International Journal of Environment, Agriculture and Biotechnology
Vol-7, Issue-6; Nov-Dec, 2022

Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Peer Reviewed

Effect of Corn Waste Fermentation as Livestock Feed on Fiber Fraction Content

Yelsi Listiana Dewi[1*], Abdi Ismail[2], Muh. Akramullah[1], Gomera Bouk[1], Yohana Kamlasi[1,] Maria Kristina Sinabang[1], Daniel Candido Da Costa Soares[3]

[1]Livestock Cultivation Study Program, Faculty of Military Logistics, Indonesian Defense University, Belu, Indonesia
[2]Ship Engineering Study Program, Faculty of Military Logistics, Indonesian Defense University, Belu, Indonesia
[3]Fish Cultivation Study Program, Faculty of Military Logistics, Indonesian Defense University, Belu, Indonesia
*Corresponding Author

Received: 04 Nov 2022; Received in revised form: 28 Nov 2022; Accepted: 03 Dec 2022; Available online: 11 Dec 2022

Abstract— *Corn straw and cob are wastes from corn farming which are not utilized. These corn wastes have potential as an alternative feed for livestock, but have low nutritional quality. Therefore, these corn wastes are fermented to improve its nutritional quality. The purpose of this study was to analyze the effect of corn straw and cob fermentation on the fiber fraction content. This experiment used a completely randomized design with 6 treatments, namely control (elephant grass and grinting grass), corn straw, fermented corn straw, corn cob, and fermented corn cob. Each treatment was repeated 5 times. The variables measured were Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), hemicellulose, cellulose, and lignin. The results showed that the treatment had a very significant effect on the content of NDF, ADF, hemicellulose, cellulose, and lignin. Based on the results of this experiment, it can be concluded that corn cob fermentation can reduce lignin content thus corn cob lignin content can match elephant grass but on the contrary corn straw fermentation cannot be able to reduce lignin content.*

Keywords— ***Fermentation, fiber fraction, straw and corn cob, lignin***

I. INTRODUCTION

Indonesia has a tropical climate with two seasons, namely rainy and dry season. East Nusa Tenggara (NTT) is one of the provinces in Indonesia which is located in the eastern part of Indonesia. The difference between this province and other provinces is that the dry season in NTT is longer than the rainy season. From June to September, the wind flows from Australia not containing much moisture thus causes dry season. On the other hand, from December to March, wind flows originating from Asia and the Pacific Ocean contain a lot of water vapor, resulting in the rainy season. This causes an eight-month dry season and a four-month rainy season in NTT. Based on rainfall and the number of rainy days, NTT region has low rainfall and short rainy days (BPS, 2022a). This condition affects the NTT existing agricultural system, including Belu Regency. This causes limited forage availability for animal feed because it is available in abundance during the rainy season while the dry season causes the dry land thus forage is also limited.

The limited feed availability in the dry season makes it difficult for stock farmers to provide animal feed. In addition, livestock that are grazed or shepherded can only eat dry grass which has low nutritional quality. Therefore, livestock lack feed quantity and quality during the dry season. Livestock condition during long dry season shows that feed consumed by livestock is only used for survival, not for increasing livestock production.

Corn is an NTT leading agricultural commodity. In 2021, corn agricultural land area in NTT reached 290.664 ha with 750,166 tons corn production (BPS, 2022b). Corn farming produces waste such as corn straw and cob, where

these by-products are not utilized by the community. Therefore, after corn main product is obtained, these by-products are then burned, however corn straw and cob can be used as livestock alternative or additional feed. Corn straw and cob still contain enough nutrition to meet livestock needs. However, these corn straw and corncob have a low palatability or preference level for livestock because corn straw and cob taste and color are not liked by livestock.

Moreover, corn straw and cob contain high lignin level. According to Sun and Cheng (2002), corn cob contains 45% cellulose, 35% hemicellulose and 15% lignin, and have low nutritional value and degradation. Lignin can inhibit the cellulose and hemicellulose material degradation in the rumen (Carrillo et al. 2004; van Kuijk et al. 2015). To improve corn straw and cob quality and reduce their environmental impact, microbial fermentation is the most effective way in dealing with these problems (Villas-Boas et al. 2002; Basu et al. 2002; Shrivastava et al. 2011).

Corn straw and cob nutritional value quality can be improved through fermentation using EM4 (Effective Microorganism). EM4 contains fermented and synthetic microorganisms consisting of lactic acid bacteria *(Lactobacillus* sp.), photosynthetic bacteria (*Rhodopseudomonas* sp.), *Actinomycetes* sp., *Streptomyces* sp., yeast and cellulose-degrading fungi (EM Indonesia.com, 2022). EM4 can degrade crude fiber content because it produces cellulase and ligninase enzymes. These enzymes are produced by the microbes contained in it, primarily Lactobacillus and Actinimycetes bacteria (Santoso and Aryani, 2007), the use of EM4 as feed fermentation inoculum can improve feed nutritional quality and palatability for livestock. Moreover, EM4 can preserve fermented feed and the feed can then be stored as dry season backup feed for a long time. Therefore, this study was conducted to analyze corn straw and cob fermentation effect on the fiber fraction content.

II. MATERIALS AND METHODS

Fermented Corn Straw and Cob Sample Preparation

Elephant grass (*Pennisetum purpureum*), grinting grass (*Cynodon dactylon*), corn straw and cob were obtained from the area around Belu Regency, East Nusa Tenggara. Sample collection of the experiment used Simple Random Sampling method, namely random sampling, the samples were then composited into one. All parts of elephant grass and grinting grass were used except the roots. This corn straw was an old corn plant where the corn fruit has been taken. Corn cob are part of the corn fruit where corn husk and seed have been taken. After the corn straw, corn cob, elephant grass, and grinting grass have been collected, then these were placed in a sack and brought to the Animal Husbandry Unit of the Haliken Nenuk SVD Mission, Atambua, Belu Regency, East Nusa Tenggara.

Corn Straw and Cob Fermentation

The fermentation process conducted in this study is solid fermentation. The fermentation method used is feed ingredient fermentation method conducted by the Animal Husbandry Unit of SVD Haliklen Nenuk Mission, Atambua, Belu Regency, East Nusa Tenggara. The inoculum was prepared prior to fermentation, by mixing 20 ml of EM4, 40 ml of molasses, and 30 ml of water. Next, 1 kg of corn straw and cob was prepared. Then, the prepared inoculum was sprayed using a sprayer onto the corn straw and cob evenly. After that, rice bran was sprinkled as much as 100 g evenly. When finished, the processed corn straw or cob were placed in a plastic bag and tightly sealed. This fermentation process occurred for 3 weeks.

Sample Preparation and Analysis

After corn straw and cob were processed by fermentation methods then each of these was dried and ground into powder. These powders were ready to be analyzed for NDF (Neutral Detergent Fifer), ADF (Acid Detergent Fiber), Cellulose, and Hemicellulose content.

Parameters

NDF (Neutral Detergent Fifer), ADF (Acid Detergent Fiber), Cellulose, and Hemicellulose were analyzed using the method of Van Soest (1982).

Data analysis

This experiment was conducted using a completely randomized block design with six treatments containing two control groups (elephant grass and grinting grass), and four treatment groups (unfermented corn straw, fermented corn straw, unfermented corn cob, and fermented corn cob). Each treatment group has five replicates. Data were analyzed using analysis of variance utilizing the WPS Excel-Statistics 2022 software (version 11.2.0.11254) for a completely randomized design. Before analysis, all percentages were logarithmically transformed log10 x + 1 to normalize data distribution. Mean values for each treatment were further tested by Duncan Multiple Range Test (DMRT), and the significance was declared when $p < 0.05$.

III. RESULTS AND DISCUSSIONS

Fiber Fraction Content

The average fiber fraction content consisting of NDF, ADF, hemicellulose, cellulose, and lignin from elephant

grass, grinting grass, corn straw, fermented corn straw, corn cob, and fermented corn cob is shown in Table 1.

Table 1. Average Fiber Fraction Content (%)

Forage	NDF	ADF	Hemicellulose	Cellulosa	Lignin
Elephant grass	81,36^{c}	48,41^{b}	32,95^{c}	33,17^{c}	12,23^{c}
Grinting grass	82,33^{c}	48,38^{b}	33,95^{c}	31,06^{d}	13,23^{bc}
Corn straw	82,73^{c}	57,93^{a}	24,80^{d}	40,53^{a}	13,35^{bc}
Fermented corn straw	83,15^{c}	59,98^{a}	23,17^{d}	36,16^{b}	20,24^{a}
Corn cob	91,29^{a}	46,98^{b}	44,31^{a}	32,31^{cd}	14,07^{b}
Fermented corn cob	85,26^{b}	48,73^{b}	36,54^{b}	32,14^{cd}	12,65^{c}

Note: Different superscripts in the same column show significant difference (P<0.05)

The analysis of variance results showed that different forage had a significant effect ($p < 0.01$) on the content of NDF (Neutral Detergent Fiber), ADF (Acid Detergent Fiber), hemicellulose, cellulose, and lignin. Based on the further DMRT test results, the NDF content of elephant grass, grinting grass, corn straw, and fermented corn straw was not significantly different ($p > 0.05$), but significantly different ($p < 0.05$) with corn cob and fermented corn cob, and the NDF content of corn cob was significantly different ($p < 0.05$) with fermented corn cob. The ADF content of elephant grass, grinting grass, corn cob, and fermented corn cob were not significantly different ($p > 0.05$), but significantly different ($p < 0.05$) with corn straw and fermented corn straw. The ADF content of corn straw was not significantly different ($p > 0.05$) with that of fermented corn straw. The elephant grass and grinting grass hemicellulose content were not significantly different ($p > 0.05$), but significantly different ($p < 0.05$) with corn straw, fermented corn straw, corn cob, and fermented corn cob. The corn straw and fermented corn straw hemicellulose content was not significantly different ($p > 0.05$), but significantly different ($p < 0.05$) with corn cob and fermented corn cob. Corn cob hemicellulose was significantly different ($p < 0.05$) with fermented corn cob. Cellulose content elephant grass; corn cob, and fermented corn cob, as well as grinting grass; corn cob; and fermented corn cob was not significantly different ($p > 0.05$), but significantly different ($p < 0.05$) with fermented corn straw and corn straw. Corn straw cellulose was significantly different ($p < 0.05$) with fermented corn straw. Lignin content of elephant grass; grinding grass; corn straw; and fermented corn cob and grinting grass; corn straw; and corn cob was not significantly different ($p > 0.05$). The fermented corn straw lignin was significantly different ($p < 0.05$) with other forages.

The fermented corn straw NDF and ADF content showed no change or did not differ from that of unfermented corn straw. This is thought to be influenced by microorganisms that had not worked optimally to break down corn straw lignocellulose due to the lack of EM4 dose used. According to Dewi et al (2019), the appropriate inoculum concentration is one of the success factors in the fermentation process. Lack of inoculum causes slow substrate degradation process. Moreover, it can also be affected by the lack of water in the substrate because the water content in this substrate will affect the microorganism growth and the dynamics that occur during the fermentation process. According to Gervais and Molin (2003), water is very important for microorganism metabolism in the solid fermentation process. It was further explained that if the need for water is not fulfilled it will cause the solute and gas diffusion interference and cell metabolism inhibition (Gervais and Molin, 2003), enzyme work disruption (Todd, 1972), plasma cell membrane damage, permeability property and cell membrane transport disruption (De Loecker et al., 1978; Wolfe and Steponkus, 1983).

The fermented corn cob NDF content showed a decrease of 7.26%. This is thought to be caused by microorganisms capable of breaking down lignocellulosic corn cob into simpler components. According to Santoso and Aryani (2007), EM4 contains Lactobacillus and Actinimycetes bacteria that produce cellulase and ligninase enzymes. Furthermore, it can be seen from corn cob hemicellulose and lignin content which decreased after fermentation. Therefore, fermented corn cob NDF content decreased. The unfermented and fermented corn cob NDF content was higher than that of corn straw, fermented corn straw, elephant grass, and grinting grass. This is influenced by the different fiber composition. According to Renge et al. (2012), one of the factors that affect the fermentation is

substrate composition. The fermentation results can vary greatly, depending on the substrate nature and characteristics (Subramaniyam and Vimala, 2012).

Corn straw and fermented corn straw have higher ADF content. This is thought to be influenced by the higher cellulose and lignin content compared to the other forage. Furthermore, fermented corn cob ADF content did not decrease compared to unfermented corn cob. This is thought to be caused by fermented corn cob cellulose content which also did not decrease. According to Amalia et al. (2000) ADF components consist of cellulose and lignin. Therefore, the fiber components have a connection.

Fermented corn straw hemicellulose content did not decrease. This is thought to be influenced by microorganisms that did not work optimally to break down lignocellulosic. The corn straw and fermented corn straw hemicellulose content is lower than other materials because fiber fraction composition of each material is different. This is in accordance with Rhamdani (2014), each feed ingredient contains different fibers. Furthermore, fermented corn cob hemicellulose content decreased. This is caused by microorganisms capable of breaking down hemicellulose into simple sugars.

Corn straw cellulose content decreased compared to that of unfermented. The decrease was 3.78%. Cellulose decrease was influenced by added EM4 inoculum microorganisms. EM4 contains cellulolytic microorganisms that can break down cellulose into simple sugars. This is in accordance with EM Indonesia.com (2022), EM4 contains fermented and synthetic microorganisms consisting of lactic acid bacteria (*Lactobacillus* sp.), photosynthetic bacteria (*Rhodopseudomonas* sp.), *Actinomycetes* sp., *Streptomyces* sp., yeast and cellulose-degrading fungi. Further explained by Santoso and Aryani (2007), EM4 can degrade crude fiber content because of cellulase and ligninase enzymes which are produced by the microbes contained in it, especially Lactobacillus and Actinimycetes bacteria. However, fermented corn cob cellulose content did not change. Although corn straw and corn cob are fermented by the same method, these two materials have different fiber components (cellulose, hemicellulose, and lignin). Therefore, fiber component composition results will differ. This is supported by Subramaniyam and Vimala (2012), the fermentation results can vary greatly, depending on the substrate nature and characteristics.

Fermented corn straw lignin content showed an increase compared to unfermented corn straw. This increase is thought to be influenced by the cellulose breakdown by microorganisms which is not followed by lignin breakdown so that the decrease in cellulose percentage causes an increase in lignin percentage. Unlike corn cob lignin content which decreased after fermentation. This decrease can be influenced by lignocellulolytic microorganisms that degrade corn straw lignin. The different microorganism ability to degrade corn straw and corn cob lignin is thought to be influenced by differences in these two materials' lignin constituent components. According to Rhamdani (2014), each feed ingredient contains different fibers. The fermentation results can vary greatly, depending on substrate nature and characteristics (Subramaniyam and Vimala, 2012).

Based on Table 6, it can be seen that the NDF, ADF, hemicellulose, cellulose, and lignin content of elephant grass and grinting grass are almost the same. Fermented corn straw and corn straw NDF content can match elephant grass and grinting grass. Fermented corn cob ADF content can match the ADF content of elephant grass and grinting grass. However, corn straw and fermented corn cob hemicellulose content could not match the hemicellulose content of elephant grass and grinting grass. The fermented corn cob and corn cob cellulose content in can match elephant grass and grinting grass. Furthermore, fermented and unfermented corn straw and corn cob lignin content can match that of elephant grass and grinting grass.

IV. CONCLUSION

Fermented corn cob was able to reduce lignin content thus corn cob lignin content could match elephant grass but on the contrary fermented corn straw was not able to reduce lignin content.

.

ACKNOWLEDGEMENTS

This research was supported and funded by LPPM (Lembaga Penelitian dan Pengabdian Masyarakat) of Indonesia Defence University funded this study through Research Lecturer Program Number: 57/IV/2022/LPPM Unhan RI. The authors also want to thank the Rector of the Indonesia Defence University, which has provided the opportunity for us in conducting this study.

REFERENCES

[1] Badan Pusat Statistik (2022a). Jumlah Curah Hujan Menurut Kabupaten/Kota dan Bulan (Milimeter), 2021. https://ntt.bps.go.id/indicator/151/64/1/jumlah-curah-hujan-menurut-kabupaten-kota-dan-bulan.html (28 November 2022)

[2] Badan Pusat Statistik (2022b). Produksi Jagung menurut Kabupaten/Kota (Ton), 2019-2021. https://ntt.bps.go.id/indicator/53/1470/1/produksi-jagung-menurut-kabupaten-kota.html (20 November 2022)

[3] Sun, Y. & Cheng, J. (2002). Hydrolysis of lignocellulosic material from ethanol production. A review. *Bioresour. Technol*., 83, 1-11.

[4] Carrillo, F., Colom, X., Suñol, J.J., & Saurina, J. (2004). Structural FTIR analysis and thermal characterisation of lyocell and viscose-type fibres. Eur Polym J 40, 2229–2234. https://doi.org/10.1016/j.eurpolymj.2004.05.003

[5] van Kuijk, S.J.A., Sonnenberg, A.S.M., Baars, J.J.P., Hendriks, W.H., & Cone, J.W. (2015). Fungal treated lignocellulosic biomass as ruminant feed ingredient: a review. *Biotechnol Adv*, 33, 191–202. https://doi.org/10.1016/j.biotechadv.2014.10.014

[6] Villas-Boas, S.G., Esposito, E., & Mitchell, D.A. (2002). Microbial conversion of lignocellulosic residues for production of animal feeds. *Anim Feed Sci Technol.,* 98(1-2),1–12. https://doi.org/10.1016/s0377-8401(02)00017-2

[7] Basu, S., Gaur, R., Gomes, J., Sreekrishnan, T.R., & Bisaria VS. (2002). Effect of seed culture on solid state bioconversion of wheat straw by Phanerochaete chrysosporium for animal feed production. *Biosci Bioeng*, 93(1), 25–30. https://doi.org/10.1016/s1389-1723(02)80049-4

[8] Shrivastava, B., Thakur, S., Khasa, Y.P., Gupte, A., Puniya, A.K., & Kuhad, R.C. (2011). White-rot fungal conversion of wheat straw to energy rich cattle feed. *Biodegradation*, 22(4), 823–831. https://doi.org/10.1007/s10532-010-9408-2

[9] EM Indonesia.com. (2022). Tentang EM4. https://www.emindonesia.com/index.php/menu/91/tentang-em4 (20 November 2022)

[10] Santoso, U & Aryani, I. (2007). Perubahan komposisi kimia daun ubi kayu yang difermentasi oleh EM4. Fakultas Pertanian Universitas Bengkulu, Bengkulu. ISSN 1978-3000.

[11] van Soest, P.J., Robertson, J.B., & Lewis, B.A. (1982). Method for dietary fiber, neutral detergent fiber and non strarch polysaccharides in relation to animal nutrition. *J Dairy Sci*., 74, 3583-3597

[12] Dewi, Y. L., Yuniza, A., Sayuti, K., Nuraini & Mahata, M.E. (2019). Fermentation of Sargassum binderi Seaweed for Lowering Alginate Content of Feed in Laying Hens. *J. World Poult. Res*., 9 (3), 147-153. DOI: https://www.doi.org/10.36380/jwpr.2019.18

[13] Gervais, P., & Molin, P. (2003). The role of water in solid-state fermentation. Biochemical Engineering Journal, 13, 85–101.

[14] Todd, W.G. (1976). *Water defificits and enzymatic activity*, in: T.T. Kozlowski (Ed.), Plant Response and Control of Water Balance, vol. 3, Water Defificits and Plant Growth, Academic Press, New York, pp. 117–216.

[15] De Loecker, R., Penninck, F., & Keremans, R. (1978). Osmotic effects of rapid dilution of cryoprotectants. I. Effect of human erythrocyte swelling. *Cryo-Lett*., 8, 131–136.

[16] Wolfe, J., P.L. (1983). Steponkus, Tension in the plasma membrane during osmotic contraction. Cryo-Lett., 4, 315–322.

[17] Renge, V.C., Khedkar, S.V., & Nandurkar, N.R. (2012). Enzyme synthesis by fermentation method: a review. Sci Rev Chem Comm., 2, 585–590.

[18] Subramaniyam, R. & Vimala, R. (2012). Solid state and submerged fermentation for the production of bioactive substances: a comparative study. *Int. J. Sci. Nat*., 3, 480–486.

[19] Subramaniyam, R. & Vimala, R. (2012). Solid state and submerged fermentation for the production of bioactive substances: a comparative study. *Int. J. Sci. Nat*., 3, 480–486.

[20] Amalia, L., Aboenawan, L., Budiarti, L.E., Ramli, N., Ridla, M., & Darobin, A.L. (2000). Diktat Pengetahuan Bahan Makanan Ternak. Laboratorium Ilmu dan Teknologi Pakan Fakultas Peternakan Institut Pertanian Bogor. Bogor.

[21] Rhamdani, Z. (2014). Kualitas silase daun dan pelepah sawit yang ditambah daun singkong dan Indigofera. Skripsi. Fakultas Peternakan Institut Pertanian Bogor. Bogor.