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Fermentation by Eco Enzyme on Nutritional Content of Rice Straw, Corn Straw, and Oil Palm Fronds

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Novelty statement: This study reveals that fermented agricultural and plantation waste by using different doses of eco enzyme turned out to have a good effect on the quality of the waste. The procedures and parameters standardised in this research can be used for production of ruminant feed.

Abstract: The low nutrient content of agricultural waste is an obstacle to use as feed. The addition of eco enzyme as biological activators can help the fermentation process. The aim of this research was to determine the effect of three doses of eco enzyme as a starter fermentation of rice straw, corn straw, and palm fronds on changes in the nutritional content of 21 days fermentation. This study used a completely randomized design method with two factorial (three treatments and three replications). Factor D: Doses (D_1 = 1%; D_2 = 3%; D_3 = 5%) and factor L: Forage (L_1 = rice straw; L_2 = corn straw; L_3 = oil palm fronds). The parameters studied were moisture content (MC), dry matter (DM), crude protein (CP), crude fiber (CF). The results of this research showed that addition of eco enzyme dose of 5% on L_1, 3% on L_2 and 3% L_3 can increased water content and crude protein, and reduce levels of dry matter and crude fiber of forage compared without fermentation.

Keywords: agricultural waste, eco enzyme, fermentation, nutritional content, plantation waste.

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1. Introduction

Agricultural and plantation sectors have residues that are no longer used and become waste. Agricultural waste is a waste product from the processing process to obtain the main product and by product. According to [1] waste can be used as an alternative to ruminant feed because the amount is abundant but the lack it has low nutrient content so needs futher processing to increased its nutritional content.

The agricultural sector in North Sumatera is dominated by rice commodity with a land area 412.141,24 ha with 12-15 ton/ha production of rice straw which contains 3,9% crude protein and 28,28% crude fiber [2]. Next is corn crop commodities with a land area 5,139 ha with 4-5 ton/ha production of corn straw [3] and containing 5.56% crude protein [4]. The plantation sector on North Sumatera is dominated by oil palm frons with a land area of 1,601,901 ha [5]. According to [6] each palm tree has 22 stems/ tree/ year production, while each stems has 2.2 kg weight and 6.06% crude protein. To increased the nutritional content of agricultural and plantation waste is by fermentation. Fermentation is the process of breaking down organic compound to produce energy and conversion the substrate becomes a new product by microbes. Fermented products are simpler and easier to digest from their original ingredients and more last longer [7]. Starter are microorganisms that were grown in substrate for a specific purpose [8]. The requirements for the fermentation starter are that can inhibit pathogenic bacteria and safe to use [9]. Organic waste can be used as a starter for feed fermentation because it contains beneficial microbes and acid product during fermentation and also easier to find thus lower price.

Eco enzyme or known as garbage enzyme is used organic waste into products with higher use value found by Dr. Rosukan Poompangvong from Thailand in 2006. According to [10] eco enzyme is the result of organis waste fermentation like fruit dan vegetables pulp, sugar, and water using certain microorganisms such as yeast and bacteria can be used to [11] accelerate biochemical reactions. According to [12] composition of organic matter in eco enzyme as organic acids, enzymes, and mineral salts can be used to compile, decompose, convert and calcify. In livestock sector, eco enzyme used as natural disinfectants to inhibit the growth of harmful microoganisms, eliminate bad odors, and according to feed additives to increased livestock immunity and improve carcass quality. Based on the background above, this research try to find out the effect of three levels of doses of eco enzyme as a starter on fermentation of rice straw, corn straw and palm fronds on changes in moisture content, dry matter, crude protein, and crude fiber.

2. Materials and Methods

Materials

Jerry cans 5 liters, polyethylene plastic, measuring cup, beaker glass, sprayer, porcelain cup, 105ºC oven, desicator, analytical balance, papaya waste, pineapple waste, banana waste, aquadest, rice straw, corn straw, oil palm folds, molasses, eco enzyme, rice bran, H_2O.

Methods

The research method used a completely randomized design method with two-factorial three replications .

Factor D : Doses of eco enzyme (D)

D_1 = 1%

D_2 = 3%

D_3 = 5%

Factor L : Various of forage (L)

L_1 = rice straw

L_2 = corn straw

L_3 = oil palm fronds

Reseacrh Parameters

1. *Water and Dry Matter analysis*

Note :

w = sample weight before drying (g)

w1 = sample weight loss after drying (g)

Dry Matter Analysis

2. *Crude Protein analysis*

Note :

W = sample weight (g)

V_1 = Volume of HCL 0,01 N used to sampel titration

V_2 = Volume of HCL used to blanco titration

N = normality of HCL

fk = conversion factor for food protein in general (6,25)

fp = dilution factor

3. *Crude Fiber analysis*

Note :

W = sample weight (g)

W1 = ash weight (g)

W2 = weight of precipitate on filter paper (g)

3. Results and Discussion

Water and Dry Matter Content

Water Content of rice straw, corn straw, dan oil palm fronds using various doses of eco enzyme (1%, 3%, dan 5%) with 21 days fermentation can be seen in "Tabel 1" below :

Table 1. Water content of rice straw, corn straw and oil palm fronds fermentation by eco enzyme in percentage (%)

Factor D	Factor L			Average
	L_1 (rice straw)	L_2 (corn straw)	L_3 (oil palm fronds)	
D_1 (1%)	9.77	12.45	11.28	11.17^{A}
D_2 (3%)	11.69	12.66	12.57	12.31^{A}
D_3 (5%)	14.33	15.92	14.92	15.04^{B}
Average	11.93^{a}	13.66^{b}	12.92^{ab}	

Note : Different superscripts in the same column show very significant differences ($P<0.05$)
The results of the analysis of variance showed that use various doses of eco enzyme has a very significant effect ($P<0.05$) on different doses treatments.

Different doses of eco enzyme has different average water content. The increased in water content occurs with the increased in the doses given. The highest average water content of the forage treatment was in the D_3 (3%), which was 15.04%, the lowest average water content was in D_1 (1%) which was 11.17%, this was due to the activity of microorganisms doing break down carbohydrates as an energy source so as to increased the water content in the treatment. The results of fermentation showed water levels were increased compared to forage without fermentation (rice straw without fermentation = 9.77%, corn straw without fermentation = 11.78%, oil palm fronds without fermentation = 10.46%). According to [13] the breakdown of carbohydrates by microorganisms will be loss of energy in the form of heat, CO_2, water so that water content can increased. The higher the dose given, the greater the provision of microbes starter during fermentation so that microbial development will increased. Higher number of lactic acid bacteria can produce more water because lactic acid bacteria can change glucose [14].

The forage treatments was signigficantly different ($P<0.05$) on the water content. Based on "Table 1", it is known that the initial moisture of corn straw is higher than that of rice straw and

corn straw. The content of lignin in L_2 lower (10.72%) [15] compared with the L_1 and L_3 may lead to the ability of microorganisms utilize the existing substrate to be blocked. According to [16] the content of lactic acid bacteria in the complete silage ration based on corn by products was higher than sweet potatoes and palm oil because the content of soluble carbohydrates in corn was quite optimal and there was no antinutrient in complete corn silage so that lactic acid bacteria were easier utilize existing substrates for further regeneration.

Based on the analysis of variance, it was known that there was no interaction between the dose treatment and the forage type ($P > 0.05$) on the water content. Each forage treatment that was given a different dose experienced an increased in water content, which indicates that the microorganisms work to remodel glucose. Based on the percentage change in water content shows the lowest percentage increased in water content in D_1L_2 (5.38%) and the highest in D_3L_1 (29.89%).

Table 2. Dry matter content of rice straw, corn straw and oil palm fronds fermentation by eco enzyme in percentage (%)

Factor D	Factor L			Rataan
	H_1 (rice straw)	H_2 (corn straw)	H_3 (oil palm fronds)	
D_1 (1%)	90.23	83.93	88.72	88.83^{B}
D_2 (3%)	88.31	87.34	87.43	87.69^{B}
D_3 (5%)	85.67	88.12	85.08	84.96^{A}
Rataan	88.07^{a}	86.34^{b}	87.08	

Note : Different superscripts in the same column show very significant differences ($P<0.05$)
The results of the analysis of variance showed that use various doses of eco enzyme has a very significant effect ($P<0.05$) on different doses treatments.

The level of dry matter decreased due to the utilization of carbohydrates by lactic acid bacteria so that a lot of water content was released, this is in accordance with the statement of [17] which stated that the greater the carbohydrate content, the dry matter content decreased due to the ability of lactic acid bacteria to utilize dissolved carbohydrates so that the water content released was higher and causes the dry matter content to decreased. From the research, it was found dry matter were decreased compared to forage without fermentation (rice straw without fermentation = 90.79%, corn straw without fermentation = 88.22%, oil palm fronds without fermentation = 89.54%). According to [18] that the decreased in dry matter levels was caused by the utilization of a number of nutrients by lactic acid bacteria in silage to produce acid. Forage treatment with additional doses was significantly different ($P < 0.05$) on dry matter content. Water content in treatment L_1 (88.07%) was not significantly different from L_3 (87.08%) but significantly different

from L_2 (86.34%). Dry matter is inversely proportional to water content, the lower the water content, the higher the dry matter content, and vice versa. This is in line with the statements of [16] which state that the higher the water content can reduce the dry matter content in a material. Based on the results of further testing, it was found that there was no interaction between dose and forage ($P > 0.05$) on dry matter. Changes in dry matter content at various doses of various forage treatments did not differ much.

Crude Protein

The result of the analysis of the crude protein content of fermented rice straw, corn straw, and oil palm fronds using various doses of eco enzyme (1%, 3%, and 5%) can be seen in "Tabel 3" below :

Table 3. Crude protein content of rice straw, corn straw and oil palm fronds fermentation by eco enzyme in percentage (%)

Factor D	Factor L			Average
	L_1 (rice straw)	L_2 (corn straw)	L_3 (oil palm fronds)	
D_1 (1%)	6.71	7.64	7.66	7.34^{A}
D_2 (3%)	7.41	7.91	9.32	8.21^{B}
D_3 (5%)	9.48	10.12	9.67	9.76^{C}
Average	7.86^{a}	8.56^{b}	8.88^{b}	

Note : Different superscripts in the same column show very significant differences ($P<0.01$)

The results of the analysis of variance showed that use various doses of eco enzyme has a very significant effect ($P<0.01$) on different doses treatments.

The increased of protein levels in each treatment was caused by the formation of single protein cells and amino acids from the substrate into N microbes attached to the substrate [19] which states that the high protein increased in the substrate is due to the high microbial population and has an impact on crude protein content high because microbes are mostly made up of protein. The result of research showed crude protein were increased compared to forage without fermentation (rice straw without fermentation = 4.59%, corn straw without fermentation = 5.32%, oil palm fronds without fermentation = 5.59%). Research by [20] showed an increased in crude protein occurs from R_0 (12.36%) to R_1 (12.73%), this showed that the nutrient content in silage can increased by the addition of a starter in silage making because it affects protein content and improves quality rations especially crude protein.

The difference in the increased in crude protein content affects the type of substrate and the size of the substrate. The smaller substrate size is easier to decompose by microorganisms, it is shown from the "Table 3" that rice straw (L_1) which had a smaller substrate size had increased protein content and was significantly different from corn straw (L_2) and palm fronds (L_3) which

were bigger. According to [21] size reduction affects the dissolved protein content, the smaller the substrate size the higher the dissolved protein. Based on the results of the analysis of variance, it was found that there was no significant interaction between the doses of eco enzyme treatments with forage species (P > 0.05). This was presumably because the ability of bacteria to degrade protein was the same in each type of forage.

Crude fiber

The result of the analysis of the crude fiber content of fermented rice straw, corn straw, and oil palm fronds using various doses of eco enzyme (1%, 3%, and 5%) can be seen in "Tabel 4" below :

Table 4. Crude fiber content of rice straw, corn straw and oil palm fronds fermentation by eco enzyme in percentage (%)

Factor D	Factor L			Average
	L_1 (rice straw)	L_2 (corn straw)	L_3 (oil palm fronds)	
D_1 (1%)	30.49^{Ba}	31.08^{Ba}	30.50^{Ba}	30.69
D_2 (3%)	29.67^{Bc}	28.20^{Aa}	28.48^{Aab}	28.78
D_3 (5%)	28.58^{Aa}	32.83^{Cb}	29.86^{Bc}	30.42
Average	29.58	30.70	29.61	

Note : Different superscripts in the same column show very significant differences (P<0.01)
The results of the analysis of variance showed that use various doses of eco enzyme has a very significant effect (P<0.01) on different doses treatments.

The crude fiber content in D_1 treatment (1%) was higher than that of D_2 treatment due to the ability of microbes and cellulase enzymes from eco enzyme to work at the time of fermentation not being able to integrate crude fiber when compared to forages treated with D_2 (3%). The result showed crude fiber were decreased compared to forage without fermentation (rice straw without fermentation = 33.75%, corn straw without fermentation = 33.46%, oil palm fronds without fermentation = 34.48%). This was accordance with [22] research which stated that crude fiber content had no significant effect on the addition of various doses because the number of bacteria contained was still insufficient so that less simple sugars were converted to organic acids, and the degradation of crude fiber occured smaller. Whereas in the D_3 treatment (5%) the crude fiber content was higher than the D_3 treatment (2%) this could be due to the 5% eco enzyme dosing which caused a more acidic pH and slower degradation than D_1 (1%). This is in line with the statement of [23] which states that the remodeling process can be stable (no remodeling occurs again) because the pH has decreased and became acidic by the presence of lactic acid produced by lactic acid bacteria. The increased in crude fiber content in D_3 can be caused by mold growth during fermentation, this is supported by [24] statement which stated that high acid levels can inhibit the

growth of lactic acid bacteria themselves, so that they will die and grow yeast and more molds tolerant to acids.

Based on "Table 4", it can be seen that there is no effect on the type of forage given different doses ($P > 0.05$). This was because the content of crude fiber forage without fermentation shows that the crude fiber content was not much different. The ability of microorganisms to degrade crude fiber in each forage treatment was the same so that there was no change in different crude fiber. In addition, the water content in forages was low so that the overhaul of crude fiber did not run optimally. In the L_1 treatment there was a decreased in crude fiber along with the increasing dose of eco enzyme, this proved that the microbes in fermentation can degrade the fiber content in rice straw, although not significantly. In the L_2 and L_3 treatments, the largest decreased in crude fiber was seen at the dose of 3% (D_2), but the crude fiber content increased at the addition of the 5% dose (D_3) which could be due to increased mold growth during the fermentation process. This was in line with the research of [25] which stated that the development of mold along with the length of fermentation increased so that it contributes to the crude fiber content in the cell walls.

Based on the analysis of variance, it can be seen that there was a very significant interaction ($P < 0.01$) between the doses and forage treatments on crude fiber content. Changed in crude fiber content in each forage with different doses of eco enzyme resulted in different changes. Crude fiber degradation in forages can be inhibited by several factors, namely the content of cellulose, hemicellulose and lignin contained in the substrate of each forage. This is in accordance with [26] which stated that the cellulase content in the substrate had an impact on increasing crude protein because it acts as a barrier to the work of enzymes released by microbes.

4. Conclusion

Based on the results of the study, it was known that the administration of various doses of eco enzyme can increased the content of water content, crude protein, and decreased crude fiber and dry matter on fermentation of agricultural waste (rice straw, corn straw, and palm frond). Protein was increased with addition 5% doses of eco enzyme on rice straw (WC 14.33%, DM 85.67%, CP 9.48%, CF 28.58%), 3% doses of eco enzyme on corn straw (WC 12,66%, DM 87.34%, CP 7,91%, CF 28.20%), and 3% doses of eco enzyme on oil palm fronds (WC 14.92%, DM 87.43%, CP 9.67 %, CF 28.48%).

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