FYP FPV

Influence of Varied Water Gradients on the Physiochemical Component of Rice Straw Silage

by

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Abstract

An abstract of the research paper presented to the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan, in partial requirement of the course DVT 5504 – Research Project.

Silage is known to be a better feed for consumption among livestock products. The fermentation process offers several benefits, as it has been proven to enhance nutrients. availability during livestock consumption, less affected by weather damage, especially seen during heavy rain season when most small-scale farmers in Malaysia will start to prepare silage for their livestock. In conjunction, Malaysia has been producing rice straw as a side product of harvesting the rice plant. Most of this by-product is not fully utilized to its maximum and has gone to waste through open burning. The utilization of rice straw silages emerges as a promising technique for enhancing the utility of this by-product in animal feed. Nevertheless, a notable research gap exists in the optimization of water levels to enhance the quality and efficacy of rice straw silages. Hence this research is mainly on determining the possibility of making rice straw silage and determining the effect of water concentration during fermentation preparation on the rice straw silage produced after 21 days of fermentation. The pre-fermentation treatment of rice straw involves five distinct groups and a control, ranging from 50% water concentration to 0 water concentration (control). The impact of water concentration is subsequently evaluated based on chemical parameters (pH and Fleigh value) and physical attributes (color, aroma, texture, presence of mold) in the resulting silage. The findings indicate a statistically significant difference at $p < 0.05$ in both chemical and physical properties as a function of varying water concentrations during the silage preparation. The data derived from the results further imply that water concentrations of 30% and 40% may represent the most optimal levels for rice straw silage preparation.

Keywords: Fermentation, Physical Qualities, Rice Straw, Silage, Water Level

Pengaruh Pelbagai Cerunan Konsentrasi Air Terhadap Komponen Fisiokimia Silaj Jerami Padi

Abstrak

Abstrak kertas penyelidikan yang dibentangkan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan, sebagai keperluan sebahagian daripada kursus DVT 5504 – Projek Penyelidikan.

Silaj dikenali sebagai makanan yang lebih baik untuk dimakan dalam kalangan hasil ternakan kerana proses penapaian mampu memberikan faedah berikut. Ia terbukti bahawa penapaian membantu meningkatkan ketersediaan nutrien semasa penggunaan ternakan, kurang terjejas oleh kerosakan cuaca, terutamanya semasa hujan lebat apabila kebanyakan penternak berskala kecil di Malaysia menyediakan silaj untuk ternakan mereka. Sempena itu, Malaysia telah mengeluarkan jerami padi sebagai hasil sampingan penuaian pokok padi. Kebanyakan produk sampingan ini tidak digunakan sepenuhnya secara maksimum dan telah dibazirkan melalui pembakaran terbuka. Penggunaan silaj jerami padi muncul sebagai teknik diyakinini untuk meningkatkan kegunaan produk sampingan ini dalam makanan haiwan. Namun begitu, jurang penyelidikan yang ketara wujud dalam menerokai paras air optimum bagi meningkatkan kualiti dan keberkesanan silaj jerami padi. Oleh itu, kajian ini adalah untuk menentukan kemungkinan membuat silaj jerami padi dan menentukan kesan kepekatan air semasa penyediaan penapaian ke atas silaj jerami padi yang dihasilkan selepas melalui 21 hari proses penapaian. Rawatan pra-penapaian jerami padi melibatkan lima kumpulan berbeza dan satu kawalan negatif, berkisar dari antara 50% kepekatan air hingga 0 kepekatan air (kawalan negatif). Kesan kepekatan air seterusnya dinilai berdasarkan parameter kimia (nilai pH dan Fleigh) dan sifat fizikal (warna, aroma, tekstur, kehadiran kulat) dalam silaj yang terhasil. Hasil dapatan kajian menunjukkan perbezaan yang signifikan secara statistik pada $p < 0.05$ dalam kedua-dua sifat kimia dan fizikal akibat dari kepekatan air yang berbeza-beza semasa penyediaan silaj. Data yang diperoleh daripada keputusan selanjutnya membayangkan bahawa kepekatan air sebanyak 30% dan 40% mungkin mewakili kepekatan air yang paling optimum untuk penyediaan silaj jerami padi.

Kata kunci: Jerami Padi, Kepekatan Air, Kualiti Fizikal, Penampaian, Silaj

CHAPTER 1

INTRODUCTION

1.1 Research background

Straw and hay are common Malaysian agriculture by-products. However, rice straw is considered an agricultural by-product of grain harvest event. The total biomass of this residue depends on various factors such as varieties, soil nutrient management, and weather. (Aquino et al., 2019). Straw, is known as the remaining stubble from harvested rice grain plants. Usually, it is grouped into rice straw bales, it comes 70cm long and 50cm in diameter (Aquino et al., 2019). As reported by Berita Harian in 2022, the prices of soy meals and corn exhibited an upward trend from January to December 2022, experiencing a rise of approximately 16.2% and 34.8%, respectively. Moreover, in compensation for the increment in the price of livestock feeding, local farmers have been working hard to find alternative natural resources for feeding ruminants. (Berita Harian, 2023) Concurrently, Malaysian researchers are actively engaged in public research endeavours aimed at identifying alternative natural resources abundantly available in the local landscape.

Recently, research from Malaysia Kedah Mada region had made a review on overall rice straw usage potential as animal feed. (Rose et al., 2019) As rice straw in nature has of high fibre content it has become a good energy resource for ruminants, however poor palatability and digestibility is the challenge when feeding raw rice straw to ruminants.

Examples of straw plants are rice, wheat, and rye straw. Most of the remaining straws are usually removed from the field, left undisturbed to serve as mulch, plowed into the ground to add nutrients to the soil, or burnt. Burning of rice straw is the fastest mode of straw disposal but causes environmental pollution by increasing the amount of greenhouse gas in the air. Rice straw is used as part of the nutritional requirements of ruminant animals in most rice-producing countries. (Oladosu et al., 2016) It is estimated that more than seventy hundred hectares of paddy fields in Malaysia will be able to produce 2 million metric tons of straw in each cultivation season . (Rose et al., 2019). This massive, huge amount of production could benefit the country if it can break the challenge and process into ruminant feed for our own country's industry consumption.

Ensiling can be considered an efficient way to improve the palatability and nutritive value of the rice straw. Fresh rice straw with a dry matter (DM) content of 250 g/kg has high concentrations of water-soluble carbohydrates, which make it suitable for ensiling. (Gao et al., 2008). The ensilaging process requires mixing silage with an optimum water that is added with molasses and effective microbes. Prominent factors influencing the quality of silage products include level of water, water-soluble carbohydrates, natural microbial population, and harvesting conditions of the forage. In this research, our primary objective is to investigate the impact of water gradients on the qualities of the produced silage.

1.2 Problem statement

Recently, researchers have recognized the potential of rice straw as a viable animal feed source, with implications for enhancing self-sufficiency in animal feed in Malaysia . (Rose et al., 2019) However, feeding rice straw directly to cattle has been proven to be ineffective due to poor palatability and digestibility (Aquino et al., 2019) Thus, this experimental study serves as a pilot study to provide insight on how the concentration of water or moisture content is able to create an effect on the final silage produced after 21 days of the fermentation process.

1.3 Research question:

Does varied water gradients affect the quality of rice straw silage in terms of physiochemical qualities

1.4 Research objectives

1. To improve the quality of rice straw silage production based on different water gradients in terms of physical and chemical qualities
2. To determine the suitable water concentration used in the ensilaging process of rice straw

1.5 Significance of study

This study is done to fill up the knowledge gap on the concentration water effect on the physiochemical of rice straw silage qualities, which has not been done yet. The study aims to develop an optimum water gradient in rice straw production, assisting Malaysian farmer to optimize their by-product in the future as beneficial ruminant feeds.

1.6 Scope of study

The scope of this study involved the determination of optimum water concentration in mass rice straw silage production. The sample of rice straw acquired from Kedah. The period of study is about one month at which the fermentation period required is 21 days. The experimental study for determining chemical qualities will be done in the UMK laboratory while physical assessment was done by a questionnaire given to UMK staff, lecturer, and student, as well as visiting some of the local farmers. Dry matter analysis in this research is not further deepening such as crude protein and crude fat evaluation, which would limit the informative of this study in the field of the nutrition level of rice straw produced. Overall, the study aims to assess the overall condition of rice straw silage after fermentation, in terms of physiochemical qualities.

CHAPTER 2

LITERATURE REVIEW

2.1 Background of silage

In the preceding year, silage production serve as an alternative provisioning livestock animal during winter and drought seasons in European countries. Silages also has been practically used in Asia countries like Malaysia and Indonesia during monsoon season. Silage is referred to as forage, crop, or agricultural by-products that undergo fermentation process in which the result to enrich the nutrient composition of feedstuff. During winter, the quality of crops, such as nutritional composition, is reduced, causing farmers to search for alternate ruminant feed. High quality diet will be used as energy fuel for the animal, especially for dairy animals as lactogenesis requires animals with excess energy stored in the body in order to keep the animal healthy during milk production. Abundant types of agricultural products can be made into silage which include grasses, legumes, fodders, sorghum, and corn. Silage making also enhances the original crops' natural nutrients and increases palatability and digestibility as well as protein concentration if treated with urea or adding effective microbes and molasses. (Mannetje 2023)

Silage production was adopted across the whole world, starting in the starting around 18 centuries. In fact, there was a link between making sauerkraut and silage among Germans (Wilkinson et al. 2015). Farms that make their own silages are also able to increase their farm productivity by cutting costs as well as adding profit by selling the silages. Furthermore, it also helps to remove excess agricultural by-products by utilizing it.

2.2 Malaysian silage production

According to Rose et al. (2019), Malaysia Kedah paddy field has about 700000 hectares and is able to produce 2 million tons of rice straw. These agricultural by-products are usually not fully utilized but rather get diminished by open burning. In order to make this by-product beneficial, researchers believe Given its economic value and high potential. This rice straw could stimulate the wider rural economy through added value as well as generally increase the socioeconomic class of farmers and improve the agricultural environment.

2.3 Silage-making

Ensiling refers to forage preservation way based on the production of spontaneous lactic acid fermentation under anaerobic conditions. Lactic acid is produced during fermentation of water-soluble carbohydrates (WSC). There are four main phases within the ensiling process. Once every component is sealed into a container, the crop that is being fermented undergoes the first phase, which is also known as the aerobic phase. This phase is usually driven by the remnant of oxygen before being sealed, so it would only take place for a few hours until all the oxygen within the silo or container is deprived. Next is fermentation phase in which the container is fully anaerobic, this condition will be left for several days up to several weeks depending on the properties of ensiled forage. This is when the time lactic acid is produced so overall pH starts to drop to about 3.8-5.0. For phase 3 some of acid tolerant microorganisms are able to survive this period but are in an inactive state for example include clostridia and bacilli spores. The last phase will be the fed-out phase or also known as the aerobic spoilage phase. This phase is further subdivided into two phases. The first phase is where the silage starts to be exposed to air again and would eventually result in spoilage of silage, due to the reduction of organic acid that is being produced. Hence results in the rise of pH value. As pH value rises, this enables normal flora growth and causes spoilage of silage in long term. To extend the life span of a batch of produced silages, ensuring that the seal is done well in the first phase is crucial to prevent the leaking of atmospheric oxygen into the container. Then during the fermentation phase and stable phase is solely dependent on the additive added. Lastly, expose the silage to the atmosphere again, the seal should close properly in order to minimize the air ingress and slow down the spoilage rate.

2.4 Silage quality

There are few studies reported in evaluating the quality of the silages. (Sadarman et al., 2023); Ozturk et al., 2006). The evaluation parameter is further separated into physical quality and chemical quality. The parameter assessed for physical quality was the final product's aroma. The aroma analysis stated that pleasant or sweet aromas are accepted for good or well-made silage. Yellowish green to pale yellow color was also preferable to be categorized as good quality silage (Abdurrahman et al 2019) While the growth of mold is considered the lesser the better quality as well as non-clumping texture (Sadarman et al 2023). Furthermore, chemical qualities will be determined by data retrieved from fleigh value. This value is usually calculated with a proper formula which includes both dry matter and pH. (Ozturk et al. 2006). Emphasizing pH within 4.0 usually accompanied by a sweet aroma will be qualified as good quality. (Abdurrahman et al 2019)

A previous study was showed that the pH value of the silage is one of the parameters to assess the quality of silages (Abdurrahman et al., 2019). As per the recommendations of Bernades et al. (2019), the optimal method for determining silage pH involves using sample-to-water ratios of 25:100 and 30:270 techniques have been used for evaluating silages under field and laboratory conditions, respectively.

CHAPTER 3

METHODOLOGY

3.1: Study design

The rice straw was given grouped into 7 different treatments prior to ensilaging., The treatment was mainly different in water concentration during preparation for silage making. The group of rice straws is separated as named as into group A starting with the highest concentration of water used during preparation, (50% Rice Straw : 50% Water), group B (60% Rice Straw : 40% Water), group C (70% Rice Straw : 30% Water) and subsequently divide successive treatment with 10% water concentration following for A to group F where group F (0 Water: 100% Rice Straw) serve as a control in this study. The additive treatment is done in a ratio according to the water concentration in the ratio of 0.5% salt, 0.05% effective microbes, and 0.4% molasses respectively. After preparation, the rice straw is left for fermentation to take place and access for physical and chemical qualities after 21 days. The study design includes triplicate for each treatment.

Treatment	Treatment
A	A 50 RS: 50 W
B	B 60 RS: 40 W
C	C 70 RS: 30 W
D	D 80 RS: 20 W
E	E 90 RS: 10 W
F/ Control	F 100 RS

RS: Rice Straw; W: Water

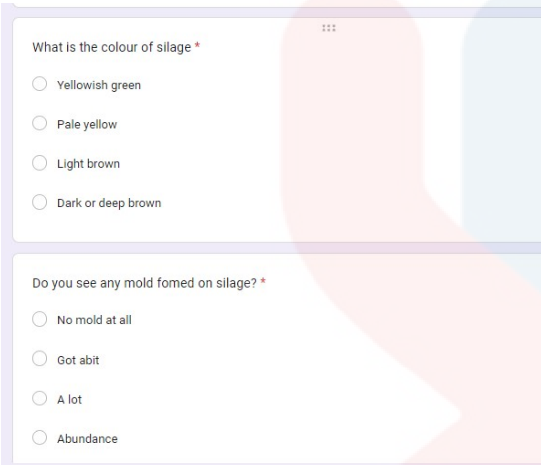
Table 3.1 shows the difference in water concentration prior to fermentation of silage during preparation.

3.2 Silage making process

Rice straw was chopped into smaller portion averagely 3 to 5 cm using chopping machine. Then, molasses and water dose were calculated as required according to the ratios of the research. This is followed by mixing molasses with water and diluting them in which the water mixture will contain 0.4% of molasses, 0.05% EM, and 0.5% salt. The treated rice straws are then filled into plastic containers, and a small amount of mixture is collected for dry matter analysis in order to obtain the result of dry matter before ensilaging. Make sure the silage is airtight within the plastic container by compressing them tightly. The containers were sealed using tape to make sure there was no leakage. All the plastic container was labelled including the type of treatment that had been given, the date made, and the date end of fermentation (21 days later) Ex: (90 rice straw: 10 moisture concentration, 12/10/23 and 03/11/23). The method stated is a modified method (Moran, 2005)

3.3: Physical qualities assessment

The physical qualities to be assessed include the aroma, mold formed, colour, and texture after the fermentation of the rice straw silage on day 21. The assessment will be done by human sensory which includes olfactory, tactile, and vision from 30 selected participants comprised of lecturers, students from UMK, and small-scale farmers of ruminants among the Kelantan demographic. All collection of data is through interview method where the evaluator has to able to access the treatment silage physically. Then, they marked down their observation on the Google Form given. (Figure 3.1)



What is the colour of silage *

Yellowish green

Pale yellow

Light brown

Dark or deep brown

Do you see any mold fomed on silage? *

No mold at all

Got abit

A lot

Abundance

Figure 1 shows an example of a Google form.

The data collected is then presented in numerical form according to the table below before being analysed by SPSS software.

Table 3.2: The panel score for the corresponding characteristic marking for physical access.

Scoring	Colour	Formation of mold	Texture of the silage	Aroma
1	Yellowish green	None	Too rough and clumping	Putrid or Rancid
2	Pale yellow	A little	Rough and clumping	Pleasant
3	Light Brown	A lot	Medium and not clumping	Sweet
4	Deep or dark brown	Abundance	Fine and not clumping	Very Sweet

3.4 Chemical qualities assessment

The chemical qualities evaluated from this research include the pH of the silage produced, the dry matter before and after the fermentation process, and to calculate the fleigh value of the silage produced. The silages produced were mixed with water in the ratio of Silage: Water at 30: 270, and the mixture pH was determined by using a pH meter Eutech 700. 30:270. This method increases the efficiency of routine laboratory analyses (Bernades et al., 2019). Dry matter analysis and moisture content of silage produced are carried out according to the AOAC method (AOAC, 1999).

The fleigh value is calculated based on the given equation.

$$NFV = 220 + [(2\, x\, \%DM) - 15] - (40\, x\, pH)$$

NF: Fleigh value

DM: Dry matter of the sample

pH: pH reading of the silages sample

(Ozturk et al. 2006)

3.5 Data management

The data collected from the physical assessment were labelled numerically. All data were collected and recorded using Microsoft Excel and analysed using the software package SPSS (Statistical Package for the Social Science 25.0, Inc., Chicago, IL, USA). The Duncan test was used for all parameters to identify significant differences among the treatments, and the means were considered significant at p< 0.05 using ANOVA.

CHAPTER 4

RESULT

4.1 Chemical properties of rice straw silage

In comparing data, ANOVA is used to measure the significance value, and the Duncan test is used to determine the relation between parameters. With a significance value of $p < 0.05$, the data results show significant differences in all the chemical parameters between each result and when compared to the control variable (100RS). A drop in pH was observed after fermentation 21 days from 6.62 (100 RS 0 W) to 5.69 (50RS 50W), respectively. Meanwhile, the fleigh value also declines from 125.93 to 84.93.

Table 4.1 Fleigh values result of rice straw triplicate

Treatment	Fleigh Value (4 hours)		
Triplicate	1	2	3
A 50 RS: 50 W	87.50	93.50	87.00
B 60 RS: 40 W	85.50	94.90	83.90
C 70 RS: 30 W	84.70	83.90	86.20
D 80 RS: 20 W	103.30	114.60	112.60
E 90 RS: 10 W	114.70	107.50	106.50
F 100 RS	120.80	132.60	124.40

Table 4.2 Chemical properties of rice straw silage

Treatment (%)	pH	DM (%)	FV
A 50 RS: 50 W	5.69^{a}	55.90^{a}	84.93^{a}
B 60 RS: 40 W	6.11^{b}	63.75^{b}	88.10^{a}
C 70 RS: 30 W	6.22^{b}	65.03^{b}	89.33^{a}
D 80 RS: 20W	6.25^{b}	76.92^{c}	109.56^{b}
E 90 RS: 10 W	6.60^{c}	84.68^{d}	110.17^{b}
F 100RS	6.62^{c}	92.40^{e}	125.93^{c}
SEM	0.14	5.68	6.68
p-value	<0.01	<0.01	<0.01

a, b, c, d Means with different superscripts along columns differ significantly at ($P < 0.05$); Means with the same letter in a column are not statistically significant. SEM: standard error of mean, FV: fleigh value, RS: Rice Straw, W: water

4.2 Physical properties of rice straw silage

Data showed a significant difference for aroma, texture, mold form and colour between treatment when compared to control at which $p<0.05$. The colour of silage shows an increment from yellowish green toward light brown colour after 21 days of fermentation. (Treatment A, B and C) Meanwhile, mold forms are similar across different water treatments (Treatment A, C, D, E and F). For texture, there is an increment of finest from low water concentration (Control: 100 RS, 0 Water) to high water concentration (Group A: 50RS: 50 Water). Lastly, aroma smells from silages recorded better when water concentration increases at 40% and 30% water is used during preparation (Treatment B and C).

Table 4.3 Physical properties of rice straw silage

Treatment (%)	Colour	Mold	Aroma	Texture
50 RS: 50 W	2.63^{cd}	2.47^{b}	1.60^{a}	2.97^{c}
60 RS: 60 W	2.47^{bc}	1.43^{a}	2.70^{c}	2.77^{c}
70 RS: 30 W	2.87^{d}	1.33^{a}	3.17^{d}	2.97^{c}
80 RS: 20W	2.07^{ab}	1.27^{a}	2.03^{b}	2.13^{b}
90 RS: 10 W	2.27^{bc}	1.43a	1.83^{ab}	1.50^{a}
100RS	1.63^{a}	1.30^{a}	1.87^{ab}	1.35^{a}
SEM	0.95	0.57	0.93	0.90
p-value	<0.01	<0.01	<0.01	<0.01

a, b, c, d Means with different superscripts along columns differ significantly at ($P < 0.05$) while ab group superscript means the group falls within two columns in the same time. SEM : standard error of mean. RS: Rice straw, W: water

Figure 4.1 Rice straw colour before fermentation (Day 0)

A B C D E F

Figure 4.2 Rice straw silage Colour after fermentation (Day 21)

CHAPTER 5

DISCUSSION

5.1 Chemical properties of rice straw silage

The degree of acidity, also called pH, is one indicator of silage quality (Kurniawan et al., 2019). pH of silage produced from different treatment show significant differences between treatment, where there is almost a decrement of pH with value of 1 from 0 water concentration (pH: 6.62) to 50% water concentration (pH: 5.69), showing a decrement of 14%. Decrement in pH during fermentation is usually associated with lactic acid bacteria added during preparation, converting dry matter within the rice straw into acid particles, which leads to a reduced pH value. Hence, this indicates that increasing water concentration during preparation can effectively help reduce the pH during fermentation, producing a good-quality silage. Quality silage is usually associated with low pH (Sadarman et al., 2023). However, note that none of the experimental silage has a pH of 3.8-4.1, which is commonly said to be a good pH, indicating a good fermentation. Nonetheless, the fleigh value calculated showed otherwise of this finding. Existing study from Kurniawan et al (2019); Saricicek et al (2016) mentioned that dropping of pH to range of 3.8-4.1 is usually associated with the fermentation of corn or Cassava leaves respectively. In this experiment usage of dried rice straw instead of fresh cut rice straw could be one of the possible reasons leading to this condition. At the same time, different plant as silage base will also give rise to different in pH value after the fermentation process. Hence, further study need to be done on the rice straw in future to ensure the pH value able to achieve the desire silage pH range that has been mentioning.

Dry matter results showed different water concentration treatments give significant effects at $p<0.05$, and different columns are categorized for each different treatment used, as shown in Table 4.2. Multiple statistic superscript indicate that different water gradient prior to fermentation of rice straw silage yield different group of dry matter content. Statistic showing a clear trend of decrement of dry matter of silage after 21 days when the preparation of water concentration is increased. In addition, dry matter content is the lowest when the water concentration during preparation is at highest. Dry matter content decreases by 40% as the water concentration during the preparation of silage increases, indicated from treatment F to A. This finding showed that water concentration during the preparation of silage does significantly affect the dry matter content of the final silage production. However, it is expected to have some dry matter loss during ensiling due to bacterial substrate degradation and carbon dioxide production (Goeser et al., 2015).

According to previous studies from Sadarman et al. (2023) and Abdurrahaman et al. (2018), the fleigh value is considered an important parameter to determine the quality of silages after fermentation. The results showed that the silage produced from treatments A, B, and C (50%, 40%, and 30% water concentration, respectively) yielded a very good silage quality. However, treatment D, E, and F fleigh values had already surpassed the 100 scores. This is likely due to the high dry matter content that is found with an incomplete fermentation process due to too low water concentration during preparation. From this, the author would think this is due to the calculation of the fleigh value itself

$$NF = 220 + [(2\,x\,\%DM) - 15] - (40\,x\,pH)$$

where dry matter is used to minus the pH, hence when the dry matter content after fermentation remains in the silage is high, this will in turn leading to overhigh fleigh score when calculated.

Nonetheless, the fleigh score for treatments D, E, and F (water concentration is 20%,10%, and 0%, respectively), the score above 100, is considered excellent quality silage (Kurniawan et al., 2019).

5.2 Physical properties of rice straw silage (Colour, Mold Found, Aroma, Texture)

The color of silage serves as an indicator of the effectiveness of the ensilaging process. Table 4.3 demonstrated that the color of silage darkened as the water concentration increased to 50% during the silage preparation. This shows that adding water concentration can influence the colour outcome of silage. The dark green to bright green color illustrates that the ensilage process is carried out typically and is a good color criterion for silage (Paulus et al., 2020). Therefore, water concentrations of approximately 30%, 40%, and 50% are deemed conducive to optimal fermentation, resulting in silage with a darker color, specifically light brown in the experimental context.

In the case of mold presence, only the 50% water concentration exhibited a slight occurrence, while other water treatments demonstrated no mold formation post-fermentation. This observation suggests that the threshold for water concentration to prevent mold formation during fermentation could be 40%. Statistical analysis of the data in Table 4.3 further indicates that modifying water concentration can influence the likelihood of mold growth in the silage fermentation of rice straw. This phenomenon may be attributed to the conducive conditions for fungal growth in high-moisture environments. Common fungal species found on silage include *Penicillium roqueforti, Aspergillus fumigatus, and Zygomycetes spp*. The proliferation of fungi significantly impacts the feed biosecurity of ruminants, given that mycotoxins produced by these fungi can act as pathogenic agents leading to disease (Alonso et al. 2013)

The aroma of silage exhibits a statistically significant difference when various water concentrations are employed in the preparation preceding the fermentation of rice straw, with a significance level of $p < 0.01$. Respondents predominantly associated the pleasant smell with the original odor of rice straw, as evident in the results of the negative control and the 10% water concentration treatment. Conversely, the use of 50% water concentration resulted in a putrid and rancid odor, as reported by a majority of respondents. This olfactory change could be attributed to elevated moisture levels fostering the growth of clostridial species bacteria and an increased likelihood of molding, both of which contribute to the generation of unpleasant odors. Particularly, Clostridial spp. organisms thrive in wet conditions, converting lactic acid to butyric acid and producing unpleasant smells. The 30% water concentration exhibited a favorable aroma after fermentation in this experiment. Successful fermentation typically imparts an acidic, fruity smell (Sadarman et al., 2023). This characteristic aroma is attributed to the rapid accumulation of lactic acid during the second phase of fermentation, resulting in a lower pH value. Therefore, it can be concluded that a 30% water concentration is more indicative of the desirable characteristics in the production of rice straw silage during preparation.

The study indicates that various water concentrations have a statistically significant effect on the texture of the produced rice straw silage at a significance level of $p < 0.05$. According to the study, optimal silage texture is characterized by fineness and the absence of clumping (Sadarman et al., 2023). Consequently, water concentrations corresponding to treatments A, B, and C (50%, 40%, and 30% water concentration, respectively) appear to be more favorable during preparation to achieve silage with a desirable texture.

CHAPTER 6

CONCLUSION

In summary, varied water concentrations exert a significant influence on both the physical and chemical properties of the resulting rice straw silage. The findings suggest that water concentrations of 30% and 40% align well with the criteria for optimal silage concerning chemical properties such as fleigh value and pH, as well as the desired attributes of aroma, absence of mold, color, and texture in the produced rice straw silage. Consequently, the objectives of the study have been successfully achieved.

CHAPTER 7

RECOMMENDATION AND FUTURE WORKS

Enhancements to the present study could be achieved by augmenting the sample size. Additionally, a more detailed examination of the dry matter parameter, dissecting it into crude fat and crude protein, would facilitate a comprehensive analysis of the impact of water concentration on the nutritional value of silage yield. Furthermore, the author recommends future investigations to elucidate the comprehensive influence of the fleigh value on silage quality, considering its dependence on the pH and dry matter of the produced silage. Subsequent studies should delve deeper into the evaluation of silage quality, particularly those with a fleigh value exceeding 100, by conducting thorough physical assessments and extensive chemical analyses.

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APPENDIX

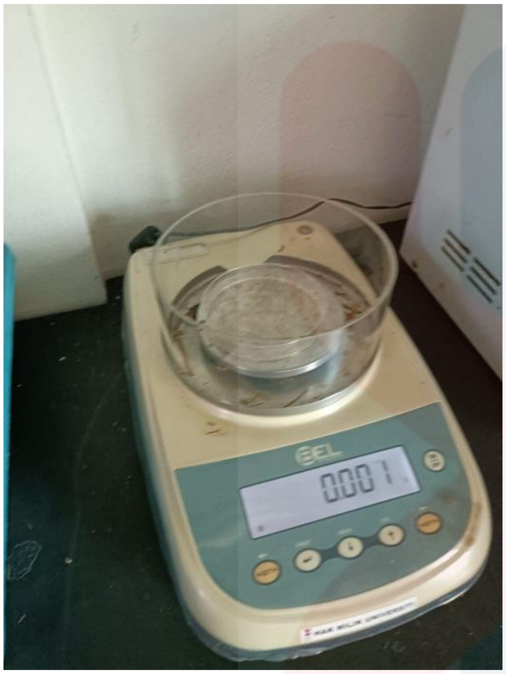

Figure 1 : 3 Decimal Weighting Machine during Dry Matter Analysis

Figure 2: Dry Matter Analysis Oven Tray

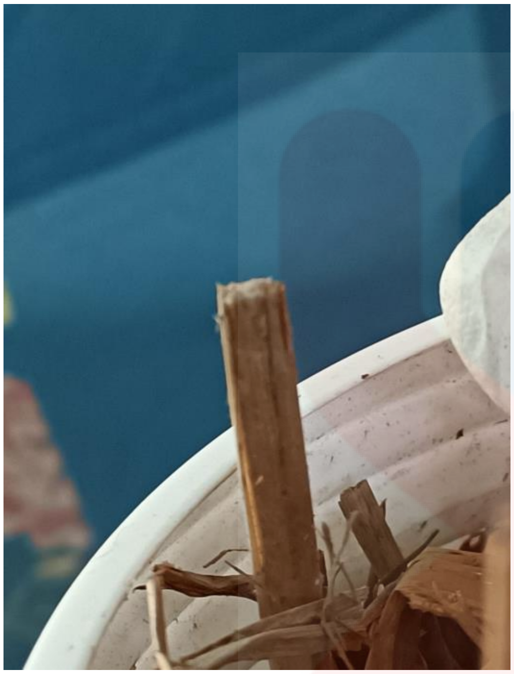

Figure 3: Presence of whitish substance on silage after fermentation - Growth of Mold

Figure 4: Physical Appearance Evaluation by Respondant

Figure 5: Preparation of rice straw prior for fermentations