Physical and chemical quality of silage from two *Pennisetum purpureum* sp varieties supplemented with molasses at different levels

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Abstract. This study aimed to determine quality of silage from *Pennisetum purpureum* sp and *Pennisetum purpureum* cv. Mott supplemented with molasses at different levels. The study was designed using a complete 2 x 3 factorial randomized design. The first factor was grass varieties, *Pennisetum purpureum* sp and *Pennisetum purpureum* cv. Mott and the second factor was supplementation of molasses with levels 0, 3 and 6%. The variables measured included physical and chemical characteristics of silage. The results showed that molasses supplementation produce silage with good physical quality in both *Pennisetum purpureum* variety used. The increased levels of molasses supplementation lowering pH and silage NH$_3$ (P<0.05) concentration, and lactic acid was significantly increase (P< 0.05). The treatment of molasses supplementation showing interactions at pH, NH$_3$ concentration and silage lactic acid concentration in both varieties. It is concluded that *Pennisetum purpureum* sp with the level of 6% molasses supplementation produce best silage in term of its physical and chemical quality.

1. Introduction

Forage commonly act as major feed for ruminants, because it contains nutrients for growth and metabolism. During dry season, the forage availability in both quantity and quality is limited [1]. In contrary, rainy season gives better condition for forage grow then the biomass production will abundant. It resulted over demand of feed, which need to be preserved as feed stock such as in dry season condition.

Silage is a method for preserving forage which has been commonly used through natural fermentation [2]. Good quality of silage will be produced when fermentation was dominated by bacteria which produce lactic acid that inhibit clostridia bacterial activity low [3]. Airtight conditions achieved by maximizing silage material in the container and adding carbohydrate sources.

The potential of elephant grass (*Pennisetum purpureum* sp) biomass production is quite high, in Indonesia it can reach about 277 tons/ha/year [4]. Indonesia have some varieties of elephant grass, for example *Pennisetum purpureum* cv. Mott, *Pennisetum purpureum* sp. Variety cv. Mott and *Pennisetum purpureum* sp. The difference between the varieties is in morphology and its nutrient conten.
In term of morphology, *Pennisetum purpureum* cv.Mott is shorter compared to *Pennisetum purpureum* sp., meanwhile the nutrient content of cv. Mott grasses is higher, in protein content, is compared to *pennisetum purpureum* sp. Moreover, *Pennisetum purpureum* sp has higher fiber and harder as well compared to cv. Mott grass. The content of extract without nitrogen in elephant grass is quite low, it is indicated that source off dissolved carbohydrates is low, for that it is needed to add molasses as carbohydrates source in silage. In this regard, silage quality was assessed from the characteristic of fermentation and aerobic stability which was influenced by forage conditions, harvesting processes and ensilage techniques.

2. Material and methods

Two varieties of elephant grass (*Pennisetum purpureum* sp) and (*Pennisetum purpureum* cv.Mott) were processed into silage by adding different level of molasses. Pre fermentation, the grass was chopped 3-6 in size, followed with molasses addition and silo filling.

This study was designed as a factorial completely randomized design (CRD) The first factor was two varieties of *Pennisetum purpureum* sp which consists of *Pennisetum purpureum* cv.Mott and *Pennisetum purpureum* sp, and the second factor was the level of molasses addition consists of 0, 3 and 6%. Each treatment was repeated 5 times. The treatments combination then namely V1M0: *Pennisetum purpureum* sp + Molasses 0%; V1M3: *Pennisetum purpureum* sp + Molasses 3%; V1M6: *Pennisetum purpureum* sp + Molasses 6%; V2M0: *Pennisetum purpureum* cv.Mott + Molasses 0%; V2M3: *Pennisetum purpureum* cv.Mott + Molasses 3%; V2M6: *Pennisetum purpureum* cv.Mott + Molasses 6%.

The variables measured were pH and physical characteristics of silage which based on questionnaire using score 1 to 5. The respondents were person who have studied feed technology, assessment in color, smell, texture and mold of silage. The NH3 content measurement was determined using previous method [5] and lactic acid using previous method [6]. In this study, silage production time was 21 days.

3. Result and discussion

3.1. pH of silage

The resulted pH of silage is shown in Table 1. According to the result, Increased level of molasses supplementation can markedly reduce the pH. This shows the soluble carbohydrates of molasses in silage production. Buffer capacity is the amount of how many acid is needed to convert into silage. The higher buffer capacity of a material used, would require higher amount of acid as conversion agent [7].

| Variety   | Molasses level | Average       |
|-----------|----------------|---------------|
|           | 0%            | 3%            | 6%            |               |
| V1        | 4.64 ± 0.072a | 4.62 ± 0.016a | 4.33 ± 0.010c | 4.53 ± 0.186k |
| V2        | 4.44 ± 0.012b | 4.23 ± 0.015d | 4.19 ± 0.011d | 4.28 ± 0.183l |
| Average   | 4.63 ± 0.050a | 4.38 ± 0.058y | 4.21 ± 0.024z |

a, b, c, d Different superscripts on the same row and column show significant differences (P <0.05)

3.2. Physical characteristics of silage

The physical characteristics of the silage in color, smell, texture and mold of the results of the research were presented in Table 2. The discoloration of silage from green to light green is thought to be caused by the activity of plant enzymes as the consequence of the presence of oxygen in silos; especially those caught between silage material piles. As long as oxygen is still available, anaerobic conditions will not occur and it affects to the slow colonization process of lactic acid bacteria (LAB). Silage
which is treated with molasses supplementation, providing carbohydrates that utilized by LAB for colonization. LAB will be formed quickly than the process of decreasing pH becomes better and/or sometime after the process of removing oxygen (vacuum) is carried out. For that the quality of silage is good in terms of silage color because this condition will inhibit the process of respiration, proteolysis, and prevent activation of Clostridiabacteria [8].

| Molasses level | Variety | Physical characteristics of silage |  
|----------------|---------|-----------------------------------|
|                | Color   | Smell | Texture                        | Mold       |
| 0%             | V1      | Light green | Acid | Solid, whole, slightly lumpy | No mold |
|                | V2      | Light green | Acid | Solid, whole, slightly lumpy | No mold |
| 3%             | V1      | Light green | Acid | Solid, whole, slightly lumpy | No mold |
|                | V2      | Light green | Acid | Solid, whole, slightly lumpy | No mold |
| 6%             | V1      | Light green | Acid | Solid, whole, slightly lumpy | No mold |
|                | V2      | Light green | Acid | Solid, whole, slightly lumpy | No mold |

Silage smell is one of indicators of the good and bad quality of silage produced. Availability of molasses as a source of carbohydrate dissolved as much as 3% and 6% were able to provide soluable carbohydrates as an energy source for LAB, then the process of converting carbohydrates dissolved into organic acids especially lactic acid was optimal. The previous study [9] showed the effect of molasses as a source of dissolved carbohydrates to grow LAB colonization by 3 and 4.5% by adding 3% rice bran for peanut straw silage production. In that study, the silage smell resulted was sour. On average, the silage produced has good texture, this because the moisture content of silage material was in accordance with water content for optimal fermentation process, ranged from 65-75%. In accordance with previous report [10], silage texture was influenced by water content of the material at the beginning of silage process takes place. Silage with high moisture content (> 80%) will show a slimy, soft and moldy texture while silage with a low moisture content (<30%) has a dry texture and it is not over grown with mold. The mold growth in silage can be caused by the process of silos filling which resulted in air leaking. Mold can grow if anaerobic conditions in the silo [12].

3.3. Chemical characteristics of silage pennisetum purpureum

3.3.1. Silage ammonia content (NH₃). The silage ammonia (NH₃) concentration in this study was decreased (P<0.05) with the increasing level of molasses. The treatment of Pennisetum purpureum sp with 6% molasses supplementation was found to produce lowest NH₃ (Table 3). According to the concentration of NH₃, <10 g/100 g of total N, the silage in this study was categorized as good quality. Silage is categorized as good if NH₃ concentration [11, 12].

Table 3. The NH₃ concentration (mg /100 g) of silage

| Variety | Molasses level | Average  |
|---------|----------------|----------|
|         | 0%             | 3%       | 6%       |
| V1      | 6.81 ± 0.37a   | 5.47 ± 0.16b | 4.44 ± 0.36c | 5.12 ± 1.27k |
| V2      | 4.23 ± 0.078d  | 4.10 ± 0.030d | 3.46 ± 0.051e | 4.38 ± 0.86l |
| Average | 6.14 ± 0.75a   | 4.33 ± 0.27y | 3.78 ± 0.33z |

a,b,c,d,e Different superscripts in the same row and column show significant differences (P <0.05)

x,y,z Different superscripts in the same row show significant differences (P <0.05)

k,l Different superscripts in the same column show significant differences (P <0.05)

3.3.2. Silage lactic acid content. The results showed that supplementation of molasses to silage had significant effect (P<0.05) to the content of silage lactic acid. The higher level of supplementation of molasses resulted high content of lactic acid. This due to higher molasses supplementation will...
provide more soluble carbohydrates for LAB to proliferate and lead to the more production of lactic acid. Lactic acid bacteria in the silage could accelerate the rate of fermentation, produce more lactic acid, reduce pH, reduce proteolysis and can improve livestock performance [13, 14].

Table 4. The average concentration of lactic acid (%) in silage

| Variety | Molasses level | 0%     | 3%     | 6%     | Average |
|---------|----------------|--------|--------|--------|---------|
| V1      | 7.42 ± 0.94 d  | 9.64 ± 0.33 c | 10.59 ± 0.38 b | 9.22 ± 1.49 |
| V2      | 7.87 ± 0.42 d  | 8.10 ± 0.30 d  | 11.79 ± 1.01 a  | 9.25 ± 1.95 |
| Average | 7.64 ± 0.72 z  | 8.87 ± 0.87 y  | 11.19 ± 0.96 x  |         |

Different superscripts in the same row and column show significant differences (P <0.05)

The different superscripts in the same row show significant differences (P <0.05)

4. Conclusions
Supplementation of molasses in silage resulted good physical and chemical quality silage. The best level of molasses supplementation is at 6%, which is characterized by high lactic acid and lower NH₃ content. Different elephant grass varieties in silage production resulted good physical and chemical qualities.

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