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Ratio of supplement for *Saccharum edule Hassk* waste ensilage

Jujun Ratnasari[1], Billyardi Ramdhan[1], Reny Sukmawani[2]
[1]Department of Biology Education, Faculty of Teacher Training and Education (FKIP), Universitas Muhammadiyah Sukabumi, Sukabumi, Indonesia
[2]Department of Agribusiness, Faculty of Agriculture, Universitas Muhammadiyah Sukabumi, Sukabumi, Indonesia

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ABSTRACT

Saccharum edule Hassk (Terubuk) is a plant of the Poaceae family that after consuming its flowers as vegetables, *Saccharum edule Hassk* waste in the form of leaves and stems can be used as alternative animal feed. Improving the nutrition of crushed waste as an alternative feed can be done through ensilage using several mixed ingredients that can maximize the fermentation process. The study aimed to analyze the effect of differences in the ratio of starter microbial with a mixture of silage, such as molasses and rice bran, on the quality of the *Saccharum edule Hassk* waste silage. The research was conducted using leaf and stem material using the anaerobic fermentation method. The ratio of microbes, molasses, and rice bran used was 0.00067%:2%:4% (S1), 0.0008%:3%:6% (S2), and 0.001%:4%:8% (S3). The fermentation time was 14, 21, and 28 days. The results obtained showed that pH <4 was achieved by S1, S2, and S3, at 21 and 28 days of fermentation. Fleigh value (NF) of S1 and S2 at 21 days of fermentation was 72.47% while in S3 it was 72.20%. The NF at 28 days of fermentation was 85.53% in S1, and 85. 67% in S2 and S3. The highest protein content is in S2 at 10.37 ± 0.69% (p>0.05) in a fermentation time of 21 days.

Corresponding Author:

Jujun Ratnasari
Department of Biology Education, Faculty of Teacher Training and Education (FKIP),
Universitas Muhammadiyah Sukabumi
Jl. R. Syamsudin, S.H. No. 50, Cikole, Kec. Cikole, Kota Sukabumi, Jawa Barat 43113, Indonesia
Email: jujun.ratnasari@ummi.ac.id

1. INTRODUCTION

Animal feed is one of the main factors in increasing livestock production. Animal feed can be in the form of concentrates or forages that are given regularly and measured. Forage livestock usually feeds in green conditions that constrain in the dry season. Forage in the dry season will be lacking obtain. One solution is to process fresh forage through the fermentation process into silage. Silage is a forage feed that has high water content, and is made using the anaerobic fermentation method [1]. Ensilage is one way to preserve forage for livestock. Ensilase can improve the nutritional quality of feed, including reducing plant secondary metabolites that interfere with livestock digestion, including reducing trypsin inhibitors and tannins [2]. The raw material for making silage can be in the form of forage which is commonly used as animal feed such as elephant grass (*Pennisetum purpureum*), kolonjono grass (*Panicum mulicum*), and corn plants (*Zea mays*). In addition, the raw materials that can be used are green vegetables from market waste. One of the plants that potentially as forages is *terubuk* [3].

Saccharum edule Hassk (*terubuk*) is also known as a sugarcane egg. *Saccharum edule Hassk* belongs to the same genus as sugarcane and maize and has similar morphology. *Saccharum edule Hassk* is an herbaceous plant that has not been widely cultivated in monoculture. *Saccharum edule Hassk* is widely planted by the community as an intercropping in gardens or rice fields. *Saccharum edule Hassk* has a promising economic value because *Saccharum edule Hassk* flowers can be eaten as vegetables or processed into several types of dishes. Based on the cultivation aspect, *Saccharum edule Hassk* is easy to grow and like sugarcane and corn can be used as forages for livestock with continuous availability of feed. In Sukabumi, apart from consuming the flowers, the *Saccharum edule Hassk* stems and leaves are generally left as waste, and only a small portion is used as forage for livestock. *Saccharum edule Hassk* waste used for forages of livestock can reduce expenses for feed by 60% [4]. *Saccharum edule Hassk* is good forage feed for livestock because it can grow in the dry and rainy seasons [3] the dry season when the grass is hard to grow, the silage can be used as an alternative forage for livestock. The silage has good nutritional content [4] (Table 1). Ensilage is a good technique for increasing the nutritional value of forages and green forage preservation in the dry season [5].

Table 1. Nutrition composition of *Saccharum edule Hassk* from Indonesian Ministry of Health

Composition	Number	Units
Energy	30	Kal
Protein	4.6	gr
Lipid	0.4	gr
Carbohydrate	3	gr
Calcium	40	mg
Phosphor	80	mg
Iron	2	mg
ß-carotene	12	mcg
Vitamin A	0	IU
Vitamin B1	0.08	mg
Vitamin C	50	mg
Niacin	1.2	mg
Zeng (Zn)	1.1	mg

Saccharum edule Hassk, after the flowers are taken as vegetables, leaf waste, husk, and *Saccharum edule Hassk* stems can be used as alternative animal feed. However, plants that have flowered or fruited generally have a decreased nutritional content because they are used to developing flowers and fruits [6]. The increase in the nutritional value of the *Saccharum edule Hassk* waste can be done through the ensilage process, which is anaerobic fermentation to produce silage. Like in sugarcane, ensilage can increase its nutritional value, especially in addition to molasses and urea [7]. The ensiling process of each forage requires different conditions. Optimal conditions can maximize the fermentation process so that the nutritional value of silage becomes optimal [8]. The optimal *Saccharum edule Hassk* ensiling conditions are not yet known. It is necessary to research the composition of the microbial starter, temperature, and optimal fermented additives to produce good *Saccharum edule Hassk* silage.

The fermentation process is generally influenced by temperature, the number of microbial starters, raw materials, pH, and the time of the fermentation process. In addition, it is also influenced by mixed materials as a supplement used to maximize the work of microbes. The mixed materials used are molasses as a source of microbial food and rice bran as an absorbent of the liquid produced during fermentation. This research aims to study the ratio of supplement material such as molasses, rice bran, and the microbe in the ensilage of *Saccharum edule Hassk*. The parameter observed is pH, aroma, dry weight, water content, total ash, and crude protein (CP) content. As the general indicators for assessing the physical quality of the silage observed were aroma, color, texture, and pH.

2. RESEARCH METHOD

Saccharum edule Hassk waste silage was conducted using a common method, with tips for making good silage [9]. The *Saccharum edule Hassk* waste is chopped ± 3-5 cm, then withered to reduce the water to 50-60%. The chopped *Saccharum edule Hassk* is then mixed with the rice bran evenly. Next, the molasses is mixed with water and microbes then mixed with the chopped *Saccharum edule Hassk*. The microbes used in this research were commercial effective microorganism 4 (EM-4). The ratio of microbes, molasses, and rice bran used was 0.00067%:2%:4% in Silo 1 (S1), 0.0008%:3%:6% (S2), and 0.001%:4%:8% (S3) (Table 2) in 3 replicates. Furthermore, the *Saccharum edule Hassk* was put into the container/silo gradually while compacting to remove the air that trap in between the chopped *Saccharum edule Hassk*. Once all in, the silo is tightly closed and stored in a slightly elevated place, not sticking to the ground. The fermentation time used was 14, 21, and 28 days.

Table 2. The ratio of the starters and supplements for *Saccharum edule Hassk* silage

Materials	Silo 1 (S1)	Silo 2 (S2)	Silo 3 (S3)
Rice rice bran	4%	6%	8%
Molasses	2%	3%	4%
EM-4	0.00067%	0.0008%	0.001%
Water	0.01667%	0.02%	0.02%

Qualitative data observed were color, gas, pH, and aroma or odor. The quantitative data observed were CP, water content, dry weight, and Fleigh value (NF). Color observations were observed visually, while gas observations were carried out visually on the plastic silage container, bulging or not. Measuring moisture content and dry weight were oven heating at 70 °C for 2 × 24 hours. Qualitative protein testing used the Biuret reaction method, while quantitatively using the Kjeldahl method. Measuring NF is done using (1) [10]. NF is a characteristic index of silage fermentation based on dry weight (DW) and pH values [10], [11]. The silage quality criteria are determined based on NF [10] (Table 3).

$$NF = 220 + (2 \times DW(\%) - 15) - (40 \times pH) \quad (1)$$

Where DW is the dry weight (%).

Table 3. Silage quality criteria based on NF [10]

NF	Criteria
60-80	Good
40-60	Enough
20-40	Medium
<20	Not good

Data analysis: quantitative data were analyzed using SPSS 25 program.

3. RESULTS AND DISCUSSION

The result showed that the color of silage *Saccharum edule Hassk* waste at 14 and 21 days of fermentation was yellowish green, while at 28 days of fermentation was brownish green. The yellowish-green color does not differ from the initial color of the waste used, indicating that the fermentation process does not cause high temperatures in the silo [12]. If the temperature in the silo is high enough, the silage color will be brownish green or dark brown to black. Fermentation of *Saccharum edule Hassk* waste aged 14 and 21 days showed an increase in temperature that was not too high so that it did not change the color of the silage. While at the age of 28 days, the temperature had increased so that the silage color became darker than yellowish green. The temperature increase in the fermentation process is caused by the higher microbial activity in the silo, but it can also be caused by the formation of ethanol. In addition to physical quality, the quantity of protein, dry weight, water content, and NF was also measured.

The results showed that the pH of the *Saccharum edule Hassk* waste silage ranged from 3-4 (Table 2). The more acidic the ensiling conditions, it helps kill spoilage microbes and maximizes the microbial activity of lactic acid and butyric acid bacteria. This happens in the general manufacture of silage from other forage materials that airtight conditions in the silo can encourage bacteria to produce lactic acid that makes the level of pH decrease. Lower pH and preventing oxygen from entering the silo can inhibit fungal growth during storage [13], [14]. This is supported by the results of research by Fariani and Akhadiarto [14], that the addition of lactic acid in sugarcane fermentation, can accelerate sugarcane silage fermentation so that it can be harvested after 7 days of fermentation. The longer the fermentation with the addition of lactic acid, the stronger the silage aroma and the higher the water content [14]. But the increases in pH do not mean to indicate deterioration and reduction in the aerobic stability of the silages [15].

The low pH is caused by the acid content produced by lactic acid bacteria or butyric acid bacteria. High microbial activity, one of which is influenced by the source of microbial food, in this case, is molasses, and bran. Silo 2 and silo 3 which were given a mixture of molasses and bran higher than Silo 1 showed a lower pH than silo 1. Likewise, along with the length of fermentation time, the pH level decreased. This shows that the amount of molasses mixture and the duration of fermentation affects the pH of the silage (Figure 1). The acid content produced in the fermentation process gives a distinctive aroma like the aroma of tape (fermented cassava or fermented sticky rice) on silage. After the ensilage process, the strong aroma of the tape on the *Saccharum edule Hassk* silage is reduced by opening it in the open air, so that the strong aroma and alcohol content in the silage is evaporated and reduced. After being opened and allowed to evaporate the aroma and the alcohol, then it is given to livestock.

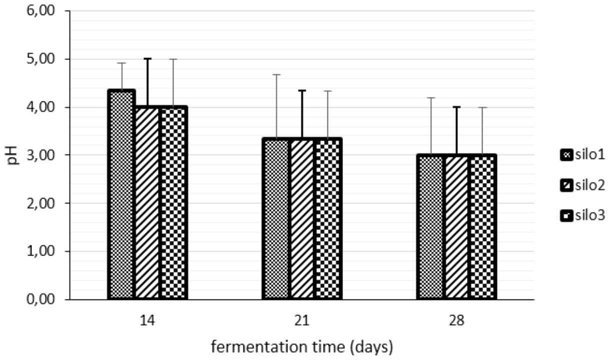

Figure 1. The pH value of the *Saccharum edule Hassk* silage in silo 1 (S1), silo 2 (S2), and silo 3 (S3) based on fermentation age

Table 4. Qualitative and quantitative data of the *Saccharum edule Hassk* waste silage

Test	Parameter	Silo 1			Silo 2			Silo 3		
		Fermentation time (days)								
		14 average	21 average	28 average	14 average	21 average	28 average	14 average	21 average	28 average
Qualitative	Color	yellowish green	yellowish green	brownish green	yellowish green	yellowish green	brownish green	brownish green	brownish green	brownish green
	Ph	4.33±0.58	3.33±1.35	3±1.19	4±1.16	3.33±1.14	3±1.10	4±1.10	3.33±1.10	3±1.08
	Gas	*	*	*	*	*	*	*	*	*
	Water	-	-	-	-	-	-	-	-	-
	Water content	80±0.00	60±0.00	73.33±11.55	60±0.00	60±0.00	66.67±11.55	60±0.00	73.33±11.55	66.67±11.55
	Dry weigth	20±0.00	40±0.00	26.67±11.55	40±0.00	40±0.00	33.33±11.55	40±0.00	26.67±11.55	33.33±11.55
	NF	45.27±0.23	72.47±23.09	85.53±0.23	45.8±0.00	72.47±23.09	85.67±0.23	45.8±0.00	72.2±23.21	85.67±0.23
	Aroma	Fermented smell	Fermented smell	Fermented smell	Fermented smell	Fermented smell	Fermented smell	Fermented smell	Fermented smell	Fermented smell
	Carbohydrate	**	**	*	**	**	*	**	*	*
	Molasses	*	*	**	*	**	**	*	**	**
	Protein	-	*	**	-	**	**	*	**	**
Quantitative	Ash analysis (%)	6.49±0.05	6.09±2.23	6.14±0.37	6.62±0.16	6.78±0.59	6.12±0.23	7.62±0.20	6.37±0.28	6.02±0.28
	Protein (%)	8.65±0.06	9.98±3.31	9.04±2.97	9.95±0.05	10.37±0.69	8.66±0.51	9.82±0.15	9.29±0.22	9.15±0.27

Note: (*) small amount, (**) more than *, (-) none

In the waste *Saccharum edule Hassk* silage, it showed that protein was produced in 14 days of fermentation in silo 1, silo 2, and silo 3. Bran and molasses can give nutrition for microbe activity to degrade and convert carbohydrates from the *Saccharum edule Hassk* waste into protein or other nutrition more quickly. As with the research results in the ensilage of orange pulp and napiergrass, the addition of wheat bran and rice bran can increase dry weight, and crude protein, and reduce acid detergent fiber (ADF) [16]–[18]. As in the ensilage of sugarcane, the addition of molasses, rice bran, and urea can increase CP content, calcium, phosphorus, and dry weight [19]–[22], also increase the ash content and lower the pH [4], [23]. The fermentation of forage into silage besides being able to improve nutrition quality can also reduce the content of lignin and cellulose crude fiber so that it is easily digested by livestock [21]. Likewise with the decreasing cellulose and lignin content in the ensilage of sugarcane [14]. But in 28 days of fermentation, the CP content decreased in all silos. The decrease in CP in fermentation is probably due to proteolytic microbes that degraded protein into amino acids and NH_3 during fermentation that uses for microorganism activities [21]. However, the highest CP content in *Saccharum edule Hassk* waste silage was gained in silo 2 at 21 days of fermentation of 10.37±0.69% ($p>0.05$) (Figure 2). Furthermore, in the *terubuk* waste silage with the addition of rice bran, molasses, and EM-4, the nutrition value is higher than fresh *terubuk* (Table 1 and Table 4). This is in line with the research of Ortega *et al*. [2] that ensilages in sugar cane can improve feed quality, including reducing plant secondary metabolites that interfere with livestock digestion, namely reducing trypsin inhibitors, and reducing tannins.

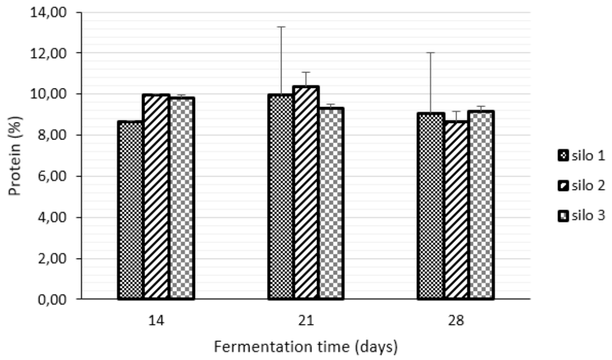

Figure 2. The protein content of the *Saccharum edule Hassk* silage in silo 1 (S1), silo 2 (S2), and silo 3 (S3) based on fermentation age

Based on the NF value, the *Saccharum edule Hassk* waste silage at S1, S2, and S3 had good criteria. The NF value in S1 and S2 is 72.67, while in S3 was 72.20 at the fermentation age of 21 and 28 days (Figure 3). This showed that the fermentation age of 21 and 28 days was sufficient time to produce silage with good criteria, with a water content of 60-70%, an acidity level of 3-4, and a good dry weight. As for the fermentation time of 14 days, it is not enough to form good silage or the fermentation is not optimal. Even at 14 days of fermentation, the pH of the silage had reached 4, which is the ideal pH to kill spoilage microbes in the silage. It turned out that along with the increase in fermentation age of 21 and 28 days, the pH value could still reach an average of 3-3.33 for both S1, S2, and S3 (Table 1 and Figure 1). Low pH can increase acetic acid content and reduce ammonia concentrations and reduce coliform bacteria and fungi in silage [22], [23].

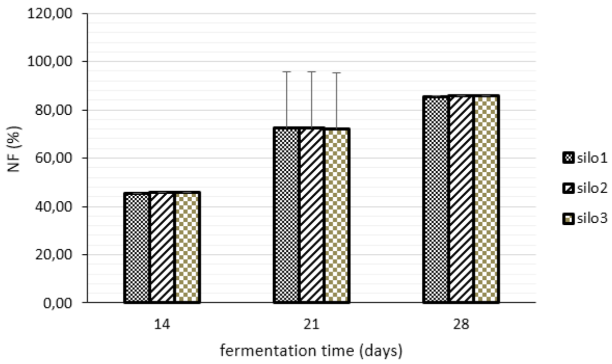

Figure 3. NF silage of crushed waste in silo 1 (S1), silo 2 (S2), and silo 3 (S3) based on fermentation age

The consistency of silage water content was quite good, about 60% in S2 at 14 and 21 days of fermentation (Figure 4). It is suitable with the criteria and definition of silage that silage is a fermented forage product with a water content of 50-60%. The water content will be related to the dry weight. The excess water content in silage indicates that the efficiency of fermentation to decompose carbohydrate compounds in forage is not optimal. Low carbohydrate decomposition affected the protein content of the silage. Likewise, the higher the moisture content, the lower the dry weight of the silage. Silo 2 has a moisture content of about 60% and has a high dry weight at 14 and 21 days of fermentation. Protein content in silo 2 in 14 and 21 days of fermentation was 9.99-10.37% compared to silo 3 with has a water content of 73.33% and dry weight of 26.67% (Figure 5). The protein content and dry weight in the sugarcane ensiling process will be maximized with the addition of cellulase enzymes and *Lactobacillus plantarum* bacteria [24]. Cellulase enzymes can increase the breakdown of fiber so that the dry weight of silage can increase [8], [24], [25].

The dry weight of the plant will be influenced by the season, the age of the plant, the fertility of the soil, and the root system that allows the absorption of nutrients from the soil [4]. In addition, the dry weight is also influenced by the physiological age of the plant and the phase of plant development [6]. Plant mass and content of plant primary and secondary metabolites will be higher in the vegetative phase than in the generative phase. The *Saccharum edule Hassk* waste silage is generally in the form of leaves, stems, and plant residues that have been flowered, therefore the dry weight of the *Saccharum edule Hassk* waste silage is not too high. However, the protein content is still relatively higher than the un-ensilage *Saccharum edule Hassk*. This showed that the ensilage process of the *terubuk* waste can increase the nutritional value of the *Saccharum edule Hassk* waste so that it can be used as an alternative feed for livestock.

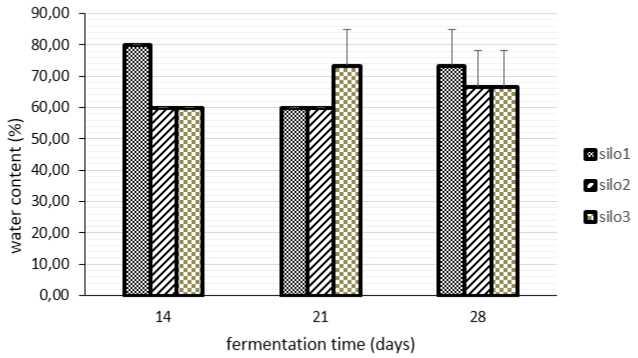

Figure 4. Water content in silage based on fermentation age

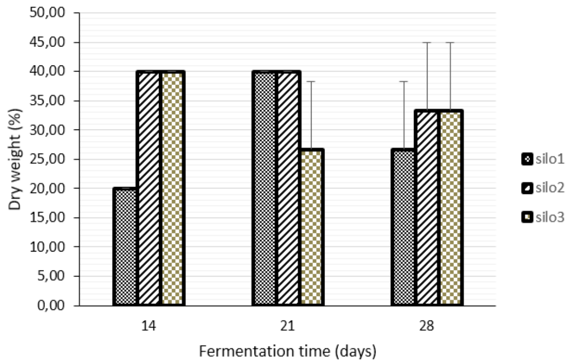

Figure 5. Dry weight value (BK) of silage on silo 1 (S1), silo2 (S2) and silo3 (S3) based on fermentation age

4. CONCLUSION

The best composition of the mixture to make the best *Saccharum edule Hassk* waste silage is rice bran, molasses, water, and microbial starter with a ratio of 6%:3%:0.02%:0.0008% with a fermentation time of 21 days. The composition resulted in silage with a protein content of 10.37 ± 0.69% of dry weight at pH 3.33.

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BIOGRAPHIES OF AUTHORS

Jujun Ratnasari has a Doctoral degree and a master's degree in biology from School Life Science and Technology, Institut Teknologi Bandung. Lecturer at Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Sukabumi. The main research is in Plant Secondary Metabolite and Microbiology. She can be contacted at email: jujun.ratnasari@ummi.ac.id.

Billyardi Ramdhan has a master's degree in ethnobotany from Institut Pertanian Bogor. Lecturer at Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Sukabumi. The main research is in Ethnobotany and Plant Secondary Metabolite. He can be contacted at email: billyardi@ummi.ac.id.

Reny Sukmawani has a Doctoral degree in Agribusiness from Universitas Padjadjaran. Lecturer in Agribusiness Department, Universitas Muhammadiyah Sukabumi. Her main research is in Agribusiness and Agricultural development. She can be contacted at email: renysukmawani@ummi.ac.id.