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Effect of Various Doses of Local Microorganism Additives on Silage Physical Quality of Corn (*Zea mays* L.) Waste

Yunilas Yunilas[1*], Nurzainah Ginting[1], Tri Hesti Wahyuni[1], Muhammad Zahoor[2], Nelzi Fati[3] and Ahmad Wahyudi[4]

[1]Department Animal Sciences, Faculty of Agriculture, Universitas Sumatera Utara, Jl. Prof. DR. A. Sofyan No 3, Medan 20155, North Sumatera, Indonesia; [2]Department of Biochemistry, University of Malakand, Lower Dir 18800, Pakistan; [3]Program of Livestock Cultivation, The State Polytechnic of Agriculture Payakumbuh, Jl. Raya Negara Km. 7 Tanjung Pati, West Sumatera 26271, Indonesia; [4]Department of Agriculture Sciences, Directorate of Post Graduate Program, University of Muhammadiyah Malang, Jl Raya Tlogomas 246 Malang 65144, Indonesia.

Abstract | Corn crop waste in the form of corn straw, cobs, and corn husks can be used as ruminant animal feed, but its utilization as animal feed is not optimal. The application of silage feed technology using local microorganism additives is expected to improve the physical quality of silage feed. This study aimed to determine the effect of adding local microorganisms (MOL) and fermentation time on the physical quality of corn straw silage. This study used a completely randomized design, factorial 3 × 3 with three replications. Factor I was various doses of MOL (1 %, 3 %, 5 %), and Factor II was different fermentation times (7 d, 14 d, 21 d). The variables observed included texture, color, odor, and taste. The results showed that the MOL dose and fermentation time had a very significant effect ($P < 0.01$) on silage's texture, color, and odor. In addition, the MOL dose and fermentation time have a considerable impact ($P < 0.05$) on the silage taste. There is an interaction between MOL dose and fermentation time on silage odor.

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***Correspondence** | Yunilas Yunilas, Department Animal Sciences, Faculty of Agriculture, Universitas Sumatera Utara, Indonesia; **Email:** yunilas@usu.ac.id
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Introduction

By-products of corn (*Zea mays* L.) consist of stems, leaves, cob, and the skin of corn fruit. At harvest time, waste production is thrown away. This corn crop waste has not been utilized optimally due to the limited knowledge and skill of processing waste into a helpful feed. A small number of breeders use by-products of corn plants in the fresh form to livestock. However, the by-products of this corn mostly left unnoticed in the field without being processed for cattle. Corn waste can be used as an alternative feed forage for animal feed because it can act as a source of fiber. This waste is potential for applicated as ruminant animal feed, especially during the dry season, due to lack of forage (Sadik *et al*., 2021).

The fodder preservation method carried out through a natural fermentation process is also called ensilage (Chen and Weinberg, 2009). Making silage is forage fermentation by microbes that produce many lactic acids. The most dominant microbes are from the homofermentative lactic acid bacteria class, which can ferment in aerobic to anaerobic conditions. Lactic

acid produced during the fermentation process will have preservatives to inhibit the growth of spoilage microorganisms (Ridwan *et al*., 2005; Wahyudi *et al*., 2017).

Good quality silage will be produced when fermentation is dominated by bacteria that produce lactic acid, and the bacterial activity of clostridia is low (Santoso *et al*., 2009). Inoculating sugarcane with *Lactobacillus buchneri* 40788 at ensiling can alter the fermentation process by increasing acetic acid production. Due to the antifungal properties of acetic acid, the total mixed ratio containing treated silages have a higher nutritive value (Schmidt *et al*., 2014).

One of the processing that can be done is making anaerobic fermentation-based complete fermentation. The primary purpose of this treatment is to extend the shelf life so that the corn plant waste remains durable and does not rot. Fermented products in the form of complete silage, besides increasing shelf life, can also increase the nutritional content of feed due to carbohydrate sources other additives and being more applicable (Wahyudi *et al*., 2019). However, if the examined other feed is seen from the value of feed quality and digestibility. Foods that are high in nutrient content (high protein) may not necessarily have high digestibility. Thus, as a matter of thought in the ensilage process, in addition to the role of anaerobic microbes (lactic acid-producing bacteria it is necessary to enrich with the addition of fiber-degrading microbes so that the digestibility of these ensilage products can be improved. Increased digestion occurs because of fermentation by microbes that degrades lignocellulose compounds into simple molecules so that cellulose and hemicellulose can be used as a carbon source for ruminants.

Fermented feed processing can involve local microorganisms (indigenous microorganisms). Local microorganisms are microbes that are exploited from their substrate, which can degrade fibrous feed. By using local microbes (indigenous microorganisms), multi enzymes will be produced, which are very instrumental in the process of feed processing. Some local microbial sources can be used as a source of probiotics to improve the quality of feed ingredients such as agricultural and plantation wastes. Fermentation feed processing using local microbes will optimize the ability of rumen microorganisms to digest high-fiber feed (Yunilas *et al*., 2013). The complete fermentation of palm oil plantation waste using Indigenous Microorganisms as a bio activator by 1 % can increase crude protein (CP) and reduce the content of crude fiber (CF), Neutral Detergent Fiber, Acid Detergent Fiber and lignin. Fermentation of industrial waste with indigenous microbes can increase protein content and reduce fiber content (Yunilas *et al*., 2014a). Yunilas (2016) showed the results of fermentation in plantation and industrial palm oil waste using MOL gave a distinctive odor that indicated during the process of microorganisms [*Bacillus* sp., *Trichoderma* sp., and *Saccharomyces* sp., Lactic acid bacteria (LAB)] were able to remodel carbohydrates into lactic acid to produce unique sour taste from the fermentation results.

Silage is preserving fresh forage under anaerobic conditions by forming or adding acids. The acids formed are organic acids such as lactic acid, acetic acid, and butyric acid. Fermentation of soluble carbohydrates by bacteria causes a decrease in acidity (pH). To increase the shelf life of complete silage products, which are easier to carry and do not require ample space, it is necessary to make a breakthrough innovation in the form of making ruminant animal feed in the form of cracker biscuits. Cracker biscuit feed is a fermented product feed processed in the form of biscuits. Thus, cracker biscuits are an innovative probiotic feed product that has a novelty in the silage process, complete with lactic acid bacteria and cellulolytic microorganism additives to produce delicious biscuits that are easy to digest have probiotic properties.

During the fermentation process, hydrolytic enzymes are also produced and make minerals easier for animals to absorb. Besides, efforts to improve the quality of nutrition reduce or eliminate the harmful effects of certain feed ingredients can be made by using local microorganisms in the fermentation process. Fermentation processing using local microorganisms will optimize the ability of rumen microorganisms to digest high-fiber feed (Yunilas *et al*., 2013).

Based on the explanation above, researchers are interested in observing the effect of local microorganism doses as additives to improve the quality of corn waste.

Materials and Methods

Material

The materials used in this study, using the isolates:

bacterial *Bacillus* sp. Fungi *Trichoderma viridae*, yeast *Saccharomyces* sp. and Lactic Acid Bacteria. The pure isolate used came from palm oil plantation waste and beef. *Bacillus* sp., *Trichoderma viridae*, *Saccharomyces* sp. isolates were isolated from oil palm plantation waste and Lactic Acid Bacteria from beef. Corn straw (70 %), rice bran (5 %), coconut cake (7 %), soybean meal (10 %), cornflour (2 %), mineral (1 %), urea (2 %) and molasses (3 %).

The equipment used is test tubes, Petri dishes, needles, bunsen, gloves, masks, inoculation chambers, spatulas, vortices, equipment for making probiotics, laboratory equipment for proximate, and van Soest analysis, chopper, spades, scales, knife, and black plastic meter.

Method

The research method used is experimental, which is making complete silage with additive MOL. Complete randomized design (CRD) factorial 3 × 3 with three replications. Factor I was the probiotic doses of MOL namely: D1 = 1 % MOL; D2 = 3 % MOL; D3 = 5 % MOL; Factor II is the fermentation time that is L1 = 7 d, L2 = 14 d and L3 = 21 d.

Research procedure

Complete silage manufacturing consists of forage sources (corn straw), sources of concentrates (rice bran, coconut cake, soybean meal, corn flour) and additives (molasses, minerals, urea, and probiotics MOL).

Manufacture of MOL probiotics include

Isolation and Purification

Isolation of indigenous bacteria

The source of indigenous isolates used oil palm waste (oil palm frond, palm carnel cake, and sludge). Amount 1 g each of samples collected aseptically were serially diluted in distilled water from 10^{-3} to 10^{-5} and spread plated on modified selective agar medium containing (0.5 g peptone, 0.5 g yeast agar, 0.1 g K_2HPO4, 0.02 g $MgSO4.7H_2O$, 1 g Na_2CO_3, 20 g agar, 0.25 g CMC, 0.25 g xylan, 0.25 g lignin, and 0.25 g mannan) in 1 000 mL distilled water. The plates were incubated at 37 °C for 24 h to 48 h, and the growing bacteria colonies were sub-cultured to obtain pure cultures (Yunilas *et al.*, 2013).

Isolation of indigenous fungi and yeast

The source of indigenous isolates used oil palm waste (oil palm frond, palm carnel cake, and sludge). Amount 1 g each of samples collected aseptically were serially diluted in distilled water from 10^{-3} to 10^{-8} and spread plated on modified selective agar Czapek Dox Agar (CDA) containing (0.2 % $NaNO_3$; 0.05 % KCL; 0.05 % $MgSO_4.7H_2O$; 0.001 % $FeSO_4.7H_2O$; 0.05 % KH_2PO_4; 0.04 % yeast extract; 2 % agar, 0.25 g CMC, 0.25 g xylan, 0.25 g lignin, 0.25 g mannan, and streptomycin 0.01 %) in 1 000 mL distilled water. The plates were incubated at 37 °C for 24 h to 48 h, and the growing fungi colonies were sub-cultured to obtain pure cultures (Yunilas *et al.*, 2019).

Isolation of lactic acid bacteria from meat

Isolation is made of two different conditions, namely 12 h postmortem (A) and 24 h postmortem (B). Amount 10 g of each sample was taken and added to 90 mL of the sterile diluent containing 0.1 % BPW then homogenized for 30 sec. Dilution was done to 108; performed on MRSA isolation media (streak plate method) containing 1 % $CaCO_3$ and BCP 60 g L^{-1} was incubated at 37 °C for 48 h. The culture was purified by repeated streaking. Pure culture on agar slant stored at a temperature of 40 °C MRS for short-term use (Yunilas *et al.*, 2014b).

Rejuvenation

The pure isolate used came from palm oil plantation waste and beef. *Bacillus* sp., *Trichoderma viridae*, *Saccharomyces* sp. isolates were isolated from oil palm plantation waste and *Lactobacillus* sp. from beef (Yunilas *et al.*, 2013; 2014b; 2019).

Pure isolates to be used are rejuvenated (refreshed). Refreshment of isolates (*Bacillus* sp. *Trichoderma viridae*, yeast *Saccharomyces* sp. and Lactic Acid Bacteria) was carried out by growing isolates in each medium nutrient broth (NB), potato dextrose broth (PDB), and de Mann Rogose Sharpe Broth (MRSB) and incubating for 24 h to 48 h at room temperature. Refresher continues until the culture adapts to life on the media, and the amount is quite a lot that is marked by the turbidity of the growing media.

Starter culture

Isolate of local microorganisms (MOL) were cultured in liquid media according to their respective isolates (*Bacillus* sp. on nutrient broth, *Trichoderma viridae* on potato dextrose broth, *Saccharomyces* sp. on potato dextrose yeast broth, and MRS broth) then incubated at room temperature. Breeding is intended to renew and multiply the culture population before being used

as a starter culture. The finished starter cultures were inoculated in liquid medium (cocktail inoculum) at doses of 1 %, 5 %, 10 %, and incubated for 7 d, 14 d, and 21 d. The best starter culture was obtained at a dose of 10 % at 14 d incubation, containing bacteria 6.12 $\times 10^9$, fungi 5.69 $\times 10^9$, yeast 12.7 $\times 10^9$, and LAB 1.1 $\times 10^9$.

Probiotic starter culture

The materials used in the manufacture of probiotic starter cultures are 3 % bran, 3 % brown sugar, 3 % molasses, 0.5 % urea and 1 % minerals (0.5 % $MgSO_4$; 0.5 % KCL; 0.01 % $FeSO_4$; 0.001 % $CuSO_4$; and 0.01 % $ZnSO_4$), various materials according to treatment are sterilized using an autoclave sterilizer 50 L sturdy sa-300vf, after being cooled inoculated with a starter culture of 10 % with incubation for 14 d. The starter culture of 10 % is containing bacteria 6.12 $\times 10^9$, fungi 5.63 $\times 10^9$, yeast 12.7 $\times 10^9$ and LAB 1.1 $\times 10^9$.

Making complete silage based on corn waste

The corn straw was chopped to a size of about 3 cm to 5 cm using a chopper. Mix all ingredients (70 % corn straw, 5 % rice bran, 7 % coconut cake, 10 % soybean meal, 2 % corn flour, 1 % mineral, 2 % urea and 3 % molasses) until homogeneous and inoculate Probiotic starter culture (MOL) according to treatment (1 %, 3 % and 5 %). After being mixed well, put into the plastic while compacted using a hydraulic press. Fermentation is carried out anaerobic. Storage was carried out according to treatment (7 d, 14 d, and 21 d). Results are harvested and analyzed.

Observed variables

After fermentation, corn silage was opened and evaluated for physical quality (texture, color, odor, and taste) organoleptic. Amount 15 panelists observed evaluation of physical quality. McEllhiney (1994) states using a rating of each physical quality observation from 1 to 9.

Physical organoleptic tests include texture, colors, odors, and tastes. Classifies the texture of silage products on three criteria: mushy (1 to 3), moderate (4 to 6) hard (7 to 9). Classifies the colors of silage products on three criteria: dark brown (1 to 3), brown (4 to 6), and light brown (7 to 9). Classifies the odor of silage products on three criteria: non-acidic (1 to 3), slightly acidic (4 to 6), and acidic (7 to 9). Finally, it classifies the taste of silage products on three criteria: non-acidic (1 to 3), less acidic (4 to 6), and acidic (7 to 9) (McEllhiney, 1994). The collected data were analyzed by using analysis of variance (ANOVA) and further tested by Duncan's Multiple Ranged Test (DMRT) (Adinurani, 2016).

Results and Discussion

Physical characteristics of corn straw complete silage

Observation of physical characteristics (organoleptic test) silage includes texture, color, odor, and taste shown in Table 1.

Texture

The texture is one indicator to determine the physical quality of silage. Good silage texture is shown by the texture's characteristics that are not destroyed, not soft, not slimy, and still close to the original texture. For example, the treatment of various doses of probiotics and time of fermentation produced a medium texture (rather hard and not mushy) (Table 1).

In general, the results of observations on the characteristics of the complete silage texture of corn straw showed that the addition of the MOL probiotic additive at various doses and times of fermentation showed that the silage texture remained clear, not lumpy, not soft, and not slimy. Therefore, the quality of the silage texture produced is good, with the texture's characteristics still clear as before and not soft. Therefore, to test the quality of the complete feed silage texture, an assessment was made based on Table 2.

The average score of complete silage-based corn straw at various doses of MOL probiotics and fermentation time ranged from 4.78 to 5.67 (moderate quality). This shows that the complete fermentation of corn straw silage at various doses and fermentation times produced silage of moderate quality (slightly hard and not mushy). The results of this study differ from those of Subekti *et al.* (2013), who used various additives and lactic acid bacteria with soft texture observations; scores ranged from 2.67 to 3.00 (mushy). Kurniawan *et al.* (2015) stated that adding a starter affected the texture of agricultural waste. The denser the resulting texture indicates that the silage has a good quality.

The diversity analysis showed that the treatment of various doses and storage time had a very significant effect ($P < 0.01$) on the texture of corn straw silage, but there was no interaction between dose and fermentation time. Fermentation treatments with various doses of probiotics and storage time resulted in corn straw

Table 1: *Physical characteristics (organoleptic test) silage of corn straw.*

Treatment		Repeated	Tests of physical characteristics (organoleptic test)			
Doses probiotic	Fermentation time		Texture	Colors	Tastes	Odors
D1 (1 %)	L1 (7 d)	1	Moderate	Light brown	Not acid	Acid
		2	Moderate	Light brown	Not acid	Acid
		3	Moderate	Light brown	Not acid	Acid
	L2 (14)	1	Moderate	Brown	Less acid	Acid
		2	Moderate	Brown	Less acid	Acid
		3	Moderate	Brown	Less acid	Acid
	L3 (21 d)	1	Moderate	Dark brown	Acid	Acid
		2	Moderate	Dark brown	Acid	Acid
		3	Moderate	Dark brown	Acid	Acid
D2 (3 %)	L1 (7 d)	1	Moderate	Light brown	Not acid	Acid
		2	Moderate	Light brown	Not acid	Acid
		3	Moderate	Light brown	Not acid	Acid
	L2 (14 d)	1	Moderate	Brown	Acid	Acid
		2	Moderate	Brown	Acid	Acid
		3	Moderate	Brown	Acid	Acid
	L3 (21 d)	1	Moderate	Dark brown	Acid	Acid
		2	Moderate	Dark brown	Acid	Acid
		3	Moderate	Dark brown	Acid	Acid
D3 (5 %)	L1 (7 d)	1	Moderate	Light brown	Acid	Acid
		2	Moderate	Light brown	Acid	Acid
		3	Moderate	Light brown	Acid	Acid
	L2 (14 d)	1	Moderate	Brown	Acid	Acid
		2	Moderate	Brown	Acid	Acid
		3	Moderate	Brown	Acid	Acid
	L3 (21 d)	1	Moderate	Dark brown	Acid	Acid
		2	Moderate	Dark brown	Acid	Acid
		3	Moderate	Dark brown	Acid	Acid

Table 2: *Average score of complete silage-based texture at various doses and time of fermentation.*

Fermentation time	Doses probiotik			Average
	D1 (1 %)	D2 (3 %)	D3 (5 %)	
L1 (7 d)	5.67	6.00	5.33	5.67 [b]
L2 (14 d)	5.33	5.67	5.00	5.33 [b]
L3 (21 d)	4.67	5.33	4.33	4.78 [a]
Average	5.22 [ab]	5.67 [b]	4.89 [a]	5.26

Note: *Superscripts with different letter in row or column showed significant differences (P < 0.01).*

silage texture with a medium texture (not soft and not mushy).

Based on the score assessment, it can be seen that the higher the dose of probiotics in the fermentation, the softer the texture (the lower the score). It is suspected that with increasing dose, the microbial activity will be higher so that changing organic matter (complete compounds) takes place quickly. This condition affects the texture of the fermented substrate. Likewise, the longer the fermentation time, the softer the texture (the score decreases). This gives the microbes more time to degrade the existing organic matter to produce a soft texture.

The silage texture was medium (not soft and not hard) produced from the fermentation process at a dose of 3 % with an incubation time of 14 d. The quality of the resulting silage showed the best quality compared to other treatments. Based on texture observations, it was found that the physical quality of complete silage was best in the fermentation process at a dose of 3 % with an incubation time of 14 d. The physical quality of this silage describes the chemical quality. Adesogan

(2006) that good silage has a texture like fresh forage, not moldy, not slimy, does not clot, contains a lot of lactic acid, and no liquid is found at the bottom of the package.

Colors

Anaerobic fermentation (silage) can indicate the quality of the silage. The treatment of various doses of probiotics and the length of fermentation to the silage color of corn straw can be seen in Table 1. The colors obtained vary depending on the initial color of the filtered feed material. The color of silage results varies, but in general, the excellent quality of silage is shown by the silage colors close to the original color (color before fermentation). But naturally, the fermentation treatment will always cause physical changes such as discoloration.

Colors changes may occur due to several things: i) the process of respiration of the substrate tissue cells by utilizing oxygen in the silo (silage making place). This aerobic respiration remodels the substrate by producing CO_2, H_2O, and ATP (energy). The heat energy produced can increase the temperature, which causes the change of dyes from the substrate to become darker, ii) the color changes that occur due to the process of glycolysis, the breakdown of sugar molecules into pyruvic acid compounds, the oxidative decarboxylation process which converts pyruvic acid to acetyl Co-A then enters the Krebs cycle and produces oxaloacetate and citric acid. Finally, electron transport occurs in the mitochondria membrane with H_2O and energy. The resulting heat energy causes changes in the colors of the substrate, iii) The presence of heat and oxygen causes the oxidation of β-carotene from the substrate so that the carotenoid damage that causes color changes leads to a darker color, or iv) the occurrence of Maillard reaction, namely non-browning reaction enzymatic that occurs due to a reaction between reducing sugars and amen groups free of amino acids or protein substrates.

To test the colors quality of complete feed silage statistically, an assessment was carried out based on scores such as Table 3.

The average silage complete color score of corn straw was obtained in the range of 2.56 to 7.22 (dark brown to light brown). Silage colors scores were obtained from light brown (high score) to dark brown (low score). In general, good silage is silage whose color is close to its natural color (color before fermentation).

Table 3: *Average silage complete colors score of corn straw at various doses and time of fermentation.*

Fermentation time	Doses probiotik			Average
	D1 (1 %)	D2 (3 %)	D3 (5 %)	
L1 (7 d)	7.33	7.33	7.00	7.22 ^{c}
L2 (14 d)	5.33	5.67	5.67	5.56 ^{b}
L3 (21 d)	2.67	2.67	2.33	2.56 ^{a}
Average	5.11^{ns}	5.22 ^{ns}	5.00 ^{ns}	5.11

Note: *Superscripts with different letter in row showed significant differences (P < 0.01) and superscripts with different letter in column showed not significance (P > 0.05).*

The diversity analysis results showed that the dose of probiotics had no significant effect ($P > 0.05$) on the colors of the silage, and there was no interaction between the probiotic dose and the fermentation time. In contrast, the fermentation time had a very significant effect ($P < 0.01$) on the colors of fermentation.

Duncan's further tests showed that additives in the form of probiotics up to a dose of 5 % had no significant effect on the silage color of corn straw. Still, it appeared the 5 % probiotics showed a trend of higher color change than other treatments. Allegedly the activity of microbes (probiotics) from the treatment of D3 (5 % probiotics) is higher in degrading the substrate to produce amine groups free of amino acids or high protein substrates. A high free amine group reacts with reducing sugars to form a Maillard reaction. The Maillard reaction is a non-enzymatic browning reaction where the D3 treatment has a higher trend than the D1 and D2 treatments.

Further test results showed the more extended the fermentation time, the more significant color changes occurred ($P < 0.01$). The colors change at 21 d of fermentation (L3) is much greater than 7 d of fermentation (L1) and 14 d of fermentation (L2). This is due to the process of aerobic respiration that lasts longer, with the final result in the form of H_2O and energy. High heat energy produced causes a higher color change than other treatments. Colors changes that occur due to forage are still undergoing the process of ensilage caused by the process of aerobic respiration that takes place while oxygen is still available.

Prabowo *et al*. (2013) state that the color change that

occurs in plants undergoing the ensilage process is caused by the process of aerobic respiration that takes place while oxygen is still available until the sugar in the plant runs out. Sugar will be oxidized to CO_2 and water, and heat is also produced in this process, so the temperature rises. The temperature that can not be controlled will cause silage dark brown to black. This causes a decrease in the nutritional value of feed because many carbohydrate sources are lost, and protein digestibility decreases. Gonzalez *et al.* (2007) stated that the high-temperature factor during the ensilation process could cause changes in the color of the silage.

At 7 d, the silage colors fermentation produced is still close to their natural color. This happens because the silage temperature has not experienced a high increase so that the dyes on the substrate do not experience significant changes. But at 14 d silage colors, fermentation becomes brown. The colors changes to brown due to the condition of the silo, which is less dense, so a lot of air is trapped in the silo, which eventually causes aerobic respiration to run long enough. Furthermore, on 21 d, the silage fermentation tends to be dark brown (blackish brown). This can occur because the high oxygen in the silo causes a long respiration process; the sugar will be oxidized to CO_2, water, and heat. This process increases the temperature of the substrate. The uncontrolled temperature will cause silage brown, dark brown to black.

Based on the color, it seems that the quality of fermented corn straw for up to 14 d is still of good quality. If the aerobic process runs fast, the degradation of carbohydrates can be reduced, and oxidation of sugar to CO_2 and less water. This condition can reduce the temperature rise that causes the silage color change is not much different from the previous color. Unlike the case with 21 d fermenters where the aerobic process runs longer and longer, and oxidation runs fast, the temperature rises, high-temperature changes occur cause carotene changes to produce a dark brown color. This condition will have a silage color that is not good. This process can be prevented if the compaction is carried out perfectly at the beginning of the processing.

This corn straw silage contains 70 % forage corn. Corn straw contains dyes (pigments) such as chlorophyll, carotenoids (carotene, lycopene, xanthophyll), and flavonoids (flavones, flavonols, and anthocyanins). The carotenoids are yellow or orange. The flavonoids are orange or red. During the fermentation process, silage color changes because the pigment of the substrate is affected by the temperature or heat of the surrounding environment. At harvest time, chlorophyll production decreases (stops), and chlorophyll is degraded, then other pigments in the leaves begin to appear.

Table 4: *Average score of complete silage odor at various doses and time of fermentation.*

Fermentation time	Doses probiotik			Average
	D1 (1 %)	D2 (3 %)	D3 (5 %)	
L1 (7 d)	2.67 [a]	5.67 [b]	7.67 [c]	5.34
L2 (14 d)	3.00 [a]	8.67 [d]	8.33 [d]	6.67
L3 (21 d)	7.67 [c]	8.67 [d]	8.67 [d]	8.34
Average	4.45	7.67	8.22	

Note: *Superscripts with different letter in column showed significant differences (P < 0.05)*

The corn straw used has started to turn yellow. The yellow color occurs because of the content of carotenoid pigments in the leaves. Changes in temperature during fermentation cause the carotenoid pigments to decrease, and when all the pigments are degraded, the leaves will turn brown due to the remaining tannin pigments.

Odor

Complete silage fermentation of corn straw at various doses of MOL and duration of fermentation produced various odors, namely not sour (slight odor), less acidic, and sour (Table 1). For example, silage with a dose of 1 % probiotic (D1) and three probiotics (D2) at 7 d of fermentation (L1) produced a non-sour odor (slightly odor). It is suspected that the dose of 3 % MOL at the corn straw ensilage stage is less able to utilize dissolved carbohydrates so that it affects the speed of fermentation to form lactic acid. Consequently, the silage produced at 7 d of fermentation was not acidic. In addition, the addition of additives to the substrate in the form of urea is not utilized optimally by microbes. This causes the content of NH_3 (ammonia) in the ensilage to be high so that the silage on the 7th d of fermentation has a slight odor.

To see the effect of various doses of probiotics and the duration of fermentation on odor, a statistical test was conducted by first determining the odor score of silage (Tabel 4).

Analysis of diversity showed that the dose of probiotics and duration of fermentation had a very significant effect ($P < 0.01$) on the odor of silage. There is an interaction between the dose of probiotics with the length of fermentation. The average aroma of fermented corn straw silage ranged from 4.45 to 8.34 (slightly sour to sour). Based on this score, the silage quality was quite good, especially after 14 d of fermentation. The quality of the resulting silage depends on the speed of fermentation to form organic acids such as lactic acid. Lactic acid production produces a fresh sour smell. McEllhiney (1994) classified the odor of silage products according to three criteria: non-acid (2 to 3), slightly acidic (4 to 6), and acidic (7 to 9).

The odor changes to become more acidic as the pH of the silage decreases. The resulting sour smell is caused by making anaerobic bacteria actively work to produce organic acids. The addition of starters in the manufacture of agricultural waste silage causes a change in the aroma to become more acidic. According to Kurniawan *et al.* (2015), the results of aerobic reactions that occur in the early phase of silage fermentation produce volatile fatty acids so that the addition of a fermentation starter will accelerate the acidic atmosphere.

The treatment with the addition of a starter gave a distinctive smell of silage, meaning that the ensilage process was running perfectly. A change in the aroma characterizes it. The odor produced in each treatment was close to the typical silage/sour odor.

Taste

Complete silage based on corn straw at various doses of probiotics and fermentation time produces a fresh sour taste (Table 1). Therefore, to test the quality of complete silage taste of corn straw was assessed based on the score (Table 5).

The results of the analysis of diversity showed that the dose of probiotics and duration of fermentation had a significant effect ($P < 0.05$) on the taste of silage, and there was no interaction between the dose of probiotics and the length of fermentation. The fermentation process produces organic acids such as lactic acid, acetic acid, and others. The resulting acetic acid gives a sour or sour taste from moderate to very sour. The higher the dose of probiotics and the longer the fermentation process, the more acidic corn straw silage. From the results obtained, it can be seen that corn straw silage fermented for 14 d and at a dose of 3 % can be used as animal feed.

Table 5: *Average scores of complete silage tastes of corn straw at various doses and time of fermentation.*

Fermentation Time	Doses Probiotik			Average
	D1 (1 %)	D2 (3 %)	D3 (5 %)	
L1 (7 d)	7.33	7.33	7.67	7.44 [a]
L2 (14 d)	7.33	8.33	8.33	8.00 [ab]
L3 (21 d)	7.67	8.33	8.67	8.22 [b]
Average	7.44 [a]	8.00 [ab]	8.22 [b]	7.89

Note: *Superscripts with different letter in row or column showed significant differences (P < 0.05).*

The physical quality of this fermented product can describe its nutritional quality. The best physical quality of complete corn wastes fermentation at a dose of 3 % MOL and an incubation period of 14 d, namely medium texture (not hard), brown color, sour aroma, and sour taste. These results are in line with the analysis of the chemical content of complete fermented corn waste at a dose of 3 %, and incubation for 14 d can increase protein content from 11.41 % to 21.21 %, reducing crude fiber content from 28.21 % to 24.32 %. Digestibility test in sheep by giving up to 80 % showed dry matter digestibility of 53.64 % and organic matter digestibility of 68.44 %. The results generally show a correlation between the physical quality of the fermented product and the chemical quality (nutrition) of a feed ingredient.

Conclusions and Recommendations

The use of various MOL doses and fermentation time affects the physical characteristics of corn straw silage (texture, colors, odor, and taste). There is an interaction between the MOL doses with the fermentation time on odor, and there is no interaction with the texture, color, and taste of corn straw silage. Corn straw fermentation with MOL at a dose of 3 % for 14 d can improve the physical quality of corn straw silage.

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Novelty Statement

Corn straw silage is a fermented product that is generally carried out spontaneously without microbial inoculum silage is produced to increase shelf life. However, in this study, corn straw fermentation was carried out with the addition of concentrate and microbial inoculum in the form of MOL so that the silage product produced in addition to increasing the nutritional content also increased shelf life.

Author's Contribution

YY: Conceptualized and designed the study, elaborated the intellectual content, and performed the literature search, data acquisition, statistical analysis and manuscript preparation.
NG: Carried out experimental studies performed the literature search and data acquisition.
THW: Analysed data and reviewed manuscript.
MZ and AW: Elaborated the intellectual content performed the literature search, reviewed manuscript and guarantor.
NF: Performed the literature search and data acquisition
All authors read and approved the final manuscript

Conflict of interest
The authors have declared no conflict of interest.

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