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Manufacturing Silage From Field Grass For Cattle Feed Using The Fermentation Method

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ABSTRACT

Ruminant livestock require forage for growth, reproduction and production. The principle of forage for livestock is that it contains good nutrition and is available throughout the year. One technology for preserving forage is by making silage. Making silage, apart from preserving and minimizing nutrient loss, can also improve feed nutrition. Silage is feed that is preserved through the ensiling process, namely the process of preserving feed or forage using fermentation work under anaerobic conditions (Suadnyana, et al, 2017). In this research, field grass silage was made with the addition of EM4 containing Lactobacillus sp bacteria at different concentrations and varied fermentation times so that making field grass silage is expected to improve the fermentative quality and improve or maintain the nutritional quality of the feed which can be seen from the content. water, protein content, pH, and color. The analysis process was carried out with varying fermentation times of 4, 8, 12, 16 and 20 days and EM4 concentrations of 0.2%, 0.4%, 0.6% and 0.8% (v/w). The test results show that the best silage is with a fermentation time variation of 20 days with an EM4 concentration of 0.6%, 20 days with an EM4 concentration of 0.2%, and 16 days with an EM4 concentration of 0.8%. This is because the longer the fermentation time and the more EM4 added, the better the quality of the silage obtained.

Keywords: EM4, Bran, Fermentation, Molasses, Silage

1. INTRODUCTION

1.1 Background

Ruminant livestock require forage for growth, reproduction and production. The principle of forage for livestock is that it contains good nutrition and is available throughout the year. One technology for preserving forage is by making silage. Making silage, apart from preserving and minimizing nutrient loss, can also improve feed nutrition. Silage is feed that is preserved through the ensilage process, namely the process of preserving feed or forage using fermentation work under anaerobic conditions (Suadnyana, et al, 2017).

Forage production, especially grass, is very high during the rainy season and during the dry season production decreases, making it difficult to obtain, both at the smallholder and large livestock levels. If there is a long dry season it can cause huge losses to ruminant farms, both those producing meat and milk. Therefore, silage is made so that the supply of grass for animal feed remains available during the dry season.

Field grass is a type of forage that is very available in the rainy season. We can find field grass almost everywhere in our environment. Field grass is a type of forage that grows wild which consists of a mixture of various local grasses that grow naturally. This grass can grow on all kinds of soil and is easy to find on the side of the road. However, the composition of the food substances in field grass does not/do not comply with SNI feed quality standards, resulting in low nutritional content such as protein, minerals and vitamins. Low nutritional content such as protein, minerals and vitamins can be corrected by making silage.

Microorganisms are naturally found in forage, but it cannot be ascertained whether they can maximize the fermentation process or not. Different concentrations in making field grass silage can reduce pH, dry matter and minimize nutrient damage. In this research, with the addition of different concentrations of microorganisms the fermentative quality was not significantly different, so the smallest concentration was recommended to be added to silage making.

In this research, field grass silage was made with the addition of EM4 containing Lactobacillus sp bacteria at different concentrations and varied fermentation times so that making field grass silage is expected to improve the fermentative quality as well as improve or maintain the nutritional quality of the feed as well as provide grass supplies for Animal feed remains available during the dry season.

1.2 Supporting Theories

1.2.1 Field Grass

The ruminant feed commonly used by breeders is field grass. Field grass is usually found on roadsides, around paddy fields or fields and grows wild so it has low quality as animal feed. Even though the production capacity and quality are low, field grass is easy to obtain, cheap and easy to manage. Field grass that is usually found is elephant grass and so on.

Field grass contains food substances that are beneficial for livestock such as water, fat, extracts without nitrogen, crude fiber, minerals (especially phosphorus and table salt) and vitamins. The requirements for grass as an animal feed ingredient include (1) having high benefits as a food ingredient, (2) being easily digested by the digestive system and (3) being available in sufficient conditions. The energy source in field grass comes from fiber components consisting of cellulose and hemicellulose. Images and general nutritional content of field grass are presented in Figure 1.1 and Table 1.1.

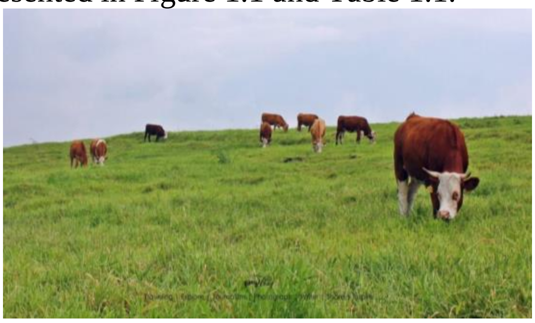


Figure 1.1 Field Grass

Table 1.1 Nutrient content of field grass

Parameter	Unit	Mark
Dry Ingredients	%	21.4
Crude Fat	%	2.56
Crude protein	%	6.99
Crude Fiber	%	29.0
Ash	%	21.0

1.2.2 Setaria Grass (Setaria sphacelata)

Setaria grass is a plant that has good quality for forage for livestock, this can be seen from the growth rate, productivity of the harvest and the nutrients contained therein. This grass originates from tropical and subtropical regions of Africa, then brought to Asia and Australia and introduced to tropical areas of the world. Planting and propagating this grass can be done with pols (teared clumps) and using seeds.

Fresh weight production of Setaria grass reaches 100-110 tons/ha/year. The nutritional value contained in Setaria Grass is 6-7% crude protein, 42.0% crude fiber, 36.1% Nitrogen-Free Extract (BETN) and 2.8% fat. Apart from being cut grass for feed, it is also used as grass for pastures, because it is resistant to trampling. Setaria grass as forage for livestock can be given in the form of cut grass, pasture grass or given after processing it first, such as making silage. An image of Setaria grass is presented in Figure 1.2.

Figure 1.2 Setaria grass

1.2.3 Rice Bran

Rice bran is a by-product of rice milling or the remainder of rice pounding. Rice bran comes from grain. If the grain is ground, it will produce 50-60% rice, the remaining 1-17% groats, 20-25% husks, 10-15% bran and 3% rice bran. Bran is a source of vitamin B and is liked by livestock. The nutritional content is quite good, but the main weakness of rice bran is that the crude fiber content is quite high, and to reduce the fiber content can be done by fermentation. Rice bran contains 11.9-13.4% crude protein, 10-16% crude fiber, TDN 70 .5-81.5%, metabolic energy 2730 kcal/kg, and minerals Ca 0.1% and P 1.51%. The maximum use of rice bran in cow rations is 40% of the total ration. Good quality rice bran has physical characteristics such as a distinctive smell, not rancid, and a smooth texture.

Figure 1.3 Rice bran

Table 1.2 SNI for Rice Bran

Parameter	Condition (%)		
	Quality I	Quality II	Quality III
Water Content (max)	13.0	13.0	13.0
Ash (max)	11.0	13.0	15.0
Crude Protein (min)	12.0	10.0	8.0
Crude Fiber (max)	12.0	15.0	18.0
Husk Content (max)	5.0	10.0	15.0

1.2.4 Molasses

Molasses is liquid waste that comes from the remains of processing sugar cane into sugar. A thick liquid that is dark brown in color and still contains lots of organics such as sugar, carbohydrates, organic acids, nitrogen compounds and ash elements. Molasses contains high nutrients, the sugar content reaches 50% in the form of sucrose, crude protein 2.5-4.5% with amino acids consisting of the amino acids aspartate, glutamate, lysine, pyrimidine, carboxylate, asparagine and alanine. These reducing sugars are very easily digested and can be directly absorbed by the blood, used for energy purposes.

Molasses as an additive also functions to accelerate the formation of lactic acid and provide an energy source that is quickly available to bacteria (Sumarsih et al. 2009). Molasses contains nutrients high enough for the needs of bacteria, so it is used as an alternative material as a carbon source in fermentation media. The image and content of brown sugar are shown in Figure 1.4 and Table 1.3.

Figure 1.4 Molasses

Table 1.3 Ingredients contained in molasses

No	Content	Average (%)
1	Water	20.0
2	Saccharose	32.0
3	Fructose	16.0
4	Glucose	14.0
5	Calcium oxide	1.5
6	Potassium oxide	3.5
7	Chloride	0.4

(Source: Toharisman and Santoso, 2008)

1.2.5 Effective Microorganisms (EM4)

Effective microorganisms(EM4) is a biotechnology system that was first discovered by Prof. Dr. Teruo Higa from Ryukyu University, Okinawa, Japan around the 1980s. Initially, this technology was introduced to farmers to improve soil conditions, suppress the growth of microbes that cause disease and increase the efficiency of organic material use by plants. EM4 solution is a microbial bacteria resulting from fermentation that changes glucose into bacteria, or bacteria made from substances containing glucose.

EM4 is a type of solution that contains bacteria including decomposers, lactobacillus sp, lactic acid bacteria, photosynthetic bacteria, Streptomyces, cellulose decomposer fungi, phosphorus solubilizing bacteria which function as natural decomposers of organic matter. This technology is proven to improve soil quality, improve growth and quantity and quality of crop yields. In the livestock sector, this technology can be used to improve the nutritional value of agricultural waste and materials that are less useful for use as feed ingredients.

However, it is necessary to consider what dosage or dose of Effective Microorganisms - 4 (EM4) will be used for field grass fermentation in order to obtain optimum changes in Crude Protein.

1.2.6 Metabolic Reactions

Metabolism is all the chemical reactions that take place in the cells of living things. Metabolism consists of two processes, namely anabolism and catabolism. Anabolism is the arrangement of simple chemical compounds into complex chemical compounds or molecules. This event requires energy from outside. The energy used in this reaction can be light energy or chemical energy. This energy is then used to bind these simple compounds into more complex compounds. So, in this process the required energy is not lost, but is stored in the form of chemical bonds in the complex compounds formed. The energy used in anabolism can be light energy or chemical energy. Anabolism that uses light energy is known as photosynthesis,

Catabolism is the reaction of breaking down/dismantling complex compounds into simpler compounds to produce energy that organisms can use to carry out their activities. The function of catabolism reactions is to provide the energy and components needed by anabolism reactions.

Bacterial cells, like the cells of all living organisms, generally carry out life activities for survival. All cells need an energy source. Even though there are very diverse types of substances that act as energy sources for microorganisms, there is a very simple basic pattern of metabolism, namely that there is a change from one complex form of energy to a simpler form of energy, so that it can enter into the metabolic chain.

Fermentation is the process of breaking down organic compounds to produce energy and converting substrates into new products by microbes. Fermentation is the processing of a substrate using the role of microbes (microorganisms) so that the desired product is produced. Fermentation products include cell biomass, enzymes, primary and secondary metabolites or bioconversion transformation products.

The fermentation process utilizes the activity of a particular microbe or a mixture of several microbial species. Microbes that are widely used in the fermentation process include yeast, mold and bacteria. Fermentation technology is one of human efforts to utilize relatively cheap or even less valuable materials into products that have high economic value and are useful for human welfare.

1.2.7 Types of Fermentation

Based on the product produced, fermentation is divided into two types, namely:

1. Homofermentative, namely fermentation where the final product is only lactic acid.
2. Heterofermentative, namely fermentation where the final product is equal amounts of lactic acid and ethanol.

Based on the use of oxygen, fermentation is divided into aerobic and anaerobic fermentation. Aerobic fermentation is fermentation that requires oxygen, while anaerobic fermentation does not require oxygen.

1.2.8 Fermentation Chemical Reactions

Reactions in fermentation vary depending on the type of sugar used and the product produced. In short, glucose ($C6H12O6$), the simplest, through fermentation will produce ethanol ($2C2H5OH$). The chemical reaction equation is:

$$C6H12O6 \rightarrow 2C2H5OH \rightarrow 2C02 \rightarrow 2\ ATP$$

The above reaction is explained: sugar (glucose, fructose and sucrose) = alcohol (ethanol) + carbon dioxide + energy (ATP).

The sequence of fermentation processes and the resulting products are explained in the image below.

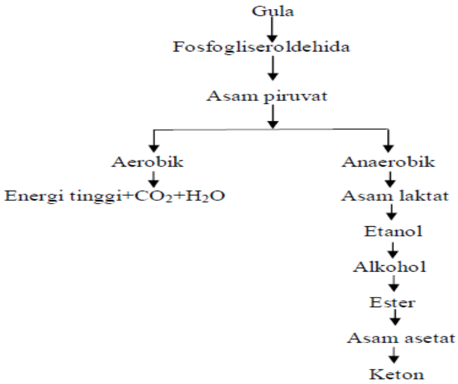


Figure 1.5 Sugar Degradation

Fermentation methods that are widely used include alcoholic fermentation and lactic acid fermentation. Alcoholic fermentation and lactic acid fermentation have differences in the final product produced. The final product of alcoholic fermentation is ethanol and CO2, while the final product of lactic acid fermentation is lactic acid. The success of fermentation is determined by several factors, namely:

1. Acidity (PH)

Foods that contain acid usually last a long time, but if there is enough oxygen and mold can grow and fermentation continues, then the durability of the acid will be lost. The acidity level is very influential in the development of bacteria. Good acidity conditions for bacteria are 4.5–5.5.

2. Microbes

Fermentation is usually carried out with pure cultures produced in the laboratory. This culture can be stored dry or frozen.

3. Temperature

The fermentation temperature determines the type of microbes that are dominant during fermentation. Each microorganism has a maximum growth temperature, a minimum growth temperature, and an optimal temperature, namely the temperature that provides the best and fastest reproduction.

4. Oxidation

Air or oxygen during fermentation must be regulated as well as possible to reproduce or inhibit the growth of certain microbes. Each microbe requires a different amount of oxygen for growth or forming new cells and for fermentation. For example, baker's yeast (Saccharomycess cerevisiae) will grow better in aerobic conditions, but both will ferment sugar much faster in anaerobic conditions.

5. Time

The rate of bacterial multiplication varies according to the species and growing conditions. Under optimal conditions, bacteria will divide once every 20 minutes. For some bacteria, the generation time chosen is the interval between divisions, which can be up to 20 minutes.

1.2.9 Field Grass Silage

Silage is an alternative feed preservation technology which aims to maintain the nutritional value of feed. Good quality is demonstrated through several parameters such as pH, lactic acid, color, texture, temperature, percentage of damage and nutritional content of the silage. Making silage must create anaerobic conditions by lowering the pH as low as possible with the aim that lactic acid producing bacteria can grow and harmful microbes such as Clostridium, Butyrilicum, Pseudemonas and others cannot grow.

The principle of making silage is fermentation of forage by microbes which produce a lot of lactic acid. Fermentation is the process of breaking down hard structures physically, chemically and biologically so that materials from complex structures become simpler so that livestock digestibility becomes more efficient. Fermentation is the process of breaking down organic compounds into simple ones involving microorganisms. The fermentation process can increase the availability of food substances such as protein and metabolic energy and is able to break down complex components into simple components (Utama, 2018).

The aim of fermentation is to produce a product (feed ingredient) that has better nutritional content and texture. Apart from that, it also reduces anti-nutritional substances, converts cellulose into simpler compounds through polymerization and increases the protein of microorganisms (Faharuddin, 2014). The advantages of this preservation method include that it does not depend on the weather, so it is the best way to preserve forage in tropical conditions (Dhalika, 2015). The fermentation process in silage has 4 stages, namely:

1. Aerobic phase, normally this phase lasts about several hours, namely when the oxygen originating from the atmosphere and between plant particles decreases. The oxygen that is between plant particles is used for the respiration process of plants, aerobic microorganisms, and facultative aerobes such as yeast and enterobacteria.
2. Fermentation phase, this phase is the initial phase of the anaerobic reaction. This phase lasts from several days to several weeks depending on the composition of the ingredients and the condition of the silage. If the ensilation process runs perfectly then the lactic acid bacteria will successfully grow. Lactic acid bacteria in this phase become the dominant bacteria and reduce the pH of the silage to around 3.8 - 5. Stabilization phase, this phase is a continuation of the second phase. The stabilization phase causes the activity of the fermentation phase to decrease slowly so that
3. There was no significant increase or decrease in pH, lactic acid bacteria, and total acid.
4. Feed-out phase or aerobic spoilage phase. Silos that are open and in direct contact with the environment will cause aerobic processes to occur. The same thing happens if there is a leak in the silo, there will be a decrease in silage quality or silage damage.

General characteristics of good silage quality are pH 4.2 or lower, lactic acid content of 5-9% and free of mold. Quality silage is yellowish or brownish in color, if it is dark brown or blackish the quality of the silage is not good, this is caused by excessive heat or poor storage processes.

1.3 Specific Objectives

The specific objectives to be achieved in this research are:

1. Can determine the effect of fermentation time on silage quality (water content and PH)
2. Can determine the effect of EM4 concentration on silage quality (water content and PH)

2. RESEARCH METHODS

Research methodology

2.1 Research Place

This research was conducted at the Laboratory of the Chemical Engineering Department of the Lhokseumawe State Polytechnic.

2.1 Tools and Materials

2.2.1Tools used

- Silos
- Knife
- Timbanbro
- Tarp
- Plastic

2.2.2Materials used

- Field Grass
- Bran
- Molasses
- EM4

2.3 Experimental Treatment Design

2.3.1Fixed/Controlled Variables

- Field Grass Weight: 1000 g/silo
- Bran mass: 10% (w/w)
- Molasses mass: 3% (w/w)

2.3.2Independent Variables

- Fermentation time: 4, 8, 12, 16 and 20 Days
- EM4 Concentration: 0.2%, 0.4%, 0.6%, and 0.8% (v/w)

2.3.3 Dependent Variable
- Assayproteins
- Test water content
- PH Test
- Color

2.4 Experimental and Testing Procedures

2.4.1 How to Make Silage
1. Silo Setup. The silo in this experiment used medium size plastic.
2. Cutting/chopping. Field grass is cut into pieces between 2-5 cm long.
3. Weighing. Weighing was carried out to equalize the weight of forage between treatments and between replications with the same weight, namely 1 kg for each silo.
4. Mixing. Mix the grass that has been cut into small pieces with Molasses, bran and EM4 in appropriate amounts until it becomes one mixture.
5. Put into silos. After the ingredients are thoroughly mixed, they are put into the silo provided.
6. Compression. When putting it into the silo, it is compacted to reduce the air space in the silo.
7. Closing. The filled silo is closed tightly so that no air or water can enter it. Next, place it in a place that is not exposed to direct sunlight and is not exposed to rain.

2.4.4 Characterization of Research Results

2.4.4.1 Protein Content Test

The method used to analyze protein levels is the Lowry method. In this analysis, what is analyzed is the nitrogen element of the material, so the results must be multiplied by the protein factor to obtain the crude protein value.

2.4.4.2 Water Content Test

In the test, water content is tested using the thermogravimetry method. In principle, the gravimetric method is carried out by measuring the difference between the weight before heating and the weight of the sample after the heating process. This method can be done using tools*oven*Andanalytical balance (analytical balance)which is supported by a desiccator, can also be done using*moisture analyzer*or*moisture balance*.

2.4.4.3 PH Test

The degree of acidity of silage is measured using a pH meter. The pH value shows the concentration of H+ ions in the solution. The more H+ ions in the silage, the more acidic the silage will be and the pH value will decrease, conversely, the fewer H+ ions in the silage, the pH value will increase.

3. RESULTS AND DISCUSSION

3.1 Research Results

Based on the results of the research "Making Silage from Field Grass for Cattle Feed Using the Fermentation Method" carried out in the laboratory of the Chemical Engineering Department of the Lhokseumawe State Polytechnic, test results were obtained, namely protein content test, water content test, PH and color test. Data from the test results can be seen in the table below.

3.1 Research Results

Table 3.1 Data from Testing and Analysis Observations

Fermentation Time (Days)	EM 4 Concentration (%)	PH	Protein Content (Pm)	Water content (%)	Color
4	0.2	4.8	-	42.34	Green
	0.4	4.7	-	44.11	Green
	0.6	4.7	-	48.36	Green
	0.8	4.6	-	50.12	Green
8	0.2	4.7	-	52.74	Green
	0.4	4.6	-	54.88	Green
	0.6	4.5	-	55.88	Green
	0.8	4.4	-	56.07	Green
12	0.2	4.6	-	56.37	Green

	0.4	4.5	-	56.52	Green
	0.6	4.4	-	56.57	Green
	0.8	4.3	-	58.28	Green
16	0.2	4.4	-	58.44	Green
	0.4	4.3	-	59.14	Green
	0.6	4.2	-	60.58	Green
	0.8	4.0	153, 365	61.38	Yellowish Green
20	0.2	4.1	109, 077	62.49	Yellowish Green
	0.4	4.0	-	64.64	Yellowish Green
	0.6	3.8	196, 643	65.50	Yellowish Green
	0.8	3.6	-	69.73	Yellowish Green

3.2 Discussion

From the results of the research data carried out, the results and description of the discussion were obtained as follows:

3.2.1pH Test Results

pH is an indicator to determine the quality and shelf life of grassland silage. Levital, et al. (2009) stated that the main factor in determining the level of success of silage fermentation is pH. The following is a graph of the pH test results for 20 samples.

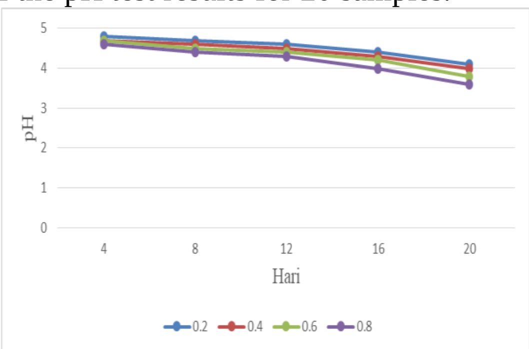


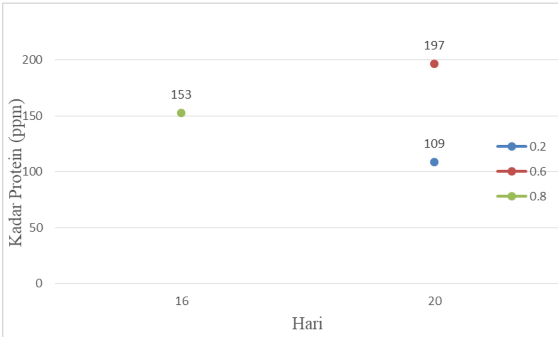
Figure 3.1 Graph of pH test results

Based on the results of the data in table 3.1 and figure 3.1, the results obtained from pH testing are that the longer the fermentation time and the more concentration of EM4 added, the lower the pH will be. The best results were a 20 day sample with an EM4 concentration of 0.6% with a pH of 3.8, a 20 day sample with an EM4 concentration of 0.2% with a pH of 4.1, and a 16 day sample with an EM4 concentration of 0.8% with a pH of 4.0, this is because the pH is in a very good range according to the SNI for animal feed silage, namely between 3.5-4.2.

The low pH of silage is caused by the activity of lactic acid bacteria which break down carbohydrate substrates into lactic acid. The aim of making silage is to produce a low pH so that Clostridia bacteria cannot grow and develop in the fermentation medium. The main characteristic of lactic acid bacteria is the ability to ferment sugar into lactic acid, resulting in a decrease in pH and inhibiting the activity of other pathogens.

3.2.2Protein Content Test Results

Crude protein is any substance that contains nitrogen. It is known that on



average protein contains 10% nitrogen (range 13-19%). The method used in protein analysis is the Lowry method. The results of the analysis of protein content of feed silage are shown in graph 3.2.

Figure 3.2 Protein Content Analysis Graph

Based on the analysis graph for feed silage protein content, the best results were obtained, namely 20 day samples with EM4 concentrations of 0.2% and 0.6% with protein levels of 109,077 ppm and 196,643 ppm, as well as 16 day samples with EM4 concentrations of 0.8%. protein of 153,365 ppm. In the protein test using the BSA standard solution and the Lowry method, reading results were obtained with the equation $y = mx+c$, ($y = 0.00605\ x + 0.02407$) with a value of $r2 = 0.98928$.

3.2.3Water Content Test Results

Water content is the amount of water contained in a food product or food ingredient. Water content is an important parameter to determine the quality of a food ingredient. Water content itself also determines the quality of the shelf life of food. The results of the analysis of the water content of feed silage are shown in graph 3.3.

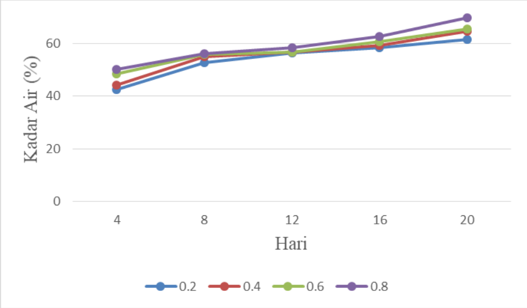


Figure 3.3 Water Content Analysis Graph

Based on the feed silage water content analysis graph, the best results were obtained, namely 20 day samples with EM4 concentrations of 0.2%, 0.4%, 0.6% and 0.8% with water content of 62.49%, 64.64% , 65.50%, and 69.73%, as well as 16 day samples with EM4 concentrations of 0.6% and 0.8% with water contents of 60.58% and 61.38%. According to the Directorate of Animal Feed (2009), the criteria for good silage is one that has a water content of between 60 - 70%. The results of this research show that the silage water content value for each treatment does not exceed 70%, so it can be concluded that the silage has good results.

3.2.4Color Test Results

Silage color is one indicator of assessing pasture silage. Good silage produces a green color like the original material or yellowish green. Based on the results of observations of 20 samples, good quality silage colors were produced, namely green and yellowish green. In accordance with the opinion of Saun and Heinrichs (2008), who reported that good quality silage will be bright green to yellow or brownish green depending on the silage material.

4. CONCLUSION

4.1 Conclusion

Based on the observation data made and the discussion that has been described, it can be concluded as follows:

1. Based on the results of the water content and pH tests, it can be seen that the fermentation time affects the quality of the silage because the longer the fermentation time, the better the silage obtained.
2. Based on the results of water content and pH tests, it can be seen that the concentration of EM4 affects the quality of silage. The more EM4 you add, the better the quality of the silage you get.

4.2 Suggestions

In further Silage Making research, it is best to test the ash content and crude fiber content so that the results obtained are more optimal to determine the quality of the silage.

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