B	C	
1	-	-	-	0
2	-	-	0	1
3	-	-	+	2
4	-	0	-	10
5	-	0	0	11
6	0	0	+	12
7	-	+	-	20
8	-	+	0	21
9	-	+	+	22
10	0	-	-	100
11	0	-	-	101
12	0	-	+	102
13	0	0	-	110
14	0	0	0	111
15	0	0	+	112

16	**0**	+	-	**120**
17	**0**	+	**0**	**121**
18	**0**	+	+	**122**
19	+	-	-	**200**
20	+	-	**0**	**201**
21	+	-	+	**202**
22	+	**0**	-	**210**
23	+	**0**	**0**	**211**
24	+	**0**	+	**212**
25	+	+	-	**220**
26	+	+	**0**	**221**
27	+	+	+	**222**

In order to analyze the general full-factorial design statistical tests were performed by using ANOVA and main effect plots.

Statistic tests of factorial design

Statistical tests were performed by using ANOVA (Walpole and Myers.1995), as shown in Table 3.

Table 3. ANOVA Tables

Source of Variation	Sum of Squares	Degrees of Freedom	Mean square	F_0
Rata-rata				
A	SS_A	**a-1**	SS_A/df	MS_A/SS_g
B	SS_B	**b-1**	SS_B/df	MS_B/SS_g
C	SS_C	**c-1**	SS_C/df	MS_C/SS_g
Interaction 3 factor				
AB	SS_{AB}	**(a-1)(b-1)**	SS_{AB}/df	MS_{AB}/SS_g
AC	SS_{AC}	**(a-1)(c-1)**	SS_{AC}/df	MS_{AC}/SS_g
BC	SS_{BC}	**(b-1)(c-1)**	SS_{BC}/df	MS_{BC}/SS_g
Interaction 3 factor				
ABC	SS_{ABC}	**(a-1)(b-1)(c-1)**	SS_{ABC}/df	MS_{ABC}/SS_g
Error	**SSg**	**abc(n-1)**	SS_g/df	MS_g
Total	SS_T	**abc(n-1)**		

RESULTS AND DISCUSSION

Normality tests

The hypotheses of the study were:

P < 0.05, the data were not normally distributed

P > 0.05, the data were normally distributed

Analysis of tofu weight data

Table 4. Results of normality tests of tofu weight data

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Tofu Weight	.092	60	.200*	.974	60	.219

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Results of normality tests of tofu weight data indicated that the tofu weight data had a K-S-Z value of 0.092 and $p = 0.2$ ($p > 0.05$), meaning that the tofu weight data were normally distributed.

Analysis of tofu height data

Table 5. Results of normality tests

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
tofu height	.108	60	.178	.962	60	.060

a. Lilliefors Significance Correction

Results of normality tests showed that the tofu height data had a K-S-Z value of 0108, $p = 0.18$ ($p > 0.05$), meaning that the tofu height data were normally distributed.

Analysis of tofu resilience data

Table 6. Results of normality tests

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Tofu Resilience	.483	60	.000	.476	60	.000

a. Lilliefors Significance Correction

Results of the normality tests showed that the tofu resilience data had a K-S-Z value of 0.483 with a $p = 0.00$ ($p < 0.05$), meaning that the tofu resilience data were not normally distributed. This was due to lack of accuracy at the time of measurement, lack of rigor at the time of composition comparison and unfavorable environmental conditions that affected the results of tofu resilience data analysis.

The purpose of the normality tests was to test whether or not the dependent and independent variables were normally distributed in the regression model. A good regression model has normal, or nearly normal, data distribution. After assuming that the results of analysis were in accordance with the criteria, multiple regressions could be performed. The present study analyzed two independent variables (X), temperature and water composition, and a dependent variable (Y), the quality of tofu. Multiple regressions in this study used only *F*-tests.

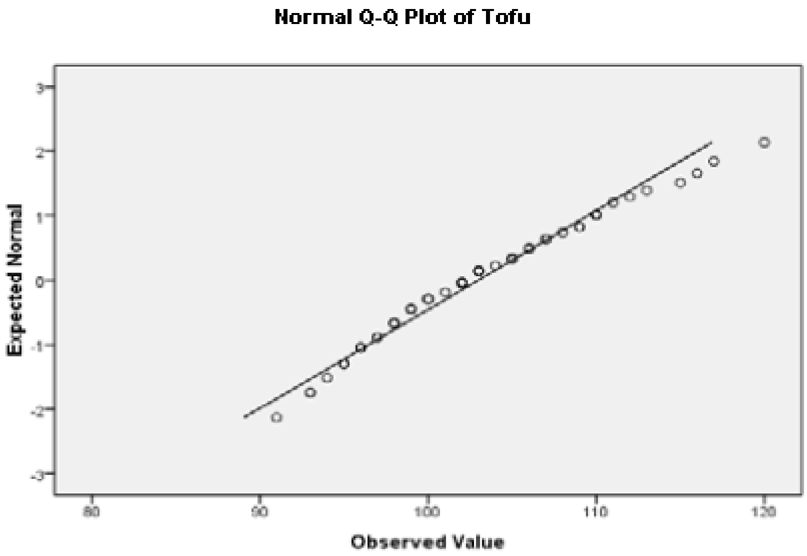

Figure 1. Results of normality tests

Analysis of *F*-test results

The SPSS software was used for *F*-tests. The hypotheses were:

H_0 : There is no significant simultaneous effect of the independent variables on the dependent variable.

H_1 : There is positive significant simultaneous effect of the independent variables on the dependent variable.

$F_{count} < F_{table}$ indicated that the independent variables had no significant effect on the dependent variable. Thus, H_0 was accepted and H_1 was rejected.
$F_{count} > F_{table}$ showed that the independent variables had significant effect on the dependent variable. Thus, H_0 was rejected and H_1 was accepted.

Analysis of tofu weight data

Table 7. Results of *F*-tests of tofu weight data

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	28.913	2	14.457	3.332	.719[a]
	Residual	2479.020	57	43.492		
	Total	2507.933	59			

a. Prediction: (Constant), Temperature, water composition

b. Dependent Variable: tofu weight

Table 7 showed a F_{count} of 3.322 and F_{table} of 3.16; these values were derived from the F_{table} with a v_1 of 2 as the residual and v_1 of 57 as df (degree of freedom) with a standard error of 0.05 (5%). *F*-tests were performed by a F_{count} of 3.322, F_{table} (df numerator/k; df denominator/n (k + 1)$_{(1; 38; 0.05)}$ of 3.16. ANOVA or F_{count} was 3.322 and F_{table} of 3.16 (a = 5%; df_1 = 2 and df_2 = 57). It means that $F_{count} > F_{table}$ (3.322 > 3.16) with a significance level of 0.000. Since $F_{count} > F_{table}$, then H_1 was accepted and H_0 was rejected. It showed that the independent variables had significant effects on the dependent variable.

Analysis of tofu height data

Table 8. Results of *F*-tests

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.110	2	.055	3.329	.721[a]
	Residual	9.492	57	.167		
	Total	9.602	59			

a. Prediction: (Constant), Temperature, water composition

b. Dependent Variable: tofu height

Table 8 shows F_{count} of 3.329 and F_{table} of 3.16; these values were derived from the F_{table} with v_1 of 1 as the residual and v_2 of 57 as df (degree of freedom) with a standard error of 0.05 (5%). *F*-tests were performed with a F_{count} of 0.329 and F_{table} (df numerator/k; df denominator/n(k + 1) $_{(1; 38; 0.05)}$ of 3.16. ANOVA or F_{count} was 3.329 and F_{table} of 3.16 (a = 5%; df_1 = 2 and df_2 = 57). It means that $F_{count} > F_{table}$ (3.329 > 3.16) with a significance level of 0.000. Since $F_{count} > F_{table}$, then H_1 was received and H_0 was rejected. It showed that the independent variables had significant effects on the dependent variable.

Analysis of tofu resilience data

Table 9. Results of *F*-tests

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.313	2	.157	3.941	.061[a]
	Residual	3.037	57	.053		
	Total	3.350	59			

a. Prediction: (Constant), Temperature, water composition

b. Dependent Variable: tofu resilience

Table 9 shows F_{count} of 3.94 and F_{table} of 3.16, these values were derived from the F_{table} with a v_1 of 2 as the residual and v_2 of 57 as df (degree of freedom) with standard error of 0.05 (5%). *F*-tests were performed with F_{count} of 3.94 and F_{table} (df numerator/k; df denominator/n (k + 1) $_{(1; 57; 0.05)}$ of 3.16. ANOVA or F_{count} was 3.94 and F_{table} of 3.16 (a = 5%; df_1 = 2 and df_2 = 57). It means that $F_{count} > F_{table}$ (3.94 < 3.16) with a significance level of 0.000. Since

$F_{count} > F_{table}$, then H_0 was rejected and H_1 was accepted. It indicated that the independent variables had significant effects on the dependent variable.

CONCLUSION

The manufacture of tofu consists of several stages, including the washing, soaking, grinding, cooking, precipitation and pressing. Results of *F*-tests showed that factors affecting the quality of tofu were temperature and water composition. Tofu home industries should pay attention to the quality of raw materials and manufacturing process of tofu in order to produce quality tofu at prices affordable to the people. In making a product, quality constitutes a factor crucial to the sales of products and determines the duration of the product availability on the market. Therefore, every produces should pay attention to the quality of every product they produce.

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