DEVELOPMENT OF THE OPTIMUM COMPOSITION OF ORGANIC LIQUID FERTILIZER USING TAGUCHI METHOD

THESIS

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AUTHENTICITY STATEMENT

In the name of Allah, I hereby certify that this research is based on my own work and studies, except for the citations and summaries in which of those is explicitly knowledge. If in the future this statement is proved not right and violates the legal regulation of papers and intellectual property rights, I agree Universitas Islam Indonesia to revoke my bachelor certificate.

Yogyakarta, 9th March 2018

Raizsa Laksmita

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THESIS APPROVAL OF SUPERVISOR

DEVELOPMENT OF THE OPTIMUM COMPOSITION OF ORGANIC LIQUID FERTILIZER USING TAGUCHI METHOD

THESIS

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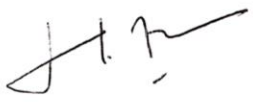

(Mr. Ir. Hartomo Soewardi, M.Sc., Ph.D.)

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DEVELOPMENT OF THE OPTIMUM COMPOSITION OF ORGANIC LIQUID FERTILIZER USING TAGUCHI METHOD

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DEDICATION

This thesis is dedicated for my family who always support me, especially my beloved mother Niken Lestari Nugrohowati, my beloved father Purwoko, my beloved grandmother Rasmini, my beloved brothers Rangga Pramudya Wardhana, Raditya Arya Wardhana, and my beloved sister Ruthy Purnitasari.

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MOTTO

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

In the name of Allah, the Most Beneficent, the Most Merciful

إِنَّ مَعَ ٱلْعُسْرِ يُسْرًا ﴿٦﴾ فَإِذَا فَرَغْتَ فَٱنصَبْ ﴿٧﴾ وَإِلَىٰ رَبِّكَ فَٱرْغَب ﴿٨﴾

For indeed, with hardship [will be] ease, Indeed, with hardship [will be] ease, so when you have finished [your duties], then stand up [for worship]

(QS. Al-Insyirah 6-8)

الصّابِرينَ مَعَ اللَّهَ إِنَّ ۚ وَالصَّلاة بِالصَّبرِ استَعينوا آمَنُوا الَّذينَ أَيُّهَا يا

you who have believed, seek help through patience and prayer. Indeed, Allah is with the patient.

(QS.Al-Baqarah 153)

لنَّبِيْنِ ا مَعَ جْرَهُ أَ وَيُعْطَى مِ سْلَ لا أْ نْنُ رُ : لمِلْمِ أْ لِبُ طَا ، حْمَةِ البَّ طَالِبُ : لْعِلْمِ ا لِبُ طِا

"The one who requires knowledge is demanding grace; the people who are studying are running the pillars of Islam and the reward given to the same as the Prophets ".

(HR. Dailani from Anas r.a)

PREFACE

Assalamu'alaikum Wr. Wb.

Alhamdulillahirrobbilalamin, all praises to Allah SWT who has given His mercy and guidance in completion of this undergraduate thesis. Gratitude is presented to Allah the Highest, while blessings and greeting *salawat* are also delegated to the Prophet Muhammad with all humility let the Author express my gratitude and highest appreciation to all those who have been supported and motivating in order to complete this Thesis. The Author would like to say thanks to:

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Raizsa Laksmita

ABSTRACT

***Abstract*—** Organic Liquid Fertilizer is a liquid made from the decomposition of organic material such as plant residue and animal waste in which its content consists of more than one nutrients. The advantages of this fertilizer are to resolve a deficiency of nutrient and provide the additional nutrients quickly. Most of the liquid organic fertilizers sold in the market are inappropriate with the national standard of agriculture in Indonesia that is in value range 4 to 9 of the potential of Hydrogen (pH). Majority of the existing fertilizer contains the pH value of less than 4 or higher than 9. It means that these fertilizers are too sour and overly bases. This condition hampers the plant's growth. Thus, it is necessary to supply the proper fertilizer. This study primarily aims to develop the optimum composition of the organic liquid fertilizer that satisfies the national standard of Indonesian agriculture. Taguchi method was used to design the optimal composition and experimental study was conducted to determine a value of Signal Noise Ratio as well as to validate the best composition. Statistical analysis was conducted by using t-test was done to test the hypothesis. The result of this study shows that the new composition of organic liquid fertilizer is valid to satisfy the national standard of pH value that is 7. Thus, it is known that the optimum composition encompassing A1 is the cow urine with 1000 ml, B3 is the probiotic with 6 ml, C1 is the goat dung with 500 grams, and D3 is the spices with 30 grams (A1-B3-C1-D3).

Keyword: *Design Experiment, Taguchi Method, Organic Liquid Fertilizer, pH value*

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CHAPTER I

INTRODUCTION

1.1 Problems Background

Soil chemistry is not able to supply sufficient nutrients to the plant. Excessive toxicity of soil conditions can prevent plant roots from growing or low nutrients in plants. If this condition happens, it makes nutrient deficiency symptoms on the plant. The existing symptoms on the plants indicate nutrients problem on plants. There are several symptoms shown by plant, such as *Chlorosis* (damaged or failed to produce chlorophyll, so it is not green, but yellow or pale almost white), *Necrosis* (a form of cell injury that results in premature death of cells in living tissues by autolysis), *Anthocyanin* (pigment which gives the colored-on flower, fruit and leaf), and *Stunning* (reduced growth). It needs fertilizer to give the nutrient to the soil and make the plant grow fertile. Therefore, it needs fertilizer in order to use value in plant's growth or increasing plant-available nutrient levels in soils. Fertilizer contains one or more plant's nutrients, which are used for plant's nutrient content. Types of fertilizer are solid, liquid and gaseous (anhydrous ammonia) (Dean & Norman, 2015).

Fertilizer is product that improves the levels of available plant nutrients, the chemical and physical properties of soil, therefore directly or indirectly enhancing plant growth, yield, and quality. Fertilizer classified of three such as mineral fertilizer, organic fertilizer, and synthetic soil conditioner. Mineral fertilizer is produced from organic and inorganic compounds. Organic fertilizers are waste products from animal husbandry such as stable manure, and slurry manure, plant decomposition products such as compost, peat,

or products from waste treatment such as composted garbage, sewage sludge, and the synthetic soil conditioners are products whose has the main function to improve the physical properties of soils. The examples are friability, water and air transport. The type of fertilizer classified as solid, liquid as solid or liquid fertilizers and as soil or foliar fertilizers (Scherer et al. 2007).

Liquid organic fertilizer is one type of artificial fertilizer that is derived from living organism (Merriam- Webster.com) and can be soluble easily in the soil as well as contains some important particles for growing the plant (Govere et al, 2011). This fertilizer has not been fully used by farmers whom still depend on the chemical fertilizers which can acidify the soil and cause irreparable damage (Chen, 2006). As for Susanto (2002) cited in Sopha & Uhan (2013) expressed that the compact organic fertilizer such as manure and compost has also left with some disadvantages such as their low density and low nutrient content. While advantages of liquid organic fertilizer, according to Govere et al, (2011) and Chen (2006) can improve the physical properties, chemical properties, and biological properties of the soil as well as it leads to faster nutrient supply than compact organic fertilizers do. Liquid organic fertilizer can be derived from manure, rice straw, *Azolla*, leaf lamtoro, rice husk, cuttlefish, Agro-industrial waste (such as palm oil processing waste) and so on.

Rohmiyat, et al (2006) cited in Sopha & Uhan (2014) stated that liquid organic fertilizers application leads to faster nutrient supply than compact organic fertilizers do. But, a high concentration on liquid fertilizer could delay nutrient uptake by the plant. Organic liquid fertilizer has advantages, which is safe for the environment and the effect can be seen in a faster time than solid manure.

Suriadikarta (2006) stated that liquid fertilizer has the low viability of the microorganisms on organic liquid fertilizer contain, the population of small microorganisms (<106 cfu / ml), does not even existed or die, microorganisms are very easily reduced or even die, and few of nutrient contents, contain the addition of urea fertilizer.

However, the composition of organic liquid fertilizer must comply with a national standard. The regulation minister of agriculture in Indonesia (2011) stated that Organic liquid fertilizer has standard quality with parameter, c-organic, pH, macro nutrient (N, P2O5, K2O5), microbe contain (*E. coli* and *Salmonella, sp*), micro nutrient (Fe, Mn, Cu, Zn, B, Co, Mo), and heavy metal (As, Hg, Pb, Cd). The standard value for organic liquid fertilizer has c-organic with minimum 6%, pH from 4 until 9, macro nutrient (Nitrogen, Phosphorous, and Potassium) from 3 - 6%, microbes contain (*E. coli* and *Salmonella*) less than10^2 and heavy metal for as max 2.5, Hg max 0.25, Pb max 12.5 and Cd max 0.5.

Davis (2009) explained that pH value in those range will increase solubility of the macronutrients such as nitrogen, Phosphorous, Calcium, Potassium, Magnesium, and Sulphur. Conversely, it decreases nutrient availability, microbial activity, and solubility as well as increases aluminum ion toxicity which influences fertilizer efficiency, plant growth, and absorption. Microbes such as *E. coli* and *Salmonella SP*, are microbes that contained in the liquid fertilizer. Organic liquid fertilizer needs microorganism to improve the efficiency of liquid fertilizer production and nutrient content (Larptansuphaphol & Jitjumroonchokchai 2009). Microbial growth and crop's response affected by soil and climatic condition, high soil fertility status, unfavorable pH, high temperature, drought, deficiency of P, Cu, Co, Mo or presence of toxic elements. Soil environment needs to be made suitable for living of useful microbial population, continuous availability of nutrient from natural sources is needed (Kashmir 2010).

In fact, three of the existing organic liquid fertilizers contain the pH value, which still have not met the standard. It is primarily because they are less than 4 or higher than 9. It indicates that the fertilizer is too acid or too base for the soil. The value of pH on the existing fertilizers in the market does not met the standard, product with initial "S" has pH value of 3.5, product with initial "J" has value of 3.7, and product with initial "N" is distributed with pH value of 3,6. Thus, this condition requires a re-development of the raw material composition of fertilizer to be better.

There are many previous researches which have been conducted about the organic liquid fertilizer such as the study investigated about the effect of different rate of organic

fertilizers on broccoli (Jayamangkala *et al.* , 2015) and study about the use of technology to process phosphate waste to establish additive in liquid complex fertilizer (Nazarbek et al., 2017). Meanwhile, Setyanto *et al.* (2014) studied to develop solid organic fertilizer.

The Taguchi method can be applied in the manufacture of liquid fertilizer because Taguchi is the power of design experiments which efficient, simple, and systematic that can optimize the cost, performance, and quality (George, 2004) by determining the control factor and noise factor. Therefore, it finds the appropriate level setting to get the qualified fertilizer made from cow liquid waste.

1.2 Problem Formulation

Based on the description in the background above, the problem that comes up in the research would be formulated and generate a research question as follows:

a. What are control factors that influence the quality of the organic liquid fertilizer?
b. What is the variable combination to develop the organic liquid fertilizer?
c. How valid is the proposed combination of the organic liquid fertilizer?

1.3 Scope of Research

a. The object of research is only to make organic liquid fertilizer from cattle's liquid waste.
b. The research only measures pH value for being the parameter of organic liquid fertilizer.

1.4 Objective of Research

The Objective of research can be summarized as follows:

a. Identifying the factors that influence the quality of the organic liquid fertilizer.

b. Determining the better variable combination of organic liquid fertilizer by using Taguchi method.
c. Validating the proposed combination of developed organic liquid fertilizer.

1.5 Benefit of Research

The expected benefits from this research are:

a. For the Student
   Enhance the knowledge on the improvement of liquid fertilizer quality by using the influence factor and composition of liquid fertilizer.

b. For the Institution
   This research becomes a direction and instruction for the organic liquid fertilizer maker.

c. For Society
   This research is expected to be used for the reference to make the reader familiar with the knowledge and also for the reference of the next research.

1.6 Systematical Research Writing

Systematical research is composed for making the research well-structured. This study was written based on the rules of scientific writing in accordance with the systematics as follows:

First, Chapter one describes the background, problems formulation, research, purposes, research boundaries.

Second Chapter is a literature review. It describes empirical and theoretical study. The empirical study is literature review from specific journals and previous research. The theoretical study is the basic theory that has the relationship with the research. Literature review contains concept and basic theories to support the researcher to solve the

problems. It includes the result description of researches that have been performed by other researchers previously.

The third chapter is the research methodology. This chapter is described about research methodology, object and place of research, collecting data method, data requirement such as primary data and secondary data, the technique for collecting analyzing data and technique for analysis.

The Fourth chapter is data collecting and processing. This chapter describes the data collecting and the processing. All data and figures will be shown in this chapter.

The fifth chapter is data collecting and data processing. This chapter describes about problems' analysis that is derived from problems formulation, research purpose and data collection.

The last in systematical research writing is conclusion and recommendation. This chapter contains conclusion and recommendation. The conclusion is defined as the brief and precise statements that describe the results of research and the suggestions based on the experience and considerations of the author and the researchers with the same fields.

CHAPTER II

LITERATURE REVIEW

In this chapter, literature review will be discussed in which it will be divided into two, empirical study and theoretical study. The empirical study is a study from previous researches that already has reputation whereas theoretical study is a study that studies that would explain the basic theory that has relation to research that would be conducted from the textbooks, etc. The empirical and theoretical study needs to be done to find out the gap between previous study and the future research to avoid the plagiarism. The literature review has aims to know the state the art. This literature review will be divided into several subchapters.

2.1 Empirical Study

The previous research related to this research. There is some research about design experiment using Taguchi methods have already existed. There are several researches using Taguchi method to identify the best combination of the factor in order to increase the quality of the product, but it is very rare to make Taguchi method to make a fertilizer. The making of fertilizer requires the right doses to produce qualified fertilizer.

The experimental study is designated to statically investigate the prominence of porosity, pressure and flexural strength on dry pressed concrete curbs. In this research, the porosity is subjected to be parameter since it influences the curb construction. While, compressive strength and flexural strength are the elements that affect the mechanical properties of curb construction. It uses Taguchi method to investigate the prominence of

porosity and compressive and flexural strength on dry pressed concrete curbs. The research uses the 27-mix design with two factors and three levels. The control factors are water to cement-ratio (0.2, 0.25 and 0.3) and cement content (300, 350 and 450 kg/m3). Using Taguchi, this study gets the result best combination that the specimen construct with 0.2 of w/c, 400 (kg/m3) cement content, and strength grade of 52.5 MPa had the maximum compressive strength of DPC (Eskandari-naddaf and Azimi-pour 2016).

Optimizing the process parameter for the removal of copper and nickel is performed by growing *Aspergillus sp.* This study optimizes the removal of copper and nickel use biosorption method by growing *Aspergillus sp* because the wastewater that contains copper very dangerous for health and environment. This study uses the ANOM (analysis of mean) for maximizing the percentage removal cooper and nickel by growing Aspergillus sp. in the batch reactor using Taguchi method. The factors that controlled are inoculum concentration, initial metal concentration, pH, and temperature. The study resulted that the influence will contribute to each factor. The design experiment technique with more number of experimental will be run and more parameters would provide a better understanding of the process of bio-sorption (Pundir *et al.*, 2016).

Optimizing of material removal rate during electrical discharge machining of cryo-treated *NiTi* (Nickel Tittanium) alloys is carried out by using Taguchi method. NiTi (Nickel Tittanium) alloy is one such as a class of advanced materials which has the unique properties such as biocompatibility, high corrosion resistance, etc. Alloy machining is difficult using conventional machining, so, it needs Electric discharge machine (non-conventional machining). EDM (Electric Discharger Machining) is the process in which electrical energy is transferred into the thermal energy and erosive action leads to removal of material using flushing fluid. This study used the orthogonal array L36. The control factor of this study is level of work, gap current, and pulse on time. It gets the optimal setting of the parameter with the second level of work EC (A2): 4219 S/m, the third level of gap current (C3): 16 A and second level of the pulse on time (D2): 38 indicates the maximum achievement value of material removal rate. Based on the analysis, it was found that work electrical conductivity, gap current and pulse on time are significant parameter that effect the material removal rates (Gaikwad & Jatti 2016).

This study uses Taguchi method and ANOVA to optimize the level cutting parameter of the stainless-steel surface roughness. The surface is the important criteria in the determination of milled steel quality. The process of cutting involves cutting parameters such as cutting speed, feed rate, helix angle on the tool life. It study uses Taguchi with orthogonal array L8 and experiments with two level of the cutting parameter. This study obtains the optimum levels of cutting parameter for surface roughness and the contribution of each parameter (Balajia *et al*., 2016).

The implementation of Taguchi method for robust suspension design is the title of research about Taguchi. This study finds the best combination of tyre pressure, spring stiffness and damping coefficient which gives a constant and targeted comfort value with reduced variance. The background of this research is manufacturing, suspension engineers and vehicle dynamic have a goal of make the comfortable of a motor-driven vehicle. The comfortable is the suspension system that makes the ride comfort. There is three-factor that influences the comfortless such as tier factor, spring factor, damping coefficient, and mass. This study is using Taguchi method and ANOVA with four factors and two levels. The result indicates the combination of the factors such as tyre pressure value of 35 psi, spring stiffness of 26000 N/s and Damping coefficient of 673 N-s/m results into a design robust of mass (Mitra *et al* ., 2016).

The optimization of a process parameter in biogas production from food waste is performed by using Taguchi and grey relational analysis. This research's objective is optimizing condition for anaerobic digestion. The background of this research is the process of anaerobic digestion process of biogas production from biomass and organic waste is considered as a cost-effective way of renewable energy generation without increasing atmospheric carbon dioxide concentration. Its successful use depends mostly on the influence of process parameters involved during the fermentation process. Process parameters that influence the biogas yield during anaerobic digestion process are solid concentration, pH, temperature, C/N ratio, and pretreatment. Using the Taguchi method, it gets the optimum condition for anaerobic digestion of food waste. The use of ANOVA gets the most significant result for the pretreatment and influence the input parameter that

will contribute to the grey relational grade by 42.50%, then followed by pH, solid concentration, temperature and C/N ratio. The results show that pretreatment is the prominent parameter that contributes towards output responses followed by pH, solid concentration, temperature and C/N ratio (Deepanraj *et al.*, 2016).

An efficient Taguchi Approach for the performance optimization of health, safety and environment in general companies is considered as few if it is examined by using Taguchi method. The objective of this study involves all economic and technical indicators (indexes), which influence the performance of the GENCO's branches. The background of this study is to identify major HSEE indicators, which affect the performance of generation companies (GENCOs). This paper presents a framework for a comprehensive performance analysis of GENCOs in terms of HSEE factors. method that used in the study is the combination of data envelopment analysis (DEA), principal component analysis (PCA), and Taguchi used for all branches of GENCOs. In this study, it calculates the correlation between rankings of the various scenarios designed. The result of correlation demonstrated that the preferred model for GENCO is Taguchi method. The result of this study emitted SOx is the most important environmental factor for ranking GENCOs. In the case study, the most influential category and factor is environment and the omission of SOx, respectively (Ali Azadeh & Sheikhalishahi 2015).

Taguchi approach in optimizing environmental factors affects productivity in the automotive industry. This study is to determine the dominance effects of environmental factor such as illuminance, humidity and WBGT (Wet Bulb Globe Temperature) on operators' productivity in the Malaysian automotive industry. Background of this study showed that the physical and chemical factors in the work environment could have a notable impact on the health and performance of the occupants, and consequently on productivity. Workplace environmental conditions, such as humidity, indoor air quality, and acoustics have significant relationships with workers' satisfaction and performance. Taguchi method uses in this study to find the dominant factors that contributed to the productivity of the operator at that the specified production workstation (Hanif *et al*., 2011).

A study entitled A Genetic Algorithm-Taguchi based on approach to inventory routing problem of a single perishable product with transshipment had an objective to incorporate the damage of the products into inventory routing problem with transshipment, in which products stocked in the depot or warehouse damaged due to their nature and also environmental issues. Method used in this study is algorithm parameters that are determined by using Taguchi design approach to achieve the best solution. The chosen control factors are population size, number of generation, in combination with the crossover and mutation rates. It is able to optimize the inventory routing problem using the genetic algorithm. It can regulate the genetic parameters using Taguchi design method to achieve the optimum solution (Azadeh *et al.*, 2016).

Taguchi can optimize the biodiesel synthesis. A study entitled "Parametric optimization of biodiesel synthesis from rubber seed oil using iron doped carbon catalyst by Taguchi approach" was aimed to optimize the biodiesel production process and identify significant parameters affecting the biodiesel yield. Experimental design by L9 orthogonal array method by Taguchi approach with linear regression and ANOVA used in this study. The result gets the optimum condition with factors such as obtained as catalyst loading, reaction temperature, M/O ratio, agitation speed, and RSME (Rubber Seed Oil Methyl Ester) yield (Dhawane *et al* ., 2016).

This study can improve the quality of organic liquid fertilizer made from raw rabbit feces. The title of this study is Design of Taguchi experiments to improve the quality of organic fertilizer made from raw rabbit feces. The objective of this research is to evaluate the composition of the organic fertilizer made from rabbit feces to get the high content of nitrogen, phosphorus and Potassium. The problem in this study is there is no standard composition for the manufacturing of organic fertilizer made from raw materials rabbit feces, so it is necessary to do research as an evaluation of the composition of the compiler of organic fertilizers made from raw rabbit droppings statistically then made improvements in the process of its manufacturing. Taguchi experiment method was used in this study. By determining the best level setting of the related factors so that the quality of organic fertilizer can be improved. From this study, it was concluded that to get the highest nitrogen, the composition will be 3000 g rabbit feces, EM4 10 ml and the amount

of chaff 200 gr, The highest phosphorus rabbit feces at the level of 3000 g, the amount of EM4 at the level of 20 ml and the amount of chaff at the level of 400 g and for the highest of Potassium are rabbit feces on level of 3000 g, the amount of rice bran at a level of 200 g, the amount of chaff at the level of 400 grams and the amount of EM4 on the level of 20 ml (Setyanto et al. 2014).

This study entitled "The Effect of Organic Manure and Chemical Fertilizer on The Growth and Nutrient Concentration of Yellow Poplar (*Liriodendron Tulipifera Lin.*) in Nursery System" has the objective to investigate the effect of organic manure and chemical fertilizer treatments on growth performance, soil, and tissue chemical properties. Organic manure increases the soil pH and concentration of nitrogen, available phosphorus, exchangeable potassium, calcium and magnesium. The chemical fertilizer decreases the soil pH and exchangeable calcium concentration of nitrogen and magnesium and increases the concentration of available phosphorus and exchangeable potassium. The NPK fertilizer treatment significantly decreases soil pH, whereas organic manure treatments increase soil pH. The conclusion of this research is organic manure that increases soil pH, concentration of nitrogen, phosphorus, and major cation. The organic manure is originated from livestock by product and sawdust not only the growth of yellow poplar but also improving the soil condition. So, organic manure should be an alternative to chemical fertilizers in nursery seedling production system (Han et al. 2016).

This study aims to identify that effective organism can be successfully fermented on prawn waste. This research related with previous study entitled "Fermentation of Prawn Waste by Using Effective Microorganism (EM) for Protein Production". Fermentation of local tiger prawn's waste by EM was conducted at various temperature condition (25^0C, 37^0C, and 60^0C). Various levels of inoculum and carbohydrate source (5%, 10%, 15%, and 20%) and their pH value compared over 72 hours. The result the pH decreased to pH 5 and fermentation profiles were similar when different types of carbohydrates were used during fermentation. The conclusion is prawn waste can successfully have fermented using EM. The best condition of fermentation process at 37^oC using 10% of EM and 10% brown palm sugar (Zulkeple *et al.* 2011).

In short, all of inductive study can be represented in Table 2.1 as follows:

Table 2.1 Previous Research of Study

No	Author's Name	Tittle of Study	Methods
1.	Naddaf et al (2016)	*Performance evaluation of dry-pressed concrete curbs with variable cement grades by using Taguchi method.*	Taguchi Method
2.	Pundir et al. (2016)	*Application of Taguchi method for optimizing the process parameters for the removal of copper and nickel by growing Aspergillus sp.*	Taguchi Method
3.	Gaikwad & Jatti (2016)	*Optimization of material removal rate during electrical discharge machining of cryo-treated NiTi alloys using Taguchi's method*	Taguchi Method
4.	Balajia et al (2016)	*Optimization of Cutting Parameters in Drilling Of AISI 304 Stainless Steel Using Taguchi and ANOVA*	Taguchi Method
5.	Mitraa et al. (2016)	*Implementation of Taguchi Method for Robust Suspension Design*	Taguchi Method and ANOVA
6.	Deepanraj et al. (2016)	*Multi-response optimization of process parameters in biogas production from food waste using Taguchi – Grey relational analysis*	Taguchi Method and Grey Relation Analysis
7.	Azadeh,& Sheikhalishahi (2015)	*An Efficient Taguchi Approach for the Performance Optimization of Health, Safety, Environment and Ergonomics in Generation Companies*	DEA (Data Envelopment Analysis), Principal Component Analysis, and Taguchi Method
8.	Haniff et al. (2011)	*The Taguchi Approach In Optimizing Environmental Factors Affecting Productivity In The Automotive Industry*	Taguchi Method
9.	Azadeh et al. (2016)	*A Genetic Algorithm-Taguchi Based Approach to Inventory Routing Problem of a Single Perishable Product with Transshipment*	Taguchi Method and Genetic Alghoritm

No	Author's Name	Tittle of Study	Methods
10.	Dhawane et al. (2016)	*Parametric optimization of biodiesel synthesis from rubber seed oil using iron doped carbon catalyst by Taguchi approach*	Taguchi Method
11.	Setyanto et al. (2014)	*Design of Taguchi experiments to improve the quality of organic fertilizer made from raw rabbit feces*	Taguchi Method
12.	Han et al (2016)	*The Effect of Organic Manure and Chemical Fertilizer on The Growth and Nutrient Concentration of Yellow Poplar (Liriodendron tulipifera Lin.) in Nursery System*	Experimental Method
13	Zulkeple et al (2011)	*Fermentation of Prawn Waste by Using Effective Microorganism (EM) for Protein Production*	Experimental Method

2.2 Theoretical Study

2.2.1 Quality

Related to the Taguchi Techniques for quality engineering, Ross (1996) stated that "Quality is related to the loss of society caused by a product derating its lifecycle. A truly high-quality product will have a minimal loss to society as it goes through this life cycle." (p. 1). Whereas, "the traditional definition of quality is based on the viewpoint that products and services must meet the requirement of those use them" (Douglas C. Montgomery, 2009, p.5) and "the modern definition of quality is inversely proportional to variability." (Douglas C. Montgomery, 2009, p.6).

2.2.2 Fertilizer

Fertilizer is a product that increases the nutrient, physical, and chemical of soil. It can enhance the growth, yield and quality of plants. There are three types of fertilizer such as mineral fertilizer, organics fertilizers, and synthetic soil conditioners. Minerals fertilizers

consist of inorganics or synthetically produced organics compound. Organic fertilizers are the waste product from animal husbandry such as stable manure, slurry manure) plants decomposition products (compost, peat) or products from waste treatment (composted garbage, sewage sludge). The synthetic soil conditioners are products that increase the physical properties of soil, for example, friability and water and air transport (Scherer et al. 2007).

2.2.3 Organic Fertilizer

Organic means that the nutrient contained in the product is derived from the remains of a once living organism. Some organic materials especially composted manure and sludges are often registered and sold as soil conditioners instead of fertilizers. Soil conditioners are materials having properties that may improve the soil's physical condition. The soil conditioners with the highest nutrient have the big potential that uses in a cost-effective manner. Animal manure is probably the most commonly available organic material used for the fertilizer value. Animal manure is essentially a complete fertilizer. Animal manures as a soil conditioner. The common manure includes such as cow, swine, and poultry. The highest nutrient found in the fresh manures and decrease as the material aged or is composted (Norman & Dean, 2015).

2.2.4 Organic Liquid Fertilizer

Various types of fertilizers are divided into organic and inorganic. Solid and liquid fertilizers have the advantage and disadvantage. Organic liquid fertilizer as known MOL (Microorganism Local), MOL consists of three components, which are carbohydrate derived from water rice water, stale rice, cassava, potatoes, wheat, bamboo shoots, grass and leaves Gliricidia, second is glucose of brown sugar, liquid sugar and coconut water, and third is the source of microorganism derived from snails, fruit skin, urine, shrimp paste (Jamilah & Juniarti, 2014).

2.2.5 Cow Urine

Cow urine has many benefits, the benefit of cow urine such as for medicine. In India, cow urine is treated as the panacea of all the diseases. It can be for treatment of *diabetes, blood pressure, eczema, heart attack, blockage in arteries, fits, cancer, AIDS, piles, prostrate, arthritis, migraine, thyroid, ulcer, acidity, constipation, gynaecological problems*. It is also used as bio-enhancer, bio-pesticide, and increase the nitrogen content of the soil. In the agriculture benefit, Total N content in the cow urine is very high ranging from 6.8 to 21.6 g N/L, out of which an average of 69% is urea. Cow urine can increase the N concentration of grass and increase the potassium concentration of grass and clover. The growth of pasture from urine patches has been observed with the following high N fertilizer and with the greater amount of N from urine such as potassium or Sulphur. As a bio-pesticide and bio-enhancer, studies about cow urine has proved to be an effective pest controller and larvicide (Fathillah & Fadli 2017).

2.2.6 Bio-Activator

Bio activator is naturally occurring microorganism attached to organic compost. It stimulates the bacteria inside in order to make waste quickly decomposes. Bio-activator is not contained the hazardous chemical and enzymes, it is eco-friendly. Bio-Activator prevents the generation of odors, increases metabolic rate of bacteria, improves the ability to handle shock loads in ETP (Effluent Treatment Plant), improves bacterial breakdown of organic material (Chheda *et al.*, 2016) .

A bio-activator is a biologically active material which can decompose agricultural solid waste. It contains cellulolytic microorganism such as tiny organism which lives on cellulose). The microorganisms were selected through studying their activity on cellulose, and ability to decompose a range of agricultural wastes. It can accelerate the composting process to one month. Organic material helps to increase the level of soil organic matter to maintain soil fertility. The advantages of the bio-activators are the production process is simple and yields a good quality product. Bio activator works with the cellulolytic microbe in the bio-activator uses the cellulose in agricultural wastes as its energy source. In this way, the cellulose in plant tissues are decomposed into simple carbohydrates that can easily be taken up by plants (Chheda, 2016).

2.2.7 EM4 (Effective Microorganism)

Effective organism-4 is the effective bio-activator that has a higher C/N ratio between the shrimp paste and boisca. EM4 can accelerate the decomposition process and increase the activity of the beneficial organism. In previous research, The treatment of EM4 culture can increase the total Ca and Mg (Fathillah & Fadli 2017).

2.2.8 Molasses

Molasses influence the acceleration of fermentation time process. Levels of molasses influence the fermentation process time and the total of the microbe. Kusmiati (2017) cited in Fifendy (2013) Adequacy of molasses influence the microbe, molasses give nutrition to microbe for the metabolism process. By Giving a small level of molasses could influence the metabolism microbe. Research about the effect of molasses utilization on the number of microbes and the nata thickness has been conducted. It resulted that the total of molasses influence the total number of microbe (Fifendy, 2013).

Molasses are containing sucrose 55%, reduction sugar 18,27%, sulfuric ash 12,74%, Pol 29,25%, Brick 81,27%. There are two types of molasses from industries such as Black strap molasses, which are the remains of sugar cane crystallization. The type contains 50%-60% sugar. The other type is light test molasses is the residual evaporation of cane sugar, lower sugar content. The type that often used as fermentation media are blackstrap molasses because contain of the sugar is high (Yusma, 1999).

2.2.9 Taguchi Method

Ross (1996) stated that “Taguchi Techniques for Quality Engineering is considered as a guide and reference source for industrial practitioners (managers, engineers and scientist) involved in product or process experimentation and development.” George et al (2004) argued that Taguchi is the power of design experiments which efficient, simple, and systematic that can optimize the cost, performance and quality.

Taguchi is the robust optimization has been adapted along with design experiment methodology and ANOVA to reduce the variability. Taguchi is easy to apply to many engineering problems with many parameters without high amount of experimentation. It helps the identifications of key parameters that affect the performance, as the parameters that affect less should be neglected. Taguchi method uses the orthogonal array for minimizing the number of the number of total experiment (Mitra *et al*, 2016).

Taguchi method is the experimental condition that uses several parameters and provides quantitative information. Taguchi method uses the Signal to noise ratio, a statistical measure for analyzing the combination of each factor. The limitation of Taguchi can solve single objective problems and cannot be used for multi-objective optimization problems. (Deepanraj *et al,* 2016).

Taguchi method was developed by Genichi Taguchi (father of quality). He can integrate the powerful statistical method in the engineering process for getting the stability and capability. The proactive based on analysis measurement, prediction, and preventive, especially focus on the designing quality into product and process rather than examining (Ross, 1996).

The parameter that influences the quality characteristic is called factors. There are three types signal factors which directly influences the intended value of the product's response, the noise factor is difficult or expensive to control and cause variation in the response, control factors are to minimize the sensitivity of products to all noises.

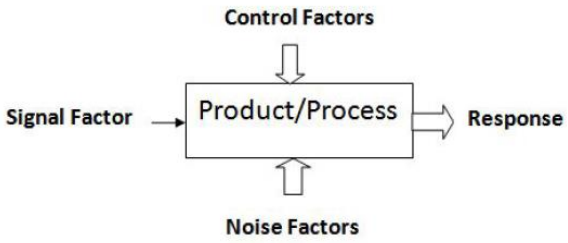

Figure 2.1 Block Diagram of Product/ Process

In the product or process, it has the signal factor; signal factors means the statistical process control. In the process, there are control factors and noise factors that influence the response and the quality characteristics or output (Rao *et al.*, 2013). Product or process design is performed in 3 steps as follows:

a. Concept design

   Concept of design consists of product architecture selection, technology processing, and examination of initial setting.

b. Parameter design

   It decides the optimum level of control factors to maximize robustness and increase the performance. The steps consist of parameter selection for the experiment, selection the orthogonal array, analysis of experiment observation, verification experiment, and iteration method for further optimization.

c. Tolerance design

   Reduce the tolerance of the product to most influential factors by using improved materials and adding extra component for controlling factors.

2.2.10 Signal to Noise Ratio

Philips (1996, p 208) argued that Taguchi measured the variation presence by creating the transformation of data repetition to another value. Signal to Noise Ratio is the transformation. There are several S/N ratios available depending on the type of character; lower is better (LB), nominal is the best (NB), or higher is better (HB).

Signal noise ratio has three categories, larger the better, smaller the better, and nominal the best. The signal noise ratio should be determining. This is to determine the optimum condition of each response, the maximum values of S/N should be used. (Deepanraj *et al*, 2016).

2.2.11 Orthogonal Array

Orthogonal Array has a function to determine the minimum experiment that can give more factor information that influences the parameter (Siswadi & Muharom, 2015). According to Peace (1993), Dr Genichi Taguchi uses an orthogonal array for determining the variation. The advantage of an orthogonal array is their cost efficiency. It means that the design of orthogonal array (combination of all factor) not required to test. Therefore, the experiment matrix should be smaller without losing the important information. According to Belavendram (1995), an orthogonal array is the matrix of factor and levels which balanced, such as the effect of any factor or level is not distracted by any other factors and levels.

Table 2.2 Orthogonal Array

Experimental trial	Process parameters			
	A	B	C	D
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

2.2.12 Degree of Freedom

Peace (1995) stated that "The number of comparison between factor (main effect) or interaction levels that need to be made to determine which level is better and specifically how much better it is."Belavendram (1993, p.84) stated that the number of degrees of

freedom associated with a factor ($_{vfl}$) is equal to one less than the number of levels for the factor. The formula for degree of freedom is V_{fl} = number of level – 1.

2.2.13 Noise and Control Factor

Taguchi divided the factor to two factors, first factor is control factor and noise factor, Control factor is factor that can be controlled by the manufacturer and cannot be changed directly by the customer whereas the noise factor is the factor which cannot be directly controlled by the manufacturer but can change by the customer's environment and usage (Philips J. Ross, 1996).

2.2.14 Analysis of Variance (ANOVA)

ANOVA is the statistical method to interpret experimental and decision-making tool for detecting difference in average performance group of items tested (Ross, 1996). According to Belavendram (1995), Analysis of variance has divided the variability into identifiable sources of variation.

Analysis variance is a statistical tool used to detect differences between experimental group means. ANOVA is justified in the experimental design with one dependent variable that is the parametric numerical outcome measure continuously, and some experimental groups in one or more independent variables (categorical). In ANOVA terminology, independent variables are factors, and groups in each factor are levels. The term array that is an integral part of ANOVA can intimidate uninitiated people, such as variance division, main effects, interactions, factors, a sum of squares, mean boxes, F scores, familywise alpha, some comparison procedures (or post hoc tests), effect size, statistical power, etc. (Steven, 2009)

ANOVA is the statistical tools for applying to determine the contribution percentage of each factor from applying the results. ANOVA table for a given analysis

helps to determine which of the factors need control and which do not. (Damle *et al*, 2016).

2.2.15 Confirmation Experiment

Confirmation experiment has the objective to validate the conclusion resulted by using certain combination of some factors and types from the previous evaluation (Soejanto, 2009).

Data processing divided into two, descriptive and inferential statistic. Statistical inferential is a set of techniques for assessing, valuing, and drawing conclusions based on data sampled from samples to illustrate the characteristics or characteristics of a population. Based on the scope, inferential statistics include: probability, theoretical distribution, sampling and sampling distribution, estimation by confidence interval, hypothesis testing, correlation analysis, and significance test, regression analysis for forecasting, variance analysis, and covariance analysis (Wyllys, 1978).

CHAPTER III

RESEARCH METHOD

In this chapter, there will be explained about the research methodology that can be divided into:

3.1 Research Object

The object of this research is to obtain the combination composition of organic liquid fertilizer. The research uses four control factors such as total cow urine, dung, probiotic EM4, and spices. Noise factors are temperature, climate when making the fertilizer, and the place of making fertilizer. Here, the researcher wants to analyze making the process

of fertilizer in order to get the combination composition to making liquid fertilizer. The research finds the combination of the factors in making liquid fertilizer in order to increase the quality.

3.2 Collecting Data Method

3.2.1 Location

The research conducted in the laboratory of Mathematics and Natural Science Faculty, Universitas Islam Indonesia.

3.2.2 Type of Data

Type of data in this study is primary data. The primary data are derived from the observation, interview and get experience data. Observation will be conducted to identify the making of the organic liquid fertilizer. The interview data will be conducted to know how to make organic liquid fertilizer from the fertilizer maker. Next, data will be used to perform an experiment on making liquid fertilizer and test the liquid fertilizer by using pH meter.

3.2.3 Apparatus

In this research, several tools were used, as follows:

1. Digital pH meter is used to measure pH value.
2. Aqua Dest is a liquid to clean up the pH meter
3. Ms. Excel software 2010 is used to calculate the signal noise ratio, ANOVA calculation, normality and homogeneous test.
4. Jar is the place for making organic liquid fertilizer

5. Dung, Spices, Probiotic Em4, and cow urine are the composition of making liquid organic fertilizer.
6. Digital Scales for measure the composition of organic liquid fertilizer.
7. Stick is used to mix the organic liquid fertilizer.
8. Sieve is used for filter the organic liquid fertilizer
9. Measuring cup for measuring the cow urine and probiotic Em4.

3.2.4 Collecting Data Method

Data collection method that used in this research is observation. First, the researcher will perform the observation. Observation is defined as how to make the organic liquid fertilizer with cow urine. Later, the observation on process, the noise and control factor in making liquid fertilizer is conducted. Furthermore, the measuring of the pH value of organic liquid fertilizer on the market also executed. Determine the factors needed to determine what factors influence when making of liquid organic fertilizer. It can be said that control factor determining is considered as a factor, which can be controlled. While, noise factor is defined as factor that cannot be directly controlled. Furthermore, the orthogonal array for experiment is determined as well as the level of each factor. Moreover, an experiment by using the orthogonal array is carried out.

3.3 Data Processing and Analysis Method

3.3.1 Taguchi Method

There are several steps in processing data of Taguchi method as follows:

1. Defining the problems to be studied in this experiment. Defining the problems is the first step that considered as compulsory.
2. Determining the experiment's objective. The objective is designated for answering the problems formulation.
3. Determining the independent variable. Determine the characteristic of the product quality for optimizing it.

4. Identifying the factors (Dependent Variable). Dependent variable is variable that the change of the factor does not depend on the others variable.
   Identify the control factor and noise factor.The control factor is a factor that can be controlled whereas the noise factor is the factor which cannot be controlled if can be controlled costly. Soejanto (2009) stated that handling for noise factor in Taguchi method could be treated in three ways such as:

   a. Ignoring the noise factor and doing the repetition in each experiment
   b. Incorporating an uncontrollable factor (noise factor) that could be considered to have an insignificant effect on the outer array of experiments
   c. Making a controlled factor variation as an uncontrollable factor and incorporate it into the outer array of experiments.
5. Determining the total level and the value of the level. In this research, the researcher determines the level with three levels. The number of levels, the experimental results will be more precise, but more levels can raise the cost of the experiment.
6. Factor selection. Selecting the factor and the level.
7. Degree of freedom calculation
   Degree of freedom use for calculating the total minimum of experiment. The formula for degree of freedom is

   Degree of Freedom = (Total of factor) x (total of level -1) ... (3.1)

8. Orthogonal array selection
   Selection of orthogonal array has equation the standard of the selection of orthogonal array is

   $$= La(b^c) \quad \text{... (3.2)}$$

   Where :
   L : Latin Rectangular design

a : total experiment

b : total level

c : total factor

Determining the orthogonal array, the researcher should choose the suitable orthogonal array for the experiment. The suitable orthogonal array should be the same or more than the degree of freedom (Soejanto, 2009). Next, the orthogonal array based on the standard of orthogonal array is chosen. The Standard of orthogonal array can be shown in Table 3.1 and Table 3.2

Table 3.1 Standard of Orthogonal Array

Orthogonal Array	**Number of Experiment**	**Maximum Number of Factors**	**Maximum Number of Factor at These Levels**			
			2	**3**	**4**	**5**
L4	4	3	3			
L8	8	7	7			
L9	9	4		4		
L12	12	11	11			
L16	16	15	15			
L'16	16	5			5	
L18	18	8	1	7		
L25	25	6				6
L27	27	13	1	13		
L32	32	31	31			
L'32	32	10	1		9	
L36	36	23	11	12		
L'36	36	16	3	13		
L50	5	12	1			11
L54	54	26	1	25		
L64	64	63	63			
L'64	64	21			21	
L81	81	40		40		

Table 3.2 Orthogonal Array from Taguchi

2 Levels	**3 levels**	**4 levels**	**5 levels**	**Mix**
$L_4(2^3)$	$L_9(3^4)$	$L_{16}(4^5)$	$L_{25}(5^6)$	$L_{16}(2^1x3^7)$
$L_8(2^7)$	$L2_7(3^{13})$	$L_{64}(4^{21})$		$L_{32}(2^1x4^9)$

$L_{12}(2^{11})$	$L8_1(3^{40})$	$L_{36}(2^{11}x3^{12})$
$L_{16}(2^{15})$		$L_{36}(2^{3}x3^{13})$
$L_{32}(2^{31})$		$L_{54}(2^{1}x3^{25})$
$L_{64}(2^{63})$		$L_{50}(2^{1}x5^{11})$

3.4 Statistical Analysis Method

Technique for analysis is conducted by collecting the data, after data collecting, the SNR (Signal to Noise Ratio) value has to be calculated. In this research, the response is pH value. First of all, it determines whether the data which collected should be normal and homogeneity. After determining the data, it needed to be calculated the contribution of each factor using ANOVA. In the parametric calculation, it needs the normal data and homogeneity data for using ANOVA.

3.4.1 Normality Test

The most commonly used statistical methods are correlation, regression and experimental design. But all of them are based on one basic assumption, that the observation follows normal (Gaussian) distribution. Therefore, it is assumed that the populations from where the samples are collected are normally distributed. For this reason, the inferential methods require checking the normality assumption (Das & Imon 2016).

The steps of normality test is by determinign the hyphothesis. The hipothesis are;
Ho : The data normal distributed (X^2 *calculation* $\leq X^2$ *Table*)
Hi : The data is not normally distributed (X^2 *Calculation* $> X^2$ *Table*)
Before use the chi-square test, it need find the formula below:

$$R = \text{Maximum of data} - \text{Minimum of Data} \quad \text{... (3.3)}$$

$$K = 1 + (3{,}32 \times \text{LOG}(N)) \quad \text{... (3.4)}$$

$$P = \frac{R}{K} \quad \text{... (3.5)}$$

$$Df = \text{Class} - 3 \quad \text{... (3.6)}$$

Where :

N : Sum of Data

σ : Average of Data

μ : Standard Deviation

R : Range

K : Total of Class

P : Long of the Class

Df : Degree of Freedom

Normality test matches between observed frequencies with expected frequency:

$$x^2 = \sum_{i-1}^{k} (\frac{Oi - Ei}{Ei}) \quad \text{... (3.7)}$$

Where:

Oi: observed frequency

Ei: expected frequency for *i*-th cell

3.4.2 Homogeneity Test

The homogeneity test is aimed to know the homogeneous data when the elements of the population studied have relatively uniform properties with each other. Test the homogeneity is using Bartlett test:

$$x^2 = (ln\ 10)\ (B - \sum (ni - 1) \log S_i^2) \quad \text{... (3.8)}$$

$$B = (\log S^2) \sum (\text{n} - 1) \quad \text{... (3.9)}$$

$$S^2 = \bar{y} = \frac{\sum(n_j - 1)S_j^2}{\sum(n_i - 1)} \quad \text{... (3.10)}$$

Where:

S^2 = Combined variance of all samples

ln 10 = 2,306

With the real level α, the Ho hypothesis is rejected if $x^2\ cal\ \geq\ x^2(1-\alpha)(dk)$, where obtained from the Chi square table of distribution with the level of trust (1-α) and dk = k-1. The calculation is done by Using Excel.

3.4.3 Signal to Noise Ratio (SNR)

This is the formula for calculate the SNR value. The number of the output is NTB Nominal the Best with the pH value with pH value is 7. In this research, the researcher makes the liquid fertilizer then calculates the pH value using pH meters. The Formula of the SNR (Signal Noise Ratio) is:

a. Larger the better

$$\text{SNR}_{\text{LTB}} = -10 \text{ Log } [\ \frac{1}{n} \sum_{1=n}^{n} \frac{1}{yi^2} \quad \text{... (3.11)}$$

Where:

n: number of tests in the experiment (trial)

yi: response value for each replication

b. Smaller the better

$$\text{SNR}_{\text{STB}} = -10 \text{ Log } [\ \frac{1}{n} \sum_{1=n}^{n} yi^2 \quad \text{... (3.12)}$$

n = number of tests in the experiment (trial)

yi = response value for each replication

c. Nominal the best

$$\text{SNR}_{\text{NTB}} = 10 \log 10 \left[\frac{\mu^2}{\sigma^2}\right] \quad \text{... (3.13)}$$

$$\mu = \frac{1}{n} \sum_{i=1}^{n} yi \quad \text{... (3.14)}$$

$$\sigma = \frac{1}{n} \sum_{i=1}^{n} (yi - \mu)^2 \quad \text{... (3.15)}$$

n = number of tests in the experiment (trial)

yi = response value for each replication

3.4.4 Analysis of Variance

Analysis of Variance (ANOVA) can be calculated by SPSS software that can be shown in the Table 3.3

Table 3.3 Analysis of Two Ways ANOVA

Sources	**SS**	**V**	**MS**	**F ratio**	**SS'**	**P%**
Factor A	SS_A	*Va*	M_A= SS_A/V_A		SS_A-V_A. *Ve*	$\frac{SS_A'}{SS} x100\%$
.....	.....	.....	.....		.....	.....
Factor n	SS_n	*Vn*	*Mn*= *SSn/Vn*		*SSn-Vn. Ve*	$\frac{SSn'}{SS} x100\%$
Error	SS_E	*VE*	M_E=SS_E/V_E	*1*		
Total	SS_T	*N*	-			

1. The calculation of the price of *Sum of Square* (SS) or sum of squares (JK) includes:

   a. Average response of each experiment ($\bar{y}_i$)

$$\bar{y}_i = \frac{\sum y_i}{n_i} \quad \text{... (3.16)}$$

Where:

i : experiment

n_i : mount of experimental data i

y : response value (observation data) to-i

b. Average overall experiment ($\bar{y}$)

$$\bar{y} = \frac{\sum y}{n} \quad \ldots (3.17)$$

n : number of observation data

c. Total Sum of Square (ST) or total sum of squares

$$ST = \sum y^2 \quad ... (3.18)$$

d. Sum of Square or the sum of the mean squares

$$Cf = n \times \bar{y}^2 \quad \ldots (3.19)$$

e. The Sum of squares of due to factors, for factor A calculation*:*

$$SS = \left[\left(\frac{1}{n} xA_1^{\,2} \right) + \left(\frac{1}{n} xA_2^{\,2} \right) + \left(\frac{1}{n} xA_3^{\,2} \right) - Cf \right] \quad ... (3.20)$$

2. The calculation of degree of freedom (v_f)

a. Degree of Freedom total (v_t), formulated by:

$$Vt = \text{N} - 1 \quad ... (3.21)$$

b. Degree of Freedom of a factor, the calculation example for factor A is formulated

$$v_A = \text{kA} - 1 \quad ... (3.22)$$

c. Degree of Freedom error (v_e), is formulated by:

$$v_e = Vt - v_{factor} \quad ... (3.23)$$

d. The sum of squares due to error

$$SSE = STT - SA - SB - SC - SD \quad \text{... (3.24)}$$

e. Calculate *mean of square* (Mq) of factor

$$MS = \frac{SS}{\mathrm{V}} \quad \text{… (3.25)}$$

f. Calculate F ratio of a factor

$$F_{Stat} = \frac{M_s}{SSE} = \frac{\frac{SSA}{VA}}{\frac{SSE}{Ve}} \quad \text{... (3.26)}$$

g. Calculate pure of square (S') of factor

$$SS' = SS - (SSE - DB) \quad \text{... (3.27)}$$

h. Calculate contribution percentage (ρ) of factor

$$\rho = \frac{S'}{SS}\ x\ 100\% \quad \text{... (3.28)}$$

3.4.5 Confirmation Experiment

The confirmation experiment is of the utmost importance in the design of an experiment. The confirmation experiment is conducted at the optimum factor level setting and the quality characteristic at the optimum setting obtained. The purpose of confirmation experiment is to warn when there are strong interaction effects. When interactions effect are strong, additivity is poor and the reproducibility of experimental results is consequently also poor (Belavendram, 1995).

In this research the confirmation experiment is compare between the pH value of the three product of organic liquid fertilizers from the optimum composition from the signal noise ration calculation compare with three product that sell on the market. In this confirmation experiment show the product has different pH value that appropriate with the standard national or not.

3.5 Research Flowchart

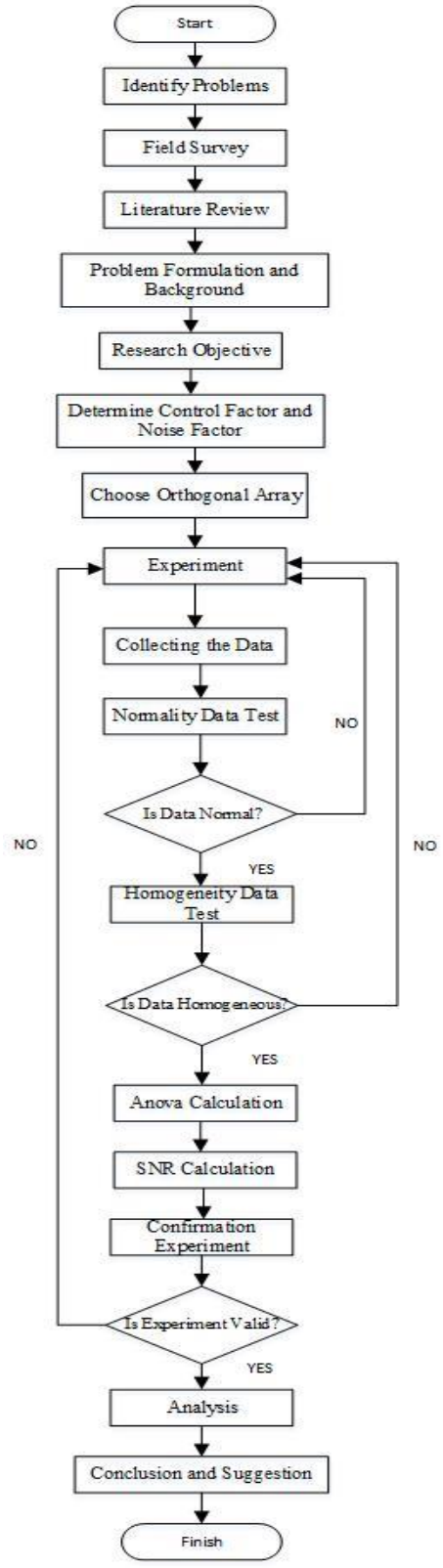

Figure 3.1 Research Flowchart

In the beginning of research, it is started by identifying the problems. The problem identification is aimed to know the existing problems. Problems in this research is identified as too much organic liquid fertilizers that are sold in the market inappropriate with the standard national of Agriculture Indonesia. One of the organic liquid fertilizer parameters is pH value. The pH value standard of organic liquid fertilizer is 4-9. One of influences in pH value is the organic liquid fertilizer composition itself and process of making the organic liquid fertilizer. After the researcher identifies the problems, the researcher does a field survey to ensure the existence of the problems. The field survey of this research is in the form of observation to learn how to make liquid organic fertilizer based on expert and find the factors that influence the pH value. Later, the supporting theories should be identified to support the problems and experiment.

After formulating the problems, a field survey could be perfomed and the literature could be found, later the problems formulation and background will be determined. The problem's formulation is the controlled factor that influences the quality of organic liquid fertilizer, the optimum combination variable to develop the organic liquid fertilizer, and validation of the proposed combination of the organic liquid fertilizer.

The background is based on the identified problem. Then, an object of the research will be made to identify goals and aims of this research. The objective of this research is to identify the factors which influence the quality of the organic liquid fertilizer, determine the variable combination of organic liquid fertilizer to be better by using Taguchi method, and validate the proposed combination of organic liquid fertilizer developed. Since this research uses the Taguchi method, it needs to determine the control and noise factor for doing an experiment. Control factors of this research are the composition of the organic liquid fertilizer such as cow urine, dung, probiotic em4 and spices. There are three levels of each control factors. The noise factor in the research is temperature, but in this research, according to Soejanto (2009), the noise factors are neglected because there are three ways to handle the noise factors in Taguchi method, one of the ways is to neglect the noise but perform a replication. The orthogonal array selection is needed to determine how many experiments that the researcher should do. The orthogonal array in this research is L9 based on the formula

with three levels and four control factors. After determining the orthogonal array and do a replication, the experiment should be performed. The experiment provides the 27 jars because there are 9 trials with three replication. Every jar is the mix of cow urine, dung, probiotic em4 and spices and then close in the jar and wait 15 days so the process fermentation occurs. After the organic liquid fertilizer fermented, the organic liquid fertilizer test by pH meters and the get the pH value of each jar.

Data collection is performed and the process will be followed by normality data test.. The normality test uses Chi-Square Test. Data should be distributed normally. If the data is not normal, the experiment should be repeated. If the data normal, it can be proceeded to the homogeneity test. Homogeneity test in this research uses Bartlett test. If the data is normal and homogeneous then the researcher should process the data with ANOVA calculation, since the requirement to calculate data by using ANOVA, the data should be normal and homogenous. ANOVA calculation is used to calculate and determine the contribution of each factor to the change of pH value, SNR (Signal Noise to Ratio) calculation is designated for determining the optimum composition of organic liquid fertilizer. After calculating the SNR and ANOVA, the researcher does the confirmation experiment for determining the before and after result whether it has a significant difference or not. The confirmation experiment uses the independent t-test since there will be a comparison between data on pH value from the optimum composition of organic liquid fertilizer with the data of pH value the liquid organic fertilizer sold in the market. This confirmation is showing the difference on pH value or not. After obtaining the data from ANOVA calculation, SNR calculation and confirmation experiment, the researcher does the analysis of the result of the calculation. After doing calculation and getting the result, then analysis is performed. Finally, the researcher can conclude by answering the problems formulation and provide suggestion for making organic liquid fertilizer with 7 pH value and finish the research by completing the report.

CHAPTER IV

DATA COLLECTION AND PROCESSING

4.1 Data Collection

This research took place in the Laboratory of Mathematics and Natural Science Faculty. The researcher collects the data from design Experiment by using Taguchi Method. The researcher makes organic liquid fertilizer from cattle waste identify the pH value. Before conducting an experiment, the researcher must plan the experiment with study field. Then, problems formulation and objective experiment are needed. The independent variable will be identified to recognize the character that can be measured. It is required to determine the control factors and noise factor of the research. After determining it, the researcher should carry out the experiment.

4.2 Process of Taguchi Method

4.2.1 Process of Experiment Planning

The process of experiment planning should be conducted before experiment. The steps are formulated as follows:

a. Defining the problems to be studied in this experiment. Defining the problems is the first step that the researcher compulsory to do. The problems in this experiment, much organic liquid fertilizers in the market do not fulfil the standard that is set by the Agriculture Minister. The standard of the organic liquid fertilizer should have the pH around 4 – 9. In fact, the pH of the existing fertilizers are above or below the standard.

The researcher should determine what factors that influence the quality of the cattle liquid fertilizer and the best combination of optimal cattle liquid fertilizer composition.

b. Determining the experiment objective. The objective is composed for answering the problems formulation. The objective of this research are to identify the factors which influence the quality of the organic liquid fertilizer from cattle waste and to identify the best combination of optimal organic liquid fertilizer composition from cattle waste.

c. Determining the independent variable. It is to determine the characteristic of the product quality for optimisation. The research is conducted by determining the characteristic of organic liquid fertilizer processing from the cattle waste by using pH value. The research measures the making process of organic liquid fertilizer with pH value to optimize the composition. The independent variable of this research is to measure pH value with Nominal The Best pH 7.

d. Identify the factors (Dependent Variable)

   The dependent variable is variable that its factor's change does not depend on the other variables. The chosen factor in this experiment which influences the pH value of the organic liquid fertilizer is the composition of the organic liquid fertilizer from the cattle waste, fermentation temperature and time of the fermentation.

e. Identify the control factor and noise factor

   The control factor is a factor that can be controlled. Whereas, the noise factor is the factor that is difficult to be controlled whereas it is costly to control it. The control factors suggested in this research are the composition of the liquid organic fertilizer such as cow urine, probiotic em4, dung and spices. The noise factor that appointed in this study is the temperature when making the liquid organic fertilizer. In this experiment, the noise factor is not put in the calculation because the noise factor cannot influence the process of making organic liquid fertilizer. The temperature

when making the organic liquid fertilizer is the noise factor in this experiment. According to Soejanto (2009), there are three ways in handling for noise factor in Taguchi method. In this study, it uses first statements to ignore the noise but conduct a replication. This experiment has three replications to decrease the error. This experiment ignores noise because of the temperature when making the organic liquid fertilizer not influenced by the process of making fertilizer because the temperature has a little influence to the container which stores the liquid organic fertilizer. The jar is made of plastic, plastic is the isolator. So, It does not deliver heat but the temperature in the jar and the temperature on the fermentation process do influence the process. So, the noise factor will be not put in the orthogonal array to be calculated. The control factor in this research is the composition of making organic liquid fertilizer. The control factor is cow urine, probiotic em4, goat dung and spices.

f. Determining the total level and the value of the level

In this research, four control factors and with three levels will be chosen. The control factors are derived from the observation location in Degolan, Jalan Kaliurang km 15. This location is subjected as a place for making the organic liquid fertilizer. Based on expert, the researcher gets the detail of composition and provided with the procedure to make the organic liquid fertilizer. The dosage of making organic liquid fertilizer is obtained from the expert but in this experiment, the ratio of dosage is reduced to adjust it with the size of jar that fits with one liter of cow urine. The dosage from the expert is designated for making a barrel of organic liquid fertilizer. Therefore, the researcher should reduce the dosage. The composition of making the liquid organic fertilizer are cow urine, probiotic Em4, dung and spices. The composition is the one of factors that can be controlled and influenced the pH value. The researcher choose three levels because many levels lead to more rigorous research. But more levels make the experiment costly. So, the researcher only choose 3 levels and 4 factors. The factors are cow urine, probiotic Em4, dung, and spices. The factors and the levels can be show on Table 4.1

Table 4.1 Control Factor

No	Factors	Level		
		level 1	**level 2**	**level 3**
1	Cow urine	1000 ml	800 ml	600 ml
2	Probiotic EM4	10 ml	8 ml	6 ml
3	Dung	500 gram	400 gram	300 gram
4	Spices	50 gram	40 gram	30gram

g. Factor Selection

1. The composition of cow urine; level used in this composition are 1000 ml, 800 ml and 600 ml. This level is chosen because if more than 1000 ml, a microorganism is difficult to decompose the organic matter which contains in the urine because of the total of urine is not proportional with the total of probiotics Em4 and molasses. Microorganism decomposes the organic material optimally if the nutrient for microorganism from molasses and nitrogen from cow urine is fulfilled. Therefore, the composition should have ratio. If the composition of cow urine is less than 600 ml the microorganism cannot obtain the nitrogen from cow urine and sufficient nutritional needs as the material for helping to decompose the organic material. Therefore, fermentation process becomes slower than before (Wijaya, 2008). The selection of 800 ml cow urine is the combination of 1000 ml and 600 ml.

2. The composition of Probiotic Em4, level used in this composition are 10 ml, 8 ml, 6 ml. If the probiotic em4 is 10 ml for cow urine 1000 ml, 800 ml and 600 ml and the molasses must be 10 ml because more than 10 ml of probiotics Em4 for cow urine 1000 ml, 800 ml and 600 ml can decrease the pH value and makes the organic liquid fertilizer become acid. If the dosage of Em4 is less than 6 ml for cow urine 1000 ml, 800 ml, and 600 ml, it causes the beneficial microorganism to fertility of soil as well as growth and help speed up the composting process because of less than 6 ml causing the least amount of microorganisms that slow

down the process of composting animal waste.The selection of 8 ml is a combination of the 10 ml until 6 ml (Utomo, 2007).

3. Dung

The composition of goat dung, level used in this composition is 500 gram, 400 gram and 300 gram. If the composition of goat dung is more than 500 gram, it same with the content of cow urine, It difficult to decompose the organic material. Lingga (1991) stated nutrients contained in solid and liquid livestock manure can be shown in the Table 4.2

Table 4.2 Nutrient on The Manure Waste

Name of manure and shape of feces	**Nitrogen (%)**	**Phosphorous (%)**	**Potassium (%)**	**Water (%)**
Horse- solid	0.55	0.3	0.4	75
Horse-liquid	1.4	0.02	1.6	90
Buffalo - solid	0.6	0.3	0.34	85
Buffalo- liquid	0.5	0.15	1.5	92
Cow-solid	0.4	0.2	0.1	85
Cow-liquid	0.5	1	1.5	92
Goat-solid	0.6	0.3	0.17	60
Goat-liquid	1.5	0.13	1.8	85
Sheep-solid	0.75	0.5	0.45	60
Sheep-liquid	1.35	0.05	2.1	85
Pig-solid	0.95	0.35	0.4	80
Pig-liquid	0.4	0.1	0.45	87
Chicken-solid and liquid	1	0.8	0.4	55

Based on Table 4.2 the livestock manure of goat solid has the second highest nutrient of the nitrogen content. It means that the goat dung has 0.6 % of nitrogen. It means that the microorganism needs nitrogen for the nutrient to decomposed the organic material. If the composition of the goat dung is more than 500 gram and not proportional to the probiotics Em4 and molasses, microorganism difficult to decomposed the organic material because the Em4 is less than with the dung. Therefore, it makes the decomposed or fermentation process slower. The other reason more than 500 gram for cow urine 1000 ml, 800 ml, and 600 is the organic liquid fertilizer become dry because the dung absorbs the cow urine and failed to

become organic liquid fertilizer. If the composition of dung is less than 300 gram, it causes the nutrient decreasing. The microorganism cannot obtain the nitrogen from goat dung and sufficient nutritional needs as the material for helping to decomposed the organic material (Wijaya, 2008).

4. Spices

   In this research, the spices in this organic liquid fertilizer divided into 6 materials. The materials are turmeric, temulawak, galangal, chilli, red onion, and garlic. So, the composition of each material is 50 gram, 40 gram, and 30 gram divided into 6. It gets a gram of each spice. The level used in this composition is 50 gram, 40 gram, 30 gram. The composition of spices if more than 50 gram, it makes the root grows is slower. Marpaung & Hutabarat (2015) stated that the spices are 100%, the result of root growth is less than with the 50% of spices. The title of research is The Response of Natural Growing Stimulant Materials and Stem Cutting Origin to the Growth of Fig Seedling, it proves that the natural growth stimulant that contains 50% can make sprout time is faster, shoot length, leaf number, length, and wet weight of the roots are high compared with 100% of natural stimulant. Therefore, if the spices are too much, it makes the plant will be longer to growing and developing. If the composition of spices is less than with 30 grams, it makes the growth stimulant is lower. Therefore, make the nutrition for the plant will be low.

h. Degree of freedom Calculation

   Degree of freedom is used for calculating the total minimum of experiment. The formula for degree of freedom is formulated as follows:

$$\text{Degree of Freedom} = (\text{Total of factor}) \times (\text{total of level} - 1)$$
$$= 4 \times (3-1)$$
$$= 8 \text{ degree of freedom}$$

i. Orthogonal Array Selection

Determining the orthogonal array based on the formula. The selection of orthogonal array below

$$= La(b^c)$$
$$= L_8(3^4)$$

In this research, the degree of freedom is 8, because the standard orthogonal array, there are four factors and three levels. By choosing the degree of freedom in accordance with the experiment, then the degree of freedom must be greater or equal to the calculation of degrees of freedom in the experiment. It should be chosen L_9. Therefore, it chooses $L_9(3^4)$ with the minimum of the experiment of 9. The orthogonal array matrix for orthogonal array $L_9(3^4)$ can be shown on the Table 4.3

Table 4.3 Orthogonal Array Matrix L_9

Trial	**A**	**B**	**C**	**D**
	Colomn Number			
	1	**2**	**3**	**4**
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

Where :

A : Cow urine

B : Probiotic Em4

C : Dung

D : Spices

4.2.2 Experimental Implementation Phase

In this phase, process of making organic liquid fertilizer covers :

a. Collect all of the Material for making organic liquid fertilizer.
   1. Collecting 21.6-liter cow urine and contained in the container or bottle.
   2. Preparing probiotic EM4 as a bio-activator and add molasses. Molasses is the food to activate microorganism in Em4.
   3. Preparing Spices, the spices consist of *galangal, temulawak, chilli, garlic, red onion, and turmeric*. The spices are mashed with a blender. It aims to make the spices easy to decompose. The dosage for spices are 21.6 kilograms for all experiment, but every spice consists of *ginger, galangal, temulawak, chilli, garlic, red onion, and turmeric* with same doses of each spice.
   4. Preparing the goat dung, then collect the dried goat dung on the container.
   5. After all of the materials are collected, then the organic liquid fertilizer is made by pouring all the materials on the jar or container. The first pour the goat dung appropriate with the dosages, then pour spices, EM4, molasses and cow urine. After that, stiring and closing the jar, then waiting for 15 days because fermentation process need 15 days. Fermentation process takes 15 days because liquid organic fertilizer can be used or already mature on the 15^{th} day (Richana 2011). All the process of making organic liquid fertilizer can be shown on the Appendices 1.

b. pH Value Test Using pH meter

   After the organic liquid fertilizer can be used or are not eligible to be used, the next process is to measure the pH of the organic liquid fertilizer using pH meter. The ways of measurement are as follows :

1. Filter the liquid fertilizer with a strainer and place it on the glass.
2. Wash the electrodes with aquades to avoid contamination.
3. Perform tool calibration.
4. Put the electrode into the liquid fertilizer.
5. Look at the pH meter screen shortly after immersion and the pH number appears. (Refers on Appedinces 2)
6. Record the number in pH meter.

The result of pH value of the experiment can be shown on the Table 4.4

Table 4.4 pH Value Result

Trial	Inner Array				Experiment Data		
	A	B	C	D			
	Colomn Number						
	1	2	3	4	Y1	Y2	Y3
1	1	1	1	1	7.6	7.5	7.6
2	1	2	2	2	7.5	7,6	7.7
3	1	3	3	3	7.7	7.7	7.6
4	2	1	2	3	7.6	7.8	7.8
5	2	2	3	1	7.6	7.4	7.4
6	2	3	1	2	8.1	8	8
7	3	1	3	2	7.7	7.5	7.5
8	3	2	1	3	6.8	6.9	6.9
9	3	3	2	1	8	8.1	8

Based on Table 4.4, the result of the pH meter shows 3 replication. A, B, C, and D in this table is the control factors with 9 trials. A factor is cow urine, B factor is EM4, C factor is Dung, and D factor is Spices. The column number is the orthogonal array gets from the standard of orthogonal array $L_9(3^4)$. First trial means that the composition of making liquid organic fertilizer are cow urine with 1000 ml, Probiotic Em4 with 10 ml, Dung with 500 gram, and spices with 50 gram. It is based on the colomn number 1. It means level 1, for 2 is levels 2 and three is level 3 and for the next trials is following with the orthogonal array. The experiment result from trial one using the level 1 into the all of the composition are 7.6, 7.5, and 7.6.

4.3 Experiment Result Analysis

4.3.1 Normality test

Normality test is needed to determine the data that are normally distributed. The steps of normality test are to determine the hypothesis. The hypothesis is;

Ho: The data normal distributed (X^2 calculation ≤ X^2 Table)

Hi : The data is not normally distributed (X^2 Calculation > X^2 Table)

Firstly, it should be determined N = sum of data, σ = average of data, μ = standard deviation, R = range, K = total of class, P = long of the class, minimum, maximum, df = degree of freedom, and X2 table. The result can be shown in Table 4.5

Table 4.5 Normality Test

N	27
Σ	7.614815
μ	0.333004
R	1.3
K	5.752128
P	0.226003
Min	6.8
Max	0.908485
Df	3
χ2 table	7,814728

Calculate the normality test, it should be calculated the Z1, Z2, Z1 Table, Z2 Table, P and ei. The result can be shown in Table 4.6

Table 4.6 Result of Z, P, and Expected Frequency

Class	Z_1	Z_2	Z_1 Table	Z_2 Table	P	ei
1	-2.4469	-1.7682	0.0072	0.0385	0.0313	0.8454
2	-1.7682	-1.0895	0.0385	0.1380	0.0995	2.6852

Class	Z_1	Z_2	Z_1 Table	Z_2 Table	P	ei
3	-1.0895	-0.4108	0.1380	0.3406	0.2026	5.4712
4	-0.4108	0.2679	0.3406	0.6056	0.2650	7.1548
5	0.2679	0.9465	0.6056	0.8281	0.2225	6.0066
6	0.9465	1.6252	0.8281	0.9479	0.1199	3.2367

Z_1 gets from lower class limit minus with average of data then divided with standart deviation. So, 6.8 minus 7.6 divided with 0.333 and gets -2.4469. For Z_2 gets upper class limit minus with average of data then divided with standart deviation. 7 minus with 7.6 divided with 0.333 and gets -1.7682. The other Z1 and Z2 is follow by the formula before. The LCL (Lower Class Limit) and UCL (Upper Class Limit) can be shown on the Table 4.7

Table 4.7 LCL and UCL

LCL	UCL
6,8	7,0
7,0	7,3
7,3	7,5
7,5	7,7
7,7	7,9
7,9	8,2

The calculation of class and range can be shown on the Table 4.8

Table 4.8 Class and Range

Class	Range	Oi	ei
1	$6.8 \leq x \leq 7.0$	3	0.8454
2	$7.0 < x \leq 7.3$	0	2.6852
3	$7.3 < x \leq 7.5$	6	5.4712
4	$7.5 < x \leq 7.7$	10	7.1548
5	$7.7 < x \leq 7.9$	2	6.0066
6	$7.9 < x \leq 8.2$	6	3.2367
	Total	27	25.3999

Based on the class range, it is obtained 6 classes and the observed frequency of the data are 3 for the range between $6.8 \leq x \leq 7.0$ with the expected frequency is 0.8454 then $7.0 < x \leq$

7.3 the observed frequency is 0, range $7.3 < x \leq 7.5$ has observed frequency 6 and expected frequency is 5.4712, range $7.5 < x \leq 7.7$ has the observed frequency 10 with expected frequency 7.1548 then range $7.7 < x \leq 7.9$ has the observed frequency 2 with expected frequency 6.0066 and the last is range $7.9 < x \leq 8.2$ with observed frequency 6 and the expected frequency is 3.2367. Based on the table the total of the observed frequency is 27 and the total of the expected frequency is 25.3999. For calculating the chi-square it should be grouping the value of Ei if the Ei is below 5 it should be sum with the next class. The calculation of chi-square can be shown in Table 4.9

Table 4.9 Chi-Square Result

	Class	**Oi**	**Ei**	**Oi-Ei**	**$(Oi-Ei)^2$**	**$((Oi-Ei)^2)/Ei$**
1	1+2	3	3.5306	-0.5306	0.2814858264049	0.07972855
2	3	6	2.6852	3.3148	10.9880111836047	4.09209012
3	4	10	7.1548	2.8452	8.0948817599131	1.13138394
4	5+6	8	6.0066	1.9934	3.9736010261457	0.66153797
					Σ(Oi-Ei)2/Ei	5.96474059

The sum of the class based on the Ei below 5. So the class become 1+2, 3, 4, and 5+6. Calculate the chi-square is based on the formula Σ(Oi-Ei) 2/Ei. It gets the chi-square is 0.07972855 for first class 4.09209012 for second class 1.13138394 for third class and the last is 0.66153797, therefore, the result of the X^2 calculation is 5.96474059. It can be concluded that the data is normal because the X^2 calculation is less than X^2 table. It can be shown in Table 4.10

Table 4.10 Result of Normality Test

χ2 table	7.814727903
χ2 calculation	5.964740589
Conclusion	NORMAL

4.3.2 Homogenity Test

The homogeneity test is aimed to identify the homogeneous data when the elements of the population studied have relatively uniform properties with each other. The hypothesis of homogeneity test are Ho = Variance of each group is same (homogeneous) and Hi = Variance of each group is not same (not homogeneous). The accepted region is Ho accepted if X^2calculation $\leq X^2$ table, H1 accepted if X^2calculation $> X^2$ table. The variance of the The calculation of the homogeneous data can be shown in the Table 4.11

Table 4.11 Homogeneous Test

Experiment	**1**	**2**	**3**
Average	7.62222222	7.611111	7.611111
s_i^2	0.36666667	0.355121	0.337062
(n-1) x s_i^2	0.73333333	0.710243	0.674125
Σ(n-1) x s_i^2	2.117700806		
Σ(n-1)	24		
s^2	0.088237534		
B	-25.30431936		

From the Table 4.11, it is obtained the standar deviation square of each experiment as follows: 0.36666667, 0.355121, and 0.337062. The calculation of homogeneity test can be obtained get from the formula on table 4.3, later the standard deviation value is obtained as follows: 0.088237534 and B value with -25.30431936. The calculation of X2 is -52.0131784 and the X2 table is 5.99146455. It means that the data is homogeneous because $\chi 2$ Calculation $< \chi 2$ table, it means -52.0131784 is more than 5.99146455. It can be shown in the Table 4.12

Table 4.12 Result of Homogeneity Test

χ^2 Calculation	-52.0131784
χ^2 table	5.99146455
Conclusion	HOMOGENEOUS

4.3.3 ANOVA (*Analysis of Variance*) Calculation

ANOVA calculation is designated for determining whether there is an influence on the factors that have been determined against the response varible pH. The steps of calculating by using ANOVA are :

a. Determine the hypothesis of the factor

Y target : pH value aproaching of 7

Factor A : Total of the use cow urine

Factor B : Total of the use probiotic Em4

Factor C : Total of the use dung

Factor D : Total of the use spice

1. Factor A

   Ho : there is no effect of cow urine factor on pH

   Hi : there is influence of cow factor to pH

2. Factor B

   Ho : there is no effect of probiotic Em4 factor on pH

   Hi : there is influence of probiotic Em4 to pH

3. Factor C

   Ho : there is no effect of goat dung factor on pH

   Hi : there is influence of goat dung factor to pH

4. Factor D

   Ho : there is no effect of spices factor on pH

   Hi : there is influence of spices factor to pH

Determine the T = Total of Data, CF = Correction Factor, SST = sum of squares total, and VT = degree of freedom . It is obtain that the T is 205.6 CF is 1565.606 SST 2.994074, and VT 26. The result can be shown in the Table 4.13

Table 4.13 Result of ANOVA

T	205.6
CF	1565.606
SST	2.994074
VT	26

The total of pH value on the first experiment, second and third experiment should be sum of and it gets the total of the pH value can be shown in the Table 4.14

Table 4.14 Result of pH Value Total

Y1	**Y2**	**Y3**	**Total**
7.6	7.5	7.6	22.7
7.5	7.6	7.7	22.8
7.7	7.7	7.6	23
7.6	7.8	7.8	23.2
7.6	7.4	7.4	22.4
8.1	8	8	24.1
7.7	7.5	7.5	22.7
6.8	6.9	6.9	20.6
8	8.1	8	24.1

After summing the pH value, then the square of each Y can be calculated. Then, total and square should be done. The result can be shown in the Table 4.15

Table 4.15 Total Square of pH Value

$\mathbf{Y_1^2}$	$\mathbf{Y_2^2}$	$\mathbf{Y_3^2}$	$\mathbf{\Sigma}$	$\mathbf{\Sigma^2}$
57.76	56.25	57.76	171.77	29504.9329
56.25	57.76	59.29	173.3	30032.89
59.29	59.29	57.76	176.34	31095.7956
57.76	60.84	60.84	179.44	32198.7136
57.76	54.76	54.76	167.28	27982.5984
65.61	64	64	193.61	37484.8321
59.29	56.25	56.25	171.79	29511.8041
46.24	47.61	47.61	141.46	20010.9316
64	65.61	64	193.61	37484.8321

the next step is calculating the sum of square, the degree of freedom, mean square, F.calculation, F. Table, pure of the square and the contribution percentage. The result of the calculation can be shown on the Table 4.16

Table 4.16 Contribution Result

FK	SS	V	MS	Source of Variance	DF	SS	MS	F cal	F Table	SS'	% Contribution
A	0.2941	2	0.147	Factor A	2	0.294	0.147	19.8500	3.55456	0.28	0.09327
B	1.6207	2	0.810	Factor B	2	1.621	0.810	109.4000	3.55456	1.61	0.53637
C	0.4363	2	0.218	Factor C	2	0.436	0.218	29.4500	3.55456	0.42	0.14077
D	0.5096	2	0.255	Factor D	2	0.510	0.255	34.4000	3.55456	0.49	0.16526
SSE	0.13	18	0.007	Residual	18	0.13	0.007			0.19	0.06432
				Total	23	2.99		**TOTAL**			**1**

Based on the Table 4.16 it is concluded that factor A, B, C, and D can influence with pH value response. Factor A, B, C, and D are cow urine, Em4, dung, and spices. The rank of the contribution is B, D, C, and A. The contribution percentage is Em4 with 0.53637, spices with 0.16526, dung with 0.14077 and cow urine with 0.09327. The contribution can be shown in Figure 4.1

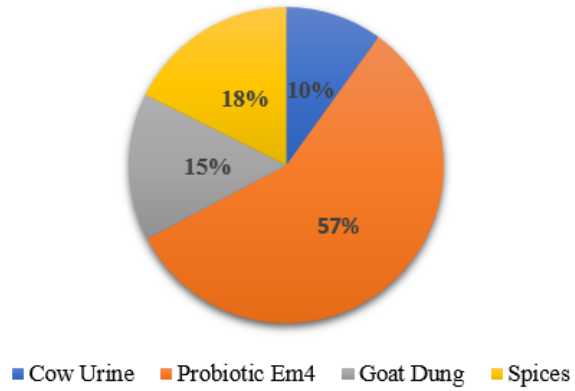

Figure 4.1 Graph of Contribution Factor

The hypothesis and the conclusion based on the table is as follows :

1. Factor A

   Ho : there is no effect of cow urine factor on pH

   Hi : there is influence of cow urine factor to pH

   Conclusion : F. Cal = 19.8500 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of cow urine factor to pH value.

2. Factor B

   Ho : there is no effect of probiotic Em4 factor on pH

   Hi : there is influence of probiotic Em4 to pH

   Conclusion : F. Cal = 109.4000 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of probiotic Em4 factor to pH value.

3. Factor C

   Ho : there is no effect of goat dung factor on pH

   Hi : there is influence of goat dung factor to pH

   Conclusion : F. Cal = 29.4500 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of goat dung factor to pH value.

4. Factor D

   Ho : there is no effect of spices factor on pH

   Hi : there is influence of spices factor to pH

   Conclusion : F. Cal = 34.4000 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of spices factor to pH value.

4.3.4 Signal to Noise Ratio Calculation

Signal to noise ratio in this research applies nominal the best with the target pH value 7. Before using the equation (3.13), (3.14) and (3.15). It should be identified first the average

and variance of every experiment data. The average and the variance can be shown in the Table 4.17

Table 4.17 Signal Noise to Ratio Result

Trial	INNER ARRAY				EXPERIMENT DATA			Average	Variance	SNR
	A	B	C	D						
	Colomn Number									
	1	2	3	4	Y1	Y2	Y3			
1	1	1	1	1	7.6	7.5	7.6	7.57	0.339	7.064
2	1	2	2	2	7.5	7.6	7.7	7.60	0.360	6.114
3	1	3	3	3	7.7	7.7	7.6	7.67	0.385	7.076
4	2	1	2	3	7.6	7.8	7.8	7.73	0.416	6.129
5	2	2	3	1	7.6	7.4	7.4	7.47	0.453	5.849
6	2	3	1	2	8.1	8	8	8.03	13.408	7.116
7	3	1	3	2	7.7	7.5	7.5	7.57	19.166	5.860
8	3	2	1	3	6.8	6.9	6.9	6.87	22.967	6.980
9	3	3	2	1	8	8.1	8	8.03	25.796	7.116

Based on the Table 4.16 average for the first trial is 7.57 with the variance 0.339. The second trial has average 7.60 and the variance is 0.360, the third trial has average 7.67 and variance 0.385, then average 7.73 and variance 0.416, fifth the average 7.47 and variance 0.453, Sixth has average 8.03 and variance 13.408 seventh trial has average 7.57 and variance is 19.166, eight trial has average 6.87 and variance 22.967 , the last has average 8.03 and variance 25.796. In this research, before finding the SNR it should calculate the variance or standard deviation and find the μ. It can be shown in Table 4.18

Table 4.18 Signal Noise to Ratio Calculation

μ	μ^2	$(y-\mu)^2$			Total	σ	σ^2	μ^2/σ^2	SNR
7.566667	57.25444	0.001111	0.004444	0.001111	0.006667	0.002222	4.94E-06	11594025	7.064234
7.6	57.76	0.01	0	0.01	0.02	0.006667	4.44E-05	1299600	6.11381
7.666667	58.77778	0.001111	0.001111	0.004444	0.006667	0.002222	4.94E-06	11902500	7.075638
7.733333	59.80444	0.001111	0.001111	0.017778	0.02	0.006667	4.44E-05	1345600	6.128916
7.466667	55.75111	0.017778	0.004444	0.004444	0.026667	0.008889	7.9E-05	705600	5.848559
8.033333	64.53444	0.004444	0.001111	0.001111	0.006667	0.002222	4.94E-06	13068225	7.116217

μ	μ^2		$(y-\mu)^2$		Total	σ	σ^2	μ^2/σ^2	SNR
7.566667	57.25444	0.017778	0.004444	0.004444	0.026667	0.008889	7.9E-05	724626.562	5.860114
6.866667	47.15111	0.004444	0.001111	0.001111	0.006667	0.002222	4.94E-06	9548100	6.979917
8.033333	64.53444	0.001111	0.004444	0.001111	0.006667	0.002222	4.94E-06	13068225	7.116217

Based on the Table 4.18 the SNR of each experiment from the calculation is the first trial 7.064, second trial 6.114, third trial 7.0756, fourth trial 6.129, fifth trial 5.849, sixth trial 7.116, seventh trial 5.860, eight trial 6.979 and the last is 7.116. From the calculation of SNR, it gets the effect of each factor. It finds effect factor of the output A (cow urine), B (Probiotic Em4), C (goat dung), and D (spices). It calculates the different and rank of each factor. The result can be shown in the Table 4.19

Table 4.19 Result of Each Factor

	Output			
	A	**B**	**C**	**D**
Level 1	**6.751227375**	6.351088154	**7.05345593**	6.67633647
Level 2	6.364563718	6.314095078	6.45298076	6.36338019
level 3	6.652082604	**7.102690466**	6.261437	**6.72815704**
different	6.265418947	7.06569739	5.66096183	6.41520076
Rank	1	3	1	3
	A1	B3	C1	D3

Based on the Table 4.19, The output of SNR gets the effect of each factor in level 1, level 2, and level 3. The factor A (cow urine) with level 1affect by 6.751, with level 2 effect by 6.365, and with level 3 effect by 6.652. Factor B (probiotic Em4) with level 1 has effect 6.35, for level 2 has effect 6.314, and level 3 has effect 7.103. Factor C (goat dung) with level 1 effect by 7.0534, level 2 effect by 6.452, and level 3 effect by 6.261. The last factor is factor D (spices), with level 1 effect by 6.676, level 2 effect by 6.363 and level 3 effect by 6.728. The different factor A of each level is 6.265, the different factor B of each level is 7.066, the different factor C of each level is 5.661 and the different of last factor is 6.415. The best formulation it gets from the nominal the best, the SNR close with 7 because of the better ph for organic fertilizer with pH 7.The closest nominal SNR of factor A in level 1, the closest

SNR of factor B in level 3, the closest SNR of factor C in level 1, and the closest SNR of factor D in level 3. The optimal composition of making organic liquid fertilizer are A1, B3, C1, and D3. The optimal composition is A1 as the cow urine with 1000 ml, then B3 as the probiotic with 6 ml, C1 as the goat dung with 500 gram and the D3 as the spices with 30 gram.

4.3.5 Experiment Confirmation

Experiment Confirmation in this research is for confirming that the result before the experiment and after the experiment has difference or there is no difference. The result of the pH value after experiment and liquid organic fertilizer on the market can be shown on the Table 4.20

Table 4.20 Result of Confirmation Experiment

Value	Class
7.6	After Experiment
7.5	
7.5	
3.5	on Market
3.7	
3.6	

Based on the Table 4.20, The result from the product after experiment are 7.6, 7.5, and 7.5 whereas the product sell on the market not approriate on the standard national of Indonesia are 3.5, 3.6, and 3.6. It means that the organic liquid fertilizer after experiment has different on the pH value compare with the organic liquid fertilizer on the market.

CHAPTER V

DISCUSSION

5.1 Experiment Analysis

5.1.1 Normality Test Analysis

Based on the normality test, in this research, the use statistic parametric, statistic parametric is a statistic that uses interval data and ratio based on fact. On the statistic parametric the data should be normal and homogeneous. By using the chi-square test formula, the data is distributed equally used to calculate the degree of freedom K-3 = 6 – 3 = 3 it gets the X^2 table is 7.815 and X^2 Calculation is 5.965. Therefore, (X^2 table = 7.815) > (X^2 calculation = 5.965), it is concluded that the data is normal distributed. Ho is accepted. The data is normal it means that symmetrically distributed data. The mode, the median, the average is the same and there is no extreme value. The pH value is obtained from the population with a normal distribution. There is no extreme data of pH value (outlier). Data should be normal because if abnormal it cannot be used in parametric statistic and cannot use in ANOVA test to determine the contribution of each factor. Abnormal data means the data not from the normal population and not distributed symmetrically. In abnormal data, the curve is not symmetrical (Steven, 2009). Abnormal data, a shape of the bell resembles the curve. If using the QQ plot for seeing whether the data normal or not, the data not in line, means that the data is abnormal. After that a homogeneity test will be performed. QQ plot can be shown in the Figure 5.1

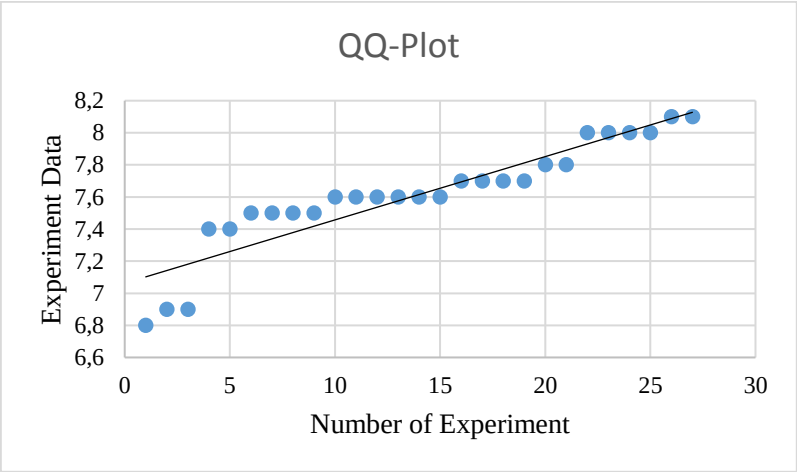

Figure 5.1 QQ-plot of the Experiment

5.1.2 Homogeneity Test Analysis

Based on the homogeneity test, it can be analyzed that the data is homogeneous. Homogeneity test used for knowing two or more sample has same variances or not. It said homogeneous if the pH value of other population has the same variance (Keselman,1979). From the homogeneity test, then use the formula. It is obtained the X^2 calculation and X^2 table. Ho will be accepted if the X^2 calculation < X^2 table. The result of this research the data of pH value is homogeneous, because of X^2 calculation lower than X^2 table with -52.013 < 5.991. It means Ho is accepted, the data is homogeneous. If the pH value data is not homogenous, a sample cannot be used, and need an evaluation from the sampling process until distribution even when permitted should be repeated to obtain a homogeneous test sample. Homogeneous data is needed is used for the parametric statistic (Johnson, 2014). A requirement of parametric is the data should be homogenous and normal.

5.1.3 Contribution of Each Factor Analysis

The contribution of each factor is obtained from the ANOVA calculation. ANOVA is a statistical analysis that tests the difference between more than two groups. ANOVA is used as an analytical tool to test the research hypothesis which assessed whether there was an

average difference between the groups (Steven, 2009). The final result of ANOVA analysis is F test or F test. This F Count value will be compared to the value in table f. If the value of f calculation is more than f table, it can be concluded that accept H1 and reject H0 or that means there is mean the significant difference in all groups. ANOVA calculation in Taguchi method is aimed to determine the control of significant factor that influences the response of pH value (Rao & Padmanabhan 2012). Based on the analysis and variance calculation, the contribution factor that influences the pH value are B, D, C, and A the contribution value of the factors B (probiotic EM4) is 0.53637, factor D is 0.16526, factor C (goat dung) is 0.14077 and factor A (cow urine) is 0.09327. The hypothesis of each factor as follows:

1. Factor B

   Ho : there is no effect of probiotic Em4 factor on pH

   Hi : there is influence of probiotic Em4 to pH

   Conclusion : F. Cal = 109.4000 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of probiotic Em4 factor to pH value.

   The em4 factor has the first and big contribution to the change of pH value in the making of liquid organic fertilizer. Fermentation is the most important process in this process. It is the process of decomposition of organic compounds to produce energy and substitution of the substrate into new products by microbes (Madigan, 2011). The fermentation process is strongly influenced by bacterial activity. Em4 is a variety of one type of solution containing bacteria, among others, decomposer bacteria that serve as decomposers of organic materials naturally in the soil. Bacterial activity greatly affects pH. According to Oliviera & Doelle (2015), organic matter from agricultural crops and wastes, animal wastes, forest and wood residues, plants and municipal waste and it is stored as chemical energy. This energy can be released as biogas such as methane (CH_4), hydrogen (H_2) and carbon dioxide (CO_2) through the anaerobic digestion process. Microbial activity in the decomposing organic matter will produce CO_2 gas, this CO_2 gas will form carbonic acid (H_2CO_3) which easily decomposes into H + and HCO3 ions. This H + ion will affect the acidity of the pH of the decreasing solution (increased acidity). In the highly acidic pH is likely to

precipitate so it cannot be absorbed optimally by the plant. At optimal pH all elements are in good solubility conditions so that nutrients will be more easily absorbed by plant roots (sutiyoso, 2003). According to research conducted by (Fathillah and Fadli 2017) entitled "Nutrient Content of Liquid Organic Fertilizer (LOF) by Various Bioactivators and Soaking Time" that probiotics can affect the value of ph and nutritional content of fertilizer. Therefore, it can be concluded that the role of microorganisms is very influential by the pH value.

1. Factor D

   Ho : there is no effect of spices factor on pH

   Hi : there is influence of spices factor to pH

   Conclusion : F. Cal = 34.4000 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of spices factor to pH value.

Spices in the manufacturing of liquid organic fertilizer consist of *temulawak, galangal, red chilli, turmeric, onion, and garlic*. Spice herbs have different nutrients or ingredients. The content is a nutritional supplement for liquid organic fertilizer. Complement in nutrients, the killing of soil pathogens, and others. For example chilli, hot chilli of a substance called capsaicin is the content contained in chilli. The heat on the chilli is caused by this substance. Capsaicin is contained in chilli seeds. capsaicin function is subjected as a calculation tool from the attack of predators and fungus attacks. Due to hot and spicy chilli, the predator will not eat it. If the fungus is exposed to capsaicin, then the growth of the fungus can be disrupted. Spice herbs have different pH on each ingredient. Different types of spices have different decay. Decomposition of each material is different so it causes changes. pH on spices causes pH changes in liquid organic fertilizer during the fermentation process.

2. Factor C

   Ho : there is no effect of goat dung factor on pH

Hi : there is influence of goat dung factor to pH

Conclusion : F. Cal = 29.4500 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of goat dung factor to pH value.

Based on the ANOVA calculation it is obtained that the dung is the third factors that contribute the pH value. Based on the research before, Wijaksono (2016) stated that the long time of fermentation process influences the pH value. The pH value influenced by the nitrogen content on the fertilizer. The beginning of fermentation process occurs the process formation of ammonia from nitrogen-containing the compound. The nitrogen compound is from goat dung. Goat dung is rich in nitrogen, based on Barker (2002), goat dung has the nitrogen content of 21.8 lb/ton. This nitrogen content that causes the change of pH value. It causes the pH is increased. In the process of fermentation, acid release happened, it causes pH value is decreasing. The increasing of phosphorus caused by the decreasing of pH value. The increasing of phosphorous caused by the activity of Lactobacillus sp bacteria that change glucose become lactic acid, so it changes the acidity.

3. Factor A

Ho : there is no effect of cow urine factor on pH

Hi : there is influence of cow urine factor to pH

Conclusion : F. Cal = 19.8500 > F. Table = 3.55456 So, H_0 is rejected, it means that there is influence of cow urine factor to pH value.

A factor is cow urin. Cow urine based on the result of calculation has influence in pH value because cow urine contain of nitrogen, phosporous, and pottasium. Nwite (2015) stated that cattle urine has made the plant to be second high compared to other urine such as human urine and goat urine. In his study, pH value of urine before applying in the soil is 9.6 and the pH value of soil before applying urine on soil is 4.6. After doing an research, there is a change in the pH value of the soil become 4.9. It means that cow urine can influence the pH value.

It concludes that factor A,B,C,and D are Ho rejected and H_1 accepted, it means that there are influence of each factor to response pH value.

5.1.4 Signal to Noise Ratio Analysis

The calculation of signal noise ratio determines the optimal composition of organic liquid fertilizer. From the signal noise to the ratio of each factor, it gets a combination of the best factor level that can optimize the pH level test of liquid organic fertilizer is A1, B3, C1, and D3. The optimal composition of organic liquid fertilizer as follows:

1. Factor A (Cow urine) with level 1 is 1000 ml
2. Factor B (Probiotic Em4) with level 3 is 6 ml
3. Factor C (Goat Dung) with level 1 is 500 gram
4. Factor D (Spices) with level 3 is 30 gram

Based on research Setyanto et al. (2014), it used Taguchi method to increase the quality of organic fertilizer made from rabbit droppings. It gets the optimal composition of making solid fertilizer with response using a nutrient that contains in the fertilizer such as Phosphorus, Nitrogen, and Pottasium. It is found that the composition of the level that has the effect of producing high Nitrogen content value is the number of rabbit droppings at 3000 gr level, 200 gr of bran, Em4 at 20 ml level and the amount of husk at 400 gr level. To obtain maximum results, 200 ml sugar cane drops as a medium for every 10 ml of Em4 probiotics while this study differs in the fertilizer, in this research, is making liquid fertilizer made by cow urine and the response of this study is pH value. It concludes that Taguchi method can find the optimal composition using the signal noise ratio.

5.1.5 Experiment Confirmation Analysis

Experiment confirmation is designated for comparing the pH value data and recommendation condition whether there is any differences or not. The purpose of the confirmation experiment

is to validate the conclusion drawn during the analysis phases. This particulary important when screening, low resolution, small fractional-fractional experiment are utilized. Because of the coufounding within the coloumn, the conclusion should be considered preeleimenary until validate by confirmation experiment (Ross, 1996). Based on the result of the experiment, the result has different pH value between some organic liquid fertilizers on the market and liquid organic fertilizer on this experiment. The pH value for organic liquid fertilizer in this experiment are 7.6, 7.5 and 7.5 whereas the pH value of three organic liquid fertilizer sell on the market are 3.5 , 3.7, and 3.6.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

1. Based on the observation of the research, control factor that influences the making the liquid organic fertilizer is the composition such as cow urine, probiotic Em4, dung, and spices.

2. Based on the data analysis, it can be concluded that:
   Based on the calculation using the Taguchi method and the experiment, it is obtained the value of SNR (Signal Noise to Ratio) Nominal The Best with pH value of 7. It is obtained the best optimal composition of liquid organic fertilizer with composition of A1, B3, C1, and D3. A1 is 1000 ml of cow urine, then B3 is 6 ml of probiotic EM4, C1 is 500 gram of goat dung and the D3 is 30 gram of spices. The output of this organic liquid fertilizer is 125 ml.The Composition of the selected level factor are :
   a. The cow urine uses the level 1, with the 1000 ml of cow urine.
   b. The probiotic use level 3, with the 6 ml of probiotic EM4
   c. The goat dung use level 1, with 500 gram of goat dung
   d. The spices use level 3, with 30 grams of spices

3. Based on the calculation of Signal Noise Ratio and Anova, it can be concluded that the organic liquid fertilizer is better than some liquid organic fertilizer in the market. The pH value of the liquid organic fertilizer in this research has different pH value with some of liquid organic fertilizer in the market and it appropriate with the standard national of

Indonesia. The pH value of organic liquid fertilizer in this research based on the optimum composition from the signal noise ratio calculation, it gets 7.6, 7.5, and 7,5 and the pH value of organic liquid fertilizer in the market are 3.5, 3.7, and 3.6. It can be concluded that the pH value from this research is different with some organic liquid fertilizer in the market.

6.2 Recommendation

1. Based on the analysis, some recommendations can be advised in the making of liquid fertilizer. The result of this research is expected to be used as consideration in making organic liquid fertilizer using the cow urine. It is expected to increase the quality of organic liquid fertilizer.

2. Based on the ANOVA and signal noise ratio result, ANOVA calculation can determine the contribution of each factor. The most influence factors of making organic liquid fertilizer are Probiotic Em4. The liquid organic fertilizer maker should use the probiotic Em4 as the main composition of liquid organic fertilizer because this composition influences the pH value the most. For the signal noise ratio result, it is recommended to use the optimal composition to make it. If making fertilizer in large quantities, it is recommended to follow the optimal ratio of composition.

3. In this research, the researcher realizes that there are still many shortcomings due to limited time and funds, it is expected that there is significant improvement. The improvement to increase the quality of organic liquid fertilizer such as adding several variables that could responsible to the quality besides the pH value such as the nutrient, the total of microorganism, and the others response that could determine the quality of organic liquid fertilizer, set the interval of level or add some level in order to increase the quality, and analyze the other factors that influence the pH value in the process of making organic liquid fertilizer.

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APPENDICES

1) How to Making Organic Liquid Fertilizer

Tools :

1. Jar
2. Plastic gloves
3. Stick
4. Digital Scale
5. Sieve
6. Measuring cup

Materials:

1. Goat Dung
2. Cow Urine
3. Spices *(ginger, galangal, temulawak, chili, garlic, red onion, and turmeric)*
4. Em4 (Effective Microorganism 4)
5. Mollasses

The making process :

1. Collecting cow urine and contained in the container or bottle.
2. Preparing probiotic EM4 as a bio-activator and add molasses. Molasses is the food to activate microorganism in Em4. Ratio between mollasess and Em4 is 1:1
3. Preparing Spices, the spices consist of *galangal, temulawak, chilli, garlic, red onion, and turmeric*. The spices are mashed with a blender.
4. Preparing the goat dung, then collect the dried goat dung on the container.
5. After all of the materials are collected, then the organic liquid fertilizer is made by pouring all the materials on the jar or container.

6. The first pour the goat dung appropriate with the dosages, then pour spices, EM4, molasses and cow urine

2) How to Measure pH Value

The ways of measurement are as follows :

1. Filter the liquid fertilizer with a strainer and place it on the glass.
2. Wash the electrodes with aquades to avoid contamination.
3. Perform tool calibration.
4. Put the electrode into the liquid fertilizer.
5. Look at the pH meter screen shortly after immersion and the pH number appears.
6. Record the number in pH meter.

3) Picture of Making Organic Liquid Fertilizer

Fig 1. Step 1 Measure the spices and goat dung

Fig 2. Step 2 Put Goat Dung and Spices

Fig 3. Step 3 Measure the Em4 and Molasses

Fig 4. Step 4 Pour the Cow urine, em4, molasses on the jar

Fig 5. Step 5 Stir the mixed material on the jar

Fig 6. Step 6 Closing the jar until 15 days

4) Measuring the pH Value of Organic Liquid Fertilizer

Fig 7. pH Value Result

Fig 8. Organic Liquid Fertilizer