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Research article

Evaluation of Physical Quality, Nutrient Content, and Nutrient Losses in Odot Grass *(Pennisetum purpureum cv. Mott)* Silage With Molasses and Pollard Additives

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Abstract

This study was conducted to evaluate the quality of odot grass made into silage with the addition of molasses and pollard additives as ruminant feed. The research materials used included odot grass, molasses, and pollard. The research method was an experiment using a complete random design (CRD) consisting of 3 treatments. The difference in treatment was based on the addition of pollard levels in the form of P1 (12.5%), P2 (22%), and P3 (32.4%), and the addition of molasses to each treatment of 5%. The variables observed consisted of nutrient content after or before silage, physical quality, pH, and nutrient loss. The results showed that the nutrient content of each treatment tended to increase with the addition of pollard to odot grass silage. The results of the analysis of variance showed that the addition of pollard at different levels had a very significant effect on the nutrient content of odot grass silage ($P < 0.01$). Physical quality showed that P3 had the best aroma, texture, and color quality with the absence of fungi, and a pH of around 3.75. The loss of nutrients from odot grass silage showed the smallest results obtained in P3, compared to other treatments. Thus, the results showed that the addition of pollard at a level of 32.4% provided good physical quality, increased nutrition, and nutrient resistance from loss.

Keywords: Odot grass, Silage, Pollard

INTRODUCTION

The ruminant feed industry plays a crucial role in promoting the production of healthy, efficient, and sustainable livestock. Its primary function is to provide high-quality feed that meets the nutritional requirements of animals on a continuous basis. Forage is the most commonly used feed resource among farmers, with odot grass (*Pennisetum purpureum* cv. Mott) being one of the superior forage species due to its high biomass yield, rapid growth rate, and favorable nutritional value for ruminants. The development of odot grass as a forage resource has a significant impact on the advancement of ruminant livestock farming systems (Solterna, 2022). To date, the utilization of odot grass in Indonesia is predominantly carried out through a cut-and-carry system, where the forage is either fed directly or subjected to wilting before feeding. This practice is mainly attributed to the high moisture content of odot grass. One common method for reducing its moisture level is wilting. According to Nikolaus et al. (2019), forage wilting can be performed by exposing the harvested forage to air for approximately 30 minutes to 2 hours, or even up to half a day, depending on the forage species and its initial moisture content. However, this method has a major limitation, namely its dependence on weather conditions. Therefore, an alternative approach to optimize the utilization of odot grass is the application of preservation technology through ensiling, resulting in the production of silage.

Silage is a practical solution to overcome the challenges associated with the wilting of odot grass, which is time-consuming and requires extensive space (Solterna, 2022). Ensiling can serve as an effective method for reducing the moisture content of odot grass while preserving its nutritional value and extending its storage life. Various additives may be incorporated during the ensiling process to maintain or even enhance the nutritional quality of odot grass. One such additive is pollard, which possesses favorable nutritional characteristics and contributes to reducing the moisture content of silage. According to Fajri et al. (2018), as cited by Rosani and Hernaman (2024), pollard contains 8.04% crude fiber, 4.7% crude fat, 88.17% dry matter, and 4.78% ash. These nutritional properties make pollard a suitable additive for improving the nutritional quality of odot grass silage while simultaneously reducing its moisture content. Consequently, the inclusion of pollard in the ensiling process has the potential to enhance the overall quality and preservation characteristics of odot grass silage.

Based on the information, this study was conducted to evaluate the use of pollard as an additive in odot grass silage and its effects on the nutritional composition of odot grass, particularly its moisture content. In addition, several key indicators were assessed, including the physical quality, nutritional composition, and nutrient losses (nutrition losses) of the resulting silage. The findings of this study are expected to provide valuable information regarding the effectiveness of pollard supplementation in improving the quality and preservation characteristics of odot grass silage.

MATERIALS AND METHODS

Time and Location of the Study

This study was conducted over a period of five months, from October 2024 to February 2025, encompassing the stages of material collection, silage preparation, fermentation, and data analysis. The silage was prepared at the Field Laboratory of Sumber Sekar, Faculty of Animal Science, Universitas Brawijaya, located in Sumber Sekar Village, Dau District, Malang Regency, East Java, Indonesia. Proximate analysis was subsequently carried out at the Laboratory of Animal Nutrition and Feed Science, Faculty of Animal Science, Universitas Brawijaya.

Sample and Management

The materials used in this study included odot grass (Pennisetum purpureum cv. Mott) obtained from local agricultural land on the slopes of Mount Kawi, Ngajum District, Malang Regency, East Java, Indonesia. The forage was harvested at 70 days of age and cut at a height of 20–30 cm above ground level. Molasses and pollard were added as energy sources to support the growth and activity of lactic acid bacteria (LAB) during the ensiling process.

The experiment was arranged in a Completely Randomized Design (CRD) consisting of three treatments and three replications. The treatments were differentiated based on the level of pollard inclusion to achieve different target dry matter (DM) contents of the silage material, as follows:

P1: Odot grass + 5% molasses + pollard (target dry matter content of 12%)

P2: Odot grass + 5% molasses + pollard (target dry matter content of 22%)

P3: Odot grass + 5% molasses + pollard (target dry matter content of 32.4%)

The treatment structure was designed to evaluate the effects of different pollard inclusion levels on the physical characteristics, nutritional composition, moisture content, and nutrient losses of odot grass silage.

Data Analysis

The collected data were tabulated and subjected to Analysis of Variance (ANOVA) to determine the effects of different pollard inclusion levels on the observed variables. When the ANOVA indicated significant ($P < 0.05$) or highly significant ($P < 0.01$) differences among treatments, the means were further compared using Duncan's Multiple Range Test (DMRT) to identify differences between treatment groups.

RESULTS AND DISCUSSION

Nutritional Composition of Silage Materials Prior to Ensiling

Feed nutrients, including carbohydrates, proteins, fats, fiber, vitamins, and minerals, play essential roles in supporting livestock productivity. Therefore, feed quality can be assessed, among other indicators, through its nutritional composition, with higher nutrient contents generally reflecting superior feed quality. The nutritional composition of the silage materials before ensiling is presented in Table 1. Odot grass, as the primary silage material, typically contains a crude protein content ranging from approximately 18–20%. As shown in Table 1, the addition of molasses and pollard improved several nutritional parameters of odot grass, including DM, CP, EE, TDN, and NFE. The magnitude of these improvements tended to increase with higher levels of pollard inclusion.

The most pronounced increase was observed in the DM, which is consistent with the findings of Umami et al. (2023), who reported that supplementation of 3% and

6% pollard in Pennisetum purpureum silage improved texture scores and reduced the moisture content of the ensiled material due to the osmotic dehydration properties of pollard. In addition, treatment P3 resulted in increases in CP content to 12.1%, TDN to 63.4%, and NFE to 62.1%. Furthermore, the ash content decreased from 14.7% in P1 to 12.40% in P3, indicating an increase in the proportion of OM The reduction in CF content also suggests an improvement in the nutritional quality of odot grass, particularly during the ensiling process, which is associated with the degradation and transformation of nutrient components by lactic acid bacteria (LAB). These findings indicate that P3 (odot grass + 5% molasses + 32.4% pollard) provided the most favorable nutrient balance among the treatments prior to ensiling, demonstrating its potential as an optimal raw material formulation for producing high-quality odot grass silage.

Table 1. Nutrition before silage

Nutrition	Treatment		
	P1	P2	P3
DM (%)	25,8	37,1	37,1
ASH*	14,7	13,6	12,4
CP*	10,7	11,4	12,1
EE*	1,2	1,3	1,5
CF*	29,2	26,8	24,4
TDN*	58,4	60,9	63,4
NFE*	59	60,5	62,1

Note: All nutrient contents are expressed as percentages of the total dry matter (DM) content of odot grass.

Physical Quality

The physical quality of silage was evaluated based on its color, aroma, texture, mold occurrence, and pH value. The mean values of the physical quality parameters and pH of odot grass silage are presented in Table 2. As shown in Table 2, all treatments exhibited favorable anaerobic fermentation conditions, as indicated by the absence of mold growth in the silage. This result suggests that the ensiling process was successfully conducted under anaerobic conditions, thereby preventing the proliferation of undesirable microorganisms.

Regarding color, treatments P1 and P3 exhibited the most desirable appearance, characterized by a greenish-brown color, indicating that chlorophyll was relatively well preserved during the ensiling process. According to Herlambang et al. (2021) and Rodriguez et al. (2024), a green to greenish-brown color in silage reflects good chlorophyll preservation, rapid pH reduction by lactic acid bacteria (LAB), and minimal oxidative deterioration. These conditions contribute to the maintenance of nutritional quality and indicate a well-preserved silage product.

The relatively high palatability of the silage was maintained across treatments. However, P2 exhibited a slightly yellowish-green color, which may reflect mild enzymatic activity or limited oxidation during the fermentation process (Aprilia et al., 2026). According to Dzulhidayat (2022), the appearance of a light yellowish hue may serve as an early indication of acetic acid formation and enzymatic activity that is not detrimental to silage quality, provided that the pH remains below 4.2.

The aroma characteristics demonstrated a gradual increase in acidity intensity across treatments (Table 2). Treatment P1 exhibited a mildly acidic aroma, P2 a moderately acidic aroma, and P3 a strongly acidic aroma, indicating the highest level of acid production in the latter treatment. A pleasant acidic aroma without rancid or putrid odors is generally considered an indicator of successful fermentation dominated by lactic acid bacteria (LAB), particularly *Lactobacillus plantarum* and *Lactobacillus buchneri*, which produce lactic acid and acetic acid as the principal fermentation products.

The mildly acidic aroma commonly observed in silage, rather than a sharp vinegar-like odor, is largely attributable to acetic acid production, which typically represents the second most abundant organic acid after lactic acid and is highly volatile (Kung et al., 2018). Acetic acid is produced through the conversion of lactic acid by heterofermentative LAB during the ensiling process and plays an important role in inhibiting the growth of spoilage fungi and yeasts, thereby enhancing the aerobic stability and preservation quality of silage (Muck et al., 2018; Okoye et al., 2023). The progressively stronger acidic aroma observed from P1 to P3 suggests that increasing pollard inclusion enhanced the availability of fermentable substrates for LAB, thereby promoting more intensive fermentation and greater organic acid production. This finding is consistent with the lower pH values observed in P2 and P3, which further indicate improved fermentation quality and silage preservation.

In contrast, the presence of putrid or rancid odors in silage is often associated with the production of butyric acid by Clostridium spp., ammonia, or volatile sulfur compounds. Such odors generally indicate undesirable fermentation resulting from inadequate silo sealing, excessive moisture content, or an unfavorable carbon-to-nitrogen ratio in the ensiled material (Foragelab, 2008). The texture of odot grass silage generally tended to be soft and easily separated, indicating satisfactory silage quality. Silage texture is strongly influenced by the moisture content of the ensiled material, with the optimal moisture range for successful ensiling typically between 65% and 70%. Excessively high moisture levels in forage increase the risk of spoilage and may result in silage with a slimy texture, excessive softness, and mold contamination (Fahmi et al., 2019). Moreover, excessive moisture can inhibit the growth and activity of lactic acid bacteria (LAB), thereby limiting lactic acid production and preventing a sufficient decline in pH. Consequently, the resulting silage becomes less acidic, creating favorable conditions for the proliferation of spoilage microorganisms and pathogenic bacteria.

The pH values of the silage decreased improvement in fermentation quality as the pollard progressively with increasing levels of pollard supplementation (Table 2). This trend indicates an inclusion level increased, particularly in treatment P3. The reduction in pH can be attributed to enhanced LAB activity and increased lactic acid production, as higher concentrations of lactic acid directly contribute to a more acidic silage environment (Irawan et al., 2021).

Among the treatments, P2 exhibited the lowest pH value (3.73), indicating highly effective LAB fermentation and excellent silage preservation. Although P3 produced a similarly low pH (3.75), the difference between the two treatments was minimal. Overall, the pH values observed across all treatments fell within the range considered indicative of good-quality silage.

According to Alfatah et al. (2023), silage quality based on pH can be classified as follows: pH 3.5–4.2 indicates very good quality silage, pH 4.2–4.5 indicates good quality silage, pH 4.5–4.8 indicates moderate quality silage, and pH values above 4.8 indicate poor-quality silage. Based on this classification, treatments P2 and P3 can be categorized as very good quality silage, while P1 falls within the good quality category. Compared with previous findings, Putra (2017) reported that odot grass silage supplemented with 20% pollard produced an average pH value of 4.58, which is higher than the values observed in the present study. This suggests that the ensiling conditions and pollard supplementation levels used in the current experiment were more effective in promoting lactic acid fermentation and reducing silage pH, thereby enhancing the overall preservation quality of odot grass silage.

Nutritional Composition of Odot Grass Silage

The nutritional composition of odot grass silage supplemented with different levels of pollard after 30 days of incubation is presented in Table 3. Table 3 shows that the contents of dry matter (DM), organic matter (OM), crude protein (CP), and ether extract (EE) tended to increase following the ensiling process compared with their pre-ensiling levels, whereas crude fiber (CF) exhibited a declining trend. Analysis of variance revealed that different levels of pollard supplementation exerted a highly significant effect on the nutritional composition of odot grass silage ($P < 0.01$). Among the treatments, P3 consistently exhibited the highest nutrient concentrations, indicating that increasing the level of pollard supplementation enhanced the nutritional quality of the resulting silage. This finding suggests that pollard not only functions as a moisture absorbent but also contributes additional nutrients to the silage matrix.

A substantial increase was observed in dry matter (DM) content, with P3 recording the highest value (39.52%) (Table 3). This result is consistent with the findings of Fangidae et al. (2024), who reported that increasing levels of absorbent additives in odot grass silage resulted in higher DM contents compared with silage prepared without absorbents. The increase in DM can be attributed to the low moisture content of pollard, generally less than 10%, which enables it to act as an osmotic dehydrating agent when mixed with fresh forage. Consequently, pollard reduces the overall moisture content of the silage material while increasing its solid fraction. Similarly, Retnaningsih et al. (2017) reported that the combination of pollard and molasses significantly increased the DM content of corn stover silage, thereby promoting more stable fermentation and reducing the risk of clostridial fermentation. The increase in DM was accompanied by a corresponding increase in organic matter (OM) content, with P3 also exhibiting the highest OM value. According to Berek et al. (2024), increases in DM content are generally associated with increases in OM content and decreases in ash concentration. Therefore, as DM increases, OM tends to increase proportionally.

Table 2. Physical quality and pH of odot grass silage

Treatment	Color	Aroma	Mold Occurrence	Texture	pH
P1	Greenish-brown	Acidic	Absent	Coarse and easily separated	4.52
P2	Yellowish-green	Slightly acidic	Absent	Soft and easily separated	3.73
P3	Greenish-brown	Strongly acidic	Absent	Soft and difficult to separate	3.75

Note: Treatments consisted of different pollard inclusion levels: P1 (odot grass + 5% molasses + 12.5% pollard), P2 (odot grass + 5% molasses + 22.0% pollard), and P3 (odot grass + 5% molasses + 32.4% pollard).

Organic matter content reflects the proportion of organic fractions, including carbohydrates, proteins, lipids, and structural carbohydrates, which serve as substrates for fermentative microorganisms. Higher OM levels indicate greater availability of fermentable nutrients, thereby supporting microbial activity and improving the overall nutritional value of the silage.

A different pattern was observed for crude protein (CP), where P1 exhibited the highest CP content among all treatments. This phenomenon may be associated with changes in the carbon-to-nitrogen ratio during fermentation. Specifically, the combination of molasses and pollard at the intermediate inclusion level (P2) may have promoted the growth of proteolytic microorganisms, including Clostridium spp., resulting in increased protein deamination and the conversion of protein into ammonia before being quantified as total crude protein. Consequently, a reduction in measurable CP content may have occurred in this treatment.

Umami et al. (2023) reported that pollard supplementation of up to 6% in Napier grass silage proportionally increased crude protein content with increasing additive levels, owing to the substantial contribution of non-protein nitrogen and peptide fractions present in pollard. Similarly, Trisandewi et al. (2016) found that the inclusion of pollard and molasses (10% each) in corn stover silage increased crude protein content to 16.19%, highlighting the role of pollard as a nitrogen source for fermentative microorganisms, which subsequently enhances the final protein value of silage.

Overall, the results demonstrate that higher pollard inclusion levels improved several nutritional parameters of odot grass silage, particularly dry matter, organic matter, crude fiber, and ether extract contents. However, crude protein retention appeared to be influenced not only by the nutrient contribution of pollard but also by fermentation dynamics and microbial activity during the ensiling process. Consequently, balancing pollard supplementation and fermentation conditions is essential to optimize both nutrient preservation and silage quality.

Table 3. Nutritional composition of odot grass silage

Component (%)	P1	P2	P3
DM	$24.22^{a} \pm 0.08$	$27.43^{b} \pm 0.07$	$39.52^{c} \pm 0.08$
OM	$24.24^{a} \pm 0.11$	$27.43^{b} \pm 0.07$	$39.13^{c} \pm 0.03$
CP	$15.91^{a} \pm 0.09$	$14.91^{b} \pm 0.18$	$15.73^{c} \pm 0.24$
CF	$19.53^{a} \pm 0.15$	$19.92^{b} \pm 0.06$	$20.32^{c} \pm 0.15$
EE	$1.39^{a} \pm 0.09$	$1.22^{b} \pm 0.05$	$2.86^{c} \pm 0.27$

Note : Different superscripts within the same row indicate highly significant differences among treatments ($P < 0.01$).

Nutrition Losses

Nutrient losses were calculated based on the differences in nutrient composition before and after the ensiling process. As shown in Table 4, treatment P2 exhibited considerably higher nutrient losses than the other treatments, whereas several nutrient fractions in P1 and P3 showed normal loss values or even negative values, indicating improved nutrient retention following ensiling. Dry matter (DM) losses varied substantially among treatments, with P3 exhibiting a negative DM loss value, suggesting that DM content was effectively preserved and even increased relative to the initial material. According to McDonald et al. (1991), as cited by Lendrawati et al. (2012), dry matter losses in well-managed silage generally range from 7% to 20%. These losses originate from several stages of the ensiling process, including silo filling (5%), effluent production (3%), fermentation losses (5%), aerobic deterioration (10%), and field losses (4%).

The highest average nutrient losses were observed in P2, which contained 22% pollard supplementation. This phenomenon may be attributed to intensified microbial activity, particularly that of lactic acid bacteria (LAB), resulting in greater utilization of available substrates and nutrients for metabolic processes during fermentation. Consequently, nutrient depletion became more pronounced in this treatment. This interpretation is supported by the fact that P2 recorded the lowest pH value among all treatments (Table 2), indicating vigorous fermentation activity.

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Dryden (2021), as cited by Sadarman et al. (2023), reported that sufficient glucose availability during ensiling promotes LAB proliferation and lactic acid production, thereby accelerating pH reduction and improving silage preservation. Under optimal conditions, rapid acidification minimizes nutrient degradation. However, when readily fermentable energy sources become limited, LAB and other microorganisms may utilize alternative substrates, including protein and other organic compounds, leading to increased nutrient losses.

Table 4. Nutrient Losses of Odot Grass Silage (%)

Nutrient Loss (%)	P1	P2	P3
DM	6.12	26.15	-6.41
OM	16.57	37.97	26.06
CP	-1.39	18.96	-6.41
CF	37.13	45.13	11.54
EE	-12.39	30.63	-110.45

Source: Primary data, processed (2024).

Similarly, Chalisty (2021) explained that enhanced lactic acid production and the accompanying decline in pH are indicative of substantial utilization of organic matter (OM) during fermentation. Consequently, greater microbial activity may contribute to higher OM losses, as observed in P2. The elevated OM losses recorded in this treatment support the hypothesis that a larger proportion of fermentable substrates was metabolized during the ensiling process.

In contrast, treatments receiving higher levels of pollard supplementation, particularly P3, tended to exhibit lower nutrient losses. This finding suggests that higher pollard inclusion improved nutrient preservation and reduced the intensity of nutrient degradation during fermentation. The ability of pollard to absorb excess moisture and increase dry matter content likely contributed to creating a more favorable fermentation environment and limiting undesirable nutrient losses. These results are consistent with the findings of Siregar et al. (2020), who reported that absorbent additives such as pollard can effectively preserve nutrients during silage fermentation, especially when optimal dry matter levels are achieved.

CONCLUSION

Based on the results of the present study, it can be concluded that the inclusion of 32.4% pollard (P3) produced the most desirable physical characteristics of odot grass silage, as evidenced by a strongly acidic aroma, favorable texture and color, absence of mold growth, and an optimal pH value of 3.75. Furthermore, supplementation with 32.4% pollard resulted in the highest nutritional quality and demonstrated the lowest tendency for nutrient losses during the ensiling process. Therefore, the inclusion of 32.4% pollard can be recommended as an effective strategy for improving both the fermentation quality and nutritional preservation of odot grass silage.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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