Physicall Quality, and Nutrient Content of Corn Straw Silage with Different Fermentation Time

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Abstract. The study aimed to determine the acidity (pH), physicall quality, and nutrient content of corn straw silage with different time fermentation. The experiments use a completely randomized design (CRD) with four treatments and each treatment was repeated five times, so there are 20 experimental units. The fourth treatments are W1 = 14 days fermentation, W2 = 21 days fermentation, W3 = 28 days fermentation, and W4 = 35 days fermentation. The parameters observed in this study are the acidity, physical quality (fungus, texture, color, aroma) and the nutrient content (dry matter (DM), organic matter (OM), ether extract (EE), crude fiber (CF), crude protein (CP), ash). Results of the experiment showed that the acidity (pH) silage of corn straw silage tended to decrease with the increasing of period fermentation, whereas from the physical of quality: fungus belonging to good criteria; texture, color and aroma showed good medium values and showed no significant difference with increasing of fermentation period. There was no significant difference in organic matter, crude fiber, and crude protein until 5 weeks of fermentation period, whereas there was significant difference in dry matter, crude fat, NFE, and TDN from 21-35 days fermentation. It can be concluded that physically of quality and nutrient content are not significant different.

Keywords : ***corn straw silage, pH, physical quality, nutrient content, fermentation period***

I. INTRODUCTION

Ruminants are belonging to herbivorous livestock where the main feed is forage that used as a source of energy as well as a source of primary protein beside concentrate as additional feed. Forage given to ruminant can be either fresh forage or preserved forage. Farmers generally provide fresh forage such as grass both local and introduce grass, and foliage. In the dry season the availability of forages is generally limited so that is needed alternative way for forage could available throughout the year.

Agricultural crop waste is one alternative that can be utilized as a source of forage feed, especially when the production is abundant. Corn straw is one of the potential waste as a source of fiber in ruminant feed. Corn waste that can be used as animal feed is the leaves, stems, corncob and cornhusk.

In general, agricultural crop waste including corn crop wastes when given to livestock or ruminant have a low nutrient content due to high crude fiber content otherwise low in protein content. Limitations of corn crop waste as animal feed can be done by doing the preservation process, so it can be stored in a longer period of time, and with the addition of additives will be able to increase the nutritional content. Yuniarsih and Nappu (2013) stated that the quality of corn straw as animal feed can be enhanced with silage technology that is fermentation process which is assisted microorganism in anaerob condition (without oxygen).

Silage that formed by fermentation process can be stored for long periods of time without much reducing the nutritional content of the raw material. The main purpose of silage making is to maximize the preservation of nutrient content in forage or other animal feed ingredients, can be stored for long periods of time, and to be given as feed for livestock, especially to overcome difficulties in obtaining feed forage in the dry season (Yusriani, 2015).

Kurniawan et al. (2015) adding various starter to make ration based on agriculture waste found that addition of 4% EM-4 starter and rumen fluid affect the color, texture, and pH, and have a significant effect on the aroma of silage. Colors that resemble their original color with the addition of EM-4 4% and the best aroma is resulted at the addition of 4% EM-4 starter and rumen fluids treatment with a rather distinctive aroma of silage close to typical silage, whereas in texture, the same texture as the original texture (without treatment) on the addition of 4% EM-4 starter with the resulting texture

rather dry. The best pH of silage was resulted on feed silage by addition of EM-4 starter and rumen fluid.

Based on the above description, it is necessary to research about the physical quality and nutrient content of the fermented corn straw that is fermented in different time period so it can be given to ruminants.

II. RESEARCH METHODS

The materials used in making corn straw silage are corn straw and additives are pollard and molasses with material composition 100% corn straw + 10% pollard + 10% molases (Trisnadewi et al. 2016). Tools used include knives for cutting corn straw, board as cutting pad, plastic sheet / tarpaulin to mix silage, and plastic bag + jar with cover as silo.

Corn straw is cut into 3-5 cm sizes and above it is sprinkled 10% pollard and 10% molasses of total corn straw weight. Mix the pieces of corn straw with pollard and molasses evenly, then put in a plastic bag, pressed and compressed until there is no air in the plastic bag to create anaerobic condition. Next, the plastic bag is tightly tied and put into the closed jar. The jar cover is also sealed with insulation and kept in a cool place and not exposed to the sun.

pH measurements using Naumann and Bassler procedures (1997). A total of 10 g of silage was mixed with 100 ml of aquadest, crushed with blender for 1 minute at 4,000 rpm. After that, it was measured with a pH meter that had been calibrated with standard solution (pH 4 and pH 7) by pH meter inserted into the sample and pH reading after 30 seconds (stable).

The physical quality of the corn straw silage include fungus, texture, color, and the aroma of the corn straw silage carried out by a panelist conducting an assessment of the corn straw silage according to the observed variables.

Laboratory analysis was performed according to treatment after fermentation lasted for 14, 21, 28, and 35 days.

The design used in this study was a complete randomized design (RAL) with four treatments and five replications, so that there were 20 experimental units. The four treatments are W1 = fermentation for 14 days, W2 = fermentation for 21 days, W3 = fermentation for 28 days, and W4 = fermentation for 35 days.

The variables observed in this study were pH (acidity degree); physical quality i.e: fungus, texture, color and aroma; nutritient quality: dry matter, organic matter, ash, crude protein, crude protein, crude fiber, ether extract, nitrogen free extract (NFE), and total digestible nutrient (TDN) of corn straw silage. The data obtained in this study were analyzed using analysis of variance, if the mean value of treatment had significant effect on the variables followed by Duncan test at 5% level (Steel and Torrie, 1991).

III. RESULT AND ANALYSIS

The Result

The highest pH value (acidity level) found in silage for 14 days fermentation (W1) treatment that was 4,022 and significantly ($P<0.05$) higher than 21 days fermentation (W2), 28 days fermentation (W3), and 35 days fermentation (W4) treatment, respectively 5.87%, 11.04%, and 7.68% (Table 1). The pH value of the corn straw silage between W2 and W4 treatments showed not significant difference ($P>0.05$), whereas W2 was 5.54% lower ($P<0.05$) compared with W3 treatment.

Assessment of physical quality include fungus, texture, color and aroma. The fungi present in corn straw silage showed not significant difference ($P>0.05$) among all treatments of fermentation with different period, either W1, W2, W3, and W4. Fungal on fermentation with different period indicate a small amount of fungus (Table 1).

The texture of corn straw silage showed significant difference ($P<0.05$) between W1 treatment with W2, W3, and W4 treatment. The treatment of W1 with 14 days fermentation treatment showed less smooth texture and significantly different ($P<0.05$) with W2, W3, and W4 treatments which showing slightly texture (Table 1).

The color of the corn straw silage with different period of fermentation showed not significant difference ($P>0.05$) between W1, W2, W3, and W4 treatments. The colors are yellow (W4) to slightly brownish (W1, W2, and W3) (Table 1).

TABEL I
pH AND PHYSICAL QUALITY OF CORN STRAW SILAGE IN DIFFERENT PERIOD OF FERMENTATION

Variables	Treatments[1)]				SEM[2)]
	W1	W2	W3	W4	
pH	4.02 a	3.79 b	3.58 c	3.71 b	0.037
Fungus	2.00 a	2.00 a	2.20 a	1.80 a	0.141
Texture	3.00 a	2.00 b	2.00 b	2.00 b	0.122
Color	2.40 a	2.40 a	2.40 a	2.00 a	0.265
Aroma	2.20 a	1.80 a	2.40 a	2.20 a	0.212

Note:
Treatments[1)]:
W1 = fermentation for 14 days
W2 = fermentation for 21 days
W3 = fermentation for 28 days
W4 = fermentation for 35 days
SEM[2)] = Standard Error of the Treatment Means

Silage of corn straw silage showed no significant difference (P>0.05) between all fermentation treatments with different periods in W1, W2, W3, and W4. The aroma of corn straw silage is classified as acid (Table 1).

The dry matter content of corn straw silage on treatment W1, W2, W3, and W4 showed significant difference (P<0.05) among all treatments. The dry matter content on W1 treatment was 93.52% and significantly higher (P<0.05) than W2, W3, and W4 treatment respectively 3.23%, 5.45%, and 8.00% (Table 2). W3 and W4 treatment were 2.29% and 4.93% significantly lower (P<0.05) than W2 treatment, respectively. W3 treatment was 2.69% higher than W4 treatment (Table 2).

The organic matter content of corn straw silage showed no significant difference (P>0.05) in all treatments with different period of fermentation. The highest organic matter was 90.34% in W3 treatment while the treatment of W1, W2, and W4 were respectively 0.65%, 0.56% and 0.64% (P>0.05) (Table 2).

The highest ash content was 10.25% in W1 treatment, while the treatment of W2, W3 and W4 were 0.78%, 5.76%, 0.10% were not significantly lower (P>0.05) compared with W1 treatment (Table 2).

The highest mean of crude protein content of corn straw silage was 13.12% in W4 treatment. The treatment of W1, W2, and W3 were 4.73%, 11.05%, 15.46% respectively higher than W1 but statistically not significant different (P>0.05) (Table 2).

The highest mean crude fiber content in the four weeks storage period (W3) was 42.81% while the W1, W2, and W4 treatments were 16.56%, 7.71%, and 5.21% respectively but statistically not significant difference (P>0.05) (Table 2).

The highest ether extract content in different fermentation periods showed no significant difference (P>0.05) among all treatments. The treatment of W2 showed the highest ether extract content of 12.21% while the W1, W3, and W4 treatments were 3.28%, 14.91%, and 22.60%, respectively (P>0.05) (Table 2).

Nitrogen free extract (NFE) was 23,20% in W1 treatment showed the highest percentage while W2, W3, and W4 treatment were 27.03%, 37.67%, and 45.47% (P<0.05) lower compared with W1 treatment (Table 2).

The highest total digestible nutrient (TDN) in W1 treatment was 54.84%, W1 treatment was 4.29% higher (P>0.05) than W2 treatment, while with W3 and W4 treatment were 23.85% and 9.35% significant (P>0.05) higher. Between W2 and W4 treatment showed no significant difference (P>0.05) (Table 2).

The analysis

The highest pH (acidity) values was 4,022 in W1 treatment and significantly (P<0.05) higher than W2, W3 and W4 treatment 5.87%, 11.04%, and 7.68%, respectively. According to Departemen Pertanian (1980) the pH silage assessment score of 1 = 3.2 - 4.2; 2 = 4.2 - 4.5; 3 = 4,5 - 4,8; and 4 = >4.48. The pH value of the corn straw silage ranged from 3.58 to 4.02 and included in excellent criteria (3.5-4.2). In general, the results of the study showed a decrease in pH value when compared with 14 days fermentation period (W1) with increasing fermentation period of corn straw silage both in W2, W3, and W4 treatment. Decreased pH is closely related to the formation of acids during the fermentation process. According to Elferink et al. (2000) silage is a process of preserving fresh forage feed under anaerobic conditions with the formation or addition of acids. The acids formed are organic acids such as lactate, acetate, and butyric acid as the result of fermentation of dissolved carbohydrate by bacteria, causing a decrease of acidity (pH). The decrease in pH value caused the growth of decomposing microorganisms will be obstructed. Furthermore, Fariani and Akhadiarto (2012) stated that the ensilase activity carried out by lactic acid bacteria will cause the pH to be low. Lactic acid bacteria will break up the carbohydrate substrate into lactic acid so that the pH becomes low.

Physical assessment results showed no significant difference (P>0.05) to the number of fungus in all treatments, either fermentation in the period of 14, 21,28, and 35 days (W1, W2, W3, and W4) with a range of values 2.00 - 2.20. Criteria for fungus assesment with a score 1 - 4 are: 1 = no fungus, 2 = little, 3 = more, 4 = many, so the results belonging slightly contaminated fungus criteria and good classified (Departemen Pertanian, 1980). Silage technology is a fermentation process that assisted microorganisms in anaerobic conditions or without oxygen (Yuniarsih and Nappu, 2013). The presence of fungus on corn straw silage of the research although in relatively small number, it

TABEL II
THE NUTRIENT CONTENT OF CORN STRAW SILAGE WITH DIFFERENT PERIOD OF FERMENTATION

Variables	Treatments[1)]				SEM[2)]
	W1	W2	W3	W4	
Dry matter (%)	93.52 [a]	90.50 [b]	88.42 [c]	86.04 [d]	0.224
Organic matter (%)	89.75 [a]	89.83 [a]	90.34 [a]	89.76 [a]	0.240
Ash (%)	10.25 [a]	10.17 [a]	9.66 [a]	10.24 [a]	0.240
Crude protein (%)	12.50 [a]	11.67 [a]	11.09 [a]	13.12 [a]	0.578
Crude fiber (%)	35.72 [a]	39.51 [a]	42.81 [a]	40.58 [a]	1.743
Ether extract (%)	11.81 [a]	12.21 [a]	10.39 [b]	9.45 [b]	0.361
Nitrogen free extract(%)	23.20 [a]	16.93[b]	14.46 [b]	12.65 [b]	1.777
Total Digestible Nutrient (%)	54.84 [a]	52.49 [ab]	41.76 [c]	49.71 [b]	1.431

Note:
Treatments[1)]:
W1 = fermentation for 14 days
W2 = fermentation for 21 days
W3 = fermentation for 28 days
W4 = fermentation for 35 days
SEM[2)] = Standard Error of the Treatment Means

possibilities caused by the silo bond less strong so it still allows the outside air into the silo. According to Fariani and Akhadiarto (2012) that the longer the fermentation the more fungus grow. This is related to the production of lactic acid produced by lactic acid bacteria getting smaller so that allow the fungus to grow. Besides, the growth of fungus is also associated with silage moisture and wet conditions of silage so that enable the growth of fungus.

The color of the corn straw silage with different fermentation period showed no significant difference ($P>0.05$) between W1, W2, W3, and W4 treatments. According to Department Pertanian (1980) silage color criteria score are: 1 = yellowish green, 2 = yellow, 3 = brownish, 4 = blackish brown. The color of corn straw silage experiment is yellow in W4 treatment until slightly browned on treatment W1, W2, and W3, and classified as a good criteria. Reksohadiprodjo (1988) states that the color changes that occur in plants undergoing the process of ensilase are caused by changes that occur in the plant because of the aerobic respiration process that lasts for the supply of oxygen is still exist, until the sugar plant runs out.

The texture of corn straw silage showed significant difference ($P<0.05$) between W1 treatment with W2, W3, and W4 treatment. The W1 treatment with 14 days fermentation period showed less smooth texture and significantly different ($P<0.05$) compared with W2, W3 and W4 treatments showing slightly smooth texture. The criteria for silage texture assessment are 1 = fine, 2 = slightly smooth, 3 = less subtle, 4 = coarse (Departemen Pertanian, 1980), and are classified as good to medium criteria.

Silage of corn straw showed no significant different aroma ($P>0.05$) among all treatments with different fermentation period in W1, W2, W3, and W4. The smell of silage corn straw is acidic to less acid. Score of silage aroma score consecutively: 1 = very acid, 2 = acid, 3 = less acid, 4 = rotten (Departemen Pertanian, 1980). The acidic aroma may also due to pollard and molasses additives that can be used as an energy source for the growth of bacteria producing lactic acid during the fermentation. According to Hidayat (2014), the changes pattern of increasingly acidic aroma is certainly in line with the lower pH silage. The results showed that observation in day 14 and day 28 the use of molasses more acid than the use of rice bran or cassava cake. Furthermore, Fariani and Akhadiarto (2012) stated that the quality of silage can be seen from the shape, color and aroma of silage. In good silage there is no or very little damage, not moldy and not sticky, green, acidic, and no rotten smell.

The dry matter content of W1, W2, W3, and W4 treatment is decreasing significantly. This indicates that storage duration or fermentation period significant influences the existence of dry matter degradation. The dry matter content on W4 treatment was significantly lower than other treatments (W1, W2, and W3). The falling dry matter content is probably due to the fermentation process using pollard and molasses that used by microorganisms as a source of energy during the ensilase. process of corn straw. The fermentation activity by microorganisms produced lactic acid so that the content of dry matter of corn straw silage decreased. According McDonald (1981) during the ensilase process is in progresses, there is a decrease of dry matter and the increase of water content caused by respiration is still ongoing where glucose is converted to CO_2, H_2O, and heat.

The organic matter content of all treatments with different period of fermentation are not significant different, this indicates that the time storage or fermentation period of W1, W2, W3, and W4 has no significant effect on the organic matter content. Organic matter is a part of dry matter where the main ingredient is derived from carbohydrate group that is nitrogen free extract consisting of cellulose, hemicellulose lignin, fructan sugar, starch, organic acid, resin, tannin, pigment, and soluble vitamin. The starch and sugar components are used by bacteria to produce lactic acid.

The crude protein content between W1, W2, W3, and W4 treatments showed no significant difference. The results of this study are in line with Jaelani et al. (2014) who found that long storage of palm leaf silage (21, 28, 35, 42, and 48 days) had no significant effect on protein content. The longer the stored silage changes the value of different crude protein levels. This is because in silage process the degree of acidity will be increased so that the activities of bacteria obstructed or stopped.

The crude fiber content in W1 treatment is 35.72% showed increase in W2 and W3 treatment but in W4 treatment going decreased but not significantly different in all treatments. The results of this study have the same tendency (increased starting on a storage period of 14-28 days, then decreasing on day 35) with Jaelani et al. (2014) where the increase of crude fiber content occurs in 21-35 days of silage duration storage, but after that there is a decrease in 42 and 49 days. Probably, this is because at a sufficient level of glucose, the alcohol forming microbes begin to activate, so that alcohol levels rise, at high alcohol levels, microbes that hydrolyze silage become inactive, consequently the amount of carbohydrates is not reduced. Meanwhile, the microbial biomass formed since the beginning of time is more accumulates, so that the increase of crude fiber occurs because the carbohydrates are no longer hydrolyzed, and the microbial biomass continues increased.

This suggests that if corn straw silage will use in the beginning so it could give to ruminant in 14 days fermentation but if corn straw silage will storage for longer period (35 days), it will not affect to the crude protein and crude fiber content of corn straw silage.

The content ether extract of corn straw silage tended to decrease with increasing length of fermentation period

but did not significant different (P>0.05). This is probably because the material used to make corn straw silage contains low of ether extract where the corn straw, pollard, and molasses contain ether extract respectively 1.25% (Badan Pengkajian dan Penerapan Pertanian Sumatera Barat, 2011), 4.06% and 0.9% (Hartadi et al., 1986).

The content of nitrogen free extract (NFE) of corn straw silage decreased significantly (P<0.05) in 21 - 35 days fermentation period compared to 14 days fermentation. NFE is obtained from the formula of 100 minus water, ash, crude protein, ether extract, and crude fiber content (NFE = 100 - (water - ash - crude protein - ether extract - crude fiber)) so that the NFE content of feedstuff is highly dependent on other components, such as ash, crude protein, crude fiber and ether extract. According to Syahrir et al. (2014) NFE is an easily fermented nutrient fraction and will rapidly hydrolyze in fermentation process therefore the fermentation process will always reduce the NFE levels in fermentation of medium. Sari et al. 2015) stated that during storage, microorganisms digest degradable materials such as carbohydrates, where carbohydrates are the main components that contained of NFE and becomes the first microorganism feed.

Total digestible nutrient (TDN) of corn straw silage decreased significantly (P<0.05) with increasing length of fermentation period. The decreased TDN content is due to the lower crude fat content of corn straw silage with increasing fermentation period. Rasby and Martin (2017) states that TDN is the number of components of fiber, protein, lipids and carbohydrates that are easily digested from feedstuffs. TDN is directly related to the digestible energy and is often calculated based on the ADF.

IV. CONCLUSIONS

Based on the result of the experiment, it can be concluded that pH silage of corn straw tends to decrease with increasing of fermentation period (14, 21, 28, and 35 days), whereas from physical quality that is fungus belongs to good criteria, while texture, color and aroma show good to medium criteria and no significant difference with increasing fermentation period. There was no significant difference in organic matter, crude fiber, and crude protein until 35 days of fermentation, whereas there were significant differences in dry matter, ether extract, NFE, and TDN from 21-35 days fermentation period.

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